BROWNFIELD REDEVELOPMENT AND ECOLOGICAL RESTORATION AT INDIAN RIDGE MARSH, CHICAGO, ILLINOIS

Robert Smalley, U.S. Army Corps of Engineers
City of Chicago Department of Environment
Jack Brunner, Dennis Haag, David Homer, and Andy Suminski, Tetra Tech EM Inc.
Warren Buchanan, Buchanan Consulting, Inc.

Abstract

The City of Chicago has established a goal of sustainable development for its Calumet region that can be achieved through a combination of redevelopment and ecological restoration of Brownfield sites. The ecological restoration of Indian Ridge Marsh (IRM) in the Calumet region will show how abandoned Brownfield industrial sites can be cleaned up while natural areas are ecologically rehabilitated to leverage the benefits of both activities toward marketing a vastly improved economic area. In addition, the IRM ecosystem restoration will show how to effectively restore scarce, highly valued wildlife habitat to an area that has been negatively impacted by urbanization. To achieve these goals, specific objectives were identified through coordination with local and regional agencies, the public involvement process, site assessments, and review of prior studies. The restoration design enhances existing aquatic, wetland, and woodland areas; creates new habitat features that historically existed in the Calumet region, including sand prairie, black oak savanna, and shrub carr; provides for public access and a trail system; protects ecological habitat features from off- and on-site sources of pollution; and contributes significantly to the Calumet Ecological Management Strategy. The restoration will include activities needed to restore ecological functions and address elevated contaminant levels at IRM, such as the creation of a phytoremediation berm and the transposition of existing soils at the site.

Introduction

The approximately 20-square-mile Calumet region of southeastern Chicago was once the site of shallow glacial lakes, sandy ridge and swale complexes, and marshes that abounded in waterfowl and other wildlife well into the 19th century. However, over the past 120 years, construction of extensive manufacturing facilities, disposal of industrial waste, dredging, and landfilling have altered the region, and transportation routes have dissected it. Although these activities have significantly affected the local ecology, region's industrial and Brownfield sites coexisting with wetland remnants and other valuable ecological resources that support a variety of wildlife. Therefore, in partnership with other government agencies, the City of Chicago is using an economic-ecosystem approach to revitalize and rehabilitate the region. The plan for this initiative identifies about 3,000 acres of land for industrial and Brownfield redevelopment and more than 4,800 acres for open space. The open space will be set aside and managed by various state and local agencies as the Calumet Open Space Reserve. The Calumet Ecological Management Strategy (Calumet EMS) provides the framework for protecting and rehabilitating land included as part of the Calumet Open Space Reserve. A feasibility study for the ecological restoration of Indian Ridge Marsh (IRM), which lies in the Calumet region, identified and evaluated several methods by which Brownfield-related sites can be ecologically rehabilitated within the framework established by the Calumet EMS.

Ecological Study Area Location and General Description

The IRM study area occupies about 146 acres and is part of the Lake Calumet wetland system. The site is located east of Lake Calumet and north and west of the Calumet River on the southeastern side of

Chicago. IRM is bounded by heavy industrial sites across streets to the east (Torrence Avenue) and north (116th Street), waste disposal sites across railroad tracks to the west, and the Sidestream Elevated Pool Aeration (SEPA) station to the south. The SEPA station is a series of retention ponds with artificial waterfalls operated along the Calumet River by the Metropolitan Water Reclamation District of Greater Chicago. Also, 122nd Street divides IRM into two parcels of about 109 acres to the north and 37 acres to the south; a ditch along the railroad tracks channels water from north to south through a culvert beneath 122nd Street.

IRM was originally an area of mixed wetland and sand prairie lying just beyond the original shoreline of Lake Calumet. Indian Ridge was a beach ridge created as part of the Lake Chicago glacial process that stood above the water surface, providing high ground for a Native American trail. After European settlement of the region, Indian Ridge continued to be used for overland transportation between Indiana and Chicago. The routing of a railroad across the site also took advantage of the relatively high elevation of the ridge. By 1870, the land was platted for residential development, and most of the more than 1,000 platted lots were sold to land speculators.

Many of the neighborhoods in the Calumet region were originally underwater but were gradually filled with various materials to create dry ground. The fill most commonly used in the area was slag, a steel industry waste. In addition to slag, river dredging spoils, cinders, fly ash, and other types of solid wastes were used to reclaim land from marshes. The neighborhoods surrounding IRM were developed in a similar manner; that is, submerged lands were sold to speculators, and then nearby industries provided the fill materials to create dry ground. Historical records suggest that some of the IRM site may have been mined for sand. Most filling activities at IRM have occurred since 1930 and have primarily involved use of dredging spoils and construction and demolition (C&D) debris.

For unknown reasons, the platted street rights-of-way were never constructed at the IRM site, and no full-scale development ever occurred at IRM. Only six houses were ever built on the approximately 1,000 platted lots that comprise IRM. The number of platted residential units in the subdivision at the site probably discouraged the disposal of industrial and solid wastes seen elsewhere in the Calumet region. However, as at most Brownfield sites, illegal dumping of C&D debris, tires, and other materials is an ongoing problem at IRM.

IRM is located in an urbanized watershed and is characterized as a degraded wetland containing about 50 percent native plant species, most of which are considered to be low in floristic quality. The land within 1 mile of the site is either highly industrialized or completely vacant. Therefore, the site area exhibits an unusual combination of wildlife habitat and industrially impacted locations. The nonnative and weedy native plant species are tolerant of compacted soil, disturbance, or both, resulting in overall

degradation of plant community quality. The wetlands have been degraded by the influx of surface water containing fill, road salt, organic nutrients, and industrial effluents. Nonetheless, the fact that IRM is classified as a wetland makes it a valuable geographical feature of the area, which is situated at the interface of terrestrial and aquatic habitats. Such transitional areas, or ecotones, contain a variety of species native to these types of habitat. The black-crowned night heron, a state-listed endangered species, has established a rookery at IRM, which is an important stopover location for migratory birds.

There appears to be great ecological potential for IRM because of its high water retention time, which is a valuable asset for filtering pollutants and contaminants from water. As such filtering occurs, water quality and thus flora and fauna diversity should increase throughout the wetland.

Study Scope and Objectives

The ecological restoration study for IRM investigated the feasibility of:

- Enhancing and naturalizing pond features and wetland habitat
- Re-creating and monitoring prairie areas
- Reintroducing native plant species to woodland areas
- Protecting the restored areas while encouraging public access

The study took into account the three priorities that form the basis for the Calumet EMS goals. The first priority involved preserving existing, valuable habitat, such as the black-crowned night heron rookery. The second priority involved improving habitat where this is possible, and the third priority was to create new habitat where possible. These priorities were considered throughout the study and are critical to the long-term success of the ecological restoration of IRM.

Development of Restoration Plan Alternatives

Eight restoration plan alternatives, including one no action alternative, were developed for IRM. The array of alternatives is summarized below.

ARRAY OF RESTORATION PLAN ALTERNATIVES

Alternative	Description
1	No Action
2	Enhance Aquatics and Wetlands
3	Enhance Aquatics and Wetlands and Re-create Prairies
4	Enhance Aquatics, Wetlands, and Woodlands
5	Enhance Aquatics, Wetlands, and Woodlands and Re-create Prairies
6	Enhance Wetlands and Re-create Prairies
7	Enhance Wetlands and Woodlands
8	Enhance Wetlands and Woodlands and Re-create Prairies

During development of the restoration plan alternatives, a thorough literature review was performed along with outreach to local community members active in ecological preservation efforts within the Calumet region. These alternatives relied on the following information sources:

- A compilation of floristic inventories for virtually all the higher-quality natural areas in the immediate vicinity of IRM
- Published articles on the history of site disturbance and predisturbance, geology, soils, landforms, and vegetation
- Soil chemistry profiles from boring information
- Personal communications with local wildlife experts and botanists
- Results of a seed germination study conducted to evaluate the suitability of IRM soils and various organic soil amendments, including biosolids, for planting the desired wetland and prairie plant species

Various restoration options or components were evaluated, and those determined to merit implementation in order to achieve the restoration objectives were incorporated into each of the restoration plan alternatives. Each restoration plan alternative contained the following primary components:

- Preservation of the existing black-crowned night heron rookery and some woodland areas
- An earthen, vegetated phytoremediation berm or embankment along the railroad tracks to control ammonia in groundwater associated with neighboring solid waste disposal sites
- Culverts and water control structures
- A combination of on-site grading and imported organic soil amendments
- Transposition of on-site soils to recover of on-site sand and to reduce potential risks associated with on-site contamination
- Disposal of debris encountered during grading
- Selective use of herbicides, physical eradication, smothering, mowing, or biological controls (beetles) to reduce and eventually eliminate invasive and undesirable plant species such as common reed, purple loosestrife, and swamp buckthorn
- Public access facilities, including a parking lot and trails

In addition to the primary components listed above, each alternative incorporated varying amounts of the following habitat types:

- Aquatic and wetland habitat
  - Open water
  - Emergent plantings
  - Marsh-sedge meadow

  - Shrub carr
- Sand prairie and black oak savanna
- Woodland

Evaluation of Restoration Plan Alternatives

The restoration plan alternatives were evaluated based on their estimated benefits; their implementation costs; their potential impacts on real estate acquisition; and cost-effectiveness, including the results of an incremental cost analysis.

To compare the cost-effectiveness of the alternatives, an evaluation of the environmental outputs associated with each alternative was required. An output is a quantification of expected improvements in key ecosystem functions as they relate to project objectives. For the evaluation process, an ecological quality index (EQI) was calculated for each alternative to identify its environmental output or its relative contribution to the three major ecological elements of the restoration project: the abiotic, biotic, and ecological diversity elements. In general, the total number of acres associated with each component or habitat of the restoration alternative was combined with an ecosystem weighting factor to generate an EQI that reflected the ecological improvement that would be provided by each alternative. The EQI analysis did not take into account the implementation cost associated with each alternative, and therefore was not a cost-benefit analysis because the focus was on the ecological improvement of the site. The purpose of the EQI analysis was to assist in the determination of the most cost-effective way to provide environmental improvements.

The marginal costs of increasing environmental outputs were determined through an incremental cost analysis. This analysis was performed for the alternatives using the results of the EQI analysis and the estimated costs of the alternatives. An incremental cost analysis is an iterative process that compares each successive alternative cost with the alternative's environmental outputs. In the first iteration of the analysis, the most cost-effective alternatives were selected. The most cost-effective alternative was that having the lowest cost per improvement in environmental output. Any remaining alternatives that produced a higher EQI than the alternatives selected in the previous iteration were then compared. The alternatives with the lowest incremental cost per incremental environmental output improvement were selected as the next most cost-effective. This process was repeated until no alternative produced more environmental output improvement units than the previously selected alternatives.

Furthermore, each alternative's contribution to the goals of the Calumet EMS was considered as part of the evaluation process.

Selected Restoration Plan Alternative:
Enhance Aquatics, Wetlands, and Woodlands and Re-create Prairies

The selected restoration plan alternative provides the most diverse habitat through enhancement of aquatic, wetland, and woodland habitat types as well as re-creation of prairies and black oak savannas. In addition to the primary components common to all the alternatives (see Development of Restoration Plan Alternatives above), the following specific activities will be implemented:

- Enhancement of existing habitats
  - Emergent wetlands (26 acres)
  - Marsh-sedge meadow (33 acres)
  - Aquatic (7 acres)
  - Woodland (9 acres)
- Creation or re-creation of habitats
  - Sand prairie (44 acres)
  - Black oak savanna (3 acres)
  - Shrub carr (3 acres)

The selected alternative also addresses issues often associated with ecological rehabilitation of Brownfield sites. Hazardous constituents have been identified in groundwater, sediment, and soils in limited areas of IRM. In addition, the Brownfields and industrial sites surrounding IRM have contaminants that pose potential environmental hazards or risks. The selected alternative includes placement of a phytoremediation berm (embankment) along the western perimeter of IRM. This berm will contain *Populus sp*. such as cottonwood trees that will use the ammonia in the groundwater as a nutrient source and will thereby reduce the levels of ammonia entering the marsh through the root zone. Based on available information, the low concentrations of contaminants in site sediment are predominantly located in the ditch along the western portion of the site. This contamination will be buried during construction of the phytoremediation berm; water previously channeled by the ditch will filter through the wetlands and enhance the system's capacity for natural improvement of water and sediment quality. Low concentrations of soil contamination believed to be associated with illegal dumping were found at IRM. The proposed parking lot for public access will cover most of the contaminated soil, and the remaining soil contamination will be covered with new material during transposition of soils and creation of the upland habitats. Furthermore, earthen berms, expanses of dense vegetation, and possibly fencing in some areas will be used to limit site access and discourage future illegal dumping at the site.

Proposed Implementation Approach for Restoration Plan

The proposed approach for implementing the restoration and enhancement options for the native plant communities included in the restoration plan involves the following elements:

- **Exclusion and Restricted Activity Zones.** Certain areas of the site contain critical nesting habitat for the black-crowned night heron, a state-listed endangered species. These areas will be defined and fenced off as construction exclusion zones. Other areas where existing wooded vegetation is to be preserved will be designated for special treatment such that mature trees will not be harmed, although enhancement landscaping might be performed in these areas.

- **Dewatering.** It will be necessary to expose the planting zones and grading work areas down to the elevations for the emergent plantings.

- **Clearing and Grubbing**. The surface of the site will be cleared of debris and existing vegetation except as specified for the exclusion zones and restricted activity zones. Debris such as abandoned cars and refuse will be hauled off site by a licensed contractor and disposed of in a licensed facility. Miscellaneous construction debris and rubble not characterized as special or hazardous waste will be buried on site.

- **Earthwork.** Buried native soils will be excavated during shaping of water bodies and enhancement of existing shorelines. The native soil materials will be supplemented with organic matter such as biosolids. Excavated silty clay materials will be used as fill and underlying sand at the site will be excavated and transposed to the surface of upland sand prairie areas. Debris encountered during excavation will be either buried on site or disposed of off site at a licensed facility, as appropriate.

- **Seeding and Planting**. The combination of planting live plants, particularly in the emergent zone, and seeding will encourage restoration success because of this approach's tolerance of some water level fluctuations.

Conclusions

The ecological restoration of IRM will significantly contribute to the economic and ecological goals of Chicago's Calumet region. The restoration plan shows how abandoned Brownfield sites can be cleaned up while natural areas are ecologically rehabilitated to leverage the benefits of both activities toward marketing a redeveloped area. As with any Brownfield-type development, the IRM restoration alternatives were thoroughly evaluated based their estimated benefits, their costs, their potential impacts on real estate acquisition, and their cost-effectiveness as well as the results of an incremental cost analysis that weighed implementation costs versus ecological benefits. Using innovative approaches such as phytoremediation, the IRM restoration will effectively address contamination, site security, and other Brownfield-related issues without compromising the integrity of its ecological goals. This restoration, conducted as part of the overall redevelopment of Chicago's Calumet region, exemplifies how ecological restoration can be an integral part of Brownfield redevelopment, significantly benefiting both local wildlife and the public.