2004 SUMMARY REPORT
of
GRAND AVENUE MARSH

Lake County, Illinois

Prepared by the

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LAKE IDENTIFICATION AND LOCATION

Lake Name: Grand Avenue Marsh

County: Lake

Nearest Municipality: Gurnee

Location: T45N, R11E, Section 23

Watershed: Des Plaines River

Sub-Basin: Upper Des Plaines River

Major Tributaries: Des Plaines River

Receiving Water Body: Des Plaines River

Surface Area: 14.26 acres

Shoreline Length: 1.71 miles

Maximum Depth: 8.0 feet (estimated)

Mean Depth: 4.0 feet (estimated)

Volume: 57.0 acre-feet (estimated)

Lake Type: Marsh

Elevation: Approximately 656 feet above mean sea level

EXECUTIVE SUMMARY

Grand Avenue Marsh's water quality is poorer than many lakes in Lake County. Most of the water quality parameters measured were at or above the averages or medians of other lakes that we have monitored.

Water clarity, as measured by Secchi disk transparency readings, averaged 2.39 feet for the season, which is 22% times below the county median of 3.08 feet. Grand Avenue Marsh does not receive large amounts of stormwater runoff, but is influenced by the Des Plaines River which periodically floods the marsh. Significant flooding occurred along the river and marsh in late-May and early-June 2004.

Flooding was also partially responsible for the high concentrations of total suspended solids (TSS) in the marsh. The 2004 average for TSS was 13.2 mg/L, which was 40% higher than the county median for near surface samples of 7.9 mg/L. Silt-laden water from the Des Plaines River also increased the water volume in the marsh. Another contributing factor to the high TSS concentrations is the extensive carp population observed in the lake.

The total phosphorus (TP) concentration in the marsh (0.119 mg/L) was 89% higher than the county median for near surface samples (0.063 mg/L). Values above 0.03 mg/L are considered sufficient enough to cause algae blooms. Some planktonic and filamentous algae were seen during the season, with dense algae mats observed in the south bay of the marsh from July through September. The phosphorus concentrations in the marsh were highest in May (0.147 mg/L) and June (0.199 mg/L), when water levels were the highest and when the marsh was hydrologically connected to the river.

Eleven aquatic floating and submersed plant species and several emergent shoreline plants were found. The dominant aquatic plant in Grand Avenue Marsh was white water lily which was found in 76% of all sites. Coontail (found at 62% of all sites) was the next most common, being particularly dominant from July-September. Two species of duckweed were found in the lake, with small duckweed being the most common. Two invasive exotic species, Eurasian water milfoil (EWM) and curlyleaf pondweed were found in 51% and 14% of all samples, respectively.

The entire shoreline of Grand Avenue Marsh was classified as undeveloped. The most common shoreline type was shrub (81.6%), with the remaining 18.4% classified as wetland. The shoreline was assessed for the degrees and types of shoreline erosion. Approximately 54.5% (4971 feet) of the shoreline was classified as slightly eroding, 3.1% (280 feet) as moderately eroding, and 0.3% (23 feet) as severely eroding.

Several exotics were found growing along the shoreline, including common buckthorn, purple loosestrife, and common reed. Removal or control of exotic species is recommended.

LIMNOLOGICAL DATA – WATER QUALITY

Grand Avenue Marsh had experienced many historical changes. The earliest aerial photograph (1939; Figure 1) shows that part of the current marsh was a wetland area, probably colonized by wetland vegetation, and part of it under cultivation (presumably after field tiles were installed). A 1974 photograph indicates a similar situation, while a 1993 aerial photograph shows the marsh in its current state.

Water samples were taken monthly from May - September at the deep-hole location (Figure 2). See Appendix B for water sampling methods. Grand Avenue Marsh's water quality is poorer than many lakes in Lake County (Table 1 in Appendix A). Most of the water quality parameters measured were at or above the county medians (where 50% of the lakes are above and below this value) of other lakes that we have monitored. Several important findings were noted.

Water clarity, as measured by Secchi disk transparency readings, averaged 2.39 feet for the season, which is 22% times below the county median of 3.08 feet. Secchi disk readings were deepest in June (3.35 feet) and shallowest in September (1.38). Grand Avenue Marsh does not receive the large amount of stormwater runoff, but is influenced by the Des Plaines River which periodically floods the marsh. Significant flooding occurred along the river and marsh in late-May and early-June 2004.
Flooding was also partially responsible for the high concentrations of total suspended solids (TSS) in the marsh. The 2004 average for TSS was 13.2 mg/L which was 40% higher than the county median for near surface samples of 7.9 mg/L. Silt-laden water from the Des Plaines River also increased the water volume in the marsh. Another contributing factor to the high TSS concentrations is the extensive carp population observed in the lake. The carp activity resuspends bottom sediments, causing poor clarity and high TSS concentrations. The problem is exacerbated when the water level drops as it did in September, when the water was at the lowest level of the season. The TSS concentration in September was 22.0 mg/L, the highest concentration of the season. Interestingly, the deepest Secchi reading and the lowest TSS concentration occurred in June when water levels were the highest of the season (Figure 3). The increase in water volume during the flooding probably reduced or diluted the impact of carp activity. As water levels dropped, carp-induced suspended sediment became more concentrated in the water column.

The 2004 average concentration of total dissolved solids (TDS) and the average conductivity reading in Grand Avenue Marsh were below the county medians. These two parameters are correlated since the higher the concentrations of TDS in the water the higher the conductivity readings. The 2004 average TDS concentration (351 mg/L) and conductivity reading (0.6318 milliSiemens/cm) were 23% and 17% lower than the county medians for near surface samples (454 mg/L and 0.7652 milliSiemens/cm, respectively). One of the most common dissolved solids is road salt used in winter road deicing. Because of the lake's proximity to Grand Avenue and State Highway 21, one additional parameter, chloride was collected (in July only) since road salt is usually sodium

Figure 1. 1939 photo

Figure 2. Sample site.

Figure 3.

chloride, calcium chloride, potassium chloride, magnesium chloride or ferrocyanide salts. The July concentration for chloride in Grand Avenue Marsh in 2004 was 66.4 mg/L. In a study by Environment Canada (equivalent to our USEPA), it was estimated that 5% of aquatic species such as fish, zooplankton and benthic invertebrates would be affected at chloride concentrations of about 210 mg/l. Additionally, shifts in algae populations in lakes were associated with chloride concentrations as low as 12 mg/l. At the present time, Grand Avenue Marsh does not appear to be adversely impacted by chloride concentrations. It appears that the marsh may receive some stormwater from the west, but currently there are no major stormwater inlets entering the marsh.

The average total phosphorus (TP) concentration in the marsh (0.119 mg/L) was 89% higher than the county median for near surface samples (0.063 mg/L). Values above 0.03 mg/L are considered sufficient enough to cause algae blooms. Some planktonic and filamentous algae were seen during the season, with dense algae mats observed in the marsh's south bay from July through September. The phosphorus concentrations in the marsh were highest in May (0.147 mg/L) and June (0.199 mg/L), when water levels were the highest and when the marsh was hydrologically connected to the river. May and June were also the only months sampled that had detectable levels of soluble reactive phosphorus (SRP), which is the form of phosphorus that is readily available to aquatic organisms. Because of the high concentrations of TP, and subsequently SRP, in the marsh during flooding, aquatic organisms could not readily use all available phosphorus.

The flooding in May and June also likely caused the high concentrations of nitrate nitrogen (NO_3-N) in the marsh of 3.450 mg/L and 1.990 mg/L, respectively. This nutrient was found to be below detection limits in the remaining months sampled. Similar to the high TP concentrations found in May and June, the nitrate nitrogen concentrations likely came from the flood waters from upstream of the Des Plaines River. The sources of nitrate nitrogen are numerous, but often result from fertilizer applications, particularly in agricultural and lawn care industries, which frequently fertilize in late spring.

Total elimination of carp is often a recommended management strategy in shallow systems like Grand Avenue Marsh. The eradication of carp would aid in the improvement of the water quality of the marsh. Water clarity would likely improve and concentrations of parameters such as TP and TSS may decline. Aquatic plant coverage would also increase. However, given the occasional overflow of the Des Plaines River into the marsh, the elimination of this rough fish would be short-lived as carp from the river would quickly recolonize the marsh.

High nutrient concentrations are usually indicative of water quality problems. Algae need light and nutrients, most importantly carbon, nitrogen (N) and phosphorus (P), to grow. Light and carbon are not normally in short supply (limiting). This means that nutrients (N&P) are usually the limiting factors in algal growth. Nitrogen, as well as carbon, naturally occur in high concentrations and come from a variety of sources (soil, air, etc.) that are more difficult to control than sources of phosphorus. To compare the availability of these nutrients, a ratio of total nitrogen to total phosphorus is used (TN: TP). Ratios < 10:1 indicate nitrogen is limiting. Ratios of >15:1 indicate phosphorus is

limiting. Ratios >10:1, <15:1 indicate that there is enough of both nutrients for excessive algal growth. The average ratio between total nitrogen and total phosphorus for Grand Avenue Marsh in 2004 was 21:1, indicating a phosphorus-limited system. Most lakes in Lake County are phosphorus-limited. Lakes that are phosphorus-limited may be easier to manage, since controlling phosphorus is more feasible than controlling nitrogen or carbon.

Despite being a shallow marsh, stratification did occur from May through July when water levels were higher. A thermocline was already established at two feet in May. By June the thermocline had weakened (due to increased water flow from flooding) and was found at four feet. A slightly stronger thermocline was at four feet in July. However, in August and September the water levels had dropped and the stratification that had occurred dissipated. There appears to have been minimal impacts on the water quality in the marsh due to the destratification, as the parameters measure did not indicate any signs of a nutrient "pulse" in to the water column that may occur when a lake destratifies and the nutrients that had been trapped under the thermocline are released into the upper waters.

The dissolved oxygen (DO) concentrations in the marsh were relatively consistent throughout the season. DO concentrations at the surface were above 5 mg/L (below which some fish species become stressed), with the exception of September when the surface reading was 4.80 mg/L. However in September, the entire water column was oxic (i.e., above 1.0 mg/L), which may be less stressful than if DO concentrations in the deeper waters were anoxic (i.e., below 1.0 mg/L). Anoxic conditions did exist in June (below six feet) and July (below five feet). Since no bathymetric map of Grand Avenue Marsh exists, an accurate assessment of the DO conditions cannot be made.

The flooding of the Des Plaines River significantly impacted the water levels on Grand Avenue Marsh. We installed a 60-inch fence post stake in the water near the shoreline in May to a depth of approximately 10 inches. In late-May, due to flooding, the water levels over-topped the stake, but by September the water levels had dropped below the level of where the stake was installed. Thus, a seasonal drop of over 50 inches occurred in the marsh. The maximum one-month change in water level occurred from June to July (26.09 inch decrease). Water levels in the marsh are also impacted by beaver (*Castor canadensis*) activity in the marsh and adjacent river. A beaver dam located at the southeastern corner of the marsh has resulted in a 4-5 foot difference between water levels in the marsh and in the river. Damage or removal of this dam may result in significant water level changes in the marsh. As discussed previously, the water level changes and related flooding had negative impacts on water quality in the marsh. In addition, fluctuating water levels potentially cause more shoreline erosion problems (see **Shoreline Assessment Section**).

Rain events and the subsequent flooding that occurred in May and June 2004 likely contribute additional sediment or nutrients (like phosphorus) to the marsh, which influenced water sample results. Rain occurred within 48 hours prior to water sampling in May (1.27 inches), June (0.01 inches), and August (0.21 inches) as recorded at the Lake

County Stormwater Management Commission rain gage in Old Mill Creek. Monthly totals at this rain gage were 7.02 inches in May and 4.65 inches in June. These values are well above the averages for precipitation in the Chicago region (May=3.38 inches, June=3.63 inches; National Weather Service).

Based on data collected in 2004, standard classification indices compiled by the Illinois Environmental Protection Agency (IEPA) were used to determine the current condition of Grand Avenue Marsh. A general overall index that is commonly used is called a trophic state index or TSI. The TSI index classifies the lake into one of four categories: oligotrophic (nutrient-poor, biologically unproductive), mesotrophic (intermediate nutrient availability and biological productivity), eutrophic (nutrient-rich, highly productive), or hypereutrophic (extremely nutrient-rich productive). This index can be calculated using total phosphorus values obtained at or near the surface. The TSIp for Grand Avenue Marsh in 2004 classified it as a hypereutrophic lake (TSIp = 73.1). Eutrophic lakes are the most common type of lake throughout the lower Midwest, and they are particularly common among manmade lakes. See Table 2 in Appendix A for a ranking of average TSIp values for Lake County lakes (Grand Avenue Marsh is #121 of 161). This ranking is only a relative assessment of the lakes in the county. The current rank of a lake is dependent upon many factors including lake origin, water source, nutrient loads, and morphometric features (volume, depth, substrate, etc.). Thus, a small, shallow, manmade lake with high nutrient loads may not expect to achieve a high ranking even with intensive management.

In Grand Avenue Marsh, the IEPA aquatic life impairment index was low, indicating a full degree of support for all aquatic organisms in the marsh. However, due to the poor clarity in the marsh the swimming index indicated only a partial degree of support. The high trophic state of the marsh, high concentrations of sediment and large amount of aquatic plants in the marsh, the recreation index indicated a degree of non-support. The degree of overall use of the marsh was classified as partial support. We did not test for bacteria or other harmful pathogens in Grand Avenue Marsh in 2004.

LIMNOLOGICAL DATA – AQUATIC PLANT ASSESSMENT

Aquatic plant species presence and distribution in Grand Avenue Marsh were assessed monthly from May through September 2004 (see Appendix B for methods). Eleven aquatic floating and submersed plant species and several emergent shoreline plants were found (see Table 3, below). Terrestrial shoreline plants were also noted, but not quantified.

The dominant aquatic plant in Grand Avenue Marsh was white water lily which was found in 76% of all sites. Coontail (found at 62% of all sites) was the next most common, being particularly dominant from July-September. Two species of duckweed were found in the lake, with small duckweed being the most common. Two invasive exotic species, Eurasian water milfoil (EWM) and curlyleaf pondweed were found in 51% and 14% of all samples, respectively (Table 4, Appendix A). The presence of EWM and curlyleaf

pondweed is a concern, since these two species can quickly outcompete native aquatic plants.

During the plant sampling we searched for the milfoil weevil (*Euhrychiopsis lecontei*) on EWM plants. This weevil attacks the tip and stem of the plant and is currently being used as a biological control for EWM in many lakes in the Midwest. The weevils are found naturally in many lakes. We did find not weevils or evidence of damaged caused by them in Grand Avenue Marsh in 2004. It is recommended that the aquatic plant populations, with particular attention given to EWM, in the lake be closely monitored.

The 1% light levels (the point where plant photosynthesis ceases) during the season were found at or near the bottom. In May and June the 1% light level was found at approximately five feet. After the June flooding subsided, the lake water level continued to drop and the light levels reaching the lake bottom were greater than 1% during the remainder of the season. Similarly, the maximum depth where we found plants growing was 9.5 feet, which was the lake's maximum depth. Since we found plants at the deepest part of the lake, and because the 1% light levels were at or near the bottom all season, it was estimated that 100% of the lake bottom was covered with aquatic plants (note: this is plant coverage on the lake bottom and not an estimate of plants at the water's surface). Although the lake bottom coverage is 100%, most of the aquatic plants did not reach the surface. Since there are no boats allowed on Grand Avenue Marsh, the main recreational use that may be impeded by the aquatic plant growth would be fishing. The aquatic plant surface coverage at the north end of the lake, where the fishing takes place was minimal and not significantly impeded fishing recreation. If aquatic plant growth becomes excessive and requires active management, care should be taken to specifically control the invasive species (EWM, curlyleaf, and the native coontail) while having minimal impact on the other beneficial native species (i.e., sago pondweed and white water lily). The selective control of the invasive species (specifically curlyleaf and coontail) with certain herbicides (i.e., 2,4-D and fluridone) may be difficult. 2,4-D does not affect curlyleaf and needs to be in higher concentrations to impact coontail. Similarly with fluridone, higher concentrations may be needed to control coontail, which would also negatively impact the native species (particularly the pondweeds and water lilies). Additional monitoring of these aquatic plant communities should be included in the lake's overall management plan.

Since the Des Plaines River periodically floods the lake impacting water levels and water quality, the aquatic plant populations are expected to be impacted as well. Generally, these conditions will favor plant species that are tolerant to disturbances. Both EWM and curlyleaf pondweed can benefit from these conditions. In addition to the floodwaters, the large carp population in the lake also likely has a negative impact on water clarity, which reduces light penetration.

Floristic quality index (FQI; Swink and Wilhelm 1994) is an assessment tool designed to evaluate the closeness that the flora of an area is 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. Each aquatic plant in a lake is assigned a number between 1 and 10 (10 indicating the plant species most sensitive to disturbance). This is done for every floating and submersed plant species found in the lake. These numbers are averaged and multiplied by the square root of the number of species present to calculate an FQI. 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 counted in the FQI calculations for Lake County lakes. In 2004, Grand Avenue Marsh had a FQI of 16.9 (#49 of 150). The median FQI of lakes that we have studied from 2000-2004 is 12.1.

Table 3. Aquatic and shoreline plants on Grand Avenue Marsh, May - September 2004.

Aquatic Plants	
Coontail	*Ceratophyllum demersum*
Water Stargrass	*Heteranthera dubia*
Small Duckweed	*Lemna minor*
Eurasian Water Milfoil[#]	*Myriophyllum spicatum*
White Water Lily	*Nymphaea tuberosa*
Water Smartweed	*Polygonum amphibium*
Curlyleaf Pondweed[#]	*Potamogeton crispus*
Small Pondweed	*Potamogeton pusillus*
Flatstem Pondweed	*Potamogeton zosteriformis*
Giant Duckweed	*Spirodella polyrhiza*
Sago Pondweed	*Stuckenia pectinatus*
Shoreline Plants	
Spikerush	*Eleocharis* sp.
Ash	*Fraxinus* sp.
Purple Loosestrife[#]	*Lythrum salicaria*
Common Reed[#]	*Phragmites australis*
Pickerelweed	*Pontederia cordata*
Cottonwood	*Populus deltoides*
Buckthorn[#]	*Rhamnus cathartica*
Willow	*Salix sp.*
Cattail	*Typha* sp.
Ironweed	*Vernonia fasciculata*
Wild Grape	*Vitis* sp.

[#] **Exotic species**

LIMNOLOGICAL DATA – SHORELINE ASSESSMENT

A shoreline assessment was conducted in August 2004 to determine the condition of the lake shoreline (see Appendix B for methods). Of particular interest was the condition of the shoreline at the water/land interface.

The entire shoreline of Grand Avenue Marsh was classified as undeveloped. The most common shoreline type was shrub (81.6%), with the remaining 18.4% classified as wetland (Figure 3). Grand Avenue Marsh is used by the public primarily for fishing, particularly at the north end by the American Legion baseball fields.

The shoreline was assessed for the degrees and types of shoreline erosion. Approximately 54.5% (4971 feet) of the shoreline was classified as slightly eroding, 3.1% (280 feet) as moderately eroding, and 0.3% (23 feet) as severely eroding (Figure 4). The moderate erosion is located along a small peninsula of land along the northwestern section of the lake. This area has likely eroded due to fluctuating water levels since it is in an isolated location, inaccessible to fishermen. However, the severe erosion is located along the northern shoreline where fishing activities occur. The slightly eroded areas should be monitored for future degradation. The moderately and severely eroded areas should be remediated immediately to prevent additional loss of shoreline and prevent continued degradation of the water quality through sediment inputs. When possible, the shorelines should be repaired using natural vegetation and not riprap or seawalls. In addition to the severe erosion, the fishing area was littered with large amounts of trash, mostly likely from the fishing activities. The installation of signage and a trash can during the summer months may help alleviate this problem.

Several exotics were found growing along the shoreline, including common buckthorn, purple loosestrife, and common reed. Similar to aquatic exotics, these terrestrial exotics are detrimental to the native plant ecosystems around the lake. Removal or control of exotic species is recommended.

LIMNOLOGICAL DATA – WILDLIFE ASSESSMENT

Good numbers of wildlife, particularly birds, were noted on and around Grand Avenue Marsh. See Appendix B for methods. Several of the species listed in Table 6 (below) were seen during spring or fall migration and were assumed not to be nesting around the lake.

Habitat around Grand Avenue Marsh was good due to the undeveloped shoreline around the lake. The habitat mix of riparian woods and wetland areas provides habitat for many wildlife species, however the presence of invasive exotic species degrades the quality of some habitat areas around the lake.

Figure 4

Figure 5.

One bird species, the least bittern, listed as threatened by the state of Illinois was seen on Grand Avenue Marsh in May. However, since the bittern was only seen once it was assumed to be not nesting in the area.

Beaver activity is evident around the lake. As mentioned previously, the dam that exists is the likely reason for the current state (particularly the current depth and water volume) of the lake.

Table 6. Wildlife species observed on Grand Avenue Marsh, April – September 2004.

Birds	
Canada Goose	*Branta canadensis*
Mallard	*Anas platyrhnchos*
Wood Duck	*Aix sponsa*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Least Bittern+	*Ixobrychus exilis*
Killdeer	*Charadrius vociferus*
Mourning Dove	*Zenaida macroura*
Common Flicker	*Colaptes auratus*
Downy Woodpecker	*Picoides pubescens*
Eastern Kingbird	*Tyrannus tyrannus*
Willow Flycatcher	*Empidonax traillii*
Barn Swallow	*Hirundo rustica*
Tree Swallow	*Iridoprocne bicolor*
Chimney Swift	*Chaetura pelagica*
American Crow	*Corvus brachyrhynchos*
Black-capped Chickadee	*Poecile atricapillus*
Catbird	*Dumetella carolinensis*
American Robin	*Turdus migratorius*
Cedar Waxwing	*Bombycilla cedrorum*
Warbling Vireo	*Vireo gilvus*
Yellow-rumped Warbler	*Dendroica coronata*
Yellow Warbler	*Dendroica petechia*
Common Yellowthroat	*Geothlypis trichas*
Red-winged Blackbird	*Agelaius phoeniceus*
Common Grackle	*Quiscalus quiscula*
Northern Oriole	*Icterus galbula*
Northern Cardinal	*Cardinalis cardinalis*
American Goldfinch	*Carduelis tristis*
Song Sparrow	*Melospiza melodia*

Table 6. Wildlife species observed on Grand Avenue Marsh, April – September 2004 (cont'd).

Mammals	
Beaver	*Castor canadensis*
Muskrat	*Ondatra zibethicus*
Amphibians	
American Toad	*Bufo americanus*
Bull Frog	*Rana catesbeiana*
Green Frog	*Rana clamitans melanota*
Reptiles	
Painted Turtle	*Chrysemys picta*
Insects	
Cicadas	Cicadidae
Dragonfly	Anisoptera
Damselfly	Zygoptera
Mussels	
Giant Floater	*Pyganodon grandis*

***Endangered in Illinois**
+Threatened in Illinois

EXISTING LAKE QUALITY PROBLEMS AND MANAGEMENT SUGGESTIONS

Grand Avenue Marsh has poor water quality compared to many of the other lakes in the county. Many of the water quality parameters measured were either at or above county medians. The lake provides good habitat for plants, fish, and wildlife, although exotic species are present in the lake and surrounding terrestrial environment. The lake is probably a very dynamic ecosystem, being subject to periodic flooding from the Des Plaines and alteration by beaver activity. This makes for active management of the system difficult. Given the limited public use of the lake, the current management strategy is probably adequate.

- *Lack of a Quality Bathymetric Map*

  A bathymetric (depth contour) map is an essential tool for effective lake management since it provides critical information on the morphometric features of the lake (i.e., acreage, depth, volume, etc.). This information is particularly important when intensive management techniques (i.e., chemical treatments for plant or algae control, dredging, fish stocking, etc.) are part of the lake's overall management plan. Currently, no such map for Grand Avenue Marsh exists. A map, which includes volumetric calculations at each depth, is needed.

- *Water Level Fluctuations*

  Although the flooding of 2004 was a rare event, Grand Avenue Marsh probably experiences significant water level fluctuations, given the proximity of the marsh to the Des Plaines River and the extent of beaver activity in the area. These water fluctuations impact the aquatic life and water quality in the lake. There are no specific management recommendations for this issue.

- *Poor Water Clarity and High Concentrations of Total Phosphorus, Total Suspended Solids, and Nitrate Nitrogen*

  Due to flooding from the Des Plaines River and an abundant carp population, the marsh had high concentrations of total phosphorus and total suspended solids (TSS) throughout the year. The high TSS concentrations resulted in poor water clarity. The high concentrations of nitrate nitrogen in May and June were likely due to the flooding. These parameters are likely to remain dynamic, given the nature of the system and the presence of carp.

- *Aquatic Plant Species*

  In the water, Eurasian water milfoil (EWM) and curlyleaf pondweed were found in Grand Avenue Marsh in 51% and 14% of all samples, respectively. Their presence should be monitored. Currently, the aquatic plant coverage of the lake bottom is

100%. Any aquatic plant management plan should focus on controlling the invasive plants (EWM, curlyleaf pondweed, and coontail), while minimizing the impact to beneficial native species. Selective control of these invasives (particularly curlyleaf and coontail) with herbicides may be difficult. Herbicides such as 2,4-D are ineffective at controlling curlyleaf and are needed in higher concentrations to control coontail, which would negatively impact the water lilies. Fluridone, another herbicide, may also not be a good choice since the concentrations to control coontail would also need to be high and would adversely impact native species.

- *Terrestrial Exotic Plant Species*

  Several other exotic species were found along Grand Avenue Marsh shoreline including buckthorn, purple loosestrife, and common reed. These exotics have the potential to become a significant problem and should be removed or kept in control to prevent their spread.