2013

Ravine 8 Ecosystem Restoration

Section 506 Great Lakes Fishery & Ecosystem Restoration (GLFER)

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Chicago District
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EXECUTIVE SUMMARY

The non-Federal sponsor, the City of Highland Park, has requested that the Chicago District, USACE initiate a study under the authority of the Water Resources Development Act 2000, Section 506, Great Lakes Fishery and Ecosystem Restoration to determine the feasibility of restoring the ecological integrity of Ravine 8. This study evaluates the feasibility and environmental effects of restoring the ravine and adjacent bluff and existing foredunes. The study addresses altered hydrology and hydraulics, ravine stream geomorphology, native plant community preservation, invasive species, connectivity, rare wetland communities and native species richness. This Feasibility Report and Integrated Environmental Assessment will identify problems and opportunities, evaluate a number of different measures, formulate plans and recommend the most cost effective and feasible solution to restoring the ecological integrity of Ravine 8.

The study area is part of the Lake Michigan coastline and is located in northeastern Illinois within the southeast boundary of Lake County. The proposed restoration project would be located east of Lake Road, north of Prospect Rd. and south of Laurel within the City of Highland Park, Illinois. The Ravine 8 study area is about 5-acres and consists of one ravine, the bluff and several small foredunes. Historically, the Highland Park moraine was dominated by several naturally occurring communities including wetlands, forests, savannas and prairies. By the late 1800s many of these communities, particularly prairies, savannas and wetlands, were converted to agricultural, urban or industrial use. Subsequently, there was a significant loss of biodiversity and adverse effects including an increase in flooding events and a decrease in water quality. Additionally, the remnant parcels of the natural community types are under pressure from continued human disturbances. Human induced disturbances include fire suppression, altered hydrology and hydraulics, increase colonization of invasive species and fragmentation.

All of the ravines along the north shore of Lake Michigan are or were used as conduits for both storm water and sanitary sewers. Before this study started, the non-Federal sponsor, City of Highland Park, addressed the major erosion and modified the sanitary and stormwater sewers within the ravine. The non-Federal sponsor sought ecosystem restoration assistance from the USACE and would like to restore the ravine stream and riparian habitat while not impacting local drainage. USACE calculations and analysis led to the derivation of target flows for the ravine consistent with pre-development conditions. To achieve the target flows it is necessary to attenuate, detain or reroute additional flows from the ravine. The most cost effective and least land intensive option was to allow for current flows to continue down the ravine and provide riffle structures to handle these flows while providing habitat. This will allow for natural ground water and pervious infiltration to feed the ravine stream and the restored ravine habitat.

Six (6) plans were generated from the 4 measures input into the IWR-Planning software. The software identified that 4 plans were cost effective, which means that no one plan provided the same benefits as another plan that was less costly. Three (3) plans were revealed as “best buys”, which are deemed the most cost efficient of the 6 plans generated. The NER and recommended plan is Plan 3. Plan 3 Consists of implementing cobble riffle and step pool structures to handle urban derived flows within the ravine channel, which facilitates naturalized the stream velocities, removal of a small check dam to restore connectivity with Lake Michigan, removal of invasive plant species and reestablishment of native plants on a .5 acre dune and 3.16 acres of ravine bluff.

The total project cost is about [redacted]The estimated Federal cost share of the project is approximately [redacted]and the non-Federal share is approximately [redacted]. The USACE will complete the design and implementation phase, which includes additional design studies, plans and specifications, contract

for construction, overall supervision during construction, preparation of an operation and maintenance manual, and participate in a portion of the post construction monitoring.

CHAPTER 1 – INTRODUCTION

1.1 – Report Organization

This Detailed Project Report (DPR) presents the results of the Ravine 8 Ecosystem Restoration study. This report consists of nine (9) parts including a main report and eight appendices with figures and tables. The report is structured as follows:

Detailed Project Report
Appendix A – Hydrology & Hydraulics Analysis
Appendix B – Civil Design
Appendix C – Cost Engineering
Appendix D – Geotechnical Analysis
Appendix E – Hazardous, Toxic, and Radioactive Waste (HTRW) Report
Appendix F – Real Estate Plan
Appendix G – Compliance & Permit Information
Appendix H – Monitoring Plan

1.2 – Study Authority

42U.S.C. § 1962d-22. GREAT LAKES FISHERY AND ECOSYSTEM RESTORATION (WRDA 2000 as amended)

Findings - Congress finds that—

(1) the Great Lakes comprise a nationally and internationally significant fishery and ecosystem;
(2) the Great Lakes fishery and ecosystem should be developed and enhanced in a coordinated manner; and
(3) the Great Lakes fishery and ecosystem provides a diversity of opportunities, experiences, and beneficial uses.

(b) Definitions - In this section, the following definitions apply:

(1) Great Lake
  (A) In general- The term "Great Lake" means Lake Superior, Lake Michigan, Lake Huron (including Lake St. Clair), Lake Erie, and Lake Ontario (including the St. Lawrence River to the 45th parallel of latitude).
  (B) Inclusions- The term "Great Lake" includes any connecting channel, historically connected tributary, and basin of a lake specified in subparagraph (A).
(2) Great Lakes Commission- The term "Great Lakes Commission" means the Great Lakes Commission established by the Great Lakes Basin Compact (82 Stat. 414).
(3) Great Lakes Fishery Commission- The term "Great Lakes Fishery Commission" has the meaning given the term "Commission" in section 931 of Title 16.
(4) Great Lakes State- The term "Great Lakes State" means each of the States of Illinois, Indiana, Michigan, Minnesota, Ohio, Pennsylvania, New York, and Wisconsin.

(c) Great Lakes fishery and ecosystem restoration

(1) Support plan
  (A) In general- Not later than 1 year after December 11, 2000, the Secretary shall develop a plan for activities of the Corps of Engineers that support the management of Great Lakes fisheries.
  (B) Use of existing documents- To the maximum extent practicable, the plan shall make use of and incorporate documents that relate to the Great Lakes and are in existence on December 11, 2000, such as lakewide management plans and remedial action plans.
  (C) Cooperation- The Secretary shall develop the plan in cooperation with—
    (i) the signatories to the Joint Strategic Plan for Management of the Great Lakes Fisheries; and
    (ii) other affected interests.
(2) Reconnaissance studies- Before planning, designing, or constructing a project under paragraph (3), the Secretary shall carry out a reconnaissance study—
  (A) to identify methods of restoring the fishery, ecosystem, and beneficial uses of the Great Lakes; and

(B) to determine whether planning of a project under paragraph (3) should proceed.

(3) Projects- The Secretary shall plan, design, and construct projects to support the restoration of the fishery, ecosystem, and beneficial uses of the Great Lakes.

(4) Evaluation program

(A) In general- The Secretary shall develop a program to evaluate the success of the projects carried out under paragraph (3) in meeting fishery and ecosystem restoration goals.

(B) Studies- Evaluations under subparagraph (A) shall be conducted in consultation with the Great Lakes Fishery Commission and appropriate Federal, State, and local agencies.

(d) Cooperative agreements- In carrying out this section, the Secretary may enter into a cooperative agreement with the Great Lakes Commission or any other agency established to facilitate active State participation in management of the Great Lakes.

(e) Relationship to other Great Lakes activities- No activity under this section shall affect the date of completion of any other activity relating to the Great Lakes that is authorized under other law.

(f) Cost sharing

(1) Development of plan- The Federal share of the cost of development of the plan under subsection (c)(1) of this section shall be 65 percent.

(2) Project planning, design, construction, and evaluation- Except for reconnaissance studies, the Federal share of the cost of planning, design, construction, and evaluation of a project under paragraph (3) or (4) of subsection (c) of this section shall be 65 percent.

(3) Non-Federal share

(A) Credit for land, easements, and rights-of-way- The Secretary shall credit the non-Federal interest for the value of any land, easement, right-of-way, dredged material disposal area, or relocation provided for carrying out a project under subsection (c)(3) of this section.

(B) Form- The non-Federal interest may provide up to 100 percent of the non-Federal share required under paragraphs (1) and (2) in the form of services, materials, supplies, or other in-kind contributions.

(4) Operation and maintenance- The operation, maintenance, repair, rehabilitation, and replacement of projects carried out under this section shall be a non-Federal responsibility.

(5) Non-Federal interests- In accordance with section 1962d-5b of this title, for any project carried out under this section, a non-Federal interest may include a private interest and a nonprofit entity.

(g) Authorization of appropriations

(1) Development of plan- There is authorized to be appropriated for development of the plan under subsection (c)(1) of this section $300,000. Other activities- There is authorized to be appropriated to carry out paragraphs (2) and (3) of subsection (c) of this section $100,000,000.

1.3 – Study Purpose & Background

The Lake Michigan coastal zone is one of the most diverse ecosystems in Lake County, Illinois. The unique landforms of ravines, bluffs, and beaches were left behind by glacial movements and the recession of Lake Chicago, a larger pre-historic lake than the present Lake Michigan. These landforms and the special coastal climate combined to host a diverse ecosystem that included densely wooded ravines and uplands, an array of herbaceous plants uniquely suited to the ravines, bluff faces and beaches, which host a multitude of migratory and resident bird species. First logging, then agriculture, and finally residential development removed much of this unique vegetation and also altered the landforms. Additionally extensive watershed development has caused the ravine morphology to degrade. An opportunity exists to restore this ravine together with the other north shore ravine restorations to establish a larger refuge for spawning lake fishes and migratory birds.

The non-Federal sponsor, the City of Highland Park, has requested that the Chicago District USACE initiate a study under the authority of Water Resource Development Act, Section 506, Great Lakes Fishery and Ecosystem Restoration to determine the feasibility of restoring the ecological integrity of Ravine 8. The scope of this study addresses the altered hydrology and hydraulics, native plant community preservation, invasive species, connectivity, rare wetland communities and native species richness. This Feasibility Report and Integrated Environmental Assessment identifies problems and opportunities, evaluates a number of different measures, formulate plans and recommend the most cost effective and feasible solution to the restore the ecological integrity of Ravine 8 problems currently existing within the

area of study. The intent of this report is not to address local drainage issues, for there are none, but to restore the ravine primarily for macroinvertebrates, fishes and migratory birds.

1.4 – Study Area

The study area is part of the Lake Michigan coastline (**Figure 1**) and is located in northeastern Illinois within the southeast boundary of Lake County (**Figure 2**). The proposed restoration project would be located east of Lake Road, north of Prospect Rd. and south of Laurel within the City of Highland Park, Illinois; Highland Park Quad Map, Illinois. The Ravine 8 study area is about 5-acres and consists of one ravine, the adjacent bluff and several small foredunes at the toe of the bluff (**Figure 3**).

Figure 1 – Ravine 8 Study Area Location within Great Lakes basin.

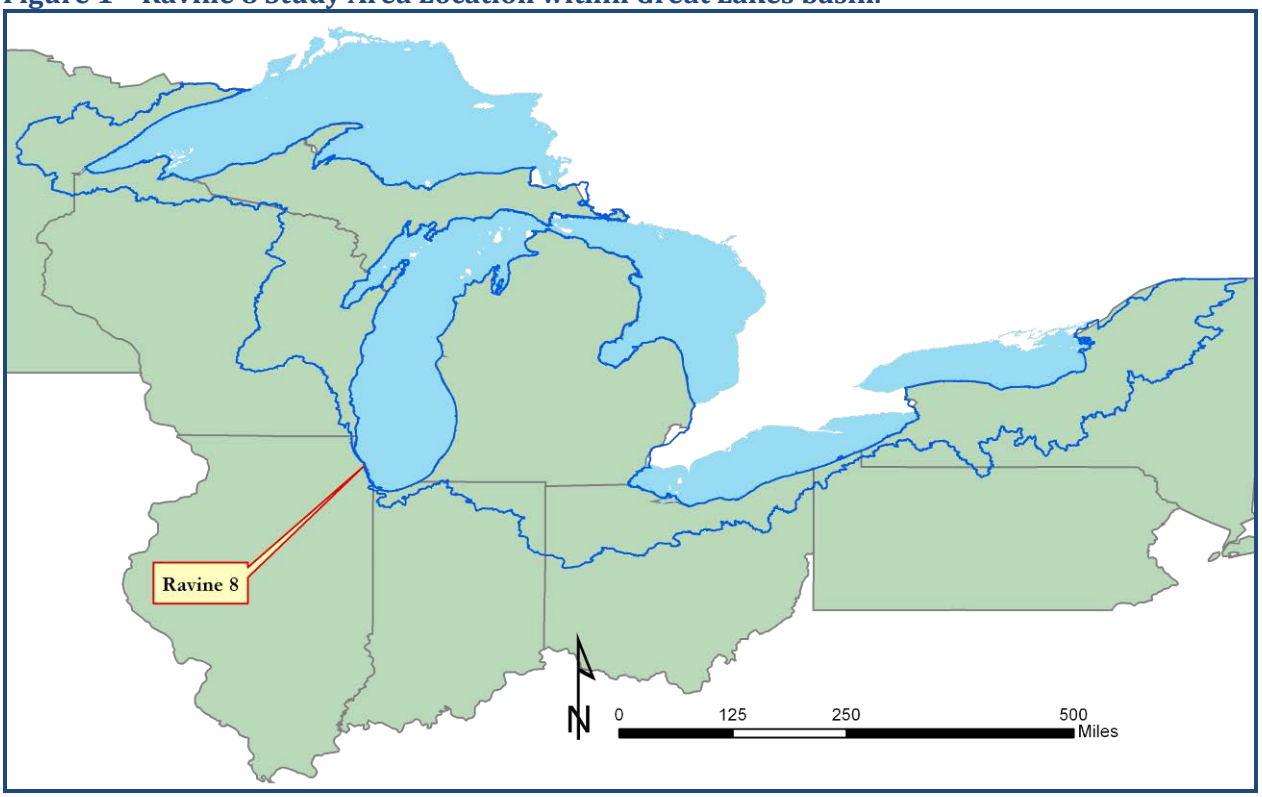


Figure 2 – Ravine 8 Study Area along Coast of Lake Michigan.

Figure 3 – Aerial View of the Ravine 8 Study Area

1.5 – Pertinent Reports, Studies & Projects

Reports & Studies

- Alliance for the Great Lakes. October 2009. Stresses and Opportunities in Illinois Lake Michigan Watersheds Strategic Sub-Watershed Identification Process (SSIP) Report for the Lake Michigan Watershed Ecosystem Partnership.

This report is organized around three aspects of the Lake Michigan land and water ecology: the water quality of Lake Michigan and the streams and rivers feeding into it, the level of erosion in ravines along the coast of the lake, and the range and quality of habitat in the region. Water quality and habitat were analyzed in terms of sub-watershed boundaries, whereas ravine erosion was analyzed ravine-by-ravine. The immediate goals of the study are to 1) prioritize sub-watersheds based on their potential to negatively impact water quality or 2) the quality and extent of habitat within their boundaries; and 3) to rank ravines based on their potential for erosion. The larger goal of the study is to serve as a tool for Lake Michigan Ecosystem Partnership, municipalities and other interested groups, such as private landowners, to make informed decisions about where to focus restoration efforts and resources in order to improve the ecology of the Lake Michigan region.

Projects

- Jane's Ravine Section 104 Estuary Habitat Restoration Program – Constructed Project

This USACE and Lake County Forest Preserve District (LCFPD) project is currently in the monitoring phase, and has restored 1000-feet of eroded, yet ecologically-significant forested ravine system. Extensive ravine slope destabilization and erosion was caused by increased stormwater entering from the surrounding urban development. The LCFPD redirected the stormwater through a series of upland vegetated swales and ponds. Ravine stream bank and slope stabilization restoration methods included the placement of channel grade control riffles, regrading and filling, and the placement of erosion control matting and coir rolls. Ecological restoration of the system included the removal of invasive trees, and the establishment of herbaceous groundcover.

- Rosewood Park Section 506 – In Design and Implementation Phase

Rosewood Park is park located on the shores of Lake Michigan in Highland Park, Illinois. It is located near Roger Williams Avenue and Sheridan Road in the Ravinia neighborhood. The restoration will encompass approximately 7-acres of unique beach, bluff, ravine, stream, and oak savanna habitat. The non-Federal sponsor is the Park District of Highland Park. The Feasibility Study was approved for Design and Implementation in November 2012.

- Ft. Sheridan Section 506 – Feasibility Phase

Four non-Federal sponsors, the Lake County Forest Preserve District (LCFPD), Openlands, the Town of Ft. Sheridan, and the City of Lake Forest have requested that the Chicago District, USACE initiate a study under WRDA 2000, Section 506, Great Lakes Fishery and Ecosystem Restoration to determine the feasibility of restoring the ecological integrity of the combined Ft. Sheridan natural areas. This study is currently evaluating the feasibility and environmental effects of restoring ravines, bluffs and littoral areas. The scope of this study addresses the issues of altered hydrology and hydraulics, native plant community preservation, invasive species, connectivity, rare wetland communities, native species richness and encourages public education. Public review of the document is scheduled for July 2013.

- Millard Park Section 506 – Federal Interest Determination Phase

The Park District of Highland Park requested that the Chicago District, USACE initiate a study under WRDA 2000, Section 506, Great Lakes Fishery and Ecosystem Restoration to determine the feasibility of restoration features to restore the ecological integrity of Millard Park. This study is currently evaluating the feasibility of restoring the ravine. Measures include day-lighting the stream from under an asphalt parking lot and connecting the fragmented stream to Lake Michigan. The scope of this study addresses the issues of altered hydrology and hydraulics, habitat fragmentation, native plant community preservation, invasive species, and native species richness.

- Ravine 8 Sanitary Sewer Replacement

The City of Highland Park recently completed the installation of a sanitary sewer along the bottom of the ravine along the beach. The sanitary sewer was backfilled with clay and the new ravine floor regraded to meet local ordinance and 404/401 permitting standards. The storm sewer at the head of the ravine was modified so that the outfall discharges to the new ravine floor. The stormsewer meets local and regional requirements.

CHAPTER 2 – INVENTORY AND FORECASTING

Consideration of ecosystems within or encompassing a watershed provides a useful organizing tool to approach ecosystem-based restoration planning. Ecosystem restoration projects that are conceived as part of a watershed initiative or other regional resources management strategies are likely to more effectively meet ecosystem management goals than those projects developed independently.

2.1 – Affected Resources

2.1.1 – Physical Resources

Climate

The climate in northeastern Illinois and southeastern Wisconsin is classified as humid continental, characterized by warm summers, cold winters, and daily, monthly, and yearly fluctuations in temperature and precipitation. Average annual rainfall is usually between 30 to 40 inches per year, with greater amounts falling between April and August. Annual seasonal snowfall averages approximately 28 inches. Early spring floods occur when snow accumulations extend into a period of increasing temperatures that result in melting. If extensive melting of accumulated snow occurs when soils are already saturated, the associated runoff increases dramatically because of the large area of impervious surfaces located within the basin, which are largely a result of urban development.

Geology & Glacial Stratigraphy

Silurian Age Bedrock – The underlying regional bedrock is Silurian-age dolomite, most likely of the Niagaran Series (Willman 1971). This rock resulted from marine deposition when all of northeastern Illinois and much of the neighboring Great Lakes region was the floor of a tropical sea from about 440 to 410 million years ago.

Wadsworth Till Member – The dominant material in the Illinois coastal zone is a compact, gray, silty and clayey till of the Wadsworth Till Member (**Plate 01**). The till may contain discontinuous layers of sand and gravel mixed with sand. This till, which is ubiquitous across the coastal zone, was deposited by glacial ice during the most recent (Wisconsinan) glacial episode. The till is exposed along the coastal bluffs, as well as the material first encountered beneath most of the soils in the area. It also occurs beneath the beach sand and it occurs on the nearshore lake bottom either beneath the nearshore sand or exposed where sand cover is absent. The cohesion of the till has contributed to the near-vertical bluffs along parts of the bluff coast.

Analysis of the till exposed in the bluffs indicate that a typical sediment size distribution is 48 percent clay, 42 percent silt, and 10 percent sand (Chrzastowski 1995). When bluff erosion occurs, only the sand-size material ultimately remains along the beaches and nearshore. The dominant clay and silt are transported offshore for eventual deposition in deep water (Colman and Foster 1994). The grayish or milky coloration that is common along the Illinois coast following times of large waves results from the suspension of the silt and clay from erosion along the bluffs or across the lake bottom.

The thickness of the till sequence above the bedrock is variable depending on the surficial landscape or lake-bottom topography compared to the subsurface bedrock topography. In general, within the Illinois coastal area, the thickest sequence of till occurs in Lake County where thickness can be 300 to 400-feet.

Highland Park Moraine – Along the coast between North Chicago and Winnetka, the lakeshore (the Zion City and Highland Park Moraines) dead-end into Lake Michigan. These end moraines formed about 14,000 years ago just prior to glacial ice permanently receding into the Lake Michigan basin. These are the youngest end moraines in Illinois. The Highland Park Moraine encompasses the entire study area. Long-term wave erosion along this morainal unit has resulted in bluffs that form the highest and steepest landscape along the Illinois coast. Maximum bluff heights of about 90-feet occur along the southern Highland Park lakeshore. The bluff slopes range from near vertical to about 45 degrees. There is considerable local variability in slope, and many segments of the bluff slope have been graded or terraced for erosion control along private lakeshore property as well as public lakeshore. A discontinuous bluff face results from a series of steep-sided, V-shaped ravines that open to the lakeshore. These ravines are cut into the morainal upland and originate as much as one mile inland from the shore. The ravines typically have intermittent streams that discharge to Lake Michigan.

Soils

Natural soils within the Ravine 8 study area have been altered for the most part. Areas of natural soil are currently present in the ravines and down the bluffs.

Beach Sands – Beach sediments along the Illinois coast consist of mixed sand, sandy gravel, and gravel. The primary source for beach sediments is erosion of the coastal sandy bluffs in Wisconsin.

Ozaukee – These soils are typically found on ground moraines, in this case the Highland Park moraine. Slopes on the plateaus range from 2 to 6% and in the ravines from 20 to 35%. These soils formed in thin loess and in the underlying loamy dense till. These soils are moderate to well drained and the potential for surface runoff ranges from medium to very high. Permeability is slow. These soils have a perched seasonal high water table at a depth of 1.5 to 3.5-feet for 1 month or more per year in 6 or more out of 10 years. Native vegetation is mixed hardwood forest of northern red oak, American basswood, white ash, and sugar maple.

Fluvial Geomorphology & Topography

Ravine 8 developed as a result of the unique geology of the Highland Park moraine intersecting with the coastline of Lake Michigan. This abrupt intersection formed a bluff as Lake Michigan's waves eroded the front face of the moraine. Rainwater falling on the moraine flowed east over this bluff and gradually carved out the ravine. Local relief is about 578-feet at the beach/water interface and a maximum elevation of 666-feet is reached along the crest of the Highland Park moraine (**Plate 02**).

Ravine Formation: As the ravines continued to deepen and widen overtime, the depth of the stream bed toward the mouth of the ravine began to attain the level of Lake Michigan. As the slope of the channel flattened out, the speed of water flowing through it slowed. The rate of channel incision and bank slumping declined, but even in mature ravines this process never stops completely; an equilibrium is maintained from sediment/detritus influx equal to the amount discharged. The heads of the ravines continue to extend landward until they run into non-erosive materials or lose their erosive power. In newly forming ravines, channel incision and mass wasting make it difficult for a diverse plant community to establish as the ravine widens and the slope of the banks decrease. Once stable, a diverse ravine specific plant community can then establish, replacing the pioneer species. Roots help to further stabilize ravine slopes by decreasing surface erosion and absorbing ground water. As the ravine further matures and widens, the rate of slumping declines, furthering the abundance of plants and trees. This positive feedback cycle eventually results in a mature ravine capable of supporting a diverse community of fungi, plants, and animals.

Littoral Processes

Seasonal variations in the dominant wind direction result in variability to the waves and currents experienced along the Lake Michigan shoreline. During the majority of the year, winds blow across the long axis of the lake from the southeast, resulting in a regional circulatory pattern moving along the Illinois shoreline in a counterclockwise direction. The resultant wave climate along this reach during this time is relatively benign. Beginning in late fall and continuing until spring, however, these trends reverse. Northerly winds drive wave fields towards the southern end of Lake Michigan, generating a significantly larger wave climate. The dominant influence by northerly waves results in a net southward littoral transport along the entire Illinois coast. Waves from the southeast can influence a northward movement of beach and nearshore sediment; however. This project is not expected to affect littoral process, but littoral process play a role in opening and closing the ravine mouths with sand in which coastal fishes have adapted to these conditions. When open during spring flood pulses, various species spawn in the ravines (lake chub, white sucker). When the ravine mouth becomes closed from the lake, they form nursery habitat for larvae and juveniles.

Land Use, Hydrology & Hydraulics

Originally formed by the erosive forces of storm water interacting with the bluffs, the ravines within the project area are the natural pathways by which watershed runoff reaches Lake Michigan. It should be recognized that many of the ravines are still in the process of forming and as a result are naturally unstable. The alterations to the hydrologic system due to urbanization, however, have resulted in accelerated erosion and degradation of this ravine system. Recent modifications of the sanitary sewer lines within the ravine addressed site erosion that had developed over time, including the placement of clay within the ravine floor to further stabilize the sewers. However, as a result of the development, the overall volume and peak discharges of storm water runoff have increased due to an increase in impervious surfaces and the introduction of permitted storm sewer outfalls (**Photo 1**). The increased volume of runoff from the subwatersheds has resulted in increased discharges to the ravines, which is resulting in modifications to the ravine structure and function and affect the ravine's ecological integrity. However, these impacts to the ravine are not the result of problems with the existing storm sewer network, or the result of a stormwater problem. Detailed description of ravine hydrology and hydraulics are included in Appendix A – Hydrology & Hydraulics.

Photo 1 – Stormwater Discharge Culvert at Head of Ravine

2.1.2 – Ecological Resources

The following is a description of the ecotypes that occur within the study area of this project. Dominant vegetation and organisms that inhabit the particular ecotype will be presented.

Aquatic Communities

Deep Water – There are no measures evaluated within this study that directly address repairing the deep water habitat of Lake Michigan; however, species that occur in the deep waters are presented to put the project into a greater context. Some of the species that primarily are found in the profundal zone and natural reefs of Lake Michigan do utilize littoral zones as well, such as the lake chub (*Couseuis plumbeus*), and the state endangered longnose sucker (*Catostomus catostomus*).

Fish data collected and specimens vouched at the Illinois Natural History Survey are presented in **Table 1**. Deep water specimens were collected from both Julian's and the Highland Park reefs. Julian's Reef is 14 miles directly east of Ft. Sheridan and the Highland Park reef is 3 miles east. Julian's Reef substrates include primarily bedrock with rubble, sand and small amounts of silt (Horns 1991), whereas the Highland Park reef consists of bedrock and cobble with its interstitial spaces filled in with sand and silt (Chotkowski & Mardsen 1995). The remaining deep water areas off the coast are primarily sand flats.

Littoral Zone – There are measures evaluated within this study that directly address providing additional structure to increase fish species richness and abundance within the littoral zone of Lake Michigan through ravine stream defragmentation. Currently, habitat consists of extensive sand flats and minor non-conformities provided by small manmade groins. Species already present within the study area are presented in **Table 1**. The most common species found along the surf zones of the beaches are the longnose dace (*Rhinichthys cataractae*), emerald shiner (*Notropis atherinoides*) and spottail shiner (*Notropis hudsonius*).

Table 1 – Fishes Collected near Ravine 8 Study Area between 1951 - 2004

Species	Common name	Deep Water	Littoral Zone	Ravine Use**
*Petromyzon marinus**	sea lamprey	X		
*Alosa pseudoharengus**	alewife		X	
*Cyprinus carpio**	common carp		X	
Couesius plumbeus	lake chub	X	X	X
Rhinichthys cataractae	longnose dace		X	X
Pimephales notatus	bluntnose minnow		X	X
Notropis atherinoides	emerald shiner		X	X
Notropis hudsonius	spottail shiner		X	X
Catostomus catostomus	longnose sucker	X	X	X
*Osmerus mordax**	rainbow smelt		X	
*Salmo trutta**	European brown trout	X	X	
Salvelinus namaycush	lake trout	X	X	
Coregonus artedi	lake cisco	X		
Coregonus hoyi	bloater cisco	X		
Lota lota	burbot	X		
Myoxocephalus thompsonii	deepwater sculpin	X		

* non-native species

Stream - There are measures evaluated within this study that address naturalizing stream flows, channel morphology and connectivity in order to increase fish species richness and abundance within the ravine. Currently, the ravine is fragmented from Lake Michigan by a manmade check dam that consists of large quarried limestone blocks and steel sheet pile. Also, instream habitat and fluvial morphology of this ravine was damaged due to increased runoff from the watershed. Fish species that could utilize the newly connected ravines are presented in **Table 5** (Section 2.3). The most common species found within other ravines along the coast of Lake Michigan are the white sucker (*Catostomus commersonii*) and longnose dace.

Macroinvertebrates – There are measures evaluated within this study that address repairing natural stream hydraulics and channel morphology in order to increase macroinvertebrate species richness and abundance. In-stream habitat and fluvial geomorphology of the ravines have been adversely impacted over the last 100-years due to the development of the watershed. Also, base flows during low periods have been reduced due to development in uplands where rainwater can no longer recharge groundwater stores.

Photo 2 – Fragmentation of Ravine 8

The most common species found within other ravines along Lake Michigan are swimming mayflies (Ephemoptera) and midges (Diptera). Both the mayflies and midges are tolerant to habitat and water quality degradation. Implemented restoration measures should improve conditions enough to increase the presence and abundance of more intolerant species such as stoneflies (Plecoptera) and caddisflies (Trichoptera). Taxa collected from Millard Park Ravine in 2011 included:

- ϕ Amphipoda scud
- ϕ Odonata: Anisoptera dragonfly
- ϕ Odonata: Calopterygidae broadwinged damselfly
- ϕ Ephemeroptera: Baetidae/Siphlonuridae swimming mayfly
- ϕ Trichoptera: Hydropsychidae hydropsychid caddisfly
- ϕ Trichoptera caddisfly
- ϕ Coleoptera: Elmidae/Dryopidae riffle beetle
- ϕ Diptera: Tipulidae crane fly
- ϕ Diptera: Chironomidae midge
- ϕ Diptera: Simuliidae black fly
- ϕ Gastropoda left-handed snail

Three nearby ravines, McCormick Ravine, Bartlett Ravine and Schenck Ravine, were surveyed on October 4, 2012 for woodland arthropods:. Schenck and McCormick both had close canopy represented by *Acer* (maple), and *Quercus* (oak) and *Betula* (Burch). A total of 73 taxonomic species were identified in this course survey, varying between Class, Order, Family, Genus, and Species. McCormick ravine had the largest richness of taxonomic species with a total of 56, while Schenck had 55 and Bartlett had 44. Bartlett represented a large contrast form both Schenck and McCormick, representing the smallest taxonomic richness of the three sites. This is due to the lack of accumulation of litter mass at the base of the ravine. The cement drainage ditches and the vehicle road at the base of Bartlett limits the accumulation of leaf litter and detritus, a key habitat and food source for a large detrital arthropod community. The potential arthropod community, shown in **Table 2,** could be reestablished within Ravine 8 if restoration measures were to be implemented.

Table 2 – Macroinvertebrates Collected from Schenck, Bartlett and McCormick Ravines

TAXONOMIC UNIT	Schenck	Bartlett	McCormick
ARACHNIDA: Class			
Araneae: Spider Families			
Araneidae	P	P	P
Clubionidae	P	P	P
Corinnidae	P		
Dictynidae	P	P	P
Hahniidae			P
Linyphiidae	P	P	P
Lycosidae	P	P	P
Salticidae	P	P	P
Tetragnathidae	P	P	P
Thomisidae	P	P	P
Xysticus sp.	P	P	P
Opiliones-Order	P		P
Pseudoscorpion-Order	P	P	P
INSECTA: Class			
Coleoptera: Beetle Families			
Carabidae	P	P	P
Chrysomelidae	P		
Diabrotica undecimpunctat		P	P
Coccinella septempuctata		P	
Harmonia axyridis		P	
Curculionidae	P	P	P
Leiodidae	P		P
Lampyridae	P		P
Scarabaeidae			P
Hydrophylidae			P
Nitidulidae	P	P	P
Staphylinidae- Sub-families			
*Aleocharinae	P		
*Steninae		P	
*Oxyporinae			
Oxyporus rufipennis			P
*Staphylininae	P	P	P
*Scaphidiinae			P
*Paederinae	P		P
*Oxytelinae			P
*Pselaphinae			P
*Tachyporinae	P		
*Ptiliidae			
Acrotrichis sp.	P		P
Blattodea-Order		P	
Dermaptera- Order		P	P
Forficula auricularia	P		
Diptera: Fly Families			
Syrphidae	P		
Hemiptera: Families			
Aphidoidea (Superfamily)	P	P	P
Reduviidae	P	P	P
Tingidae	P		P
Cicadellidae	P		P
Miridae	P	P	
Pentatomidae	P	P	P
Gerridae			P

TAXONOMIC UNIT	Schenck	Bartlett	McCormick
Hymenoptera: Families			
Apidae	P	P	P
Vespidae			
Vespula pensylvanica	P		P
Formicidae-Ant genera			
Amblyopone sp.			P
Myrmecina sp.	P		
Myrmica sp.	P		P
Prenolepis sp.	P	P	P
Tetramorium sp.	P	P	P
Lepidoptera- Order	P	P	P
Mantodea -Order			
Tenodera aridifolia	P		
Orthroptera- Order			
Melanoplus differentialis	P	P	P
Thysanoptera- Order	P	P	P
MIRIOPODA -Class			
Diplopoda: Millipede Families			
Paradoxosomatidae	P	P	P
Polycenidae			
Polyxenus sp.		P	
Parajulidae	P	P	
Polyzoniidae			P
Chilopoda: Centipede Orders			
Geophilomorpha	P	P	P
Lithobiomorpha	P	P	P
ENTOGNATHA -Class			
Collembola: Families			
Entomobryidae	P	P	P
Isotomidae	P	P	P
Tomoceridae	P		P
Hypogastruridae	P	P	P
Diplura -Order	P	P	P
MALOCOSTRACA Class			
Isopoda: Species			
Armadillidium nasatum		P	
Haplophthalmus danicus?**	P		P
Hyloniscus riparius	P	P	P
Philoscia muscorum?**	P	P	
Tracheoniscus rathkei	P	P	P
Trichoniscus pygmaeus	P	P	P
TOTAL TAXONOMIC UNITS:	**55**	**44**	**56**

The letter (P) represents a presence of that taxonomic unit at the each site. The (*) represent sub-family level identification. The (**) represents new state record.

Resident & Migratory Birds

The Ravine 8 study area resides within a band of important state natural areas and parks that span Lake County, Illinois. These natural areas serve as a crucial foraging and breeding grounds along the Lake Michigan flyway, which is an important migration route for many songbirds. The flyway provides a visual north-south sight line, the coast of Lake Michigan, which the birds have evolved to follow as they undergo migration. During the migration periods, March to May and September to mid-October, more than five million song birds are believed to traverse this flyway.

Over seventy four (74) species of bird were recorded within the North Shore Ravine area during lakefront bird surveys at various points of the year (**Table 3**). Of these species, Bald Eagle, Brewer's blackbirds, Broad-winged Hawk, Golden Eagle, Grasshopper Sparrow, Gyrfalcon, Long-Tailed Duck, Mississippi Kite, Red Headed Woodpecker, and Smith's Longspurs are listed as species of concern by the National Audubon Society.

Table 3 – Birds Observed Along the Coast and Ravines

Common Name	Resident	Migratory	Rare/Concern		Common Name	Resident	Migratory	Rare/Concern
American Crow		X			Indigo Bunting		X	
American Goldfinch		X			Lesser Scaup		X	
American Kestrel		X			Long-Tailed Duck		X	X
Bald Eagle		X	X		Louisiana Waterthrush		X	
Baltimore Oriole		X			Merlin		X	
Barn Swallows		X			Mississippi Kite		X	X
Bay-breasted Warbler		X			Northern Flicker		X	
Black Scoter		X			Northern Goshawk		X	
Blackburnian Warbler		X			Northern Harrier		X	
Blue Jay		X			Northern Mockingbird		X	
Blue-winged Teal		X			Orchard Oriole		X	
Brewer's Blackbirds		X	X		Osprey		X	
Broad-winged Hawk		X	X		Peregrine Falcon		X	
Brown Creeper		X			Prairie Falcon		X	
Brown Thrasher		X			Purple Finch		X	
Bufflehead		X			Red Bellied Woodpecker		X	
Caspian Terns		X			Red Knot		X	
Common Goldeneye		X			Red-Headed Woodpecker		X	X
Common Night Hawks		X			Red-shouldered Hawk		X	
Common Tern			X		Red-tailed Hawk		X	
Connecticut Warbler		X			Ring-bill Gulls	X		
Cooper's Hawk		X			Rough-legged Hawk		X	
Cormorant		X			Sharp-shinned Hawk		X	
Eastern Kingbird		X			Short-eared Owl		X	
Eastern Phoebe		X			Smith's Longspurs		X	X
Eastern Towhee		X			Snowy Bunting		X	
Eastern Wood Peewee		X			Snowy Owls		X	
Ferruginous Hawk		X			Solitary Sandpiper		X	
Forester's Tern			X		Spotted Towhee		X	
Golden Eagle		X	X		Swainson's Hawk		X	
Grasshopper Sparrow		X	X		Tree Swallow		X	
Great Blue Heron		X			Turkey Vulture		X	
Great Crested Flycatcher		X			Warbling Vireo		X	
Green Teal		X			Willow Flycatcher		X	
Gyrfalcon		X	X		Winter Wren		X	
Horned Grebes		X			Yellow-breasted Chat		X	
Horned Lark		X			Yellow-throated Warbler		X	

Mammalian Community

The Ravine 8 study area provides suitable habitat for common "urban" wildlife species, including whitetail deer (*Odocoileus virginianus*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), possum (*Didelphis marsupialis*), thirteen-lined ground squirrel (*Citellus tridecemlineatus*), gray squirrel (*Sciurus carolinensis*), cottontail rabbit (*Sylvilagus floridanus*), and striped skunk (*Mephitis mephitis*).

Plant Communities

Ravine – The evolution of the study area's ravines has shaped a unique environment with impressive flora. A multitude of factors contribute to the high diversity of plant species found within the higher quality ravines of which include the underlying glacial substrate, close proximity to Lake Michigan, varying slope inclinations and natural instabilities, and presence of groundwater seeps.

The wide range of niches provided by the ravines support a suite of rare and conservative plant species including graminoids such as long-awned wood grass (*Brachyelytrum erectum*), black-seeded rice grass (*Oryzopsis racemosa*), silky wild rye (*Elymus villosus*), purple-sheathed graceful sedge (*Carex gracillima*), long-stalked hummock sedge (*Carex pedunculata*), and slender satin grass (*Muhlenbergia tenuifolia*); forbs such as seneca snakeroot (*Polygala senega*), big leaved aster (*Aster macrophyllus*), yellow pimpernel (*Taenidia integerrima*), red baneberry (*Actaea rubra*), bishop's cap (*Mitella diphylla*), large-leaved shinleaf (*Pyrola elliptica*), broad-leaved goldenrod (*Solidago flexicaulis*), and spikenard (*Aralia racemosa*); and ferns such as spinulose sheath fern (*Dryopteris spinulosa*), maidenhair fern (*Adiantum pedatum*), and lady fern (*Athyrium filix-femina michauxii*). However, high quality areas harboring these conservative species have been significantly degraded because of increased runoff, fire suppression, and exacerbated rates of soil erosion which has caused an increase in bare ground and invasive species establishment – areas becoming dominated by common buckthorn (*Rhamnus cathartica*), exotic honeysuckles (*Lonicera* spp.), garlic mustard (*Alliaria petiolata*), tall fescue (*Festuca elatior*), black locust (*Robinia pseudoacacia*), and Japanese barberry (*Berberis thunbergii*).

A diverse canopy of trees and shrubs exists within the ravines, allowing various amounts of sunlight over different slope inclinations to reach the ravine's understory. Red oak (*Quercus rubra*), white oak (*Quercus alba*), sugar maple (*Acer saccharum*), blue beech (*Carpinus caroliniana virginiana*) and hop hornbeam (*Ostrya virginiana*) make up the majority of trees, while a diverse shrub strata consists of witch hazel (*Hamamelis virginiana*), dwarf honeysuckle (*Diervilla lonicera*), alternate-leaved dogwood (*Cornus alternifolia*), round-leaved dogwood (*Cornus rugosa*), serviceberry (*Amelanchier arborea*), and maple-leaved arrow wood (*Viburnum acerifolium*). The ravine's understory, dependant on an open canopy of trees, has suffered from an increasing amount of shade as invasive and opportunistic woody species have become more dominant such as common buckthorn (*Rhamnus cathartica*), glossy buckthorn (*Frangula alnus*), black locust (*Robinia pseudoacacia*), Norway maple (*Acer platanoides*), white mulberry (*Morus alba*), green ash (*Fraxinus lanceolata*), cottonwood (*Populus deltoides*), and basswood (*Tilia americana*).

The ravines are also known for their abundance of spring ephemerals including sharp-leaved hepatica (*Hepatica acutiloba*), early meadow rue (*Thalictrum dioicum*), large-flowered trillium (*Trillium grandiflorum*), red trillium (*Trillium recurvatum*), bellwort (*Uvularia grandiflora*), bloodroot (*Sanguinaria canadensis*), and jack-in-the-pulpit (*Arisaema triphyllum*). Soil erosion, fire suppression, and an increase in invasive species have also significantly impacted populations of spring ephemerals.

The current conditions of Ravine 8 as compared to the higher quality ravines described in the preceding paragraphs is significantly less rich and diverse as evident from the difference in species composition. Fifty-one (51) species were identified from Ravine 8 in early November 2012 (**Plate 03**). There were 27

native species and 24 non-native species recorded that give the site a Conservatism Coefficient (Mean C) for all species of two (2). Common invasive species include garlic mustard (*Alliaria petiolata*), Norway maple (*Acer platanoides*), Canadian thistle (*Cirsium arvense*), common dandelion (*Taraxacum officinale*), European buckthorn (*Rhamnus cathartica*), and European privet (*Ligustrum vulgare*). High quality native species present are minimal, but do include large-leaf wood aster (*Eurybia macrophylla*), sweet-scented joe-pye-weed (*Eutrochium purpureum*), American witch hazel (*Hamamelis virginiana*), northern red oak (*Quercus rubra*), and zig-zag golden rod (*Solidago flexicaulis*).

Photo 3 – Ravine 8 Current Vegetation Cover

Bluff – The unique climate and erosive-prone clay bluff within the study area welcomes an interesting suite of native plants that have evolved to withstand its harsh conditions. Rare northern boreal species have found suitable habitat within the bluff such as paper birch (*Betula papyrifera*), buffalo berry (*Shepherdia canadensis*), and common juniper (*Juniperus communis*). The wooded areas on the bluff inhabit species such as eastern white cedar (*Thuja occidentalis*), red oak (*Quercus rubra*), hop hornbeam (*Ostrya virginiana*), ninebark (*Physocarpus opulifolius*), golden alexanders (*Zizia aurea*), white baneberry (*Actaea pachypoda*), red honeysuckle (*Lonicera dioica*), wood betony (*Pedicularis canadensis*), and common oak sedge (*Carex pensylvanica*).

A few extant shrub prairies occur on the bluff where stands of buffalo berry (*Shepherdia canadensis)* and common juniper (*Juniperus communis*) occur along with the following species: veiny pea (*Lathyrus venosus*), false toadflax (*Comandra umbellata*), ivory sedge (*Carex eburnea*), golden sedge (*Carex*

aurea), prairie brome (*Bromus kalmii*), spreading dogbane (*Apocynum androsaemifolium*), smooth blue aster (*Aster laevis*), and stiff gentian (*Gentiana quinquefolia occidentalis*).

Just as the ravines have become heavily shaded, the bluff has degraded from fire suppression, in turn degrading the rich herbaceous understory which has increased rates of soil erosion. Invasive and native species are for the most part the same for the bluff as the ravine (**Plate 03**).

Photo 4 – Bluff & Dune Current Vegetation Cover (*Leymus arenarius* European Lyme Grass)

Beach and Dune – The study area has little space between the shore of Lake Michigan and the bluff's toe, but in places where enough sand accumulates, small formations of beach communities can be found. Where the beach is disturbed by winter waves and less so by waves of summer, a collection of annual plants begin colonizing the area including winged pigweed (*Cycloloma atriplicifolium*), sand grass (*Triplasis purpurea*), and the state listed seaside spurge (*Chamaesyce polygonifolia*) and sea rocket (*Cakile edentula*). More stable areas further inland, but still within active moving sand are stands of state listed, dune-forming marram grass (*Ammophila breviligulata*).

The current conditions of the study area bluff as compared to the higher quality bluff sections described in the preceding paragraphs is far more degraded as evident in the species composition. Twenty species were identified from Ravine 8 in early November 2012 (**Plate 04**). There were 11 native species and 9 non-native species recorded that give the site a Conservatism Coefficient (Mean C) for all species of one and a half. Common invasive species include garlic mustard (*Alliaria petiolata*), European lyme grass (*Leymus*

arenarius), ground ivy (*Glechoma hederacea*), European buckthorn (*Rhamnus cathartica*), and European privet (*Ligustrum vulgare*). High quality native species present are minimal, but do include marram grass (*Ammophila breviligulata*) and American sea rocket (*Cakile edentula*).

Threatened & Endangered Species

The County Distribution of Federally-listed Threatened, Endangered, Proposed and Candidate Species was reviewed for Lake County by the Chicago District. The following federally listed species and their critical habitats are identified by the USFWS as occurring within Lake County:

- Piping plover (*Charadrius melodus*) – Endangered – Wide, open, sandy beaches with very little grass or other vegetation
- Eastern massasauga (*Sistrurus catenatus*) – Candidate – Graminoid dominated plant communities (fens, sedge meadows, peat lands, wet prairies, open woodlands, and shrublands)
- Karner blue butterfly (*Lycaeides melissa samuelis*) – Endangered – Pine barrens and oak savannas on sandy soils and containing wild lupines (*Lupinus perennis*), the only known food plant of the larvae
- Eastern prairie fringed orchid (*Platanthaera leucophaea*) – Threatened – Moderate to high quality wetlands, sedge meadow, marsh, and mesic to wet prairie.
- Pitcher's thistle (*Cirsium pitcheri*) – Threatened – Lakeshore dunes

Habitats that will be restored through this project include stream, ravine, bluff, and foredune. Recent surveys done by the USACE Chicago District and other state and local agencies found no Federally threatened or endangered species or viable critical habitats within the restoration site. For these reasons, we conclude the Ravine 8 Section 506 Restoration Project will have “no effect” on listed species or proposed or designated critical habitat.

Two plant, 2 fish and 1 bird species that are state listed (**Table 4**). The marram grass is specific to the foredune and sea rocket is specific to the zone between the surf and the foredune. The longnose sucker and lake herring are specific to deep water and littoral zone of Lake Michigan; however, it is possible that longnose sucker would utilize the ravines as spawning habitat. The common tern is specific to the littoral zone for foraging and it appears there is not suitable breeding habitat currently within the study area for this species.

Table 4 – Threatened & Endangered Species Recorded from Study Area.

Species	Common Name	Status
Ammophila breviligulata	marram grass	SE
Cakile edentula	sea rocket	ST
Catostomus catostomus	longnose sucker	ST
Coregonus artedii	lake herring	ST
Sterna hirundo	common tern	ST

2.1.3 – Cultural Resources

Social Properties

The City of Highland Park is located about 25 miles north of Chicago in Lake County, Illinois. Communities surrounding Highland Park include Highwood, Glencoe, Deerfield and Bannockburn. Highland Park is primarily a white upper middle-class residential community of about 12.5 square miles and about 31,300 residents. In 2010 the median home value was $467,500; and the median household income was $157,700.

Archaeological & Historical Properties

There are no archaeological or historic properties within the study area boundaries. The Illinois Historic Preservation Agency was consulted with a letter dated November 15, 2012. Native American groups having an historic cultural interest in northeast Illinois were consulted with letters dated November 15, 2012 as well. In the event that cultural remains are discovered during the project, the Chicago District Archaeologist will be notified immediately and work will cease to allow for consultations with the Illinois State Historic Preservation Agency to take place.

There are 43 properties and four historic districts listed on the National Register of Historic Places located within Highland Park. Only two properties, the Granville-Mott House (listed in 1982) and the Mary W. Adams House (listed in 1982) are located near the project area on the north side of Ravine 8. Neither of these properties will be affected by this project.

Land Use History

The Highland Park area was settled primarily by people from Ohio and New York State in the early 1840s. The area that now comprises Highland Park was originally two separate settlements, Port Clinton and St. Johns. The area remained a farm and lake port based community until 1855 when the Chicago and Milwaukee Railroad were constructed through the area. This attracted additional settlement, and in 1869 the two settlements were merged and incorporated as Highland Park. The town became a popular area for summer homes with the Chicago elite. Today it remains an upscale bedroom community for Chicago.

Recreational Activities

The Park District of Highland Park, founded in 1909, operates and manages over 650-acres of land in 44 park areas, and offers approximately 3,000 recreation and seasonal programs. Facilities include an indoor ice arena, tennis and racquetball complex, two recreation centers, a nature center, an 18-hole golf course, driving range, adventure golf, aquatic park, indoor pool, beaches, boat launch ramp and yacht club on Lake Michigan. None of these features are within the study area boundaries.

Beach Open Space – Central Park is located 550-feet to the north of Ravine 8 where there is beach access; however, beach use is low in this area. Beach combing with machinery does not occur and only requires minor flotsam and jetsam to be removed by hand.

Ravine Open Space – The city's Steep Slope Ordinance Article IXI states that:

"The topography of the City of Highland Park is occupied by an abundance of ravines and bluffs. These areas exhibit steep slopes which may contain unstable sediment, rock and soils. Development on potentially unstable soils or other rock can be hazardous to life and property. Development in these areas

should utilize construction methods which minimize the impact upon or removal of vegetation, including Trees, and ensure slope stabilization and minimize erosion.

The City's ravines and bluffs are valuable scenic resources which should be preserved and the steep slopes associated with these areas should be protected in order to preserve the City's unique visual setting, promote its economic well-being, and encourage architectural splendor.

Regulating the intensity of development according to the natural characteristics of steep slope terrain, such as degree of sloping, significant vegetation, and soil stability and existing drainage patterns, will allow for suitable development while minimizing the physical impact of such development on sensitive ravine and bluff steep slope areas. (Ord. 38-01, J.27, p. 146-167, passed 6/25/01; Ord. 26-08, J. 34, p. 050-068, passed 4/14/08)."

The main intent for the ravines in Highland Park is to maintain them as a natural and open space resource. Although people are allowed to own the ravines, they are protected enough to maintain them as natural areas. This green space would benefit from an ecological restoration project via visual aesthetic improvement and an increase in migratory and local bird activities. Bird watching is a significant activity that occurs along the entire coastline of Lake Michigan in Illinois since it is a significant route of the Mississippi Flyway.

2.1.4 – Hazardous, Toxic & Radioactive Waste (HTRW) Analysis

A HTRW investigation was performed to determine if the selected measures for the Ravine 8 Restoration Project will have an impact on any Recognized Environmental Conditions (RECs) that may exist in the surrounding areas, and if RECs will have an impact on the implementation of the project. According to ER 1165-2-132, non-HTRW issues that do not comply with federal, state, and local regulations should be discussed in the evaluation along with HTRW issues.

During the investigation, existing environmental data were examined in order to determine risks associated with the project site. Historical aerial photographs, USGS topographic maps, and Sanborn fire insurance maps all indicate that the area surrounding the project site has always been residential. The database search did not indicate any surrounding sites that are likely to pose concerns to the project. The site visit did not reveal any RECs at the project site. The City of Highland Park maintains a sanitary sewer line under the ravine. The Ravine 8 Project will ensure the protection of the City of Highland Park's work.

Based on this information, the investigation concluded that the work proposed for the Ravine 8 Project site has little potential for encountering a REC. No investigation can wholly eliminate uncertainty regarding the potential for encountering RECs associated with a project area. Performance of this investigation is intended to reduce, but not eliminate, uncertainty regarding the potential for encountering a REC in connection with a project area.

2.2 – Problems and Opportunities

The overall problem within the study area is the decrease in biodiversity. Biodiversity is used to describe aspects of biological variety including species richness, ecosystem complexity and genetic variation. Biodiversity is degraded as a result of hydrogeomorphic function, fluvialgeomorphic function, littoral processes and land use change.

Ecosystem is a term used to describe organisms and their physical and chemical environments and can be described and delineated at various scales. For example, a pond or an ocean can be equally referred to as an ecosystem. Communities are naturally occurring groups of species that live and interact together as a relatively self-contained unit, such as a sedge meadow. Habitat refers to the living space of an organism or community of interacting organisms, and can be described by its physical or biotic properties, such as substrate, woody debris or a depression. Ecosystems may contain many communities and habitat types. These are usually assessed by describing and/or quantifying the physical structure, function and/or present organism community contained in the area of interest. They may also be assessed at various scales, depending on the level of resolution needed to answer specific questions. To achieve the objectives of the proposed project, the different types of ecosystems or communities contained in the study area were described and delineated based on their respective geomorphic position, soils series, dominant species assemblages and physical structure of respective habitats.

Historically, the Highland Park moraine was dominated by several naturally occurring communities including wetlands, forests, savannas and prairies. By the late 1800s, many of these communities, particularly prairies, savannas and wetlands, were converted to agricultural, urban or industrial use. Subsequently, there was a significant loss of biodiversity and adverse physical effects such as an increase in flooding events and a decrease in water quality. Human induced disturbances to the remaining natural areas include fire suppression, altered hydrology and hydraulics, increase colonization of invasive species, urbanization pressures and fragmentation. While plant communities can be described in terms of dominant organisms, the quality of their habitat is directly related to the level at which natural processes function, such as groundwater discharge, fire or fluvial erosion and deposition. Habitat quality displays a negative relationship to the amount of human disturbance, in which the disturbance affects natural areas in direct or indirect ways.

Dune & Bluff – Recreation and development has allowed invasive nonnative species to colonize these altered areas that no longer provide suitable life requisites for native species. Lacustrine process of littoral drift and wave/current patterns have been altered from their natural state through shoreline development; the construction of harbors, break walls, jetties, piers, etc. Coastal habitat can no longer rely on the natural replenishment and movement of sand down the coast since these structure now intercept a great deal of the material. Sand flats are located far enough from the shore as to not be effected by this; however, near shore, beach, dune and bluffs are dramatically affected by these altered conditions. Specific problems with primary ecosystem drivers include:

- Altered hydraulics and littoral drift from manmade infrastructure
- Altered coastal geomorphology from manmade infrastructure and land use
- Altered coastal geomorphology from non-native plant species colonization

Based on these problems with the ecosystem drivers the following are specific resulting ecological problems for the Ravine 8 study limits:

- Reduced richness and abundance (quality) of the native species per community type
    - Dune/Beach loss of over 20 species
    - Bluff loss of over 50 species
- Reduced richness and abundance of higher level organisms including insects, amphibians, reptiles, birds and mammals

Opportunities to remedy these issues and return some stability in terms of littoral sands exist. Based on the problems for the Ravine 8 study limits, the following opportunities exist to improve ecological diversity within the beach, dune and bluff communities:

- Manipulation of the plant community to increase size of beach and dune habitat through root matrix establishment of dune grasses
- Address invasive plant species issues to increase quality of dune and bluff habitat
- Increase quantity and improve quality of habitat for hundreds of migratory and resident birds

Ravine – The development of the ravine's watershed is primarily responsible for the ravines' continued degradation. The proliferation of impervious surfaces and turf grass within the subwatersheds of these north shore ravines has greatly increased the rainfall runoff. The result is an increase in channel erosion. Specific problems with primary ecosystem drivers include:

- Altered watershed hydrology from urbanization
- Altered stream hydraulics from storm water resultant of urbanized hydrology
- Altered fluvialgeomorphic processes from storm water and failed in channel BMPs
    - Channel degradation
    - Channel aggradation
- Altered hydrology, hydraulics and geomorphology from check dam at mouth of ravine
- Altered hydrology and geomorphology from invasive plant and tree species
    - Large amounts of unnatural woody debris & leaf litter
    - Unnatural erosion
    - Evapotranspiration irregularities

Based on these problems with the ecosystem drivers above, the following are specific resulting ecological problems for Ravine 8:

- Reduced length (quantity) of accessible stream habitat (fragmentation) ~800-feet
- Reduced richness and abundance (quality) of the native species per community type
    - Ravine (stream) loss of about 32 species of fishes
    - Ravine (ravine slopes) loss of over 100+ species
- Reduced richness and abundance of higher level organisms including insects, amphibians, reptiles, birds and mammals

Opportunities to remedy these issues and return stability in terms of ravine incision exist. Based on the problems for the Ravine 8 study limits, the following opportunities exist to improve ecological diversity within the ravine and riparian communities:

- Manipulation/removal of manmade structures to increase length of accessible stream to fishes
- Manipulation/removal of storm water to reduce unnatural flows within ravines
- Address acute problems caused by hydraulic issues within the ravines
    - Attenuate channel incision to natural rate
- Address invasive plant species issues to increase quality of ravine habitat
- Increase quantity and improve quality of habitat for hundreds of migratory and resident birds

2.3 – Habitat Assessment Methodology

Many methods are available to measure current ecosystem resource conditions and to predict future conditions of those resources. Habitat assessment methods developed for individual species may have limitations when used to assess ecosystem restoration problems and objectives. They do not consider communities of organisms and typically consider habitat in isolation from its ecosystem context. The assessment methodology selected for this study is community based and governed by how well the technique meets the needs of the study goals, objectives, and level of detail. The assessment methodology, or Habitat Suitability Index (HSI), focuses on native species richness and function of plant

and fish communities. This HSI was developed to assess the ecological value of the proposed future without-project condition and any proposed management measures for Ravine 8. This index is based on how native species of plants and fish will respond to a given condition and will be quantified through use of the Floristic Quality Assessment (FQA) and native fish species richness (R). There was no weighting per community type since each part of the coastal ecosystem is just as important as the other. The FQA is a regionally approved model for USACE use and fish species richness is currently under review.

Floristic Quality Assessment

The determination of "quality" with respect to plant assemblages has been the subject of much research and development since the mid 1970's. Quality, as used in this study, is essentially an assessment of the degree to which native plant species are present within defined plant communities. Plants are exceptional indicators of short and long term disturbance in terms of habitat function and structure. Out of the approximate 2,500 plant species known to occur in the Chicago Region, around one-third were not present before European colonization. Non-native species did not evolve within the same environmental conditions as the native species, and their persistence indicates a certain degree of functional disablement. Numerically describing the quality of an area using vegetation reflects the level of disturbance to the biological integrity of the site. In the Chicago Region, there is one commonly used approach that attempts to describe plant community quality with a simple numerical metric, which is the FQA (Swink and Wilhelm 1979). This assessment tool was designed to be used as an all inclusive method, not just as a way to identify high quality sites. The FQA was originally developed for the Chicago Region, but has since been developed for regions and states throughout North America. This method has been extensively studied and shows great promise as a quick and easily understood method of assessing the quality of plant communities.

The FQA method specifically excludes the use of "indicator" species, instead assessing the sensitivity of individual plant species that inhabit an area. Species "conservatism" is used as its basis for assessment; conservatism being known as a level of tolerance each plant species exhibits to disturbance type, amplitude, and frequency, as well as fidelity to specific habitat types. As an area's equilibrium is disturbed, the habitat's capacity to absorb disturbance is weakened and the first plants lost will come from the high end of the conservatism spectrum. Therefore, what is being measured is the extent to which an area supports conservative native plants.

Based on species inventory, the FQA generates two essential metrics: the Mean C, which is the average coefficient of conservatism for a site, and the FQI, which is derived by multiplying Mean C by the square root of the number of native species inventoried,

$$FQI = \overline{C}\sqrt{N}$$

where C is the coefficient of conservatism and N is the species richness. The FQI, therefore, is a function of both conservatism (function) and species richness (structure). Typically, larger sites have a greater number of habitat types and likely will have greater species richness. Generally, both mean C and FQI values are considered in the evaluation of an area or landscape unit. Based on statistical analysis of previous studies, the FQI shows a significant positive relationship to species richness (Ervin et al. 2006) and as such the Mean C value represents the more comparable and accurate metric.

Each native species has been assigned a coefficient of conservatism (C), ranging from 0 to 10. C values were assigned to species within a predefined geographic area by Swink and Wilhelm (1979). A 0 is assigned to species that are highly tolerant to disturbance and are considered general in their habitat distribution and a 10 is assigned to species with a very low tolerance to disturbance which display very

specific relationships to certain habitat types. The following descriptions of categories were used to assign coefficients of conservatism to native plant species:

- 0-3 Wide range of ecological tolerance and found in a variety of conditions
- 4-6 Mid range of ecological tolerance and a smaller variety of conditions
- 7-8 Low range of ecological tolerance and associated with advanced succession
- 9-10 Very low range of ecological tolerance and niche specific

It has been demonstrated that sites with mean C and Floristic Quality Index (FQI) values less than 2.8 and 20 respectfully, as surveyed during the growing season, are degraded or derelict plant communities. Sites with mean C values that approach 3.2 are considered to be moderately disturbed. When site inventories yield mean C values greater than 3.4 or higher, one can be confident that there is sufficient native character present for the area to be at least regionally noteworthy - such landscapes are essentially irreplaceable in terms of their unique composition of remnant biodiversity. Sites with mean C and FQI values greater than 4.0 and 50, respectively, are rare and indicate highly significant natural areas of statewide importance.

With an active land management plan and time, the mean C and FQI values will reflect the extent to which conservative species are being recruited and the floristic quality is improving. In this way, the FQA method can be used to assess restoration management decisions, as well as to document floristic changes (positive or negative) in the landscape over time.

Fish Species Richness & Abundance

This portion of the assessment uses fish species richness (R), which is the total number of native fish species. An assessment was done utilizing the Fishes of the Chicago Region database, which is a robust dataset comprised of fish collection vouchers stowed primarily at the Field Museum on Natural History, the Illinois Natural History Survey and the University of Michigan from 1895 – 2007. One hundred and fifty six (156) fish collections were queried from the whole coast line of Lake County, IL and from two similar streams just north of the study in Kenosha County, WI (**Table 5**).

Table 5 – Projected Fish Species Richness for Ravine Habitat Restoration

Species	Ravine R		Species	Ravine R
Acipenser fulvescens			*Luxilus cornutus*	1
Ambloplites rupestris	1		*Micropterus dolomieu*	1
Ameiurus melas	1		*Micropterus salmoides*	1
Ameiurus natalis	1		*Moxostoma erythrurum*	1
Ameiurus nebulosus			*Moxostoma anisurum*	
Anguilla rostrata			*Moxostoma macrolepidotum*	
Catostomus catostomus	1		*Myoxocephalus thompsonii*	
Catostomus commersonii	1		*Notemigonus crysoleucas*	1
Coregonus artedi			*Notropis atherinoides*	1
Coregonus clupeaformis			*Notropis dorsalis*	1
Coregonus hoyi			*Notropis heterodon*	
Cottus bairdii	1		*Notropis heterolepis*	
Cottus cognatus			*Notropis hudsonius*	1
Couesius plumbeus	1		*Notropis stramineus*	1
Culaea inconstans	1		*Noturus gyrinus*	
Dorosoma cepedianum			*Perca flavescens*	
Erimyzon sucetta			*Percopsis omiscomaycus*	
Esox americanus	1		*Phoxinus erythrogaster*	
Esox lucius			*Pimephales notatus*	1
Etheostoma exile			*Pimephales promelas*	1
Etheostoma microperca			*Pomoxis annularis*	
Etheostoma nigrum	1		*Prosopium cylindraceum*	
Fundulus diaphanus	1		*Pungitius pungitius*	1
Gasterosteus aculeatus	1		*Rhinichthys cataractae*	1
Lepomis cyanellus	1		*Rhinichthys obtusus*	1
Lepomis gibbosus	1		*Salvelinus namaycush*	
Lepomis macrochirus	1		*Semotilus atromaculatus*	1
Lota lota	1		*Umbra limi*	1
			Total Species Richness, R	**32**

It was determined from these historic collections that about 32 native species have in the past utilized ravine stream habitat. Several species that formerly used ravines were listed but not counted, such as blacknose shiner, since the chance of these rare and sensitive species recolonization is not likely.

Habitat Suitability Index

Habitat outputs for the future without and future with project condition were estimated over the entire 50 year period of analysis. In order to restore the ecosystem within the study area, both ecosystem function and structure were addressed through the two methods described above. These predicted benefits are resultant of the measures described in Section 3.1. The following were used for the HSI:

- Dune HSI = (C)
- Ravine/Bluff HSI = (R_R/3.2 + C)/2

where R_R = ravine species richness, and C = coefficient of native plant conservatism. To make the ravine species richness equivalent to the coefficient of conservatism, species were divided into bins of ten (10);

so an increase in the plant mean C of 1 point is equivalent to an increase of 3.2 species for ravine. Total habitat outputs, in terms of habitat units (HUs) were calculated by multiplying the affected area times the habitat suitability index:

$$HUs = A(HSI)$$

where A is the affected habitat area expressed in acres.

2.4 – Future Without-Project Conditions (FWOP)

The future without project condition, in general, is expected to further decline for the dune, bluff and ravine habitat within the Ravine 8 study area (**Table 6 & Figure 1**). The City of Highland Park has already repaired the failing sanitary sewer and major erosion issues, but does not have the means to ecologically restore the ravine. The community has installed and maintains sanitary sewers in accordance with municipal and country storm water ordinances and is in compliance with 404/401 permitting. Increased rainfall-runoff and the topography of the ravines exacerbate the impacts of increased flows that discharge to the ravine by surface runoff as well.

The ravine would remain fragmented from the lake and greatly affected by excessive urban runoff. Habitat diversity in the ravine would remain low, preventing many floral and faunal species from utilizing the area while providing conditions for weedy and invasive species to remain dominant and increase in abundance as time progresses. The continuation of maintaining the ravine as a drainage conduit would prevent ecological rebound, in which case, would cause further degradation in ecologically significant patches within the study area. Overall, biological diversity would remain low within the ravine because of the lack of channel connectivity, complexity and stability, which is caused by the altered fluvial hydraulics.

The bluff along the entire Highland Park moraine is in need of invasive species removal and native plant reestablishment. Without a Federal project, this needed activity cannot be accomplished effectively across the 500-foot reach. The continuation of allowing large patches of invasive species to be present would prevent ecological rebound and in some cases would cause further degradation in ecologically significant patches along the bluff within the study area. Overall, biological diversity would remain low along the bluffs because of the lack of habitat complexity and stability that native plants would provide.

Table 6 – Future Without-Project Conditions for the Three Habitat Zones

Description	R	Mean C	AAHSI	Acres	AAHUs
Dune		1.45	1.51	0.5	0.8
Ravine/Bluff		2.02	1.23	3.16	3.9
Stream*	0		0	0.08	0

*usable stream length for fish/macros is 700-ft and should averages about 10-ft wide during spring flood pulses

Figure 4 – Future Without Project Conditions for the Habitat Zones

2.5 – Goals, Objectives & Constraints

The primary goal of this Feasibility Study is to determine a cost effective restoration plan that meets the goal and objectives.

National Ecosystem Restoration (NER) Goal

The primary goal of a resulting project would be to restore required habitat within Ravine 8 for animal communities within the coastal zone of Lake Michigan.

Objectives

Planning objectives are statements that describe the desired results of the planning process by solving the problems and taking advantage of the opportunities identified. The planning objectives must be directly related to the problems and opportunities identified for the study and will be used for the formulation and evaluation of plans. Objectives must be clearly defined and provide information on the effect desired, the subject of the objective (what will be changed by accomplishing the objective), the location where the expected result will occur, the timing of the effect (when would the effect occur) and the duration of the effect.

Federal Objective

The Federal objective of water and related land resources planning is to contribute to national economic development or the national ecosystem restoration in accordance with national environmental statutes, applicable executive orders, and other Federal planning requirements and policies. The use of the term "Federal objective" should be distinguished from planning/study objectives, which are more specific in terms of expected or desired outputs whereas the Federal objective is considered more of a National goal. Water and related land resources project plans shall be formulated to alleviate problems and take

advantage of opportunities in ways that contribute to study objectives and to the Federal objective. Contributions to national improvements are increases in the net value of the national output of goods, services and ecosystem integrity. Contributions to the Federal objective include increases in the net value of those goods, services and ecosystems that are or are not marketable.

Protection of the Nation's environment is achieved when damage to the environment is eliminated or avoided and important cultural and natural aspects of our nation's heritage are preserved. Various environmental statutes and executive orders assist in ensuring that a water resource planning is consistent with protection. The objectives and requirements of applicable laws and executive orders are considered throughout the planning process in order to meet the Federal objective. The following laws and executive orders that specifically provided guidance for this study are not limited to, but include:

- Invasive Species (E.O. 13112)
- Nonindigenous Aquatic Nuisance Prevention & Control Act of 1990, as amended (16 U.S.C. 4701 et seq.)
- National Invasive Species Act of 1996 (Public Law 104 – 332)
- Endangered Species Act of 1973, as amended (16 USC 1531 et seq.)
- Fish and Wildlife Coordination Act, as amended (16 USC 661)
- **Migratory Bird Treaty Act of 1918, as amended (16 USC 703 et seq.)**
- Responsibilities of Federal Agencies to Protect Migratory Birds (E.O. 13186)
- Clean Water Act of 1977, as amended (33 USC. 1251 et seq.)
- Safe Drinking Water Act of 1986 as amended (42 USC 201)
- National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.)
- Resource Conservation and Recovery Act of 1976, as amended (42 USC 6901, et seq.)
- **Protection and Restoration of the Great Lakes (E.O. 13340)**
- Protection and Enhancement of Environmental Quality (E.O. 11514)
- Floodplain Management (E.O. 11988)
- Protection of Wetlands (E.O. 11990)
- Wild and Scenic Rivers Act of 1968 (16 USC 1271-1287 Public Law 90-542 82 Stat. 906)

Study Objectives

The non-Federal sponsor has general goals for ecosystem restoration. These are to improve and increase viable habitats and improve ecological functions along the coast of Lake Michigan to support sustainable populations of diverse and valuable plant and animal species. Specifically, the sponsor aims to protect, enhance, naturalize and restore coastal ecosystems. The following objectives are those that will be directly measured for alternative analysis within this feasibility study:

Naturalize Ravine Hydraulics – This objective seeks to stabilize channel geomorphology and naturalize flow characteristics. As the small ravine watershed became developed and land use changed from forest, savanna and grassland to impervious surfaces, the ravine shifted from a naturally small stream, to a discharge channel with erratic flows. This objective would be measured by the projected increase in native fish species richness and the coefficient of conservatism for ravine plant communities in response to the naturalized hydraulic regime.

Reduce / Eliminate Invasive Plants – This objective seeks to remove or ease the adverse effects of non-native and invasive species, particularly plant species for this study. Typically, invasive species gain a foot hold and eventually dominate a site due to soil disturbance at the site, particularly to hydrologic, soils, or bio-chemical parameters. In this case, once the ravine's hydrology and geomorphic impairments are remedied, invasive plant species may be addressed quite effectively. The objective would be to

achieve a target overall Conservatism Coefficient (Mean C) of ~5 for the ravine, bluff and dune plant communities as described in Section 2.3 Habitat Assessment Methodology, Floristic Quality Assessment; and to reduce the targeted invasive species plant population to <1% of aerial coverage.

Increase Native Plant Species Richness & Coverage – This objective seeks to increase number of native plant species and their abundance over the entire project footprint. Plants are the secondary driver to providing critical habitats for both micro and macro organisms. Ultimately, there is no habitat restored without a native and diverse plant community mosaic. This object would be measured by the coefficient of conservatism for the ravine, bluff and dune plant communities.

NER Constraints

Planning constraints are items of consideration that limit the planning process and are used along with the objectives in the formulation and evaluation of solutions. The establishment of planning constraints is done in concert with the entire study team and in cooperation with stakeholders. A list of planning constraints for the NER purpose follows.

Any measures/alternatives implemented should:

- Avoid adverse impacts to the hydrology, hydraulics and erosion processes of the ravines
- Avoid adverse impacts to the littoral drift of Lake Michigan
- Avoid adverse impacts to the state listed species present on site

CHAPTER 3 – PLAN FORMULATION AND EVALUATION

The formulation, evaluation, and comparison of alternative plans comprise the third, fourth, and fifth steps of the Corps' planning process. These steps are often referred to collectively as plan formulation. Plan formulation is an iterative process that involves cycling through these steps to develop a reasonable range of alternatives, and then narrow those plans down to a final plan, which is feasible for implementation.

Plan formulation for ecosystem restoration (ER) presents a challenge because alternatives have non-monetary benefits. To facilitate the plan formulation process, the methodology outlined in the Corps' Engineering Circular 1105-2-404, "Planning Civil Work Projects under the Environmental Operating Principles," 1 May 2003 was used. The steps in the methodology are summarized below:

1. Identify a primary project purpose. For this portion of the study, ecosystem restoration (ER) is identified as the primary purpose. Alleviating local drainage issues is not a purpose of this project.
2. Formulate management measures to achieve planning objectives and avoid planning constraints, where measures are the building blocks of alternative plans.
3. Identify and select those sites/patches most beneficial for ecological restoration.
4. Formulate, evaluate, and compare an array of alternatives to achieve the primary purpose (ER) and identify cost effective plans.
5. Perform an incremental cost assessment on the cost effective plans to determine the NER plan.

3.1 – Measure Identification

In general, there are two types of activities investigated for this project – physical repair and biological reestablishment. The biological reestablishment measures are dependent upon fixing the current conditions of the physical environment. For example, if one were to remove invasive species and replant native species along the ravine slopes without first repairing the hydraulics of the ravine's stream, the biological measures would fail over time. Consequently, complimentary measures were developed to address physical parameters (hydraulics, geomorphology) and biological reestablishment (invasive species removal, planting) and assessed in an incremental fashion to guide decisions in identifying and selecting the most significantly beneficial plan that has an associated reasonable cost. Measures assessed for this project may be viewed on **Plate 05**.

Hydraulics

There are several different measures that could be developed to address the issues related to stream power within the ravine. The existing storm sewer networks within the tributary watersheds to Ravine #8 comply with local and regional requirements so the project is not addressing inadequate storm sewers. Further, the sponsor has recently remediated some sanitary sewer issues within the ravine, and regraded the ravine after completion of the remediation. Excess runoff from the subwatersheds has been characterized using conservative modeling methods, in order to evaluate the functionality of the ravine under a range of conditions, and in order to evaluate and design features complimentary to ravine restoration. Measures identified include diverting water around the ravine in swales or pipes, detaining/retaining water in ponds or underground storage, placing instream features to reduce velocities and alleviate localized hydraulic issues, and reconnecting the stream to Lake Michigan. Rerouting of the flow in excess of the targeted flow to facilitate restoration measures is a key component of the measure designs. The use of engineered features as part of restoration is consistent with Corps policy on restoration. The use of diversion pipes as part of a restoration measure supports the restoration and is not required to address local stormwater problems. In addition, measure designs will focus on the inclusion of natural materials and stones/boulders similar to those that currently exist within the ravines.

(HA) Open Channel – This measure would deal with the current hydraulic conditions that developed in the ravine due to increased rainfall runoff from the watershed.

Cobble riffles and step pools would be sized appropriated for the current stream flows. These structures would need to be installed across the full cross section of the ravine to reduce head-cutting and channel incision. Woody structures such as cribs and cross veins would be used as well to further armor against the high flows and velocities. This measure would aid in alleviating the adverse physical disturbance caused by the higher flow and velocities; however, habitat benefits would not be maximized since the larger substrate, wooden structures and remaining velocities would preclude certain species of plants, macroinvertebrates and fishes from utilizing the ravine. Species adapted to high velocities such as longnose dace and mottled sculpin are examples of species that would benefit from this measure. This measure would require significantly more stone and wooden structures than measure HB and does not shift the hydrology and hydraulics of the ravine closer presettlement watershed conditions. This measure is not combinable with HB or HC, but must be combined with the Stream Connectivity Measure in order for fish to have passage to the restored habitat.

(HB) In-Ravine Pipe – This measure includes the diversion of excess rainfall runoff from the head of Ravine #8 to a discharge point at the base of the ravine. Removing the excess volume of rainfall runoff from the ravine would allow for hydrology and hydraulics to be shifted closer to conditions if the watershed was in natural vegetation.

Flow would be diverted from the storm sewer outlet via a stone chute from the head of the ravine to a preformed scour hole. One (1) 30”PVC/HDPE-inch pipe would be installed to receive water from the preformed scour hole. The pipe would be installed and covered with natural stream substrates and ravine soils. No man holes would be installed, but limited (2 or 3) inconspicuous PVC/HDPE stand pipes would be installed to allow for access in case of clogging. To further alleviate clogging, a vortex filter would be fitted at the head of the pipe. This measure would require the installation of small riffles and step pools to restore lost stream habitat. Since the excess water is removed from the ravine, the riffles and step pools under this measure would have optimized dimensions over HA for habitat in terms of size and quantity. The use of fewer cobbles will mimic pre-development conditions and will in turn return the ravine to a more natural state and allow for great species richness colonization.

The water quality of the storm flows would be the same at the Lake Michigan discharge point with or without project conditions. To further stabilize the beach and allow for minor storm (2-year or less) filtration of pipe waters, a cobble plunge pool and apron, vegetated with native plants would catch the discharging water before it flows over the beach and into the lake. Also a vortex fitting would be used at the head of the bypass pipe. This fitting is a hydrodynamic particulate separator (removes particulate matter via gravity). Flows in excess of the separator's capacity are bypassed without the need for additional structures. This measure would require less and smaller stone than measure HB and would shift the hydrology and hydraulics of the ravine closer presettlement watershed conditions. This measure is not combinable with HB or HC, but must be combined with the Stream Connectivity Measure in order for fish to have passage to the restored habitat.

(HC) Underground Detention – This measure would deal with the storm water by diverting the flows from the head of the ravine into an underground detention system that would attenuate flows into the ravine.

This measure would also need to employ stream bed riffles similar to measure HB. A short system of pipe and a discharge culvert would be needed at the head of the ravine to intercept and return attenuated flows to the ravine. This measure is not combinable with HA or HB. The only location for the underground

detention to be placed would be underneath an adjacent tennis court in the neighboring resident's backyard, which is not within the Steep Slope Ordinance; this could be problematic for future O&M needs and may not be desired by the resident. The tennis court would need to be replaced in-kind as well, further driving the cost of the measure out of the "reasonable cost" range. The cost without replacing the tennis court or real estate would be about $229,946 just for the underground detention and piping system. The non-Federal sponsor does not support this measure moving forward due to real estate and logistical issues, and is therefore screened out as infeasible and would not undergo CE/ICA analysis.

Stream Connectivity – This sub-measure would be complimentary to and a component of measures HA and HB. Stream connectivity would be facilitated by the removal of the checkdam at the mouth of the ravine, and includes regrading of the ravine mouth to facilitate access for lake fishes that utilize the ravine during spring pulses. In addition to recontouring the mouth, cobble riffles are part of this measure that would be used to ensure stability while providing fish spawning and macroinvertebrate habitat. Measures HA and HB are dependent on this measure to accrue benefits for the stream habitat.

Plant Communities

The following measures for the establishment of native dune, bluff and ravine plant communities consist of clearing and herbicide application to remove invasive species, collecting and sowing of native seed per community type, and collecting seed of the purpose of growing plug material to be planted.

(D) Dune Plant Community – This measure seeks to remove all woody and herbaceous invasive species within about 0.5-acres of dune area by hand pulling and/or spot herbicide application. This measure is cost out on the per acre basis and will fluctuate per the measure. Native plant establishment of dune would be achieved primarily through the installation of sand stabilizing marram grass (*Ammophila breviligulata*) as well as other species of local genotype that regularly inhabit beach and foredune areas. In order to replicate the genetic diversity and local genotypes found within native stands of marram grass in Illinois, only rhizome transplants of marram grass from existing stands along the North Shore coast and Illinois Beach State Park, with permission from IDNR, will be used within the project area. Current available commercial sources of marram grass do not match the genetic constitution or genetic diversity of local native populations of marram grass and thus may negatively impact long term establishment and success of restored populations as well as potentially threaten the sustainability of nearby native stands of this state endangered species (Fant 2008).

(RB) Ravine & Bluff Plant Community – This measure seeks to selectively remove invasive and opportunistic woody vegetation shading the ravine and bluff's understory. This measure is dependent on HA or HB. Selective shrub and tree clearance includes, but is not limited to, common buckthorn (*Rhamnus cathartica*), glossy buckthorn (*Frangula alnus*), European highbush cranberry (*Viburnum opulus*), black locust (*Robinia pseudoacacia*), staghorn sumac (*Rhus typhina*), Norway maple (*Acer platanoides*), gray dogwood (*Cornus racemosa*), white mulberry (*Morus alba*), green ash (*Fraxinus lanceolata*), cottonwood (*Populus deltoides*), and basswood (*Tilia americana*). This measure also includes the removal of invasive herbaceous species by spot application of herbicide as well as the incorporation of a prescribed burn. This measure would plant native species of local genotype that are known to inhabit lakeshore ravine and bluff communities; species harder to establish from seed will be introduced as plugs. Given the unique climate of lakeshore ravines and bluffs and the suite of rare flora that inhabit them, genetic preservation of species, including rare and state listed species, will be maintained by contract growth of certain species that currently reside in low numbers and/or which are not available commercially. Use of contract grown species from sources within the site and nearby areas not only preserves the unique genetics of the area, but also maximizes the success of establishment as local genotypes within or near the study area are more likely adapted to the harsh conditions presented by lakeshore bluffs.

3.2 – Measure Costs & Assumptions

Detailed discussion on planning level feature costs is presented in Appendix C – Cost Engineering. Conceptual, planning level cost estimates were prepared for measures/features that were identified by the study team in conjunction with the non-Federal sponsors (**Table 7**). These cost estimates do not represent complete project construction cost estimates, but rather individual measures of work or components of the entire project. The measures were used to provide an economic basis for the development of project alternatives. Once the project alternatives have gone through the plan formulation process, and additional design information was developed for the recommended plan, a more detailed and reliable cost estimate was performed (**Appendix C**). Estimates were developed using cost information from previous studies, lump sum and unit prices, and for plant, labor and material methods. Planning level unit costs were placed into a matrix to utilize the different costs for each measure of work.

Cost Annualization: Annualizing costs is a method whereby the project costs are discounted to a base year then amortized over the period of analysis. The base year for this project was determined to be the year in which the first phase of the project is to be completed (calendar year 2013). Costs that occur prior to this year need to be compounded to the base year, while those occurring after the base year need to be discounted to the base year. The period of analysis for the Section 506 project is 50 years. Discounting to the base year is the present value method. Costs are compounded or converted to present value for the base year then amortized over the 50-year period of analysis to give the annual cost. Discount rate was determined by the appropriate Economic Guidance Memorandum 13-01, Federal Interest Rates for Corps of Engineers Projects. The method shown in the above table does this for each measure. The individual measures of the project have the construction period spread out over 1 to 5-years, depending on magnitude or redundancy. Each year of every measure is either compounded or discounted to the base year. Calculation of the measures Average Annual Cost (AA Cost) is completed by multiplying the present value to the 50-year amortization factor.

Real Estate: An Initial Value Estimate (IVE) of the lands necessary to implement measures for this ecosystem restoration project was included in the Average Annual costs per measure on an acre basis. The IVE of ~$285,000 provided by the real estate section determined various preliminary numbers to accomplish plan formulation. This number is preliminary and does not constitute the gross appraisal, which would be completed for the NER Plan.

Table 7 – Planning Level Total & Average Annual Costs per Measure

Removed intentionally

3.3 – Measure Benefits

The evaluation of habitat benefits is a comparison of the with-project and without-project conditions for each measure. Environmental outputs are the desired or anticipated measurable products or results of restoration measures and plans. The term “outputs” is often used interchangeably with “benefits” or “habitat units (HUs).” Ecosystem restoration proposals may possess multiple output categories, as well as other effects that may need to be considered, but the evaluation must at least address cost and an output category that has been determined to represent reasonable ecosystem restoration benefits. A comparison of the future without-project and future with-project HUs was performed in order to determine if a measure, or group of measures, will actually have beneficial effects to the affected area’s dune, bluff, ravine and stream ecosystem. The measures for this study were evaluated with the HSI methodology described in Section 2.3 and were prescribed benefits in which the derivations of are depicted on **Plate 6**.

Measure RB is dependent on the implementation of HA or HB to first repair stream hydraulics; without one of these measures riparian vegetation could not be restored.

Table 8 – Average Annual Habitat Units per Measure

Measure	Code	FWO NAAHSI	FW NAAHSI	Acres	NAAHUs
Open Channel	HA	1.2	3.5	0.0	15.3
In-Ravine Pipe	HB	1.2	3.8	0.0	16.7
Dune	D	1.5	2.6	0.5	1.9
Ravine & Bluff	RB	1.2	3.3	3.16	NA*

*since RB is dependent on the implementation of HA or HB, RB benefits are nested within HA and HB to avoid double counting

Through the implementation of hydraulic repair measures for the purpose of stream habitat and riparian restoration, hydraulic conditions would be able to provide life history requisites for a given assemblage of fishes. The main structures providing fish and macroinvertebrate habitat for this potential project are stone riffles (woody debris and rootwads would natural accumulate overtime). It is well known that the force of water over and through these riffle structures create prime conditions for lotic fishes and macroinvertebrates to colonize, and in turn attract those fish that do not need faster flowing water but do like to feed on those invertebrates and fishes in the riffles, such as rockbass and smallmouth bass. These structures when constructed properly will provide habitat in itself and induce other habitat features such as point bar formation, scour pools, and diverse substrate patches. In turn, these new formations can provide critical hydraulic conditions such as critical and helical flows, all of which would attract lotic macroinvertebrates and fishes.

Measure HA affects in stream structure only to compensate for abnormally high flows while measure HB affects both the quantity of flow and in stream structure. Measure HA was assessed with the HSI conservatively in that the benefit of the doubt was given in that some fish and invertebrate species would still be able to use the ravine and withstand high flows that would push most species out of the ravine and into the lake. HSI calculations for Measure HA predicted that about 10 fish species may utilize the ravine in this condition, which translated to about 15.3 NAAHUs once combined with the riparian vegetation HSI.

Measure HB was assessed with the HSI to show that a few more fish species would utilize the ravine since the hydraulics and physical habitat were put back as close as possible to the natural condition. HSI calculations for this measure conservatively predicted that about 14 fish species would utilize the ravine in this condition, which translated to about 16.7 NAAHUs once combined with the riparian vegetation HSI. There are probably more fish species that would utilize the ravine in this “closer to natural condition”, but to remain conservative the 14 fish species certain of ravine use provide enough clarity on the difference in benefits between measures.

3.4 – Cost Effectiveness / Incremental Cost Analysis

Cost effectiveness and incremental cost analysis (CE/ICA) are two distinct analyses that must be conducted to evaluate the effects of alternative plans according to USACE policy. First, it must be shown through cost effectiveness analysis that a restoration plan’s output cannot be produced more cost effectively by another alternative. *Cost effective* means that, for a given level of non-monetary output, no other plan costs less and no other plan yields more output at a lower cost. Subsequently, through incremental cost analysis, a variety of alternatives and various-sized alternatives are evaluated to arrive at a “best” level of output within the limits of both the sponsor’s and the USACE’s capabilities.

The subset of cost effective plans are examined sequentially (by increasing scale and increment of output) to ascertain which plans are most efficient in the production of environmental benefits. Those most efficient plans are called "best buys." As a group of measures, they provide the greatest increase in output for the least increases in cost. They have the lowest incremental costs per unit of output. In most analyses, there will be a series of best buy plans, in which the relationship between the quantity of outputs and the unit cost is evident. As the scale of best buy plans increases (in terms of output produced), average costs per unit of output and incremental costs per unit of output will increase as well. The incremental analysis by itself will not point to the selection of any single plan. The results of the incremental analysis must be synthesized with other decision-making criteria (i.e., significance of outputs, acceptability, completeness, effectiveness, risk and uncertainty, reasonableness of costs) to help the study team select and recommend a particular plan.

Six (6) plans were generated (**Table 9**) from the 4 measures input into the IWR-Planning software. The software identified that 4 plans were cost effective (**Figure 5**), which means that no one plan provided the same benefits as another plan that was less costly. Three (3) plans were revealed as "best buys" (**Table 10**), which are deemed the most cost efficient of the 6 plans generated. **Figure 6** shows one significant break point going from Plan 3 to 4, which is the difference between HA Open Channel vs. HB In Ravine Pipe.

Table 9 – All Plans (6) Generated

	Generated Plan	HUs	Cost	Cost/HU	Type
1	No Action Plan	0.0	0	-	-
2	D	1.9	$ 426	$ 224	Best Buy
3	HA & RB	15.3	$20,929	$ 1,368	Cost Effective
4	HB & RB	16.7	$27,260	$ 1,632	Ineffective
5	HA & D &RB	17.2	$21,355	$ 1,242	Best Buy
6	HB & D &RB	18.6	$27,686	$ 1,488	Best Buy

Figure 5 – Cost Effective Analysis on All (6) Plan Combinations

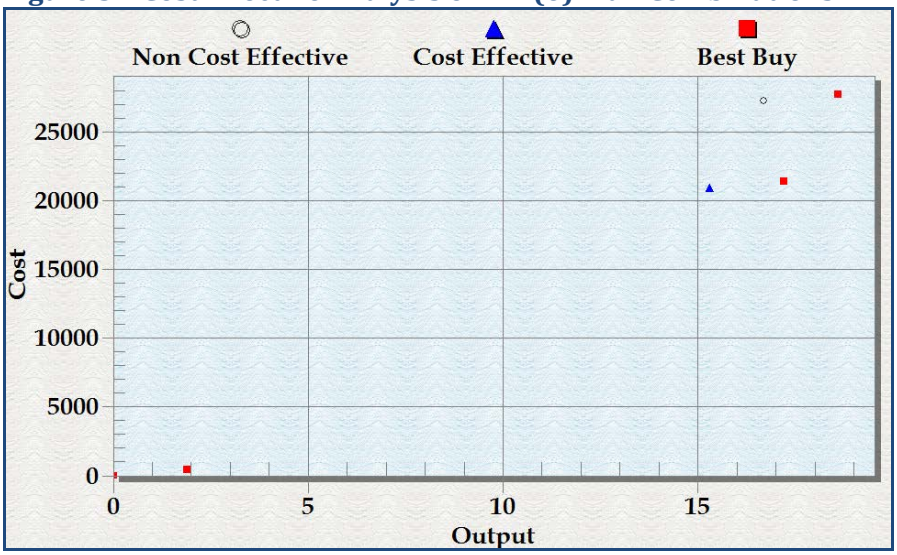
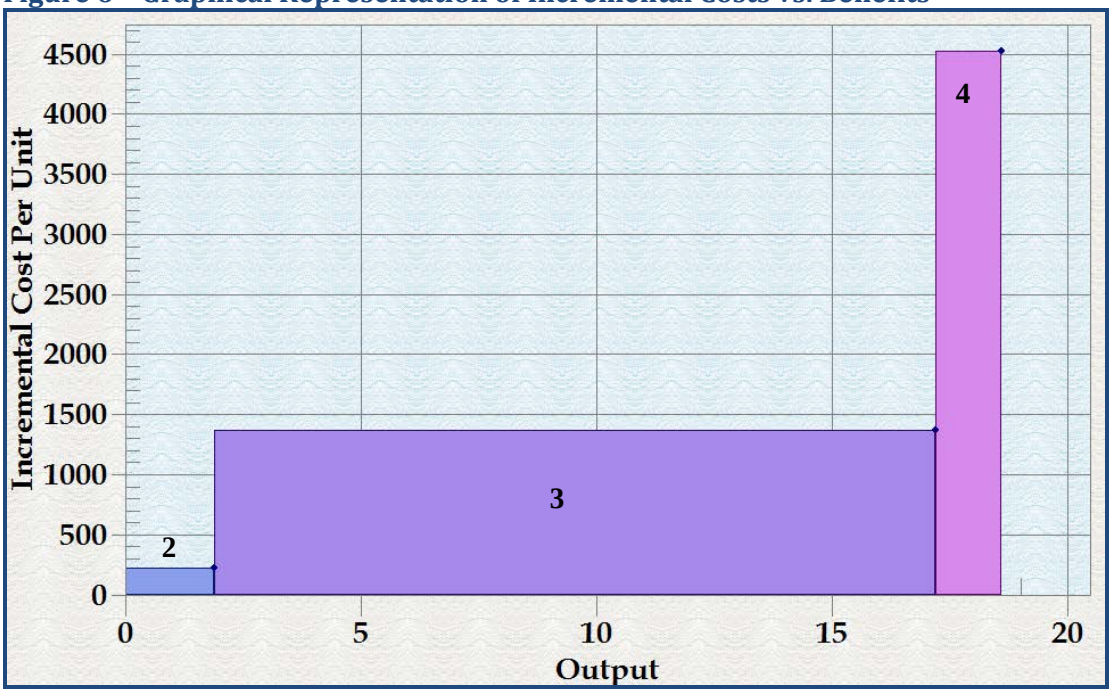


Table 10 – Incremental Analysis of Best Buy Plans for Ravine Restoration

#	Plan	HU	AA Cost	AA Cost / HU	Inc. Cost	Inc. HU	Inc. Cost / HU
1	No Action Plan	0	$ -				
2	D	1.9	$ 426	$ 224	$ 426	1.9	$ 224
3	HA & D & RB	17.2	$ 21,355	$ 1,242	$ 20,292	15.3	$ 1,368
4	HB & D & RB	18.6	$ 27,686	$ 1,488	$ 6,331	1.4	$ 4,522

Figure 6 – Graphical Representation of Incremental Costs vs. Benefits



3.5 –Plan Trade-Off Analysis

Alternative plans that qualified for further consideration will be compared against each other in order to identify the selected sites and their associated alternatives to be recommended for implementation. A comparison of the effects of various plans must be made and tradeoffs among the differences observed and documented to support the final recommendation. The effects include a measure of how well the plans do with respect to planning objectives including NER benefits and costs. Effects required by law or policy and those important to the stakeholders and public are to be considered. Previously in the evaluation process, the effects of each plan were considered individually and compared to the without-project condition. In this step, plans are compared against each other, with emphasis on the important effects or those that influence the decision-making process. The comparison step concludes with a ranking of plans.

3.5.1 –Tentatively Selected Plan

Alternative Plan 3 “Best Buy” (**Plate 7**) was selected as the tentative plan based on cost effectiveness, ecological outputs, significance and meeting the goals and objective of the study.

3.5.2 – Acceptability, Completeness, Effectiveness and Efficiency

Acceptability, completeness, effectiveness, and efficiency are the four evaluation criteria specified the USACE uses in the screening of alternative plans. Alternatives considered in any planning study, not just ecosystem restoration studies, should meet minimum subjective standards of these criteria in order to qualify for further consideration and comparison with other plans. Since this project is quite small and not very intricate, the following discussion addresses the tentative plan, which is Best Buy Plan 3.

Acceptability

An ecosystem restoration plan should be acceptable to state and Federal resource agencies and local governments. There should be evidence of broad-based public consensus and support for the plan. A recommended plan must be acceptable to the non- Federal cost-sharing partner. However, this does not mean that the recommended plan must be the locally preferred plan.

All plans would be acceptable to state and Federal resources based on the nature of the project and the outputs. Ecological restoration with incidental benefits of water quality improvements are in congruence with the goals and objectives the US Fish & Wildlife Service, US Environmental Protection Agency, the Illinois Dept. of Natural Resources, Illinois EPA, the Lake County Stormwater Management Commission and the Lake County Forest Preserve. All measures, alternatives and resulting plans were formulated through various iterations under the close guidance and review of the non-Federal sponsors. The plans were tailored to meet the needs and integrity of the non-Federal sponsor's ecosystem holdings.

Completeness

A plan must provide and account for all necessary investments or other actions needed to ensure the realization of the planned restoration outputs. This may require relating the plan to other types of public or private plans if these plans are crucial to the outcome of the restoration objective. Real estate, operations and maintenance, monitoring, and sponsorship factors must be considered. Where there is uncertainty concerning the functioning of certain restoration features and an adaptive management plan has been proposed it must be accounted for in the plan.

The tentative plan, Plan 3, is complete unto itself, which means the plan can be implemented without any supporting projects or contributions from other entities. The tentative plan would restore about 3.66-acres of ravine, bluff and dune within the natural open space of the study area. The tentative plan is in congruence with the Alliance for the Great Lakes' 2009 publication that identifies restoration of the north shore ravines and coastal habitats. Currently, there are no recommended restoration features under the tentative plan that has a significant degree of uncertainty concerning functionality or structure.

Effectiveness

An ecosystem restoration plan must make a significant contribution to addressing the specified restoration problems or opportunities (i.e. restore important ecosystem structure or function to some meaningful degree).

The tentative plan makes significant contributions to addressing the problems identified in Section 2.2. Based on planning level assessments, this plan would restore important habitat along the coast of Lake Michigan in terms of ravine hydrology and hydraulics, geomorphic repairs and the establishment of viable and diverse native plant communities. A potential of about 3.66-acres of restoration was assessed under this Feasibility Study, with the tentative plan recommending 3.66-acres as high priority under the Corps Ecosystem mission. The tentative plan effectively would restore about 85% of this ravine, while

the remaining 15% was previously restored by the non-Federal sponsor. The 15% of the ravine that was restored included repairing the large erosion areas caused by the stormwater erosion; this would not be a cost shared element of the project or a creditable item towards the non-Federal sponsor's cost share. The placement of the sanitary sewer is inconsequential to the potential restoration project resulting from this study.

Efficiency

An ecosystem restoration plan must represent a cost-effective means of addressing the restoration problem or opportunity. It must be determined that the plan's restoration outputs cannot be produced more cost effectively by another agency or institution.

The tentative plan provides outputs that cannot be produced more cost effectively by the Corps or other agencies/institutions. All components of the tentative plan have passed tests of redundancy, habitat output significance, cost effectiveness and Corps Authority expertise. The USACE sets criteria for selecting projects based on Corps expertise. The implementation of the tentative plan is reflected under the following criteria and numerical scores according to the requirements identified in the Corps Budget guidance (EC 11-2-194):

- Habitat Scarcity – Score of 25/25
- Connectivity – Score of 25/25
- Special Status Species – Score of 5/10
- Hydrologic Character – Score of 20/20
- Geomorphic Character – Score of 20/20
- Plan Recognition – Score of 10/10
- Self Sustaining – Score of 10/20
- Nationally Significant – No
- Regionally Significant – Yes

3.5.3 – Significance of Ecosystem Outputs

Because of the challenge of dealing with non-monetized benefits, the concept of output significance plays an important role in ecosystem restoration evaluation. Along with information from cost effectiveness and incremental cost analyses, information on the significance of ecosystem outputs will help determine whether the proposed environmental investment is worth its cost and whether a particular alternative should be recommended. Statements of significance provide qualitative information to help decision makers evaluate whether the value of the resources of any given restoration alternative are worth the costs incurred to produce them. The significance of the Ravine 8 ecosystem restoration outputs are herein recognized in terms of institutional, public, and/or technical importance.

Institutional Recognition

Significance based on institutional recognition means that the importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups. The following are exemplary instances:

Clean Water Act – Restore the chemical and biological integrity of the Nation's waters. Restoration of native plant communities as well as stream hydraulics and hydrology will not only improve habitat diversity, but also biogeochemical processes important in the filtering of precipitation and runoff. This in

turn will mean the return of higher quality water to Lake Michigan and prevent the ravine from mass wasting into Lake Michigan.

Endangered Species Act of 1973 – All Federal departments and agencies shall seek to conserve endangered species and threatened species. The purpose of the act is to provide a means whereby the ecosystems upon which endangered and threatened species depend may be conserved and to provide a program for the conservation of such endangered and threatened species. Although no Federal listed species have been recorded from the project site, project features would be beneficial to Federally endangered and/or threatened species that may colonize the area in the future. In addition, restored site conditions could support colonization or continued habitation of state rare, threatened, and endangered species such as the following species: common tern (*Sterna hirundo*), Forster's tern (*Sterna forsteri*), marram grass (*Ammophila breviligulata*), sea rocket (*Cakile edentula*), seaside spurge (*Chamaesyce polygonifloia*), common juniper (*Juniperus communis*), downy Solomon's seal (*Polygonatum pubuescens*), longnose sucker (*Catostomus catostomus*), and lake herring (*Coregonus artedii*).

Fish and Wildlife Conservation Act of 1980 – All Federal departments and agencies to the extent practicable and consistent with the agencies authorities should conserve and promote conservation of non-game fish and wildlife, and their habitats. Restoring the vegetative structure and increasing the native plant growth of the bluff, ravine, and dune, habitats will enhance the habitat diversity of the ravine system. The restored site would have increased native species richness and fewer invasive and non-native species. In addition, removal of manmade structures that are impediments to aquatic species dispersal would increase availability of high quality habitat. All habitat improvements will benefit plants, invertebrates, fish, birds, amphibians, reptiles, and other wildlife. A letter provided by the USFWS 07 March 2013 indicates the importance of coastal ravine habitat and restoration projects of this type.

EO 11514 Protection and Enhancement of Environmental Quality – The Federal Government shall provide leadership in protecting and enhancing the quality of the Nation's environment to sustain and enrich human life. Improving the quality of Ravine 8 would help to restore the unique Bluff-Lake Michigan interface, an area that once had many environmental treasures.

EO 13186 Responsibilities of Federal Agencies to Protect Migratory Birds – Federal agencies shall restore or enhance the habitat of migratory birds and prevent or abate pollution or detrimental alteration of the environment for migratory birds. This project will restore native plant diversity and thus provide better forage and shelter to numerous migratory bird species as discussed in Section 2.1.2, Resident and Migratory Birds.

Executive Order 13340 - Identified the Great Lakes as a national treasure and defined a Federal policy to support local and regional efforts to restore and protect the Great Lakes ecosystem through the establishment of regional collaboration. A number of activities have been accomplished by Federal agencies working in partnership with state, tribal and local governments in response to the Executive Order. The USACE has been a major participant in these activities. The Executive Order established the Great Lakes Interagency Task Force. The Task Force worked with the governors of the eight Great Lakes states, mayors, and tribal leaders to establish the Great Lakes Regional Collaboration. The initial goal of the Collaboration was to develop a "strategy for the protection and restoration of the Great Lakes" within 1 year. The Collaboration developed the strategy by using teams consisting of 1,500 stakeholders for the following eight priority issues identified by the Great Lakes governors and mayors with items in bold relative to this project:

1. Toxic contaminants
2. **Non-point source pollution**
3. **Coastal health**
5. Contaminated sediments/AOCs
6. **Indicators/information**
7. **Sustainable development**

4. Habitat/species **8. Invasive species**

Public Recognition

Public recognition means that some segment of the general public recognizes the importance of an environmental resource, as evidenced by people engaged in activities that reflect an interest or concern for that particular resource. Such activities may involve membership in an organization, financial contributions to resource-related efforts, and providing volunteer labor and correspondence regarding the importance of the resource.

Alliance for the Great Lakes. October 2009. Stresses and Opportunities in Illinois Lake Michigan Watersheds Strategic Sub-Watershed Identification Process (SSIP) Report for the Lake Michigan Watershed Ecosystem Partnership.

This report is organized around three aspects of the Lake Michigan land and water ecology: the water quality of Lake Michigan and the streams and rivers feeding into it, the level of erosion in ravines along the coast of the lake, and the range and quality of habitat in the region. Water quality and habitat were analyzed in terms of sub-watershed boundaries, whereas ravine erosion was analyzed ravine-by-ravine. The immediate goals of the study are to 1) prioritize sub-watersheds based on their potential to negatively impact water quality or 2) the quality and extent of habitat within their boundaries; and 3) to rank ravines based on their potential for erosion. The larger goal of the study is to serve as a tool for LMWEP, municipalities and other interested groups, such as private landowners, to make informed decisions about where to focus restoration efforts and resources in order to improve the ecology of the Lake Michigan region.

Technical Recognition

Technical recognition means that the resource qualifies as significant based on its "technical" merits, which are based on scientific knowledge or judgment of critical resource characteristics. Whether a resource is determined to be significant may of course vary based on differences across geographical areas and spatial scale. While technical significance of a resource may depend on whether a local, regional, or national perspective is undertaken, typically a watershed or larger (e.g., ecosystem, landscape, or ecoregion) context should be considered. Technical significance should be described in terms of one or more of the following criteria or concepts: scarcity, representation, status and trends, connectivity, limiting habitat, and biodiversity.

Scarcity is a measure of a resource's relative abundance within a specified geographic range. Generally, scientists consider a habitat or ecosystem to be rare if it occupies a narrow geographic range (i.e., limited to a few locations) or occurs in small groupings. Unique resources, unlike any others found within a specified range, may also be considered significant, as well as resources that are threatened by interference from both human and natural causes.

Scarcity is represented at Ravine 8 by the presence of significant and unusual topographic features including beach, foredune, bluff, and ravine habitat. Fort Sheridan lies within the Illinois Beach Resource Rich Area (RRA) which has the second highest percentage of urban/built-up acreage (63%). Only 24% of the RRA contains natural habitats such as forest, wetland, and grassland. This narrow band of habitats is comprised of beaches, sand dunes, swales, marshes, sand prairies, savannas, and oak forests that occur along the coast of Illinois as a result of the gradual lowering of Lake Michigan. The Illinois Beach RRA is one of the most biologically diverse areas in the state with more than 650 species of plants having been identified from this area.

Representation is a measure of a resource's ability to exemplify the natural habitat or ecosystems within a specified range. The presence of a large number and percentage of native species, and the absence of exotic species, implies representation as does the presence of undisturbed habitat. Although the study area has been highly disturbed from anthropogenic activities, the Ravine 8 natural area is representative of a southwestern Lake Michigan ravine-lake interface. This project would restore connectivity between the ravine and lake, upstream aquatic species dispersal, and a diverse array of rare and conservative plant species. This project would repair the ravine-lake interface to a representative form, and to once again provide habitat for ravine species as well as refuge for lacustrine species.

Status and Trends of the Ravine 8 natural area describe a once highly functional lacustrine habitat that has become degraded primarily due to effects of urbanization from the ever expanding Chicago metropolitan area. However, it is part of the Illinois Beach RRA which is one of the most ecologically rich and unique areas in Illinois. This RRA is comprised of a diverse array of habitats that were created because of its proximity to the shores of Lake Michigan. Ravine 8 contains many of these unique habitats, one of which is the notable bluff habitat. With implementation of the proposed project, distinctive habitats may be restored to their former excellence and provide beneficial outputs to terrestrial and aquatic wildlife.

Connectivity of Ravine 8 to other natural areas and Lake Michigan is crucial for fish species as well as migratory birds. Ravine 8 is one of several areas along the Lake County lakeshore to be undergoing restoration or proposed restoration. Additional areas where bluff and ravine restoration has been proposed to occur within the next decade are Ft. Sheridan, Moraine Park, Central Park, Millard Park, and Rosewood Park. Extensive restoration of this coastline will provide connected high quality habitat for wildlife, especially migrant birds which follow the Lake Michigan Flyway during spring and fall migration. In addition, Ravine 8 is located within the Illinois Beach RRA which encompasses 49,172 acres stretching from Cook County to Lake County, Illinois. Included within the Illinois Beach RRA is Illinois Beach State Park, North Dunes, and Spring Bluff; three nature preserves that provide critical habitat to wildlife and form a habitat corridor with the aforementioned parks.

Limiting Habitat exists at Ravine 8. Although no Federal listed species have been recorded from the project site, numerous state species have been found in the area. Once restored, site conditions could support colonization or continued habitation of state rare, threatened, and endangered species such as the following species: common tern (*Sterna hirundo*), Forster's tern (*Sterna forsteri*), marram grass (*Ammophila breviligulata*), sea rocket (*Cakile edentula*), seaside spurge (*Chamaesyce polygonifloia*), common juniper (*Juniperus communis*), downy Solomon's seal (*Polygonatum pubuescens*), longnose sucker (*Catostomus catostomus*), and lake herring (*Coregonus artedii*).

Biodiversity within the Chicago Region is in decline due to the replacement of a number of high quality species that have links throughout the food web and ecosystem, with species that have few or no users in the system. As more species are lost, a cascade effect results in the loss of the species that are dependent on the ones immediately affected by the problem. Through the restoration of ravine hydraulics and hydrology, ravine-lake connectivity, lacustrine habitat, native plant community richness, water quality, and nutrient cycling; species diversity would increase logarithmically along with existing populations of fish, amphibians, and other species.

3.6 – Selection of the National Ecosystem Restoration Plan

When selecting a single alternative plan for recommendation from those that have been considered, the criteria used to select the NER plan include all the evaluation criteria discussed above. Selecting the NER plan requires careful consideration of the plan that meets planning objectives and constraints and reasonably maximizes environmental benefits while passing tests of cost effectiveness and incremental

cost analyses, significance of outputs, acceptability, completeness, efficiency, and effectiveness. Additional factors to consider include the following items.

3.6.1 – Partnership Context

This restoration project was planned in cooperation with the City of Highland Park. This restoration project makes a significant contribution to regional, national, and international programs that include the North American Waterfowl Management Plan, Lake-wide Management Plans, the ILDNR Coastal Zone Management Plan and the Alliance for the Great Lakes' plan to restore north shore ravines. The USFWS service has also indicate the importance of ravine restoration along the north shore of Lake Michigan.

3.6.2 – Reasonableness of Costs

All costs associated with a plan were considered and tests of cost effectiveness and incremental cost analysis have been satisfied for the alternatives analyzed. The cost estimate was reviewed by the Walla Walla District, which is the USACE's Civil Works Cost Engineering and Agency Technical Review Mandatory Center of Expertise (MCX). A risk analysis was also performed to establish the level of confidence associated with the estimated costs.

Having established confidence in the estimated implementation costs, the remaining test of reasonableness is to assess the value of the resource to be improved based on the cost to implement the improvement. The importance of the Great Lakes in terms of habitat, and human uses has been documented through numerous sources. The importance of the Great Lakes to the nation was established through Executive Order 13340. As previously noted, the Great Lakes is one of the world's largest bodies of freshwater, providing drinking water, food, recreation, and aesthetics for about 32 million people

In terms of non-monetary values, the ecosystem of the Ravine 8 natural area and its importance to the region is emphasized by the institutional significance of this area as identified by the Chicago Wilderness and the Alliance for the Great Lakes. Numerous studies by these groups identified resource impacts and subsequent restoration needs for the Great Lakes ecosystem. The conclusion is that restoration projects such as proposed can address the significant impairments to the aquatic ecosystem, which includes macroinvertebrates, fish, reptiles, aquatic dependent wildlife including waterfowl and piscivorous mammals.

3.6.3 – Risk and Uncertainty

When the costs and outputs of alternative restoration plans are uncertain and/or there are substantive risks that outcomes will not be achieved, which may often be the case, the selection of a recommended alternative becomes more complex. It is essential to document the assumptions made and uncertainties encountered during the course of planning analyses. Restoration of some types of ecosystems may have relatively low risk. For example, removal of drainage tiles to restore hydrology to a wetland area. Other activities may have higher associated risks such as restoration of coastal marsh in an area subject to hurricanes. When identifying the NER/recommended plan, the associated risk and uncertainty of achieving the proposed level of outputs must be considered. For example, if two plans have similar outputs but one plan costs slightly more, according to cost effectiveness guidelines, the more expensive plan would be dropped from further consideration. However, it might be possible that, due to uncertainties beyond the control or knowledge of the planning team, the slightly more expensive plan will actually produce greater ecological output than originally estimated, in effect qualifying it as a cost effective plan. But without taking into account the uncertainty inherent in the estimate of outputs, that plan would have been excluded from further consideration.

Native plantings have an associated risk of not establishing due to a variety of unforeseen events. Predation from herbivorous animals and insects is a possibility and can be reasonably estimated based on baseline surveys of the existing flora and fauna. However, weather also plays a large role in the establishment success of new plantings. Periods of drought or early frost may alter the survival percentage of plantings. Although historical records can help to predict the best possible location and timing of new plantings, single unforeseen events may lead to failure. To mitigate these risks, planting over several years, overplanting and/or adaptive management and monitoring may be incorporated into the overall plan. In addition, climate change in the years to come may play a role in impacting the project outcome. Increased temperatures or rainfall may lead to changes in the ecosystem of the project area; however, Lake Michigan primarily drives the weather in the Chicagoland area and may partly mitigate climate change concerns.

Complete eradication of invasive species always presents a certain level of risk and uncertainty as the chances of reinvasion are likely to occur without proper management, increasingly so when native species have not yet established. Changes in nutrient cycling processes and soil chemistry (due to impaired hydrology and prolonged invasive species establishment) further increases uncertainty with the eradication of invasive species. Measures that prevent further degradation to soils and measures that alleviate impaired hydrology, which therefore alleviate the invasibility of the ecosystem, should lessen the risk and uncertainty associated with invasive species removal. It is the intent for USACE to discuss with the City of Highland Park to remove invasive species in the 1.1-acres with their own contracting or in-house capabilities or via volunteer work days in order to reduce the risk of invasive plant species recolonization within the allowable USACE project footprint.

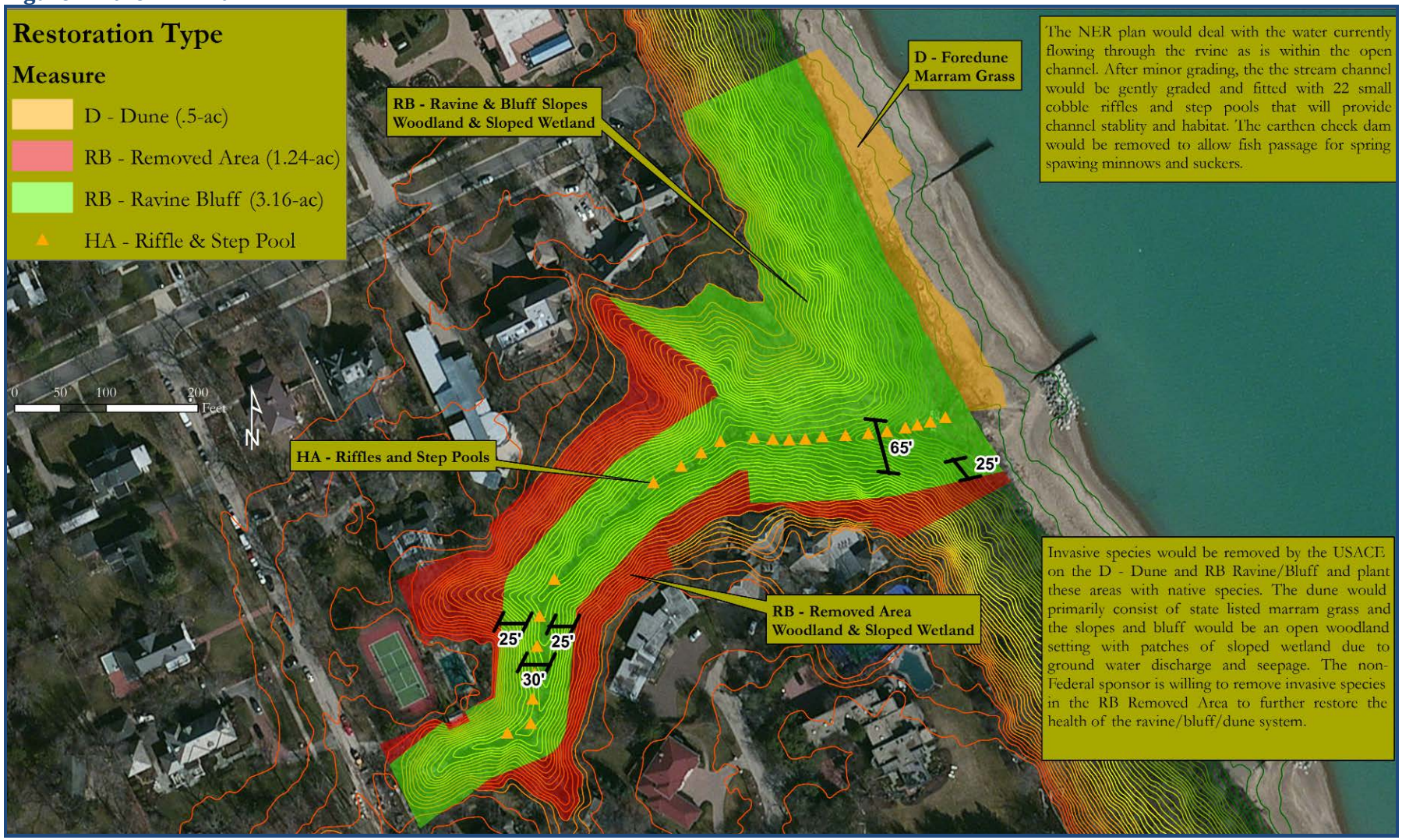
3.6.4 – The NER Plan

The plan that reasonably maximizes net national ecosystem restoration benefits, consistent with the Federal objective and USACE Policy, is identified as the NER plan. Thus, the plan that maximizes net NER benefits and has shown great merit in the trade-off analysis will be a number of selected sites with their associated best buy alternative plans. It is determined that the NER plan consists of Plan 3 with a reduced riparian zone of restoration by 1.24-acres (**Figure 7 & Plate 8**). The loss of habitat benefits for the 1.24-acres is currently not predicted because of the indication that the non-Federal sponsor would eradicate invasive species in this area. This is why a reevaluation of benefits was not recalculated for the loss in acreage. If for some reason this area does not have invasive species removed in the future by the non-Feds, a brief Limited Reevaluation Report would be drafted to show the difference in NER benefits predicted vs. those gained.

The NER plan would first perform minor grading to prepare the new stream channel and banks for riffle and step pool placement. All riffles and step pools would be installed before the next step, which is to remove the earthen check dam to allow fish passage for spring spawning minnows and suckers. No piping or water diversion structures would be used to divert higher flows. The riffles and step pool are designed to specifically handle the larger urban derived flood pulses.

Once the stream channel is in place, invasive species would be removed by the USACE on the D - Dune and RB Ravine/Bluff and plant these areas with native species. The dune would primarily consist of state listed marram grass and the slopes and bluff would be an open woodland setting with patches of sloped wetland due to ground water discharge and seepage. The non-Federal sponsor is willing to remove invasive species in the RB Removed Area to further restore the health of the ravine/bluff/dune system.

Figure 7 – the NER Plan



CHAPTER 4 – ENVIRONMENTAL ASSESSMENT

This chapter involves identification of direct environmental effects to current conditions stemming from any of the proposed alternatives if they were to be implemented. All sections denoted with an asterisk are pertinent to the Environmental Assessment.

4.1 – Need & Purpose

Historically, the Highland Park moraine was dominated by several naturally occurring communities including wetlands, forests, savannas and prairies. By the late 1800s, much of these communities, particularly prairies, savannas and wetlands, were converted to agricultural, urban or industrial use. Subsequently, there was a significant loss of biodiversity and adverse physical effects such as an increase in flooding events and a decrease in water quality. Furthermore, the remnant parcels of natural community types are under pressure from continued human activities. Human induced disturbances to the remaining natural areas include fire suppression, altered hydrology and hydraulics, increase colonization of invasive species and fragmentation. Specific problems that need to be addressed are detailed in Section 2.2.

Dune & Bluff – Recreation and residential development has had a major influence on the physical structure of coastal habitat and the processes that created and sustained these habitats. This has allowed invasive nonnative species to colonize these altered areas that no longer provide suitable life requisites for native species. Lacustrine process of littoral drift and wave/current patterns have been altered from their natural state through shoreline development; the construction of harbors, break walls, jetties, piers, etc. Coastal habitat can no longer rely on the natural replenishment and movement of sand down the coast since these structure now intercept a great deal of the material. Sand flats are located far enough from the shore as to not be effected by this; however, near shore, beach, dune and bluffs are dramatically affected by these altered conditions. It is apparent that littoral drift sands accumulate where humans have built structures and erode away from natural areas where there are no effective structures.

Ravine – The colonization and subsequent development of the land surrounding the north shore ravines has greatly accelerated the pace of the natural forces which first created them. The primary force responsible for the ravines' continued degradation is the increased volume of water flowing into and through them. The proliferation of impervious surfaces and turf grass within the subwatersheds has greatly increased the flow of rainwater runoff. The result is an increase in the quantity and velocity of water flowing through the ravine, which increases the rate of erosion. The greater the quantity of water, the level of downward stream cutting increases, making the lower portion of the ravine slopes adjacent to the stream much steeper and increases the frequency of slumping. This condition has ultimately caused the ravine stream and bank habitats to become severely degraded to a point where the ravine currently does not provide fish with any habitat and minimal habitat for riparian macroinvertebrates and migratory birds.

4.2 – Alternatives Considered

Chapter 3 details the plan formulation process and how the NER plan was selected. An iterative screening process ultimately looked at 6 combinations for ravine restoration. The habitat output / cost comparisons identified 3 plans for ravine restoration that were incrementally justified cost wise for their additions of habitat benefits. After taking into considerations of habitat benefits, costs, USACE policy, risk and uncertainty and plan acceptability, completeness, efficiency, and effectiveness, the NER plan was selected. This plan consists of naturalizing stream velocities within the ravine, restoring connectivity to Lake Michigan, restoring the stream channel with alluvial material and riffles, removing invasive plant

species and reestablishing native ravine, bluff and dune plant species within a 3.66-acre project area. The NER plan is depicted in **Figure 7** and **Plate 8**.

4.3 – The Affected Environment

The affected environment is described in detail in Chapter 2 – Inventory & Forecasting. In general, the ravine, dune and bluff habitats under consideration for ecological restoration activities outlined by this report are degraded. The ravine was originally formed by the erosive forces of stormwater interacting with the bluff (Highland Moraine), but became a conduit for stormwater as the watershed was developed. This has lead to an increase in the volume of stormwater discharged into the ravine systems and has resulted in their prompt habitat degradation. The source of the unnatural water stems from impervious surfaces within the entire 31-acre Ravine 8 watershed. The watershed's collection system ends up at a discharge pipe at the head of Ravine 8. The water is discharged openly into the ravine where it flows for about 800-feet, over a small check dam, onto the beach for about 20-feet and then into Lake Michigan. Ravine, bluff and dune plant communities have become degraded due to the presence of disturbed habitat. This has led to the reduction in richness and abundance of native plants species within these entire 3.66-acres.

4.4 – Direct & Indirect Effects of the Preferred Plan

4.4.1 – Physical Resources

Climate

The minor scale of the proposed project would not be able to affect the regional climate. The increase in acreage of natural plant communities would increase evapotranspiration in a minor way, but still not great enough to affect weather patterns or rainfall within the region. No significant adverse effects are expected as a result of implementing the proposed project.

Geology & Glacial Stratigraphy

The proposed project would not adversely affect geology or glacial stratigraphy. All of the proposed features under the proposed project are too small in scale to affect the local geology and glacial stratigraphy.

Soils

The proposed project would result only in beneficial effects to natural soils. Currently at the study site, natural soils for the most part have already been destroyed. Only those soils along the ravines, upland edges and down the bluffs, and along the beaches are considered intact with the exception of disruption to their A horizons due to years of tilling, fertilization, carbon stripping, and overwatering. Through the reestablishment of natural flow regimes, return of native plant communities, and return of mycorrihizzal fungi/bacterial interactions, overtime the A horizons of these soils would heal, thusly feeding back to diversify the native plant and animal assemblages of those restored soils. Since the proposed project would be implemented in a fashion as to facilitate the return of natural soils structure, no significant adverse affects resultant from implementation of the project are expected.

Fluvial Geomorphology & Topography

Implementation of the proposed project would result in beneficial effects to fluvial geomorphology and natural topography within the project area limits. The removal of unnatural urban flows to the ravines would effectively near the presettlement hydraulics to the ravine streams, whether they are ephemeral or perennial. Restoration of the stream channel morphology as well will aid in the restoration of sediment transport and critical hydraulic parameters within the ravines. Fluvialgeomorphic processes would be further restored by removing invasive plant species that cause stream banks to unravel and unnaturally erode. No adverse affects to fluvial geomorphology and topography are expected resulting from implementation of the preferred plan.

Littoral Processes

Implementation of the proposed project would not affect littoral processes since there are no measures planned for Lake Michigan under this study. No adverse affects to the littoral process, coastal geomorphology and topography are expected resulting from implementation of the preferred plan.

Hydrology, Hydraulics & Land Use

Hydrology: Implementation of the proposed project would result in minor changes to the current hydrology of the ravine that would promote a more healthy and diverse ecosystem. The natural hydrology of the ravine and bluff was impaired due to watershed development. The increased rainfall-runoff from the subwatersheds discharged through the ravine has greatly impaired the stability of the plant communities of these features. The proposed plan would be implemented in a fashion to as to work with the existing hydrologic regime to the ravine and bluff by installing cobble riffles and step pools. The project would not negatively or positively affect ground water in any manner since the land use cover types that are impairing groundwater are not being addressed under this project.

Hydraulics: Implementation of the proposed project would result in changes to the current hydraulics of the ravine to promote a more healthy and diverse ecosystem. The natural hydraulics of the ravines and coast were impaired due to watershed development. Increased rainfall-runoff from the tributary areas impaired the stability of the ravine side slopes and bed. The proposed plan would naturalize stream hydraulics to the ravine. The ravine hydraulics would be restored by removing the earthen dam and installing cobble riffles and step pools. The project would not adversely affect fluvial or coastal hydraulics.

Land Use: Implementation of the proposed project would result in no changes to the current land uses since open space areas are conducive for restoring back to natural plant community cover types. Open space areas that would change typically consist of degraded natural plant communities or mowed turf grass. The proposed project would be implemented in a fashion as to restore land use instead of converting it; therefore, no significant adverse effects are expected.

Water Quality

The water quality of the storm water would be the same at the Lake Michigan discharge point with or without project conditions. The rate at which these storm water pulses flow through the open ravine allows no attenuation time for nutrients to be up taken or sediments to fall out, and in fact, the pulses pick up more sediment and organic matter (leaf litter) from the ravine and wash them into the lake. So ultimately, the with-project conditions have no change for metals and salts, but could result in a minor reduction in nutrients and sedimentation to Lake Michigan.

4.4.2 – Ecological Resources

Lacustrine Communities

The proposed project would ultimately improve native aquatic species richness and abundance. Restored stream connectivity to the lake would provide increased foraging and spawning habitat for littoral zone species (e.g. sand shiners and longnose dace) as well as some deep water species (e.g. lake chub and longnose sucker). There are no significant adverse effects expected.

Beach Communities

Implementation of the proposed project would ultimately improve native floristic species richness and abundance within the beach and dune habitats by removing invasive species and seeding areas with native vegetation exhibiting local genotypes. There are no significant adverse effects expected.

Ravine Communities

Implementation of the proposed project would ultimately improve native floristic species richness and abundance within the ravines by repairing fluvial hydraulics, removing invasive species and seeding areas with native vegetation exhibiting local genotypes. There are no significant adverse effects expected.

Bluff Communities

Implementation of the proposed project would ultimately improve native floristic species richness and abundance along the bluff by removing overland stormwater flows, removing invasive species and seeding areas with native vegetation exhibiting local genotypes. There are no significant adverse effects expected.

Threatened & Endangered Species

Implementation of the proposed project would benefit endangered and threatened species if they were to colonize the project site. Currently, no Federal listed endangered or threatened species or their critical habitats have been recorded from the project site; however, numerous state listed species have been recorded. Restoration features would directly increase the quality of the habitat present at Ravine 8; hence potentially encouraging colonization or continued habitation of the area by state listed species such as the common tern (*Sterna hirundo*), longnose sucker (*Catostomus catostomus*), marram grass (*Ammophila breviligulata*), common juniper (*Juniperus communis*), downy Solomon's seal (*Polygonatum pubescens*), seaside spurge (*Chamaesyce polygonifloia*), and sea rocket (*Cakile edentula*).

Coordination with the USFWS and the Illinois Department of Natural Resources (IDNR) was commenced on November 15, 2012 with a project scoping letter. The USACE has concluded in this report that the project is not likely to adversely affect federal or state listed species, which precludes the need for further consultation for this project. It is expected that the USFWS will provide a letter of "No Objection" in response to the public/agency release of the NEPA document based on the support letter dated 07 March 2013.

4.4.3 – Cultural Resources

Cultural & Social Properties

There are 43 properties and four historic districts listed on the National Register of Historic Places located within Highland Park. Only two properties, the Granville-Mott House (listed in 1982) and the Mary W. Adams House (listed in 1982) are located near the project area on the north side of Ravine 8. The proposed NER plan would have no adverse effects on either of these properties since they will be unaffected by implementation.

Archaeological & Historical Properties

The proposed project would have no adverse impact on archaeological or historic properties.

Areas of planned ecological restoration have been heavily modified. Channeled rainwater and drain runoff has heavily eroded the existing ravines. In the event cultural resources are discovered during this project, work in that area will stop and the Illinois State Historic Preservation Agency will be notified.

National Historic Preservation Act of 1966 – The proposed construction would have no adverse impact on archaeological or historic properties. The Illinois Historic Preservation Agency has been contacted letter dated November 15, 2012 and responded in a letter dated November 29, 2012 with their concurrence with this determination.

Native American groups having an historic cultural interest in northeast Illinois have been consulted (letters dated November 15, 2012).

In the event that cultural remains are discovered during the project, the Chicago District Archaeologist will be notified immediately and work will cease to allow for consultations with the Illinois State Historic Preservation Agency to take place.

Land Use History

The proposed project would result in beneficial effects to land use within the watershed. The proposed project would be implemented in such a fashion as to restore an open space parcel to a more natural condition. Significant adverse effects as a result of implementing the proposed project are not expected to occur.

Social Properties

During construction, increased traffic congestion would be localized and intermittent. Employment could increase slightly during construction, and the region’s labor force should provide the necessary workers. Noise levels would be increased during construction as a result of passing trucks. Any aesthetic impacts would be negligible and temporary. The proposed project would have no significant adverse effect on human health or welfare, municipal or private water supplies, recreational or commercial fisheries, property values or aesthetic values.

Recreational Activities

The proposed project would not have any long-term adverse effects to recreation. Implementation of the plan would not affect recreational opportunities. Any impacts to recreational opportunities from construction of the proposed project would be temporary in nature.

Environmental Justice

All of the proposed alternative plans would not cause adverse human health effects or adverse environmental effects on minority populations or low-income populations. Executive Order 12898 (environmental justice) requires that, to the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands.

A database search of the EPA EJView mapping tool (Accessed 31 May 2012), revealed that within the portion of Highland Park containing the Ravine 8 project site, 0-20% of the population is considered below the poverty line and 0-30% of the population is considered a minority. Since the overall project is considered ecosystem restoration and will only benefit the surrounding environment and communities, no adverse effects to any low income populations and/or minority populations are expected.

4.4.4 – Hazardous, Toxic & Radioactive Waste (HTRW) Analysis

The proposed project would not have any long-term adverse effects stemming from the disturbance of HTRW materials. Investigation of existing environmental data, maps and site conditions determined the risks associated with the project site are negligible. The database search and site visit did not indicate any surrounding sites that are likely to pose concerns to the project. Based on this information, the investigation concluded that the work proposed for the Ravine 8 project site has little potential for encountering a REC.

4.4.5 – 17 Points of Environmental Quality

The 17 points are defined by Section 122 of Rivers, Harbors & Flood Control Act of 1970 (P.L. 91-611) from (ER 1105-2-240 of 13 July 1978). Effects to these points are discussed as follows:

Noise: Any of the alternative plans would cause minor and temporary increase in noise levels beyond the current conditions. The minor noise effects would stem from machinery utilized for grading banks, placing cobble riffles, removing manmade structures from the ravines and lake, and removal of trees and brush. Long term, significant effects in terms of noise is not expected.

Displacement of People: Any of the alternative plans would not displace local residents within the township of the study area since only open space parcels are proposed for restoration.

Aesthetic Values: Any of the alternative plans would not reduce the aesthetic values of the study area. Temporary deteriorations in aesthetics would occur from herbicide application to stands of invasive species, temporary storage of debris piles, and graded areas of stream banks before native vegetation has established. These affects on aesthetics are minor and temporary as native plant species would sufficiently

cover the ground after the first growing season. The removed foreign debris, removed invasive species, and restored plant communities would provide an increase in aesthetic values. This would be visually evident by a diverse mix of native wildflowers and grasses that would also attract new fish and wildlife species that would otherwise not be present without this restoration project.

Community Cohesion: Any of the alternative plans would not disrupt community cohesion, but provide restored open space for community activities.

Desirable Community Growth: Any of the alternative plans would not adversely affect community growth and would potentially attract people to a more aesthetically pleasing area based on project restoration measures.

Desirable Regional Growth: Any of the alternative plans would not adversely or beneficially affect regional growth.

Tax Revenues: Any of the alternative plans would not adversely or beneficially affect tax revenues.

Property Values: Any of the alternative plans would not have adverse affects on property values, but has the potential to increase surrounding land values since the aesthetics would improve to do project restoration measures.

Public Facilities: Any of the alternative plans would not adversely affect Highland Park public facilities, but would provide a more natural and healthy open space, such as the retirement home located north of the study boundary.

Public Services: Any of the alternative plans would not adversely or beneficially affect public services.

Employment: Any of the alternative plans would not adversely affect employment and would temporarily increase employment during construction activities.

Business and Industrial Activity: Any of the alternative plans would not adversely or beneficially affect local commerce.

Displacement of Farms: Any of the alternative plans would not adversely affect farmland since restoration areas do not occur on agricultural fields.

Man-made Resources: Any of the alternative plans would not adversely or beneficially affect man-made resources.

Natural Resources: The No Action Alternative allows for the continued degradation of native species, rare communities, and significant habitats. The proposed project would not adversely affect natural resources, but improve them greatly.

Air: Any of the alternative plans would not adversely affect air quality since machinery for construction activities would be unnoticeable compared to current traffic and activities of the immediate project area.

Water: Any of the alternative plans would not adversely affect water quality; however, ravine and lacustrine features are expected to improve dissolved oxygen, sediment transport, and provide substrate for denitrifying bacteria.

4.5 – Cumulative Effects

Consideration of cumulative effects requires a broader perspective than examining just the direct and indirect effects of a proposed action. It requires that reasonably foreseeable future impacts be assessed in the context of past and present effects to important resources. Often it requires consideration of a larger geographic area than just the immediate "project" area. One of the most important aspects of cumulative effects assessment is that it requires consideration of how actions by others (including those actions completely unrelated to the proposed action) have and will affect the same resources. In assessing cumulative effects, the key determinant of importance or significance is whether the incremental effect of the proposed action will alter the sustainability of resources when added to other present and reasonably foreseeable future actions.

Cumulative environmental effects for the proposed ecosystem restoration project were assessed in accordance with guidance provided by the Council on Environmental Quality (CEQ) and U.S. Environmental Protection Agency (USEPA 315-R-99-002). This guidance provides an eleven-step process for identifying and evaluating cumulative effects in NEPA analyses.

The overall cumulative impact of the proposed Ravine 8 restoration project is considered to be beneficial environmentally, socially, and economically. The restoration of about 3.66-acres of ravine, bluff, and dune will contribute to the overall restoration and preservation of coastal habitat along the Highland Park Moraine and Zion Beach-Ridge Plain.

4.5.1 – Scope of Cumulative Effects Analysis

Through this environmental assessment, the cumulative effects issues and assessment goals are established, the spatial and temporal boundaries are determined, and the reasonably foreseeable future actions are identified. Cumulative effects are assessed to determine if the sustainability of any of the resources is adversely affected with the goal of determining the incremental impact to key resources that would occur should the proposal be permitted.

The spatial boundary for the assessment has been broadened to consider effects beyond the footprint of Ravine 8. The spatial boundary being considered is normally in the general area of the proposed ecological restoration; however, this area may be expanded on a case-by-case basis if some particular resource condition necessitates broadening the boundary.

Three temporal boundaries were considered:

- Past –1830s because this is the approximate time that the landscape was in its natural state, which included forested ravines, wet mesic/mesic forest and oak savanna.
- Present – 2013 when the decision is being made on the most beneficial ecological restoration
- Future – 2063, the year used for determining project life end, although the ecological restoration should last until a geologic event disturbs the area.

Projecting the reasonably foreseeable future actions is difficult. The proposed action (ecosystem restoration) is reasonably foreseeable; however, the actions by others that may affect the same resources are not as clear. Projections of those actions must rely on judgment as to what are reasonable based on existing trends and where available, projections from qualified sources. Reasonably foreseeable does not include unfounded or speculative projections.

- Stable growth in both population and water consumption near the study area

- Sowing of native plants to return plant communities across the landscape
- Continued increase in tourism/recreation in the open spaces of the region
- Continued, but slowed urban development near the study area
- Continued application of environmental requirements such as those under the Clean Water Act
- Implementation of various programs and projects to deal with runoff and waste water pollution and to restore degraded environments
- Community will increasingly value not only the open space but the biodiversity as well
- Improvement to nearby natural areas such as Ravinia Bluff and Rosewood Park

4.5.2 – Cumulative Effects on Resources

Physical Resources

The topography, soils, hydrology, hydraulics and geomorphology of this area was significantly disturbed by past actions of vegetation stripping, draining, ditching, tilling, dumping, impervious surface creation and poorly functioning water use infrastructure. Cumulative effects of past practices and infrastructure have damaged in some way, shape or form the physical properties that are primary drivers to ecosystem diversity. Remedying the physical resource impairments would in some ways push the area back to a more naturalistic landscape. Naturalizing the hydraulics and native plant community of the ravine would produce a setting more representative of historical natural conditions of the area. Future actions such as infrastructure upgrading may have damaging or beneficial effects in the future, and should thusly be part of the non-Federal sponsors operations and maintenance responsibilities to safeguard the future. Cumulative impacts of the proposed and combined future actions to the physical resources would be beneficial to the human environment, water resources and ecosystem sustainability.

Biological Resources

The project area lies upon the Highland Moraine geologic feature. Forested ravines, wet mesic/mesic forest and oak savanna typically dominated this area. Along with all of the Physical Resource impairments (primary drivers), the plant communities (secondary drivers), were all but completely eradicated for agriculture and urban space. These plant communities supported an enormous diversity of aquatic plants and animals that also aided in regulating hydrology and hydraulics. Cumulative effects of the past have decimated plant communities for thousands of species and reduced them to isolated patches scattered throughout the area. After naturalizing the past physical impairments, biological resource impairments would be reestablished as well, which in this case are the plants. This would set the stage for higher organism recolonization. Reestablishing the ravine, bluff and dune plant communities would produce spatial structure, food source and reproductive habitat for many native species. Future actions such as infrastructure upgrading may have damaging or beneficial effects and should thusly be part of the non-Federal sponsors' operations and maintenance responsibilities to safeguard the project's future. Cumulative impacts of the proposed and combined future actions to the biological resources would be beneficial to the human environment, water resources and ecosystem sustainability.

Cultural Resources

Adverse cumulative impacts to archaeological and cultural resources were inflicted by agriculture, creation of infrastructure, and residential development, which began in the 1800s. The landscape changed from a mosaic of ravine, forest, dune, and beach to an urbanized area. Although these probably increased the comfort of human life, it probably adversely affected archaeological and cultural resources strewn about the landscape. Proposed project features and foreseeable land use restoration would not adversely affect cultural resources because these parcels were already disturbed from their natural conditions and all of the work is surficial in nature. The quality of human life would not be adversely affected, but may see

some improvement with the procurement of natural open spaces to escape the hardened urban landscape. The project would restore the current degraded nature of the ravine, bluff and dune plant communities. This will include removing non-native species and reestablishing vegetation. Reestablishing native vegetation (including wildflowers) and removing antiquated structures (sewer drains) would only increase the aesthetic value of the project site. Cumulative impacts of the proposed and combined future actions to the cultural resources would be beneficial to the human environment, water resources and ecosystem sustainability.

4.5.3 – Cumulative Effects Summary

The overall cumulative effects of the Ravine 8 habitat restoration project are considered to be beneficial environmentally, socially and economically. The irreversible and irretrievable commitment of resources was not identified to be resultant from implementation of the proposed action; NEPA 1502.16 (102(2)(C)(v)). Relationships between local short-term uses of man's environment and maintenance and enhancement of long term productivity would be swayed towards ecological recovery of Ravine 8 since man's short term use of the Ravine as a drainage conduit would cease; NEPA 1502.16 (102(2)(C)(iv)). No adverse environmental effects which cannot be avoided were identified should the proposal be implemented; NEPA 1502.16 (102(2)(C)(ii)).

The restoration of about 3.66-acres of degraded habitats, which were once part of a vast Lake Michigan coastal ecosystem, would contribute to increased acreage of viable open space and habitat within the Great Lakes basin, while improving water quality, visual aesthetics and migratory bird habitat within the Lake Michigan portion of the Central Flyway.

4.6 – Discussion of Environmental Compliance

The NER /Preferred Plan presented is in compliance with appropriate statutes and executive orders including the Endangered Species Act of 1973 as amended; the Fish and Wildlife Coordination Act of 1934 as amended; Executive Order 12898 (Environmental Justice); Executive Order 11990 (Protection of Wetlands); Executive Order 11988 (Floodplain Management); and the Rivers and Harbors Act of 1899 as amended; the Clean Air Act of 1970 as amended and the National Environmental Policy Act of 1969 as amended.

Environmental Justice EO12898

To the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands. The preferred plan would not have any adverse effects to any populations including minority and low-income populations.

Clean Air Act

Due to the small scale, short duration and relatively unpolluted nature of the restoration project, it is assumed that the project is below the de minimis level of PM 100 tons per year. As a reference, other USACE projects that are much grander in scale and earthwork have General Conformity Act emissions well below the PM 100 tons per year.

Section 401 & 404 of the Clean Water Act

A Section 404 analysis was completed for the preferred plan. Features addressed by the 404 include the fill materials for stream restoration where cobble, gravel, sand and clean clays would be placed to mimic natural substrates. No adverse effects to water quality or aquatic habitat were determined.

Section 401 Water Quality Certification is granted under the U.S. Army Corps of Engineers, Chicago District Regulatory Branch Regional Permit 5, Wetland & Stream Restoration and Enhancement. All aspects and project features fall within the guidelines of this Regional Permit. All applicable information and analyses required to receive 401 Water Quality Certification were included as part of the study document. No adverse effects to water quality or aquatic habitat were determined.

USFWS Coordination

Coordination with the USFWS commenced with a project scoping letter dated 15 November 2012. The recommended plan was determined to have “no effects” on Federally listed threatened or endangered species or their habitats, which precluded Section 7. The USFWS has provided a “Letter of No Objection” to the project dated __ ____ ____.

State of Illinois Historic Preservation Act

Pursuant to Section 106 of the National Historic Preservation Act (16 U.S.C. § 4701) and 36 C.F.R. Part 800, the staff of the Illinois State Historic Preservation Officer (Illinois SHPO) has conducted an analysis of the materials dated 15 November 2012. Based upon the documentation available, the staff of the Illinois SHPO has not identified any historic buildings, structures, districts, or objects listed in or eligible for inclusion in the National Register of Historic Places within the probable area of potential effects. Therefore the SHPO has no objection to the project. All areas affected by ground disturbance under this project have already been previously disturbed; therefore an archaeological survey is unnecessary and is consistent with the SHPO letter dated 29 November 2012.

Highland Park Steep Slope Ordinance

This project is in compliance with the Highland Park’s Steep Slope Ordinance (Ord. 38-01, J.27, p. 146-167, passed 6/25/01; Ord. 26-08, J. 34, p. 050-068, passed 4/14/08), which was passed to protect the natural conditions of these rare natural ravine landforms. Regulating the intensity of development according to the natural characteristics of steep slope terrain, such as degree of sloping, significant vegetation, and soil stability and existing drainage patterns, will allow for suitable development while minimizing the physical impact of such development on sensitive ravine and bluff steep slope areas. This project would restore and maintain natural ravine features, which is in support of this ordinance.

Public Interest

An Environmental Assessment (EA) was prepared for the project and sent to Federal, State and local agencies along with the general public for review. A 30-day Public Review period was held from 15 ____ 2012 to 07 _____ 2012 for the Environmental Assessment. Significant comments from the Federal, State or local agencies or the public were addressed and are attached to this FONSI. All comments and correspondence are attached to this FONSI.

Conclusion

In accordance with the National Environmental Policy Act of 1969 and Section 122 of the River and Harbor and Flood Control Act of 1970, the U.S. Army Corps of Engineers has assessed the environmental impacts associated with this project. The purpose of this EA is to evaluate the impacts that would be associated with the restoration of the 5-acres at Ravine 8. The proposed project has been determined to be in full compliance with the appropriate statutes, executive orders and USACE regulations.

The assessment process indicates that this project would not cause significant effects on the quality of the human environment. The assessment process indicates that this project would have only beneficial impacts upon the ecological, biological, social, or physical resources of this area, and would provide environmental benefits to the Lake Michigan coastal zone and the Great Lakes as a whole. The findings indicate that that the proposed action is not a major Federal action significantly affecting the quality of the human environment. Therefore, I have determined that an Environmental Impact Statement (EIS) is not required.

CHAPTER 5 – DESCRIPTION OF THE NER PLAN

5.1 – Plan Components

The National Ecosystem Restoration (NER) Plan is the recommended plan, which is Plan 3 (**Plate 08 & Appendix B**). All of these community types would have been represented within the pre-settlement coastal zone within the Chicago Region. The implementation of these features is generally described as follows and according to the measure descriptions in Section 3.1. A detailed set of plans & specifications would be created if approval of this Detailed Project Report (DPR) is granted.

Site Preparation – The first task would be to install safety fencing, signage and other safety features in order for public safety. Staging areas and access roads would be demarcated. All defunct surficial infrastructures would need to be removed and discarded or stockpiled and saved depending on the non-Federal sponsors needs.

HA - Open Channel – This measure would deal with the current hydraulic conditions that developed in the ravine due to increased rainfall runoff from the watershed. Cobble riffles and step pools would be sized appropriated for the current stream flows. These structures would need to be installed across the full cross section of the ravine to reduce head-cutting and channel incision. Woody structures such as cribs and cross veins would be used as well to further armor against the high flows and velocities. This measure would aid in alleviating the adverse physical disturbance caused by the higher flow and velocities; however, habitat benefits would not be maximized since the larger substrate, wooden structures and remaining velocities would preclude certain species of plants, macroinvertebrates and fishes from utilizing the ravine. Species adapted to high velocities such as longnose dace and mottled sculpin are examples of species that would benefit from this measure.

Final Grading Stabilization – All of the flow currently flowing through the ravine will be allowed to remain. Due to the higher gradient slope within the ravine, however, there is still potential for the remaining flow to reach a sufficiently high velocity that down-cutting will be a concern. To prevent these excessive velocities, and to provide macroinvertebrate habitat, cobble riffles will be constructed at various gradient break locations, as described in **Appendix A**. This would restore a stream channel of shallower slope with riffle cascades for the primary purpose of providing accessible, functional and usable stream habitat.

Native Plant Community Establishment – The finishing touch of the project would be to establish native ravine, bluff and dune plant communities over the remainder of the construction period. Species would be located according to new hydrogeomorphology, soils and substrates established by the previous steps. Once the physical work is complete and all invasive species removed native seed and plugs would be planted. Years 2 – 4 of the project would manage and establish the native plant communities. This work includes spot herbicide application for invasive species regrowth and replanting small areas if necessary.

Prescribed burns would be conducted by a burn crew that is highly trained and experienced in fire management and the prescribed burning of natural areas. The burn crew will be under the direct control of a qualified burn coordinator having completed at least the minimum amount of training, including S-230 (Single Resource Boss), required to provide controlled burning services in a safe and responsible manner. Primary fire breaks will be installed around the boundary of the site and additional fire breaks will be mowed at least 15 feet around any private parcels within the area of the prescribed burn. The resulting smoke from the burn will be minimized by burning during the daytime when transport winds and mixing heights are such that smoke can be lifted and dispersed safely away from roads and residences unless adequate safeguards have been taken such as appropriate notifications and traffic control. Burns will only

take place under acceptable weather parameters (air temperature, humidity, etc) and once all required burn permits are obtained.

Recreational Features – Components of recreation are not proposed under this project.

5.2 – Plans & Specifications

During the design phase, a detailed set of plans and specifications will be fashioned in order to solicit and award a construction contract. Also, prior to finalization of the plans and specifications, assurance will be made that all areas to be prepared by the non-Federal sponsor shall be in compliance with ER 1165-2-132, Federal, State, and local regulations. A schedule, quality control plan, and labor estimate was fashioned along the FS QCP for the plans and specifications phase; if approval is granted to this project, the QCP would continue to be followed.

5.3 – Real Estate

The current non-Federal LERRDs credit is estimated based on the Informal Value Estimate, which is $106,000.

5.4 – Operation and Maintenance

The O&M costs of the project are estimated to total an annual cost of $5,000 with a 4.875% interest rate over 50 years. Slope maintenance includes the addition of stone or soil in certain areas that experienced minor erosion. Natural plant community maintenance includes the prevention of non-native and exotic species colonization and the addition of native species overtime. A detailed O&M Manual containing all the duties will be provided to the non-Federal sponsor after construction is closed out.

5.5 – Monitoring Plan

Section 2039 of WRDA 2007 directs the Secretary to ensure that when conducting a feasibility study for a project (or a component of a project) for ecosystem restoration that the recommended project includes a plan for monitoring the success of the ecosystem restoration. Within a period of ten years from completion of construction of an ecosystem restoration project, monitoring shall be a cost-shared project cost.

A five year monitoring plan following completion of construction will be implemented for this project (**Appendix H**). The USACE, Chicago District would conduct monitoring in conjunction with the non-Federal sponsors to determine the success of the project. The primary goal of this project is restore ravine, dune and bluff coastal communities in support of Great Lakes fishes, amphibians, reptiles, and migratory bird species. Baseline data for current conditions on Ravine 8 are detailed in this DPR. The following specific monitoring objectives were established to determine the effectiveness of this project:

- Restore ravine stream and riparian corridor habitat as measured by the presence of naturalized stream hydrology and hydraulics
- Improve native fish species richness as measured by Fish Species Richness: Target R Score for Ravine Stream **≥8**
- Improve native plant species richness and assemblage structure as measured by coefficient of conservatism of the Chicago Region Floristic Quality Index: Target Overall Mean C Score **≥ 5**
- Eradicate/reduce the presence of non-native and invasive species: Target Invasive Species Eradication Percentage **<1% Areal Coverage**

5.6 – Division of Responsibilities

As established in PL99-662, as amended, project costs are shared with the non-Federal sponsor in accordance with project outputs. The City of Highland Park has agreed to serve as the local cost-sharing sponsor for the Ravine 8 506 Great Lakes Fishery & Ecosystem Restoration project. The cost-sharing requirements and provisions will be formalized with the signing of the Project Partnership Agreement (PPA) between the local sponsor and USACE prior to initiation of contract award activities. In this agreement, the local sponsor will agree to pay 35 percent of the total project costs. Based on the cost sharing requirements, the total project cost and pertinent cost-sharing information for the restoration project are summarized in **Tables 11** and **12**.

Table 11 – Total Project Cost*

Removed intentionally

*All costs Certified TPC by the Walla Walla Cost TCX on 22 February 2013 except Monitoring Costs obtained from Appendix H

Table 12 – Cost Sharing Breakout in 1000's*

Removed intentionally

*All costs Certified TPC by the Walla Walla Cost TCX on 22 February 2013 except Monitoring Costs obtained from Appendix H

Responsibilities

Federal - The estimated Federal cost share of the project is about [redacted]. The USACE would accomplish the plans and specifications phase, which includes additional design studies and plans and specifications, contract for construction, overall supervision during construction, prepare an operation and maintenance manual, and participate in a portion of the post construction monitoring.

Non-Federal Responsibilities - Prior to initiation of the design phase, the Federal Government and the non-Federal sponsors will execute a PPA. The LERRDs and OMRR&R of the project will be the responsibility of the non-Federal sponsors for the proposed project. The estimated non-Federal share of the total first cost of the project is about [redacted] and will be covered by LERRDs credit of [redacted] and a cash contribution of [redacted]. In addition to the total first cost, the feasibility level operations and maintenance costs of the project are estimated to total an annual cost of [redacted]. The non-Federal sponsors shall, prior to implementation, agree to perform the following items of local cooperation:

1. Provide 35 percent of the separable project costs allocated to environmental restoration as further specified below
   a) Provide the non-Federal share of all complete planning and design work upon execution of the PCA
   b) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or ensure the performance of all relocations determined by the government to be necessary for the construction and O&M of the project
   c) Provide or pay to the government the cost of providing all features required for the construction of the project
   d) Provide, during construction, any additional costs as necessary to make its total contribution equal to 35 percent of the separable project costs allocated to environmental restoration
2. Contribute all project costs in excess of the USACE implementation guidance limitation of $10,000,000

3. For so long as the project remains authorized, operate, maintain, repair, replace, and rehabilitate the completed project or the functional portion of the project at no cost to the government in accordance with applicable federal and state laws and any specific directions prescribed by the government
4. Give the government a right to enter, at reasonable times and in a reasonable manner, upon land that the local sponsor owns or controls for access to the project for the purpose of inspection and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project
5. Assume responsibility for operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) of the project or completed functional portions of the project, including mitigation features, without cost to the government in a manner compatible with the project's authorized purpose and in accordance with applicable federal and state laws and specific directions prescribed by the government in the OMRR&R manual and any subsequent amendments thereto
6. Comply with Section 221 of Public Law (P.L.) 91-611, Flood Control Act of 1970, as amended, and Section 103 of the WRDA of 1986, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resource project or separable element thereof until the nonfederal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element
7. Hold and save the United States free from damages due to construction of or subsequent maintenance of the project except those damages due to the fault or negligence of the United States or its contractors
8. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs
9. Perform or cause to be performed such investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 *U.S. Code* 9601 through 9675, that may exist in, on, or under lands, easements, or rights-of-way necessary for the construction, and O&M of the project, except that the nonfederal sponsor shall not perform investigations of lands, easements, or rights-of-way that the government determines to be subject to navigation servitude without prior written direction by the government
10. Assume complete financial responsibility for all necessary cleanup and response costs for CERCLA-regulated material located in, on, or under lands, easements, or rights-of-way that the government determines necessary for the construction and O&M of the project
11. To the maximum extent practicable, conduct OMRR&R of the project in a manner that will not cause liability to arise under CERCLA
12. Prevent future encroachment or modifications that might interfere with proper functioning of the project
13. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, P.L. 91-646, as amended in Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987, P.L. 100-17, and the uniform regulation contained in Part 24 of Title 49, *Code of Federal Regulations* (CFR), in acquiring lands, easements, and rights-of-way for construction and subsequent O&M of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said acts
14. Comply with all applicable federal and state laws and regulations, including Section 601 of Title VI of the Civil Rights Act of 1964, P.L. 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto and published in 32 CFR, Part 300, as well as Army Regulation 600-7 entitled "Non-Discrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"
15. Provide 35 percent of that portion of the total cultural resource preservation, mitigation, and data recovery costs attributable to environmental restoration that are in excess of
    1 percent of the total amount authorized to be appropriated for environmental restoration
16. Do not use federal funds to meet the nonfederal sponsor's share of total project costs unless the federal granting agency verifies in writing that the expenditure of such funds is expressly authorized by statute

Financial Capability of Sponsor

In accordance with regulation ER1105-2-100, Appendix D, where the non-Federal sponsor's capability is clear, as in the instances where the sponsor has sufficient funds currently available or has a large revenue base and a good bond rating, the statement of financial capability need only provide evidence of such.

The non-Federal sponsor is committed to its specific cost share of the Design & Implementation (D&I) Phase, and expresses willingness to share in the costs of construction to the extent that can be funded.

CHAPTER 6 – RECOMMENDATION

I have considered all significant aspects of the problems and opportunities as they relate to the project resource problems of the Ravine 8 natural area. Those aspects include environmental, social, and economic effects, as well as engineering feasibility.

I recommend Best Buy Plan 3, which consists of establishing a diverse ravine stream and riparian habitat. The recommended plan has a total project cost of approximately [redacted] (2013 price levels). This plan provides 17.2 net average annual habitat units over 3.66-acres of coastal zone. All costs associated with the restoration of Ravine 8 natural area ecosystem have been considered.

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CHAPTER 7 – BIBLIOGRAPHY AND ACRONYMS

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