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**Name of Organization:** University of Illinois / Illinois State Water Survey

**Type of Organization:** College or University

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**Project Title:** Reversing the Degradation of Calumet Area Wetland Ecosystems

**Project Category:** Habitat (Ecological) Protection and Rest

**Rank by Organization (if applicable):** 0

**Total Funding Requested (\$):** 75,932 **Project Duration:** 2 Years

**Abstract:**

The current development of the environmental center at Indian Ridge Marsh by the City of Chicago presents an excellent opportunity to reverse the degradation that has occurred in wetlands of the Calumet region of the southern Lake Michigan basin. The purpose of this project is to make the restoration efforts at the marsh as successful as possible by providing water quality and plant survival data that will direct restoration design and by constructing innovative phytoremediation bioreactors to treat contamination hot spots. This project will be a multi-disciplinary collaboration between water quality specialists at the Illinois State Water Survey, wetland plant specialists at the Illinois Natural History Survey, and an aquatic ecologist at the University of Illinois.

The first task is to map the water quality in the marsh to understand the spatial and temporal variability and to pinpoint the suspected seeps of inflowing ground water contaminated with excessive levels of ammonium. A phytoremediation bioreactor will then be constructed over one of these seeps. The phytoremediation design provides for biological uptake of ammonium and other contaminants throughout the year, avoiding the effects of reduced remediation activity in the winter. Floristic surveys will be conducted simultaneously to examine the relationship between the current water quality conditions and the distribution of the dominant invasive species and the few conservative native plant species that remain. Soil samples will be collected for seed bank analysis and root elongation tests to examine the diversity of the seed bank, the viability of seeds and seedlings, determination of the correlation between water quality and hydrology. The results of the project will be used to identify wetland maintenance strategies, using methods such as water-level control, water mixing with cleaner sources, and seeding, to restore the wetland ecosystem and promote the growth of desirable wetland species.

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**Geographic Areas Affected by the Project**

**States:**

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|--|---------------------------------------|
| <input checked="" type="checkbox"/> Illinois | <input type="checkbox"/> New York     |
| <input type="checkbox"/> Indiana             | <input type="checkbox"/> Pennsylvania |
| <input type="checkbox"/> Michigan            | <input type="checkbox"/> Wisconsin    |
| <input type="checkbox"/> Minnesota           | <input type="checkbox"/> Ohio         |

**Lakes:**

- |  |                                    |
|--|------------------------------------|
| <input type="checkbox"/> Superior            | <input type="checkbox"/> Erie      |
| <input type="checkbox"/> Huron               | <input type="checkbox"/> Ontario   |
| <input checked="" type="checkbox"/> Michigan | <input type="checkbox"/> All Lakes |

**Geographic Initiatives:**

- |   |                                  |                                     |                                      |   |
|---|----------------------------------|-------------------------------------|--------------------------------------|---|
| <input checked="" type="checkbox"/> Greater Chicago | <input type="checkbox"/> NE Ohio | <input type="checkbox"/> NW Indiana | <input type="checkbox"/> SE Michigan | <input type="checkbox"/> Lake St. Clair |
|---|----------------------------------|-------------------------------------|--------------------------------------|---|

**Primary Affected Area of Concern:** Grand Calumet River/IHC, IN

**Other Affected Areas of Concern:**

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***For Habitat Projects Only:***

**Primary Affected Biodiversity Investment Area:** Chicago Wilderness

**Other Affected Biodiversity Investment Areas:**

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**Problem Statement:**

Like many other estuarine wetlands on the Great Lakes, the water quality of Indian Ridge Marsh and the other remnant wetlands in the Calumet region have been under attack by the inflow of polluted ground water and surface water from surrounding upland areas. Many of these areas are Brownfield sites that contain large amounts of fill material comprised of steel mill slag, construction debris, garbage, dredge spoil, and other wastes. Previous sampling results from Indian Ridge Marsh show that there are significant variations in water quality, with the worst quality occurring during the colder months along the west edge of the marsh where ground water seeps in from the adjacent area filled with mixed wastes. The ammonium levels in this portion of the marsh during the winter and early spring were two to four times greater than the general-use standard and were at levels potentially toxic to many fish and aquatic invertebrates. The ammonium concentrations dropped significantly during the late spring and summer when actively growing plants, algae, and bacteria convert it to biomass. The levels of dissolved and suspended solids were also very high and are implicated in the decline of native vegetation, especially those species that are not salt tolerant. Iron and lead concentrations occasionally exceeded the general-use standards while the aluminum, boron, lead, and zinc concentrations were significantly greater than the maximum values reported for other Illinois natural marshes. Disruptions to the natural hydrology of the marsh have exacerbated the water quality problems by eliminating the upstream watershed and limiting interactions with the Calumet River system and Lake Michigan, which could dilute and remediate degraded groundwater.

These physical and chemical alterations of the site have contributed to the decreased biodiversity and the dominance of invasive and weedy wetlands plant species, such as common reeds (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), and cattails (*Typha* spp.). The existing vegetation map shows that monocultures of these species dominate different portions of the marsh. Although invasive species dominate the site, site surveys have listed conservative species typical of high quality wetlands. The importance of water quality and hydrology in controlling the dominance of invasive species and the distribution of conservative species is unknown. If strong relationships are found to exist, potential restoration strategies for the marsh could be designed to improve biodiversity and wetland plant community quality. It is also unknown what viable seeds exist in the wetland or if the seed bank has been damaged by the hydraulic disruptions, poor water quality, or the long-term dominance of the invasive and weedy species. An ongoing seed bank study is being conducted on six samples of the native wetland soil that has been buried underneath 4-8 feet of fill for several decades on the upland portion of the marsh. After six months, two of the samples produced plants of two native wetland species, a sedge and a rush, both of which are not currently found at the site. If the effort to control the purple loosestrife stands are successful, most likely through the use of beetles, knowledge of the seed bank will play an important role in managing the wetland so a desirable diversity of species takes their place.

Hydrologic modeling of the marsh shows that it is possible to greatly improve the overall water quality without affecting the diversity of the potential plant communities through hydrologic control and mixing with cleaner water from the Calumet

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River. Other recommendations include reducing the amount of ground-water inflow, controlling the runoff from adjacent roads, and adding clean soil and removing fill. Experimental results show that simple aeration and mixing can decrease the ammonia concentrations and the toxicity of the highly-alkaline springs found at steel slag piles throughout the region. However, many of the springs, such as those on the west side of Indian Ridge Marsh, have a near neutral pH so that ammonium is the predominant form reduced nitrogen, which is much less volatile and more difficult to remove by aeration than ammonia. Developing a method of directly treating the ammonium in these springs would greatly increase the amount of flexibility in managing the marsh as well as the chances of improving the aquatic habitat.

**Proposed Work Outcome:**

This project takes a practical, multi-disciplinary approach to wetland restoration that builds on GLNPO-funded research efforts. Past research assessed the water quality, hydrology, and the effects of different management schemes on wetland plant communities (Roadcap et al., 1999). A current research effort by the Chicago Department of Environment (CDOE) is assessing methods to control the invasive purple loosestrife. The three main tasks of this project will be focused on Indian Ridge Marsh because of the CDOE effort to develop an environmental center at the site and the need for critical and timely data to help manage the site. Because the problems at the marsh are endemic throughout the Calumet region, the results of this project will be applicable to most of the other wetlands in the region.

A quality assurance project plan (QAPP) will be submitted at the beginning of the project. The location and sampling information will be input into a Geographic Information Systems (GIS) for analysis and presentation and to provide basemaps for future research. The GIS information will be consistent with the GLNPO location data policy. The results of the project will be detailed in quarterly progress reports and a final report. The results of this project also will be used to help create educational material for the environmental center, such as displays, interpretive signs, and field labs where students could continue making similar observations and measurements as the marsh changes over time.

Task 1 - Conduct water quality and floristic surveys. This task has three objectives. The first is to understand the spatial variability in water quality and how this variability may change through the year. The second objective is to see if there is a relationship between water quality in the marsh and the distribution of existing plant species, especially the few native plant species that remain. The third objective is to pinpoint the suspected seeps of inflowing ground water contaminated with excessive levels of dissolved solids and ammonium. The results of these surveys will be used to help implement remediation and management strategies to improve the quality on the aquatic habitat and promote the growth of native vegetation.

The surveys will be conducted by establishing a grid of sampling stations over the marsh with additional stations where there are surface water inflows. The location of each station will be established with a global positioning system (GPS). At each station measurements will be taken for specific conductivity, pH, and dissolved oxygen using field probes. Previous research has shown there is a strong correlation between the specific conductivity and the total dissolved solids and ammonium contents of the marsh. A subset of stations with high conductivities will be selected for sampling and laboratory analysis for ammonium and general water chemistry. An ion-selective electrode for ammonium also be used in the field if it can reliably give accurate readings. The different plant species will be recorded for each station or appropriate groupings of stations. A floristic quality index (FQI) will be computed for all stations. The survey will be conducted at least five times during the year. The first two surveys, pending approval of the QAPP, will be for water quality in the fall and late winter to establish the spatial and temporal trends and to pinpoint the high ammonium seeps for the bioreactor. The combined surveys will start in the early spring as early germinating plants begin to come up and then be repeated two to three times during the growing season. An additional water quality survey will be conducted after a spring storm event.

Task 2 - Demonstrate a cold-weather bioreactor to treat the ground-water seeps. The objective of this task is to treat the high levels of ammonium in the ground water seeping into the marsh during the six cold-weather months. The bioreactor would take advantage of natural processes using plants, algae, and bacteria to converting the nitrogen in the ammonium into biomass. The potential uptake of other contaminants that may be in the ground water such as iron, manganese, and other metals, would be an important added benefit. The bioreactor will consist of an enclosed greenhouse-like structure built over a seep and extending out into the marsh roughly 5-10 feet. The bioreactor will take advantage of the natural heat from the warm inflowing ground water and solar radiation to maintain a warm enough temperature throughout the winter to keep the biological uptake active. These springs can keep a localized area ice-free through the winter, when the rest of the marsh can have more than a foot of ice. The structure will be constructed with clear plastic sheathing over a frame that will

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extend from the wetland bottom to only a few above the water level. An aerator may be added inside to enhance volatilization of dissolved ammonia. The flow rate, ammonium concentration, and temperature of the seep will be used to determine the rate at which biomass will need to be produced. This information will then be used to determine the size of the structure.

To maximize the amount of biomass, submerged aquatic plants will be placed in the deeper portions while short emergent plants will be used along the shoreline. Tolerance to cold temperatures, high levels of nitrogen, and salinity will be considered in the selection of species. The success of the bioreactor will be determined by collecting water-quality samples at the seep and bioreactor outlet. The growth rate of the plants will be monitored along with the accumulation of detrital material on the bottom and the amount of excess biomass harvested to allow for new growth. The presence of nitrifying and denitrifying bacteria will be monitored with culturing tests.

Task 3 - Perform seed bank analyses and seed germination/root elongation bioassay tests. The objective of this task is to see what kind of viable seeds exist in the wetland soil and if the soil will likely support species that are sensitive to environmental degradation. This task will be coordinated with the CDOE effort to control purple loosestrife. Soil samples will be collected in the early spring from approximately 10 locations selected from different regions defined by the results of the water quality and floristic surveys and from the CDOE test locations. Soil samples will be potted in flats and placed in a controlled greenhouse at the Illinois Natural History Survey. The flats will be placed on a slant and the water level will be held constant at the midpoint to provide a variety of saturation and inundation conditions. The experiments will be carried for at least one year to allow the plants to get large enough to identify and to detect species that may require a longer germination period. Seed germination/root elongation bioassay tests will be conducted on subsamples of soils using buttercrunch lettuce seeds and/or other species recommended by USEPA method OPPTS 850.4200. The percent seed germination and the individual root lengths will be correlated with water-quality and floristic data. The results of this task will be used to determine if any supplemental seeding or planting would be desirable and what species are likely to be successful.

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<b>Project Milestones:</b>	<b>Dates:</b>
Project Start	10/2000
Submit Quality Assurance Project Plan	11/2000
Begin water quality/floristic surveys	02/2001
Collect samples for seed bank tests	04/2001
Construct and monitor bioreactor	08/2001
Fiinsh surveys	10/2001
Finish seed bank test	04/2002
Project End - Submit final report	06/2002

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Project Addresses Environmental Justice

**If So, Description of How:**

The heavy concentration of hazardous and municipal waste facilities (i.e. landfills, incinerators, and sewage treatment plants) in the Calumet area and the degradation of the rivers, lakes, and wetlands have been major environmental justice issues to the low-income and minority neighborhoods in the region. Many of these neighborhoods, such as the Altgeld Gardens public housing complex, are completely surrounded by these types of facilities. The stigma associated with environmental contamination has hampered attempts to attract new economic development to the area. Providing high-quality open space and educational activities to residents of the southeast side of Chicago is of vital importance. By investing in the natural resources of Indian Ridge Marsh and the Lake Calumet area, we hope to reverse previous injustices and improve the quality of life of residents.

Project Addresses Education/Outreach

**If So, Description of How:**

With the development of the environmental center at Indian Ridge Marsh by the Chicago Department of Environment, this project will have a major educational and public outreach component. A main focus of the center will be the interpretation of the ecological, industrial, and cultural landscape of the Lake Calumet region. Visitors will learn about the function of wetlands as agents in water quality improvement and as important components of wildlife habitat. At the center naturalists will explain how the maintenance of water levels, good water quality, and control exotic species are central to the health of the wetland. The demonstration of green technologies, such as the phytoremediation bioreactor, will also be a main focus of the center. The results of this project will be used to help create educational material for the center, such as informational pamphlets, displays, and interpretive signs along the nature trails. The techniques used in this project could be used to create field labs where students could make additional observations or conduct experiments as the marsh changes over time with rehabilitation.

**Project Budget:**

	<b>Federal Share Requested (\$)</b>	<b>Applicant's Share (\$)</b>
<b>Personnel:</b>	26,763	2,755
<b>Fringe:</b>	6,166	634
<b>Travel:</b>	3,200	0
<b>Equipment:</b>	0	0
<b>Supplies:</b>	5,500	0
<b>Contracts:</b>	5,000	0
<b>Construction:</b>	0	0
<b>Other:</b>	3,000	0
<b>Total Direct Costs:</b>	49,629	3,389
<b>Indirect Costs:</b>	26,303	1,797
<b>Total:</b>	75,932	5,186
<b>Projected Income:</b>	0	0

**Funding by Other Organizations (Names, Amounts, Description of Commitments):**

The CDOE is pursuing the construction of an environmental center in rehabilitation of adjacent wetlands prairies and woodlands. These many tasks will rely on a wide variety of funding sources. In addition to money from the city's operating budget, funds are being sought through the not-for-profit Chicago's Environmental Fund (CEF) which is organizing a major capital campaign for the environmental center. The board of the CEF has hired a professional fund raiser for the specific purpose of soliciting funds for the center. The CEF has already secured \$250,000 for a "Supplemental Environmental Project" settlement with a landfill company in the area.

The CDOE, along with the working group of governmental agencies mentioned below, are applying for Section 1135 "Project Modifications for Improvement of Environment" funds from the U.S. Army Corps of Engineers. This fund will provide up to \$5 million toward ecological rehabilitation of wetland areas previously impacted by Corps activities. The agencies in the working groups are required to provide a 25 percent match which can include in-kind services.

The Illinois Department of Natural Resources is providing additional funding through the Conservation 2000 program for Lake Calumet Ecosystem Partnership. The partnership is focused on restoring the region's ecosystem including Indian Ridge Marsh. The Illinois Environmental Protection Agency is also providing funds indirectly through cleanup efforts at the contaminated Lake Calumet Cluster site adjacent to the marsh. The results of this project also will help guide future work by IEPA at the site.

This CDOE will also be seeking education grants from a variety of foundations. These funds will facilitate educational programming, summer camps, and volunteer stewardship activities to be conducted at the environmental center.

**Description of Collaboration/Community Based Support:**

There is a working group of local, state, and federal agencies collaborating with the CDOE on the environmental center. The working group meets bimonthly to coordinate activities in the region, report on the progress of the environmental center development, and exchange technical information. Participating agencies include the following:

- U.S. Environmental Protection Agency - Region V
- Illinois Environmental Protection Agency
- Illinois Department of Natural Resources
- Illinois State Water Survey
- Illinois Natural History Survey
- University of Illinois - Urbana
- University of Illinois - Chicago, Great Cities Institute
- U.S. Army Corps of Engineers

U.S. Geological Survey  
U.S. Fish and Wildlife Service  
U.S. Forest Service  
Forest Preserve District of Cook County

In addition to the agencies listed above, we have and will continue to collaborate with a variety of community groups, environmental organizations, and businesses, many of which participate in the Lake Calumet Ecosystem Partnership. Some of these groups include:

Calumet Ecological Park Association  
Openlands Project  
Chicago State University - Calumet Environmental Resource Center  
Citizens for a Better Environment  
Southeast Environmental Task Force  
Chicago Legal Clinic  
Chicago Audubon Society  
Hegewisch Chamber of Commerce  
Calumet Area Industrial Commission