UPPER DES PLAINES RIVER AND TRIBUTARIES, ILLINOIS AND WISCONSIN

INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

January 2015

Study Partnership

Cook County Highway Department (CCHD)
Forest Preserve District of Cook County (FPDCC)
Kenosha County
Lake County Stormwater Management Commission (LCSMC)
Lake County Forest Preserve District (LCFPD)
Metropolitan Water Reclamation District of Greater Chicago (MWRDGC)
Illinois Department of Natural Resources (IDNR)
Southeastern Wisconsin Regional Planning Commission (SEWRPC)
U.S. Army Corps of Engineers (USACE)
U.S. Fish and Wildlife Service (USFWS)

US Army Corps
of Engineers
Chicago District

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Executive Summary

The Upper Des Plaines River watershed originates in Racine and Kenosha counties of southeastern Wisconsin. The watershed then extends south into Illinois through Lake County and then Cook County, where it converges with the Salt Creek watershed near Riverside, Illinois. The Des Plaines River then flows southwest on to its confluence with the Kankakee River, where the two rivers combine to form the Illinois River. The study area for this Study includes the entire drainage area upstream of the confluence with Salt Creek, including 12 major tributaries to the river. The Upper Des Plaines watershed covers approximately 477 square miles, an area that spans approximately 60 miles from north to south and 8 miles from east to west. The Upper Des Plaines River travels over 87 miles before its confluence with Salt Creek. Tributaries within the study area include about 330 miles of perennial and intermittent streams.

Development in the watershed coincided with the development of the Chicago metropolitan area. Although the southern portion of the watershed in and around Chicago is more urbanized than the northern portion within Lake County in Illinois and Kenosha and Racine Counties in Wisconsin, land use changes have impacted the entire study area. Significant portions of the watershed in northern Lake County and in the two Wisconsin counties are primarily agricultural. Only 9% of the current land use remains as natural open space. Communities along the Upper Des Plaines River and its tributaries have experienced major flooding resulting in hundreds of millions of dollars in damages over the past several decades.

An earlier study, the *Upper Des Plaines River, Illinois Feasibility Study* (Phase I Study), formulated plans to address severe overbank flooding along the Upper Des Plaines River. Two particularly severe events in 1986 and 1987, which combined resulted in over $100 million in damages, prompted initiation of that study. Federal interest in flood risk management (FRM) in the Upper Des Plaines watershed was established in a Reconnaissance Report that preceded the Phase I Study and was approved in 1989. The Phase I Study recommended six projects to reduce mainstem flooding. The Feasibility Report was approved in 1999 and the recommended projects were authorized in Section 101 of the Water Resources Development Act (WRDA) of 1999. Project benefits for the authorized project would provide an estimated 25% reduction in flood damages.

This *Upper Des Plaines River and Tributaries, Illinois and Wisconsin Feasibility Study* (Phase II Study), was authorized by Section 419 of the WRDA of 1999 (P.L. 106-53). The Phase II Study provides an opportunity to develop a more comprehensive solution to address ongoing occurrences of flooding and restore the degraded aquatic ecosystems within the Upper Des Plaines River watershed. The study authorization directs the Secretary to evaluate plans to manage flood risk and address environmental restoration and protection on both the mainstem and tributaries. Additionally, the study authorization includes water quality, recreation and related purposes. Further reduction of flooding along the mainstem Des Plaines River and its tributaries, and environmental restoration of degraded ecosystems within the basin have been prioritized as the primary purposes of the study. Improving water quality and enhancing recreational opportunities throughout the basin are secondary to the identified primary purposes. The study considers sites located within tributary watersheds and along the mainstem for both Flood Risk Management (FRM) and Ecosystem Restoration (ER) potential. It also evaluates the effects of FRM sites within tributary watersheds on mainstem flooding.

An assessment of existing and projected future without project conditions determined that a significant risk of overbank flooding exists and that the aquatic ecosystem is severely degraded across most of the watershed. Expected annualized flood damages are estimated at $52,253,000 across the watershed and the aquatic ecosystems of approximately 39,000 acres containing scarce wet prairie, savanna, forested floodplain woodlands, isolated wetlands, and floodplain wetlands located within the riparian zones will remain highly fragmented and degraded. The need to manage flood risk within the watershed was highlighted by major flooding that occurred in the spring of 2013. On April 18, 2013, the Chicago area received an average of 5 inches of rainfall, with localized precipitation of over 7 inches over an 18 to 24 hour period. The study area received widespread rainfall between 0.25 and 1.5 inches several days before the event, which saturated the ground and increased the potential for overbank flooding when heavier rains fell a few days later. These antecedent conditions resulted in significant flooding throughout northeast Illinois with the greatest impacts on the Des Plaines River, Fox River, and East Branch of the DuPage River.

Major flood stages were reached across the entire Upper Des Plaines study area. New record stages were reached at the Des Plaines (0.02-ft over previous 1986 record) and Riverside (0.67-ft over previous 1987 record) U.S. Geological Survey USGS gage stations. These record stages resulted in widespread overbank flooding along the majority of the study area. Thousands of structures were inundated and many road crossings and parallel roads were closed for several days. The Federal Emergency Management Agency issued a Major Disaster Declaration (DR-4116) on May 10, 2013.

The feasibility study evaluated a range of measures to meet both the FRM and ER purposes. To develop the FRM plan, structural measures such as floodwater storage reservoirs, levees and floodwalls, road raises, and non-structural measures such as floodproofing and elevating structures were evaluated individually to determine whether they were economically justified. Individually justified sites were then combined to form an incrementally justified plan, optimizing benefits throughout the watershed. To develop the ER plan, undeveloped lands throughout the watershed were evaluated to determine whether cost-effective aquatic ecosystem restoration at that site was possible and what measures would provide the lowest incremental cost per unit of habitat output. Cost-effective ecosystem restoration sites were then grouped to determine the most incrementally cost effective plan that would best improve habitat quality and quantity throughout the watershed. The FRM and ER plans were then compared to determine whether there was competition between purposes. Since there is no physical overlap between the indentified FRM and ER plans and their effects, it was determined there is no competition between the plans and a combined FRM/ER plan that includes all features of both plans was identified.

Three plans, as discussed below, are identified by this study: a *Combined NED/NER Plan*, a *CAP Plan*, and a *Comprehensive Plan*. A combined National Economic Development / National Ecosystem Restoration (NED/NER) plan is recommended for congressional authorization. In addition, projects that could reasonably be implemented under the Continuing Authorities Program (CAP) are recommended for conversion to that program for implementation. All economically justified features, regardless of USACE policy compliance, are included in the *Comprehensive Plan*. Non-policy compliant portions of the *Comprehensive Plan* are recommended for implementation by the appropriate state and local agencies.

Policy compliant features that are either economically justified (for FRM projects) or cost-effective (for ER projects) and of such scope that they could not reasonably be implemented under CAP authorities are included in a plan designated as the *Combined NED/NER Plan*, as shown in Table ES.1. This plan, upon approval by the Chief of Engineers, will be recommended for specific authorization by Congress.

There are 14 projects in the *Combined NED/NER Plan*. The projects in this plan include a structural FRM system consisting of three levee/floodwalls and two floodwater storage reservoirs providing compensatory storage and additional flood risk management benefits as well as non-structural measures to be implemented in two counties (Lake and Cook) and seven ER projects throughout the watershed where aquatic ecosystems will be restored to more natural conditions. The *Combined NED/NER Plan* is recommended for Congressional authorization.

A *CAP Plan*, as shown in Table ES.2, has also been identified that includes all policy compliant, separable features that are economically justified (for FRM projects) or cost-effective (for ER projects) and of such scope that they could reasonably be implemented under the Continuing Authorities Program. This program allows USACE to plan, design, and construct smaller projects using delegated program authorities provided by Congress. Small FRM projects with a Federal cost under $7 million are authorized by Section 205 of the Flood Control Act of 1948, as amended. Small Ecosystem Restoration projects with a Federal cost under $5 million are authorized by Section 206 of the WRDA of 1996, as amended. Individual projects within the *CAP Plan* are recommended for implementation by USACE under these existing authorities.

There are 6 projects in the *CAP Plan*. The projects in this plan include one FRM project consisting of a levee/floodwall and five ER projects consisting of dam removals along the Des Plaines River. Projects included in the *CAP Plan* will be converted to this program upon approval by the Division Engineer.

Table ES.1 – Combined NED/NER Plan

ID	Project Name	Purpose	Measure	Municipality	Total First Cost	Annual OMRR&R[1]
Kenosha County, WI						
K47	Bristol Marsh	ER	Restoration	Bristol	$	$
K41	Dutch Gap Forested Floodplain	ER	Restoration	Pikesville	$	$
Lake County, IL						
L43	Red Wing Slough and Deer Lake Wetland Complex	ER	Restoration	Antioch	$	$
L39	Pollack Lake and Hastings Creek Riparian Wetlands	ER	Restoration	Antioch	$	$
L31	Gurnee Woods Riparian Wetland	ER	Restoration	Wadsworth	$	$
--	Lake County Non-structural	FRM	Non-structural	Gurnee	$	Nominal
Cook County, IL						
C09	Northbrook Floodplain and Riparian Complex	ER	Restoration	Wheeling	$	$
C15	Beck Lake Meadow and Floodplain Forest	ER	Restoration	Des Plaines/Glenview	$	$
WLRS04	Harry Semrow Driving Range Reservoir	FRM	Floodwater Storage	Des Plaines	$	$
DPLV09	Touhy-Miner Levee[2]	FRM	Levee/Floodwall	Des Plaines	$	$
DPLV05	Belmont-Irving Park Levee	FRM	Levee/Floodwall	Schiller Park/Franklin Park	$	$
DPLV04	Fullerton-Grand Levee	FRM	Levee/Floodwall	River Grove	$	$
DPRS04	Fullerton Woods Reservoir[2]	FRM	Floodwater Storage	River Grove	$	$
--	Cook County Non-structural[2]	FRM	Non-structural	Various	$	$

[1] Operation, Maintenance, Repair, Rehabilitation, and Replacement

[2]Touhy-Miner Levee, Fullerton Woods Reservoir, and Cook-County Non-structural include cost-shared recreation features.

(FY2015 Price Level)

Table ES.2 – CAP Plan

ID	Project Name	Purpose	Measure	Municipality	Total First Cost	Annual OMRR&R
Cook County, IL						
--	Dam #1 Removal	ER	Dam Removal	Wheeling	$	$0
--	Dam #2 Removal	ER	Dam Removal	Des Plaines	$	$0
--	Dempster Ave Dam Removal	ER	Dam Removal	Des Plaines	$	$0
--	Touhy Ave Dam Removal	ER	Dam Removal	Park Ridge	$	$0
--	Dam #4 Removal	ER	Dam Removal	Park Ridge	$	$0
DPLV01	Groveland Ave Levee	FRM	Levee	Riverside	$	$

(FY2015 Price Level)

The study authorization directs the Secretary to *"not exclude from consideration and evaluation flood damage reduction measures based on restrictive policies regarding the frequency of flooding, the drainage area, and the amount of runoff."* Sites along tributaries that do not meet the minimum criteria for USACE participation in urban flood risk management as outlined in 33 CFR Part 238 (flows greater than 800 cfs during the 10% annual chance of exceedance event) were therefore included in the formulation and evaluation. In addition, implementation of road raises and bridge modifications for the sole purpose of addressing flood-induced road closures, which have not traditionally been included in the USACE mission, were also included. In order to meet the study authority, these measures, which are not compliant with current USACE policy, are included in a plan designated as the *Comprehensive Plan.* This is the plan that includes all economically justified FRM features and cost-effective ecosystem restoration features evaluated during the course of the study, regardless of USACE policy compliance.

The *Comprehensive Plan* is the most inclusive plan and includes 23 projects as shown in Table ES.3. It includes all of the projects identified in the Combined NED/NER Plan and CAP Plan along with economically justified projects regardless of policy compliance. The projects in the *Comprehensive Plan* include 11 FRM projects consisting of two floodwater storage reservoirs, four levees/floodwalls, one road raise, one modification to an existing structure and non-structural measures to be implemented in three counties (Kenosha, Lake and Cook), seven ER projects throughout the watershed, and five dam removals along the Des Plaines River.

Projects included in the *Comprehensive Plan* that are not compliant with current USACE policy, and therefore not included in the *Combined NED/NER Plan* or *CAP Plan,* include the First Avenue Bridge Modification (DPBM04), Lake Mary Anne Pump Station (FPCI01), and economically justified non-structural sites that are in portions of tributaries not meeting the minimum flow criteria. These features are recommended for implementation by state or local agencies.

Table ES.3 – Comprehensive Plan

ID	Project Name	Purpose	Measure	Municipality	Total First Cost	Annual OMRR&R
Kenosha County, WI						
K47	Bristol Marsh	ER	Restoration	Bristol	$	$
K41	Dutch Gap Forested Floodplain	ER	Restoration	Pikesville	$	$
--	Kenosha County Non-structural (Comprehensive Plan)	FRM	Non-structural	Various	$	Nominal
Lake County, IL						
L43	Red Wing Slough and Deer Lake Wetland Complex	ER	Restoration	Antioch	$	$
L39	Pollack Lake and Hastings Creek Riparian Wetlands	ER	Restoration	Antioch	$	$
L31	Gurnee Woods Riparian Wetland	ER	Restoration	Wadsworth	$	$
--	Lake County Non-structural	FRM	Non-structural	Gurnee	$	Nominal
Cook County, IL						
C09	Northbrook Floodplain and Riparian Complex	ER	Restoration	Wheeling	$	$
--	Dam #1 Removal	ER	Dam Removal	Wheeling	$	$0
--	Dam #2 Removal	ER	Dam Removal	Des Plaines	$	$0
C15	Beck Lake Meadow and Floodplain Forest	ER	Restoration	Des Plaines/Glenview	$	$
--	Dempster Ave Dam Removal	ER	Dam Removal	Des Plaines	$	$0
WLRS04	Harry Semrow Driving Range	FRM	Floodwater Storage	Des Plaines	$	$
FPCI01	Lake Mary Anne Pump Station	FRM	Structure Mod.	Maine	$	$
DPLV09	Touhy-Miner Levee[1]	FRM	Levee/Floodwall	Des Plaines	$	$
--	Touhy Ave Dam Removal	ER	Dam Removal	Park Ridge	$	$0
--	Dam #4 Removal	ER	Dam Removal	Park Ridge	$	$0
DPLV05	Belmont-Irving Park Levee	FRM	Levee/Floodwall	Schiller Park/Franklin Park	$	$
DPLV04	Fullerton-Grand Levee	FRM	Levee/Floodwall	River Grove	$	$
DPRS04	Fullerton Woods Reservoir[1]	FRM	Floodwater Storage	River Grove	$	$
DPBM04	First Avenue Bridge Modification	FRM	Bridge Mod.	River Grove	$	$
DPLV01	Groveland Ave Levee	FRM	Levee	Riverside	$	$
--	Cook County Non-structural[1]	FRM	Non-structural	Various	$	$
--	Cook County Non-structural (Comp Plan Increment)	FRM	Non-structural	Various	$	Nominal

[1]Touhy-Miner Levee, Fullerton Woods Reservoir, and Cook-County Non-structural include cost-shared recreation features.

(FY2015 Price Level)

Overall, the cumulative impact of all three identified plans is beneficial economically, environmentally and socially. The *Combined NED/NER Plan* provides flood protection to 862 homes and businesses along the Des Plaines River and non-structural flood risk management for 377 structures across the watershed resulting in $4,641,000 in annual net economic benefits. The plan also restores hydrology and geomorphology on over 6,800 acres by filling an estimated 4,000 feet of manmade ditch and disabling hundreds of thousands of feet of agricultural drain tiles, restore scarce native community types such as marsh, sedge meadow, wet prairie, savanna, forested floodplain, woodlands, and forest resulting in 9,034 net average annual habitat units (AAHUs). The *CAP Plan* provides additional flood protection to 73 homes and businesses totaling $193,000 in annual net economic benefits and removes five dams along the Des Plaines River totaling 81 net AAHUs. The *Comprehensive Plan* provides flood protection to 935 homes and businesses along the Des Plaines River, non-structural flood risk management for 486 structures across the entire watershed, and protection for a major four-lane arterial road totaling $8,636,000 in annual net economic benefits and restoration and connectivity of over 6,800 acres of scarce marsh, sedge meadow, wet prairie, savanna, forested floodplain woodlands and forest habitat and connectivity of the Des Plaines River totaling 9,115 net average annual habitat units (AAHUs).

The total costs for the NED/NER Plan and CAP plan, along with the Federal and non-Federal shares, are presented in Table ES.4. Operation, Maintenance, Repair, Rehabilitation, and Replacement of project features will be required to ensure the sustainability of the projects and is a non-Federal responsibility. A summary of annualized costs and benefits for the recommended FRM and ecosystem restoration plans is presented in Table ES.5.

Table ES.4 –Total Costs by Plan

Plan	Federal	Non-Federal	Total Implementation	Annual OMRR&R (Non-Federal)
NED/NER Plan	[redacted]	[redacted]	[redacted]	[redacted]
CAP Plan	[redacted]	[redacted]	[redacted]	[redacted]
Comprehensive Plan	[redacted]	[redacted]	[redacted]	[redacted]

(FY2015 Price Level)

Table ES.5 – Economic Summary

		Comprehensive Plan	NED/NER Plan	CAP Plan
Flood Risk Management	Annualized First Cost	$6,657,000	$5,566,000	$247,000
	Annualized OMRR&R	$237,000	$172,000	$15,000
	Total Annualized Cost	$6,894,000	$5,738,000	$262,000
	Annual Benefits	$15,530,000	$10,379,000	$455,000
	Net Benefits	$8,636,000	$4,641,000	$193,000
	BCR	*2.3*	*1.8*	*1.7*
Ecosystem Restoration	Annualized First Cost	$5,562,000	$5,432,000	$130,000
	Annualized OMRR&R	$229,000	$229,000	$0
	Total Annualized Cost	$5,791,000	$5,661,000	$130,000
	Net Habitat Units	*9,115 AAHUs*	*9,034 AAHUs*	*81 AAHUs*

(FY2015 Price Level, Federal Discount Rate 3.375%)

UPPER DES PLAINES RIVER AND TRIBUTARIES
ILLINOIS & WISCONSIN
INTEGRATED FEASIBILITY REPORT AND
ENVIRONMENTAL ASSESSMENT

**Sections pertain to Environmental Assessment*

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FIGURES

PLATES

APPENDICES

1 Study Overview*

1.1 Introduction

This report presents the results of the *Upper Des Plaines River and Tributaries, Illinois and Wisconsin Feasibility Study* (Phase II Study). The report is organized into several sections describing the plan formulation process and conclusions and separate technical appendices:

1.1.1 Study Authority

This feasibility study was authorized by Section 419 of the Water Resources Development Act (WRDA) of 1999 (P.L. 106-53), and is identified as the Upper Des Plaines River and Tributaries, Illinois and Wisconsin. The authority provides the following:

> ***"Sec. 419. Upper Des Plaines River and Tributaries, Illinois and Wisconsin***
>
> *a) In General. –The Secretary shall conduct a study of the Upper Des Plaines River and tributaries, Illinois and Wisconsin, upstream of the confluence with Salt Creek at Riverside, Illinois, to determine the feasibility of improvements in the interests of flood damage reduction, environmental restoration and protection, water quality, recreation, and related purposes.*
>
> *b) Special Rule. – In conducting the study, the Secretary may not exclude from consideration and evaluation flood damage reduction measures based on restrictive policies regarding the frequency of flooding, the drainage area, and the amount of runoff.*
>
> *c) Consultation and Use of Existing Data. – In carrying out this section, the Secretary shall – (1) consult with appropriate Federal and State agencies; and (2) make maximum use of data in existence on the date of enactment of this Act and ongoing programs and efforts of Federal agencies and States."*

1.1.2 Study Purpose

This Phase II Study builds on the work completed in the *Upper Des Plaines River Flood Damage Reduction Feasibility Study* (Phase I Study), conducted under the Chicago – South End of Lake Michigan (C-SELM) Urban Water Damage Study Authority, contained in Section 206 of the 1958 Flood Control Act (P.L. 85-500). The Phase I Study was initiated to address severe overbank flooding along the Upper Des Plaines River. Two particularly severe events in 1986 and 1987 together caused over $100 million in damages. Federal interest in flood risk management (FRM) in the Upper Des Plaines watershed was established in a Reconnaissance Report that preceded the Phase I Study and was approved in 1989. The Phase I Study investigated plans for urban FRM in the Upper Des Plaines River watershed and recommended six projects to reduce mainstem flooding. The Feasibility Report was approved in 1999 and the recommended projects were authorized in Section 101 of WRDA 1999. Project benefits, if all projects are built, would result in a 25% reduction in flood damages. This Phase II Study provides an opportunity to develop a more comprehensive solution to ongoing occurrences of flooding in the Upper Des Plaines River watershed, evaluating plans to manage flood risk on both the mainstem and tributaries.

The study area for the Phase II study encompasses the Phase I study area as well as the Des Plaines headwaters in Wisconsin and all tributaries to the mainstem. Additionally, the Phase II study authorization directs the Secretary to develop plans that also address environmental restoration and protection, water quality, recreation, and related purposes.

The study team, including USACE and the non-Federal sponsors, identified two primary purposes: 1) further reduction of flooding along the mainstem and tributaries, and 2) environmental restoration of degraded ecosystems within the basin. Improving water quality and enhancing recreational opportunities throughout the basin were identified as secondary purposes. The study considers sites located within tributary watersheds and along the mainstem for both FRM and Ecosystem Restoration (ER) potential. The effects of FRM sites within tributary watersheds on mainstem flooding were also evaluated.

1.1.3 Study Sponsors and Participants

During the development process for this study, key state and local agencies formed an Advisory Committee. The Advisory Committee includes a broad group of stakeholders, interested parties and resource agency personnel who advised the non-Federal members of the Project Delivery Team (PDT). Participants in the Advisory Committee included the Illinois Department of Natural Resources (IDNR); Cook County Highway Department (CCHD); Lake County Stormwater Management Commission (LCSMC); Southeastern Wisconsin Regional Planning Commission (SEWRPC); the Forest Preserve District of Cook County (FPDCC); the Lake County Forest Preserve District (LCFPD); the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC); and representatives from local communities throughout the study area. It is the intent of this committee that the feasibility study be undertaken with a spirit of collaboration and mutual trust.

The Advisory Committee appointed an Executive Steering Committee to identify ways to: 1) provide a higher level of flood protection than the 25% damage reduction that could be achieved through the implementation of the Phase I project authorized in WRDA 1999, and 2) incorporate ecosystem restoration, water quality improvements and enhancement of recreational opportunities as additional

study purposes. Study goals have been developed in collaboration with the committee and the findings of this study presented herein are fully supported by the Executive Steering Committee. This committee has provided the appropriate avenue for full collaboration between project partners.

In August 2000, the Upper Des Plaines River Sponsors & Stakeholders Alliance was formed by members of the Advisory Committee. The Alliance, a working group of the Executive Steering Committee, was developed in a collaborative fashion and produced a Recommendation and Guidance Report focusing on a scope of work for use as a basis for this feasibility study. The report, which also ensured direct community input into the development of this feasibility study, included the efforts of the states, local sponsors, and stakeholders.

A coalition of state and local agencies is acting as non-Federal sponsors with the USACE for this study. The partnering agencies are the IDNR, CCHD, LCSMC, and Kenosha County, Wisconsin. A Feasibility Cost Sharing Agreement was signed between the sponsors and the USACE in 2002. Study costs are shared 50%-50% between the USACE and the non-Federal sponsors.

As the Alliance recommended, the USACE and the key local sponsors have been full partners in the development of this feasibility study. This study focuses on the development of a multi-purpose FRM and ecosystem restoration plan for the Upper Des Plaines River watershed. This report also identifies additional measures, not implementable under USACE authorities, to address the study authority as well as finding opportunities for further study and implementation. The preliminary efforts of the alliance and committees have allowed the Corps and non-Federal sponsors to proceed with the feasibility study with a clear direction.

1.1.4 Study Area

The Upper Des Plaines River watershed originates in the agricultural landscape of Racine and Kenosha counties of southeastern Wisconsin. The watershed then slopes south into Illinois through Lake County and then Cook County, where it converges with the Salt Creek watershed near Riverside, Illinois. The Des Plaines River then flows southwest on to its confluence with the Kankakee River, where the two rivers combine to form the Illinois River. The study area for this Phase II Study includes the entire drainage area upstream of the confluence with Salt Creek, including 12 major tributaries to the river.

The Upper Des Plaines watershed covers approximately 477 square miles, an area that spans approximately 60 miles from north to south and 8 miles from east to west. The Upper Des Plaines River travels over 87 miles before its confluence with Salt Creek. Tributaries within the study area include about 330 miles of perennial and intermittent streams. The study area is shown in Plate 1, and includes 73 municipalities in Illinois and Wisconsin. The municipalities are located in the following congressional districts, as shown on Plate 2, and represented by the noted members of the 113th U.S. Congress:

IL-4 (Gutierrez-D)	IL-5 (Quigley-D)	IL-6 (Roskam-R)
IL-7 (Davis-D)	IL-8 (Duckworth-D)	IL-9 (Schakowsky-D)
IL-10 (Schneider-D	IL-14 (Hultgren-R)	WI-1 (Ryan-R)

Illinois is represented in the Senate by Durbin-D and Kirk-R. Wisconsin is represented by Baldwin-D and Johnson-R.

1.1.5 Prior and Ongoing Studies and Reports

1.1.5.1 U.S. Army Corps of Engineers

The Chicago District conducted three studies investigating flooding in the Des Plaines Watershed under the Chicago – South End of Lake Michigan (C-SELM) Urban Water Damage Study Authority, contained in Section 206 of the 1958 Flood Control Act (P.L. 85-500). The 1989 Reconnaissance Report led to the 1999 Phase I Study.

- *Plan of Study C-SELM – Urban Water Damage Study*; 1976.
- *C-SELM, Interim III Lower Des Plaines River Basin Reconnaissance Report*; 1981.
- *Upper Des Plaines River Flood Damage Reduction Reconnaissance Report;* 1989.
- *Upper Des Plaines River Flood Damage Reduction Study*; 1999 (Phase 1 Study).

Additional related reports prepared by the Chicago District include:

- *Summary of Urban Water Damage Characteristics on the Des Plaines River in Lake County, Illinois*; 1974. (Prepared by Greeley and Hansen)
- *After Action Flood Report, Flooding in the Des Plaines, Fox River and North Branch Basins, September to October 1986*; 1986 inter-office report.
- *Inventory and Analysis of Urban Water Damage Problems, Farmer's and Prairie Creeks, Cook County, Illinois,* 1988. (Prepared for the State of Illinois)
- *North Libertyville Estates Section 205 Detailed Project Report,* 1995.
- *Hofmann Dam Section 206 Detailed Project Report, 2006*

1.1.5.2 State of Illinois

In 1943, the 63rd Illinois General Assembly appointed a Commission to investigate flooding in the state. This Commission submitted a report to the Illinois General Assembly in 1947 that outlined a scope for survey of the Des Plaines River area by the Illinois Division of Waterways. Reports on Addison Creek (1950), Salt Creek (1955), and the basin (1958) were submitted. In 1961, a *Report on Plan for Flood Control and Drainage Development for Cook, Lake and DuPage Counties* was prepared. This 1961 report outlined plans and cost estimates for major channel modifications, bridge and dam structural modifications, and two large (25,000 and 30,000 acre-ft) upstream reservoirs on the mainstem of the Des Plaines River and its Mill Creek tributary in Lake County. Channel, bridge, and dam modifications were to be constructed from Hodgkins upstream to the Village of Gurnee. Reservoirs were planned to be constructed upstream of the Village of Gurnee in Lake County. Many of the structures recommended in this report have been built and are part of the existing conditions of the Upper Des Plaines River and its tributaries.

The Illinois Department of Transportation (IDOT) Division of Water Resources (now the IDNR Office of Water Resources [IDNR-OWR]) has implemented regulations to minimize the adverse effects of construction in the Des Plaines River flood plain:

- State of Illinois; Administrative Code, *Section 3708: Floodway Construction in Northeastern Illinois*; 1989.
- Illinois Department of Transportation Division of Water Resources; *Report on the Regulations of Construction within the Floodplain of the Des Plaines River, Cook and Lake Counties*; 1978.

The IDNR- OWR has also developed local Flood Control Plans for various communities in the Upper Des Plaines River watershed:

- Crystal Creek Flood Control Project
- Farmer/Prairie Creek Flood Control Plan
- Gurnee Flood Control Plan

The Illinois Department of Energy and Natural Resources (now the IDNR) conducted a number of studies investigating natural resources in the Upper Des Plaines River watershed:

- Illinois Department of Energy and Natural Resources (now IDNR); *The Changing Illinois Environment: Critical Trends* (Summary Report and Volumes 1-7 Technical Report); 1994.
- IDNR; *Upper Des Plaines River Basin: An Inventory of the Region's Resources;* 1998.
- IDNR; *Upper Des Plaines River Area Assessment Volume 1, Geology;* Critical Trends Assessment Project; 1998.
- IDNR; *Upper Des Plaines River Area Assessment Volume 2, Water Resources*; Critical Trends Assessment Project; 1998.
- IDNR; *Upper Des Plaines River Area Assessment Volume 3, Living Resources*; Critical Trends Assessment Project; 1998.
- IDNR; *Upper Des Plaines River Area Assessment; Volume 4, Socio-Economic Profile, Environmental Quality and Archaeological Resources*; Critical Trends Assessment Project, 1998.

1.1.5.3 Soil Conservation Service/Natural Resources Conservation Service

The Soil Conservation Service (SCS), now the Natural Resources Conservation Service (NRCS) has partnered with state and local organizations to investigate and analyze flooding along the Des Plaines River. The results of these studies were published in the following reports:

- SCS and MWRDGC; *Floodwater Management Plan, Des Plaines River*; 1976.
- SCS and Illinois Division of Water Resources; *Flood Hazard Analysis, Des Plaines River Tributaries*; 1981.
- SCS, MWRDGC, and Illinois Division of Water Resources; *Final Watershed Plan and Environmental Impact Statement, Lower Des Plaines Tributaries Watershed*; 1985 and 1987.

- SCS, MWRDGC, and Illinois Division of Water Resources; *Lower Des Plaines Tributaries Watershed, Floodplain Information Maps and Profiles*; 1987.

1.1.5.4 Regional and Local Organizations

In Cook and Lake Counties, stormwater management is regulated countywide:

- MWRDGC; *Cook County Stormwater Management Plan*; 2007. MWRDGC assumed authority over stormwater management in Cook County in 2004, pursuant to Illinois Public Act 93-1049. The Stormwater Management plan has been developed as a precursor to the Cook County Stormwater Management Ordinance, currently in progress.
- LCSMC; *Lake County Watershed Development Ordinance (as amended)*; 2008. The Watershed Development Ordinance establishes minimum countywide standards for stormwater management including floodplains, detention, soil erosion / sediment control, water quality treatment, and wetlands.

The MWRDGC has completed a number of watershed plans to address flooding in Cook County, including the Des Plaines watershed:

- MWRDGC; *Lower Des Plaines River Detailed Watershed Plan;* 2011. This report evaluates measures to address flooding in communities along the Des Plaines River and its tributaries.

The LCSMC is conducting several studies investigating opportunities for ecological restoration in the study area:

- LCSMC; *Des Plaines River Wetland Restoration Study – DRAFT;* 2000. This report, funded by a U. S. Environmental Protection Agency (USEPA) Region 5 Grant, prioritizes wetland restoration opportunity sites in Lake County and assesses flood flow reduction possibilities.
- LCSMC and Northeastern Illinois Planning Commission; *Des Plaines Water Resources Action Strategy*. This report outlines multi-objective action priorities for watershed restoration.
- LCSMC; *Bull Creek/Bull's Brook Watershed Based Plan*; 2008. This report, funded by a 319 Grant from the Illinois Environmental Protection Agency (IEPA) addresses ways to control stormwater and improve water quality.
- LCSMC; Indian Creek Watershed Based Plan; in progress. This report, funded by a 319 Grant from IEPA will address ways to control stormwater and improve water quality.
- LCSMC; *Newport Draining Ditch Sub-watershed*; This project is a preliminary assessment of wetland restoration feasibility of three specific, privately owned sites in preparation for a C-2000 Grant Application.

In Illinois, the Northeastern Illinois Planning Commission (now the Chicago Metropolitan Agency for Planning) has participated in several studies investigating restoration opportunities in the Illinois portion of the study area:

- Northeastern Illinois Planning Commission and Liberty Prairie Foundation; *Upper Des Plaines River Watershed Restoration Action Strategy*; 2000.
- Northeastern Illinois Regional Planning Commission, Openlands Project, and the Illinois Paddling Council; *Northeastern Illinois Regional Water Trail Plan*; 1990.
- Northeastern Illinois Regional Planning Commission and Openlands Project; *Northeastern Illinois Regional Greenways Plan*; 1990.
- Northeastern Illinois Regional Planning Commission and Openlands Project; *Year 2000 Regional Trails & Greenways Plan*; 2000 (Draft).
- Northeastern Illinois Regional Planning Commission and Liberty Prairie Foundation; *Watershed Restoration Action Strategy for the Upper Des Plaines River*; 2000 (Draft).

In Wisconsin, the SWRPC has conducted several studies investigating restoration opportunities in the Wisconsin portion of study area and has collected comprehensive rainfall and groundwater data:

- SWRPC; *Planning Report No. 44, A Comprehensive Plan for the Des Plaines River Watershed*; 2003. This comprehensive study of the Wisconsin portion of the Des Plaines River watershed provides a guide to the future development of the 133-square-mile watershed in Kenosha and Racine Counties. The plan, which investigates water resource-related problems and presents recommendations to address those problems, is intended to be adopted and implemented by County and local governments and State and Federal agencies. The plan envisions that the Counties, along with the Watershed Advisory Committee, will coordinate plan implementation in partnership with a diverse group of governmental and private sector organizations.
- SWRPC; *Community Assistance Planning Report No. 58 (2nd Edition), A Lake Management Plan for Pewaukee Lake*, 2003. This report describes the physical, chemical, and biological characteristics of Pewaukee Lake. It also contains information about the feasibility of various watershed and in-lake management measures, which may be applied to enhance water quality conditions, biological communities, and recreational opportunities of the Lake.
- SWRPC; *Community Assistance Planning Report No. 66, A Park and Open Space Plan for the City of New Berlin*; 2003. This report led to the development of a new plan for a park and open space in New Berlin. The New Berlin Common Council approved the plan May 13, 2003. The plan updated an earlier plan adopted in 1995. The new plan calls for the acquisition and development of a variety of parks and related outdoor recreation facilities to meet the outdoor recreation needs of city residents. The plan also includes an open space preservation element, intended to protect important natural resource areas within the city.
- SWRPC; *Technical Report No. 40, Rainfall Frequency in the Southeastern Wisconsin Region*; 2000. This report presents the most current rainfall depth-duration-frequency information for the seven-county Southeastern Wisconsin Region. The data are recommended by the Commission staff for use in stormwater management applications.
- SWRPC; *Technical Report No. 37, Groundwater Resources of Southeastern Wisconsin*; 2002. This report presents the results of an inventory and analysis of groundwater

resources of the Region. The report was prepared by SEWRPC and the Wisconsin Geological and Natural History Survey in cooperation with the Wisconsin Department of Natural Resources (WDNR).

1.1.6 USACE Authorized Projects

Six FRM projects within the Upper Des Plaines River watershed were authorized by Section 101 of the WRDA of 1999 (P.L. 106-53), and include:

- Van Patton Woods Lateral Storage in Wadsworth and Russell, IL
- North Fork Mill Creek Dam Modification in Old Mill Creek, IL
- Buffalo Creek Reservoir Expansion in Buffalo Grove, IL
- Big Bend Lake Reservoir Expansion in Des Plaines, IL
- Levee 37 in Prospect Heights and Mount Prospect, IL
- Levee 50 in Des Plaines, IL

In addition to the Phase I projects listed above, USACE has participated in two projects that were implemented under the USACE Continuing Authorities Program (CAP):

- A levee for flood risk management at North Libertyville Estates was constructed as authorized under Section 205 of the CAP. North Libertyville Estates is a residential subdivision located on the east bank of the Des Plaines River in southern Lake County, approximately 2 miles northeast of Libertyville, Illinois. The project included construction of 5,500 linear feet of earthen levee, 150 linear feet of steel sheetpile floodwall, realignment of an existing drainage ditch, and implementation of an interior drainage plan and a flood warning system. The levee encircles the subdivision and ties into Buckley Road on the east and west sides of the subdivision. Interior drainage is provided by pipes through the levee with flexible check valves to prevent backflow into the subdivision. Additional drainage is provided by a permanent 2,000 gpm pump station and portable pumps used on an as-needed basis.
- The Chicago District, in partnership with IDNR, has completed an Ecosystem Restoration Project at the southern end of the watershed. *Hofmann Dam Section 206 Ecosystem Restoration* included removal of Armitage and Fairbanks Dams as well as notching Hofmann Dam. Armitage and Fairbanks Dams were removed in January and February 2012, respectively. The notching of Hofmann Dam was completed in September 2012. Implementation has reconnected 58 miles of riverine habitat, allowing the recolonization of fishes in the Upper Des Plaines River, and restoring natural riverine hydraulics to support the fish communities. Armitage Dam is within the study area, Hofmann Dam is at the downstream end of the study area (the dam itself is outside the study area but a portion of the pool is within the study area), and Fairbanks Dam is downstream of the study area. The dam removals are being monitored for three years to ensure the effectiveness of the project in accomplishing its restoration goals.

1.2 Study Team

1.2.1 Study Team Organization

The study team is organized into committees that oversee, review, and conduct the study activities. The Executive Steering Committee, representing the USACE and the non-Federal sponsors for the study, was appointed by the Advisory Committee to direct the study efforts. The Advisory Committee includes key state and local agencies involved in the study. Members of these and additional interested organizations constitute the PDT which conducts the actual work of the study. The PDT is organized into Technical Committees organized to focus on particular aspects of this complex multi-purpose study. Technical committees focused on Hydrology and Hydraulics, Ecosystem Restoration, Transportation, Water Quality, and Plan Formulation.

Study Team Component	**Agency**
Executive Steering Committee	
	County of Cook, Illinois
	County of Kenosha, Wisconsin
	IDNR
	LCSMC
	USACE Chicago District
Advisory Groups	
	Chicago Metropolitan Agency for Planning (CMAP)
	FPDCC
	LCFPD
	Northwest Municipal Conference
	SEWRPC
	Upper Des Plaines River Partnership
	WDNR
Project Delivery Team	
	CCHD
	County of Kenosha, Wisconsin
	FPDCC
	IDNR
	LCFPD
	LCSMC
	MWRDGC
	SEWRPC
	USACE, Chicago District
	U.S. Fish and Wildlife Service (USFWS)
Technical Committees	
	Membership drawn from agencies and groups listed above

1.3 Public Coordination*

1.3.1 Stakeholders

In addition to the non-Federal sponsors and state and local agencies who participated in the study as members of the PDT, representatives and citizens of the following communities have expressed concern and provided input to the planning process: Addison, Antioch, Arlington Heights, Barrington, Beach Park, Bensenville, Brookfield, Buffalo Grove, Des Plaines, Franklin Park, Glenview, Grayslake, Gurnee, Harwood Heights, Hawthorn Woods, Kenosha, Lake Zurich, Libertyville, Lincolnshire, Lindenhurst, Long Grove, Morton Grove, Mount Prospect, Mundelein, Niles, Norridge, Northbrook, Northlake, Oak Park, Paddock Lake, Palatine, Park Ridge, Prospect Heights, River Forest, Riverside, Riverwoods, Round Lake Beach, Round Lake Park, Schiller Park, Third Lake, Wadsworth, Waukegan, Wheeling, Wood Dale, and Zion.

1.3.2 Public/Agency Scoping Coordination

Public scoping and coordination of the study has been conducted in accordance with the requirements of the National Environmental Policy Act (NEPA). Additional details of mailings and meetings held can be found in Section 9 – Environmental Assessment, as well as in Appendix L.

2 Planning Overview*

2.1 The Planning Process

This feasibility study followed the six-step planning process defined in the Principles and Guidelines (P&G) adopted by the Water Resource Council and the Planning Guidance Notebook, ER 1105-2-100. The six steps are:

Step 1 – Identifying problems and opportunities
Step 2 – Inventorying and forecasting conditions
Step 3 – Formulating alternative plans
Step 4 – Evaluating alternative plans
Step 5 – Comparing alternative plans
Step 6 – Selecting a plan

Identification of problems and opportunities begins at the outset of the study and forms the foundation of the planning process. The identified problems and opportunities for the Upper Des Plaines Watershed, as developed in Step 1, are described below. These problems and opportunities can be expressed through overall study goals, aligning the goals of the participating organizations.

These problems, opportunities and goals give rise to specific planning objectives and constraints. The objectives state the intended outcome of the planning process and the constraints describe the limitations. Measures and alternative plans can then be evaluated with respect to these criteria. The objectives and constraints for this study are outlined in Section 2.4.

Developing a detailed inventory of existing conditions and forecast of future conditions, Step 2, creates a comprehensive picture of the study area. By gathering both qualitative and quantitative data, the study team can develop and evaluate alternative plans with respect to the unique variables within the study area. Forecasted conditions provide a basis for comparison and evaluation of alternative plans. An overview of the existing and forecasted conditions is presented in Section 3.

Plan formulation is an iterative process that involves formulating, evaluating, comparing, and re-formulating plans until an array of alternatives that meet the identified objectives within constraints are determined. Section 2.1.1 discusses the plan formulation process that encompasses Steps 3 through 6 and the unique challenges presented in formulating a combined plan that achieves both FRM and ecosystem restoration.

2.1.1 Creating a Combined Flood Risk Management/Ecosystem Restoration Plan

The Corps Environmental Operating Principles (EOPs) (see Section 9.6.2 for further discussion of the EOPs) strive to achieve environmental sustainability by: seeking balance and synergy among human development activities and natural systems; and designing economic and environmental solutions that support and reinforce one another. This study uses these principles with the formulation of plans that serve both FRM and ecosystem restoration purposes. Corps planning guidance promotes the formulation of combined plans that serve both economic and environmental purposes whenever possible.

Formulation options when developing plans with measures that serve both flood risk management and ecosystem restoration purposes depend on whether measures within the plan are physically or functionally interdependent versus independent. Combined plans that have interdependent measures either share the same physical location or functions. Interdependent measures can sometimes negatively impact each other or compete for the same resources. In those cases, the outputs from the measures that impact each other or are in competition with each other must be traded off. Trade offs are not necessary for outputs from those measures that do not impact or even benefit each other. Plans that have independent measures will include all measures of the separately identified flood risk management and ecosystem restoration plans. Below is a summary of the formulation options:

1. Physically and/or functionally interdependent (combined plan)
    a. Without trade-offs (no impacts on each other)
    b. With trade-offs (impacts on or competition with each other)
2. Physically and functionally independent (separate plans)

To formulate a combined plan, single purpose FRM and ecosystem restoration plans must be formulated and evaluated separately to form the basis for a trade-off analysis, if needed, and to ensure the plan that maximizes net economic and environmental outputs is identified. The respective single purpose plans are determined to be the most efficient, effective, complete and acceptable plans. The combined plans results in the "best" Recommended Plan so that no alternative plan or scale has a higher excess of national economic development (NED) benefits plus national ecosystem restoration (NER) benefits over total project costs. This plan attempts to maximize the sum of net NED and NER benefits, and to offer the best balance between two Federal objectives. Recommendations for multipurpose projects are based on a combination of NED benefit-cost analysis, and NER benefits analysis, including cost effectiveness and incremental cost analysis.

Formulating plans that have interdependent elements where there is a competition for resources, meaning more of one output (e.g., NER) can only be obtained by accepting less of another (e.g., NED), requires a trade-off analysis. Trade-offs between NED outputs and NER outputs can be made as long as the value of what is gained exceeds its implementation cost plus the value of what is foregone. Since the unit of measure is different between NED and NER accounts, a method is needed to normalize the units and compare benefits where necessary. Corps guidance dictates the use of the Separable Cost-Remaining Benefit (SC-RB) method for obtaining an equitable distribution of the costs of a multipurpose project among the purposes. Incremental costs are the added cost necessary to realize added environmental outputs minus the reduced cost of reduced NED outputs. Trades of one output for another are made until it is not possible to make further trades to improve the total project. The potential trades can go in both directions: more NER output for less NED output and more NED output for less NER output. The result of this process is an optimized Combined Plan.

Detailed plan formulation discussions of the FRM and ecosystem restoration plans are presented in Section 4 and Section 5, respectively. Formulation and evaluation of the combined Plan is presented in Section 6.

2.1.2 Integrating Evaluation of Water Quality and Recreation Benefits

Once a Combined Plan has been identified the study team will investigate opportunities for implementing features to improve water quality and provide additional recreational opportunities in the watershed. Individual plans will not be formulated to meet these secondary purposes. Instead, the

study team will assess the potential for implementing measures that meet these purposes in conjunction with the Combined FRM/ER Plan and within existing USACE policy. Additional measures that could improve water quality and recreational opportunities within the watershed will be identified as incidental costs or for implementation by others.

2.2 Planning Model Certification and Approval

Evaluating and forecasting existing and projected Future Without Project (FWOP) conditions and the impacts of potential measures and plans requires systematic evaluation procedures. Analytic tools used to support decision making in USACE studies – planning models – are reviewed and approved or certified by HQUSACE. This review process ensures that the analysis is technically and theoretically sound. The review requirements are provided in EC 1105-2-412: Assuring Quality of Planning Models. The review is conducted by the associated USACE Planning Center of Expertise and the model is either certified (for general or regional use) or approved (for one time use) by a model certification panel at HQUSACE. The planning models used in this study and their review status are presented in Table 2.1. Reviews for ecosystem models are conducted by the Ecosystem Restoration Planning Center of Expertise (ECO-PCX). Reviews for models used to evaluate measures to address flood damages are conducted by the Flood Risk Management Planning Center of Expertise (FRM-PCX).

Table 2.1 – Study Planning Models

Model Name and Version	Brief Description of the Model and How It Will Be Applied in the Study	Certification / Approval Status
Qualitative habitat Evaluation Index (QHEI)	Evaluation of stream habitat quality based on physical characteristics, providing a quantitative index.	Approved for study-specific use
Index of Biotic Integrity (IBI)	Quantifies response of the in-stream fish community to disturbance and/or restoration.	Approved for study-specific use
Floristic Quality Assessment (FQA)	Assigns to plant species a rating that reflects the fundamental conservatism that the species exhibits for natural habitats and quantities changes in plan community composition.	Approved for regional use
Habitat Evaluation Procedures (HEP)	Using the Habitat Evaluation Procedure, these models quantify changes in community attributes (e.g., function and structure) that are targeted for ecosystem restoration.	Approved for study-specific use
Hydrogeomorphic Models (HGM)	Using the Hydrogeomorphic Approach, these models quantify changes in wetland structure and function that are expected to respond based on alternative restoration scenarios	Approved for study-specific use
Flood Damage Analysis (HEC-FDA) ver 1.2.4	Based on economic and hydrologic inputs, computes risk based equivalent annual damages for various hydrologic conditions.	Certified for general use
Visual Interactive System for Transportation Algorithms (VISTA)	This commercial off-the-shelf transportation model was developed for the Chicago Area Transportation Study (CATS). Based on road characteristics and conditions as well as user demand data, estimates travel distance and times in a transportation network.	Approved for study-specific use

2.3 Problems and Opportunities

The problems associated with the Upper Des Plaines River watershed are system-wide; therefore, a system-wide approach to FRM and large-scale restoration of natural ecotypes and hydrology is needed to develop holistic solutions for the Upper Des Plaines River watershed. The study area, however, is politically diverse and crosses state boundaries. The development of integrated solutions would be difficult if not impossible without Federal involvement.

The long and narrow study area includes many smaller tributary watersheds connecting to the mainstem Des Plaines River along its length. Flooding along tributaries impacts not only residential, commercial, industrial, and public structures in the subwatershed, but also along the mainstem. Similarly, ecosystem habitats within subwatersheds are linked to each other by their connection to mainstem habitat. Therefore, the most appropriate approach is a watershed wide definition of problems and opportunities, guiding the study to formulate plans and consider the interconnected benefits and impacts throughout the watershed.

This study enables local communities and agencies to work in cooperation and develop plans that efficiently use both Federal and non-Federal resources to address identified problems and opportunities. The amount of resources available to individual agencies would be ineffective at addressing problems across the entire watershed.

This study works within Corps FRM, ecosystem restoration, and recreation authorities to develop a Recommended Plan. Unlike a Watershed Study, as authorized by Section 729 of WRDA 1986, this study will result in a Recommended Plan for implementation.

2.3.1 Problems

Several problems in the study area were identified:

1. **Impacts of Agriculture and Development on Natural Hydrology and Processes:** Watershed development, agriculture, and the presence of features that modify the natural hydrology such as drain tile systems, channelization, bank armoring, low head dams, bridge footings and foreign debris all have significantly contributed to the degradation of natural palustrine and riverine processes. These are manifested through poor water and sediment quality, unnatural and erratic stream flows, loss of instream complexity, unbalanced sediment budgets, disproportion of nutrient influx and uptake, poor biological integrity, and ultimately an overall loss in aquatic diversity.

2. **Ongoing and Increasing Flood Risk:** Not only are the natural systems affected, but the changes caused by development have also led to an increase in the frequency and severity of floods in the watershed. Additionally, the draining of land for agricultural and urban development has reduced the amount of natural floodplain. Most communities along the Upper Des Plaines River including Gurnee, Libertyville, Vernon Hills, River Grove, Wheeling, Mount Prospect, Prospect Heights, Des Plaines, Schiller Park, Franklin Park, Elmwood Park, and Riverside have suffered significant flood damages in the past.

3. **Lack of Open Spaces Available to Natural Plant and Wildlife Communities:** As agriculture and urban communities occupied lands, the natural processes that drive diversity in the ecosystems they supported were removed or impaired. Additionally, invasive species take advantage of these modifications, dominating the affected area and inhibiting ecosystem diversity.

4. **Diminished Recreation Opportunities:** As open space becomes less available and water quality decreases, opportunities for recreation within the watershed are diminished. Urbanization and development impede interaction with the river and nearby lands as human contact with the river is restricted by impaired water quality and established areas for outdoor activities become less available.

2.3.2 Opportunities

Watershed-wide opportunities exist within the watershed to lessen the effects of the described holistic problems. These include:

1. **Reduce Flood Risk:** Reducing the risk of severe and frequent flooding and associated flood damages can improve the financial security of property owners and local agencies responsible for maintaining the roads and infrastructure impacted by flood events.

2. **Improve the Quality and Increase Acres of Naturally Functioning Ecosystems:** The health of streams, as measured by the Index of Biotic Integrity, declined significantly when the amount of urban land use measured as impervious cover exceeded 13.8%. The quality of physical habitat fell below expectations consistent with Clean Water Act goals when impervious cover exceeded 27.1% (Miltner et al 2004). Declining biological integrity was noted in several streams with suburbanizing watersheds at levels of total urban land use as low as 4% and biological integrity was maintained where the floodplain and riparian buffer were relatively undeveloped, demonstrating the impact of urbanization on streams. Miltner (2004) recommends an aggressive stream protection policy prescribing mandatory riparian buffer widths, preserving sensitive areas and minimizing hydrologic alteration. As a response to these findings and recommendations, this study affords the opportunity to determine effective means for the restoration of the hydrology, hydraulics, and geomorphology. This, in turn, would restore significant habitat, resulting in increased species richness and abundance in faunal communities. Incidental to the ecosystem benefits, the naturalized functions may also provide flood attenuation, water storage during periods of drought, water quality enhancement and increased opportunities for recreation.

3. **Restore Connections Between Natural Spaces:** Reconnecting aquatic and riparian/buffering habitats will allow for greater interaction between species populations to improve genetic heterogeneity and provide for dispersal routes of native plant and animal species, while lessening the adverse effects of sink/source populations of native plants and animals. Four dams fragmenting the watershed riverine system have been removed, but there are dams that remain along the Des Plaines mainstem that continue to fragment the system.

4. **Improve Water Quality:** Improved water quality can enhance both wildlife habitat and recreational opportunities.

2.3.3 Goals

The Federal (USACE) and non-Federal sponsors' goals and objectives for water resources implementation studies establish the overall goals for this feasibility study.

The Federal goal of water and related land resources planning is to contribute to National Economic Development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. These contributions are the direct net economic benefits that accrue in the

planning area and the rest of the nation. The non-Federal partners also have FRM goals similar to the national NED goals.

USACE also has a Federal goal of ecosystem restoration in response to legislation and administration policy. This goal is to contribute to the nation's ecosystems or NER by restoring degraded aquatic ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. Contributions to NER are increases in ecosystem value and productivity and are measured in non-monetary units such as acres or linear feet of habitat, increased habitat function, average annual habitat units, or increased species number or diversity. The study non-Federal partners have general goals for ecosystem restoration that include both increasing land holdings for ecosystem purposes and reestablishing natural communities to support sustainable natural areas.

As a team, USACE and the non-Federal sponsors aim to further the restoration of the Upper Des Plaines River watershed, harmonizing the benefits of ecosystem restoration and FRM. These two goals can be met to form a single overall multi-purpose plan.

Study Goal: The primary goal of this study is to determine a cost effective and implementable plan for FRM and ecological restoration, while considering improvements to water quality and enhanced recreational opportunities as secondary goals.

Project Goal: The principal goals of a resulting multi-purpose project are: 1) to reduce future flood risk along the mainstem of the upper Des Plaines River; 2) to reduce future flood risk along tributaries to the upper Des Plaines River; 3) to restore the environmental integrity and beneficial uses of the river and its tributaries; and 4) to reestablish hydrology, hydraulics, geomorphology and appropriate native vegetation to set the stage for self regulating and sustainable habitats.

2.4 Objectives and Constraints

The problems, opportunities and goals described above give rise to objectives and constraints which will inform the planning process. These parameters are specific and measurable and are used to evaluate the ability of potential measures to resolve identified problems and take advantage of opportunities. The NER objectives were developed to set the stage for integrating plan formulation with USACE policy on appropriate measures that focus on hydrology, hydraulics, geomorphology and native vegetation.

2.4.1 Objectives

Planning objectives were established in concert with the entire study team and in cooperation with stakeholders. The principal goal of this study is to reduce existing flood risk and prevent increases in future risk while protecting and restoring the environmental integrity and beneficial uses of the river and its tributaries. This goal can be accomplished through cooperative, watershed-based efforts to identify and incrementally implement multiple projects that cumulatively achieve the following objectives:

1. **Reduction in mainstem flood risk:** This objective seeks to build upon the Phase I Study and the six flood risk reduction projects that were authorized as a result of the study. Only a portion of mainstem damages will be reduced (approximately 25%) from the implementation of these six authorized projects. Since significant residual flood risks remain within on the Upper Des Plaines

River watershed, this study will seek to further reduce residual flood risks. Specific plans will be developed to address flood damages associated with overbank flooding and transportation delays and damages along the mainstem Upper Des Plaines River.

2. Reduction in tributary flood risk: This objective seeks to identify and reduce flood risks associated with tributary flooding. Previous studies concentrated on damages associated with the mainstem Upper Des Plaines River. Specific plans will be developed to address flood risks associated with overbank flooding and transportation delays and damages on the tributaries.

3. Naturalize watershed hydrology, hydraulics and geomorphology: This objective seeks to naturalize hydrogeomorphic functions and features for the primary purpose of ecosystem restoration. Soil structure and composition are an integral part of geomorphology and are the functional drivers of any ecosystem. Evident impairment exists throughout the watershed in the form of drain tile systems, ditches, control structures, dams, bank armoring, stream channelization, floodplain and wetland filling, etc. In order to establish secondary drivers, the impairments to the primary drivers must be addressed.

4. Increase acreage of native community types: Currently, very little natural land cover remains in the 477 square mile watershed and over 90% of the streams have been modified or channelized. As little as 30% land cover disturbance causes significant impairments to biodiversity, especially in aquatic systems. To improve the quality of ecosystems on a watershed scale, increases in native community types should be considered on a large scale.

5. Reduce/control/eradicate non-native plant and animal species: This objective seeks to remove the adverse effects of invasive and non-native species on native communities. Non-native and invasive species, particularly plants, have had significant adverse impacts in the watershed. Typically, these species gain a foothold and eventually dominate a site due to existing impairments, particularly hydrologic, soil, or anthropogenic chemical. Once the hydrologic and geomorphic impairments are repaired, invasive plant species may be addressed quite effectively, often keeping invasive plant species cover to less than 1% of the site after a period of establishment. This target has been achieved at several restoration projects in the region. Ongoing monitoring has shown that these projects have successfully achieved less than 1% invasive species spatial coverage not only upon completion of construction, but also for as long as 15 years after construction.

6. Increase connectivity of natural areas: This objective seeks to increase both riverine and greenway connectivity. It is well documented that habitat fragmentation leads to many ecological and biological problems, such as inbreeding, sink populations, food chain collapse, road kill, etc. This objective should guide measures, alternatives and plans to consider removing impediments to faunal migration and creating greenways or restoring adjacent parcels to high quality areas to increase the transfer of native species and their associated local genotypes.

7. Increase watershed biodiversity: Biodiversity, as defined for restoration purposes, is the total number of native species, abundance, genetic heterogeneity, and population health of the study area's open lands and stream corridors. Currently, the number of native species within the Upper Des Plaines watershed is not much different than what historically occurred before disturbance by man, meaning there are only a few species that have been completely removed from area. The vast majority of the remaining native species are located in small isolated populations. The abundance and health of the remaining native species/populations have been dramatically reduced and impaired. Dominant land uses in the watershed support very few native species. Once hydrology, hydraulics, geomorphology and invasive species issues are addressed through restoration, these sites would have the potential to

provide life requisites for vast numbers of native fungi, plant, insect, fish, amphibian, reptile, bird, and mammal species. The major increases in biodiversity would be detected through increases in abundance and population health for restored native species on tracts of land that did not previously contain these species. Any restoration measures, alternatives or plans selected should provide life requisites for a variety of plant communities providing a diversity of habitat types, which would facilitate the return of hundreds, if not thousands of native species to areas once void of their presence. It is expected, based on previous hydrologic and hydraulic restoration projects that the Chicago District has implemented, that species start to colonize the site as soon as the impairments to the functional drivers are disabled. Immediate recolonization of birds and crayfish has resulted through the disablement of drain tiles within several Chicago District projects. Biodiversity benefits are primarily expected for those parcels of land that are directly restored; however, spillover effects could be expected up and downstream for riverine work, and in any natural areas that are adjacent/directly connected to the restored sites.

8. **Preserve existing natural resources:** This objective seeks to preserve areas of existing significant natural resources. This may be accomplished through simple procurement of land, restoration and management. Adding buffers to existing natural areas (i.e. riparian corridors) and avoiding the implementation of FRM plans that change natural land use, will also serve this objective. The USACE is not able to participate in ecosystem preservation projects where the sole purpose is the acquisition of land; however, by working with non-Federal sponsors to restore adjacent lands and avoid converting land use from its natural state, this objective would be met.

9. **Improve water quality for aquatic organisms:** This objective seeks to reduce non-point source runoff, point source discharges and combined sewer overflows (CSOs). Improved water quality may result in upgraded water quality use designations throughout mainstem and tributaries of the Upper Des Plaines River watershed. The USACE is not able to participate in implementation of projects for the sole purpose of improving water quality or pollution problems where other parties would have a legal responsibility; however, incidental water quality benefits resulting from implementation of ecosystem restoration or FRM projects would support this objective.

10. **Increase open space and recreational opportunities:** This objective seeks to incorporate passive recreation into ecosystem restoration or flood risk management projects. The USACE is not able to participate in projects where the sole or primary purpose is recreation; however, where recreational uses would be compatible with the primary purposes, recreational features may be considered. There may also be an opportunity to create active recreational facilities within the footprint of a flood risk management project.

2.4.2 Constraints

Planning constraints are items of consideration, specific to the study, that limit the planning process and are used along with the objectives in the formulation and evaluation of solutions. Planning constraints were identified in concert with the entire study team and in cooperation with stakeholders. The constraints identified for this study are:

1. **Compatibility with multipurpose planning:** Through the planning process, measures and plans will be identified to meet the study objectives. However, while each measure may meet the requirements of a single purpose, the measures must not violate additional study objectives.

2. **Minimize adverse impacts to hydraulic & hydrologic regimes:** Small changes in flood stages can have significant impacts in the study area due to the flat topography. Identified measures

must ensure that implementation will not result in adverse effects or induced damages to other parts of the watershed.

3. Minimize adverse impacts to local drainage districts: Although flooding resulting from local drainage issues is not considered in this study, the impacts of proposed measures on existing infrastructure must be evaluated and avoided.

4. Compatibility with existing development: The majority of the study area is highly urbanized. Measures and plans must avoid adverse impacts to existing features providing flood risk management, ecosystem, water quality, and recreation benefits.

3 Study Area Inventory and Forecast*

3.1 Existing Conditions

A comprehensive inventory of the study area is an essential step in defining the scope of the issues to be addressed. The inventory is also used to identify and evaluate appropriate measures to address the identified problems and opportunities.

In general, elevations used in this study are in North American Vertical Datum (NAVD) 1988. However, the mainstem hydraulic model and several tributary models were developed using National Geodetic Vertical Datum (NGVD) 1929. Some existing FEMA floodplain maps use NGVD 1929 and the models have been extensively verified in their accuracy within this datum. Therefore, the hydraulic and economic models for these streams were maintained in NGVD 1929 and data used from these models for the design of features were carefully reviewed and converted for NAVD 1988. The NAVD 1988 will be used in the design of all recommended features as required by ER 1110-2-8160, Policies for Referencing Project Elevation Grades to nationwide Vertical Datums. Within this watershed, the difference between NVGD 1929 and NAVD 1988 is approximately 0.3 feet. See Appendix A (Hydrology and Hydraulics) and Appendix D (Civil Design) for further discussion of elevation data.

The study team developed the following inventory of physical, ecological, and cultural resources to guide the study process. Sections 4 and 5 discuss the development of quantifiable FWOP conditions for each primary study purpose.

3.1.1 Physical Resources

3.1.1.1 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.

3.1.1.2 Bedrock Stratigraphy

The oldest rocks found on Earth are of the Precambrian period, which can be located in and around the Chicago area and are approximately 1-1.5 billion years old. This stratum of rock occurs from depths ranging from 2,500 to 5,500 feet. The only Precambrian rock present at the surface in the Upper Des Plaines River basin are glacial erratics, igneous and metamorphic rocks transported by glaciers from the north found in glacial drift. Overlying the Precambrian stratum is the Cambrian System, which is also deeply buried. The next layer is Ordovician System in which strata range from 1,100 to 7,000 feet thick. There are few isolated areas where the glacial till of the basin lies directly over the Maquoketa Group (Om) (Scales Shale, Fort Atkinson Limestone, Brainard Shale, Neda Formation) of the

Cincinnatian Series. The majority of the glacial drift within the Upper Des Plaines River basin overlies the Silurian System. Silurian rocks are predominantly dolomite. The Silurian System consists of the Alexandrian Series (Edgewood & Kankakee Dolomites) and the Niagaran Series (Joliet, Waukesha & Racine Dolomites). Bedrock is not exposed at the surface within the Upper Des Plaines River basin.

The underlying bedrock forms a series of valleys, lowlands and uplands. These formations were probably formed and in place before the continental glaciers encroached over the area. The bedrock valleys include important and productive aquifers, formed from the deposition of sand and gravel when the valleys were buried from proceeding glacial activities. The current river course flows in a perpendicular direction relative to the buried valleys. Within the watershed, the depth of the bedrock below the ground surface ranges from as much as 400 feet in the northern area to less than 25 feet at the southern end.

3.1.1.3 Glacial Stratigraphy

The study area has been impacted by four major glaciation events, lasting from approximately 1.6 million to 10,000 years ago. The last major glacial advance was called the Wisconsinan cycle and evidence of its existence is prominently displayed throughout the study area. Glaciers sculpted the underlying landscape by abrasion, erosion and deposition. Continental glaciers, such as the types of glaciers that passed over the study area, tended to produce a more rounded topography, by scraping away at the bedrock in some areas and depositing the accumulated debris in other areas. The deposition of accumulated materials by glaciers is referred to as glacial drift, which can be further identified by how and where it was deposited. The two general categories of drift are referred to as till and outwash.

The underlying bedrock of the study area is covered by various depths of a complex layering of beds and lenses of outwash with different layers of till left by surging and retreating glaciers. In addition, the study area is laced with several clustered end moraines (ridges left by retreating glaciers), which are oriented in a north-south direction that roughly parallels the shore of Lake Michigan as shown in Plate 3. The importance of glacial history is the profound effect that the deposited drift had on the area's modern and moderately productive soils. These deposits range from 20 to 35 feet thick and some extend down to bedrock. The parent material for soils in this area are loess (windblown silt) and till, mainly a compact matrix of clay, silt and sand mixed with other larger sized grains.

3.1.1.4 Soils

There are 13 soil associations found within the study area as shown in Plate 4 and of these, the most widespread are the Morely-Markham-Ashkum (30%), Urbanland-Markham-Ashkum (18%) and Elliott-Ashkum-Varna (14%). Typically, these soil associations are slowly permeable and can be subject to hydric conditions. Higher frequencies of wetlands and poorly drained soils, along with the most agriculturally productive soils, occur in the northern portion of the study area. The moderately slow permeability exhibited by many soils in the agricultural and urbanized portions of the study area create conditions conducive to flooding and standing water during periods of high water table or heavy precipitation. Many soils in Cook County were modified by human activities and are overlaid by a few feet of miscellaneous fill and/or regraded top soil. Additional discussion of the soils and subsurface conditions can be found in Appendix G (Geotechnical Analysis).

3.1.1.5 Hydrology, Hydraulics & Land Use

The study area includes the mainstem of the Des Plaines River and all tributary streams above the confluence with Salt Creek, encompassing a portion of four counties including Kenosha and Racine counties in Wisconsin and Lake and Cook counties in Illinois. The Upper Des Plaines River watershed is approximately 477 square miles with 133 square miles in Wisconsin and 344 square miles in Illinois. The watershed is aligned primarily along a north-south axis with a length of approximately 60 miles and average width of 8 miles. Elevations in the Upper Des Plaines River watershed upstream of Salt Creek vary from nearly 900 to 600 feet NAVD88. From the junction with Salt Creek in Illinois upstream to the junction with Root River in Wisconsin, the Des Plaines River rises 76 feet over 86 miles for an average gradient of 1.1 ft/mi.

Historically, the Des Plaines River system was a narrow elongated depression within the late Wisconsinan Age glacial drift. The Upper Des Plaines River, from the confluence of Salt Creek northward, was very shallow and averaged about 30 feet wide with banks of accumulated sediments and soils and covered with aquatic vegetation. As European settlement increased, the watershed was stripped of natural plant communities, initially due to agricultural practices. Streams became more entrenched and began to exhibit signs of altered hydrology with increased peak flows and reduced base flows. Land use in many areas of the watershed was gradually converted to urban and suburban use dominated by rooftops, pavement and other impervious surfaces. Table 3.1 below shows a breakdown of existing land use based on data collected by SEWRPC and Northern Illinois Planning Commission (NIPC), now the CMAP. Data in the table reflects land use in 1995 and 2001. Plate 5 illustrates existing land use across the watershed. As of 1995, land use in the Wisconsin portion of the watershed consisted of 68.3% agriculture, 14.7% open space, and 11.8 % urban. As of 2001, land use in the Illinois portion of the watershed consists of 57.4% urban, 23% open space, and 19.6% agriculture. These landscape-scale changes in land-use, and subsequent hydrologic and hydraulic alterations, contribute to increased flooding and subsequent flood damages, decreased habitat quality, degraded water quality and reduced species richness.

Table 3.1 – Land Use in the Upper Des Plaines River Watershed, 1995 and 2001

Land Use	Description	Area (ac)	Area (mi^2)	Percent
Residential	single & multi-family dwellings	96,614	151	32%
Commercial	retail and general merchandise	14,371	22	5%
Industrial	manufacturing, warehousing, etc.	15,197	24	5%
Public	government, education, hospital, etc.	9,514	15	3%
Infrastructure	roads, railroads, utilities, etc.	16,724	26	5%
Recreational	parks & fields	30,612	48	10%
Agricultural	farmland	77,970	122	26%
Open	vacant previously developed land	288	0.5	<1%
Forest/grassland	forest, prairie, grasslands	24,556	38	8%
Wetland	wetlands	12,887	20	4%
Water	open water	6,776	11	2%
Total		**305,508**	**477**	**100%**

Source: Northern Illinois Planning Commission (NIPC, now CMAP) and SWRPC

Development and agriculture in the Upper Des Plaines River watershed have altered the natural hydrologic regime. An increase in impervious areas has increased the average daily and peak flows. This trend can be shown through long term stream gage data. There are eight stream gaging stations currently operating within the study area as shown in Table 3.2 and Plate 6. Historically, there were an additional 20 stream gages that were located along the mainstem Des Plaines River and tributaries, but these gages are no longer in service.

The longest continuously operating gage is USGS gage number 05532500, Des Plaines River at Riverside, IL, located just downstream of the study area. This gage has been continuously recording since 1914. Annual flow statistics are shown in Table 3.3 below. As shown in the table, average daily flows in the Upper Des Plaines River have steadily increased with watershed development.

Table 3.2 – USGS Stream Gages Currently Operating in the Upper Des Plaines River Watershed

Gage ID (link)	Site Name	Drainage Area (mi^2)	Gage Datum (NGVD29)	Dates of Operation	
				From	To
05527800	Des Plaines River at Russell, IL	123	662.00	4/2/1960	current
05528000	Des Plaines River near Gurnee, IL	232	650.30	1/11/1946	current
05529000	Des Plaines River near Des Plaines, IL	360	626.31	7/4/1938	current
05532500	Des Plaines River at Riverside, IL[1]	630	594.68	5/14/1914	current
05527950	Mill Creek at Old Mill Creek, IL	61	668.00	3/31/1960	current
05528500	Buffalo Creek near Wheeling, IL	19.6	658.60	3/15/1953	current
05529500	McDonald Creek near Mt Prospect, IL	7.93	638.12	3/15/1953	current
05530000	Weller Creek at Des Plaines, IL	13.2	634.02	2/19/1951	current

[1]Note – Des Plaines River at Riverside, IL is located just downstream of study area. This gage was moved approximately 400 feet in January of 2011. While the relocation does not affect flow measurements, measured stages are impacted. Adjustments to account for changes in stage have been calculated to provide continuity.

Table 3.3 – Annual Flow Statistics at USGS Gage 05532500, Des Plaines River at Riverside, IL

Water Years	Minimum Daily Flow (cfs)	Average Daily Flow (cfs)	Peak Recorded Flow	
			cfs	year
1944-1956	0.5	359	6,510	1948
1957-1966	0.0	380	5,950	1957
1967-1976	20	598	5,460	1972
1977-1986	48	670	6,360	1985
1987-1996	126	723	9,770	1987
1997-2006	101	695	6,990	1997

A number of flow modifications including dams, channel modifications, and reservoirs have been constructed over the past century. Table 3.4 lists the existing major watershed modifications and the years the projects were completed. Plate 7 shows the locations of the projects within the watershed.

Table 3.4 – Existing Major Watershed Modifications within Upper Des Plaines River Watershed

River or Tributary	Project	Size	Year Completed
Des Plaines River	Channel Modification (Hofmann Dam to North Ave.)	8 miles	1932
	Channel Modification (Upstream of Wadsworth Rd.)	0.3 miles	1935
	Ryerson Dam downstream of Deerfield Rd. (RM 78.6)	2 ft	1956
	Dam near Armitage Ave. (RM 51.5)	2 ft	1957
	Berm at Big Bend Lake (RM 66.1 to 66.5)	0.4 miles	1978
	Levee at North Libertyville Estates (RM 91.1 to 90.2)	1 mile	1999
	Hofmann Dam Replacement (RM 43.5)	12 ft	1950
	Hofmann Dam Notching (RM 43.5)	12 ft	2012
	Dam #4 upstream of Higgins Rd. (RM 59.5)	2 ft	1922
	Dam upstream of Touhy Ave. (RM 61.2)	2 ft	
	Dam downstream of Dempster St. (RM 63.5)	2 ft	
	Dam #2 downstream of Euclid Ave. (RM 69.0)	4 ft	
	Dam #1 downstream of Hintz Rd. (RM 73.5)	4 ft	
	Wright Dam upstream of Half Day Rd. (RM 83.4)	2 ft	
Indian Creek	Channel Modification at Forest Lake	0.3 miles	1996
Buffalo-Wheeling Creek	Heritage Park Reservoir	151 ac-ft	1982
	Buffalo Creek Reservoir	700 ac-ft	1990
	Diversion Channel	0.2 miles	1999
	Strum Subdivision Buyouts & Modifications	Varies	1999
McDonald Creek	White Pine Ditch Reservoir	50 ac-ft	1986
	Lake Arlington Reservoir	540 ac-ft	1990
Weller Creek	Crumley Basin	40 ac-ft	1969
	Wilke-Kirchoff Reservoir	100 ac-ft	1973
	Clearwater Park Reservoir	160 ac-ft	1977
	Mount Prospect Reservoir	130 ac-ft	1978
Willow-Higgins Creek	CUP O'Hare Reservoir	1050 ac-ft	1998
	Touhy Avenue Reservoir	1,178 ac-ft	2004
	Willow-Higgins Reservoir	1200 ac-ft	2005
	Willow-Higgins Channel Improvement	1.0 mile	
Crystal Creek	Lake O'Hare Reservoir	1120 ac-ft	1965
	Crystal Creek Channel Improvements	0.5 miles	
Silver Creek	Jack B. Williams Reservoir	245 ac-ft	1990
	Silver Creek Reservoir	500 ac-ft	1992

All dams currently present within the study area are low-head, run-of-the-river type structures. They were originally designed to maintain a minimum channel depth during low flows for water quality and recreational purposes. Several were once used as fords across the river for livestock and early automobiles. These dams do not possess any appreciable impoundment characteristics that contribute to flood risk management (FRM).

Channel modifications and reservoirs were constructed within the study area to combat flooding caused by urban development. Despite the presence of these structures, flooding continues to pose significant risk to the communities of the Upper Des Plaines watershed as described further in Section 4.

The baseline conditions for the Phase II Study include the implementation of FRM projects recommended by the Phase I study and authorized for construction under Section 101 of WRDA 1999.

Although the six projects, if fully implemented, would reduce flood damages in the watershed, it was estimated during the Phase I Study that even with construction of the recommended projects constructed, there is a significant residual flood risk in the watershed. Additional discussion of the Phase I authorized projects is included in Section 4.

The hydrology of the Upper Des Plaines River watershed in Illinois has been modeled using the USACE Hydrologic Engineering Center's HEC-1 hydrologic model. The mainstem model was originally developed during the Phase I study. The baseline hydrologic conditions of this model were based on land use mapping for 1995 conditions, and the future conditions were based on predictions of land use changes in 2010. In order to ensure the mainstem hydrologic model is representative of current and future conditions for this Phase II study, a detailed analysis consisting of extending and updating the four mainstem gage records for urbanization and reservoir construction and comparing frequency analysis results with that used to calibrate the Phase I mainstem H&H models was performed. The analysis showed that, while there were minor changes, there is not a statistically significant change in the flow data; therefore the mainstem models from the Phase I Study are still valid for use in hydrologic analyses for the Phase II Study. A summary of the analysis and a white paper documenting the analysis are included in Appendix A (Hydrology and Hydraulics).

Table 3.5 shows peak flood flows by frequency as computed by the mainstem HEC-1 model for 1995 baseline conditions, which includes the implementation of FRM projects authorized from the Phase I study. These results represent baseline conditions on the mainstem for this Phase II study.

Table 3.5 – Peak Flows Computed by Mainstem HEC-1 Model, Baseline Conditions

	Peak Flow at USGS Gage (cfs)			
Flood Event (% Chance)	**Russell Rd ID#5527800**	**Gurnee ID#5528000**	**Des Plaines ID#5529000**	**Riverside ID#5532500**
99%	323	782	2,005	2,874
50%	624	1,262	2,604	4,540
20%	1,230	2,152	3,535	5,821
10%	1,727	2,898	4,138	6,643
4%	2,468	3,991	4,974	7,588
2%	3,086	4,741	5,594	8,225
1%	3,773	5,586	6,075	8,726
0.2%	5,580	7,853	7,386	10,098

The hydraulics of the mainstem Upper Des Plaines River was modeled using the USACE Hydrologic Engineering Center's HEC-2 hydraulic model. This model was also originally developed for the Phase I study.

Both mainstem models have undergone extensive calibration and review by both the IDNR and the Federal Emergency Management Agency (FEMA). Review and updates have occurred during the Phase I study, design of Phase I projects, and a full remapping of the floodplain that was completed along the mainstem Des Plaines River. These models are also used as the regulatory models for the watershed.

A series of new hydrologic and hydraulic models were developed for 15 of the tributaries in the basin. In order to allow the new more detailed tributary models to be incorporated into the mainstem model, HEC-1 was used to model the hydrology of the tributaries. The hydraulic models were developed from

newly surveyed geographic and cross-section data using USACE Hydrologic Engineering Center's River Analysis System (HEC-RAS). Previously developed hydrologic and hydraulic models of the Wisconsin tributaries and the Upper Des Plaines River mainstem in Wisconsin used Hydraulic Simulation Program FORTRAN for the hydrologic analysis and HEC-2 for the hydraulic analysis. These existing models were used to extend the study area to the northern end of the Des Plaines River watershed.

Several study partners participated in the development of the models. Table 3.6 lists the tributaries from upstream to downstream and the agencies responsible for developing models.

Table 3.6 – Hydrologic and Hydraulic Models

Tributary	County	Responsible Agency	Year Completed
Brighton Creek	Kenosha	SEWRPC	2003
Dutch Gap Canal	Kenosha	SEWRPC	2003
Salem Branch	Kenosha	SEWRPC	2003
Unnamed Tributary No. 6	Kenosha	SEWRPC	2003
Kilbourn Road Ditch	Kenosha	SEWRPC	2003
Newport Drainage Ditch	Lake	LCSMC	2008
Mill Creek	Lake	LCSMC	2008
Bull Creek	Lake	USACE	2005
Indian Creek	Lake	USACE	2007
Buffalo Creek	Lake/Cook	IDNR	2006
McDonald Creek	Cook	USACE	2008
Weller Creek	Cook	USACE	2004
Farmer-Prairie Creek	Cook	IDNR	2005
Willow-Higgins Creek	Cook	CCHD	2005
Silver Creek	Cook	USACE	2007
Des Plaines River Mainstem	Lake/Cook	USACE	1999

3.1.1.6 Fluvial Geomorphology & Topography

Landforms and topography were created by the erosional and depositional processes of glacial activity and flowing rivers. Plate 8 shows how the streams and rivers of the upper Des Plaines River system have influenced topography after the glaciers retreated about 10,000 years ago. The isolated depressions are scattered across the area. These depressions, combined with a general lack of an extensive drainage network, strongly influence soil development and drainage. Rivers flowing across the landscape generally increase in size and merge with other rivers. The network of rivers formed is a drainage system, which is dendritic in this watershed due to the regional topography and underlying geology. Rivers and streams are not only conduits of water, but also of sediment that the water entrains from working the land. As the water flows, it is able to mobilize sediment from the channel, banks and floodplain and deposit them at different points downstream. The rate and amount of sediment transport depends on the availability of sediment, particle size and stream discharge. One of the most evident instances of this is where a bank erodes on one side of the stream and a bar forms on the opposite side. This process is called cut and fill alluviation, and without it, the diverse habitat mosaic of the floodplain and river channel would not exist. Therefore, natural erosion and deposition processes are quite important and should not be halted if the goal is to preserve biodiversity. Excessive erosion due to increased discharge from urbanized areas may require engineered solutions.

3.1.1.7 Air Quality

The IEPA and the WDNR list nonattainment area designations for counties in Illinois and Wisconsin, respectively, which do not meet the National Ambient Air Quality Standards (NAAQS). Cook County and Lake County in Illinois and Racine County and Kenosha County in Wisconsin are moderate nonattainment areas for ozone. Cook County and Lake County in Illinois and Racine County in Wisconsin are nonattainment areas for PM2.5 (particulate matter with a diameter equal or less than 2.5 microns). Nonattainment areas are regions within the country where the concentration of one or more criteria pollutants exceeds the level set as the federal air quality standards. Particulate concentration and ozone trends are generally downward, but are still elevated in the study area, and are often above the national standards. The national standard for PM-2.5 is 35 µg/m3 (24 hour average) and 15 µg/m3 as an annual mean, while the national standard for ozone 0.075 ppm (8 hour average) and 0.12 ppm (1 hour average).

3.1.2 Ecological Resources

The ecology of the watershed has been severely impacted since the late 1800s through human modifications to land use, hydrology and stream channels. Typical of highly urbanized and agricultural areas, human modification to the landscape has negatively affected and altered the surface and ground water processes. Accordingly, a large portion of the native floral and associated faunal communities have been lost. Only 9% of the current land use is natural open space; however, most of these areas have become degraded and overrun by non-native and invasive plant species. Riverine communities are valued as “moderately to highly degraded” through fish community assessment. The riverine system is also fragmented by 21 dams and structures, negatively affecting riverine community diversity. In comparison, there is much greater diversity in the unfragmented reaches beyond the most downstream dam. Illinois and Wisconsin have 36 bird, 3 reptile, 1 amphibian, 5 insect, 5 fish, 4 mussel, and 31 plant species listed as threatened or endangered. A detailed description is presented in the following sections.

Before European settlement, the Upper Des Plaines River and associated streams had catchments fully covered with native vegetation. As with most natural processes in the region and elsewhere, human modifications to landscape vegetation negatively affect and alter the natural hydraulics and hydrologic regime of wetland and riverine systems. Accordingly, a large portion of the native vegetation and associated faunal communities have been lost to agricultural, urban or industrial conversion. Most historic records suggest that there were four major types of plant communities present in the study area: prairie, savanna, woodland, and wetland. The communities that were once located within the study area are described in detail below. Table 3.7 provides a summary of all community types present in the Upper Des Plaines watershed.

Table 3.7 – Plant Community/Habitat types of the Upper Des Plaines River Watershed

Community / Habitat Type	General Location	General Hydrology
Prairie	Flat- to mid-slopes, adjacent to wetlands	dry-mesic; mesic; wet-mesic; wet
Savanna	East and north facing slopes	dry-mesic; mesic; wet-mesic; wet
Woodland	Riparian	dry-mesic; mesic; wet-mesic; northern flatwoods
	Floodplain	mesic; wet-mesic; wet
Wetland	Isolated depression / floodplain depression	marsh; shrub swamp; calcareous floating mat
		fen; graminoid fen; sedge meadow; seep
Riverine	Stream	medium gradient; low gradient
	River	medium gradient; low gradient
Other	Lake	glacial; artificial
	Ponds	vernal; artificial
	Ruderal (human induced)	urbanland; cropland; pastureland; successional fields

Four of the above listed communities provide habitat associated with a distinct plant community. The two most dominant types of habitat were oak savanna and prairie, with lesser amounts of woodland and wetland. Wetland communities include restored wetland areas such as mitigation banks. Development has led to significant changes in the plant communities. Table 3.8 describes the degree of changes to the native communities from pre-European settlement to present. By far the most dramatic change has been the loss of prairie and savanna in both Wisconsin and Illinois. As wild fires were suppressed as part of the expansion of human settlement, savanna and prairie were either converted to agricultural uses or were allowed to succeed to woodland. The vast majority of the remaining areas designated as prairie or savanna is of poor habitat quality and requires restorative actions.

Table 3.8 – Plant Community Change From Pre-European Settlement to Present Conditions

Community / Habitat Type	Wisconsin		Illinois	
	1800s	Present	1800s	Present
Prairie	26%	5.3%	34%	9%
Savanna	17%	0.0%	27%	~0%
Woodland	43%	5.6%	13%	18%
Wetland	14%	8.0%	26%	6%

The ecological resources of the Upper Des Plaines River watershed are described below by vegetation cover type. A description of the dominant vegetation and associated animal species that occupy them are presented to paint a picture of the degraded current conditions. Please note that the plant scientific names were used for the first reference of each species, but were not used for each successive reference. Also, scientific names were not listed for non-plant species because there is more consensus among researchers and professionals on the use of common names for these species. The descriptions are focused on remnant high quality areas left in the watershed, since this quality is what should be aimed for in recommending restoration plans. The Upper Des Plaines River watershed is quite degraded, with only 38,500 acres of natural area left, 9% of the total watershed acres. Of these acres, 528 are considered high quality or remnant, and the remaining area is dominated by invasive and non-native plant species. The 528 acres of high quality, remnant parcels are not targeted for restoration, but are used as reference sites to calibrate habitat suitability models.

3.1.2.1 Prairie

Prairie communities are dominated by grass species and are likely the result of frequent fires, which retard the growth of woody species and allow the development of a rich assortment of deep-rooted herbaceous species. Prairie communities were able to establish on a wide variety of soil types. There are 18 acres of high-quality prairie remnants located within the study area. A few degraded prairie remnants exist along railroad right-of-ways. Disturbance to prairie communities includes lack of fire, conversion to agricultural and farm uses, habitat fragmentation, establishment of invasive species and altered hydrology and water quality. Prairie habitats within the study area can be further characterized as *dry-mesic prairie, mesic prairie, wet-mesic prairie* and *wet prairie* based on topographical location, soil type and moisture. In larger intact sections of prairie, community subtypes would seamlessly interweave with one another to form wetland prairie complexes depending on the level of moisture.

Dry-mesic prairie: Dry-mesic prairie communities previously occurred on crests and upper slopes of major moraines with well-drained and somewhat permeable soils of moderate water-holding capacity. No areas of high-quality dry-mesic prairie have been identified from the study area. Listed species are not associated with dry-mesic prairies. Community synonyms of the dry-mesic prairie include dry fine-textured-soil prairie (Chicago Wilderness) and Midwest dry-mesic prairie (The Nature Conservancy). The dry-mesic prairies are experiencing an encroachment of invasive species and opportunistic woody plants which are shading out herbaceous prairie plants. Degraded conditions within the study area due to fire suppression and fragmentation have invited non-native and invasive species such as common teasel (*Dipsacus laciniatus*), Queen Anne's lace (*Daucus carota*), wild parsnip (*Pastinaca sativa*), white and yellow sweet clover (*Melilotos sp.*), Hungarian brome (*Bromus inermis*), and Kentucky blue grass (*Poa pratensis*), which collectively have outcompeted and inhibited the establishment of native species. Dry-mesic prairies used for agricultural purposes in the past suffer from legacy effects of high nutrient levels which enabled the establishment of many non-native and invasive species adapted to such conditions and thus have outcompeted native plants adapted to low nutrient levels.

Mesic prairie: Mesic prairie communities occur on crests of the landscape between dry-mesic prairie and wet-mesic prairie. Soil moisture is intermediate, moderately well drained and often saturated for short durations throughout the growing period. There are 11 acres of high-quality mesic prairie identified within the study area, totaling 4% of the high-quality mesic prairie in the state of Illinois. High quality remnants possess high species richness, from 100 to 130 species found in small parcels. Anthropogenic disturbances and potential restoration activities for the mesic prairie community are consistent with other prairie community types. Animal species associated with mesic prairie include the Franklin's ground squirrel, bobolink and meadowlark. Illinois state listed species associated with mesic prairie include small sundrops (*Oenothera perennis*), mountain blue-eyed grass (*Sisyrinchium montanum*) and possibly ear-leaved fox glove (*Tomanthera auriculata*). The Wisconsin state endangered loggerhead shrike is associated with the prairie community type. Community synonyms of the mesic prairie include mesic fine-textured-soil prairie (Chicago Wilderness) and Central mesic tallgrass prairie (The Nature Conservancy). Most mesic prairie areas within the watershed have succeeded into degraded woodlands comprised of invasive and opportunistic woody and herbaceous vegetation including common buckthorn (*Rhamnus cathartica*), white mulberry (*Morus alba*), box elder (*Acer negundo*), multiflora rose (*Rosa multiflora*), European highbush cranberry (*Viburnum opulus*), Japanese honeysuckle (*Lonicera japonica*), garlic mustard (*Alliaria petiolata*), and Japanese knotweed (*Polygonum cuspidatum*). Other areas have experienced an invasion

of non-native leguminous species such as crown vetch (*Securigera varia*), bird's foot trefoil (*Lotus corniculatus*), and black locust (*Robinia pseudoacacia*), which have carpeted large acreages of prairie habitat and enriched the soil with excess nitrogen that favor the establishment of other non-native and invasive species adapted to high-nutrient conditions.

Wet-mesic prairie: Wet-mesic prairie communities occur between mesic prairie and wet prairie. Soil moisture is intermediate, poorly drained, with shorter inundation periods than wet prairie communities. There are 2.6 acres of high-quality wet-mesic prairie identified within the study area, totaling 2% of the high-quality wet-mesic prairie in the state of Illinois. Wet-mesic prairie and wet prairie would typically be found adjacent to or intermingled with sedge meadows, marshes and fens forming a mosaic of communities across the landscape. Anthropogenic disturbances and potential restoration activities for the wet-mesic prairie community are consistent with other prairie community types, although altered hydrology does pose a larger threat to this system then dry prairie community types. The federally-endangered prairie-fringed orchid (*Platanthera leucophaea*) is associated with wet-mesic prairie. Illinois state listed species include white lady's slipper (*Cypripedium canadidum*) and queen of the prairie (*Filipendula rubra*). Community synonyms of the wet-mesic prairie are Central wet-mesic tallgrass prairie (The Nature Conservancy). Most of the wet-mesic prairies within the study area have been heavily impacted by stormwater runoff from urban and agricultural lands allowing sedimentation, altered hydrologic conditions, and high nutrient and sodium inputs to significantly alter soil structure and chemistry. Most of these areas are now occupied by monospecific stands of the invasive species reed canary grass (*Phalaris arundinacea*), common reed (*Phragmites australis*), and purple loosestrife (*Lythrum salicaria*), which have eliminated or significantly reduced native species richness. Encroachment of opportunistic and invasive woody species are also creating stands within the prairie including sandbar willow (*Salix interior*), gray dogwood (*Cornus racemosa*), quaking aspen (*Populus tremuloides*), smooth arrow-wood (*Viburnum recognitum*), and glossy buckthorn (*Frangula lanceolata*).

Wet prairie: Wet prairie communities occur on poorly drained and slowly permeable soils. There are 4.3 acres of high-quality wet prairie identified within the study area, totaling 2.4% of the high-quality wet prairie in the state of Illinois. Wet prairie would typically be found adjacent to or intermingled with wet-mesic prairie, sedge meadows, marshes and fens forming a mosaic of communities across the landscape. Anthropogenic disturbances and potential restoration activities for the wet prairie community are consistent with other prairie community types, although altered hydrology does pose a larger threat to this system then dry prairie communities. The federally-endangered prairie-fringed orchid is associated with wet prairie. Within 1 mile of the study area boundary, a population of the Illinois state endangered American slough grass (*Beckmannia syzigachne*) occurs in a wet prairie community. Community synonyms of the wet-mesic prairie include wet fine-textured-soil prairie (Chicago Wilderness) and Central wet-mesic prairie / cordgrass wet prairie (The Nature Conservancy). Areas within the study area have become invaded with monospecific stands of common reed, reed canary grass and cattail (*Typha* sp.) with encroaching stands of opportunistic and invasive woody species including sandbar willow, quaking aspen, and glossy buckthorn. Agricultural drain tiles are known to exist in wet prairie and other communities and have disrupted the natural hydrologic regimes that wet prairie species depend on, creating drier conditions where the drain tiles exist and unnaturally flooding areas where drain tile water is directed.

3.1.2.2 Savanna

Savanna communities are typically a mix of forest and grassland species, described as an intermediate community type between closed canopy forests and open prairie. Features that are characteristic of savannas include open-canopied structures, canopy dominance by a few species of oak, ground cover usually rich in species associated with tall grass prairie and fire dependence. Impacts to savanna communities include habitat fragmentation and fire suppression, which have caused a shift in species composition within this community type. The absence of a natural fire regime has allowed woody growth to crowd out the herbaceous cover and to change the structure and composition of savanna communities to more of a typical forest community. Very little savanna occurs in the study area and high-quality areas do not remain. Savanna restoration efforts should focus on removal of subcanopy/shrub growth and non-native species and establishment of a managed fire regime. Although state listed species are not associated with the savanna community, species richness has a tendency to be higher in transitional habitats. Subclasses of savanna communities within the region of assessment can be characterized as *dry-mesic savanna, mesic savanna, wet-mesic savanna* and *wet savanna* based on soil type and moisture.

Dry-mesic savanna: Dry-mesic savanna communities would have been located on well-drained sites exposed to periodic fire. High quality dry-mesic savanna areas do not remain in the study area. The lack of regular or periodic fire allows woody undergrowth to crowd out herbaceous vegetation and convert the community to forested or woodland. Other possible disturbances to the dry-mesic savanna community include grazing pressure and invasive species establishment. Animal species associated with dry-mesic savanna include eastern bluebird, redheaded woodpecker, field sparrow, fox squirrel and prairie deer mouse. Illinois state listed species associated with the dry-mesic savanna community include veery, Swainson's hawk, hoary elfin and the federally endangered Karner blue butterfly. Community synonyms of the dry-mesic savanna include dry-mesic fine-textured-soil savanna (Chicago Wilderness) and North-central bur oak openings (The Nature Conservancy). Nearly all dry-mesic savanna communities within the study area are now degraded successional woodlands with very low native species richness. Fire intolerant woody species such as green ash, sugar maple, common buckthorn and non-native honeysuckle species (*Lonicera* sp.) have shaded the once open canopy that herbaceous savanna flora depend on.

Mesic savanna: Mesic savanna communities were located adjacent to prairie groves on level to slightly rolling terrain and along riparian segments. Mesic savanna communities are one of the rarest presettlement floral communities in the Midwest and high quality areas are currently absent from the study area. Mesic savannas are highly dependent on fire and easily affected by human activities. Two degraded areas remain in the study area and appear to have strong potential for restoration. Animal species associated with mesic savanna include silvery blue butterfly, redheaded woodpecker, eastern bluebird, northern flicker, eastern kingbird, black-billed cuckoo, and blue-winged warbler. The Illinois state threatened pale vetchling (*Lathyrus ochroleucus)* occurs in the mesic savanna remnant areas. Community synonyms of the mesic savanna include mesic fine-textured-soil savanna (Chicago Wilderness) and North-central bur oak openings (The Nature Conservancy). Most mesic savannas within the study area have impenetrable thickets of the invasive common buckthorn, do not support new generations of oak (*Quercus sp*.) and hickory (*Carya sp*.) species, and lack or contain only small patches of remnant herbaceous savanna flora.

Wet-mesic and wet savanna: Wet-mesic and wet savanna communities were located adjacent to streams and according to historical records along the mainstem Des Plaines River. Wet-mesic/wet savanna communities are very similar to mesic savannas in terms of rarity and fire dependence. Wet-mesic/wet savanna remnants are currently absent from the study area. Subsequent to fire suppression, wet-mesic/wet savanna communities would have rapidly converted to floodplain forests. Animal species associated with wet-mesic and wet savanna include hobomok skipper and silvery checker spot. Illinois state listed species associated with wet-mesic/wet savannas include Kirtland's water snake, sharp-shined hawk and, also the newly federally-listed candidate species, eastern massasauga. Community synonyms of the wet-mesic/wet savanna include wet-mesic fine-textured-soil savanna (Chicago Wilderness) and Bur oak terrace woodland (The Nature Conservancy).

3.1.2.3 Woodland

Plant communities dominated by woody vegetation resulted from a certain level of protection from the intensity and frequency of pre-European settlement fires, which allowed the development of structural and compositional features characteristic of forests. Forests primarily exist along slopes, ravines and floodplains and other protected areas. Disturbance to forest communities includes habitat fragmentation, establishment of invasive species, altered hydrology and water quality, and fire absence. Direct habitat degradation is typically associated with overgrazing by not only domesticated livestock but also native deer.

Common insect species associated with forest habitat are the giant swallowtail, northern pearly eye, Appalachian eyed brown, and Juvenal's dusky wing. Common amphibian and reptile species associated with forest habitat include the blue-spotted salamander, Cope's grey treefrog, eastern gray treefrog and the brown snake. Common mammal species associated with forest habitat include hoary bat, silver-haired bat, eastern chipmunk, gray and fox squirrels, southern flying squirrel, woodland vole, and gray fox. Common bird species associated with forest habitat include Cooper's hawk, wild turkey, great horned owl, redheaded woodpecker, northern flicker, bluejay, black-capped chickadee, least flycatcher. Tree dominated habitats within the region of assessment can be further characterized as *dry-mesic forest, mesic forest, wet-mesic forest, mesic floodplain forest, wet-mesic floodplain forest, wet floodplain forest,* and *northern flatwoods* based on topographical location, soil type and moisture.

Dry-mesic forest: Dry-mesic forest communities are located on the Upper slopes and ridges of dissected terrain bordering the Des Plaines River and its major tributaries. Since oak species can tolerate a higher level of fire disturbance than other canopy species, this community is primarily oak dominated. In Illinois, there are 111 acres of high quality dry-mesic forest located in the study area, which is approximately 8% of the total undegraded dry-mesic forest remaining in the state. Fire absence and over grazing are the leading causes of degradation in this forest community, and as a result, cover is shifting from oak to other substratum species such as sugar maple. Illinois state listed endangered species associated with the dry-mesic forest community are the northern cranesbill (*Geranium bicknellii*), the sharp-shinned hawk, veery and brown creeper. Two Wisconsin state listed threatened species associated with the dry-mesic forest are the Acadian flycatcher and cerulean warbler. Community synonyms of the dry-mesic forest include dry-mesic woodland (Chicago Wilderness) and white oak-red oak dry-mesic forest (The Nature Conservancy). Fire intolerant woody species such as green ash, sugar maple, common buckthorn, and non-native honeysuckle species (*Lonicera* sp.) have established within this community and are preventing favorable oaks and other fire tolerant trees from establishing along with their associative conservative flora.

Mesic forest: Mesic forest communities are located along lower slopes, in ravines, on higher terraces of the major streams and tributaries, and occasionally as isolated remnants of former larger blocks of forest. The mesic forest community is relatively rich, at times with no true dominance displayed by one species. The wood thrush and ovenbird are characteristic bird species of the mesic forest. Sources of ecological disturbance arise from grazing pressure, habitat fragmentation from urban development and invasive species. In addition, the effect of fire absence is similar to the dry-mesic forest in the reduction of oak and the increase in the frequency of sugar maple. An overabundance of deer, as in most other communities, has also significantly decreased the number of conservative and rare flora that occur within this habitat such as large-flowered trillium (*Trillium grandiflorum*), white baneberry (*Actaea pachypoda*), and dwarf raspberry (*Rubus pubescens*). In Illinois there are 115 acres of high quality dry-mesic forest located in the study area, approximately 4.5% of the total undegraded dry-mesic forest remaining. Species listed as threatened or endangered by the state of Illinois associated with the mesic forest community within the study area are the northern grape fern (*Botrychium multifidum*), pretty sedge (*Carex woodii*), pale vetchling, millet grass (*Milium effusum*), black-seeded rice grass (*Oryopsis racemosa*), downy Solomon's seal (*Polygonatum pubescens*), dwarf raspberry (*Rubus pubescens*), American dog violet (*Viola conspera*), hairy white violet (*Viola incognia*), the sharp-shinned hawk, veery and brown Creeper. Community synonyms of the mesic forest include North-central maple-basswood forest (The Nature Conservancy).

Wet-mesic forest: Wet-mesic forest communities are not identified in the study area, nor does the community appear to be mentioned as a separate continuous community in this region. However, some small, degraded, localized examples are present in forested areas where drainage is particularly poor. Poor drainage in these areas is probably a result of a slowly permeable subsoil horizon and seepage that may contribute to locally saturated soils. Chicago Wilderness recognizes this community as very different in structure, function and composition as compared to floodplain forests. Common species associated with wet-mesic forests include swamp white oak, shagbark hickory, white ash and wetland adapted sedges and ferns. State listed species are not associated with the wet-mesic forest community within the study area.

Mesic floodplain forest: Mesic floodplain forest communities are located on high terraces adjacent to rivers and streams. Flood frequency and duration are shorter than wet-mesic or wet floodplain forests. The less intensive flood regime allows a more diverse species component for mesic floodplain forest communities. Changes in the hydrologic regime of the watershed have increased the frequency and depth of floodwater, which has resulted in a less diverse plant community for impacted mesic floodplain forests. Two sites, totaling 63 acres, have been located as high quality mesic floodplain forests within the study area. Swollen sedge (*Carex intumescens*) is an Illinois state listed species associated with the mesic floodplain forest community within the study area.

Wet-mesic floodplain forest: Wet-mesic floodplain forest communities are located along terraces adjacent to rivers and streams. Relative to flood frequency and duration, wet-mesic floodplain forest communities are intermediate of mesic and wet floodplain forests. Although the wet-mesic floodplain forest community has fewer drier species than a mesic floodplain forest, the understory is more species rich and structurally well developed. Changes in the hydrologic regime of the watershed have increased the frequency and depth of floodwater, which has resulted in a less diverse plant community for floodplain forests. Other impacts to this community include high intensity grazing and invasive species colonization. High quality remnants of this community have not been discovered in

the study area. Animal species associated with wet-mesic floodplain forests include the Federally-listed candidate massasauga rattlesnake, also the barred owl, red-shouldered hawk, Acadian flycatcher, yellow-throated vireo and prothonotary warbler. Illinois and Wisconsin state listed snake species within the study area is the Kirtland's water snake. Community synonyms of the wet-mesic floodplain forest include Central green ash-elm-hackberry forest (The Nature Conservancy). The invasive garlic mustard (*Alliaria petiolata*) has almost entirely colonized the understory of this community; some areas to the exclusion of native flora.

Wet floodplain forest: Wet floodplain forest communities are located within floodplains adjacent to the river and associated streams. Wet floodplain forests are flooded for portions of the year, typically in the spring and late winter. Generally, species richness is less in areas of intense flooding and as a result, wet floodplain forests have fewer tree species then the other subtypes of floodplain forest communities. Changes in the hydrologic regime of the watershed have increased the frequency and depth of floodwater. Other impacts to this community include high intensity grazing and invasive species colonization. Exotic species found in this community are similar to wet-mesic floodplain forest. High quality remnants of this community have not been discovered in the study area. Animal species associated with wet floodplain forests include the Federally-listed candidate massasauga rattlesnake, also the barred owl, red-shouldered hawk, Acadian flycatcher, yellow-throated vireo and prothonotary warbler. State listed species associated with this community are not found within the study area. Community synonyms of the wet floodplain forest include Central green ash-elm-hackberry forest (The Nature Conservancy). Wet floodplain forest communities within the study are either void of herbaceous vegetation or only allow for the establishment of non-native and invasive species as more frequent and intense floods from urban development inhibit establishment of native flora and significantly decrease the function of floodplain forests.

Northern flatwoods: Northern flatwood communities are located in level and terraces that occur on impervious subsoil horizons (claypans) and have seasonally wet and dry soils. Small depressions on relatively flat landscapes will hold standing water for portions of the year forming a mosaic of wet and dry areas within the flatwoods community. The herbaceous diversity associated with flatwoods is dependent on periodic fires. There are 54 acres of high quality northern flatwoods identified from a single site located within the study area. This site represents 64% of the known high quality northern flatwoods throughout the state of Illinois. Disturbance to northern flatwoods communities include absence of fire, grazing pressure, invasive species establishment and altered hydrologic regime. Altered hydrology has changed the duration and frequency of flooding within these communities. Animal species associated with northern flatwoods include Appalachian eyed-brown butterfly, blue-spotted salamander, tiger salamander, wood frog, tree frog, spring peeper, chorus frog, wood duck, solitary sandpiper, and redheaded woodpecker. Plant species associated with the northern flatwoods community within the study area and designated as Illinois state listed species are the Tuckerman's Sedge (*Carex tuckermanii*), downy willow herb (*Epilobium strictum*) purple fringed orchid (*Platanthera psycodes*), dwarf raspberry (*Rubus pubescens*), American dog violet (*Viola conspera*) and hairy white violet (*Viola incognia*). Community synonyms of the northern flatwoods include northern flatwood forest (Chicago Wilderness) and northern flatwood (The Nature Conservancy).

3.1.2.4 Wetland

The low-lying areas where water either inundates or saturates the soil for portions of the year and the vegetation is dominated by hydrophytic species are considered wetland communities. Wetlands can be

found along side streams and rivers and situated in isolated depressions. There are 149 acres of high-quality wetland areas located within the study area, mostly mesic floodplain forest, sedge meadow, calcareous floating mat and marsh. Overall, the study area within Illinois contains 12,140 acres of wetland, mostly consisting of marsh habitat. Disturbances to wetland communities are mainly linked to altered hydrology by anthropogenic development, which results in increased sedimentation, erratic hydrology, agricultural practices and invasive species infestation. Wetland habitats within the region of assessment can be further characterized as *mesic prairie, wet prairie, floodplain forests, marsh, shrub swamp, bog, calcareous floating mat, gramminoid, sedge meadow, calcareous seep* and *seep* based on topographical location, soil type and moisture. In larger intact sections of prairie, community subtypes would seamlessly interweave with one another depending on moisture level to form wetland prairie complexes. Great egret are Illinois and Wisconsin state listed as threatened in the study area and are associated with wetland communities.

Marsh: Marsh communities are characterized as having water at or near the surface during most of the growing season and being dominated by herbaceous vegetation. There are 13 acres of high-quality marsh identified within the study area, totaling 0.6% of the high-quality marsh in the state of Illinois. Marsh would typically be found adjacent to or intermingled with wet prairie and sedge meadows. Disturbance to marsh communities is mainly linked to increased sedimentation, erratic hydrology, agricultural pollution input and establishment of invasive species. Most species currently within the study area are invasive and form monocultures within the marsh; these species include common reed, cattail, purple loosestrife, and reed canary grass. Lack of fire has also allowed woody species such as green ash (*Fraxinus lanceolata*) and sandbar willow (*Salix interior*) to inhabit this community and decrease native species richness. Marsh restoration efforts should include maintaining and improving natural hydrologic cycles and removal of invasive species. Animal species associated with marsh communities include broad-winged skipper; purplish copper; Illinois state listed Blanding's turtle; muskrat; Illinois state listed yellow-headed blackbird; least bittern; sora; Virginia rail; map turtle; green heron and central mudminnow. Illinois state listed plant species associated with marsh communities listed include beaked sedge (*Carex rostrata*); marsh speedwell (*Veronica scutellata*) and *Scirpus hattorianus*. Within 1 mile of the study area boundary, a population of the Illinois state endangered Crawford's sedge (*Carex crawfordii*) was recently discovered in two disjunct marsh communities. Community synonyms of marsh include basin marsh and streamside marsh (Chicago Wilderness) and Bulrush-cattail-burreed shallow marsh, Midwest mixed emergent deep marsh, River bulrush marsh (The Nature Conservancy).

Shrub swamp: Shrub swamp communities are characterized as having at least 50% cover of shrub species. High quality shrub swamp areas are not identified in the study area; however, shrub swamp communities intermingle with marsh, sedge meadow and seep communities forming diverse complexes. Many species associated with shrub swamps also occur in other wetland communities. Activities which degrade shrub swamp communities are shared by other wetland communities. Animal species associated with shrub swamp include Acadian hairstreak, silvery checkerspot, common yellowthroat, willow flycatcher, woodcock and yellow warbler. State listed species are not specifically associated with the shrub swamp, although the swollen sedge (*Carex intumescens*) is found in a mixed shrub swamp/marsh habitat within 1 mile of the study area boundary. Community synonyms of shrub swamp communities include wet-mesic fine-textured-soil shrubland (Chicago Wilderness) and Dogwood-mixed willow shrub meadow (The Nature Conservancy).

Bog**:** Bog communities are characterized as acid peatlands, mostly oligotrophic (poorly nutrient fed) in Illinois. Bogs are located within the Morainal Section of the Northeast Moraine, are hydrologically isolated and fed by precipitation. Bog communities do not exist in the study area, although high-quality bogs occur to the west within the adjacent Fox River drainage system. Animal species associated with bog communities include willow flycatcher and yellow warbler. Although no bog communities occur in the study area, two bogs in Lake County, Illinois occur within 1 mile of the study area boundaries. Numerous Illinois state listed species are associated with bog habitat. These include larch (*Larix laricina*); high-bush blueberry (*Vaccinium corymbosum*); dwarf birch (*Betula pumila*); three-seeded bog sedge (*Carex trisperma*); rusty cotton grass (*Eriophorum virginicum*); alder buckthorn (*Rhamnus alnifolia*); inland shadbush (*Amelanchier interior*); red-berried elder (*Sambucus pubens*); white beak rush (*Rhynchospora alba*); large cranberry (*Vaccinium macrocarpon*); round-leaved sundew (*Drosera rotundifolia*); and cord root sedge (*Carex chordorrhiza*).

Fen: Fen communities are characterized as calcareous peatlands. Fens are fed by mineral rich groundwater discharge. Fens can form when groundwater emerges from the edges of moraines usually in a basin, but some form on the sloping edges of the moraines. Species that occur in fens are typically specialized to live in the alkaline conditions created by the amount of groundwater discharge. Fens are most common within the adjacent Fox River drainage system. Two subtypes of fens occur or previously occurred in the study area, *calcareous floating mat* and *gramminoid fen.*

Calcareous floating mat: Calcareous floating mat communities are located as a buoyant mat of sedge accumulated peat usually over a pond or lake. Fire helps maintain the herbaceous (sedges and grasses) structure of the community. There are 16 acres of high-quality calcareous floating mat identified in the Illinois portion of the study area, totaling 10% of high-quality calcareous floating mat in the state. Disturbance of these communities include polluted runoff from roads and developed areas and altered hydrology through artificial drainage systems. Altered nutrient dynamics from increased urban and agricultural development has introduced increased amounts of nitrogen and phosphorus, allowing for higher productivity in invasive species and their establishment within the study area. One animal species associated with calcareous floating mat is the swamp sparrow. Plant species associated with the calcareous floating mat community listed as threatened or endangered in the State of Illinois include downy willow herb (*Epilobium strictum*), bog bedstraw (*Galium labradoricum*), common bog arrow grass (*Triglochin maritimum*), and little green sedge (*Carex viridula*). Community synonyms of calcareous floating mat include Midwest calcareous floating mat (The Nature Conservancy).

Graminoid fen: Graminoid fen communities are located along a slope or as an elevated island in the middle of either marsh or sedge meadow. Fire helps maintain the herbaceous (sedges and grasses) structure of the community. There is 0.1 acre of high-quality graminoid fens identified in the Illinois portion of the study area, totaling 0.08% of high-quality calcareous floating mat in the state. Graminoid fens are composed of a mix of prairie, sedge meadow, and seep species. Disturbance to this community include fire deprivation, grazing pressure and altered hydrology through artificial drainage systems. Eutrophication within the study area allowed for the dominance of a fewer number of taller herbaceous and woody vegetation where the fens would otherwise have been dominated by a diverse assemblage of native short vegetation with low nutrient levels. Animal species associated with the graminoid fen include Baltimore checkerspot, mulberrywing skipper, swamp metalmark, elfin skimmer and *Nanothemis bella*. A plant species associated with the graminoid fen community listed as threatened in the state of Illinois is the slender bog arrow grass (*Triglochin palustris*). Graminoid fens host a variety of rare and unique species. Efforts should focus on preserving the last remnants of this

community and identifying areas where these formerly existed for restoration purposes. Community synonyms of graminoid fen communities include Cinquefoil-sedge prairie fen (The Nature Conservancy).

Sedge meadow: Sedge meadow communities are characterized as sedge dominated grasslands, typically located adjacent to wet prairie and marsh communities. Soils are saturated throughout most of the year and shallowly inundated for short periods. Fire helps maintain the herbaceous structure of the community, allowing the sedges to build hummocks (mounds), dominated by *Carex stricta*. There are 50 acres of high-quality sedge meadow identified in the Illinois portion of the study area, totaling 7.3% of high-quality sedge meadow in the state of Illinois. Disturbances to this community include fire depravation, grazing pressure, altered hydrology, excessive siltation from agricultural practices, and invasive species infestation. Most sedge meadows within the study area are currently occupied by reed canary grass and purple loosestrife. Animal species associated with sedge meadow habitats include Baltimore checkerspot, eyed brown, black dash skipper, dion skipper, American bittern, sandhill crane, sedge wren, swamp sparrow and pygmy shrew. Plant species associated with the sedge meadow community listed as threatened or endangered in the state of Illinois include the beaked sedge. The federally-endangered prairie white-fringed orchid and federally-listed candidate eastern massasauga is also associated with sedge meadow. Community synonyms of the sedge meadow community include lake sedge meadow and tussock sedge wet meadow (The Nature Conservancy).

Seep: Seep communities are located along lower slopes of moraines, ravines and terraces. Seeps are characterized as small areas where ground water slowly discharges to the surface. The boundary of the seep is delineated by the area of saturation of the soil. There are different types of seeps depending on the type of material the ground water flows through. Possibly two subtypes of seep occurs in the study area, seep (neutral) and calcareous seep. Because of the small areas designated as seep communities, seeps are generally seen as inclusions contained in other larger habitats such as sedge meadows, marshes, forests, fens and wet to wet-mesic prairie. High quality seep communities are not identified in the study area. Disturbance to this community include altered hydrology, excessive siltation from agricultural practices, grazing pressure and invasive species infestation. Animal species associated with the seep habitat include brook stickleback (*Culaea inconstans*) and mottled sculpin (*Cottus bairdii*) (when seeps collect into runs flowing into headwater streams). State listed species are not specifically associated with the seep community. Community synonyms of the seep community include neutral seep (Chicago Wilderness) and Skunk cabbage seepage meadow (The Nature Conservancy).

Calcareous seep: Calcareous seep communities are located at the base of river valley walls and moraines and sometimes occur within fen communities. Many species associated with fens are found within the calcareous seep community. High quality calcareous seep communities are not identified in the study area. . Animal species associated with the calcareous seep include the federally-endangered Hine's emerald dragonfly, also the pickerel frog and blacknose dace. State listed species are not specifically associated with the seep community. A community synonym of the seep community is Cinquefoil-sedge prairie fen (The Nature Conservancy).

3.1.2.5 Riverine

The riverine community consists of small to medium sized streams that flow into the mainstem Des Plaines River. Most of the stream miles are fairly flat. These segments are sluggish flowing, have

substrates primarily of sand and silt, and have aquatic macrophytes as the main structure of habitat. Other stream miles have some slope and do exhibit some riffles of small cobble and gravel. These segments have more hydraulic diversity, have substrates primarily of sand and gravels, and have woody debris, undercut banks, small riffles and shallow pools as the main structure of habitat.

Riverine structure and function of the Upper Des Plaines River watershed are severely impacted based on observations and data from surveys performed for this study and past surveys. Most of the river and stream miles have been modified. Low gradient streams are easily degraded through anthropogenically sourced sediment deposition and decreased water quality. Human activities in the watershed (e.g. agriculture, residential, and industrial development), have caused changes in riverine structure and function and decreased overall riverine species richness. To further compound the effects of land use change, direct impacts to channel morphology, instream habitat complexity, side stream vegetation, and hydraulic regimes have completely compromised the pre-European riverine ecology of the Upper Des Plaines River system. The construction of dams has prevented the recolonization of fishes and has disallowed genetic flow between fish populations.

In 2002, 43 native species of fishes were found, 23 less than the reconstructed pre-settlement fish assemblage. One species not native to the Upper Des Plaines River system, redear sunfish (*Lepomis microlophus*), and four species not native to the North American continent, common carp (*Cyprinus carpio*) goldfish (*Carassius auratus)*, tinfoil barb (*Barbonymus schwanenfeldii*) and sailfin catfish (*Pterogloplichthys disjunctivis*), were also collected. The Index of Biotic Integrity (IBI) developed by the IEPA was utilized to assess biological integrity. IBI scores ranged from 0 to 44, with most in the range classified as “limited aquatic resource”. Although some of the stations in the Upper watershed received higher IBI scores, overall scores were similar in the agricultural areas of Wisconsin and the urbanized areas in Illinois. The Qualitative Habitat Evaluation Procedure (QHEI) developed by the Ohio Environmental Protection Agency was utilized to assess riverine habitat quality. The average QHEI score of 44 classifies the Upper Des Plaines River system as a “moderate aquatic resource” in terms of riverine habitat. Fish and habitat survey results suggest Newport Ditch, Kilbourn Road Ditch, Brighton Creek, Bull Creek, Center Creek and the Upper reaches of the Des Plaines River subwatersheds as high restoration priorities. See Appendix C for a more detailed discussion of riverine quality and a list of fish species.

3.1.2.6 Other

Lake: Lake communities are characterized by open water and are located in pothole depressions left by the last retreating glacier. Lakes are typically deeper and larger (>20 acres) than ponds. Thermal stratification may occur depending on lake depth. The depth of the water prohibits colonization of most rooted plant species. High quality lake communities do not occur in the study area, although, there are 502 acres of degraded lake habitat in the study area. Disturbances to lakes are caused by artificial drainage, anthropogenic recreational use, septic and sewer contamination, siltation from agricultural practices and vegetation removal. The Illinois state listed endangered grass-leaved pondweed (*Potamogeton gramineus*) is associated with lake communities. Two other plant species that are Illinois state listed as endangered and found within 1 mile of the study boundary are the fern pondweed (*Potamogeton robbinsii*) and white-stemmed pondweed (*Potamogeton praelongus*). Illinois state listed endangered fish species include pugnose shiner (*Notropis anogenus*), blackchin shiner (*Notropis heterodon*), blacknose shiner (*Notropis heterolepis*), banded killifish (*Fundulus diaphanus)*,

and the Iowa darter (*Etheostoma exile*). A community synonym of the lake community is glacial (kettle) lake.

Pond: Pond communities are characterized by shallow water and are less than 20 acres in size. There are no high-quality pond communities, although, there are 468 acres of degraded pond habitat in the study area, mostly located in the northern half of the study area. Disturbances to pond communities are caused by artificial drainage, grazing pressures, siltation from agricultural practices in surrounding landscape and establishment of invasive species. There are around 1,412 acres of artificial ponds in the study area such as sewage lagoons, excavated and impounded ponds. In general, artificial ponds have little value as habitat and are not considered in this study.

Cultural: Cultural communities are directly influenced and controlled by human activities. Examples are cropland, pasture, artificial lakes and ponds, tree plantations, urban parks and recreational areas. Around 57% of the land located within the study boundary can be classified as cultural habitat.

3.1.2.7 Threatened & Endangered Species

Threatened and endangered species are discussed in this section by habitats. A complete list of threatened and endangered species is found in Appendix C. Preliminary coordination with the USFWS and plan formulation methodologies have recognized and considered threatened and endangered species from the study's onset. USFWS participated early in the planning process as a cooperating agency and has therefore provided significant input on the plan formulation. Formulation was formally reviewed and critiqued by the agency through a Fish & Wildlife Coordination Act Report.

The following Federally-listed species and their critical habitats are identified by the USFWS as occurring within Cook and Lake Counties, Illinois and Kenosha County, Wisconsin:

Kenosha County

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

- Northern long-eared bat (*Myotis septentrionalis*) – Proposed as Endangered – Hibernates in caves and mines - swarming in surrounding wooded areas in autumn. Roosts and forages in upland forests and woods
- Whooping crane (*Grus americanus*) – Non-essential experimental population – Open wetlands and lakeshores
- Eastern prairie fringed orchid (*Platanthera leucophaea*) – Threatened – Wet grasslands

Lake County

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

Cook County

The County Distribution of Federally-listed Threatened, Endangered, and Candidate Species was reviewed for Cook County by the Chicago District. The following federally listed species, their status, and critical habitat are identified by the USFWS as occurring with Cook 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, peatlands, wet prairies, and shrublands)
- Hine’s emerald dragonfly (*Somatochlora hineana*) – Endangered – Spring fed wetlands, wet meadows, and marshes
- Eastern prairie fringed orchid (*Platanthera leucophaea*) – Threatened – Moderate to high quality wetlands, sedge meadow, marsh, and mesic to wet prairie
- Leafy-prairie clover (*Dalea foliosa*) – Endangered – Prairie remnants on thin soil over limestone
- Mead’s milkweed (*Asclepias meadii*) – Threatened – Late successional tallgrass prairie, tallgrass prairie converted to hay meadow, and glades or barrens with thin soil

3.1.3 Cultural & Archeological Resources

3.1.3.1 Prehistoric Archeological Sites

Most prehistoric sites in the Upper Des Plaines River watershed, with the exception of megafauna and paleo-indian sites, occupy high or well-drained ground, in areas unlikely to be affected by flood control or ecosystem restoration measures. Areas recommended for prairie restoration were selected to

avoid known prehistoric archeological sites. A number of burial mounds and hilltop cemeteries were reported during the last half of the 19th century, and were subsequently destroyed by urban development and gravel mining; these included occupation sites at the Robinson Reserve Forest Preserve (11-Ck-2, 3, 4), Late Archaic burials at Half Day (11-L-64), Russell/Rosecrans (1l-L-65, 11-L-85), and the Kennicott Mounds (11-Ck-671) at Elmwood Park. Conventional archaeological survey in wetlands is difficult or impossible, but construction monitoring in wetlands will be undertaken, in view of the number of mammoth and mastodon finds from Kenosha County wetlands.

The two miles of floodplain immediately south of Wadsworth Road in Lake County contain 23 known sites. Surveys of this area were done by McGimsey/King/Wiant in 1986 and Lurie/MARS Inc. in 1989 for a wetland demonstration project developed by The Wetlands Initiative.

Cook County Forest Preserve land at Big Bend Lake in Des Plaines was once part of the De Mayorga farm; in the 1890s Joseph De Mayorga had a large collection of prehistoric tools from a multi-component prehistoric site (11-Ck-93) on his property. The Mayorga farm parcel is of particular interest because of the large number of stone tools found there. This site was probably part of a cluster of sites; its exact location is uncertain, and it appears to have been destroyed by Illinois Tollway construction.

3.1.3.2 Historic Archeological Sites

There are a number of historic sites in the Upper Des Plaines River watershed. In Illinois on the Des Plaines River just southeast of downtown Libertyville prior to 1906 was the White Sulphur Springs; this may have been a medicinal spa in the late nineteenth century, and has probably been obliterated by modern construction. At Forest Park, the Forest Home cemetery was the site of a Potawatomi town and cemetery in the 1830s; a collection of Native American artifacts from this site is on display at the Forest Park Public Library. In close proximity to Mill Creek near Millburn are two pre-Civil War mill sites and the Millburn Cemetery. Millburn Cemetery was moved to its present location in the mid-1860s, and is of local and state-wide significance

In Wisconsin, an 1878 atlas shows the Bristol Mineral Springs now known as the Bristol Soda Springs, which is currently a spa and tourist attraction on the south bank of the Des Plaines River about 1 mile southwest of the Woodford railroad station. Bain Station was a railroad depot in the late 19th and early 20th centuries; this site was just north of present Pleasant Prairie Power Station and just south of the power station's landfill, about 1½ miles east of Pleasant Prairie; named for Bain Wagon Works of Kenosha. The Hercules Powder Company operated a powder mill at Pleasant Prairie during 1899-1930. The plant closed in April-May 1930; structures and rail spur were removed sometime before 1958. The powder mill is said to have occupied a square-mile complex southwest of town; however, the 1905 USGS topographic map shows a large building at the end of a railroad spur about ¾ mile west-northwest of Pleasant Prairie, on a site now occupied by a post-1960 residential subdivision.

3.1.3.3 Megafauna and Paleo-Indian Sites

Wetlands in northeastern Illinois have potential to contain mammoth or mastodon bones associated with Paleo-Indian tools. At least nine mastodon finds are known from Cook, McHenry, Lake, Kane, and DuPage counties in northeastern Illinois. There have been numerous finds of mammoth or mastodon in southeastern Wisconsin (all associated with marshes); portions of the Des Plaines River

watershed were topographically similar to extreme southeastern Wisconsin 12,000 years ago. Paleo-Indian campsites are known from moraine crests in the Des Plaines valley, and more are probably buried under later alluvium in floodplains.

Wetlands in southeastern Wisconsin are likely to contain megafauna remains, including mammoth bones associated with Paleo-Indian tools. There have been over 30 accidental finds of mammoth or mastodon in Kenosha County, all associated with marshes. Kenosha County was about 30% marsh 12,000 years ago, and has yielded more mammoth/mastodon finds than any other county in the United States. Paleo-Indian people lived near the moving glacier and were butchering mammoth, musk ox and caribou (at the Schaefer, Mud Lake, Fenske, and Hebior sites) in Kenosha County 12,500 years ago. Paleo-Indian campsites are known from moraine crests; the Lucas site (47-Kn-226) lies near Pleasant Prairie, the multi-component Chesrow site (47-Kn-40) lies south of Kenosha, and more are probably buried under later alluvium in floodplains.

3.1.3.4 Historic Structures

There are numerous historic structures within the Des Plaines watershed. In Illinois, properties listed on the National Register of Historic Places occur at Millburn (Millburn Historic District); at Deerfield (Ryerson Conservation Area Historic District); at Mettawa (Adlai Stevenson Farm); at Des Plaines (Des Plaines Methodist Campground); at Maywood (Masonic Temple, Maywood Fire Department, and 13 historic houses); at River Forest (River Forest Historic District); at Riverside (Riverside Landscape Architecture District); and at Lyons (the Hofmann Tower, on the river at Barry Point Road). At Forest Park and River Forest the Des Plaines River runs through the historic Forest Home and Waldheim cemeteries. There is potential for additional historic structures at Aptakisic, Druce Lake, Half Day, Des Plaines, Franklin Park, Gurnee, Wheeling, Russell, and Wadsworth.

In Wisconsin, properties listed on the National Register of Historic Places occur at Kenosha (Civic Center, Library Park, and Third Avenue historic districts); and at Racine (Sixth Street, Northside, Old Main Street, and Southside historic districts); and at Union Grove (Southern Wisconsin Center for the Developmentally Disabled). There is potential for additional historic structures at Brighton, Bristol, Paddock Lake, Paris, Pleasant Prairie, Salem, Salem Oaks, and Woodworth.

3.1.3.5 Social and Economic Setting

The major portion of the project study area lies within the Chicago metropolitan area and has moderate to high housing values and income levels, a diverse ethnic demographic composition that is predominately Caucasian, and good recreational facilities. The most densely populated areas are located in Cook County. Municipalities that lie in or intersect the watershed have a total estimated 2010 population of approximately 500,000. Municipalities in Lake County that lie in or intersect the watershed have an estimated 2010 population of approximately 350,000. Municipalities in Kenosha and Racine Counties that lie in or intersect the watershed have an estimated 2010 population of over 100,000. Recent population growth has been greatest in Kenosha and Racine Counties (11.4%) as compared to Lake County (3.2%) and Cook County (-1.3%) from 2000 to 2010. These trends are projected to continue to at least 2020 (Table 3.9).

Table 3.9 – Population Trends in Primary Upper Des Plaines River Basin Communities

State	County	Municipality	2000[1]	2010[2]	% Change 2000-2010	2020[3]	% Change 2010-2020
WI	Racine	Union Grove Village	4,322	4,915	13.72%	5,410	25.17%
	Kenosha	Kenosha City	90,352	99,218	9.81%	106,837	18.25%
		Paddock Lake Village	3,012	2,992	-0.66%	3,708	23.11%
		Pleasant Prairie Village	16,136	19,719	22.21%	20,215	25.28%
IL	Lake	Gurnee Village	28,834	31,295	8.54%	33,472	16.09%
		Hawthorn Woods Village	6,002	7,663	27.67%	12,635	110.51%
		Libertyville Village	20,742	20,315	-2.06%	21,293	2.66%
		Lincolnshire Village	6,108	7,275	19.11%	9,004	47.41%
		Long Grove Village	6,735	8,043	19.42%	9,476	40.70%
		Mettawa Village	367	547	49.05%	1,073	192.37%
		Mundelein Village	30,935	31,064	0.42%	33,062	6.88%
		Old Mill Creek Village	251	178	-29.08%	3,575	1324.30%
		Riverwoods Village	3,843	3,660	-4.76%	3,935	2.39%
		Vernon Hills Village	20,120	25,113	24.82%	23,312	15.86%
		Wadsworth Village	3,083	3,815	23.74%	5,730	85.86%
		Waukegan City	87,901	89,078	1.34%	91,110	3.65%
	Cook/ Lake	Arlington Heights Village	76,031	75,101	-1.22%	80,304	5.62%
		Barrington Village	10,168	10,327	1.56%	10,342	1.71%
		Buffalo Grove Village	42,909	41,496	-3.29%	44,475	3.65%
		Deer Park Village	3,102	3,200	3.16%	3,598	15.99%
		Deerfield Village	18,420	18,225	-1.06%	19,734	7.13%
		Wheeling Village	34,496	37,648	9.14%	39,376	14.15%

1 - U.S. Census Bureau 2000

2 - https://www.census.gov/popest/data/cities/totals/2011/index.html

3 - (NIPC, now CMAP endorsed 2030 forecasts interpolated down to 2020 and SWRPC endorsed 2020 forecasts

Table 3.9 – Population Trends in Primary Upper Des Plaines River Basin Communities

State	County	Municipality	2000[1]	2010[2]	% Change 2000-2010	2020[3]	% Change 2010-2020
IL	Cook	Bellwood Village	20,535	19,071	-7.13%	21,064	2.58%
		Des Plaines City	58,720	58,364	-0.61%	59,802	1.84%
		Elmwood Park Village	25,405	24,883	-2.05%	25,854	1.77%
		Forest Park Village	15,688	14,167	-9.70%	15,720	0.20%
		Franklin Park Village	19,434	18,333	-5.67%	19,860	2.19%
		Lyons Village	10,255	10,729	4.62%	10,777	5.09%
		Maywood Village	26,987	24,090	-10.73%	26,122	-3.21%
		Melrose Park Village	23,171	25,411	9.67%	22,486	-2.96%
		Mount Prospect Village	56,265	54,167	-3.73%	57,454	2.11%
		Niles Village	30,068	29,803	-0.88%	31,943	6.24%
		Norridge Village	14,582	14,572	-0.07%	14,450	-0.91%
		North Riverside Village	6,688	6,672	-0.24%	7,014	4.87%
		Northlake City	11,878	12,323	3.75%	11,260	-5.20%
		Park Ridge City	37,775	37,480	-0.78%	37,005	-2.04%
		Prospect Heights City	17,081	16,256	-4.83%	16,426	-3.83%
		River Forest Village	11,635	11,172	-3.98%	11,632	-0.03%
		River Grove Village	10,668	10,227	-4.13%	10,838	1.59%
		Riverside Village	8,895	8,875	-0.22%	9,190	3.32%
		Rosemont Village	4,224	4,202	-0.52%	4,111	-2.68%
		Schiller Park Village	11,850	11,793	-0.48%	11,669	-1.53%
		Stone Park Village	5,127	4,946	-3.53%	4,611	-10.06%
WI	Racine & Kenosha County Totals		113,822	126,844	11.44%	136,170	19.63%
IL	Lake County Totals		344,029	354,970	3.18%	382,798	11.27%
	Cook County Totals		482,949	476,609	-1.31%	491,996	1.87%

1 - U.S. Census Bureau 2000

2 - https://www.census.gov/popest/data/cities/totals/2011/index.html

3 - (NIPC, now CMAP endorsed 2030 forecasts interpolated down to 2020 and SWRPC endorsed 2020 forecasts

In 2005, median housing values and household incomes for the project study area were moderate to high. In Kenosha and Racine Counties, these values ranged from $108,000 (Kenosha) to $159,800 (Pleasant Prairie) for housing, and $41,902 (Kenosha) to $62,856 (Pleasant Prairie) for median household income. For Lake County, these values ranged from $118,200 (Waukegan) to $823,300 (Mettawa) for housing and $42,335 (Waukegan) to $158,990 (Riverwoods) for median household income. For Cook County the median housing values ranged from $105,400 (Maywood) to $386,600 (River Forest) and median household income from $40,050 (River Grove) to $89,284 (River Forest).

Much of the land adjacent to the Des Plaines River in Illinois is owned by the Lake and Cook County Forest Preserve Districts. These lands are maintained principally as plant and wildlife preserves. As such, they provide major aesthetic, picnicking, hiking, and recreational opportunities to the communities within the project study area.

Current and projected population data for 43 primary Des Plaines River communities is shown in Table 3.9. The five communities affected by Des Plaines River overbank flooding having the greatest populations as of 2010 are Arlington Heights (74,620), Des Plaines (56,551), Mount Prospect (54,482), Park Ridge (36,983), and Gurnee (30,772).

3.1.4 Hazardous, Toxic, and Radioactive Wastes (HTRW)

The preliminary hazardous, toxic, and radioactive waste (HTRW) investigations included a preliminary screening followed by full Phase I investigations. The HTRW site screening is included in Appendix H. The preliminary site screening, completed in March 2010, assessed whether FRM and ecosystem restoration sites considered for implementation during alternative development were enrolled in any regulatory remedial program. Data obtained from the IEPA, the WDNR, and the USEPA suggested that none of the sites under investigation were currently, or had previously been, enrolled in any regulatory remedial program. Due to the limited scope of the preliminary HTRW screening, Phase I HTRW investigations were recommended for project sites recommended for implementation during the final stages of the feasibility study.

Phase I HTRW investigations for all recommended sites have been completed in accordance with ER 1165-2-132 and are included in Appendix H. A list of unresolved issues, short-term actions, and future project recommendations to resolve potential environmental concerns are provided and included in Section 9. Sites with known HTRW concerns were avoided. Potential risks associated with unknown recognized environmental concerns were considered in the development of project cost contingencies.

3.1.5 Water Quality

The Des Plaines River watershed is generally characterized as impaired in terms of water quality. Section 303(d) of the Clean Water Act requires that all states maintain and publish lists of impaired waterways, waters that do not meet water quality standards set by those states. Water quality standards and characterizations are prepared independently for the Illinois and Wisconsin portions of the watershed by the IEPA and WDNR, respectively.

3.1.5.1 Illinois

In Illinois, the Upper Des Plaines River and tributaries are classified as general use water bodies by the IEPA. The general use water quality standards apply to almost all waters of the state and are intended to protect aquatic life, wildlife, agricultural, primary contact, secondary contact, and most industrial uses. The general use standards are also designed to ensure the aesthetic quality of the aquatic environment and to protect human health from disease or other harmful effects that could occur from ingesting aquatic organisms taken from surface waters.

Aquatic life use assessments in streams are typically based on the interpretation of biological information, physiochemical water data, and physical habitat information. The assessment of primary contact use is based on fecal coliform bacteria data. The assessment of fish consumption use is based on water body-specific fish-tissue data and resulting fish-consumption advisories issued by the Fish Contaminant Monitoring Program. Public and food processing water supply is only assessed in water bodies where the use is currently occurring (as evidenced by the presence of an active intake).

Various portions of the study area in Illinois have been assessed for all or some of their designated uses. Mill Creek, Indian Creek, Buffalo Creek, Willow and Higgins Creeks, and the Des Plaines mainstem are listed as impaired streams in the IEPA 2006 Integrated Water Quality Report and 303(d) list (IEPA 2006) due to an inability to achieve the applicable general use water quality standards. Mill Creek and Bull Creek have been assessed for aquatic life use and fully support this function. Smaller systems, including McDonald, Silver, Crystal, and North Mill Creeks have not been assessed by IEPA.

Some segments of the Des Plaines River do not support the aquatic life, fish consumption, or primary contact designated uses. The potential causes for aquatic life impairment include elevated levels of chloride, nitrogen, phosphorous, total dissolved and suspended solids, zinc, and silver; excessive sedimentation and siltation caused primarily from combined sewer overflows municipal point source discharges, urban runoff, storm sewers, highway/road/bridge runoff, site clearance and land development, hydrostructure flow regulation; and the presence of sediment contaminated with various chemicals. Sediments with elevated concentrations of mercury and PCBs of unknown origin have resulted in fish consumption advisories in several reaches of the study area. Elevated levels of fecal coliform, resulting from combined sewer overflows, urban runoff, and storm sewers have impaired primary contact recreation uses in many areas.

Willow Creek is an aquatic life impaired waterway due to the presence of elevated levels of phosphorous and dissolved solids from municipal point sources, urban runoff, and storm sewers; the same types of sources impact Higgins and Buffalo Creeks. Higgins Creek is an aquatic life and primary contact impaired waterway due to the presence of elevated levels of chloride, fluoride, nickel, nitrogen, phosphorous, silver, total dissolved solids, zinc, and fecal coliform. Buffalo Creek is impaired for aquatic life and primary contact recreation due to the presence of elevated levels of manganese, silver, and fecal coliform. Indian Creek is an aquatic life impaired waterway due the presence of contaminated sediment containing endrin, methoxychlor, and nitrogen at highly elevated levels (Short 1997).

3.1.5.2 Wisconsin

In Wisconsin, the Des Plaines River and its tributaries are not included in the state's 303(d) list of impaired waterways. The WDNR is responsible for protecting, maintaining, improving and managing the state's surface waters, including the Des Plaines River and its tributaries. WDNR establishes water quality standards for individual surface waters based on the potential or attainable uses of the water, divided into four categories: fish and aquatic life, recreational, public health and welfare, and wildlife. Ideally, all surface waters in the state should meet the water quality standards associated with the proposed Diverse Fish and Aquatic Life (DFAL) use sub-category. DFAL surface waters generally support both warm and cool water ecosystems with the potential to contain fish and macroinvertebrate communities that include some species relatively intolerant of low dissolved oxygen levels. This use designation encompasses a large range of aquatic communities, habitats, and ecosystem types (WI 2004).

The Pleasant Prairie tributary and one other unnamed tributary to the Des Plaines River in Wisconsin are proposed for listing as limited aquatic life (LAL) waters. This designation indicates the surface water only supports a small number of forage fish species and other non-fish aquatic like species that are very tolerant to organic pollutants. LAL or very tolerant aquatic life ecosystems (VTAL) do not have the potential to maintain a fish community and have either limited natural capacity or irretrievable water quality conditions that prevent them from fully supporting aquatic life forms. These waters may contain macroinvertebrate communities dominated by species that are very tolerant of low levels of dissolved oxygen. Some VTAL or LAL waters may briefly contain a few stray fish during high-flow periods when water quality and habitat conditions allow for their existence. These waters may have extreme variation in flow, temperature and/or water quantity, yet may contain macroinvertebrate communities dominated by very tolerant species.

The mainstem of the Des Plaines River downstream of State Highway 50 historically did not fully meet water quality standards associated with the recommended water use objectives prior to 1976. Data collected between 1979 and 2001 indicate that the standards associated with the recommended water use objectives were not fully achieved from 1976 to 2001. Violations of dissolved oxygen, total phosphorus, and fecal coliform levels occurred at one station on the mainstem of the Des Plaines River just south of the Wisconsin-Illinois border. However, based upon review of the water quality sampling and water quality simulation data developed under the regional water quality management plan and the state of implementation of that plan, it is likely that violations of the dissolved oxygen, fecal coliform, and phosphorus standards also occurred at upstream stations at that time. This finding is consistent with the presence of pollution-tolerant fish species in the watershed.

3.1.6 Recreation Resources

There are many recreation opportunities available to the public throughout the Upper Des Plaines watershed. Table 3.10 presents a summary of existing recreation and open space lands in the watershed. Plate 9 shows the distribution of the lands within the study area. Properties included in this list are public and privately owned parks and open spaces that are available for a variety of recreation activities.

As shown in the table, the majority of the recreational and open space acreage available in Cook and Lake Counties is owned by those counties. The bulk of this land consists of County Forest Preserve sites. In Cook County, there are extensive Forest Preserves along the Des Plaines River which connect

to the lands and trail networks managed by Lake County Forest Preserve District. The Lake County Forest Preserve District lands extend north along the Des Plaines River mainstem and along the tributaries as well. Both Forest Preserve Districts maintain amenities such as hiking, biking, horse riding, and cross-country skiing trails; access to the river for fishing and boating; and golf courses.

In Wisconsin, however, most of the land is owned by private entities or the state. The private lands consist mainly of land owned by sport, recreation, or community clubs. The largest portion of the state lands in Wisconsin, over 1,300 acres, is part of the Bong State Recreation Area. The recreation area differs from other state owned parks and forest in that it provides additional opportunities such as areas for flying a variety of items from model airplanes to hot air balloons, dog and falcon training, hunting, and all-terrain vehicle and horse riding. Other state lands are primarily nature areas and forests.

Table 3.10 – Watershed Recreation Sites

State	County	Ownership	Sites	Acres
WI	Kenosha/Racine	State	9	1,787
		County	5	594
		Local	23	486
		Private	27	2,359
		Total	64	5,226
IL	Lake	State	13	803
		County	185	14,746
		Local	276	5,506
		Private	52	2,503
		Total	526	23,558
	Cook/DuPage	State	0	0
		County	106	9,941
		Local	217	2,186
		Private	22	1,061
		Total	345	13,188
Watershed Total		State	22	2,590
		County	294	23,427
		Local	512	8,033
		Private	103	5,924
		Total	931	39,973

3.2 Expected FWOP Conditions*

The without-project condition of the Upper Des Plaines River watershed is the basis for comparing the outputs of alternative plans and is the “No Action Alternative” as described in the NEPA. In forecasting these conditions, an effort is made to describe foreseeable changes to the most important aspects of the study area over the next several decades. This forecasting is based on an assessment of the existing conditions within the study area. The without-project condition describes the future conditions that will exist if no new Federal action is taken. Expected conditions, previous trends, and predicted trends are considered in describing the without-project condition. Forecasted environmental conditions can be based on a variety of key assumptions and different sources of information available

from Federal, State, local agencies and private conservation entities. National and State environmental and health standards and regulations are recognized. Water quality, air quality, public health, wetlands protection, and floodplain management are given specific consideration in forecasting the without-project condition.

3.2.1 Urbanization and Land Use Conditions

Expectations are for the continued development of the upper portions of the watershed encompassing Lake, Kenosha and Racine Counties. Since the lower portion of the watershed is almost fully developed, the Cook County portion of the watershed is not projected to have new development other than renewal, removal, and replacement of existing structures. The watershed is urbanizing from downstream to upstream, and future higher urbanization rates in upstream areas will likely impact the entire watershed.

Future land use conditions in the watershed were computed by using population projections and estimating the increase in footprint area from new development within existing municipalities. These estimates were based on local planning commission population projections; trends in city growth were extrapolated to 2020. The SEWRPC and CMAP compute population projections for each community every five years. Population projection data for municipalities within the watershed as shown in Table 3.9 above was used to compute future land use. Table 3.11 below shows the predicted land use changes due to urbanization for Cook and Du Page Counties, Lake County, and for Kenosha and Racine Counties.

Cook County is almost fully developed; therefore, changes to land use in this area were minimal. Kenosha and Racine Counties show the greatest percentage change to urban land uses because most of the area in those counties is currently agricultural and development stemming from Chicago and Milwaukee is impinging on these counties. As the population in the Upper Des Plaines River watershed grows, the resulting modifications to the landscape will negatively affect the existing ecosystem and hydrology. Although remaining natural areas are unlikely to be converted to other uses, increases in impervious surfaces resulting from increased urbanization will increase run-off impacts to the ecosystem.

Table 3.11 – Predicted 2020 Future Land Use Changes Within Study Area

	Cook/DuPage County			Lake County		
	Baseline 2001	**Future 2020**	**Diff**	**Baseline 2001**	**Future 2020**	**Diff**
Land Use	Area (ac)	Area (ac)	Change (%)	Area (ac)	Area (ac)	Change (%)
Residential	41,349	41,579	1%	45,569	50,761	11%
Commercial	7,376	7,422	1%	6,737	7,775	15%
Industrial	11,021	11,036	0%	3,373	3,719	10%
Public	5,360	5,375	0%	2,965	3,311	12%
Infrastructure	9,236	9,236	0%	2,659	2,659	0%
Recreational	12,219	12,070	-1%	18,355	18,351	0%
Agricultural	400	373	-7%	26,353	19,452	-26%
Open	97	97	0%	191	191	0%
Forest/grassland	1,997	1,873	-6%	13,563	13,551	0%
Wetland	115	108	-6%	5,667	5,662	0%
Water	1,021	1,021	0%	4,487	4,487	0%
Total	**90,191**			**129,919**		

	Kenosha/Racine County			Entire Study Area		
	Baseline 1995	**Future 2020**	**Diff**	**Baseline 1995/2001**	**Future 2020**	**Diff**
Land Use	Area (ac)	Area (ac)	Change (%)	Area (ac)	Area (ac)	Change (%)
Residential	9,696	15,192	57%	96,614	107,532	11%
Commercial	258	637	147%	14,371	15,834	10%
Industrial	804	1,130	41%	15,198	15,886	5%
Public	1,189	1,515	27%	9,514	10,202	7%
Infrastructure	4,829	4,829	0%	16,724	16,724	0%
Recreational	38	38	0%	30,612	30,459	0%
Agricultural	51,217	44,696	-13%	77,970	64,521	-17%
Open	0	0	0%	288	288	0%
Forest/grassland	8,998	8,993	0%	24,558	24,416	-1%
Wetland	7,106	7,105	0%	12,888	12,875	0%
Water	1,268	1,268	0%	6,776	6,776	0%
Total	**85,403**			**305,513**		

3.2.2 Hydrologic and Hydraulic Conditions

SEWRPC completed a comprehensive study of the Wisconsin portion of the Des Plaines River watershed in 2003 and provides a guide to the future development of the 133-square-mile watershed in Kenosha and Racine Counties. The plan investigates water resource-related problems and presents recommendations to address those problems. The Lake County Forest Preserve District has and continues to acquire floodplain lands along the Upper Des Plaines River in Lake County. The Forest Preserve District of Cook County has, through land acquisitions, prevented considerable development on the floodplain along the mainstem Des Plaines River, but most of the watershed in Cook County has become highly urbanized as a direct result of outgrowth of the metropolitan area of Chicago.

These actions alone will not prevent future flood conditions from worsening as open space in Lake and Kenosha Counties becomes developed by the continuing outgrowth of the metropolitan area.

Even if future development in the basin is controlled through sound land use planning and storm water runoff ordnances, the experience in the Chicago metropolitan area in this watershed and on adjacent watersheds has shown that increased development causes an increase in peak discharges within receiving rivers and streams through increases in impervious areas. These increases in discharges result in increased flood stages for the given frequency storm event and a proportionate increase in flood damages to existing structures within the floodplain. Increases in flood flows and stages also increase the footprint area of floodplains making more structures susceptible to flood risks.

A detailed assessment of projected FWOP conditions using hydrologic and hydraulic modeling utilized for this study can be found in Section 4.

3.2.3 Habitat Conditions

As discussed above, the Upper Des Plaines watershed is urbanizing and open space is projected to be developed as populations increase. Development of unprotected natural areas will destroy the few remaining ecosystems and habitat structure left in the study area. In addition to habitat destruction from development, adverse impacts to existing hydrology and water quality will cause further decline in habitat quality and ecosystem function. As a result, FWOP habitat quantity and quality are expected to decline without large-scale intervention. State and Local governmental activities are not expected to be able to provide the type of landscape-level changes needed to beneficially affect altered hydrology and restore ecological functions.

The non-Federal sponsors for the feasibility study have strong missions in ecological restoration and do have some limited funding streams to implement small scale projects. The extent and focus of these projects is limited by agency jurisdictions and overall goals. Federal partnership with multiple agencies across the jurisdictional boundaries allows for the development of an ecosystem restoration plan optimized on a watershed scale, leveraging Federal and non-Federal funding and expertise. Without Federal involvement, implemented restoration projects will not be of the scale and focus required to create significant improvements in the watershed habitat.

A detailed assessment of projected FWOP conditions using habitat assessment methodologies utilized for this study can be found in Section 5.

3.2.4 Water Quality

Water quality impairments are related to the watershed hydrology and hydraulics, and human impacts to these processes. The increased water stages and velocities during flood events result in erosion and transport of pollutants within the waterways. During some events, CSOs also introduce untreated sewer and stormwater directly to the waterways. In the FWOP condition for the study area, watershed hydrology and hydraulics would not be significantly changed and, as a result the water quality would remain impaired.

A detailed assessment of projected FWOP water quality conditions in the watershed can be found in Section 7.

3.2.5 Recreation

Open space conservation and improvement of trail networks are priorities for agencies within the watershed. Realizing these goals would increase and improve opportunities for recreation. Federal involvement could aid state and local agencies in providing linkages between recreation sites across agencies.

A detailed assessment of projected FWOP recreational opportunities in the watershed can be found in Section 8.

3.2.6 Climate Change

Although some changes in precipitation patterns in the watershed are possible as a result of climate change, there is insufficient data to support a detailed analysis of the impact of these changes on flooding and aquatic habitats in the watershed. This uncertainty poses the risk that the formulated plans will not achieve the intended effects. To address this risk, the team evaluated the potential impacts of climate change on flooding and habitat and identified mitigation strategies as discussed below.

Illinois State Water Survey (ISWS) Bulletin 70 rainfall is the current state standard for expected extreme rainfall and was used in the hydrologic and hydraulic analysis of this study. The frequency distributions are based on analysis of precipitation data from 1901 to 1983. NOAA Atlas 14 precipitation became available in 2004 and included an additional 20 years of data. A comparison of the 99% through the 1% chance exceedance event with a 10-hour critical duration shows that Bulletin 70 rainfall totals are slightly greater than the Atlas 14 totals for all frequencies. All frequencies, with the exception of the 1% chance total, were within the upper limit of the 90% confidence interval. This comparison of the two precipitation studies does not indicate an increase in total precipitation from more recent data. However, there is other evidence that long term shifts in precipitation frequencies with increased storm intensities are possible in the future. Shifts towards greater intensity storms would likely result in an increase in flood damages within the study area.

Based on these predictions, the proposed FRM projects may provide greater benefits in this future condition than currently estimated. In terms of impacts to life safety, proposed excavated reservoirs are inherently low risk. When their capacity is reached, diversion to the reservoir automatically ceases and they retain flood waters until river stages recede and they can be emptied. As such, these reservoirs will continue to provide flood risk reduction benefits, just at a greater frequency than planned. For levees, shifts in the storm frequency distribution could ultimately change the level of protection afforded by the proposed levees. As increased storm intensities are realized in the future, it will be important for USACE to work with the non-Federal sponsor and local community to help them understand the protection level and risks associated with living behind a levee.

For the proposed ecosystem restoration projects, 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, a single unforeseen event 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 outputs. Increased temperatures or rainfall may lead to changes in the ecosystem of the project area; however, in this study area Lake Michigan can drive weather patterns in the Chicagoland area and may partly buffer /mitigate changes to ecosystems as a result of climate change.

4 Flood Risk Management

4.1 USACE Flood Risk Management Program

Every year floods affect communities across the United States taking lives, destroying property, shutting down businesses, impacting the environment, and causing millions of dollars in damages. Nearly 94 million acres of land in the United States are at risk for flooding and the nation averages over $4 billion in flood damages annually. One of the primary missions of the USACE is to support the flood risk management (FRM) activities of communities in both urban and rural areas throughout the United States.

The goal of the USACE FRM mission is to reduce flood risk by saving lives and reducing property damage in the event of floods and coastal storms. By supplying technical and geographical data, the USACE assists communities in developing responses to flood risks and hazards. The USACE also directly enhances public safety with structural and non-structural measures and emergency action. Specific USACE activities geared towards preparing individuals and communities for potential floods include:

Flood Risk Management Structures: The USACE is responsible for the construction and operation of 383 major lake and reservoir projects, construction of over 8,500 miles of levees and dikes, building of hundreds of smaller local flood risk reduction projects that have been turned over to non-Federal authorities for operation and maintenance (O&M), construction of about 90 major shoreline protection projects along 240 miles of the nation's 2,700 miles of shoreline, and implementation of several non-structural projects to reduce susceptibility to flood damages

Advance Measures: When it appears that a flood is imminent in a specific area, the USACE can take a number of immediate steps to protect life and property, such as constructing temporary flow restriction structures and removing log debris blockages.

Floodplain Management Services Program: The USACE provides information, technical assistance and planning guidance (paid for by the Federal Government) to states and local communities to help them address floodplain management issues. Typical focus areas are wetland assessment, dam safety/failure, flood damage reduction, floodplain management and coastal zone management and protection.

Federal Emergency Management Agency (FEMA) Mapping: Over the past 40 years, the USACE has completed 3,000 studies for FEMA, mapping the flood potential of various areas of the country and has been instrumental in training private firms to carry out similar studies.

Flood Hazard Mitigation Measures: The USACE assists in coordinating Federal and state agency efforts to assist local communities with flood hazard mitigation measures. This includes the work of the Silver Jackets Program.

Levee Inspections, Certification and Emergency Rehabilitation: The USACE periodically inspects completed projects and assists local communities with obtaining certification of their projects in the Federal program. USACE assists in both Federal and non-Federal emergency rehabilitation of damaged levees.

Planning and Design of Structural and Nonstructural Flood Risk Reduction Projects: Districts throughout the USACE partner with state and local interests to plan and implement flood risk reduction projects. Through comprehensive planning and strong partnerships the USACE is helping reduce flood risks across the nation.

Since the Flood Control Act of 1936 when the USACE was given authority to address flooding across the nation, numerous FRM projects have been implemented. These projects have prevented an estimated $706 billion in riverine and coastal flood damage, most of that within the last 25 years.

For more information on the national USACE Flood Risk Management Program including ongoing activities, partners and future challenges, visit the USACE "Value to the Nation" website at: http://www.corpsresults.us/flood

For the Upper Des Plaines River and its tributaries, the Chicago District has identified and evaluated structural and non-structural FRM projects. The overall plan developed for this study incorporates the identified FRM projects into a multi-purpose plan with the additional goals of ecosystem restoration, water quality improvement, and recreation enhancement.

4.2 Flood Risk Inventory and Forecasting

Flood risk assessment phases include: a review of study area population growth trends needed to establish current and likely future conditions; historic flooding research to determine the location, scale, and impacts of previous flooding; a review of existing floodplain mapping; and assembly of data needed to develop damage assessment models for use in the evaluation alternative flood risk mitigation plans. This data gathering phase includes the assembly of floodplain structure inventories (residential, commercial, industrial and public structures) as well as data to reflect the road system and traffic patterns subject to flood impacts.

The Upper Des Plaines River and its tributaries have experienced major flooding resulting in hundreds of millions of dollars in damages over the past several decades. Local, state, and Federal agencies have taken steps to reduce flooding, yet many instances of residual flooding and subsequent damages continue throughout the study area.

Following record flooding in 1986 and 1987 on the Upper Des Plaines River, the Chicago District completed a reconnaissance study in 1989 that recommended further evaluation of risk reduction measures to address flooding within the watershed. In partnership with the IDNR, USACE completed the Upper Des Plaines River Flood Damage Reduction Feasibility Study (Phase I Study), which was approved in November 1999. The Phase I Study focused on alleviating flooding along the Upper Des Plaines River from the confluence of Salt Creek upstream to the Illinois/Wisconsin Stateline. The WRDA of 1999 authorized a Locally Preferred Plan consisting of six structural FRM components.

The need for additional FRM in the watershed was highlighted by major flooding during the spring of 2013. On April 18, 2013, the Chicago area received on average 5 inches of rain, with localized precipitation of over 7 inches over an 18 to 24 hour period. The study area received widespread rainfall between 0.25 and 1.5 inches several days before the event, which saturated the ground and increased the potential for overbank flooding when heavier rains fell a few days later. These

antecedent conditions resulted in significant flooding throughout northeast Illinois with the greatest impacts on the Des Plaines, Fox, and East Branch DuPage Rivers.
Major flood stage was reached along the entire Des Plaines study area. New record stages were reached at the Des Plaines (0.02-ft over previous 1986 record) and Riverside (0.67-ft over previous 1987 record). These record stages resulted in widespread overbank flooding along the majority of the study area. Thousands of structures were inundated and many road crossings and parallel roads were closed for several days. FEMA declared this a Major Disaster Declaration (DR-4116) on May 10, 2013 and as of July 2013 approved over 60,000 applications totaling nearly $150M in individual disaster relief.

This study, while building on the work of the Phase I Study, is different in significant ways. The study authorization is different: ecosystem restoration, not considered in the Phase I Study, was added as an additional purpose of the Phase II Study. In addition, the Phase II study area includes tributaries to the mainstem and the Wisconsin headwaters. Also, Federal (Corps) planning guidance and computer analysis tools continue to evolve. Geographic Information Systems (GIS) are heavily used in the economic analysis for managing flood risks for this study: structure inventories located within both mainstem and tributaries floodplains and information from public records concerning the parcel improvements are relied on where actual structure inventories are lacking. Similarly, the analysis of transportation impacts is migrated to a new and technically proven platform. A spreadsheet model was used in the Phase I Study. A dynamic computer simulation model of traffic flows and the flooding impact on those flows has been used for this study.

Due to the emphasis on the use of proven and tested models within the Federal planning community, the two major flood damage assessment models to be used in this Phase II study evaluations are the USACE Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) for structure impacts and the Visual Interactive System for Transportation Algorithms (VISTA) for transportation impacts. VISTA was created by a team of researchers and developers, primarily from Northwestern University, at the forefront of the research in traffic modeling, and has been evolving since 1995. The model has been used by several state and Federal agencies including the U.S. Department of Transportation, Alabama Department of Transportation, the National Science Foundation, and USACE.

VISTA was originally developed by Northwestern University in association with other universities. The model is now maintained by the VISTA Transportation Group, established in 2004. VISTA is a collection of several models and modules which dynamically simulate and route traffic over a network of roads, finding an equilibrium condition in which no vehicle can shorten its travel time or mileage between origins and destinations. The basic procedure is to define a road network and route all traffic over the network to determine the base condition total travel times and mileage for the known average daily traffic on the system for passenger cars and heavy vehicles. For analyzing the effects of flooding on traffic, the network is modified to close certain roads and intersections to simulate flood conditions. The total time and distance is recalculated as the model algorithms search for the "best" routes between origins and destinations given the closures to determine effects on the system due to flooding. The differences between the with-flood condition and the normal condition are the disruption effects due to flooding. VISTA has great flexibility in its reporting, which includes the reporting of time and distance traveled by vehicle type and distributes delays versus vehicle counts. Time effects are monetized by applying the value of time for vehicle occupants to the additional minutes of travel. Detour distances are monetized by applying per-mile vehicle operating costs. This is repeated over the range of flood events selected for analysis.

4.2.1 Inventory of Historic Flooding

Severe floods have occurred in the Upper Des Plaines River basin over the past several decades resulting in millions of dollars in damages. Two major floods that occurred in 1986 and 1987 in and around the Upper Des Plaines River basin (FEMA declarations #776 and #798 respectively) together caused more than $100 million in damages to more than 10,000 residential, commercial and public structures as well as damages attributed to traffic impacts. More than 15,000 residents were evacuated during the 1986 flood alone. Over 40 river crossings and numerous roads running parallel to the Des Plaines River flooded, causing traffic delays, prolonged detouring, and physical damage to the roadways.

There are several ways in which flooding across the study area results in structural and transportation damages, including:

- Mainstem overbank flooding
- Tributary overbank flooding caused by backwater flood stages on mainstem
- Tributary overbank flooding (non-mainstem backwater)
- Storm sewer backup due to downstream stages on mainstem and tributaries
- Combined sewer backup due to downstream stages on mainstem and tributaries
- Groundwater seepage into structure basements

This study will focus on addressing structure and content damages caused by overbank flooding and transportation impacts from detours and delays caused by flooded roadways on both the mainstem Upper Des Plaines River and its tributaries within the study area. Flooding associated with sewer backup and groundwater seepage is outside the scope of this study and is being addressed through construction of the Chicago Underflow Plan and local initiatives in upgrading sewer systems.

Major flood events that have occurred in the Upper Des Plaines River watershed over the past 25 years are listed in Table 4.1, including the two large flood events recorded on the system in 1986 and 1987 as well as a recent large event in 2013. Flood event return periods for gages on the mainstem Des Plaines River are based on frequency curves that were adjusted for urbanization and watershed modifications such as the construction of reservoirs up through water year 2005. Return periods for the gages on the tributaries are based on unadjusted frequency curves. Gages are listed in order of upstream to downstream within the watershed. The location of the gages is shown in Plate 6.

Table 4.1 – Historical floods Within the Upper Des Plaines River Watershed (1986-2013)

Water Year	Gage Station	Peak Stage (ft NGVD29)	Flow (cfs)	Annual Chance of Exceedance
1986	Des Plaines River at Russell, IL	672.80	1,640	12%
	Des Plaines River near Gurnee, IL	662.30	3,530	7%
	Buffalo Creek near Wheeling, IL	665.40	581	20%
	Des Plaines River near Des Plaines, IL	637.20	4,900	6%
	Des Plaines River at Riverside, IL	603.55	7,625	4%
1987	Buffalo Creek near Wheeling, IL	665.94	717	10%
	McDonald Creek near Mt Prospect, IL	646.20	806	2%
	Des Plaines River near Des Plaines, IL	635.08	3,370	29%
	Weller Creek at Des Plaines, IL	648.92	1,490	5%
	Des Plaines River at Riverside, IL	604.58	9,770	0.3%
1990	Weller Creek at Des Plaines, IL	645.06	1,190	10%
	Des Plaines River at Riverside, IL	602.69	5,950	20%
1993	Des Plaines River at Russell, IL	670.89	1,750	10%
	Mill Creek at Old Mill Creek, IL	680.06	1,090	13%
	Des Plaines River near Gurnee, IL	660.19	2,370	22%
1996	Des Plaines River at Russell, IL	670.31	1,200	22%
	Mill Creek at Old Mill Creek, IL	679.94	1,020	14%
	Buffalo Creek near Wheeling, IL	665.76	670	13%
	Des Plaines River near Des Plaines, IL	634.98	3,850	21%
1997	Mill Creek at Old Mill Creek, IL	679.9	1,000	17%
	Des Plaines River near Des Plaines, IL	634.36	3,540	26%
	Weller Creek at Des Plaines, IL	644.47	1,040	20%
	Des Plaines River at Riverside, IL	603.13	6,990	8%
1999	Des Plaines River at Russell, IL	670.38	1,250	21%
	Mill Creek at Old Mill Creek, IL	680.21	1,160	11%
	Buffalo Creek near Wheeling, IL	665.59	621	14%
	Des Plaines River near Des Plaines, IL	634.11	3,420	28%
	Des Plaines River at Riverside, IL	602.34	5,680	23%
2000	Des Plaines River at Russell, IL	671.95	2,130	6%
	Mill Creek at Old Mill Creek, IL	680.01	1,060	13%
	Des Plaines River near Gurnee, IL	660.6	2,690	20%
2001	Buffalo Creek near Wheeling, IL	665.85	680	13%
2002	Weller Creek at Des Plaines, IL	643.86	1,070	20%
	Des Plaines River at Riverside, IL	602.57	6,050	18%
2004	Des Plaines River at Russell, IL	673.09	3,500	1.4%
	Des Plaines River near Gurnee, IL	662.06	3,890	5%
	Des Plaines River near Des Plaines, IL	634.82	3,760	22%
2007	Des Plaines River at Russell, IL	672.57	1,610	12%
	Des Plaines River at Gurnee, IL	660.15	2,390	21%
	Des Plaines River at Des Plaines, IL	634.91	3,780	22%
	Des Plaines River at Riverside, IL	602.41	5,790	22%
2008	Des Plaines River at Russell, IL	671.47	1,910	8%
	Des Plaines River at Gurnee, IL	659.29	1,900	31%
	Des Plaines River at Des Plaines, IL	636.31	3,010	42%
	Des Plaines River at Riverside, IL	604.55	9,560	0.4%
2010	Des Plaines River at Riverside, IL	602.96	6,720	11%
2013	Des Plaines River at Russell, IL	671.96	2,240	5%
	Des Plaines River at Gurnee, IL	661.73	3,460	8%
	Des Plaines River at Des Plaines, IL	637.24	4,970	6%
	Des Plaines River at Riverside, IL	605.25	12,200	0.2[1]%

[1]Flows were more than 1,800 cfs greater than the 0.2% annual chance of exceedance.

4.2.2 Summary of Previously Reported Flood Damages

4.2.2.1 Phase I Study

The six authorized projects recommended by the Phase I Study, if fully implemented, would reduce flooding and flood damages along the Upper Des Plaines River mainstem. According to a Limited Reevaluation Report (LRR) approved in 2007, the authorized project has an estimated initial cost of $54.7 million, average annual reduction in damages of $9.2 million and a benefit to cost ratio (BCR) of 2.6.

The authorized Phase I project includes the expansion of two existing reservoirs, the construction of one lateral storage area, two levee units and the modification of an existing earthen dam to provide additional flood storage. Table 4.2 lists the names, locations, and flood storage volume, where appropriate, of each of the project elements. Plate 10 shows the location of each project within the watershed. The total additional floodwater storage volume provided is 1,975 acre-feet. A flood warning preparedness plan and a remapping of the mainstem Upper Des Plaines River floodplain were also included in the authorized project.

Table 4.2 – Authorized Projects Included in Baseline and Future Conditions

Authorized Project	Location (City, State)	Additional Storage (acre-ft)	Current Status
Van Patton Woods Lateral Storage	Wadsworth/Russell, IL	412	In Design
North Fork Mill Ck. Dam Modification	Old Mill Creek, IL	500	On hold[1]
Buffalo Creek Reservoir Expansion	Buffalo Grove, IL	476	On hold[2]
Big Bend Lake Reservoir Expansion	Des Plaines, IL	587	In Design
Levee 37	Prospect Heights/ Mount Prospect, IL	N/A	Complete
Levee 50	Des Plaines, IL	N/A	Complete
	Total Storage Volume:	**1,975**	

[1]Implementation of the North Fork Mill Creek Dam Modification is being reevaluated.
[2]Expansion of Buffalo Creek Reservoir is on hold pending resolution of landowner considerations with the site owner, Lake County Forest Preserve District.

The Van Patton Woods Lateral Storage Area is located south of Russell Road and east of the Milwaukee Road Railroad in the Wadsworth area. This site is on property owned by Lake County Forest Preserve District. The Van Patton Woods design includes two bermed storage areas, one to the east and the other to the west of the river. This site covers approximately 66 acres and provides approximately 412 acre-feet of flood storage.

The North Fork Mill Creek Dam is located in Lake County on the north fork of Mill Creek, tributary to the Des Plaines River. An existing dam was constructed on private property just north of Kelly Road creating Rasmussen Lake. This dam is approximately 550 feet in length with a 30-foot crest width at an elevation of 743.2 feet NGVD29. The primary spillway is 30 feet in length at an elevation of 738.9 feet NGVD29. The authorized plan is to raise the existing dam by 3 feet to an elevation of 746.2 feet NGVD29, providing an additional 500 acre-feet of storage. To tie into the existing topography a new section approximately 900 feet in length would be added. With this modification the maximum storage volume would increased to 1,040 acre-feet. Implementation of this project is being reevaluated due to changes in land availability as discussed in Section 4.4.1.

The Buffalo Creek Reservoir Expansion involves expanding the existing Buffalo Creek Reservoir to Schaefer Road to obtain 476 acre-feet of floodwater storage. The plan combines revised contouring and lowering of the design water elevation of the two existing permanent pools to create one permanent pool.

The Big Bend Lake Reservoir Expansion expands the existing Big Bend Lake to obtain an additional 587 acre-feet of storage. The lake bottom and side slopes will be expanded and re-contoured. The plan also calls for a lower normal lake level to accommodate additional floodwater storage. Two storm sewer lines which currently empty into the lake will be rerouted to the Des Plaines River as well. This will eliminate the reduction in the lake's available storage caused by the stormwater discharge.

Levee 37 is located in Mount Prospect and Prospect Heights along the east side of River Road and Milwaukee Avenue. The levee was initially proposed by local interests as a project to raise roads to hold back floodwater, effectively operating as a levee. A Value Engineering (VE) study during the design phase led to the revision of the project from a road raise to an equivalent length, 9,600 feet, of earthen levee and concrete floodwall at the authorized crest elevation of 641.0 feet NGVD29. The project also includes interior drainage structures. The revisions to the design reduce costs and do not significantly impact project benefits, as documented in the LRR approved in 2007.

Levee 50 is located in the City of Des Plaines on the east side of the Des Plaines River, between Dempster Road on the west and the Tollway on the east. The length of this levee is about 2,600 feet, with its height varying from 3.8 to 9.0 (average 5.3) feet and crest widths from 8 to 10 (mostly 8) feet. Levee 50 also includes interior drainage features.

The Phase I projects, when constructed, will reduce the flood risk along the main stem and provide valuable benefits to local communities. However, a significant amount of flood risk remains on the Des Plaines River mainstem. Table 4.3 shows remaining damages by category with Phase I authorized projects implemented for the baseline year, 1995, and future, 2010, conditions, as documented in the Economics Appendix of the 1999 Feasibility Report. Tributary damages are not included in this summary, as these subwatersheds were not part of the authorized Phase I study area.

As can be seen in the table, significant flood damages remain on the mainstem of the Upper Des Plaines River even after the implementation of the authorized projects from the Phase I study. In addition to the residual damages in the study's baseline conditions, increased urbanization in the watershed, as illustrated by the future 2010 condition shown in Table 4.3, causes an increase in flood damages by 25%.

The Phase I Study calculated damages using six major categories; three structural (residential, apartments, and commercial) and three road and traffic related (detours due to flooding, detours due to road repairs, and road repair expense). Flood fighting and relief costs as well as FEMA policy administration costs were also evaluated.

Table 4.3 – Phase I Mainstem Des Plaines River With-Project Damages

	Expected Annual Damages ($1,000)		
Damage Category	**Phase I Baseline (1995)**	**Phase I Future (2010)**	**Damage Increase (1995-2010)**
Apartments	$1,468	$1,925	31%
Commercial/Industrial/Public	$1,404	$1,918	37%
Residential	$2,151	$2,714	26%
Road Closures Due to Flooding	$4,143	$5,736	38%
Road Closures Due to Repairs	$8,226	$9,577	16%
Roadway Repair Costs	$1,257	$1,571	25%
TOTAL	**$18,648**	**$23,441**	**26%**

The Phase I Study formulated and evaluated several potential sites for implementing structural flood risk reduction measures by either capturing floodwater (reservoirs and lateral storage areas) or protecting homes and businesses from flood stages (levees and floodwalls). Most of the measures that were evaluated would have reduced flood risk but were either not implementable due to land availability issues or did not have positive net benefits.

This Phase II study builds upon the results of the Phase I Study and considers sites located both within tributary watersheds and along the mainstem to address flood damages across the watershed. Phase I authorized projects are included as part of the without project conditions of this study, with modifications as discussed in Section 4.4.1.

4.2.2.2 Other Reported Flood Damages

Many damage areas reported in the Phase I Study are located at the mouth of tributaries (e.g., Farmer-Prairie Creek at mile 63.7, Aptakisic Creek at mile 75.5). However, these damages are calculated solely based on the flood stages on the mainstem Des Plaines River. In addition to damages from stages on the mainstem Des Plaines River, this Phase II Study includes estimated damages caused by flood stages along the entire length of major tributaries. See Table 4.7 for a listing of Average Annual Damages (AADs), including tributaries.

In addition to results from the Phase I Study, previous estimates of AADs on several tributaries over the past 40 years were compiled. Average Annual Damage estimates were escalated using the Bureau of Labor Statistics historical Universal Consumer Price Indices (CPI-U). Sources of flood damages in these estimates include residential and non-residential structures, their contents, and traffic impacts. A summary list of previous average annual flood damage estimates by tributary is shown in Table 4.4.

Table 4.4 – Previous Estimated Average Annual Flood Damages; Various Studies

Tributary	County	AAD	Price Level Year (CPI-U)	Escalation Factor[1]	AAD 2012 Prices
Gurnee Tributary[2]	Lake	$198,542	1989 (126.8)	1.76	$349,526
Buffalo-Wheeling Creek[3]	Cook/Lake	$351,000	1984 (105.1)	2.12	$745,506
McDonald Creek[3]	Cook	$136,300	1984 (105.1)	2.12	$289,494
Farmers-Prairie Creek[4]	Cook	$666,364	2005 (197.9)	1.13	$751,644
Willow-Higgins Creek[3]	Cook/DuPage	$47,700	1984 (105.1)	2.12	$101,312
Crystal Creek[5]	Cook	$711,968	2003 (185.8)	1.20	$855,385
Silver Creek[3]	Cook/DuPage	$1,090,600	1984 (105.1)	2.12	$2,316,378

[1] Bureau of Labor Statistics CPI-U for 2012 is 223.23
[2] IDOT Div of Water Resources; Strategic Planning Study for Flood Control, Des Plaines River, Gurnee, IL; 1989
[3] USDA SCS; Lower Des Plaines Tributaries Final Watershed Plan and Environmental Impact Statement; June 1985.
[4] IDNR, OWR; Strategic Planning Study for Farmers/Prairie Creek, Cook County, Illinois; 2007. (unpublished)
[5] IDOT, Div of Water Resources, Strategic Planning Study for Flood Control, Crystal Creek, Mar 1991 as amended.

4.3 Flood Risk Analysis

A comprehensive flood risk analysis was performed for the watershed. The analysis accounted for the following categories: structural and content damages to buildings, damages to vehicles that are parked or abandoned during flooding, and damages caused by flood-induced transportation detours and delays. Damages to buildings and parked vehicles together are presented as structural damages and damages attributed to vehicles detoured and delayed on the impacted transportation network are presented as transportation damages.

Although location and intensification benefits may be considered as NED benefits, these categories were not included in benefit calculations for this study. Location benefits, benefits accrued by making development possible on land that had been previously subject to frequent flooding, would be minimal in this study area. Most available land in the floodplain has already been developed and additional development is not likely to occur. Intensification benefits, benefits resulting from increased income due to a reduction in flood risk, have similarly limited application for urban, developed lands. Any increases in net income over the cost of intensification reduction would be small and difficult to verify.

4.3.1 Structure Damage Assessment

Structural Damages were estimated using the Hydrologic Engineering Center Flood Damage Assessment (HEC-FDA) model. Structures within the 1% and 0.2% annual chance of exceedance (100-year and 500-year) floodplain of the Upper Des Plaines River and the modeled tributaries were included in the analysis. A preliminary assessment of potential structural flood damages was completed for the entire watershed using GIS. Plate 11 shows the existing 1% chance (100-year) floodplain in the study area. In Illinois, existing floodplains were extracted from FEMA digital flood insurance rate maps across the watershed. In Wisconsin, a detailed mapping of the floodplain was performed by SEWRPC.

A structure inventory was compiled consisting of specific information for individual structures within the floodplain including location, use, elevation, and value. Table 4.5 presents the number of

structures inventoried in each watershed by category. The 1% chance floodplain, FEMA hazard data (HAZUS), and block information from the 2000 Census were used to determine the number of structures located within the 1% chance floodplain by structure category. A buffer of 250 feet was added to capture any additional structures that may be impacted. As shown in the table, over 10,000 structures and vehicles are included in the inventory.

Structures are grouped in six categories: apartment (multi-unit residential), commercial, industrial, public (tax-exempt structures in the public ownership), residential, and automobiles. Building structure types were determined using local tax assessor category information for individual properties. First floor and low entry point elevations for all structures within the 1% chance floodplain were surveyed. Data previously collected for the Phase I Study by the Chicago District and for other local studies by IDNR and others were used where available. Surveys were conducted by MWRDGC in Cook County, IDNR in Lake County, and SEWRPC in Kenosha County for the remaining structures. For structures within the 0.2% chance floodplain but not captured by the survey, an offset was applied to available Light Detection and Ranging (LIDAR) land surface data. Further discussion of this procedure is included in Appendix E (Economic Analysis).

Table 4.5 – Structures in HEC-FDA Inventory

Watershed	APT	COM	IND	PUB	RES	AUTO	TOTAL
Brighton Creek	0	0	0	0	0	0	0
Unnamed Tributaries	0	0	0	0	24	0	24
Kilbourn Road Ditch	0	0	0	0	1	0	1
Jerome Creek	0	0	0	0	10	0	10
Dutch Gap Canal	0	0	0	0	8	0	8
Hooker Lake	0	0	0	0	3	0	3
Des Plaines River Mainstem (WI)	0	0	0	0	5	0	5
Newport Drainage Ditch	0	0	1	0	29	7	37
Mill Creek	8	28	10	5	496	104	651
Bull Creek	0	4	0	2	69	16	91
Indian Creek	1	4	1	0	138	31	175
Buffalo Creek	37	80	31	6	1,089	211	1,454
McDonald Creek	0	1	4	1	179	35	220
Weller Creek	0	1	1	0	413	78	493
Farmer-Prairie Creek	78	68	1	9	864	157	1,177
Willow-Higgins Creek	32	16	3	2	100	18	171
Silver Creek	6	57	19	4	1,004	193	1,283
Des Plaines River Mainstem (IL)	288	220	96	32	3,220	627	4,483
TOTAL	**450**	**479**	**167**	**61**	**7,601**	**1,477**	**10,235**

For residential structures, depreciated replacement values were estimated by correlating the results of a limited survey to structure values listed in tax assessor databases for each county. For residential structures, a random sample of 10% of structures within the 1% chance floodplain was surveyed. Based on this survey, a relationship to tax assessor valuation data by county was determined and the values of the remaining structures were estimated by applying this relationship. For non-residential structures, depreciated replacement values developed for the Phase I Study were verified and updated and a survey was conducted to incorporate new structures.

For residential and non-residential structures generic depth damage relationships developed for use nationally by the USACE were used where applicable and direct depth-damage relationships were developed for high-valued and non-typical non-residential structures. Direct depth-damage relationships were developed through use of a survey and, for selected structures, an interview.

In estimating damages to parked or abandoned vehicles, procedures outlined in EGM 09-04: Generic Depth-Damage Relationships for Vehicles (June 2009) were utilized. A distribution of vehicle types obtained from the Illinois Secretary of State was combined with generic depth-damage relationships by vehicle type and applied to the list of residential structures. Depreciated replacement values were assigned by vehicle category and distributed among the vehicles assigned to residential structures. The number of vehicles per residence was assigned according to 2000 Census block data. Based on analysis previously conducted by SEWRPC and the small number of residential structures in the inventory with which to associate vehicles, automobiles were not included for the portion of the watershed in Wisconsin.

Structure inventory data and associated uncertainties were input to HEC-FDA resulting in calculated depth-damage relationships by reach. The hydrologic and hydraulic modeling results developed for the Des Plaines River and tributaries were also input to HEC-FDA for estimating the depth of flooding at each structure by modeled flood event. This data allows the model to perform simulations of flood damage experienced during various events.

4.3.2 Transportation Damages

Impacts to the road network were estimated based on increases in vehicle delay and distance traveled caused by flood induced detours. Simulations of flood induced detours on vehicles traveling the area transportation network were obtained through Visual Interactive System for Transport Algorithms (VISTA) Transportation modeling.

Flood hydrographs, showing modeled flood stages and durations, were created for each major roadway section susceptible to overbank flooding. Low-point elevations on the roadways, reviewed and confirmed by local transportation agencies, were used to determine the timing, duration, and depth of flooding. Roads crossing the mainstem and tributaries along with parallel roads were included in the inventory. Table 4.6 presents the number of crossings included in the analysis for each watershed.

The modeled damages include only those attributable to overbank flooding. Records of pavement flooding maintained by the of IDOT indicate that the modeled results showing inundation during storm events as frequent as the 50% annual chance of exceedance reflect actual conditions.

USACE provided these flood schedules for use in the VISTA model. The model was used to calculate the impact of flood events on travel time and distance traveled. Damages associated with flooded crossings are based on delays and detours and assess impacts to passenger and commercial vehicles as separate categories. Detour damages are based on vehicle operating costs. Delay damages are based on the value of time associated with trips for vehicles in each category. A direct depth-damage function was assigned to individual road crossings. Additional discussion of the methodology used to determine transportation damages can be found in Appendix E (Economic Analysis). Physical damages to roads and delays associated with those damages are not included in the flood damages calculated for this study.

Table 4.6 – Road Crossings included in HEC-FDA inventory

Watershed	Crossings
Newport Drainage Ditch	4
Mill Creek	13
Bull Creek	4
Indian Creek	6
Buffalo Creek	13
McDonald Creek	2
Weller Creek	2
Farmer-Prairie Creek	6
Willow-Higgins Creek	7
Silver Creek	7
Des Plaines River Mainstem[1]	62
TOTAL	108

[1] Includes all 18 crossings in Wisconsin

4.4 Without Project Condition

The without-project condition of the Upper Des Plaines River watershed is the basis for comparing the outputs of alternative plans. In forecasting these conditions, an effort is made to describe foreseeable changes to the most important aspects of the study area over the next several decades. This forecasting is based on an assessment of existing conditions within the study area. The without-project condition describes the future conditions that will exist if no action is taken. Expected conditions, previous trends, and predicted trends are considered in describing the without-project condition. Projected hydrologic and hydraulic, land use, and population trends are discussed in Section 3. The period of analysis used for the study is 50 years. 2010 conditions represent existing conditions. Projected 2020 conditions represent future conditions, which were then held constant for the remainder of the period of analysis.

The without project conditions incorporate benefits accrued by implementation of various FRM projects throughout the watershed, including projects authorized by the Phase I Study, by including the projects in the hydrologic and hydraulic model development. Although, as shown in Table 4.2, four of the six Phase I projects have not yet been constructed, they are considered in the without project conditions, as discussed in the following section. The Phase I projects have been authorized independently of this study and the benefits associated with their implementation have been accounted for in that authorization. If significant changes in design, cost, or benefits result in the need for changes to the authorized plan, approval for these changes will be sought through the appropriate reporting mechanism as outlined in ER 1105-2-100.

The benefits for various FRM projects in the same study area can overlap; for example, a reservoir may reduce flood stages at a proposed levee site, reducing the benefits associated with the levee. To prevent double-counting of benefits between projects, a “last added analysis” was used in both the Phase I study and this study (see Section 4.6.6). The 1,975 acre-feet of storage authorized by the Phase I project provides benefits throughout the watershed by reducing flood stages. Incorporation of these reduced flood stages in the without project conditions for this study prevents allocation of benefits that have already been used to justify federally-authorized projects to evaluations conducted in this study.

This approach ensures that the Recommended Plan will be justified with or without construction of the Phase I storage; and, until those projects are constructed, the benefits of each FRM project recommended by this study will actually be greater than those presented here.

The hydrologic and hydraulic models developed for the watershed, as discussed in Section 3, were combined with the depth-damage relationships developed using the methodology described above in HEC-FDA. Once the HEC-FDA model was developed, the expected and AADs of the without-project condition were calculated. The without project condition is used as a benchmark to compare the output of all proposed projects and their performance. HEC-FDA accounts for uncertainties in the input data by performing a Monte Carlo simulation incorporating the many uncertainties associated with the input data. Numerous iterations are performed, with inputs randomly varied according to their probability of occurrence. The mean value calculated by this process is reported here as the equivalent annual damages.

Average annual damages are synonymous with Expected Annual Damages (EAD), the terminology used by HEC-FDA. EAD is the sum of the weighted values of estimated damages resulting from modeled flood events. The damages are weighted according to the likelihood of occurrence of the flood. Equivalent annual damages (EqAD) were estimated in HEC-FDA using a 50-year period of analysis (2010–2059) using the Federal discount rate at the time of the analysis. Equivalent annual damage is calculated by first calculating expected annual damage over the analysis period (base and most likely future analysis years), discounting those values to present worth, and then annualizing. Figure 4.1 below illustrates the calculation of Equivalent Annual Damages and Expected Annual Damages (also AADs). Table 4.7 shows without-project equivalent annual damage by reach and damage category.

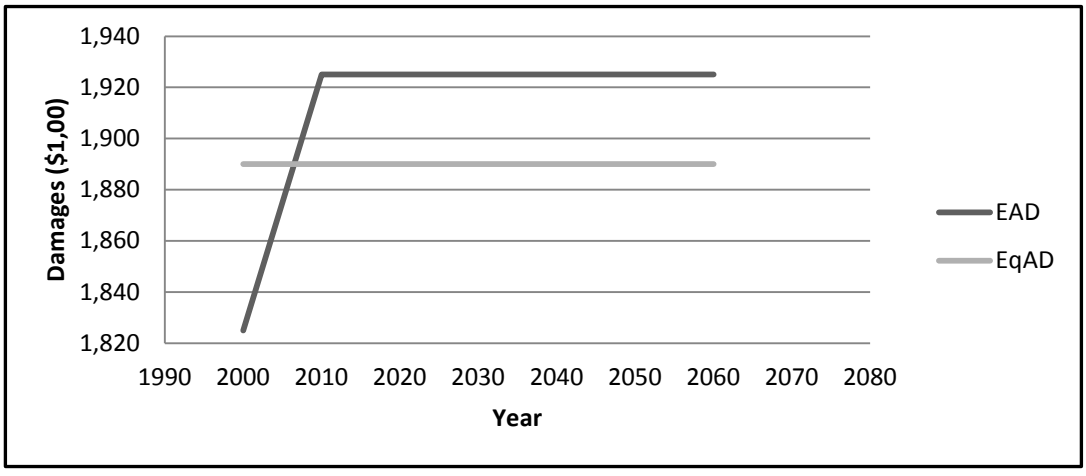

Figure 4.1 – Computation of Average Annual Damages

4.4.1 Updates to Without Project Conditions

During the course of the study, the need for three revisions to the without project condition model inputs were identified. Due to the scale and complexity of the study, both the H&H and economic analyses that had been accomplished at the time these revisions were identified had required a considerable investment of time. Before attempting to repeat the analyses, an evaluation of the effects of each revision was conducted before proceeding.
The first revision came about as a result of a technical review within the USACE. The work produced by the PDT underwent Agency Technical Review (ATR) at key points in the study process. During the review immediately prior to finalization of the FRM plans, a need for revisions to the estimated value of time delays incurred as a result of flooded road crossings that were identified, as discussed in Appendix E (Economics Analysis). The revision resulted in a decrease in calculated damages and a parallel decrease in project benefits.

The need for the second revision was identified as a result of an investigation by IDNR into projects at the downstream end of the watershed near the community of Riverside (see Attachment 1 to Appendix B (FRM Plan Formulation). In developing hydraulic modeling of the flood event in that specific area, IDNR found that the H&H model developed for the study did not accurately reflect hydraulic conditions verified by recent flooding. IDNR adjusted the model as discussed in Appendix A (Hydrology & Hydraulics) for analysis of alternatives in this portion of the watershed. While the revised model was able to more accurately reflect actual hydraulic conditions, the impacts of the changes to the model propagated upstream with increased flood stages. In order to evaluate potential FRM sites as a group, a consistent set of boundary conditions was needed. The increased flood stages, while resulting in increased damages, had the greatest impact on transportation damages. This increase in damages would be mitigated by the implementation of the first revision.

Examination of the model near Riverside also led to discussion of the partial removal of Hofmann Dam at the south end of the watershed as part of a CAP Section 206 Ecosystem Restoration project (as discussed in Section 1.1.6) The project was completed in 2012, prior to the future condition used for this study. Notching the dam was modeled by IDNR as part of their investigation of alternatives at Riverside. As with the adjustments to the model by IDNR for the without project conditions of their study, the notching of Hofmann Dam resulted in lower flood stages and corresponding decreased benefits when applied to projects upstream of Riverside. This project also included removal of two additional dams. One site, Armitage Dam, is upstream of Hofmann Dam but this low head structure did not effect on flows in the river. The other site, Fairbanks Dam, was downstream of the study area are there for did not affect flows. The Hofmann Dam project implementation includes a three year monitoring period to ensure the effectiveness of the restoration measures.

At the site identified by the Phase I Study for the North Fork Mill Creek Dam Modification, Lake County has pursued partial removal of the dam. With the dam notching, this site can no longer be used for the authorized storage expansion. To more accurately reflect existing conditions, the hydrologic model for the mainstem was revised to remove the extra storage and, in the future condition, include the effects of the dam removal. To evaluate options for providing this valuable storage at an alternate location in the watershed, the District and non-Federal sponsor are discussing the initiation of a post-authorization change study.

The without project condition data presented here is the most current and includes all updates and revisions. However, due to the scale and complexity of the study, both the H&H and economic analyses that had been accomplished at the time these revisions were identified had required a considerable investment of time. As each revision was made, the team considered the impacts to the completed analyses. The investigations were repeated only where it was likely that eliminated measures would be retained using the revised models. Therefore, where the PDT determined that the results would not change, the data was not updated.

4.4.2 Without Project Condition Equivalent Annual Damages

The largest portion of damages is on the Des Plaines River mainstem, as shown in Table 4.7. As discussed above, Phase I authorized projects are considered in the without project condition. The reduced flood stages resulting from the storage are incorporated in the hydrologic and hydraulic models and the protection provided by Levee 37 and Levee 50 has been incorporated in the economic model.

Table 4.7 – Equivalent Annual Damages for Without Project Conditions

Watershed		County	State	Equivalent Annual Damages ($1,000)		
				Structural	Transportation	Total
US	Brighton Creek	Kenosha/Racine	WI	$145	$0	$145
	Dutch Gap Canal	Kenosha	WI	$33	$0	$33
	Center Creek	Kenosha	WI	$4	$0	$4
	Kilbourn Road Ditch	Kenosha/Racine	WI	$45	$0	$45
	Jerome Creek	Kenosha	WI	$32	$0	$32
	Des Plaines Mainstem (WI)	Kenosha/Racine	WI	$45	$187	$232
	Newport Ditch	Lake	IL	$0	$0	$0
	Mill Creek	Lake	IL	$179	$82	$261
	Bull Creek	Lake	IL	$117	$17	$135
	Indian Creek	Lake	IL	$36	$51	$87
	Buffalo-Wheeling Creek	Cook/Lake	IL	$344	$8	$351
	McDonald Creek	Cook	IL	$0	$0	$0
	Weller Creek	Cook	IL	$139	$3	$142
	Farmer-Prairie Creek	Cook	IL	$140	$4	$144
	Willow-Higgins Creek	Cook/DuPage	IL	$21	$22	$43
DS	Silver Creek	Cook/DuPage	IL	$881	$229	$1,110
	Des Plaines Mainstem (IL)	Cook/Lake	IL	$7,396	$42,093	$49,489
TOTALS				**$9,556**	**$42,696**	**$52,253**

[1]Wisconsin Transportation Damages are not attributed to individual tributaries. This amount represents the total average annual transportation damages on the Des Plaines mainstem and tributaries in Wisconsin. (FY2014 Price Level, FDR 3.5%)

4.5 Evaluation of Flood Risk Management Measures

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.

Plan formulation for FRM presents a challenge because the evaluation of alternative plans involves estimating both project costs and FRM benefits through rigorous analyses. To facilitate plan formulation, a series of intermediate steps were developed to successively screen the measures carried forward to more rigorous evaluation. Non-compatible and low performing measures were eliminated through this screening process. A flowchart describing this process is shown in Figure 4.2.

As shown in Figure 4.2, only sites determined to be individually justified are evaluated as part of the multi-site FRM plan. These sites, referred to as "first added," are then combined with other individually justified sites in a "last added" analysis as discussed in Section 4.6.5.

4.5.1 Flood Risk Management Measures

Management measures are the building blocks of alternative plans. Formulation of potential measures to be utilized across the entire Upper Des Plaines River watershed has been completed in collaboration with the all of the study team. Flood risk management measures consist of two basic techniques: structural and non-structural.

Structural measures aim to reduce the risk of flooding by altering the frequency, stage and duration of floodwaters and include measures such as levees, floodwalls, reservoirs, and channel modifications. Structural measures have historically been the technique most utilized throughout the nation to alleviate flooding.

Non-structural measures take the reverse approach by reducing potential damages from the risk of flooding. Non-structural flood risk reduction techniques consist of measures such as relocation, acquisition, flood proofing, flood insurance, flood preparedness/warning/response and public education. Historically non-structural techniques have not been utilized to their fullest potential. They are not generally desired by the public because they involve disruption to existing private properties. A full description of each management measure considered for reducing flood risk is presented in the following sections.

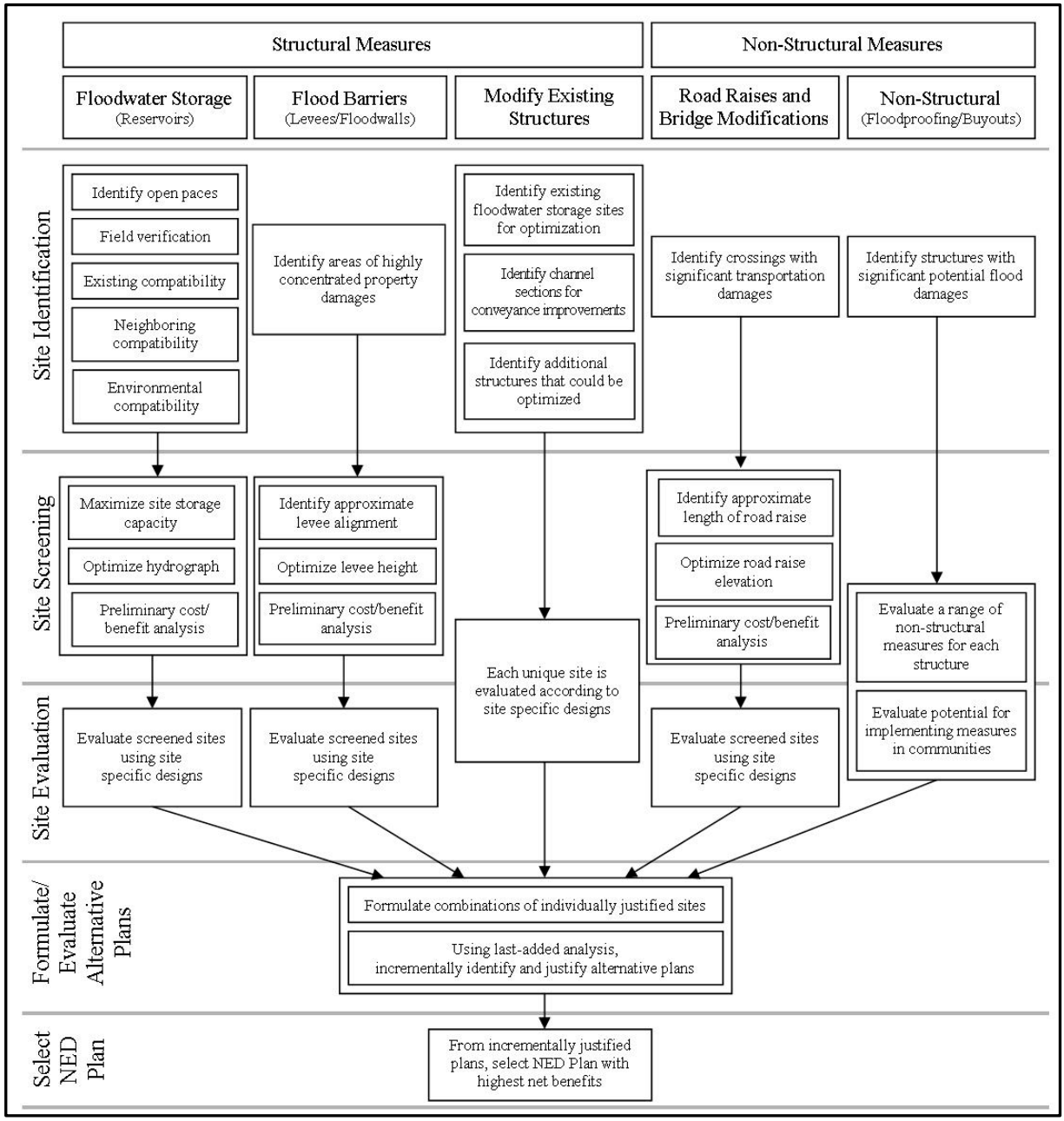

Figure 4.2 – Plan Formulation Process for Determining Flood Risk Management Plans

4.5.1.1 Structural Measures

Floodwater Storage Reservoirs

The purpose of reservoirs is to capture and store floodwater during the rising limb of a flood event to reduce flood stages downstream. Depending on the configuration of the floodwater storage reservoir in relation to the channel they are classified as either online or offline reservoirs.

Offline Reservoirs: Offline storage reservoirs receive water during a flood event, thereby reducing peak flows and subsequent water surface elevations. Once the flood hydrograph is receding and downstream stages have decreased to a suitable elevation, the stored water can be returned via pump or gravity to the stream. The inlet structure, such as an overflow weir, is designed to optimize the storage capacity of the reservoir by capturing the peak flows that cause the greatest flood damages. The configuration and elevation of the inlet controls the amount of water diverted to the storage reservoir; if the inlet is too large or low, the reservoir would fill up too quickly and early during a flood event, making it useless for reducing the peak discharge. Determining the reservoir size and inlet control structure is an iterative process targeting peak stage reductions.

Online Reservoirs*:* Online storage reservoirs are placed along a channel and function to attenuate a flood hydrograph by ponding water during a flood event. The effectiveness of an online reservoir in reducing flood peaks is less than an offline reservoir because flow is not removed from the system, however online reservoirs can be easier to construct as wide areas in the floodplain can be utilized for storage. The outlet structure, such as an inline weir, is designed to optimize the storage capacity of the reservoir. Design of the reservoir size and outlet control structure is an iterative process targeting peak stage reductions.

Flood Barriers

The purpose of flood barriers is to reduce flood risk in areas subject to overbank flooding. In areas where significant and concentrated potential flood damages exist, structural measures such as levees and floodwalls can be effective. The type of structure selected depends on several factors including required height above existing grade, real estate requirements, mitigation requirements and geotechnical stability. Since these types of structures remove areas from the floodway and/or floodplain, increases in stages upstream and downstream must be mitigated through compensatory storage or other means.

Levees*:* Levees are embankments designed to protect areas from flooding. The height of the levee provides a level of protection corresponding to the frequency and scale of flood damages reduced. Levees require a relatively large footprint area for geotechnical stability and seepage requirements.

Floodwalls*:* Floodwalls protect areas from flooding the same way as levees do. Since floodwalls require a significantly smaller footprint area than levees, they tend to be utilized in developed urban areas where real estate availability is more limited. In many cases the increased costs of constructing a floodwall over a levee are offset by reductions in real estate and mitigation requirements.

Modifications to Existing Structures

Large portions of the Upper Des Plaines River watershed and waterway have been developed without considering the hydraulic effects to the watershed as a whole. Additionally, there are existing FRM structures that could be improved or optimized to increase their flood risk mitigation effects within the watershed. These measures look at ways these structures can be beneficially altered.

Bridge Modifications: Bridge Modifications in this category look at the influence of the bridge piers on flow in the channel and ways to optimize the influence of the structure.

Channel Improvements*:* Channel improvements increase the flow-carrying capacity of a stream's channel and thereby reduce flood stages. Various types of alterations include: straightening, deepening, or widening the channel; removing debris; raising or enlarging culverts; and removing dams and other obstructions.

Modify Existing Structures: There are numerous existing FRM structures within the watershed, as shown in Table 3.4 in Section 3.1.1.5. This study provides an opportunity to evaluate the efficiency of these structures and opportunities for expanding or improving them. This category looks in particular at reservoirs for opportunities to expand or otherwise increase the capacity of the existing structures.

Other Modifications

In order to develop an optimal plan that utilizes the full experience and insight of the project development team, additional measures that do not fit into traditional categories analyzed in FRM studies were evaluated. Such measures include clearing trees in the riparian greenway of the Des Plaines River mainstem and coordinating and optimizing reservoir operations within the watershed.

4.5.1.2 Non-Structural Measures

Manage Risk to Transportation Network

The purpose of measures in this category is to reduce flood risk associated with road closures. At crossings and intersections where significant damages are caused by transportation delays, elevating a road section or bridge can alleviate these damages.

Road Raises: Road raises target roads parallel to the waterway that are overtopped during flood events. Raising the elevation of the road can reduce the incidence of flood-flood induced road closures and thereby reduce the risk of transportation damages.

Bridge Modifications*:* Bridge Modifications in this category target sites where roadways cross the Des Plaines River or a tributary and are overtopped during flood events. As with road raises, raising the elevation of the bridge can reduce the incidence of flood-induced road closures and thereby reduce the risk of transportation damages.

Manage Risk at Individual Homes and Businesses

Although USACE may not implement plans that benefit individual homes or businesses, implementation of a non-structural plan benefitting multiple owners collectively can be the best way to

manage flood risk in a community. Where these measures are investigated, implementation will be considered for neighboring structures collectively or to efficiently include more isolated structures in the protection provided by structural measures.

Flood Proofing: Flood proofing includes any effort to reduce flood damage to individual structures and their contents. Flood proofing measures either reduce the number of times the structure is flooded or limit the potential damage to the structure and its contents when it is flooded. There are three general approaches to flood proofing:

1) elevating the structure to reduce the frequency of flooding;

2) constructing small barriers such as berms to stop floodwaters from reaching the structure; and,

3) modifying the susceptibility of the structure to damages through wet and dry flood proofing to minimize flood damage.

Other techniques reduce damages by anchoring floatable structures and facilities and locating damageable contents and utilities above flood levels. Flood proofing measures are implemented voluntarily with the consent of the property owner.

Structure Relocations and Buyouts: Relocation looks at removing all businesses and residences located within a floodplain subject to flood damages. The alternative would include the purchase of properties, moving or demolition of structures, and compensation for moving and relocation expenses for current property owners, residents, and tenants.

Floodplain Acquisitions: In the upper reaches of the watershed in Lake, Kenosha, and Racine Counties some of the floodplains have been retained mainly as agriculture and preserved open space. Current and future acquisition of floodplain lands by conservation agencies in both Illinois and Wisconsin have a major impact on future flood damages in the Upper basin since development pressures from outgrowth of the Chicago region are projected to be intense during the next 50 years. Acquisition measures include obtaining undeveloped lands within the floodplain by either purchase or a permanent open space or conservation easement to ensure future development does not occur.

Manage Risk within Communities

Flood Insurance: All communities are required to participate in the National Flood Insurance Program (NFIP) in order to qualify for Federal investment in FRM measures. Participation in the NFIP provides a means of compensation for flood damages suffered and mandates the local governments to adopt and enforce floodplain regulations that require all future development within the 1% chance floodplain to be elevated above the 1% chance flood elevation. Flood insurance measures include the revision of local building ordinances where necessary to conform to NFIP regulations. The majority of the communities in the Upper Des Plaines watershed participate in the NFIP.

Flood Preparedness: The goal of flood preparedness is to enhance the local and Federal agency network for flood emergency forecasting. A Flood Warning Plan is a system with the capability to collect precipitation and river stage information and transmit the data to a central processing station where the flood threat severity can be determined and from which a warning can be sent to key local officials and affected citizens. An emergency response plan will then guide local officials and citizens through the steps necessary to minimize adverse flooding impacts (e.g., closure structure placement, evacuation, flood fighting). Other Flood Warning Plan elements include plans for recovery and plan improvement based on post flood lessons learned.

Public Awareness: Outreach programs can educate the public about flooding, FRM projects, and residual risks within their community. Public awareness can increase support and helps local citizens become more involved in the process of FRM.

4.5.2 Flood Risk Management Site Identification

Numerous sites within the watershed where potential flood risk reduction measures should be evaluated were identified. The goal of this step is to acquire a large sample of potential sites based on general criteria. Site selection was an iterative process conducted over a number of months by the entire study team. In order to efficiently identify sites for selection, a visual GIS analysis of the flood damage analysis results from the HEC-FDA model was coupled with aerial photography. From these maps, problem areas as well as all potential open spaces within the Upper Des Plaines River were identified. Criteria used to identify potential sites varied by problem area and type of flood risk reduction measure formulated to address flood damages as explained below. Plate 12, Plate 13, and Plate 14 show all of the identified structural FRM sites.

4.5.2.1 Floodwater Storage

The Phase I Study identified floodwater storage as a critical measure to alleviate major damages caused by overbank flooding and/or provide compensatory storage for flood barriers, due to the urbanized nature of the lower half of the study area. Open spaces in the watershed were digitized and boundaries were determined based on features such as land use, roads, important property lines, watershed boundaries, stakeholder ownership, and land designations. The following site identification criteria were established for identifying potential floodwater storage sites:

1. **Sites classified as currently open or undeveloped:** It was assumed that conversion of developed sites would not be cost effective or supportable.

2. **Sites with an area of at least 10 acres:** It was assumed that smaller areas would not gain enough benefits to justify the implementation costs.

3. **Sites within at least 250-ft of an existing stream channel:** It was assumed that it would be too costly to convey floodwaters into and out of a site over greater distances.

Using these criteria, 200 potential floodwater storage sites were identified throughout the entire Upper Des Plaines River watershed study area for screening. The locations of the sites are shown in Plate 12, Plate 13, and Plate 14.

A set of four screening criteria was developed to identify potential floodwater storage sites with compatibility issues and those with the greatest likelihood of being implementable. At this step in the plan formulation process, the study team decided to exclude existing real estate ownership as a factor in screening sites. The study team reached a consensus decision for each identified sites to either keep it for further evaluation or eliminate it from consideration based on the following criteria:

A. Field Verification: Site identification was originally done using GIS-based land-use data provided by the Northern Illinois Planning Commission (NIPC), now the CMAP, and SEWRPC from 2001. Sites that were coded as “open or undeveloped” in the land-use data may not actually be available for site implementation due to either coding errors or new development within the basin since the dataset was compiled. Using aerial photography and field verification, each site was checked

to determine whether or not the site was actually undeveloped. Developed sites were eliminated from further consideration.

B. Existing Compatibility: Some sites that were identified during the site selection process based on "open or undeveloped" land use may actually serve a critical hydrologic, recreational, cultural, social or other purpose thus making significant alterations for floodwater storage impractical. Examples of existing compatibility constraints include: important established recreational lands, unique culturally significant lands, historic properties, waste disposal areas, etc.

C. Neighboring Compatibility: Adding potential floodwater storage at a given site needs to be compatible with adjacent lands in order for it to be supported by local interests. Adjacent properties were checked to ensure adding floodwater storage would not be detrimental. Examples of neighboring compatibility constraints include: safety concerns (nearby schools, playgrounds, and airports), aesthetics, property values, etc.

D. Environmental Compatibility: It is impractical to propose a floodwater storage site on lands that currently possess significant ecological habitats. In addition to protected areas and those possessing threatened and endangered species, the high cost of mitigation and the inability to replace significant ecosystems makes this practice undesirable. Examples of environmental compatibility constraints include: natural areas, protected tracts, conservancy set-aside lands, etc.

Through this preliminary screening process, 130 of the 200 floodwater storage sites were eliminated, leaving 70 sites for further consideration as shown in Table 4.8. The eliminated sites are shown in the plates as red polygons, and the retained sites are green.

Table 4.8 – Summary of Preliminary Screening Results for Identified Floodwater Storage Sites

ID	Watershed	County	State	Identified	Eliminated	Kept
BR	Brighton Creek	Kenosha/Racine	WI	7	4	3
CC	Center Creek	Kenosha	WI	7	7	0
KR	Kilbourn Road Ditch	Kenosha/Racine	WI	7	2	5
JC	Jerome Creek	Kenosha	WI	0	-	-
ND	Newport Ditch	Lake	IL	7	4	3
NM	North Mill Creek	Lake/Kenosha	IL/WI	8	3	5
ML	Mill Creek	Lake	IL	14	11	3
CT	Sub. Country Club Trib.	Lake	IL	0	-	-
DR	Delaney Road Tributary	Lake	IL	0	-	-
GT	Gurnee Tributary	Lake	IL	1	0	1
BC	Bull Creek	Lake	IL	4	3	1
IN	Indian Creek	Lake	IL	11	7	4
AC	Aptakisic Creek	Cook/Lake	IL	9	4	5
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	41	28	13
MD	McDonald Creek	Cook	IL	7	5	2
FD	Feehanville Ditch	Cook	IL	3	0	3
WL	Weller Creek	Cook	IL	3	2	1
FP	Farmer-Prairie Creek	Cook	IL	1	1	0
WH	Willow-Higgins Creek	Cook/DuPage	IL	9	5	4
CR	Crystal Creek	Cook	IL	1	1	0
SC	Silver Creek	Cook/DuPage	IL	3	2	1
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	57	41	16
			TOTAL	**200**	**130**	**70**

4.5.2.2 Flood Barriers

To identify sites for potential construction of levees or floodwalls, areas of concentrated damages were identified using GIS mapping of without project condition damages. Areas where there were several structures with significant damages clustered together were identified as potential flood barrier sites. Both the magnitude and frequency at which structural damages occurred were used as criteria for selecting sites. The majority of clustered damages were identified along the Des Plaines River, although potential sites were also identified in the Buffalo-Wheeling Creek and Silver Creek watersheds. Table 4.9 provides a summary of identified potential flood barrier sites. The potential sites are shown as brown lines in Plate 12, Plate 13, and Plate 14.

Table 4.9 – Summary of Identified Flood Barrier Sites

ID	Watershed	County	State	Levees/ Floodwalls
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	2
SC	Silver Creek	Cook/DuPage	IL	4
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	17
			TOTAL	**23**

4.5.2.3 Modifications to Existing Structures

Using the GIS mapped flood damage analyses results and through collaboration with study partners and stakeholders, 16 potential modifications to existing structures were identified. These measures address a variety of identified structural and transportation flood damages. Table 4.10 provides a summary of existing structures identified for further evaluation. The types of measures are discussed in further detail in Section 4.5.4.4. The potential sites are shown as purple lines or points in Plate 12, Plate 13, and Plate 14.

In the Buffalo-Wheeling Creek Farmer-Prairie Creek, and Silver Creek watersheds, site where channel or flow improvements that could potentially relieve overbank flooding were identified. In the Buffalo-Creek and Farmer-Prairie Creek watersheds, expansion of existing lakes to improve flood retention capacity was identified for further investigation. In the Weller Creek, Willow-Higgins Creek, and Silver Creek watersheds, existing reservoirs were identified for investigation of potential expansion. On the Upper Des Plaines mainstem, two bridges at the southern end of the watershed were identified for investigation due to their impact on flows. Other identified measures include investigation of interbasin flow concerns in the Silver Creek Watershed, evaluation of the flow diversion from Salt Creek, reducing channel roughness along the mainstem by improving maintenance practices, and optimizing operations at existing reservoirs to ensure efficient use of the structures.

Table 4.10 – Summary of Identified Potential Structure Modification Sites

ID	Watershed	County	State	Modify Existing Structure	Drain/Channel Improve	Other
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	1	2	0
WL	Weller Creek	Cook	IL	1	0	0
FP	Farmer-Prairie Creek	Cook	IL	1	1	0
WH	Willow-Higgins Creek	Cook/DuPage	IL	1	0	0
SC	Silver Creek	Cook/DuPage	IL	2	2	1
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	2	0	3
			TOTAL	**8**	**5**	**3**

4.5.2.4 Road Raises and Bridge Modifications

Using analysis of transportation damages provided by the VISTA study, 25 sites with high transportation damages were identified for evaluation of potential road or bridge raisings. Implementation of these measures would prevent flooding of the roadway at the event where the highest net benefits could be gained. The highest transportation damages are concentrated along the mainstem of the Des Plaines River, and these 25 sites are all along the mainstem. The potential sites are shown as green points in Plate 12, Plate 13, and Plate 14.

4.5.2.5 Non-Structural Measures

A number of sites throughout the watershed were identified for potential implementation of non-structural measures including acquisition and flood proofing. Using the GIS mapped flood damage analyses results of structures damaged by frequency, structures damaged at or before the 1% chance flood were identified for potential implementation of non-structural measures.

Structures were grouped by municipality. By grouping structures, evaluations could be made addressing implementation of measures at all structures as a group to prevent preference for one owner over another and to ensure that benefits are shared appropriately within the community. The tables below provide a summary of the sites identified for further evaluation by county.

Table 4.11 – Summary of Identified Non-Structural Flood Risk Reduction Sites

County	Municipality	Structures in Municipality	Structures in County
Cook	Riverside	6	1,084
	River Forest	22	
	Elmwood Park	54	
	River Grove	132	
	Franklin Park	130	
	Schiller Park	20	
	Rosemont	2	
	Des Plaines	243	
	Prospect Heights	9	
	Wheeling	239	
	Park Ridge	47	
	Melrose Park	16	
	Franklin Park	130	
	Buffalo Grove	34	
Lake	Riverwoods	55	385
	Buffalo Grove	30	
	Lincolnshire	50	
	Mettawa	2	
	Libertyville	198	
	Gurnee	50	
Kenosha	Pleasant Prairie	16	58
	Salem	6	
	Bristol	12	
	Somers	1	
	Paddock Lake	23	

4.5.3 Flood Risk Management Site Screening

Identified FRM sites were screened based on the development of preliminary BCRs at each site. Benefits were estimated based on conceptual hydrologic and hydraulic modeling results and associated reductions in flood damages calculated using HEC-FDA. Costs were estimated using idealized designs that could be applied to all sites independent of specific site conditions, and estimated operations and maintenance costs based on similar studies. General estimates of real estate costs were developed either based on county-wide averages of tax assessed market values for sites in private ownership and escalated real estate values of sites in public ownership.

4.5.3.1 Floodwater Storage

Individual floodwater storage sites were screened for flood risk reduction potential using conceptual designs that targeted storage at the 4%, 2%, and 1% annual chance of exceedance flood events. Available storage capacity was estimated based on the size of each site. Volume was removed from each of the respective peak hydrographs corresponding to the maximum estimated available storage on a given site. Detailed discussion on the procedure used to evaluate the hydrologic output of potential floodwater storage sites is presented in Appendix A.

Conceptual-level cost estimates were prepared for floodwater storage sites. These estimates are not reflective of actual construction costs at a given site, but rather provide a general estimate for screening individual sites for detailed evaluation. A range of scales were estimated including variable floodwater storage volumes with associated combinations of excavation and berm heights. Detailed discussion on the procedure used to develop screening costs is presented in Appendices D and F.

Flood risk management potential was translated to economic reductions in damages as discussed in Appendix B (FRM Plan Formulation), and the potential reduction in damages was compared to the screening level costs developed for each site. Preliminary benefit-to-cost ratios were used to screen sites. Floodwater storage sites with preliminary analyses resulting in a BCR greater than 1.0 were retained for further analysis.

Only 9 of the 70 floodwater storage sites identified for further evaluation had preliminary benefits that outweighed costs. A summary of screening results for floodwater storage sites by watershed is presented in Table 4.12. Floodwater storage sites retained through the site screening are presented in Table 4.13, including the screening-level estimated benefits and costs.

Table 4.12 – Summary of Floodwater Storage Site Screening Results

ID	Watershed	County	State	Identified	Eliminated	Kept
BR	Brighton Creek	Kenosha/Racine	WI	3	3	0
KR	Kilbourn Road Ditch	Kenosha/Racine	WI	5	5	0
ND	Newport Ditch	Lake	IL	3	3	0
NM	North Mill Creek	Lake/Kenosha	IL/WI	5	5	0
ML	Mill Creek	Lake	IL	3	3	0
GT	Gurnee Tributary	Lake	IL	1	1	0
BC	Bull Creek	Lake	IL	1	0	1
IN	Indian Creek	Lake	IL	4	4	0
AC	Aptakisic Creek	Cook/Lake	IL	5	3	2
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	13	12	1
MD	McDonald Creek	Cook	IL	2	2	0
FD	Feehanville Ditch	Cook	IL	3	1	2
WL	Weller Creek	Cook	IL	1	1	0
WH	Willow-Higgins Creek	Cook/DuPage	IL	4	4	0
SC	Silver Creek	Cook/DuPage	IL	1	1	0
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	16	14	2
				70	62	8

Table 4.13 – Summary of Retained Floodwater Storage Sites

Site ID	Storage Volume (acre-ft)	Total Equivalent Annual Damages	Equivalent Annual Costs	BCR ($/$)
BCRS02	177	$2,517,606	$788,083	3.2
ACRS03	248	$1,559,100	$796,651	2.0
ACRS08	418	$3,311,900	$1,087,945	1.5
BWRS31	383	$1,381,251	$1,027,954	1.3
FDRS01	4,400	$16,594,600	$4,010,543	4.1
FDRS03	24	$1,214,100	$413,268	2.9
DPRS07	1,000	$2,523,600	$1,890,603	1.3
DPRS23	330	$1,388,200	$914,274	1.5

(FY2011 Price Level, FDR 4.125%)

4.5.3.2 Flood Barriers

Identified flood barrier sites were screened individually for flood risk reduction potential using conceptual designs and costs over a range of elevations. Crest elevations were optimized by determining which elevation at each site had the highest net benefits.

The constructability of the identified sites, incorporating considerations such as tie-back requirements and floodplain impacts, was reviewed prior to the development of preliminary costs and benefits. The local topography made identification of tie-back locations challenging for several levees and limited the height to which the levee could be built. Seven sites along the mainstem were eliminated through this analysis: DPLV02, DPLV11, DPLV12, DPLV13, DPLV14, DPLV16 and DPLV17. Although tie-back limitations were also identified at sites DPLV06, DPLV07, DPLV08, and DPLV10, these adjacent sites were combined into a single levee system, DPLV09. The highest possible tie-back

elevation for DPLV01 was identified as 618 feet (NAVD 1988). For DPLV15, the highest possible tie-back was 660 feet.

Benefits and costs were calculated over a range of elevations corresponding with a range of flood events including the 10%, 2%, 1%, and 0.02% annual chance of exceedance events. As a maximum elevation, benefits and costs for a crest elevation two feet above the 1% chance flood event water surface elevation were also calculated.

Conceptual levee construction costs were based on the berm construction costs developed for use in the floodwater storage site screening. Construction costs at DPLV01, where an existing levee is in place, were adjusted to account for the potential cost savings incurred by incorporation of the existing structure into the new design. Net benefits for each levee at each crest elevation were calculated by subtracting the estimated costs from estimated benefits. For sites that showed positive net benefits at one or more crest elevation, the elevation which had the highest net benefits was selected for further evaluation.

Sites with positive net benefits were retained for further analysis, and the crest elevation at which net benefits were maximized was used as the basis for site evaluation. The screening results for flood barrier sites that had positive net benefits are presented in Table 4.14. Two of the 23 flood barrier sites had positive net benefits and were retained for further evaluation. A summary of screening results by watershed is presented in Table 4.15.

A detailed discussion on the procedure used in the screening analysis is presented in Appendix B (FRM Plan Formulation). Detailed discussion on the procedure used to develop screening costs is presented in Appendices D (Civil Design) and F (Cost Engineering).

Table 4.14 – Summary of Retained Flood Barrier Sites

Site ID	Max. Net Benefits	Length (ft)	Approximate Grade (ft)	1% Annual Chance Flood Elev (ft NGVD29)	Optimized Crest Elev (ft NGVD29)
DPLV01	$324,000	2,800	610	616.3	618.3[1]
DPLV04	$1,604,000	6,400	618	625.8	627.8
DPLV05	$1,091,000	7,400	616	627.4	629.4
DPLV09[2]	$1,357,000	11,000	621	631.6-634.1	635.0-636.5

[1]Although higher levee elevations resulted in greater net benefits, the indicated crest elevation is the maximum achievable due to tie back considerations.
[2]Due to the length of DPLV09, the site was evaluated along four reaches with varied crest elevations at each reach.
(FY2011 Price Level, FDR 4.125%)

Table 4.15 – Summary of Flood Barrier Site Screening Results

ID	Watershed	County	State	Total	Eliminated	Kept
BW	Buffalo-Wheeling Creek	Cook/Lake	IL	2	2	0
SC	Silver Creek	Cook/DuPage	IL	4	4	0
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	14	10	4
			TOTAL	**20**	**16**	**4**

4.5.3.3 Road Raises and Bridge Modifications

Road raises and bridge modifications at high transportation damage sites were screened for FRM potential in coordination with the IDOT, the owner of the majority of these major arterial roads. Implementation of these measures would occur in conjunction with planned major rehabilitation of roads and bridges to minimize impacts to roadway users and optimize use of Federal and state funds.

Road and bridge rehabilitation is prioritized by IDOT according to the agency's highway planning and programming objectives: preserve and maintain the existing highway system of roads and bridges, upgrade existing facilities for congestion mitigation and safety improvements, and expand the system to enhance economic development. Several roadway characteristics are used to select roads for major rehabilitation. Primary factors are capacity, age, and structural soundness. IDOT also monitors reports of flooding and maintains a priority list of roadways impacted by flooding: roadways where a flood has been reported to IDOT within the past two years and more than twice since this information has been recorded – are included in this "flood priority list." However, due to limited funding, other concerns such as structural soundness can take priority.

The design life used by IDOT is 50 years for bridges and 90 years for box culverts. Parallel roads are not assigned a design life, but instead undergo major rehabilitation when required for safety or capacity improvements. Using the age of each identified bridge or road segment identified and whether IDOT has identified the site for consideration in their multi-year plan, three sites were identified as likely to undergo rehabilitation within the study's period of analysis: DPBM04 (First Avenue Bridge in River Grove), DPBM06 (Rand Road Bridge in Des Plaines), and DPBM13 (IL Route 120 in Grayslake). Additional discussion of this preliminary screening procedure can be found in Appendix B (FRM Plan Formulation).

For each of the sites, conceptual-level designs were prepared to provide a general cost estimate for screening. The extents of the project were determined using LIDAR mapping of elevations along the roadway. General costs for roadway construction and fill, coordinated with IDOT, were used to determine the approximate cost. It was also assumed that the design would include mitigation for the effects of the increased roadway elevation on the floodplain, and an estimate of the associated costs was included. Lands and damages and utility relocations, however, were not included in the estimates.

A range of elevations were considered, corresponding to flood stages used in the transportation modeling. The comparison of benefits to costs resulted in positive net benefits at each site. The elevation that maximized net benefits was selected for further evaluation. The results, including estimated net benefits and optimized elevation, are presented in Table 4.16.

Table 4.16 – Summary of Retained Road Raise and Bridge Modification Sites

Site ID	Annual Benefits	Annual Costs	Max Net Benefits	1% ACE Flood Elevation (ft NGVD29)	Pavement Elev (ft NGVD29)		Approx Extent (ft)
					Lowest Existing	Optimized	
DPBM04	$5,339,000	$235,000	$5,104,000	626.0	620.0	625.5	1,900
DPBM06	$1,182,000	$618,000	$564,000	634.5	632.0	634.2	3,000
DPBM13	$736,000	$151,000	$586,000	665.1	661.5	664.7	1,000

(FY2011 Price Level, FDR 4.125%)

4.5.3.4 Modifications to Existing Structures

Due to the uniqueness of each site considered for modification to existing structures, no parameters for site screening were available. Instead, site specific evaluations as discussed in Section 4.5.4.4 were conducted for each identified site.

4.5.3.5 Non-Structural Measures

Within each municipality where non-structural measures were identified, each structure was individually evaluated for implementation of a range of measures: elevation, wet and dry floodproofing, filling the basement combined with floodproofing, construction of nonstructural berms, and buyouts. The decision-making procedure for determining which structure would be implemented is shown in Figure 4.3 for residential structures and Figure 4.4 for non-residential structures. Measure benefits and costs that maximized net benefits at each structure were then aggregated within communities to determine whether implementation of non-structural measures is economically justified within a community. Table 4.17 shows the results of this analysis.

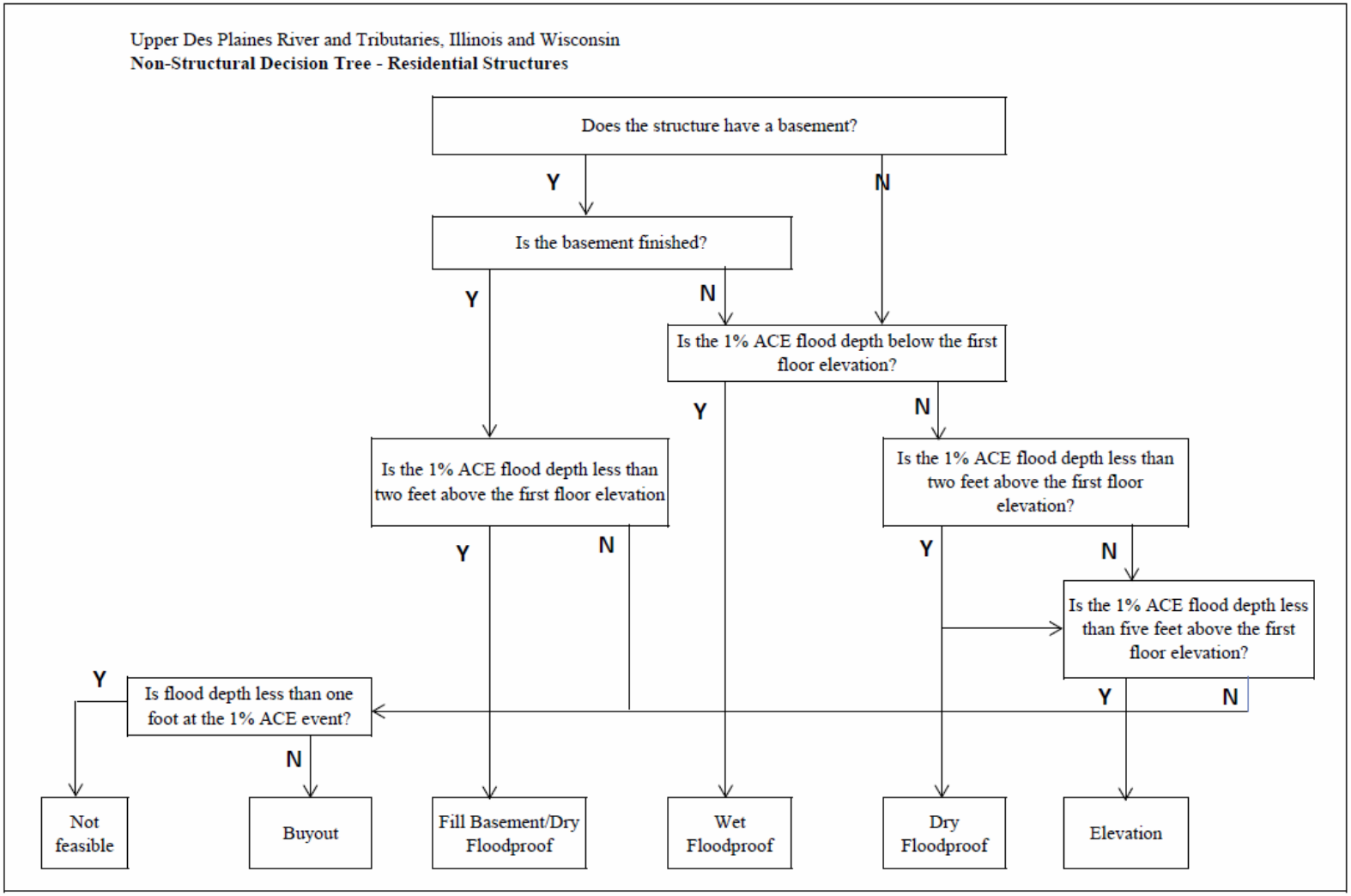

Figure 4.3 – Residential Non-Structural Measure Decision Tree

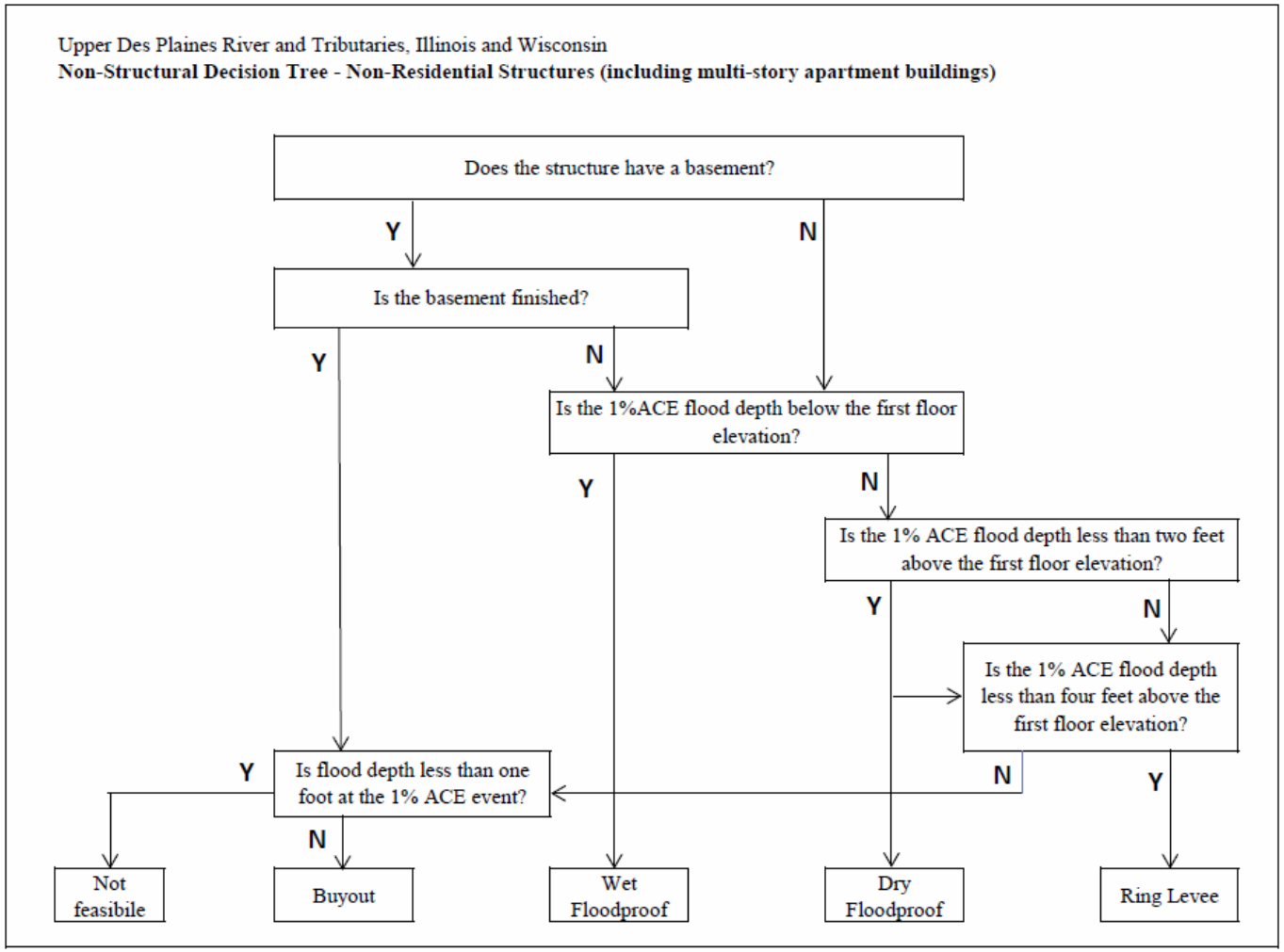

Figure 4.4 – Non-residential Non-structural Decision Tree

In the City of Des Plaines, where a large number of structures are located in the floodway, these higher risk structures were evaluated separately. In coordination with the City of Des Plaines, this group of structures was evaluated for buyout with replacement of the homes by a natural area and recreational trails. This buyout group, in combination with the recreation improvements, was economically justified as shown in the table. Discussion of the recreation formulation is included in Section 8.

Detailed discussion of the procedures used to screen the non-structural sites is in Appendix B (FRM Plan Formulation). Discussion of the procedures used to develop screening level costs is in Appendix F (Cost Engineering). A summary of retained non-structural measures in the watershed is shown in Table 4.17 and Table 4.18. As shown in the Tables, approximately 430 total sites were retained. These sites are in the communities of Buffalo Grove, Des Plaines, Leyden Township, Rosemont, Schiller Park, Wheeling, Wheeling Township, Gurnee, Lincolnshire, Long Grove, Riverwoods, and Vernon Township in Illinois and Salem and Somers in Wisconsin. The approximate number of proposed measures would include 250 structure elevations, dry floodproofing at 40 structures, wet floodproofing at 50 structures, 30 structures where the basement would be filled and any portion of the first floor at risk of flooding would be floodproofed, construction of nonstructural berms at 40 structures, and 100 buyouts. Participation in the non-structural plan would be voluntary and implementation subject to verification of the structure characteristics, first floor elevation, and low water entry point. With regard to the buyouts, to the extent practicable, acquisition would be on a willing seller basis, but eminent domain could be utilized when determined to be warranted.

Table 4.17 – Summary of Non-structural Screening Results

County	Community	Structures in Community	WOP Damages ($1,000)	Optimized Floodproofing Measures				
				Structures		Benefits ($1,000)	Annual Costs ($1,000)	Net Benefits ($1,000)
				Number	% of Total			
Cook	Buffalo Grove	34	$23.9	31	91%	$22.1	$18.7	$3.4
	Des Plaines	568	$1,536.5	374	65%	$1,090.7	$1,977.9	($887.2)
	Des Plaines (Floodway)	109	$990.9	79	100%	$679.3	$802.5	$32.9
	Elmwood Park	54	$107.5	48	89%	$100.1	$248.6	($148.5)
	Franklin Park	109	$103.5	49	45%	$53.0	$139.5	($86.5)
	Leyden Township	21	$90.7	16	76%	$78.1	$34.7	$43.4
	Maine Township	34	$60.5	32	94%	$60.0	$98.5	($38.5)
	Maywood	2	$0.7	2	100%	$0.6	$0.8	($0.2)
	Melrose Park	16	$7.3	15	94%	$7.0	$18.7	($11.8)
	Park Ridge	5	$1.4	3	60%	$0.6	$3.8	($3.2)
	Prospect Heights	9	$25.9	9	100%	$26.4	$56.4	($30.0)
	River Forest	22	$57.5	14	64%	$40.3	$69.4	($29.1)
	River Grove	127	$400.6	102	80%	$205.8	$455.6	($249.8)
	Riverside	8	$44.5	5	71%	$32.2	$41.6	($9.4)
	Rosemont	2	$291.3	2	100%	$295.0	$24.6	$270.5
	Schiller Park	20	$110.6	20	0%	$111.0	$46.3	$64.8
	Wheeling	221	$287.0	166	75%	$231.3	$207.3	$24.0
	Wheeling Township	23	$134.8	21	91%	$134.2	$55.8	$78.4
Lake	Gurnee	48	$957.5	39	81%	$797.5	$160.5	$637.0
	Libertyville	28	$57.6	21	75%	$15.5	$403.9	($388.4)
	Lincolnshire	40	$63.4	38	95%	$63.0	$48.9	$14.1
	Long Grove	2	$16.4	2	100%	$16.4	$13.7	$2.7
	Mettawa	2	$3.0	2	100%	$3.0	$28.0	($25.0)
	Riverwoods	49	$171.9	45	92%	$169.3	$150.4	$18.9
	Libertyville Township	80	$147.4	63	79%	$135.7	$481.4	($345.7)
	Newport Township	3	$1.7	2	67%	$1.3	$8.3	($7.0)
	Vernon Township	46	$166.7	40	87%	$161.0	$107.7	$53.4
	Warren Township	1	$1.1	1	100%	$1.1	$2.8	($1.6)
Kenosha	Pleasant Prairie	16	$81.3	16	100%	$81.3	$100.8	($19.6)
	Salem	6	$52.1	6	100%	$52.1	$32.9	$19.2
	Bristol	12	$44.9	12	100%	$44.9	$73.0	($28.1)
	Somers	1	$59.3	1	100%	$59.3	$14.1	$45.2
	Paddock Lake	23	$85.1	23	100%	$85.1	$122.4	($37.3)

(FY2013 Price Level, FDR 3.75%)

Table 4.18 – Summary of Non-structural Screening Results by County

County	Total Structures	Benefits	Project Costs	Annual Costs	Net Benefits
Cook	335	$1,720,000	[redacted]	$1,203,000	$517,000
Lake	164	$1,207,000	[redacted]	$481,000	$726,000
Kenosha	7	$111,000	[redacted]	$47,000	$64,000
Total	506	$3,039,000	[redacted]	$1,731,000	$1,308,000

(FY2013 Price Level, FDR 3.75%)

4.5.4 Flood Risk Management Site Evaluation

Site specific designs and cost estimates were developed for all sites retained in the site screening process. Benefits were estimated using HEC-FDA based on hydrologic and hydraulic modeling results for the optimized site. Costs were estimated using site specific designs taking into account site specific concerns. Estimates of real estate costs were also refined based on site specific information.

4.5.4.1 Floodwater Storage

To evaluate potential floodwater storage sites, a review of the site configuration and likely soil conditions at each site was conducted. Sites where installation of a reservoir would be impractical were eliminated from further analysis. Optimized hydraulic models and site designs of the remaining sites were developed. Reductions in damages and total estimated costs were calculated for the sites based on site specific considerations. Further discussion of the evaluation procedure can be found in Appendix B (FRM Plan Formulation).

Two sites still had positive net benefits after this more detailed analysis and were retained for inclusion in formulated FRM plans. The retained floodwater storage sites are presented in Table 4.19. Once economic justification was established, each potential reservoir was evaluated to determine whether construction could cause any adverse impacts to natural resources on the site. Site ACRS08 is currently agricultural land and the project would not cause significant adverse impacts to natural resources. Additional investigation of site BCRS02 showed that there is a wetland complex on the site consisting of marsh and wet prairie communities.

The wetland at BCRS02 provides 135.5 average annual habitat units, providing habitat for marsh and prairie species of insects, amphibians, reptiles, and birds. The team evaluated strategies for implementing storage at the site while avoiding impacts to the wetland and determined that even a limited or reduced size would impact the wetland by inundating the site for an extended period during a flood event. Therefore, a mitigation plan was developed. A nearby site that is currently in the public ownership was identified for restoration. The mitigation site, L22, contains lands that were historically marsh and wet prairie and could be restored to compensate for the impacts of construction of BCRS02. Although the Lake County Forest Preserve District and the Libertyville Township Open Space District have acquired these lands for the purposes of land preservation, no funding is available for restoration of these agricultural lands to provide quality habitat for native marsh and prairie species. Mitigation includes restoration of the site's hydrology and plantings to reestablish native communities. The total costs for BCRS02 presented below include these mitigation costs. Additional discussion of the

determination that mitigation would be required and the procedure used to select the mitigation plan can be found in Appendix B (FRM Plan Formulation).

Table 4.19 – Floodwater Storage Site Evaluation Results

Site ID	Storage Vol. (acre-ft)	Annual Damages Reduced	Total Costs	Annual O&M	Equivalent Annual Costs	Net Benefits	BCR ($/$)
BCRS02	177	$1,502,000	[redacted]	$104,000	$1,317,000	$185,000	1.1
ACRS08	420	$928,000	[redacted]	$111,000	$923,000	$5,000	1.0

(FY2011 Price Level, FDR 4.125%)

4.5.4.2 Flood Barriers

Flood barrier sites were evaluated according to site-specific considerations. Using the optimized crest elevations developed during site screening, site specific designs and costs were developed for the retained flood barrier sites.

Table 4.20 presents the retained flood barrier sites. Hydraulic modeling of the optimized levee height at each levee site was conducted to determine whether the structure would cause stage impacts. Modeling at DPLV01 showed that the proposed barrier did not have an effect on the water surface profile. The combination of DPLV04, DPLV05, and DPLV09 did cause increased flood stages and damages. Although the maximum stage increase was less than 0.2 feet for each levee individually, the impacts typically extend over a large area, impacting hundreds of properties. A real estate takings analysis determined that when considering the levees individually, the stage impacts would not result in any takings due to the small increment of flooding at infrequent events.

The magnitude of induced damages for each levee are summarized below. The goal of the screening and evaluation steps is to identify economically justified projects that can be combined to form alternative plans. Because the flood barrier sites would likely be combined with other projects, mitigation requirements are determined based on the Recommended Plan. Where possible, induced damages would be accounted for and mitigated. The mitigation requirements would be based on the combined impacts of economically justified levees. See Section 4.6.4 for this analysis.

Table 4.20 – Flood Barrier Site Evaluation Results

Site ID	DPLV01	DPLV04	DPLV05	DPLV09
Approximate Grade (ft NGVD 29)	610	618	618	621
Crest Elevation (ft NGVD 29)	618.3[1]	628.7	629.6	633.6-635.1[2]
Approximate Height (ft)	8.30	10.7	11.6	12.5-14.0
1% Chance Flood Elevation (ft NGVD 29)	616.5	626.7	627.6	631.6-633.1
Approximate Length (ft)	2,500	6,200	8,400	11,200
Equivalent Annual Damages Reduced	$397,000	$2,350,000	$1,805,000	$2,560,000
Equivalent Annual Damages Induced	NA[3]	($206,000)	($214,000)	($492,000)
Equivalent Annual Costs	$282,000	$547,000	$499,000	$1,056,000
Net Benefits	$136,000	$1,597,000	$1,092,000	$1,504,000
BCR ($/$)	1.5	3.9	3.2	2.4

[1] Maximum elevation limited by available tie-back elevations.
[2] Due to the length of DPLV09, the structure was evaluated along 4 reaches with the structure at varying heights for each reach.
[3] Hydraulic modeling showed that this flood barrier did not have an effect on the water surface profile and floodplain mitigation is not required.

(FY2011 Price Level, FDR 4.125%)

4.5.4.3 Road Raises and Bridge Modifications

To evaluate road raise sites, detailed designs and costs were developed for the screened sites. At DPBM06, the length of road required to tie into high elevations made the design impractical and it was eliminated from further consideration. Based on a hydraulic analysis, the length of the remaining bridges was extended onto land to allow flood waters to flow unimpeded through the surrounding forest preserve lands and prevent adverse stage impacts. The increased bridge length resulted in increased costs at both sites. The results of the site evaluations are presented in Table 4.21. As shown in the table, site DPBM04 remained justified and was retained for further evaluation. The estimated costs for constructing DPBM13, however, exceed the estimated benefits and the site was eliminated. Further discussion of the evaluation procedure can be found in Appendix B (FRM Plan Formulation).

Table 4.21 – Road Raise Site Evaluation Results

	Elevation					
Site ID	Feet NGVD29	Annual % Chance Flood	Total Equivalent Annual Damages	Equivalent Annual Costs	Net Benefits	BCR $/$
DPBM04	627.1	1%	$5,339,000	$863,000	$4,476,000	6.2
DPBM13	639.4	1%	$736,000	$1,919,000	($1,183,000)	0.4

(FY2011 Price Level, FDR 4.125%)

4.5.4.4 Modifications to Existing Structures

Evaluations of structure modifications were conducted on a site by site basis. At each of the sixteen sites, an evaluation of the whether the project would be implementable was conducted before developing site specific designs, costs and hydraulic models. Benefits and costs were then used to calculate a BCR for each site.

Implementable sites with a BCR greater than one were retained for inclusion in formulated alternative plans. Table 4.22 presents the retained measure. Further discussion of the evaluation procedure can be found in Appendix B (FRM Plan Formulation).

FPCI01 looks at opportunities to increase the storage capacity at Lake Mary Anne. This measure optimizes storage capacity by connecting the lake, located at Golf Road and Interstate 294, to nearby Dude Ranch Pond.

Table 4.22 – Modification to Existing Structure Site Evaluation Results

Site ID	Total Equivalent Annual Damages Reduced	Equivalent Annual Costs	Net Benefits	BCR ($/$)
FPCI01	$105,000	$79,000	$26,000	1.3

(FY2011 Price Level, FDR 4.125%)

4.5.4.5 Non-Structural Measures

A large number of sites were identified for possible implementation of non-structural measures. Because this information can only be evaluated at a detailed level using site specific information, site evaluations were not conducted for each of the structures retained in the screening. Additional evaluation was conducted during the formulation of alternative plans. However, a more detailed investigation of implementation requirements at individual structures will be conducted during the Preconstruction Engineering and Design (PED) Phase.

4.5.5 Individually Justified Sites

Through the identification, screening, and evaluation steps several individually justified sites were developed. Each site was reviewed to ensure that the design maximized net benefits and that all site specific concerns had been addressed.

Based on the previous analyses, the following FRM sites were identified for further evaluation: BCRS02, ACRS08, DPLV01, DPLV09, DPBM04, and implementation of non-structural measures at approximately 700 structures throughout the watershed.

A site specific estimate of lands, easements, relocations, rights of way, and disposal areas (LERRDs) required for implementation of each structural project was included in the estimated costs. Details of the estimated LERRD requirements can be found in Appendix I (Real Estate).

For the levee sites, an estimate of flood-fighting costs that would be avoided with project implementation was estimated as discussed in Appendix E (Economics). Additional opportunities for optimizing site DPLV09 through the inclusion of multi-purpose recreation trails in the site design (DPLV09R). Adding recreation trails to the site, however, increased the overall net benefits and the DPLV09R alternative was retained. Additional discussion of the recreation evaluation procedure, including costs and benefits, can be found in Section 8. Further discussion of the levee and floodwall evaluation procedure can be found in Appendix B (FRM Plan Formulation).

For the reservoir sites, the hydrologic and hydraulic modeling was updated to optimize reductions in flood stages on the mainstem. The ACRS08 optimization did not result in significant changes.

However, at BCRS02, refinement of the sub-basin delineations for the tributary hydrologic model resulted in a significant decrease in benefits. The reduced benefits resulted in negative net benefits for the project and BCRS02 was therefore eliminated.

An additional update to the without project conditions was made to capture changes in Phase I projects: changes in the design of Van Patten Woods Lateral Storage Area were incorporated in the model and the North Fork Mill Creek Dam Modification was removed from the model as Lake County is in the process of notching the dam for ecosystem restoration purposes. The notched dam was incorporated in the future condition model. Updated benefits and costs are presented in Table 4.23. As shown in the table, all sites except BCRS02 remain individually justified when considering the updated cost and benefit calculations.

Table 4.23 – Structural Measure First Added Benefits and Costs

	Benefits ($1,000)							
Site	**Flood Damage Reduced**	**FIA Savings**	**Flood Fighting Prevente**	**Recreation**	**Total**	**Annual Costs ($1,000)**	**Net Benefits ($1,000)**	**BCR**
DPBM04	$4,287				$4,287	$767	$3,520	5.6
DPLV04	$2,144	$35			$2,179	$557	$1,622	3.9
DPLV09	$2,029	$190	$60	$187	$2,466	$1,281	$1,184	1.9
DPLV05	$1,591	$38			$1,629	$490	$1,139	3.3
ACRS08	$1,290				$1,290	$858	$432	1.5
DPLV01	$418	$23			$441	$325	$116	1.4
FPCI01	$107				$107	$72	$35	1.5
BCRS02[1]	$433				$433	$895	($462)	0.5

[1] Costs for BCRS02 include fish and wildlife mitigation.

(FY2013 Price Level, FDR 3.75%)

4.6 Formulation of Flood Risk Management Plans

4.6.1 Tributary Minimum Flows

In evaluating benefits for FRM projects in urban areas, USACE participates in projects addressing discharges that represent a serious threat to life and property. Discharges in this category are defined in 33 CFR Part 238, Water Resources Policies and Authorities: Flood Damage Reduction Measures in Urban Areas, as those from the portion of a natural stream or modified natural waterway where the drainage area is at least 1.5 square miles and discharge from the 10% chance flood is greater than 800 cfs, although exceptions may be granted where the discharge for the 1% flood exceeds 1800 cfs and a hydrologic disparity between the 10% and 1% floods can be demonstrated.

However, not all streams in the watershed meet the requirements of 33 CFR Part 238. The flows in the mainstem and tributaries where benefits are accrued for both structural and non-structural individually justified projects were assessed to compare the drainage area and flows to the policy requirements. The mainstem meets the 800 cfs flow criteria throughout the watershed. However, as shown in Table

4.24, although a portion of some tributaries meet the criteria, none of the modeled tributaries meet the criteria along their entire length.

The severity of overbank flooding in these tributary watersheds is due to their highly urbanized condition. The complex hydraulics of the channels includes features such as channelized and conduit flows with sharp turns. The streams flow underground in several locations and grates have been installed in the channels to prevent debris accumulation. Additionally, existing development in the floodplain extends right up to the channel banks. In these watersheds, structural damages due to overbank flooding occur in events as frequent as the 50% chance flood. Flood risk management projects on these tributaries meet study objectives of reducing the risk of flood induced damages in the watershed. However, USACE policy defines the damages addressed by these projects as local drainage issues and precludes Corps participation.

Table 4.24 – Tributary Drainage Areas and Flows

State		Tributary	Drainage Area (mi^2)	Average. Watershed Slope (ft/ft)	Stream Length (mi)	Station at Which Tributary Meets Minimum Flow Requirement (mi)	
						10% chance	1% chance
DS	WI	Brighton Creek	20.7	0-0.06	9.0	--	--
		Center Creek	9.8	0-0.06	5.6	--	--
		Dutch Gap Canal	13.6	0-0.06	4.1	--	--
		Kilbourn Road Ditch	23.7	0-0.06	12.6	1.3	--
		Jerome Creek	5.9	0-0.06	1.7	--	--
	IL	Newport Drainage Ditch	7.9	0.0013	8.2	0.3	--
		Mill Creek	66.4	0.0013	18.6	5.0	5.0
		Bull Creek	11.3	0.0045	7.4	0.9	0.9
		Indian Creek	37.8	0.0025	14.0	6.6	6.6
		Buffalo-Wheeling Creek	26.8	0.0053	15.9	3.1-2.4, 1.1-0[1]	6.5-2.4[1]
		McDonald Creek	10.2	0.0038	8.9	--	--
		Weller Creek	18.7	0.0025	7.3	2.0-1.4[1]	2.8-1.4[1]
		Farmer-Prairie Creek	4.4	0.0025	5.3	--	--
		Willow-Higgins Creek	19.7	0.0017	9.7	5.2	--
US		Silver Creek	13.0	0.0032	8.9	1.0	--

[1]Flows achieve policy threshold within the listed area(s), but drop below the threshold downstream due to a flow diversion.

4.6.2 Measures Formulated to Address Only Transportation Damages

Benefits for the evaluated measures include prevention of flood damages to residences; apartment buildings; commercial, industrial, and public structures; and parked automobiles. An additional damage category consists of delays and detours caused by flood-induced road closures. While benefits resulting from prevention of these damages, calculated according to the requirements of ER 1105-2-100, Planning Guidance Notebook, Appendix D, Paragraph 4.f, are policy compliant, implementation of measures formulated solely to address these transportation damages are not. Road raises or bridge modifications designed to elevate the road surface above flood stages fall within this category.

4.6.3 Continuing Authorities Program

The CAP is a group of legislative authorities under which the Secretary of the Army, acting through the Chief of Engineers, is authorized to plan, design, and implement certain types of water resources projects without additional project specific congressional authorization. Section 205 of WRDA 1992 includes FRM projects for which the Federal share does not exceed $7 million.

Individually justified projects meeting the requirements of Section 205 will be converted to CAP and implemented under that program. The recommendations of this Feasibility Study and the associated Environmental Assessment (EA) will serve as the decision document for these projects. The conversion to CAP will occur at the start of the PED Phase.

4.6.4 Mitigation for Levee Induced Damages

As discussed in Section 4.5.4.2, the hydraulic model showed that construction of DPLV04, DPLV05, and DPLV09 would result in increased stages outside of the proposed levee reaches. Each levee is individually justified according to federal rules, regulations and policies even when accounting for the induced damages; however, they are not permissible according to state rules and regulations. Additional analysis was conducted to identify and evaluate alternatives so that the levees would be permissible according to state rules and regulations and any induced damages would be avoided. USACE guidance provides for mitigation of induced flooding (see ER 1105-2-100, Paragraph 3-3). Mitigation for induced damages should be investigated and recommended if appropriate. Mitigation is appropriate when economically justified or there are overriding reasons of safety, economic or social concerns, or a determination of a real estate taking has been made. Because these levees are relatively close to each other along the mainstem, they were modeled together to ensure that the impacts were fully accounted for, as discussed in Appendix A (H&H Analysis).

The increased stages, while relatively small (they were never more than three inches and were typically less than an inch), spread over miles within the watershed, impacting hundreds of properties and structures. An analysis was conducted to determine whether the induced stages would result in a taking of property under the Fifth Amendment to the U.S. Constitution. Based on the small increase in stage (less than two inches) during more frequent (10% and 4% ACE) flood events, it was determined that these levees would not result in a taking of property (see Appendix I – Real Estate Plan).

The combined levees resulted in compounded impacts resulting in more significant stage increases and induced damages. The total induced damages for the combined levees, including transportation damages, would be $2,855,000. Because of the large extent of the impacts, purchasing flowage easements for all impacted properties was determined to be impractical. As alternatives to address the induced stages, four compensatory storage alternatives were evaluated for mitigating for the induced damages:

1. Site ACRS08 is individually justified as a floodwater storage reservoir, based on flood damage reduction benefits. Because this site had been shown to be effective for reducing flood stages, it was also evaluated as a compensatory storage site to address the levee induced damages. The annualized cost of constructing the reservoir, $819,000, is less than the total induced damages. The levees were modeled in combination with this reservoir and the combination resulted in stage increases in a very limited area. The impacts of the increased stages at three cross-sections, located between the alignments of the existing Rand Park Levee and the proposed DPLV09, would be to a parcel along the river owned by the Forest Preserve District of Cook County. The stage increases, between 0.04 and 0.05 feet, would have minimal impact on this undeveloped land. A preliminary estimate of the value of the flowage easements was prepared as discussed in Appendix I (Real Estate Plan). The estimated value is $1,000. The net benefits of the levees when combined with ACRS08 are greater than for any of the sites individually. However, during public review of the proposed plan, the public expressed significant opposition to use of this site for floodwater storage. In addition to hundreds of letters from citizens and stakeholders, the neighboring community of Buffalo Grove passed a resolution in opposition to construction of a reservoir at the site. As a result, the site was removed from consideration not only as a compensatory storage site, but also as an element of the formulated plan.

2. DPRS15 had previously been eliminated from consideration as a reservoir, but was evaluated for compensatory storage as it is located near the impacted area. The site is located in the Forest Preserve District of Cook County's (FPDCC's) Campground Road Woods, south of Algonquin Road. The optimized storage at the site was determined to be 220 acre-ft. The total annualized estimated cost for the compensatory storage, including required fish and wildlife mitigation, was $904,000. Although the cost of this site is much less than induced flood damages, the site was not able to mitigate for all of the induced stages. This alternative was therefore eliminated.

3. Site WHRS01 had previously been eliminated from consideration based on the minimal benefits that would result from the reservoir. The site is located along Mannheim Road in Rosemont, just east of O'Hare airport. Two factors, however, led to the reconsideration of this site: removal of an existing spoil pile is planned, impacting the quantity of spoil removal required and the resulting cost of construction; the site is close enough to the mainstem Des Plaines River that a pipe or ditch could be configured to capture mainstem backwater in the tributary. The site would then be storing floodwaters from the mainstem rather than the Willow-Higgins Creek tributary, allowing the site to more effectively reduce mainstem stages and mitigate for the levee impacts. Because the site is also in close proximity to O'Hare airport, consideration of restrictions associated with open water near runways would be incorporated in the designs. Hydrologic and Hydraulic modeling showed that 600 acre-feet of storage would mitigate for the induced stages. This site, however, has been acquired by the City of Chicago for

use in the O'Hare Modernization Plan and is not available for development as a floodwater storage site.

4. Much of the undeveloped land near the proposed levee sites is owned by the FPDCC. A search for unforested Forest Preserve District lands, reducing the likely environmental impacts of reservoir construction, led to the identification of two sites:

> **DPRS04,** located south of River Road between First and Fifth Avenues in River Grove, had previously been eliminated during the site identification phase due to the presence of stockpiles of stone and construction fill. However, since that time the material has been removed. Because this site had been previously been deforested it was recommended for investigation by FPDCC. Trails and picnic facilities, similar to those found at other FPDCC sites in the area, were included in the site design and costs. A cost-benefit analysis of the recreation features was conducted as discussed in Section 8, and the features are economically justified at this site.
>
> **WLRS04** is an existing Driving Range along Golf Road in Des Plaines that was not previously identified as a potential storage site. The site is not immediately adjacent to a waterway and is actively used as a recreation site. However, a route for a potential ditch or pipeline connecting the site to the Des Plaines River was identified. FPDCC agreed that investigation of this site would be acceptable contingent upon continued availability of the site for use as a Driving Range.
>
> H&H modeling showed that, while neither site could address the induced stages independently, a combination of 150 acre-feet of storage at DPRS04 and 200 acre-feet of storage at WLRS04 would address the induced stages. For both of these sites, FPDCC requested that compatible recreation uses be incorporated in the designs. Cost-shared recreation features were incorporated in the site designs for DPRS04. Reconstruction of the existing recreation features at WLRS04 would be a non-Federal requirement.
>
> Ecological assessments of the proposed storage sites were conducted to determine whether construction would cause impacts to significant environmental resources. As discussed in Section 9.4.2.2 , the assessments determined that the sites had very little ecological resources and that mitigation would not be required.

The total annualized cost of providing the compensatory storage at DPRS04 and WLRS04 is $1,319,000. This is much less than the $2,855,000 in induced damages that would result from construction of the levees without mitigation. This analysis demonstrates that the induced stages caused by the levees can be addressed through implementation of compensatory storage. The storage capacity at DPRS04 and WLRS04 is economically justified by the reduction in flood losses (mitigated damages).

In addition to an evaluation of DPRS04 and WLRS04 as compensatory storage, the sites were evaluated as stand-alone reservoir projects. A summary of the benefits, costs, and net benefits associated with each individual site is presented in Table 4.25. As shown in the table, each site is individually justified.

Table 4.25 – Compensatory Storage Project Individual Benefits and Costs

Project	Flood Damage Reduced	Recreation Benefits	Total Benefits	Annual Costs	Net Benefits
WLRS04	$981,000	$0	$981,000	$715,000	$266,000
DPRS04	$498,000	$150,000	$648,000	$604,000	$44,000

(FY 2014 Price Level, FDR 3.5%)

4.6.5 Flood Risk Management Plans

The authorization for this study directs USACE to "not exclude from consideration and evaluation flood damage reduction measures based on restrictive policies regarding the frequency of flooding, the drainage area, and the amount of runoff." (WRDA 1999, Sec. 419.b) Therefore, a broad range of measures throughout the watershed have been investigated and evaluated. However, not all of the individually justified projects are compliant with current USACE policy as discussed in Sections 4.6.1 and 4.6.2, above: measures justified by benefits in portions of tributaries not meeting the minimum flow requirements and measures formulated solely to address transportation damages.

In order to fully respond to the study authority while also considering existing policy and guidance, four distinct plans have been formulated:

1. **No Action Plan:** Assumes that no projects would be implemented by USACE. Projects planned for implementation by local interests are included in this plan.
2. **Comprehensive Plan:** A plan that fully responds to the study authority and includes all economically justified, environmentally acceptable separable projects evaluated during the course of the study. This plan includes projects the USACE recommends be implemented by appropriate non-Federal agencies, projects that USACE may address under its CAP, and projects for which USACE will seek congressional authorization for implementation. The CAP Plan and NED Plan are subsets of the Comprehensive Plan.
3. **CAP Plan:** All policy compliant, economically justified, environmentally acceptable separable projects of such scope that they could reasonably be implemented under CAP.
4. **NED Plan:** All policy compliant, economically justified, environmentally acceptable separable projects of such scope that they could not be implemented under CAP.

As required by USACE policy and guidance, a No Action plan, synonymous with the FWOP condition will be evaluated in comparison to other identified plans. The No Action plan assumes that no new projects would be implemented by USACE. Projects planned for implementation by local interests are included in this plan. This alternative would result in continued occurrence of flood damages throughout the watershed. Damages to structures and traffic delays and detours would continue, causing significant economic impacts, as discussed in Section 4.4. The benefits, costs, and net benefits of the No Action Plan are $0.

4.6.6 Last Added Analysis

Flood risk management plans are formulated to maximize NED net benefits. To determine the optimal combination of measures for evaluation, the screened and evaluated sites shown to be individually justified ("first added") were further evaluated using a "last added" analysis. Through the screening and evaluation process, each site has been individually justified and optimized with respect to without project conditions. Since the benefits of implementation of many of the measures are interdependent, the last added analysis ensures that benefits are not claimed by two projects in the same plan.

The individually justified projects are presented in Table 4.26, below. The locations of the sites within the watershed are shown in Plate 15. Combinations of these projects form the basis of the flood risk management plans. To formulate the plans, projects were first evaluated to determine which plan they would be part of (NED, CAP, or Comprehensive). Policy compliant projects were added to the formulated plan first to determine the NED and CAP Plans. The remaining non-policy compliant projects were then added to determine the Comprehensive Plan.

Table 4.26 – Summary of Individually Justified Projects

Site	Description	Plan[1]	Total Benefits[2,3]	Annual Costs[2]	Net Benefits	BCR
DPLV04	Fullerton-Grand Levee	NED	$2,186	$864	$1,322	2.5
DPLV05	Belmont-Irving Park Levee	NED	$1,762	$789	$973	2.2
DPRS04	Fullerton Woods Reservoir	NED	$648	$604	$44	1.1
DPLV09	Touhy-Miner Levee	NED	$2,488	$1,176	$1,312	2.1
WLRS04	Semrow Driving Range Reservoir	NED	$981	$715	$265	1.4
--	Policy Compliant Non-Structural	NED	$2,831	$1,835	$996	1.5
DPLV01	Groveland Avenue Levee	CAP	$441	$264	$177	1.7
DPBM04[4]	First Ave Bridge Modification	Comprehensive	$4,258	$656	$3,602	6.5
FPCI01[4]	Lake Mary Anne Pump Station	Comprehensive	$107	$85	$22	1.3
--	Non-policy compliant Non-Structural	Comprehensive	$270	$157	$113	1.7

[1] HQUSACE has directed the District to prepare a plan that includes all individually justified sites, a plan that includes all policy compliant plans that could not be implemented under the CAP, and sites for implementation under CAP. Comprehensive, NED, or CAP is shown to indicate which plan they would fall within.

[2] Benefits and costs are annualized over a 50 year period of analysis, using a 3.5% discount rate.

[3] Additional benefit categories include Flood Insurance Administration cost savings for structures removed from the floodplain, reductions in flood fighting costs, and recreation benefits.

[4] Road Raises formulated to solely address transportation damages, such as DPBM04, and projects that accrue benefits in portions of watersheds where 10% ACE flows are less than 800 cfs, such as FPCI01, are non-policy compliant. These projects would be implemented by the appropriate non-Federal agency and would not be cost-shared with USACE.

(FY 2014 Price Level, FDR 3.5%)

For this analysis, the policy compliant increment with the highest net benefits is the starting point, using the with-project hydraulic and economic models of that site as the formulated plan. The remaining projects are then each added to the plan, and net benefits are calculated for each combination. An increase in net benefits indicates that the new element is incrementally

justified within the plan. The combination with the highest net benefits becomes the new formulated plan.

The remaining projects are added to the hydraulic and economic model of the new formulated plan to determine the next site to be included in the plan. The analysis is repeated until either all sites have been added or there are no combinations of remaining sites with the formulated plan that result in increased net benefits.

The levee and reservoir system that includes DPLV04, DPLV05, DPLV06, DPRS04, and WLRS04 has the highest net benefits, with a total of $3,982,000 in net benefits for the individual projects. However, for the last added analysis, the system was broken into two increments to ensure that net benefits would be maximized by the system: the first increment DPLV04, DPLV05, and DPRS04 and the second increment includes DPLV09 and WLRS04. As discussed below, the analysis demonstrated that the combined increments do maximize net benefits.

A summary of the formulated plans is presented in Table 4.27. The mainstem levee and reservoir system increments were added to the plan first. The policy compliant non-structural projects were then added to the plan, followed by the CAP project, DPLV01, and the non-policy compliant projects. The analysis showed that net benefits continued to increase and that all sites remain justified in combination with each other.

The incrementally justified non-structural measures were determined using screened non-structural sites as a basis. The previous non-structural analysis considered measures at structures regardless of their location along tributaries. However, some of the structures are in portions of tributaries that do not meet the minimum flow requirements discussed in 4.6.1. The structures in Kenosha County, Buffalo Grove, Leyden Township, and some of the structures in Wheeling fall in this category, and are therefore would only be included in the Comprehensive Plan. A summary of the NED non-structural measures is presented in Table 4.28 and the Non-policy complaint portion is presented in Table 4.29. The non-structural measures include structure elevations, dry floodproofing, wet floodproofing, filling basements in combination with floodproofing of any portion of the first floor at risk of flooding, nonstructural berms, and buyouts in 13 communities across the watershed. The non structural measures would be implemented on a voluntary basis, subject to verification of the structural characteristics, first floor elevation, and low water entry point. With regard to the buyouts, to the extent practicable, acquisition would be on a willing seller basis, but eminent domain could be utilized when determined to be warranted.

Table 4.27 –Last Added Analysis Summary

Round of Analysis	Plan Components	Total Benefits	Total Costs	Cumulative Net Benefits	Incremental Net Benefits
1	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee	$4,802,000	$2,250,000	$2,552,000	--
2	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner Levee	$7,964000	$3,982,000	$3,982,000	$1,430,000
3	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner Levee Policy Compliant Non-structural	$10,380,000	$5,737,000	$4,643,000	$661,000
4	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner Levee Policy Compliant Non-structural DPLV01 - Groveland Ave Levee	$10,835,000	$5,999,000	$4,836,000	$193,000
5	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner Levee Policy Compliant Non-structural DPLV01 - Groveland Ave Levee DPBM04 - First Ave Bridge Modification	$15,180,000	$6,652,000	$8,528,000	$3,885,000
6	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner Levee Policy Compliant Non-structural DPLV01 - Groveland Ave Levee DPBM04 - First Ave Bridge Modification Non-policy Compliant Non-structural	$15,421,000	$6,809,000	$8,612,000	$84,000
7	DPRS04 - Fullerton Woods Reservoir DPLV04 - Fullerton-Grand Levee DPLV05 - Belmont-Irving Park Levee WLRS04 - Semrow Reservoir DPLV09 - Touhy-Miner Levee Policy Compliant Non-structural DPLV01 - Groveland Ave Levee DPBM04 - First Ave Bridge Modification Non-policy Compliant Non-structural FPCI01 - Lake Mary Anne Pump Station	$15,530,000	$6,894,000	$8,636,000	$27,000

(FY2015 Price Level, FDR 3.375%)

Table 4.28 – Summary of NED Plan Non-structural Measures

County	Elevation	Dry Floodproof	Wet Floodproof	Fill Basement	Ring Levee	Buyout	Total Structures
Cook	79	15	24	9	5	81	213
Lake	80	18	21	12	19	14	164
Total	159	33	45	21	24	95	377

County	Total Structures	Benefits	Project Costs	Annual Costs	Net Benefits
Cook	213	$1,315,000	[redacted]	$1,188,000	$127,000
Lake	164	$1,100,000	[redacted]	$567,000	$533,000
Total	377	$2,415,000	[redacted]	$1,755,000	$660,000

(FY2015 Price Level, FDR 3.375%)

Table 4.29 – Summary of Non-policy Compliant Non- Structural Measures

County	Elevation	Dry Floodproof	Wet Floodproof	Fill Basement	Ring Levee	Buyout	Total Structures
Cook	92	1	1	4	2	2	102
Kenosha	1	0	3	0	0	3	7
Total	93	1	4	4	2	5	109

County	Total Structures	Benefits	Project Costs	Annual Costs	Net Benefits
Cook	102	$142,000	[redacted]	$113,000	$29,000
Kenosha	7	$99,000	[redacted]	$43,000	$56,000
Total	109	$2413,000	[redacted]	$156,000	$85,000

(FY2015 Price Level, FDR 3.375%)

4.6.7 Acceptability, Completeness, Effectiveness, and Efficiency

Completeness, effectiveness, efficiency, and acceptability are the four evaluation criteria outlined in the P&G and used by USACE in evaluating alternative plans. Alternatives are evaluated against these criteria in fulfilling the established planning objectives.

Completeness: Plan formulation has included a complete accounting of life-cycle costs, which includes both the costs associated with construction and the operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) required to ensure sustained realization of the project benefits. In addition, formulation has accounted for appropriate mitigation of adverse effects as an integral part of each plan including the regulations set in place by local floodplain management agencies to ensure that the projects will be implementable under these rules.

Effectiveness: The proposed plans meet the study objectives of reducing flood risk within the study area. Although significant residual flood risk would remain, the Comprehensive Plan reduces estimated annual flood damages in the watershed by 27%. The NED Plan would reduce those damages by 18% and the CAP Plan would add an additional 1% increment to the NED Plan damage reduction.

Efficiency: Plans meeting NED criteria must maximize net economic benefits. A last-added plan formulation procedure was utilized to ensure net benefits are maximized by retaining only those combinations of projects that result in increased net benefits.

Acceptability: FRM plan formulation has been conducted in close coordination with the study non-Federal sponsors and stakeholders to ensure that the analysis accurately reflects the flooding issues experienced within the watershed and that plans are acceptably addressing those problems. The formulated alternative plans are acceptable in terms of applicable laws, regulations and public policies.

4.7 Description of Flood Risk Management Plans*

4.7.1 Plan Elements

The incrementally justified FRM sites include two reservoirs, four levees, one road raise, modification of an existing structure and four types of non-structural measures. The reservoirs provide storage during a flood event and until flood elevations decrease and the water can flow into the channel without impacting structures in the floodplain. The levees protect homes and businesses by constructing a barrier between the floodwaters and the structures. Each of the levee sites was optimized to maximize the net benefits, taking into consideration the cost of construction. At the road raise site traffic delays and detours are prevented by raising the elevation of the road. Modifications to existing structures were identified through PDT and stakeholder knowledge of the watershed and are described below. A preliminary implementation schedule is summarized in Table 4.30. An economic summary of each plan is shown in Table 4.31. Plate 15 shows the location of the sites in the watershed. Plate 16 through Plate 22 shows conceptual site plans for each structural measure.

Table 4.30 –Preliminary Implementation Schedule for Flood Risk Management Projects

Plan	Site ID	Project	Engineering and Design Start	Real Estate Acquisition Start	Construction Start	Construction Completion
CAP 205	DPLV01	Groveland Avenue Levee	10/2014	4/2015	10/2016	10/2018
NED	DPRS04	Fullerton Woods Reservoir	10/2014	10/2017	4/2018	4/2020
	DPLV04	Fullerton-Grand Levee	10/2016	10/2017	10/2019	10/2021
	DPLV05	Belmont-Irving Park Levee	10/2016	10/2017	10/2019	10/2021
	WLRS04	Harry Semrow Driving Range Reservoir	10/2019	10/2019	10/2020	10/2022
	DPLV09	Touhy-Miner Levee	10/2020	10/2018	10/2021	10/2023
		Cook County Non-structural	10/2017	10/2017	10/2019	10/2025
		Lake County Non-structural	10/2017	10/2017	10/2019	10/2025
Comprehensive[1]	DPBM04	First Avenue Bridge Modification	10/2014	4/2015	10/2015	10/2017
	FPCI01	Lake Mary Anne Pump Station	10/2014	4/2015	10/2015	10/2017
		Cook County Non-structural (Comprehensive Plan)	10/2017	10/2017	10/2019	10/2025
		Kenosha County Non-structural	10/2017	10/2017	10/2019	10/2025

[1]Road Raises formulated to solely address transportation damages, such as DPBM04, and projects that accrue benefits in portions of watersheds where 10% ACE flows are less than 800 cfs, such as FPCI01, are non-policy compliant. These projects would be implemented by the appropriate non-Federal agency and would not be cost-shared with USACE.

Table 4.31 – Summary of Flood Risk Management Plans

Plan	Sites	Benefits ($1,000)	Costs ($1,000)	Net Benefits ($1,000)	BCR
Comprehensive[1]	DPBM04 + DPLV04 + DPLV05 + DPLV09 + WLRS04 + DPRS04 + DPLV01 + FPCI01 + non-structural measures (13 communities)	$15,530	$6,894	$8,636	2.3
NED	DPLV04 + DPLV05 + DPLV09 + WLRS04+DPRS04+ non-structural measures (9 communities)	$10,379	$5,738	$4,641	1.8
CAP	DPLV01	$455	$262	$193	1.7

[1]Road Raises formulated to solely address transportation damages, such as DPBM04, and projects that accrue benefits in portions of watersheds where 10% ACE flows are less than 800 cfs, such as FPCI01, are non-policy compliant. These projects would be implemented by the appropriate non-Federal agency and would not be cost-shared with USACE.

(FY2015 Price Level, FDR 3.375%)

The sites below are the individual elements of the Flood Risk Management Plans. The NED Plan would be recommended for congressional authorization, projects in the CAP Plan would be recommended for implementation under existing USACE authorities for implementation of small projects. Sites in both of NED and CAP Plans are also included in the Comprehensive Plan. In addition, the Comprehensive Plan includes projects that would not be implemented by USACE, but rather by local FRM or transportation agencies. These additional projects—DPBM04, FPCI01, and non-structural measures that are not along portions of streams that meet the 800 cfs criteria—are economically justified, but do not meet current USACE policy and guidance.

National Economic Development Plan:

The NED Plan includes two separable components: structural and non-structural. The NED Plan is recommended for authorization by Congress and implementation by USACE.

Structural: As discussed above, the structural projects form a levee and storage system that provides flood risk management benefits without inducing flood stages or damages in the watershed. A description of each project included in this system is presented below.

WLRS04: The Harry Semrow Driving Range Reservoir would be a 200 acre-foot floodwater storage reservoir in Des Plaines. The site, located along Golf Road just east of Rand Road, is the location of an existing golf driving range and the reservoir design will allow for continued recreational use of the site. The reservoir would be connected to the Des Plaines River through a ditch at the east side of the site. This site, in combination with DPRS04, would serve as compensatory storage for DPLV09, DPLV05, and DPLV04.

DPLV09: The Touhy-Miner Levee would be a 11,200 floodwall and levee along the west bank of the Des Plaines from Touhy Avenue to Miner Street in Des Plaines. The floodwall and levee would have a greater than 95% chance of not being overtopped during a 100 year flood event. Multi-purpose recreation trails would be included in the project, extending along the floodwall from Oakton Street to Algonquin Road and connecting to the existing Des Plaines River Trail system.

DPLV05: The Belmont-Irving park Levee would be an 8,400 foot levee and floodwall along the west bank of the Des Plaines River in Schiller Park. The structure would protect homes and businesses along the mainstem Des Plaines River from Belmont to Irving Park Road. The crest elevation is 2 feet above the 1% annual chance of exceedance flood elevation. The probability that this levee would not be overtopped during the 1% annual chance of exceedance flood event will be greater than 95%.

DPLV04 : The Fullerton-Grand Levee would be a 6,200 foot levee and floodwall along the west bank of the Des Plaines River in River Grove. The structure would protect homes and businesses along the mainstem Des Plaines River from south of Fullerton Avenue at Fifth Avenue along Fifth Avenue and River Road, extending north of Grand Avenue. The crest elevation is two feet above the 1% annual chance of exceedance flood elevation. The probability that this levee would not be overtopped during the 1% annual chance of exceedance flood event will be greater than 95%.

DPRS04: The Fullerton Woods Reservoir would be a 150 acre-foot floodwater storage reservoir in River Grove. The site is located south of River Road between First and Fifth Avenues. The project would include trails, picnic facilities, and a parking lot to allow for use of the site as a recreation area. This site, in combination with WLRS04, would serve as compensatory storage for DPLV09, DPLV05, and DPLV04.

Non-structural: Non-structural measures recommended for implementation include floodproofing, structure elevations, construction of non-structural berms, and buyout and evacuation of properties in flood prone areas. These measures would be implemented at 377 structures in nine communities across the watershed. These communities include Rosemont, Wheeling, Wheeling Township, Riverwoods, Lincolnshire, Long Grove, Vernon Township, and Gurnee in Illinois. Non-structural buyouts in Des Plaines would also include construction of recreational trails on the vacated lands. Participation will be on a voluntary basis and structure eligibility will be verified prior to implementation. With regard to the buyouts, to the extent practicable, acquisition would be on a willing seller basis, but eminent domain could be utilized when determined to be warranted.

Continuing Authorities Program:

The project below is a separable element that is within the scope of the flood risk management authority delegated to USACE by Section 205 of the Flood Control Act of 1948, as amended. This authority allows USACE to construct, without specific authorization, small flood risk management projects where the Federal share of the cost does not exceed $7 million.

DPLV01: The Groveland Avenue Levee would raise and extend an existing levee in Riverside, tying back the structure to high ground. The levee would have a greater than 95% chance of not being overtopped during a 100 year flood event. This levee would not impact the water surface profile and will not require compensatory storage.

Non-Policy Compliant Projects:

Additional projects that address flood risk in the watershed and are economically justified were identified by this study. These projects, however, are not compliant with current USACE policy and are therefore recommended for implementation by the appropriate state and local agencies.

DPBM04: The First Avenue Bridge Modification would raise the pavement elevation of First Avenue Bridge in River Grove above the 1% annual chance of exceedance flood elevation The site would be designed to prevent adverse impacts to surrounding structures by extending the bridge length, providing greater conveyance capacity under the roadway.

FPCI01: The Lake Mary Anne Pump Station would increase the storage capacity of Lake Mary Anne by connecting the lake to Dude Ranch Pond. Lake Mary Anne is located at Golf Road and I-294 and the pond is immediately south of the lake across Golf Road.

Non-structural: Non-structural measures along portions of tributaries that do not meet minimum flow requirements would be implemented at structures in 5 communities across the watershed. These communities include Wheeling, Buffalo Grove, and Leyden Township in Illinois and Salem and Somers in Wisconsin. Participation would be on a voluntary basis and structure eligibility will be verified prior to implementation.

4.7.2 Costs of Plan Elements

The costs used to compare plan elements are annualized over the 50 year period of analysis. These first costs are implementation; supervision and administration; LERRDs; and interest during construction. These costs, annualized at the current federal discount rate (3.375%), together with the annual O&M costs are the basis for the average annual costs. The first costs, O&M costs, and average annual cost of each element of the FRM plans are presented in Table 4.32.

Table 4.32 – Flood Risk Management Plan Costs

Site	Plan[1]	Economic Costs[2]	Annual OMRR&R	Average Annual Costs
DPRS04[3]	NED	$13,038,000	$59,000	$602,000
DPLV04	NED	$21,587,000	$19,000	$861,000
DPLV05	NED	$19,558,000	$24,000	$787,000
WLRS04	NED	$16,664,000	$56,000	$706,000
DPLV09[3]	NED	$28,730,000	$12,000	$1,026,000
Lake County Non-structural	NED	$15,514,000	Nominal	$567,000
Cook County Non-structural[3]	NED	$32,520,000	$1,000	$1,188,000
DPLV01	CAP	$5,941,000	$15,000	$262,000
DPBM04	Comprehensive	$15,672,000	$21,000	$653,000
FPCI01	Comprehensive	$1,300,000	$30,000	$84,000
Kenosha County Non-Structural (Comprehensive Plan)	Comprehensive	$1,189,000	Nominal	$43,000
Cook County Non-structural (Comprehensive Plan Increment)	Comprehensive	$3,106,000	Nominal	$113,000

[1]The NED and CAP Plans only include indicated projects. The Comprehensive Plan includes NED, CAP, and non-policy compliant projects (DPBM04, FPCI01, and non-structural along portions of tributaries that do not meet the 800 cfs criteria)

[2] Economic Costs include implementation, preconstruction engineering and design, supervision and administration, estimated lands and damages, and Interest During Construction.

[3]DPRS04, DPLV09, and Cook County Non-Structural include cost-shared recreation features.

(FY2015 Price Level, FDR 3.375%)

4.7.3 Long-Term Risk

The FRM measures identified for inclusion in the Recommended Plans are designed to maximize the net benefits at that site. Levees and floodwalls are often perceived as total protection from flood risk; however, with the implementation of any FRM measure, there will be remaining residual risks of flooding due to the chance of extreme events exceeding the design capacity.

The HEC-FDA model used to calculate FRM benefits also calculates the long-term risk associated with implementation. The risk associated with the two levees selected for inclusion in the FRM plans is presented in Table 4.33. The table presents the data in three ways to more completely depict the risk associated with each project. The annual probability of flooding is the chance that the top of the levee will be reached in any year. The long term risk of flooding shows the likelihood that the levee or floodwall will be overtopped at least once during a 10, 30 , or 50 year period. The conditional probability of flood avoidance (also known as the conditional non-exceedance probability) is the percent chance that the structure will *not* be overtopped during a variety of flood exceedance probabilities.

The risk presented in the table reflects the design analysis and hydraulic modeling conducted to date. Geotechnical analyses have not been conducted. Due to the fact that the levee designs will be required to follow current guidelines there is little additional risk from the geotechnical analysis. During the design phase, the analyses of each structure will be further developed, refining the assessment of the long-term risk.

A preliminary evaluation of levee superiority and overtopping considerations was conducted for each proposed levee sites. The intent of this analysis is to ensure that risk to life-safety is minimized as required by ER 1110-1405 and ETL 1110-2-299. A summary of the evaluation for each site is provided below.

DPLV01 parallels the river for approximately one third of a mile tying into high ground at both ends. The current design of the levee is at one elevation, therefore it would overtop at the upstream tieback which will be incorporated in a road raise. This hardened road surface would provide additional protection against sudden levee failure. There would be broad sheet flow as the levee cell fills to the level of the river. It is unlikely that a breach will form as the levee fills, as the levee is a substantial structure that serves as a roadway. The area protected by the levee consists of dense residential development and there are no available undeveloped sites. Any overflow, regardless of the location, will fill the low lying area along the portion of the levee that parallels the river first. Use of the hardened road raise as the current location of the overflow provides an optimal overtopping location for this small levee system.

DPLV04 and DPLV05 both parallel the river for just over a mile, tying into high ground at both ends. The current designs for these levees are each at one elevation unique to that project, so overtopping would occur first at the upstream end. River Road provides a significant setback buffer of approximately 200 feet between the levee and residential and commercial structures in the areas of primary overflow for both levee systems. The low lying areas that would fill first lie between the levee and River Road, where there are no structures. River Road would act as a natural energy dissipater and provide additional erosion protection riverward of structures in the event of a breach, giving added protection for the structures which are all located west of River Road.

DPLV09 parallels the river for approximately two miles, tying into high ground at both ends. Because the design water surface profile drops over two feet across this levee reach, the current design of this levee is stair-stepped into four crest elevations. The extent of each of the four segments is: from the railroad tie in at the upstream/north end to Algonquin Road, Algonquin Road to Oakton Avenue, Oakton Avenue to approximately 1,000 feet downstream/south of Oakton Avenue, and from that point to the tie in at the Interstate 94 interchange. With the current design, overtopping would likely occur at the ends/break points of the elevation changes. At the upstream end at the railroad, River Road provides a buffer of only about 100 feet. At the Algonquin and Oakton breakpoints, there are structures between fifteen to twenty feet from the proposed floodwall. Due to this higher level of risk, some adjustments to these break points will be investigated during the design phase. Possible locations for planned overtopping include road crossings along the levee alignment such Oakton Avenue or the small lake between Algonquin and Oakton.

The levee design and locations of likely and planned overtopping will be coordinated with the impacted communities. For all sites, USACE will partner with the non-Federal sponsors and local communities to develop appropriate warning, response, and evacuation plans.

The potential impacts of climate change on the long term risk were also evaluated as discussed in Section 3.2.6.

Table 4.33 – Levee/Floodwall Long Term Risk (Analysis Year 2020)

		Site ID			
		DPLV01	**DPLV04**	**DPLV05**	**DPLV09**
Annual Probability of Flooding	Median	0.01%	0.01%	0.01%	0.01%
	Expected	0.002%	0.002%	0.002%	0.02%
Long-Term Risk of Flooding (years)	10	0.02%	0.02%	0.02%	0.02%
	30	0.05%	0.05%	0.06%	0.1%
	50	0.09%	0.09%	0.10%	0.10%
Conditional Probability of Flood Avoidance by Events (Annual Percent Chance of Exceedance)	10%	100%	100%	100%	100%
	4%	100%	100%	100%	100%
	2%	100%	99.9%	99.9%	100%
	1%	100%	99.7%	99.6%	100%
	0.40%	99.9%	99.3%	99.1%	99%
	0.20%	99.9%	99.1%	99.0%	99%

4.7.4 Residual Risk

Implementation of this Flood Risk Management Plan will provide significant relief to communities in the watershed at risk of flooding. However, it is important to emphasize that the plan does not address all potential flood damages in the watershed and that even where potential flood damages are addressed, risk of flooding remains.

The Upper Des Plaines River watershed is very large and the impact of storm events varies according to the location, duration, and intensity of rainfall. Communities in the watershed use the established river gage network to monitor potential flood events. Using National Weather Service forecasts for

rainfall and stages at gages in the watershed, communities respond according to procedures outlined in their Flood Hazard Mitigation Plans. As discussed above, flood warning and response plans will be developed for each recommended levee project to supplement the existing community response plans. The plans will address the installation of any required closure structures, monitoring of flood levels, and plans for emergency response and/or evacuation in the event of levee overtopping or failure. These plans will be developed in conjunction with the non-Federal sponsors and the local community concurrent with development of Operations and Maintenance manuals.

Should a levee overtopping event occur, there are risks associated with the inundation of homes and businesses as well as access to evacuation routes. In areas where homes and businesses are floodproofed, evacuation in the event of a flood remains as a significant concern. Fatalities that have occurred in the watershed during flood events have been associated with flooding in homes, evacuation, and access to emergency services. Due to the flat topography of the watershed, high velocity overbank flooding is unlikely, so primary risks are associated with the length of the warning time and the depth and duration of flooding.

The amount of warning time available to a community for execution of evacuation plans varies, and can be as little as a few hours in advance of a flood event, but is typically about a day prior to significant flooding. Similarly, the duration of a flood can vary as well, lasting from a few hours to a few days. Longer duration flood events will build slowly before reaching the peak stage and receding.

If an overtopping event occurs during an extreme flood event, the majority of flooding would occur on surface streets and in basements. The majority of structures protected by the levees are homes, as shown in Table 4.34. and the inundation can last several days. During this time, access to structures by emergency vehicles is limited, and boats or helicopters would be used to access stranded residents.

Table 4.34 – Summary of Structures Behind Levees

		Type of Structure				
		Residential and Apartment		Commercial, Industrial, and Public		Maximum Flood Depth (ft above First Floor Elevation)
Levee	# of Structures	Number	Percent	Number	Percent	
DPLV01	73	72	99%	1	1%	4.6
DPLV04	196	177	90%	19	10%	3.6
DPLV05	108	68	63%	40	37%	3.9
DPLV09	558	504	90%	53	10%	3.2

In addition to the areas where flood risks are reduced, discussed above, there are many areas in the watershed where flood risk is not reduced. It is estimated that the Comprehensive Plan would reduce watershed flood damages by approximately 27%. The NED Plan would only reduce those damages by 19% and the CAP Plan would reduce an additional 1% increment of flood damages. The majority of the flood risk reduction is along the Des Plaines River, with some additional risk reduction in tributary watersheds. Additional detail regarding the residual risk can be found in Appendix E (Economics).

5 Ecosystem Restoration

5.1 Ecological History & Setting

The ecology of the watershed has been severely impacted since the late 1800s through modifications to land use, geomorphology, hydrology, and hydraulics. Typical of highly urbanized and agricultural areas, human modification to the landscape has negatively affected and altered the native communities of the watershed. Accordingly, a large portion of the native floral and associated faunal communities were lost. Only 9% of the current land use is natural open space; however, most of these areas have become degraded and overrun with non-native and invasive plant species. Riverine communities are valued as "moderately to highly degraded" through fish community assessment. Eutrophication, sedimentation, geomorphic manipulation and changes in the hydrologic regime has allowed for the establishment of invasive plant species within all community types of the watershed, thus having created habitats that favor generalists over specialists, thereby decreasing or eliminating foraging and breeding habitat for native fauna.

Their establishment in a significant portion of the watershed has created monospecific stands of reed canary grass (*Phalaris arundinacea*), common reed (*Phragmites australis*), and cattail (*Typha sp*.) that have entirely displaced native vegetation and severely disrupting the structure and function of the watershed. Some of these invasive plant species, such as buckthorn, have also impaired fluvial geomorphic functions and soil quality. Fire suppression and hydrologic impairments have allowed most open habitats such as prairies and savannas to succeed into degraded woodlands, inhibiting critical interrelationships between the watershed's flora and fauna. The riverine system is also fragmented by 21 significant dams or structures, which have negatively affected riverine community diversity when compared to reaches below the most downstream dam that are not fragmented.

Additionally, Illinois and Wisconsin have 36 bird, 3 reptile, 1 amphibian, 5 insect, 5 fish, 4 mussel, and 31 plant species listed as State threatened or endangered. Most large mammals, including the American bison, had been hunted to local extinction and several bird species such as the sharp-tailed grouse and the yellow rail have vanished from the basin. Forty-three mammal species are still known or are thought to still occur here, along with 16 amphibian,23 reptile, and about 270 bird species (Krohe 1998).

Before European settlement, the Upper Des Plaines River and associated streams had catchments. As with most natural processes in the region and elsewhere, human modifications to landscape vegetation negatively affect and alter the natural hydraulics and hydrologic regime of wetland and riverine systems. Accordingly, a large portion of the native vegetation and associated faunal communities have been lost to agricultural, urban or industrial conversion. Most historic records suggest that there were four major types of plant communities present in the study area. The communities that were once located within the study area are described in detail below; Table 5.1 provides a summary of the types of communities.

Table 5.1 – Habitat Types/Plant Communities of the Upper Des Plaines River Watershed

Community / Habitat Type	General Location	General Hydrology
Prairie	Flat- to mid-slopes, adjacent to wetlands	dry-mesic; mesic; wet-mesic; wet
Savanna	East and north facing slopes	dry-mesic; mesic; wet-mesic; wet
Woodland	Riparian	dry-mesic; mesic; wet-mesic; northern flatwoods
	Floodplain	mesic; wet-mesic; wet
Wetland	Isolated depression/floodplain depression	marsh; shrub swamp; calcareous floating mat
		fen; graminoid fen; sedge meadow; seep
Riverine	Stream	medium gradient; low gradient
	River	medium gradient; low gradient
Other	Lake	glacial; artificial
	Ponds	vernal; artificial
	Ruderal (human induced)	urbanland; cropland; pastureland; successional fields

The two most dominant types of habitat were oak savanna and prairie, with lesser amounts of wetland and woodland. Forest communities in southern Lake County and Cook County were situated along the east side of the Des Plaines River along with small pockets of savanna, prairie, and marsh. Areas west of the river, being exposed to fire, were predominately prairie, marsh, and savanna. According to the General Land Office survey conducted in 1820, the Upper Des Plaines River watershed was made up of about 40% prairie and 60% savanna and forest (Anderson 1970). These savanna and prairie communities were largely dependent on fires, varying in frequency and intensity. Half of Lake County was historically savanna; today's acreage of high quality savanna is almost non-existent (Table 5.2). However, degraded savanna habitat still exists across the basin. Nearly 90,000 acres of prairie are believed to have been present in 1840, of which currently only about 18 acres are considered as high-quality. The basin is predicted to have about the same amount of forest as would have been present prior to 1840, however, only 343 acres is considered to be in an undisturbed state of high ecological quality (Krohe 1998). Most wetlands in the study area were comprised of wet prairie, sedge meadow, floodplain forest, and prairie pothole marsh. Assuming the watershed had a similar proportion of wetlands compared with Lake County, presettlement acreage of wetlands would be roughly around 57,600 acres (26 percent) (IDNR 1998).

Table 5.2 – Plant Community Change from Pre-European Settlement to Present Conditions

Community / Habitat Type	Wisconsin		Illinois	
	1800s	Present	1800s	Present
Prairie	26%	5.3%	34%	9%
Savanna	17%	0.0%	27%	~0%
Woodland	43%	5.6%	13%	18%
Wetland	14%	8.0%	26%	6%

The Upper Des Plaines study area currently includes twenty sites identified by the Illinois Natural Areas Inventory (INAI) as natural areas with significant features, with an additional six sites occurring at or near the basin's boundary. Fourteen of these sites have been identified as Category I (high quality, undegraded) natural areas, containing twenty-one high quality remnants of ten different natural communities; a total of 440 acres. These high quality, remnant natural communities include marsh, sedge meadow, graminoid fen, calcareous floating mat, wet prairie, wet-mesic prairie, mesic prairie, northern flatwoods, mesic floodplain forest, mesic forest, and dry-mesic forest. The remaining

natural areas were identified as Category II (threatened and endangered species localities). The total area of all Category I and II INAI natural areas, including buffer areas, totals about 2,271 acres (IDNR, 1998).

The study area also contains nine sites that are dedicated as Illinois Nature Preserves, totaling 1,475.7 acres with eight occurring in Lake County and one in Cook County (440 acres). Nature Preserves exist to protect and preserve significant natural features for the purposes of conserving biodiversity, scientific research, education, and esthetic enjoyment. These nature preserves as well as the INAI and other natural areas are vital to the Upper Des Plaines study area as there are no state or federally-owned parks, conservation areas, fish and wildlife areas, or forest preserves within the watershed (IDNR 1998).

5.2 Ecosystem 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 planning initiative or other regional resources management strategies are likely to more effectively meet ecosystem management goals than those projects and decisions developed independently. Independently developed ecosystem restoration projects, especially those formulated without a system context, partially and temporarily address symptoms of a chronic/systemic problem. This section outlines the past, present and FWOP conditions of the Upper Des Plaines River watershed's biological and human environment.

In order to derive the current, FWOP and future with project (FWP) ecological value of the Upper Des Plaines River watershed, both as a whole and in significant pieces, several specific assessments/surveys were completed. Assessments conducted included a riverine survey of fish assemblages and habitat, and a vegetation survey to obtain a general trend of species richness, plant community quality and plant community structure in terms of wildlife habitat. All of these data collected from these surveys were used to develop a watershed specific Habitat Evaluation Procedure (HEP) model and Hydrogeomorphic Model (HGM). These surveys and results are detailed in Appendix C – *NER Plan Formulation*, HEP documentation section:

- Burks-Copes, K., A. Web. 2009. Community Models for the Upper Des Plaines River Watershed, Illinois and Wisconsin. ERDC/EL TR-SWWRP-09-X.
- Jeff P. Lin. 2009. A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Depressional Wetlands in the Upper Des Plaines River Basin. ERDC/EL TR-06-4.
- Veraldi, F.M., S.M. Pescitelli, & T.M. Slawski. 2005. A Survey of Riverine Fish Assemblages and Habitat of the Upper Des Plaines River System.
- Slawski, T.M., F.M. Veraldi, S.M. Pescitelli, and M.J. Pauers. 2008. Effects of Tributary Spatial Position, Urbanization, and Multiple Low-Head Dams on Warmwater Fish Community Structure in a Midwestern Stream. North American Journal of Fisheries Management: 28:1020-1035.

5.2.1 Riverine Survey

Fish community and habitat surveys were conducted in the Upper Des Plaines River system to determine the current status of fish species distribution, to assess overall stream quality and to evaluate the potential for ecosystem restoration. During the period from 2002 to 2004, forty-nine sites upstream of Salt Creek in Illinois and the entire watershed in Wisconsin were surveyed for fish species richness, biological integrity and riverine habitat. Fish and habitat survey results suggest Newport Ditch, Kilbourn Road Ditch, Brighton Creek, Bull Creek, Center Creek and the Upper reaches of the Des Plaines River subwatersheds have areas of high ecological quality.

Fishes. Forty-three native species of fishes were found; twenty-three less than the reconstructed pre-settlement fish assemblage, which was based on historic records and voucher specimens (Appendix C, p.343, Table 9). One species not native to the Upper Des Plaines River system and four species not native to the North American continent were also present.

5.2.2 Vegetation & Wetland Surveys

In order to assess the current conditions of the various native cover types, classified by soil, hydrologic and plant community characteristics (e.g., wet prairie, northern flatwoods), that could be restored, systematic and statistically robust sampling methods were developed. The main focus of the data collection was to ensure proper calibration of the plant community index for the HEP model. Reference sites were chosen based on the range of variability that occurs throughout the watershed, high quality though degraded. In addition, reference sites were chosen based on their predominant cover type. This is to ensure a robust assessment of the range of function among specific cover types. Reference sites represented a range of conditions, from low disturbance (high quality) to high disturbance (low quality), based on the amount of human activity within the site. Reference cover type assessment was used to calibrate the HEP and HGM models. The variables chosen to measure through empirical data collection represent ecological functions and biological community structures known to affect the ecological integrity of the specific cover types. In other words, there is a relationship that can be mathematically quantified between the measured variable and the overall quality and health of the biodiversity contained within the watershed. The sampling scheme was designed to optimize the precision with which each variable was measured. The sampling scheme was also developed with the ability to appropriately calculate the Floristic Quality Index (FQI), which is treated as a variable within the ecosystem models.

5.3 Ecosystem Analysis

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 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, referred to as cover types, 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. Biodiversity is a term that is used to describe all aspects of biological diversity including species richness, ecosystem complexity and genetic variation. Biodiversity is decreased through the loss of hydrogeomorphic function, fluvialgeomorphic function, native vegetation loss and land use change, which in turn leads to a reduction in ecosystem complexity. These are manifested through a decreased level of natural services such as flood moderation, maintenance of adequate water quality, wildlife habitat, etc. For this study, a period of analysis of 50 years was used.

Historically, the Upper Des Plaines River watershed was dominated by several naturally occurring cover types such as wetlands, forests, savannas and prairies. By the late 1800s, many of these cover types, particularly prairies, savannas and wetlands, were converted to agricultural, urban or industrial use. Subsequently, there was a significant loss of biodiversity within the last hundred plus years. Furthermore, the remnant parcels of natural cover types are under pressure from continued human activities. Human induced disturbances to the remaining natural areas include fire suppression, altered hydrology, increase colonization of invasive species and fragmentation. While cover types 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.

For this study, a period of analysis of 50 years was used. The projected without project conditions during this time period are discussed in Section 5.3.2.

5.3.1 Habitat Assessment Methodology

Many methods and models are available to measure ecosystem function and structure and to predict their future conditions base on differing scenarios. Habitat models developed for individual species may have limitations when used to assess more holistic ecosystem problems and restoration objectives. Individual species models do not include consideration for communities of organisms and typically consider habitat in isolation from its ecosystem context. The assessment methodology chosen for this study is community based and meets the needs of the study goals, objectives, and level of detail. The assessment methodologies, Habitat Evaluation Procedure (HEP) and Hydrogeomorphic Wetland Assessment (HGM), focus on specific habitat parameters designed to capture changes in function, structure and health of the ecosystems within the Upper Des Plaines River watershed. These methodologies were developed with the Corps Environmental and Research Development Center (ERDC).

The baseline condition, FWOP condition, and future with proposed alternatives were evaluated with a consistent and quantifiable set of environmental metrics to allow for comparison of outputs and costs. A multi-agency working group was formed to aid ERDC in the development of these numerical models that serve as a quantifiable description of project outputs. This group, also known as the Ecosystem Team (E-Team), consists of biologists from:

SEWRPC	LCSMC	FPDCC
LCFPD	ISWS	IDNR
NRCS	USFWS	USACE

A detailed description of the assessment methodologies, modeling and variable sampling procedures are provided in Appendix C:

- USACE. 2005. A Survey of Riverine Fish Assemblages and Habitat of the Upper Des Plaines River System.
- USACE. 2006. A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Depressional Wetlands in the Upper Des Plaines River Basin.
- USACE. 2009. Community Models for the Upper Des Plaines River Watershed, IL and WI.

Two methods were used to quantify the quality of identified cover types, the Habitat Evaluation Procedure (HEP) and the Hydrogeomorphic Assessment of Wetlands (HGM). Both methods have a long history of use by several federal, state and local agencies and have been used extensively throughout North America. The HEP methodology uses an ecologically based mathematic model called the Habitat Suitability Index (HSI). In the past, the HSI was primarily used for a single species' habitat requirements; however, the model has evolved to utilize multiple species or community level characteristics to assess the quality of habitats. The HGM method utilizes a model referred to as the Functional Capacity Index (FCI), which is an ecologically based mathematical model, derived from the assessment of physical and biological functions of wetlands. This study uses the FCI to assess the functionality and quality of isolated and floodplain wetlands, while other cover types are assessed using the HSI model. Both models were developed and calibrated specifically for the study area.

Cover type (Table 5.3) quality was quantified by measuring an array of habitat variables through data collection from reference sites, previous scientific studies, and historical accounts. Variables are attributes of the habitat that can be directly measured such as, species richness (number of species), proportion of edge to core area of the habitat, source of water, and type of adjacent land use practices. Typically, several measures of each variable are taken for each cover type contained within the designated sampling site. The arithmetic mean was then calculated per variable per cover type. Each variable per cover type is normalized by assigning a score based on Suitability Index (SI) curves, where scores range from 0.0 (lowest quality) to 1.0 (highest possible quality or optimum range), are based on data collected in the field and are calibrated according to the range of variable means measured from natural areas displaying the least disturbance within the study area. The variable scores are then aggregated step-wise into mathematical formulas to generate a geometric mean that numerically represents the quality of each cover type, again ranging from 1.0 to 0.0.

Table 5.3 – Des Plaines River Watershed Habitat Cover Types

Acronym	Cover Type	Community Type	Assessment Method
LAKEGLACL	glacial lakes	Natural	HGM / Isolated Depression
STREAMS	rivers & streams	Natural	Riverine / IBI - QHEI Indices
MARSHBASIN	basin marshes	Natural	HGM / Isolated Depression
MARSHSTRMS	streamside marshes	Natural	HGM / Floodplain Depression
MEADOW	sedge meadows	Natural	HGM / Isolated Depression
FENS	fens	Natural	HGM / Isolated Depression
PRAIRIEDRY	dry & mesic prairies	Natural	HEP Prairie Model
PRAIRIEWET	wet prairies	Natural	HEP Prairie Model
SAVANNADRY	dry-mesic & mesic savannas	Natural	HEP Savanna Model
SAVANNAWET	wet-mesic savannas	Natural	HEP Savanna Model
WOODLNDDRY	dry-mesic & mesic woodlands	Natural	HEP Woodland Model
FORFLPLWET	wet-mesic & wet floodplain forests	Natural	HEP Woodland Model
FORNFLATS	northern flatwoods	Natural	HEP Woodland Model
FORUPLWET	wet-mesic forests & woodlands	Natural	HEP Woodland Model
LAKEARTIFC	artificial lakes	Anthropogenic	HGM / Isolated Depression
DETENTION	detention ponds & borrow pits	Anthropogenic	HGM / Isolated Depression
AGCROPLAND	agricultural croplands	Anthropogenic	HEP Prairie Model
PARKS	parks, open recreation	Anthropogenic	HEP Prairie Model
PASTURES	pastures, haylands and urban fields	Anthropogenic	HEP Prairie Model
URBAN	urban lands (residential, roads, etc)	Anthropogenic	HEP Prairie Model

Baseline data (i.e., curve calibration is the standard protocol for the HEP/HGM methods) was developed from the average of the variable data collected from all the reference sites in the field for a specific cover type. In some instances, the county average of the variable data for a specific cover type was used. Ultimately, the curves developed for the watershed were the result of an iterative process where the E-Team (Interagency Ecosystem Assessment Team) directed the model developers (Burkes-Copes and Webb 2009) to refine the curves to better reflect reality as they perceived it “in-the-field”. These changes are a part of the standard protocol implemented during the HEP/HGM process and are documented in Burkes-Copes & Webb 2009, found in Appendix C. In the documentation, curves that had been altered as directed by the E-Team “expert judgment” are presented as “red” curves in the graphs and supporting text. For example, after reviewing the preliminary results, the percent forb canopy cover variable curve was adjusted based on the opinion of the E-Team to better reflect the broader watershed conditions. The variable data was then used to calculate HSI/FCI scores for all sites. To achieve overall outputs, the HSI/FCI scores were multiplied by the amount of area within each respective cover type associated with the individual HSI model or HGM subclass. The results from this equation are referred to as Habitat Units or Functional Capacity Units (HU/FCU).

Based on an analysis of soil unit classification descriptions, hydrologic influences and aerial maps of vegetation structure the current condition of the watershed was mapped for the above described cover types. This analysis identified around 5,128 acres of prairie cover type, 3,593 acres of savanna cover type, 22,175 acres of woodland cover type, 6,109 acres of isolated wetland cover type, and 2,288 acres of floodplain wetland cover type identified within the watershed. An average and a range for each variable for each cover type were calculated from the sampled reference sites (Plate 25). A baseline

score was generated from the HEP/HGM models using the reference site based variable data for each cover type (Table 5.4). The total baseline Habitat Units, calculated by multiplying the total acres of each cover type by the HSI/FCI score for that cover type is shown in the table.

Table 5.4 – Watershed Baseline Habitat Units

Cover Type	Acres	HSI/FCI	HUs
Prairie	5,128	0.26	1,333
Savanna	3,593	0.19	686
Woodland	22,175	0.40	8,870
Isolated Wetlands	6,109	0.73	4,460
Floodplain Wetlands	2,288	0.72	1,647

The difference between the north (agriculture dominated) and the south half (urban dominated) of the watershed translates into different types and frequencies of stressors effecting the ecological function of natural areas located within the two relatively distinct regions of the watershed. Because of this disparity the HEP and HGM models were developed with two different baselines and future variable projections, one for the south half (urban) and one for the north half (rural). Based on the knowledge that ecological function is heavily influenced by the dominant landscape use, the alternatives developed for sites located within these two regions were also developed separately. However, both urban and rural restoration alternatives were developed based on the same set of measures described in Section 4. The rural alternatives were evaluated using the rural baseline and variable projections for selected sites located within Kenosha, Racine and north Lake Counties. The urban restoration alternatives were evaluated using the urban baseline and future variable projections for sites located in Cook and south Lake Counties.

Two HEP methods were used to assess riverine ecosystems in the Upper Des Plaines River watershed, the IBI and QHEI. The Region 4 Illinois IBI employs fish the assemblage as the indicator of biological form and function. Fish are not only a highly visible part of the aquatic resource, but they are quite sensitive to the surrounding water and habitat quality. This does not suggest that the use of other organisms is insufficient or inappropriate (Simon 1991).

The ambient condition of the Upper Des Plaines River system was evaluated using the IBI (Karr 1981, Karr et. al. 1986, Simon 1991, Smogor 2002). This method makes use of a systematic process to set quantitative criteria that enables the measurement of riverine stream quality. This index employs ten parameters or “metrics” based on structural and functional components of the fish assemblage. Structural components include diversity, taxonomic guilds, and abundance. Functional components include feeding or trophic guilds, reproductive behavior, tolerance to adverse environmental stressors, and individual stresses (Simon 1991, Smogor 2002). These metrics are calibrated for differences in stream size and geographic region. The following 10 metrics may each receive a score 0 to 6, based on comparison to unaltered reference sites, with a total IBI score ranging from 0 to 60 (Smogor 2002):

1. Number of native fish species
2. Number of native Catostomid species
3. Number of native Centrarchid species
4. Number of native intolerant species
5. Number of native Cyprinid species

6. Number of native benthic insectivore species
7. Proportion of individuals as specialist benthic insectivores
8. Proportion of individuals as generalist feeders
9. Proportion of individuals as obligate course-mineral substrate spawners and intolerant
10. Proportion of tolerant species

The Qualitative Habitat Evaluation Index (QHEI), developed by the Ohio EPA was employed to assess the habitat quality of the Upper Des Plaines River system. The QHEI consists of eight criteria with a maximum total of 100 points:

1. Characterization of substrate types and the effects of siltation
2. Characterization of in-stream cover
3. Characterization of channel morphology
4. Characterization of the riparian zone and bank erosion
5. Assessment of the pool / glide & riffle / run
6. Gradient
7. Shade
8. Channel incision

Five transects were completed for each site. The sites were assessed from a river right descending perspective. The transects were dependent and based on the area sampled for fishes and began some distance up or downstream from evident bridge disturbance to the stream; however, the impacts from these structures should be taken into consideration when developing restoration measures. A variable of impoundment was added to the QHEI for this particular study under the channel morphology section to give weight to stream connectivity. If backwater effects from a downstream structure impacted the stream section, a score of zero was received, if the stream section was free flowing, a score of nine was received. Other impacts of dams were indirectly reflected in stream morphology and function parameter.

5.3.2 Future Without Project (FWOP) Conditions

The FWOP conditions in general would continue to degrade in several specific areas including dominance of non-native vegetation, low remnant habitat acreage and overall poor native habitat structure, and visual aesthetics. Invasive species would continue to spread and replace native plant species, creating habitats that favor generalists over specialists, thereby decreasing or eliminating foraging and breeding habitat for native fauna. Acreage of successional woodlands would continue to expand and eventually eliminate rare and significant ecosystems. Any remaining seed banks of remnant habitats would become depleted as fire-suppressed areas with resultant woody growth would continue the current inhibition of their germination. Hydrological processes and nutrient cycling would continue to function in an impaired state, further disrupting and inhibiting critical interrelationships between hydrology and the watershed's flora and fauna.

As the structure and function of the current habitat declines through these stressors, the watershed's ability to supply migratory and resident birds with resting and foraging habitat would decline. The Upper Des Plaines River watershed is a key component of the Lake Michigan Flyway. Lake Michigan's shoreline is acknowledged as a globally significant flyway and one of the most important flyways for migrant songbirds in the United States by ornithologists and bird watchers worldwide. An estimated 5,000,000 migrant songbirds which represents a noticeable fraction of the total number of

migrant songbirds moving through the entire North American continent use the shoreline as their north-south reference in addition to many other species of birds. Many migratory birds must pass twice yearly above a continent suffering huge development pressures and offering fewer and fewer productive stop-over sites for birds. Without locations that provide the right kind of high calorie, high protein food such as seeds, fruit and insects and shelter sufficient to protect them from predators and extremes of weather, the long-distance journey becomes more arduous and even fatal. When migratory birds cross into Illinois, they encounter a monoculture of corn and soybean fields throughout most of the state which are not fertile stop-overs.

Analysis focusing on watershed streams and rivers suggests the FWOP condition to be the current present condition. Data from a 30 year period show that stream conditions have not changed much in terms of biological integrity and habitat quality. If no in-stream restoration activities were to occur, these streams would be roughly in the same condition in 50-years based on reasonable foresight. The Hofmann, Fairbanks, Armitage, and Ryerson dams are removed, and the Dan Wright and MacArthur Woods dams (scheduled for removal in 2013) will be removed under the conditions. These actions will improve certain reaches of river, but the five remaining dams still fragment lower system from the upper system. These actions were considered in the future without and with conditions for those sites that would benefit. It was assumed there would be improvement in riverine habitat and an increase is species richness since free flowing hydraulics and fish passage would then be possible. These dams are scheduled to be removed by 2013. There have been no significant riverine restoration projects in the past nor are any reasonably foreseen within the 50 year period of analysis.

In the broader sense FWOP conditions would observe lost opportunities for significant mitigation of greenhouse gas emissions and sequestration of carbon dioxide through wetland restoration. The declining health of the ecosystem and continued reduction of remnant natural communities will also reduce opportunities for research, education, recreation, and aesthetic pleasures.

The problems associated with the watershed are system-wide; therefore, a systems approach to large-scale restoration of native vegetation cover is needed to develop holistic solutions for the Upper Des Plaines River watershed. The study area is politically diverse and the development of system-wide solutions would be very difficult without Federal involvement. A piece-meal approach to addressing watershed problems will not effectively solve or moderate these wide spread issues. There is limited local funding to properly restore the watershed's ecology with sustainable and beneficial habitats. If an initiative were taken by one township or municipality to implement a restoration project, it would not address the overarching problems plaguing neighboring communities within the watershed. This Phase II study affords the opportunity to implement a comprehensive watershed plan, which can only be realized by concurrently leveraging federal and local resources. A watershed approach will help moderate the negative effects of human alterations to the landscape and will effectively reverse or severely limit the long-term trend decreasing biodiversity.

Future without project conditions were modeled with the Riverine, HEP, and HGM models. FWOP conditions are expected to decline minimally without restorative intervention. The reason for the assumption, of minimal decline, is because of the current low quality of the majority of open space within this watershed, which has been described in the above sections. This is to be expected based on massive land cover conversions and habitat fragmentation as a result of intensive anthropogenic activities. The riverine model output is presented as an example of FWOP conditions in comparison with FWP conditions based on the five alternatives that integrate riparian modifications (e.g., stream

remeandering, dam removal, etc.). Model output is presented as average annual habitat units (AAHUs). For instance, the riverine model has an output of 1,737 AAHUs for FWOP for all sites under consideration. All restoration alternatives (Alt5-Alt9) result in an increase in AAHUs, which indicates that restorative actions will increase the overall quality of the riverine and riparian zone and provide benefits to the environment.

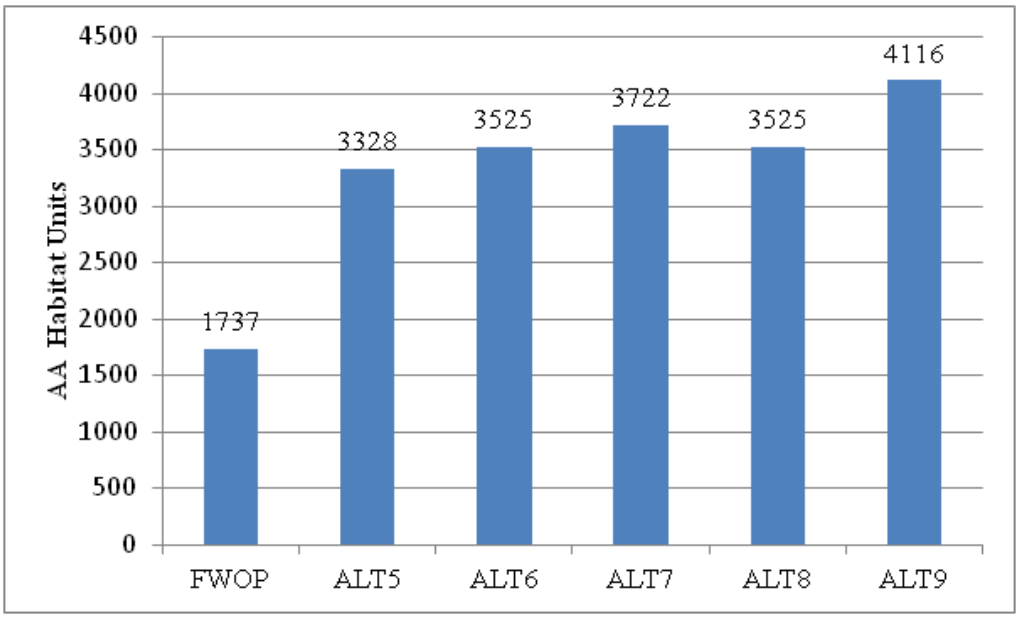

Figure 5.1 – Riverine FWOP vs. FWP Model Output Comparison.

While climate change could have an impact on the future conditions in the watershed, 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 outputs. Increased temperatures or rainfall may lead to changes in the ecosystem of the project area; however, in this study area Lake Michigan can drive weather patterns in the Chicagoland area and will partly buffer /mitigate changes to ecosystems as a result of climate change.

5.4 Ecosystem Restoration 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 incrementally cost effective for implementation.

Plan formulation for ecosystem restoration (ER) presents a challenge because alternatives have non-monetary benefits. 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 to guide the formulation process. These principles, reissued in October 2012, are defined in Section 9.6.2. 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.
2. Formulate management measures to achieve planning objectives and avoid planning constraints. Measures are the building blocks of alternative plans.
3. Identify and select those sites 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.

5.4.1 Ecosystem Restoration Measures

Ecological restoration measures are the basic building blocks for developing alternatives. Some measures, such as dam removal, stand on their own and provide significant ecological output. Others, such as invasive species removal and soil nitrogen depletion, are dependent on each other to support restoration. All measures include activities requiring Corps expertise to restore ecosystem structure and function over the entire evaluated footprint. Only lands needed for restoration activities were identified for acquisition. The goal of aquatic ecosystem restoration is to provide stream, wetland, and riparian habitat for higher level organisms such as fish, amphibians, reptiles, birds and mammals. The quality and success of these habitats and resultant colonization is dependent on the three fold interaction between hydrology-hydraulics, geomorphology-soils, and plant-fungus-microbe structure. Measures were identified that would result in synergy between these critical aspects to achieve sustainable and functioning ecosystems within the Upper Des Plaines River watershed.

5.4.1.1 Hydrologic Restoration Measures

These restoration measures would result in the repair of hydrologic functions as a first effort to store water naturally and to restore native plant communities that are characteristic of the site. This group of measures would include tile breaking, ditch filling/plugging, removing soil compaction. Hydrologic restoration would be quite beneficial in enhancing soil infiltration, reducing initial runoff and increasing base flow during dry periods.

H1 Tile Disablement: Agricultural drain tile fields are known to exist throughout the Upper Des Plaines River watershed. These effectively disrupt the natural hydrologic regimes of both the and the wetlands, especially in the large marsh basins in the headwaters. Tile disablement is one of the best and most cost effective methods of hydrologic restoration. This is because it typically recreates the natural hydrologic regime of the site, the one to which the species native to the site are adapted, and does not require intensive maintenance in most cases.

There are several methods for the disablement of drain tile and their applicability varies from location to location. In flat lands, tiles are typically valved and/or crushed at select intervals. In more rolling topography, plugs are installed much closer. Disablement could also be accomplished by excavation and removal of the tile from the entire field; however, this would require significant site disturbance. Installation of valves and/or plugs, which requires very little disturbance, has been shown to be equally effective. It should be noted that many drain tiles eventually collapse in the absence of maintenance and replacement. Use of valves and plugs also allows for adjustment of the design to avoid negative impacts to neighboring properties.

H2 Ditch Filling / Plugging: Agricultural ditches are located throughout the Des Plaines River watershed. These effectively disrupt the natural hydrologic regimes of native plant communities, especially when natural streams were excavated. Ditch filling and plugging is another cost effective method of hydrologic restoration. These measures will typically recreate the natural hydrologic regime and landscape of the site and do not require periodic maintenance, thereby maximizing biodiversity and minimizing future artificial disturbances to the site.

There are several methods for ditch remediation and their applicability varies from location to location. Small ditches that were never a natural drainage channel could easily be filled with a small dozer by pushing fill into the ditch and finishing to landscape grade. Large unnatural ditches can be plugged with earth or structures, the result would include a long open body of water that is not characteristic of the landscape-aimed restoration. A ditch that was once a natural stream may be remedied through the stream restoration measure described in H3.

The decision whether to implement ditch filling or plugging depends on a number of site specific factors that will be uncertain until detailed analysis is completed during the design phase. The critical factors in feasibility level decisions are whether restoring the hydrology will provide benefits, whether the anticipated costs are justified, and whether adverse effects can be avoided. Although ditch filling is the preferred restoration method, the feasibility level cost estimate assumes a combination of ditch filling and plugging to account for adaptation to site conditions and design requirements.

H3 Cobble Riffle as Naturalization Structures: Cobble riffles can be installed to raise the water levels in ditches and channelized streams and to prevent further channel incision. Adjusting the riffle crest to the desired elevation would influence the ground water table upstream of the riffle, while allowing for fish passage. The placement of a riffle would also increase habitat diversity in terms of substrata and flow. Compared to the uniform flow conditions of a channelized reach, cobble riffles increase and diversify the velocity of flow, which in turn increases the complexity of in-stream habitat, which is essential for a diverse riverine community. These riffles provide substrate and flow velocity for microorganisms and macroinvertebrates, and improve water quality by facilitating gas exchange.

These riffles would be created from alluvial material consisting of boulders, cobbles, and gravel resembling substrates of the region, and would be sized properly to withstand peak discharge events. Riffle material would be deposited at a staging area at the restoration site, sorted by stone size, and then placed in the river to specified elevations.

H4 Soil Compaction Removal: Compaction is a mechanical process that increases soil density or unit weight, accompanied by a decrease in interstitial space for air and water percolation and subsurface flow. Agricultural fields become compacted overtime from machinery. Compaction

discourages the growth of native plant species and disrupts hydrology by ponding too much water or not allowing natural subsurface groundwater process to occur.

Minor soil compaction can be relieved through aeration, which consists of the removal of small plugs of soil to make space for aeration and water transfer. More significant soil compaction can be alleviated through disking or deep plowing.

H5 Excavation: This measure would focus on removing layers of sediments that currently cover natural soil types or removing layers of soil to achieve proper hydrology (in particular to remove beds of reed canary grass *(Phalaris arundinacea)*. Layers of sediment may have accumulated over the years due to poor erosion control methods and the lack of Best Management Practices. Removing these depositions would aid in the restoration of native plant communities and may expose the native seed bank below. Removing layers of soil that have fully established beds of reed canary grass may be necessary if a native plant community is to be restored. By removing the seed contaminated layers and creating areas of standing water would create situations that do not favor this highly invasive species.

H6 Impervious Surface Removal**:** This measure would remove old parking lots or former roads where native habitat could be restored. Very few sites would be in need of this measure.

5.4.1.2 Riverine Restoration

R1 Dam Removal / Bypass: Most of the dams and impoundments within the Upper Des Plaines River system are classified as small, run-of-the-river low-head dams. Very few of these dams currently serve a purpose and were constructed in the past to service gristmills and recreational pools. This measure would address the resource problems associated with dams that impound and fragment streams and rivers. Dam removal will benefit fish passage, habitat restoration and water quality. This measure applies to the mainstem Des Plaines River dams for complete removal only.

R2 Sinuosity Reestablishment: A method to restore a previously channelized section of a stream first involves deciphering historic flow paths to return the stream to a sinuous form, and if possible to re-engage the stream or river with its floodplain. Historical aerial photographs and topographic maps of the reach may be used to determine where the original channel geometry was located prior to channelization. The historic stream valley may also be used to identify topographic elevations and soil types.

Methods used to restore stream sinuosity are physically meandering the stream by excavating a new channel or simply setting the stream back in motion, allowing natural processes to restore meanders. Channel excavation requires significant environmental disruption and has much higher costs than natural meandering. Therefore, natural meandering is the method selected for this study. The stream channel would be redirected with a series of directional riffles. A temporary, quasi-graded floodplain would allow the stream to establish its functions more quickly. The shifting habitat mosaic of the riverine system may again be established by restoring cut and fill alleviation and returning stream power to the floodplain. At sites where this is not possible, such as urban / residential streams, bank terracing and stream grade control will be considered, as described below.

Restoring natural instream complexity includes the addition of large and/or small woody debris from natural sources to the stream channel. Woody debris and large boulders are essential for pool

formation, exposure of hard substrates, flow velocity diversification, and cut and fill alluviation. Removal of riprap and foreign debris from the stream channel will actually increase the natural stream complexity by allowing cut and fill alluviation to go unimpeded. Riparian corridors may be restored in varying widths, which are dependent on site characteristics and other restoration features, such as plant community restoration. This measure would restore riverine habitat that could be recolonized by native herpetofauna, fishes, mussels and macroinvertebrates.

R3 Cobble Riffles: Riffle-pool sequences are one of the preferred methods to restore degraded agricultural and urban stream habitat, and to prevent further channel incision. The placement of a riffle would increase habitat diversity in terms of substrata and flow. Compared to the uniform flow conditions of a channelized reach, cobble riffles increase and diversify the velocity of flow, which in turn increases the complexity of in-stream habitat, which is essential for a diverse riverine community. These riffles provide substrate and flow velocity for microorganisms and macroinvertebrates, and improve water quality by facilitating gas exchange.

Riffles would be created from alluvial material including boulders, cobbles, and gravel resembling substrates of the region, and would be sized properly to withstand peak discharge events. Riffle material would be deposited at a staging area at the restoration site, sorted by stone size, and then placed in the river to specified elevations.

5.4.1.3 Plant Community Restoration

These restoration measures would result in the re-establishment of plant community functions and, as a secondary effect, increase capacity of the site to store water. This will restore the physical habitat structure that is characteristic of the given site. This group of measures would include removal of invasive species and reestablishing native flora through planting seeds, plugs, bushes and trees. There may be some instances where the flora may recover independently from a remnant seed bank once the hydrology is returned. Some areas would have to be seeded with the appropriate native seed mixes for a particular community type, which is based on elevations, soils and hydrology.

P1 Invasive Woody Vegetation Removal: Many natural areas are densely wooded with invasive and/or non-native species, at least partly due to fire suppression. Fire suppression causes numerous problems that include: loss of native ground cover species through the reduction in light levels and other mechanisms, reduced reproduction of native trees such as oaks, which require minimum light levels to survive, increased soil erosion because of the loss of ground cover species, loss of forage species especially graminoids and mast producing shrubs, and loss of habitat for native fauna

The most efficient way to remove invasive woody shrubs and small trees is to cut stems, treat the stumps with herbicide, and perform follow-up herbicide treatment and prescribed burning (see below). Herbicide treatment of resprouts is typically required. Cutting alone will result in an increase in stem count for most woody invasive species due to stump sprouting, because these species are often adapted to grazing and browsing. Follow-up herbicide application will ensure removal of these woody invasives.

Girdling can kill most trees except white poplar and black locust. It is a highly cost effective method for invasive woody control especially of larger trees. Girdling is best implemented in late spring/early summer. The method requires two parallel cuts, to the depth of the smooth wood of the xylem, that are

several inches apart. Thus it severs the phloem and prevents photosynthetic energy from leaves from reaching roots, which results in the death of the tree in 1-3 years. The presence of inaccessible shunts may somewhat prolong the life of the tree. The parallel cuts must be separated enough that bark cannot reform over the girdle. Cuts lower on the trunk are preferred for aesthetic reasons, but require more effort. Suckers must be removed. Herbicide can be painted over the girdle and on suckers if an immediate result is desired but this adds expense. These now dead trees are termed "snags", which provide habitat for many species, but are not favored in prairie restorations where grassland birds may recolonize. Grassland birds will not nest on sites with live or dead trees. It is thought that this is an adaptation to predation by raptors.

P2 Invasive Herbaceous Vegetation Removal: Mowing should be used to control annual weeds after an area is cleared, whether or not it has been planted. The seed bank of adventive and ruderal species can be quickly exhausted by mowing at the appropriate time of year, before seed has set but after the plant has flowered and the start of seed production. Mowing as well can deplete some perennial weeds.

Mowing should not be used as a primary method for the removal of invasive species, especially shrubs. It will cause many shrubs to send up suckers, thus adding to the problem rather than solving it. Mowing also may destroy habitat for insects in less disturbed areas, compact the soil, and kill larger animals.

Once sufficient plant material is established to provide fine fuels, prescribed burns are an important component of the restoration and long-term management of the site. Dormant seeds of invasive species can germinate after an area is cleared and light again reaches the soil. Burns are a cost effective and less risky method for the control of young growth compared to the extensive use of herbicide on juvenile plants. A sufficient matrix of grasses must be present to fuel the fire. Fire should be used on an annual basis for two-three years after clearing to control germination of invasive species and on a less frequent rotational basis for longer-term maintenance of the restored area. All controlled burns will require the contractor(s) to acquire various permits depending on where the project is located. These permits dictate safety and coordination requirements. Also, during the PED phase, specific coordination with adjacent land owners would take place to ensure controlled burns are understood and supported locally. Considerations for burns include, but are not limited to weather and wind patterns, notification of local fire and police departments, and strategic plans provided by contractors as a submittal requirement.

P3 Soil Nitrogen Depletion/ Soil Amendments: This measure seeks to deplete nitrogen (N) levels in areas with excess inorganic nitrogen where monospecific stands of invasive species have established using soil microbial processes triggered by the addition of high carbon-to-nitrogen (C:N) soil amendments. This measure limits the establishment of invasive vegetation, allowing favorable conditions for desired native species to outcompete invasive species. Specific tasks would include the incorporation of a high C:N sawdust into the top 20 cm of soil in the fall (immediately preceding seeding). In urban situations, additional amendments would need to be added to unnatural soils to increase carbon content and reduce compaction, such as organic materials or sand.

P4 Native Seed Bank: In many areas where landscape and the natural soils are still intact, a diverse and somewhat high quality seed bank is likely to be present. Restoration of hydrology and the discontinued anthropogenic uses of the site may allow the native plant community to reestablish itself.

Management of non-native and invasive plant species accompany this measure, which may include sowing of a cover crop, mowing, burning and selective herbicide application.

P5 Seeding: The use of local genotypes is strongly favored in ecosystem restorations because local genotypes are likely to be the best adapted for the specific conditions of any given site. This must be balanced by the following concerns.

If a site has been disturbed, especially in its hydrology, the local genotype may no longer be adapted to that site. More diverse seed sources should be considered under that circumstance, with the goal of introducing a wide genetic variation that, over time, will result in a genotype that is adapted to the contemporary conditions. The plants needed for seed may be rare in the vicinity and the removal of propagules cannot be justified from any site. The cost of seed collection may be too high. If the local sponsor or an active volunteer program cannot supply skilled collectors, professionals must be employed to collect the seed. Often a sufficient quantity of locally collected seed to revegetate a large site is not available. In this circumstance, growers must be employed to produce a large enough volume of seed to produce a viable population. This also increases project duration and cost.

Nevertheless, collection and contract growing of species indigenous to the site and not available in the trade may be required to achieve a diverse and healthy plant community. If the plant is regionally rare, there may be a special concern to maintain that genotype.
Seed collection should occur throughout the growing season as different species reproduce in spring, summer, and fall. A frequent problem with restorations is that species that flower at a particular time of year are favored because of the seed collection time. Many, but not all seeds can be stored for different periods of time, but some species, particularly some *Carex* sp., need to be sowed immediately. Nurseries carry premixed seed mixes that provide an inexpensive method for site revegetation, but it may not include local genotypes or the seeds may not meet site-specific conditions. Nurseries can also be employed to grow seed collected from the site and its immediate environs or to produce a custom mix of native species.

P6 Plugging: While many desired native species can be readily established directly from seed, other species do not respond as well. In addition, concerns about competition from weeds may require a faster establishment of the desired native vegetation matrix. Thus planting plugs (small container grown plants) and rootstock of some species is desired. While possibly more expensive than seeding, many restorations employ a mix of seeding and introduction of plugs at varying densities to maximize establishment of an appropriately diverse native plant community.

P7 Tree/Shrub Planting: While many desired native species can be readily established directly from seed, trees and shrubs do not respond as well. In addition, consumption by deer and small browsing mammals require a faster establishment of the desired native tree to combat this situation. Thus planting trees and shrubs from 1 to 5-gallon root balls and rootstock is desired.

5.4.2 Site Screening and Selection

This step of the planning process uses a large array of sites based on open space available in the watershed. Using aerial photos (captured in 2005 and reassessed in 2012), GIS analysis of the watershed was completed to identify all potential open spaces within the Upper Des Plaines River watershed. Most boundaries for sites were based on features such as land use, roads, watershed

boundaries, property boundaries, and land designations. Sites that are currently developed or less than 5 acres were eliminated from consideration in the selection process. The GIS analysis resulted in 713 total sites that could be assessed with the Ecosystem Restoration (ER) screening criteria (Plate 26).

The next step was to identify those sites that had the greatest restoration potential within the USACE mission to be carried further along in the plan formulation process. The Ecosystem Committee (E-Team) developed a list of criteria that each site should meet in order to identify those sites that are most consistent with USACE restoration projects and in providing benefits to the Upper Des Plaines River watershed (Table 5.5). These criteria were established by local ecologists and scientists that are well versed in the flora, fauna and systems of the Upper Des Plaines River watershed.

The goal of ecosystem restoration is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. Restored ecosystems should mimic, as closely as possible, conditions which would occur in the area in the absence of human changes to the landscape and hydrology with a minimum of maintenance. This includes an emphasis on materials and species native to the project location. Those restoration opportunities that are associated with wetlands, riparian and other floodplain, and aquatic systems are most appropriate for USACE involvement.

The criteria in Table 5.5 were developed with the intent to maintain a nationwide perspective to assure that available funding is used to provide the most cost effective restoration of nationally and regionally significant resources. The intent of using these criteria was to identify sites that required hydrologic (wetland/floodplain), hydraulic (riverine), geomorphic (riverine/wetland) and riparian restoration that would maximize habitat diversity for a variety of native species including endangered species, and provide connectivity to other natural areas. Each of the objectives and criteria for this study was designed to select a restoration plan is consistent with the Ecosystem Restoration goals. The criteria in Table 5.5 correspond to the Ecosystem Ranking Criteria in EC 11-2-194, Appendix II-2-10:

- Habitat Scarcity**:** A & B
- Connectivity**:** C, E, & F
- Special Status Species**:** F
- Hydrologic Character**:** C & D
- Geomorphic Condition**:** B, C & D
- Self-Sustaining**:** All
- Plan Recognition**:** E & F

Table 5.5 – Ecosystem Restoration Site Selection Criteria

#	Screening Criteria	Score	Description	Policy Correlation
A	Potential Restoration Acreage (based on site polygon size)	3	greater than 100 acres	Habitat Scarcity Self-Sustaining Biodiversity Limiting Habitat
		2	between 50 & 100 acres	
		1	between 20 & 50 acres	
		0	less than 20 acres	
B	Number of Potential Cover Types (based on NRCS soil mapping)	3	6 or more	Habitat Scarcity Geomorphic Condition Self-Sustaining Biodiversity
		2	4:5	
		1	2:3	
		0	0:1	
C	Proximity to a Stream (based on USGS streams coverage)	3	direct riparian zone	Connectivity Hydrologic Character Geomorphic Condition Self-Sustaining
		2	between 0 & 200 feet	
		1	between 201 & 500 feet	
		0	over 500 feet	
D	% of Site as Hydric Soils (based on NRCS soil mapping)	3	75:100%	Hydrologic Character Geomorphic Condition Self-Sustaining
		2	50:74%	
		1	25:54%	
		0	0:24%	
E	Proximity to an existing natural area (based on IDNR and WDNR datasets)	3	within ¼ mile buffer	Connectivity Self-Sustaining Plan Recognition
		2	between ¼ & ½ mile buffer	
		1	between ½ & 1 mile buffer	
		0	over 1 mile buffer	
F	Proximity to species that are state listed (based on IDNR and WDNR state endangered species datasets)	3	within ¼ mile buffer	Connectivity Special Species Status Self-Sustaining Plan Recognition
		2	between ¼ & ½ mile buffer	
		1	between ½ & 1 mile buffer	
		0	over 1 mile buffer	
Maximum Points		18		
Minimum Points		0		

Each site could receive a maximum point score of 18, which would equate to having a high potential for ER benefits, whereas a minimum score of 0 would equate to a site having a very low potential for ER benefits. The potential restoration sites were evaluated through screening criteria using ArcView 9.0 GIS software in order to provide a list of sites that had the greatest potential for ecological restoration. Sites with a total of eleven points were selected for further consideration. A site with 12 or more points would have an average score of at least two of the six criteria, with any low scores balanced by higher scores in other criteria. These sites, therefore, are ones that are most likely to succeed in meeting the planning objectives. However, in order to avoid eliminating sites with good aquatic ecosystem restoration potential, the cut-off was set at 11 points to include any additional significant areas that would be considered borderline by these criteria. The cost-effective/incremental cost analysis would then determine the final array. The result of this initial analysis was that 131 sites were retained. These sites are shown in Plate 27.

5.4.3 Measure Costs & Assumptions

Detailed discussion on planning level feature costs is presented in Appendices C and F. Conceptual, planning level cost estimates were prepared for measures/features that were identified by the study team. These measures/features were quantified by measuring distances, acres, square feet, etc utilizing geospatial analysis tools; therefore, each site was custom fitted with measures and appropriate quantities and costs. 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 alternative plan formulation process was completed, and additional design information was developed for the Recommended Plan, a more detailed and reliable cost estimate was performed (Appendix F). Estimates were developed using cost information from previous studies, lump sum and unit prices, for plant, and labor and material methods.

Implementation Cost: The planning level costs were based on quantities for a 60 acre site. An average construction duration of 12 months was assumed. 10% profit was included for the prime contractor. There was only one sub-contractor used in the estimate for drain tile disablement. Depending on the contracting mechanism for these jobs, it may be reasonable to adjust to account for an earthwork contractor as a sub or a prime with a landscape contractor as the sub. A 25% contingency was applied. Escalation was accounted for through year 2019. Fuel rates are currently shown as $4.00 for unleaded gasoline, and $4.25 for diesel fuel (on-road) and $4.00 for diesel fuel (off-road). Labor rates were derived from the following: Service Contract Wage Determination 03-0288 (Rev. -9) dated 02 June 2009: for Forestry and Land Management Services. Because some of the work is demolition, and earthwork, it is reasonable to use wage rates for construction, as these are in keeping with current market conditions. Therefore, the Davis-Bacon Wage Rates were used for heavy landscaping. See Appendices C and F for detailed assumptions per measure.

Monitoring: Section 2039 of WRDA 2007 directs the Secretary of the Army to ensure that, when conducting a feasibility study for a project (or component of a project) under the USACE ecosystem restoration mission, the recommended project includes a monitoring plan to measure the success of the restoration. For complete details on the monitoring plan and associated measures, see Appendix M.

Annual Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R): The OMRR&R costs estimated during the feasibility phase will vary from project to project depending on the restoration measures described within the recommended alternative. If no annual OMRR&R is recommended then the annual cost is zero. For projects that have recommended alternatives that call for any type of vegetation reestablishment or control, management of native vegetation will be required such as prescribed burns for certain cover types, mowing, invasive species removal/control and reseeding of with native plant species. OMRR&R costs are projected to occur after the completion of the construction phase and continue for the period of analysis, 50 years. Costs for any management measures were predicted per year per site (based on area affected and frequency of treatment) and these costs were annualized for the period of analysis. The OMRR&R cost is included in the annualized project cost estimate and will not be cost shared.

Costs per OMRR&R activity were based on the unit costs used to calculate the total planning level construction costs per site. The unit costs are shown in Table 5.6. These are typical activities conducted within naturalized areas to maintain a targeted level of ecosystem integrity. Every activity is not needed every year. For example, burning is not recommended every year. Research indicates that the historical fire regime in this area was around every three years and even then it was patchy in nature. Current practices follow a 3-year rotation while limiting burning anywhere between a quarter to half of the site at a time. Management regimes also vary between community types. A wet floodplain forest would not require burning, but may include more intensive invasive species control

for woody species. OMRR&R costs for each site were calculated based on the amount each specific community type, the reoccurrence and frequency of activities, and the site location (urban or rural).

Table 5.6 – OMRR&R Unit Costs

Activity	Reoccurrence (Years)	Cost per Acre
Burning	3	[redacted]
Mowing	3	
Invasive Control (herbaceous)	1	
Invasive Control (Woody)	2	
Seeding	5	

(FY2010 Price Level)

Total OMRR&R costs are a small percentage of the initial construction costs. This is due to both the financial and technical aspects of the upfront construction activities. The current conceptual designs per site would result in a self-sustaining and self-organizing native community that will need very low input of energy and effort to maintain. The main construction work includes two to five years of controlling invasive species and maintaining a diverse native plant community. Once this work has been completed, maintaining at the same level of ecological integrity requires a much lower level of effort then the original contract. While the cost per activity is the same used to calculate total construction costs per site, the difference in the magnitude and frequency of implementing these activities results in a much lower total cost.

Total Annualized Cost: Equivalent annualized cost is calculated amortizing project costs, discounted to a base year, 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. 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 this project is 50 years. Discounting to the base year is the present value method. Costs are compounded or discounted to present value at the base year then amortized over the 50-year period of analysis to give the equivalent annual cost. The Federal Discount rate current at the time of the analysis, 4.375%, was utilized for the analysis. (Economic Guidance Memorandum 10-01, Federal Interest Rates for Corps of Engineers Projects.) Examples of several site's cost annualization per alternative are presented in Appendix C.

LERRD Value: Preliminary real estate costs, based on estimated per acre values, were used for planning level analyses. Lands, easements, rights-of-way, relocations, and disposal areas (LERRD) values were incorporated in the second round of CE/ICA when sites are compared against each other. LERRD values were not used for the first round since comparing alternatives within the same site is not affected by the site's own real estate value.

Pre-construction, Engineering and Design (PED) Phase: PED Costs are set at a standard of 7% of the total construction cost and was used for this cost element to conservatively reflect further work to be completed on the Recommended Plan. This cost includes any required future sampling, testing, and modeling, as well as more typical design analysis activities.

5.4.4 Ecosystem Restoration Alternatives

5.4.4.1 Rural Restoration Alternatives and Associated Measures (Table 5.7)

Rural restoration alternatives would be applied at sites in Racine and Kenosha Counties as well as the northern portion of Lake County.

Alternative R1: This alternative plan consists of restoring the site's hydrology only. This would include removal of farm drain tiles, soil compaction removal, filling unnatural ditches, adding cobble riffle control structures to raise the ground water table and adding ditch plugs in at strategic points to raise the groundwater table as well. There would be no invasive species control or seeding or plugging. This alternative relies on recolonization of the native plant community from nearby source populations and any remaining native seed bank communities. The plant community would be allowed to follow an unmanaged successional pathway.

The decision whether to implement ditch filling or plugging depends on a number of site specific factors that will be uncertain until detailed design is developed and construction is underway. Although ditch filling is the preferred restoration method, the feasibility level cost estimate assumes a combination of ditch filling and plugging to account for adaptation to site conditions and design requirements.

Alternative R2: This alternative plan consists of restoring the site's hydrology, as in Alternative R1. In addition, this alternative includes invasive species control and sowing native seed to the appropriate cover types. Appropriate maintenance would be implemented by the non-Federal sponsors to ensure native plant growth and eliminate invasive species threats.

Alternative R3: This alternative plan is identical to alternative R2, with the addition of soil nitrogen depletion, planting cover types with native herbaceous plugs and woody tree and shrubs. This will expedite site recovery and provide for a quicker accumulation of ecological benefits.

Alternative R4: This alternative plan consists of restoring the site's hydrology, as in Alternative R1, with the exception that certain portions of the floodplain would be excavated to further the influence (or interaction) of riparian flooding cycles (or hydrological regime) within the excavated portions. In addition, this alternative includes invasive species control and sowing native seed to the appropriate cover types. There would be no planting of native herbaceous plugs or woody trees and shrubs. Appropriate maintenance would be implemented by the non-Federal sponsors to ensure native plant growth and eliminate invasive species threats.

Alternative R5: This alternative plan is identical to alternative R1, with the addition of restoring riverine habitat. Riverine habitat restoration consists of stream sinuosity repair, contouring of banks to a more natural condition, cobble riffle placement and woody debris placement.

Alternative R6: This alternative plan is identical to alternative R2, with the addition of restoring riverine habitat. Riverine habitat restoration consists of stream sinuosity repair, contouring of banks to a more natural condition, cobble riffle placement and woody debris placement.

Alternative R7: This alternative plan is identical to alternative R3, with the addition of restoring riverine habitat. Riverine habitat restoration consists of stream sinuosity repair, contouring of banks to a more natural condition, cobble riffle placement and woody debris placement.

Alternative R8: This alternative plan is identical to alternative R4, with the addition of restoring riverine habitat. Riverine habitat restoration consists of stream sinuosity repair, contouring of banks to a more natural condition, cobble riffle placement and woody debris placement.

Alternative R9: This alternative plan is identical to alternative R7, with the addition of removing five (5) dams on the mainstem Des Plaines River to restore connectivity and fish passage. Removal of these dams has implications to benefits at each and every site with the riverine habitat type present.

Table 5.7 – Rural Restoration Alternatives and Associated Measures

		Rural Alternatives								
Measure	**Code**	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**
Hydrologic Restoration										
Tile Disablement	H1	X	X	X	X	X	X	X	X	X
Ditch Filling and Plugging	H2	X	X	X	X	X	X	X	X	X
Cobble Riffle Control Structures	H3	X	X	X	X					
Soil Compaction Removal	H4	X	X	X	X	X	X	X	X	X
Excavation	H5				X				X	
Riverine Restoration										
Dam Removal/Bypass	R1									X
Sinuosity Reestablishment	R2					X	X	X	X	X
Cobble Riffles	R3					X	X	X	X	X
Plant Community Restoration										
Invasive Woody Veg. Removal	P1		X	X	X		X	X	X	X
Invasive Herbaceous Veg. Removal	P2		X	X	X		X	X	X	X
Soil Nitrogen Depletion	P3			X				X		X
Native Seed Bank	P4									
Seeding	P5		X	X	X		X	X	X	X
Plugging	P6			X				X		X
Tree & Shrub Planting	P7			X				X		X

5.4.4.2 Urban Restoration Alternatives and Associated Measures (Table 5.8)

Urban restoration alternatives would be applied at sites in southern Lake County and Cook County.

Alternative U1: This alternative plan consists of restoring the site's hydrology. This would include removal of farm drain tiles, soil compaction removal, filling unnatural ditches, adding cobble control structures to raise the ground water table and adding ditch plugs in at strategic points to raise the groundwater table as well. This includes invasive (herbaceous and woody) species control through mechanical and chemical means, sowing native seed to the appropriate cover types and a 5-year burning cycle and invasive species control for maintenance that continues for the life of the project.

Alternative U2: This alternative is the same combination of measures as U1, plus, converting all urban areas to natural habitat type by removing impervious surfaces and amending substrate to support a native plant community.

Alternative U3: This alternative is the same combination of measures as U2, plus, floodplain wetland restoration, which includes excavating an area within the existing floodplain to restore depressions. These floodplain wetlands will be allowed to succeed to forested communities.

Alternative U4: This alternative is the same combination of measures as U3, plus, installation of shrubs and trees into restored savanna and forested habitat types.

Alternative U5: This alternative is the same combination of measures as U4, plus, installation of live herbaceous plugs into the appropriate habitat types.

Alternative U6: This alternative is the same combination of measures as U5, plus, removal of dams and minimal regrading to re-meander stream (if present on-site) and cobble riffles.

Alternative U7: This alternative is the same combination of measures as U2, plus, floodplain wetland restoration, which includes excavating an area within the existing floodplain to restore depressions. These floodplain wetlands will be seeded and managed as emergent marsh communities.

Alternative U8: This alternative is the same combination of measures as U7, plus, installation of shrubs and trees into restored savanna and forested habitat types and live herbaceous plugs into the appropriate habitat types.

Alternative U9: This alternative is the same combination of measures as U8, plus, removal of dams and minimal regrading to re-meander stream (if present on-site) and the installation of cobble riffles.

Table 5.8 – Urban Alternatives and Associated Measures.

		Urban Alternatives [1]								
Measure	**Code**	**U1**	**U2**	**U3**	**U4**	**U5**	**U6**	**U7**	**U8**	**U9**
Hydrologic Restoration										
Tile Disablement	H1	X	X	X	X	X	X	X	X	X
Ditch Filling and Plugging	H2	X	X	X	X	X	X	X	X	X
Cobble Riffle Control Structures	H3	X	X	X	X	X		X	X	
Soil Compaction Removal	H4	X	X	X	X	X	X	X	X	X
Excavation	H5			X	X	X	X	X	X	X
Impervious Surface Removal	H6		X	X	X	X		X	X	X
Riverine Restoration										
Dam Removal/Bypass	R1						X			X
Sinuosity Reestablishment	R2						X			X
Cobble Riffles	R3						X			X
Plant Community Restoration										
Invasive Woody Veg. Removal	P1	X	X	X	X	X	X	X	X	X
Invasive Herbaceous Veg. Removal	P2	X	X	X	X	X	X	X	X	X
Soil Nitrogen Depletion/Amend Soil	P3		X	X	X	X		X	X	X
Seeding	P5	X	X	X	X	X	X	X	X	X
Plugging	P6					X	X		X	X
Tree & Shrub Planting	P7				X	X	X		X	X

[1] Alts U3, 4, 5, & 6 allow for excavated wetlands to succeed to forest, where Alts U7, 8 & 9 maintain the excavated wetlands as marsh.

5.4.5 Alternative Benefits

Ecosystem benefits predicted to occur from the proposed restoration measures and combined in the different alternatives were analyzed using the Riverine, HEP and HGM models. Through the use of the various ecological indices, predicted benefits were calculated for "FWP" conditions over the entire 50-year period of analysis per alternative per selected site (131 selected sites x 9 alternatives = 1,179 possible future scenarios). The scores generated from the models were then annualized over the entire period of analysis. The calculation of predicted benefits and the annualization of benefits were generated using the software HEAT (Habitat Evaluation Assessment Tools, produced and managed by the USACE ERDC, and for riverine benefits, IBI was used. The FWOP condition for areas that experience land conversion, such as replacing natural cover type with non-natural cover type (e.g., agriculture, urban, detention pond, etc.) were assumed to lose natural structure and therefore function. Areas that are not predicted to undergo land conversion and have been degraded to a point where it is no longer likely to degrade further were assumed to be stable in structure and function. Loss of ecosystem function equates to a significant decrease in "future without project" habitat value. Modeling results suggest there is an overall increase in ecosystem value as alternatives to reduce unnatural disturbances are implemented and further increase when the returned natural structure of selected sites are combined. However, a further analysis of the results does show a close relationship between the size of the area under examination and predicted benefits. This is an expected side effect of using area (in this case acres) to calculate Habitat Units. Although this is an overall trend, the following analysis also takes into account the quality of the site and the cost per benefit. These results suggest that there is a good deal of potential ecosystem benefits to gain within the watershed and that restoration of the function and structure of these selected sites is possible within the watershed. A summary of outputs for each alternative per county is shown in Table 5.9.

Table 5.9 – Summary of Countywide Net Average Annual Habitat Units per Alternative.

		Cook[1]	S Lake[1]	Racine	Kenosha	N Lake	Total
	Acres	5705.55	12653.33	3229.48	46215.93	9558.31	**77,363**
ALT1	**Score**	0.50	0.69	1.02	0.82	0.90	
	Output	2827.26	8703.257	3294.161	37866.622	8638.175	**61,329**
ALT2	**Score**	0.52	0.72	0.91	0.96	1.10	
	Output	2976.104	9051.224	2954.533	44542.288	10482.166	**70,006**
ALT3	**Score**	0.55	0.57	1.02	0.91	0.93	
	Output	3129.43	7616.741	3280.52	41946.738	8851.921	**64,825**
ALT4	**Score**	0.56	0.63	1.02	1.00	1.17	
	Output	3187.15	7984.166	3284.41	46111.8	11195.517	**71,763**
ALT5	**Score**	0.71	0.76	1.04	0.84	0.92	
	Output	4035.72	9676.218	3357.326045	38945.98981	8817.268427	**64,833**
ALT6	**Score**	0.71	0.80	0.94	0.99	1.12	
	Output	4035.72	10153.218	3026.669458	45703.74593	10683.87764	**73,603**
ALT7	**Score**	0.78	0.76	1.04	0.94	0.95	
	Output	4426.46	9561.089	3361.62787	43283.14604	9076.250847	**69,709**
ALT8	**Score**	1.05	0.92	1.04	1.02	1.19	
	Output	5968.4	11580.966	3356.546458	47244.31793	11397.22864	**79,547**
ALT9	**Score**	1.05	0.95	1.05	1.03	1.20	
	Output	5968.4	12057.766	3383.460695	47615.93827	11466.08327	**80,492**

[1]Cook and S. Lake are (U) urban alternatives and Racine, Kenosha and N. Lake are (R) rural alternatives. Output is net average annual habitat units and the score is an overall indicator value based on model output scores.

5.4.6 Cost Effectiveness & Incremental Cost Analysis

The cost effective (CE) and incremental cost analysis (ICA) are two distinct analyses that are conducted to evaluate the effects of alternative plans and for this study are twofold. A first CE/ICA was run to ascertain the best alternative to restore a particular site, and then a second CE/ICA was run to ascertain the most beneficial sites to restore per county, to obtain a watershed plan.

First, it must be shown through a CE analysis that a restoration plan's output cannot be produced more cost effectively by another means. 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.

Through ICA, a variety of various-sized alternatives are evaluated to arrive at a best level of output within the limits of both the sponsor's and the USACE 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." 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. Usually, 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, efficiency, risk/uncertainty, reasonableness of costs) to help the study team select and recommend a particular plan.

The USACE's Institute for Water Resources (IWR) developed procedures and software to assist in conducting CE/ICA. The IWR Report 94-PS-2, *Cost Effectiveness Analysis for Environmental Planning: Nine EASY Steps*; IWR Report 95-R-1, *Evaluation of Environmental Investments Procedures Manual Interim: Cost Effectiveness and Incremental Cost Analyses*; and IWR Report 98-R-1, *Making More Informed Decisions in Your Watershed When Dollars Aren't Enough* were utilized as guidance for this study. The Windows-based IWR-PLAN Decision Support Software Beta Version was used as the tool for this CE/ICA analyses.

Alternatives per Site CE/ICA

The alternatives presented above in Section 5.4.4 are combinations of proposed restoration measures. Alternatives were categorized into two sets, one set of nine alternatives for sites located in the rural north (R) and one set of nine alternatives for sites located in the urban south (U) of the watershed. Alternatives are not combinable because the alternatives were specifically constructed from the measures, presented in Section 5.4.3, in order to meet specific restoration benefit thresholds,. This first cut of the CE/ICA determined cost effective and "best buy" alternatives per site. This analysis indicated the best implementable plan per site (Table 5.10 and Table 5.11).

Table 5.10 – Rural (R) Best Buy Alternatives per Site

Sites	Alt #	Net AAHUs	AA Costs	Sites	Alt #	Net AAHUs	AA Costs
K01	3	199	$ 311,032	K45	9	1,748	$ 1,573,204
K02	6	779	$ 1,001,860	K46	2	585	$ 1,000,652
K03	2	260	$ 467,452	K47	9	2,332	$ 1,695,581
K04	3	204	$ 678,250	K48	2	717	$ 870,470
K05	2	1,089	$ 1,136,652	K49	3	455	$ 784,364
K06	9	1,201	$ 1,227,530	K50	9	792	$ 1,328,918
K07	9	590	$ 580,696	K51	2	128	$ 307,138
K08	9	55	$ 244,828	K52	2	257	$ 423,856
K09	9	1,124	$ 710,010	K53	9	589	$ 1,026,729
K10	9	957	$ 1,414,993	K54	4	1,221	$ 1,683,974
K11	9	464	$ 542,251	K55	2	429	$ 897,742
K12	2	1,481	$ 1,762,130	K56	9	809	$ 909,133
K13	2	31	$ 106,890	K57	2	1,313	$ 1,550,874
K14	9	264	$ 382,385	K58	3	661	$ 1,361,201
K15	9	302	$ 604,599	K59	4	2,243	$ 2,871,271
K16	2	91	$ 653,577	K60	2	744	$ 1,120,660
K17	2	195	$ 196,168	K61	9	2,287	$ 2,219,563
K18	9	722	$ 1,501,027	K62	9	1,303	$ 1,115,051
K19	2	495	$ 543,101	K63	4	1,008	$ 1,427,412
K20	7	270	$ 494,642	K64	9	1,890	$ 1,426,074
K21	6	140	$ 270,072	K65	9	115	$ 348,452
K22	9	398	$ 672,885	L31	4	939	$ 2,819,167
K23	9	1,268	$ 1,876,416	L33	4	415	$ 537,474
K24	2	59	$ 431,313	L34	2	251	$ 1,188,221
K25	2	222	$ 548,272	L35	2	337	$ 802,247
K26	2	121	$ 323,219	L36	9	1,168	$ 3,943,747
K27	9	1,079	$ 1,719,657	L37	4	837	$ 2,416,109
K28	2	142	$ 403,082	L38	7	647	$ 3,509,006
K29	9	488	$ 800,355	L39	6	626	$ 497,067
K30	9	977	$ 1,470,448	L40	6	329	$ 855,504
K31	2	709	$ 789,313	L41	9	1,281	$ 2,819,167
K32	6	327	$ 497,729	L42	9	152	$ 669,253
K33	9	2,621	$ 2,479,799	L43	2	1,513	$ 5,130,113
K34	9	1,046	$ 914,527	L45	2	250	$ 633,786
K35	2	807	$ 637,986	L46	6	324	$ 1,119,022
K36	9	2,146	$ 2,023,603	L47	9	286	$ 633,184
K37	2	322	$ 496,185	R01	6	663	$ 1,101,127
K38	2	392	$ 1,044,447	R02	3	377	$ 508,061
K40	2	434	$ 906,197	R03	6	912	$ 1,208,697
K41	6	1,286	$ 1,050,026	R04	5	324	$ 454,626
K42	2	584	$ 1,144,141	R05	7	438	$ 1,292,749
K43	2	348	$ 617,534	R06	3	438	$ 715,579
K44	9	1,755	$ 2,540,822				

(FY2011 Price Level, FDR 4.125%)

Table 5.11 – Urban (U) Best Buy Alternatives per Site.

Sites	Alt #	Net AAHUs	AA Costs	Sites	Alt #	Net AAHUs	AA Costs
C1	6	287	$2,153,102	L11	8	271	$1,104,410
C3	8	486	$2,120,141	L12	6	258	$647,234
C4	6	61	$406,552	L13	6	518	$2,009,403
C5	4	194	$1,216,424	L14	6	109	$993,226
C7	3	212	$871,299	L15	6	91	$304,437
C8	6	82	$231,920	L16	6	97	$348,139
C9	8	925	$3,345,753	L17	6	81	$348,462
C10	6	181	$405,850	L18	9	392	$1,430,558
C11	8	488	$2,144,591	L19	9	1788	$5,328,667
C13	6	7	$145,712	L20	6	120	$385,098
C14	6	20	$151,182	L21	6	184	$1,308,821
C15	8	1494	$3,989,931	L22	6	514	$2,910,666
C16	8	329	$1,518,097	L23	9	1015	$3,496,017
C17	8	153	$695,152	L24	6	434	$2,440,174
C18	6	20	$222,966	L25	8	294	$1,069,665
L01	2	390	$727,118	L26	8	160	$816,937
L02	9	475	$2,120,227	L27	6	253	$904,758
L03	6	504	$1,901,600	L28	9	812	$4,553,527
L05	8	234	$87,329	L29	9	400	$3,061,277
L06	9	777	$3,440,622	L30	6	254	$1,275,340
L09	7	366	$1,551,920	L32	6	437	$1,501,488
L10	7	254	$1,891,131	L44	8	652	$1,478,842

(FY2011 Price Level, FDR 4.125%)

Site Comparison

Once the best buy alternatives were identified per site, a second round of CE analysis was performed comparing the 85 rural and 44 urban sites with each other. The urban and rural sub-groups were used to account for disparities in costs associated with implementing the different measures that would be used for restoration at the two types of sites. To develop a plan that will fully meet the planning objectives across the watershed, cost effective rural and urban sites were identified independently and then used to formulate watershed ecosystem restoration plans.

For this second round of CE analysis, estimated per acre real estate values were incorporated in the average annual costs. Based on recent restoration projects implemented in the region, per acre land values were established: $10,000 for publicly owned lands and privately owned farmland and $20,000 for other privately owned lands. The cost effective analysis is presented below in Figure 5.2 and Figure 5.3 and the results are presented in Table 5.12 and Table 5.13. As a result of this analysis, 17 rural and 9 urban cost-effective sites were identified.

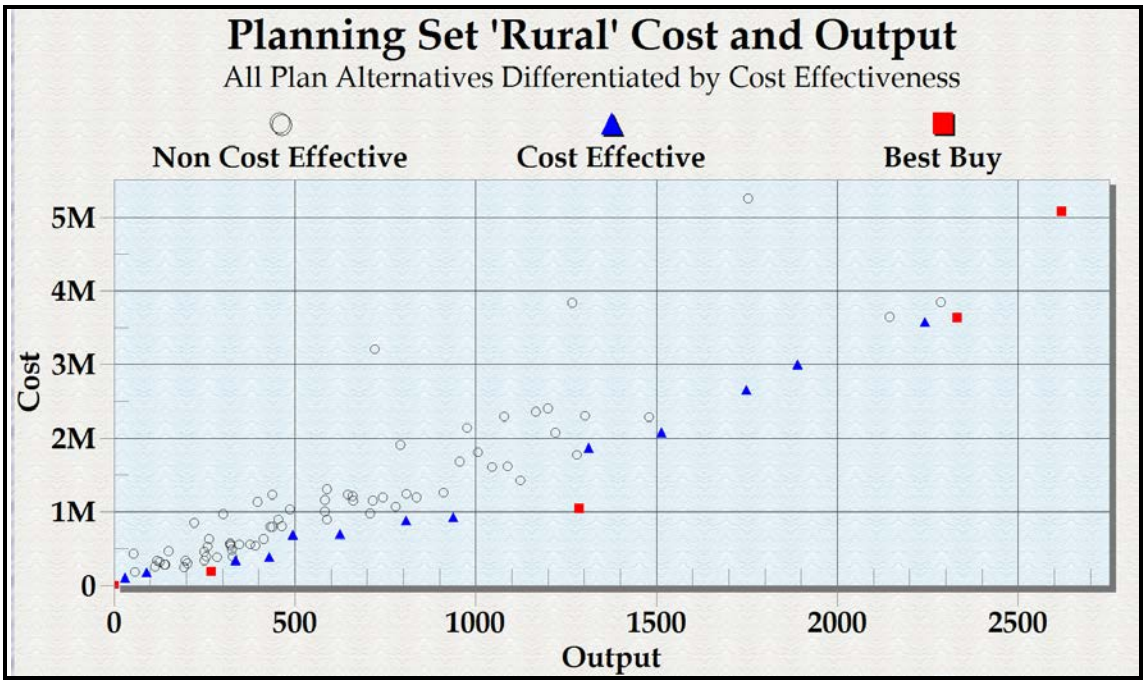

Figure 5.2 – Rural Site Cost Effective Analysis

Table 5.12 – Rural Cost Effective Sites

Site	Alt#	AA Cost	Net AAHUs	Average Cost/HU
K13	2	$104,002	31	$3,355
K16	2	$178,758	91	$1,964
K20	7	$191,245	270	$708
L35	2	$338,338	337	$1,004
K55	2	$390,039	429	$909
K19	2	$694,557	495	$1,403
L39	6	$695,630	626	$1,111
K35	2	$885,014	807	$1,097
L31	4	$924,126	939	$984
K41	6	$1,051,019	1,286	$817
K57	2	$1,872,305	1,313	$1,426
L43	2	$2,081,794	1,513	$1,376
K45	9	$2,659,903	1,748	$1,522
K64	9	$3,000,885	1,890	$1,588
K59	4	$3,574,344	2,243	$1,594
K47	9	$3,631,178	2,332	$1,557
K33	9	$5,080,549	2,621	$1,938

(FY2014 Price Level, FDR 3.5%)

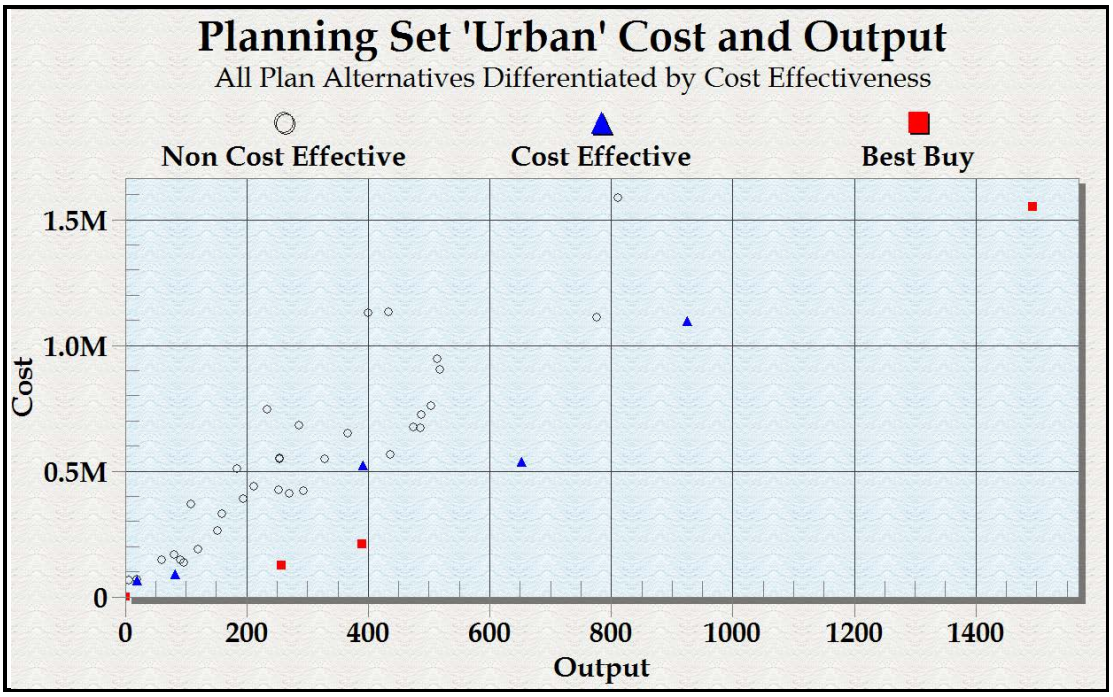

Figure 5.3 – Urban Cost Effective Analysis

Table 5.13 – Urban Cost Effective Sites.

Site	Alt#	AA Cost	Net AAHUs	Average Cost/HU
C14	6	$64,597	20	$3,230
C08	6	$90,181	82	$1,100
L12	6	$126,562	258	$491
L01	2	$208,837	390	$535
L18	9	$523,369	392	$1,335
L44	8	$536,266	652	$822
C09	8	$1,098,619	925	$1,188
C15	8	$1,550,212	1,494	$1,038

(FY2014 Price Level, FDR 3.5%)

Secondary Site Screening

The 26 rural and urban cost-effective sites were further evaluated to ensure that they would contribute to meeting the planning goals and objectives. To meet these goals and objectives, retained sites must provide:

a) Significant habitat connectivity through proximity to natural areas and riparian corridors within the watershed; and

b) Habitats critical for special status species or native habitat types considered rare or uncommon; and

c) Diversity of native habitat types that support a high number of native species; and

d) The ability to sustainably restore habitat types that are rare in the watershed by providing large contiguous areas, thereby minimizing edge effects.

Connecting natural areas within a highly fragmented watershed is important as it will increase the likelihood of successful dispersal of individuals, energy, and genetic information between patches of native habitat. Increased dispersal will ensure a greater likelihood of maintaining sustainable populations of native species through time and especially during periods of environmental change, including future climate change. Connectivity may be increased by decreasing the distance between sites or by creating stepping stones between suitable habitat patches. Connectivity may also be increased within open areas by increasing the amount of optimal habitat within the chosen open area. Sites which are located near current natural areas and along riparian corridors that act as stepping stones increase the overall watershed connectivity. Sites that include riverine restoration along the mainstem or major tributaries would provide connectivity across the watershed. Sites that provide large, contiguous parcels of critical habitat types would provide connectivity between habitats within the site.

The rare and uncommon aquatic habitat types critical to the watershed are sedge meadow, wet prairie, and wet savanna. As a result of past and current land use activities, these pre-settlement habitat types are now rare and uncommon. Because the habitats types are rare and uncommon, many native species that depend on them are also rare uncommon (e.g., Federally-listed candidate eastern massasaugua - wet prairie dependent). Sites that provide at least 50 acres of these three critical habitat types would support these special status species.

Diversity of native aquatic habitat types and hydrogeomorphic features found within a site of concern is critical to support the greatest number of native plant and wildlife species. Many of the remaining open areas have a homogenous land cover type (e.g., one plant community) or stream substrate (e.g., channelized silty bottom), which does not support a diverse suite of native species. Higher habitat heterogeneity, or number of different habitat types, will support the highest diversity of species. In order to address the loss of biodiversity within the watershed, there needs to be a diversity of restorable habitat types available within the selected sites. Sites that support a high number (at least 3) of restorable habitat types provide an opportunity to restore high levels of biodiversity within the watershed.

Restoring large contiguous areas provides opportunities for area sensitive species to successfully reproduce and maintain consistent populations within the watershed. Area sensitive species are species that are adapted to low levels of human disturbance and large unfragmented continuous open habitats endemic to the Midwest region. Grassland breeding birds (e.g., Henslow's sparrow, Short-eared owl, etc.) are good examples of area sensitive species that once occurred in great numbers within the region. Walk and Warner's (1999) research suggests that a small population of Henslow's sparrow requires at least 200 acres of continuous grassland to maintain a population. These species are now rare or uncommon in our area because the majority of remaining natural areas are small and isolated. Small and isolated natural areas experience greater levels of disturbance as a result of increased edge effects, in other words, the amount of buffered (e.g., protected) core area is decreased. Small core

areas provide suboptimal habitat for area sensitive species. Bollinger and Switzer (2002) suggest that even minimum areas needed for some populations to be present are not really big enough to overcome edge effects in order to sustain successful reproduction. As the area of the contiguous habitat increases, more individuals of an area sensitive species may co-exist, increasing the chances of sustaining a population on that tract of land over the long-term. Large contiguous open areas are now rare within the watershed. For example, the median size of the remaining 25 sites under consideration for restoration within this watershed is 461 acres, indicating that many of the remaining natural areas within the entire watershed are less than 450 acres in size. Kane County Forest Preserve, located adjacent to the Upper Des Plaines Watershed, has a goal of trying to purchase and preserve parcels that are at least 400 acres in size (Toth et al., 2009). This decision is driven in a large part by the need to provide suitable habitat to area sensitive species. Large contiguous sites provide a unique advantage over smaller isolated sites. Large sites, over 400 acres in size, would provide suitable habitat to support area sensitive species.

The sites were evaluated with respect to these criteria, as shown in Table 5.14. Only sites that met all of the criteria were retained for consideration in formulated restoration plans. This screening process resulted in the selection of a total of eight sites, located throughout the watershed that would contribute to the planning goals and objectives.

Table 5.14 – Secondary Site Screening

	CRITERIA				
	a	**b**	**c**	**d**	
Site	Provides increased connectivity	Provides at least 50 acres of one or more critical habitat type	Includes three or more habitat types	Provides large, contiguous area (400 acres or more)	**# of Criteria Met**
K59		X		X	2
K33	X	X	X	X	4
K47	X	X	X	X	4
L43	X	X	X	X	4
K64	X			X	2
K57		X			1
K45	X			X	2
C15	X	X	X	X	4
K35	X	X		X	3
C09	X	X	X	X	4
L31	X	X	X	X	4
K41	X	X	X	X	4
K19		X		X	2
L39	X	X	X	X	4
L44	X	X	X		3
L18	X	X	X		3
K55	X	X	X		3
L01	X	X	X		3
L35		X	X		2
K20		X	X		2
K16		X	X		2
L12		X	X		2
K13	X	X	X		3
C08		X	X		2
C14		X	X		2

Watershed Plan Formulation

To formulate watershed plans, a third round of CE analysis was conducted for the eight retained sites. The sites are located throughout the watershed and would all contribute to accomplishing the planning goals and objectives. The retained sites are summarized in Table 5.15.

Table 5.15 – Screened Cost-Effective Sites (ranked by output)

Site	Alt#	AA Cost	Net AAHUs	Average Cost/HU
L39	Rural 6	$695,630	626	$1,111
C09	Urban 8	$1,098,619	925	$1,188
L31	Rural 4	$924,126	939	$984
K41	Rural 6	$1,051,019	1,286	$817
C15	Urban 8	$1,550,212	1,494	$1,038
L43	Rural 2	$2,081,794	1,513	$1,376
K47	Rural 9	$3,631,178	2,332	$1,557
K33	Rural 9	$5,080,549	2,621	$1,938

(FY2014 Price Level, FDR 3.5%)

A full range of plans was generated using these screened cost-effective sites identified above (two in Cook County, three in Lake County, and three in Kenosha County). All combinations were generated using these eight sites. No constraints or dependencies were applied to the plan generator (i.e. all sites were included in this analysis at one time). A total of 256 plans of varied scale were generated. An additional round of cost effective and incremental cost analysis (CE-ICA) was conducted on the full range of plans generated. The CE-ICA analysis resulted in 38 plans identified as cost-effective and a subset of 8 plans in addition to the No Action Plan identified as "best-buys" having the lowest incremental cost per unit of output as shown in Figure 5.4. The incremental cost per unit output for each best-buy plan is show graphically in Figure 5.5. The average and incremental cost of each "best-buy" plan is shown in Table 5.16.

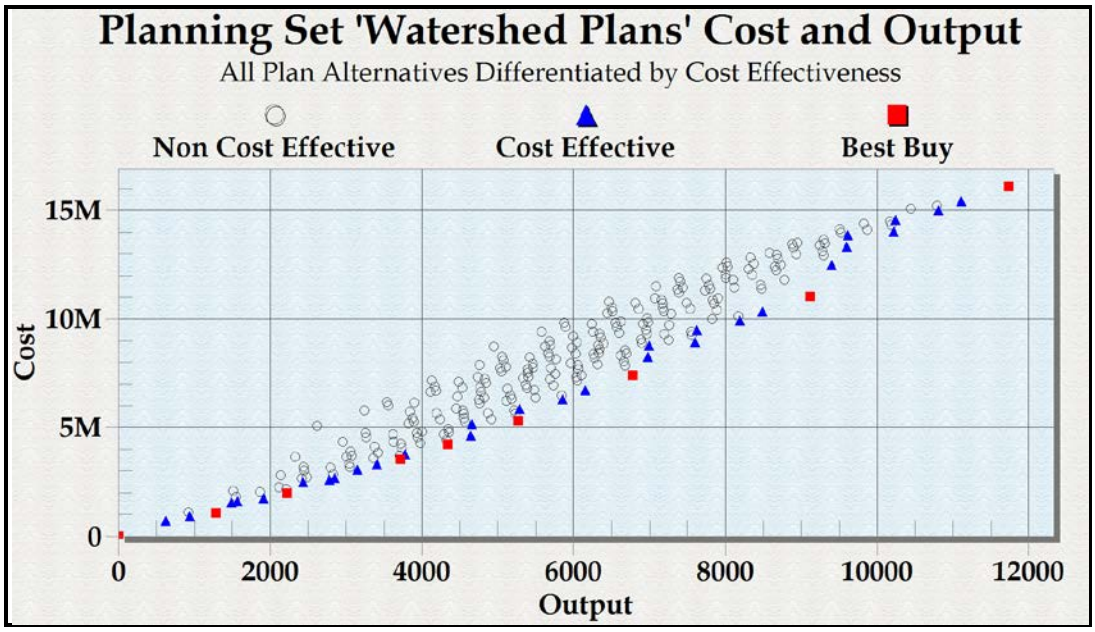

Figure 5.4 – Differentiation of Plans by Cost Effectiveness

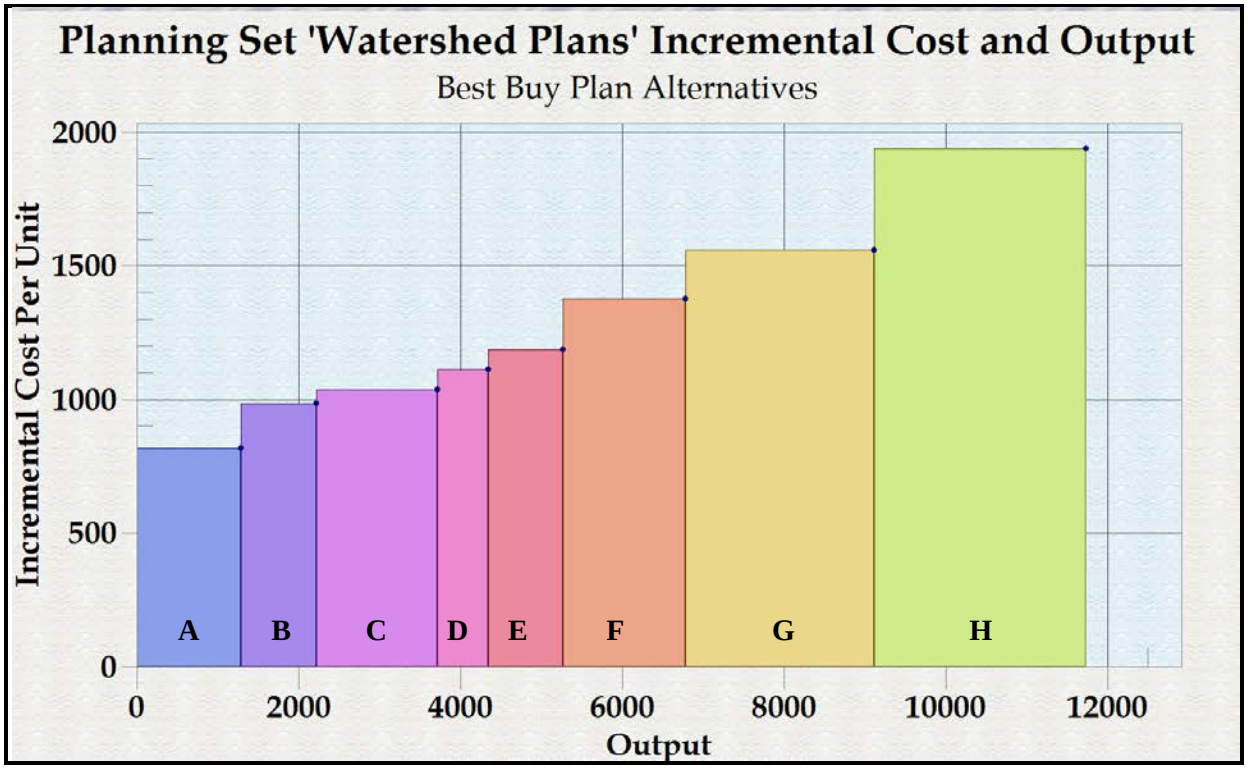

Figure 5.5 – Incremental Cost of Best Buy Plans

Table 5.16 – Incremental Cost of Best Buy Watershed Plans

Name	Plan Summary	AA Cost	Net AAHUs	Average Cost/HU	Increase in Avg Cost/ HU
0	No Action	$0	0	$0	--
A	K41	$1,051,019	1,286	$817	$817
B	K41 L31	$1,975,145	2,225	$888	$71
C	K41 L31 C15	$3,525,357	3,719	$948	$60
D	K41 L31 C15 L39	$4,220,987	4,345	$971	$23
E	K41 L31 C15 L39 C09	$5,319,606	5,270	$1,009	$38
F	K41 L31 C15 L39 C09 L43	$7,401,400	6,783	$1,091	$82
G	K41 L31 C15 L39 C09 L43 K47	$11,032,578	9,115	$1,210	$119
H	K41 L31 C15 L39 C09 L43 K47 K33	$16,113,127	11,736	$1,373	$163

(FY2014 Price Level, FDR 3.5%)

There are four distinct break points from the incremental cost analysis shown above:

***Plan C*:** AAHU = 3,719; Average cost per HU = $948

***Plan F*:** AAHU = 6,783; Average cost per HU = $1,091
(This plan provides an incremental increase over *Plan C* of 3,064 AAHUs for an incremental cost of $3,876,000. The resulting increase in average cost per habitat unit is $143.)

***Plan G*:** AAHU = 9,115; Average cost per HU = $1,210
(This plan provides an incremental increase over *Plan F* of 2,332 AAHUs for an incremental cost of $3,631,178 equating to an incremental cost/output of $119.)

***Plan H*:** AAHU = 11,736; Average cost per HU = $1,373
(This plan provides an incremental increase over *Plan G* of 2,621 AAHUs for an incremental cost of $5,080,549 equating to an incremental cost/output of $163.

These four plans were identified for further consideration and selection as the NER Plan.

5.4.7 Alternative Plan Trade-Off Analysis

The four "best-buy" plans where a distinct break point existing in the incremental cost analysis were compared against each other in order to identify a single plan to be recommended for implementation. A comparison of the effects of various plans must be made and tradeoffs among the differences between plans will be used 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 current step, plans are compared against each other, with emphasis on the important effects or those that influence the decision-making process. This plan comparison step concludes with a ranking of plans.

Ecosystem Plans: Four Ecosystem Plans and the No Action Plan are discussed in the following sections. The No Action Plan is always considered and required by NEPA. The four action

plans are: 1) Ecosystem Plan C, which includes two additional sites (one in Cook county) and at a greater incremental cost, 2) Ecosystem Plan F, which includes three additional sites (two in Cook County) at an even greater incremental cost, 3) Ecosystem Plan G, which includes one additional site (the second largest cost-effective site in watershed) at an even greater incremental cost, and, 4) Ecosystem Plan H, which includes one additional site (the largest cost-effective site in the watershed) at an even greater incremental cost.

Table 5.17 – Ecosystem Plans Considered for Implementation

County	Site	Alternative	No Action	C	F	G	H
Cook	C9	Urban 8			X	X	X
	C15	Urban 8		X	X	X	X
Lake	L31	Rural 4		X	X	X	X
	L39	Rural 6			X	X	X
	L43	Rural 2			X	X	X
Kenosha	K33	Rural 9					X
	K41	Rural 6		X	X	X	X
	K47	Rural 9				X	X

5.4.7.1 Ecological Benefits of Identified Plans

Plan G was identified as the NER Plan due to its ability to most completely and efficiently achieve the planning objectives for restoration of this watershed. Plan G includes two of the three largest cost effective sites within the watershed, K47 (1,619 acres) and K43 (1,401 acres). Large contiguous sites, such as K47 and K43, represent the last remnants of large open areas left in the watershed and in many respects the Chicago metropolitan region. The ecological significance of these sites includes the ability to support species that require contiguous uninterrupted tracts of habitat. These include species of concern ranging from grassland breeding birds to the Federally-listed eastern prairie fringed orchid to the plains garter snake, both require high quality aquatic habitat. These species are rare and in decline through much of their range. The ability to provide adequate habitat for area sensitive species can only be accomplished by restoring large contiguous tracts of land such as those present within K47 and K43. In addition to providing suitable habitat for area sensitive species, large continuous sites provide larger core areas that have greater likelihood of sustaining a highly diverse array of all types of species, ranging from wetland sedges to reptiles and amphibians. A higher diversity of species from all functional groups (e.g., functional redundancy) has a higher likelihood of persisting under changing climatic conditions.

Plan G also includes restoration within the southern portion of the watershed that is highly fragmented and yet has some of the largest tracts of undeveloped land directly adjacent to the mainstem of the Des Plaines River. Reconnection of a high quality functioning riparian zone along large rivers is one of most well understood techniques for aquatic restoration. The interface of rivers and floodplains displays high levels of biodiversity and ecosystem function. Restoring large tracts of land (C15 is 1,007 acres and C9 is 815 acres) along the Des Plaines River mainstem floodplain will provide a high quality functioning riparian zone for wildlife that require both river and floodplain habitat to survive and reproduce, especially migratory birds (e.g., Illinois state listed Black-crowned night heron), reptiles (e.g., Federally-listed candidate eastern massasauga) and amphibians (e.g., green frog). Sites C15 and C9, which are both included in Plan G, are two of the largest undeveloped tracts left along the

Des Plaines River in Cook County and provide a unique opportunity to achieve the study's restoration goals and objectives within the watershed.

Although Plan H provides more output (11,736 Net AAHUs) than Plan G (9,115 Net AAHUs), the increase of output requires a bigger increase in cost per unit output. This increase in output and cost is driven by the addition of one site (K33). Plan H does provide opportunities to address the identified problems (e.g., K33 has 2,134 acres, is the largest site within the watershed, reference Table 5.14) within the watershed, but at a less efficient cost than Plan G. The incremental difference in cost between Plan G and Plan H is $163, which is the largest increase in cost per unit output between any of the "Best Buy" plans (Table 5.16), disregarding the NA alternative. Similar sites, and with a similar amount of area, such as L41combined with L43, were compared to K33. Both sites are located in the upper part of the watershed and to the south of K33. L41 and L43 provide restoration of a total of 2,274 acres with an output of 2,794 Net AAHUs for an average annual cost of $3,585,597 vs. K33, that has 2,134 acres with an output of 2,621 Net AAHUs for an average annual cost of $5,080,549, as shown in Table 5.18. Restoration of the combination of L41 and L43 provides for more environmental output with less cost than the restoration of K33. In conclusion, Plan H is a less efficient plan than Plan G, because the increase in incremental costs is not justified based on the output of environmental benefits in comparison to the other "Best Buy" plans.

Table 5.18 – Comparison of Site K33 (additional site in Plan H) to similar sites within watershed

Site	Acres	AA Cost	Net AAHU
K33	2,134	$5,080,549	2,621
L41	673	$1,503,803	1,281
L43	1,601	$2,081,794	1,513
L41+L43	2,274	$3,585,597	2,794

(FY2014 Price Level, FDR 3.5%)

The total with and without project ecological benefits per plan are displayed in Table 5.19 and Figure 5.6. The FWOP condition for the entire Upper Des Plaines River watershed was determined to be 28,881 habitat units. Since these habitat units are already being provided by the system, each alternative was considered in terms of net benefit gain. The most beneficial and cost efficient plan is Ecosystem Plan G since it is able to increase the overall habitat quality of the entire Upper Des Plaines River watershed by 32% with the most efficient use of funds. No Action Plan provides no improvement.

Table 5.19 – Upper Des Plaines River Watershed Total With & Without Project Habitat Units

Plan	FWOP AAHUs	Net FWP AAHUs	Total FWP AAHUs	% Improvement
No Action	28,881	0	28,881	0%
C	28,881	3,719	32,600	13%
F	28,881	6,783	35,664	23%
G	28,881	9,115	37,996	32%
H	28,881	11,736	40,617	41%

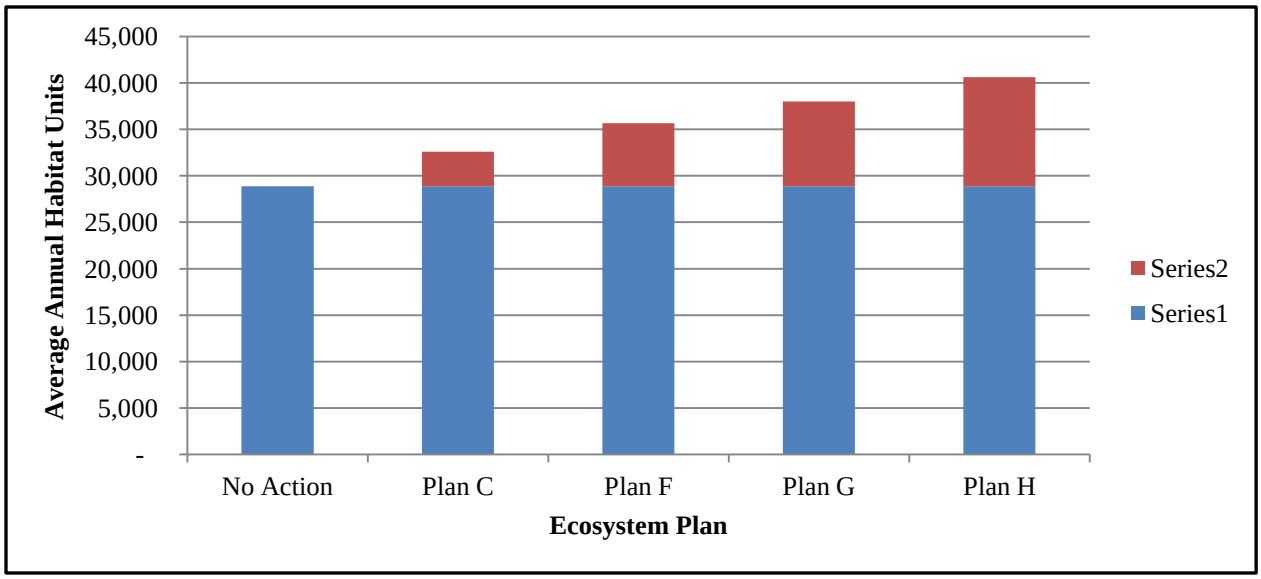

Figure 5.6 – Upper Des Plaines River Watershed Total With & Without Project Habitat Units

5.4.7.2 Significance of Ecosystem Habitat Outputs

Because of the challenge of dealing with non-monetized benefits, the concept of significance of outputs plays an important role in ecosystem restoration evaluation. Along with information from cost effectiveness and incremental cost analyses, information on the significance of ecosystem habitat units 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 decision makers regarding the value of the ecosystem proposed for restoration

The alternative plans identified for restoration of ecosystems in the Upper Des Plaines River watershed were systematically developed through the efforts of a collaborative study partnership. The core study team included professionals representing local, state and federal resource agencies as well as the USACE. Implementation of the alternative plans identified through this rigorous process will restore and preserve ecosystems within the highly developed Upper Des Plaines River watershed. The cost-effective plan maximizes the output based on the environmental investment and will compliment the ongoing activities of state and local agencies as well as public groups to maintain the remaining scarce natural habitats within the watershed. The addition of seven restoration sites totaling over 6,800 acres will serve to increase connectivity of the highly fragmented ecosystems located within the riparian zone of the Upper Des Plaines River, and significantly increase structure and function within the river and in the adjacent floodplains. The restoration plan will increase the number of acres of scarce high quality habitat and thereby provide significant resources for native flora and fauna. The plan will also provide habitat for 3 federally listed and 89 state listed species.

It is USACE policy that all projects, including flood risk management and ecosystem restoration projects, are guided by seven Environmental Operating Principles (EOPs). These EOPs are the USACE commitment to sustainability, preservation, accountability, stewardship, and restoration of our Nation's natural resources. They guide USACE efforts to foster and promote the general welfare, to

create and maintain productive harmony, and to fulfill the social and economic requirements of present and future generations. The Upper Des Plaines River and Tributaries feasibility study, if implemented, exemplifies and strengthens the USACE environmental commitment by providing protection and/or restoration to significant natural resources. The significance of those resources is discussed in the following sections in terms of three categories: institutional recognition, public recognition, and technical recognition.

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. Sources of institutional recognition include public laws, executive orders, rules and regulations, treaties, and other policy statements of the Federal Government; plans, laws, resolutions, and other policy statements of states with jurisdiction in the planning area; laws, plans, codes, ordinances, and other policy statements of regional and local public entities with jurisdiction in the planning area; and charters, bylaws, and other policy statements of private groups.

Migratory Bird Treaty Act (1918): The Migratory Bird Treaty Act is the domestic law that implements the United States' commitment to four international conventions for the protection of migratory birds and their habitats. The Act protects species or families of birds that live, reproduce, or migrate within or across international borders at some point during their annual life cycle. The four Migratory Bird Conventions are:

- Convention for the Protection of Migratory Birds with Great Britain on behalf of Canada (1916)
- Convention for the Protection of Migratory Birds and Game Mammals - Mexico (1936)
- Convention for the Protection of Migratory Birds and Their Environment - Japan (1972)
- Convention for the Protection of Migratory Birds and Their Environment - Union of Soviet Socialist Republics (1978)

The Mississippi Flyway*:* There are four principal North American flyways, the Atlantic, Mississippi, Central and Pacific. Except along the coasts, such as Lake Michigan, the flyway boundaries are not always sharply defined. Its eastern boundary runs along western Lake Erie and the western boundary is ambiguous, as the Mississippi Flyway merges unnoticeably into the Central Flyway. The longest migration route in the Western Hemisphere lies in the Mississippi Flyway; from the Arctic coast of Alaska to Patagonia, spring migration of some shorebird species fly this nearly 3,000 mile route twice. Parts of all four flyways merge together over Panama.

The flyway route which includes the Des Plaines River watershed is ideal for all migratory birds, but especially waterfowl because it is uninterrupted by mountains, dotted with tens of thousands of lakes, wetlands, ponds, streams and rivers, and is well timbered in certain reaches. The Des Plaines River watershed is located in the Mississippi Flyway and about 300 to 400 species of birds pass over annually. This urbanized reach of the flyway is also one of America's most important migration routes for songbirds, with more than 5 million individuals (a noticeable fraction of the total number of birds migrating through the entire North American continent) passing through during the migration season. Many migratory birds must pass twice yearly above a continent suffering huge development pressures

and thus offering birds fewer and fewer productive stop-over sites. The Upper Des Plaines Watershed when restored will provide essential foraging, nesting and resting habitat. It will provide the right kind of high calorie, high protein food such as seeds, fruit and insects and shelter sufficient to protect them from predators and extremes of weather. Unless these provisions are readily available along the flyway, the long-distance journey becomes more arduous and even fatal. When migratory birds cross into Illinois, they encounter a monoculture of corn and soybean fields throughout most of the state which are not fertile stop-overs. Upper Des Plaines River Watershed will provide comparatively rich feeding and resting opportunities, makes a huge contribution to the survival of many migratory birds that pass through Illinois, Indiana and Wisconsin. The NER Plan restoration projects have great potential to provide 6,800-acres of critical migratory bird habitat.

E.O. 13186 Responsibilities of Federal Agencies to Protect Migratory Birds (2001): 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 would restore native riparian/riverine and buffering communities, thus providing forage and shelter to numerous migratory bird species. This project will serve to increase connectivity of the highly fragmented ecosystem located within the riparian zone of the Upper Des Plaines River, and significantly increase structure and function within the river and in the adjacent floodplains. The Upper Des Plaines River watershed provides an important stopover for the Mississippi Flyway. Vulnerable migratory birds are expected to increase their usage of restored areas within the watershed. Restoration of native habitat types is a powerful tool to positively influence the success of migratory species through this area. As evidence of migratory bird use by important species, Chicago District biologists have observed great flocks of American Pelican and Sand Hill Cranes heavily utilizing the Des Plaines River and associated wetlands.

Alternative Plans C through E would have benefits added for migratory and residential birds, with F, G and H being the most beneficial in terms of providing habitat lost to agriculture and urbanization effects. Implementation of Plans F, G or H would fulfill the USACE's role and Federal responsibility by utilizing its high priority Ecosystem Restoration mission, authority and supporting polices to restore diverse habitats for migratory waterfowl and fishes that support these bird species.

Endangered Species Act of 1973: All Federal departments and agencies shall seek to conserve endangered 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. Project features would restore critical habitats (stream, marsh, sedge meadow, wet prairie, mesic prairie, savanna, floodplain forest, woodland) for the Federally-listed Karner blue butterfly (*Lycaeides melissa samuelis*); eastern prairie fringed orchid (*Platanthera leucophaea*); eastern massasauga (*Sisturus catenatus*); an experimental recovery population of Whooping Crane and the proposed Northern long-eared bat (*Myotis septentrionalis*). There are 89 state endangered and threatened species within 1 mile of the study area including the Illinois state endangered short-eared owl (*Asio flammeus*); yellow-headed blackbird (*Xanthocephalus xanthocephalus*); sandhill crane (*Grus Canadensis*); yellow rail (*Coturnicops noveboracensis*); blacknose shiner (*Notropis heterolepis*); slippershell mussel (*Alasmidonta viridis*); hoary elfin (*Incisalia polia*); swamp metalmark (*Calephelis mutica*); eastern massasauga (*Sistrurus catenatus*); Tuckerman's sedge (*Carex tuckermanii*); ; white-stemmed pondweed (*Potamogeton praelongus*); and purple fringed orchid (*Platanthera psycodes*). Illinois state threatened species include the double-crested cormorant (*Phalarocorax auritus*); great egret (*Ardea*

albus); loggerhead shrike (*Lanius ludovicianus*); elephant ear (*Elliptio crassidens*); ironcolor shiner (*Notropis chalybaeus*); ottoe skipper (*Hesperia ottoe*); kirtland's water snake (*Clonophis kirtlandii*); American dog violet (*Viola conspersa*); beaked rush (*Rhynchospora alba*); crawe's sedge (*Carex crawei*); and dwarf raspberry (*Rubus pubescens*). Wisconsin state endangered species include the common tern (*Sterna hirundo*); forster's tern (*Sterna forsteri*); blanchard's cricket frog (*Acrid crepitans blanchardi*); and purple milkweed (*Asclepias purpurascens*). Wisconsin state threatened species include sullivant's milkweed (*Asclepias sullivantii*); prairie Indian plantain (*Cacalia tuberosa*); Acadian flycatcher (*Empidonax virescens*); cerulean warbler (*Dendroica cerulea*); blanding's turtle (*Emydonidea blandingi*); and redfin shiner (*Lythrurus umbratilis*). The Chicago region is a very important biodiversity hotspot within the Midwest (Chicago Wilderness Biodiveristy Recovery Plan).The recommended measures would directly and indirectly benefit an array of valued species found in the Midwest. Many of the habitat types that are proposed for restoration could potentially support migratory or permanent breeding populations of many of the species listed.

As required, the USACE requested that the USFWS provide a report under the Fish and Wildlife Coordination Act. In the draft Fish and Wildlife Coordination Act Report for the Upper Des Plaines River and Tributaries, the USFWS noted that they support ecological restoration at all of the sites identified in the restoration plan. In particular they indicate strong support for the removal of five small dams in Cook County and restoration at six of the seven sites identified in the restoration plan. Several of the restoration sites might include two T&E species, the eastern prairie fringed orchid and the eastern massasauga rattlesnake. Additional site evaluations are recommended for the eastern prairie fringed orchid. The FWS also recommends the development of a conservation plan for the eastern massasauga rattlesnake. FWS indicated they do not object to proposed levees, floodwalls and reservoirs, but recommend that the Corps consider other measures during the formulation of regional solutions to address flooding. Finally, the USFWS also indicated that extensive tree clearing may affect declining bat species and could require mitigation. The draft Fish and Wildlife Coordination Act Report is located in Appendix L.

Alternative Plans C through E would have benefits added for Federal and State listed species, with Plans F, G and H being the most beneficial in terms of restoring habitat lost to agriculture and urbanization effects. Ongoing coordination with USFWS will be continued during design and implementation to avoid and minimize impacts to bats and T&E species habitat as noted in the draft FWCAR. Implementation of Plan F, G or H would fulfill the USACE's role and responsibility complying and supporting the Endangered Species Act of 1973.

Fish and Wildlife Conservation Act of 1980: All Federal departments and agencies, to the extent practicable and consistent with the agency authorities, should conserve and promote conservation of non-game fish and wildlife and their habitats. Restoring different types of habitat, focusing on habitat for native non-game species, and in-stream structures within the Upper Des Plaines watershed will result in an increase in ecosystem function (e.g., net annual primary native plant growth) and habitat diversity of the system. Increases in ecosystem function and structure would also result in an overall increase in native species diversity. By restoring sites located along the mainstem and major tributaries of the Upper Des Plaines River, the overall connectivity of the watershed will increase. Increased connectivity will provide increased dispersal of individuals, energy and genetic information, thereby increasing the likelihood of isolated populations of native species to persist over time and under changing environmental conditions. Restoring in-stream habitat will decrease impediments to native fish migration as well as increase habitat structure and availability for

in-stream native species. Removal of ruderal (unnatural/human induced) habitats such as drained farm fields, thickets, and successional woodlands would reduce the abundance and resulting propagule pressure from exotic/invasive species on native species populations. All proposed habitat improvements would benefit native plants, invertebrates, fish, birds, amphibians, reptiles and other wildlife.

Alternative plans C through E would have benefits added for all species of fish and wildlife; however, F, G and H would be the most beneficial in terms of providing habitat lost to agriculture and urbanization effects. Maximizing the diversity of plant community types and their spatial coverage is necessary within the Des Plaines Watershed due to the massive loss in habitat acres through history (88% loss) and would fulfill the USACE's role and responsibility for complying and supporting the Fish and Wildlife Conservation Act of 1980.

Clean Water Act of 1972: The Clean Water Act provides for the protection and restoration of the chemical and biological integrity of the Nation's waters. Restoration of native plant communities within the watershed will not only improve habitat diversity, but also biogeochemical and evapotranspirative processes important in the filtering and recycling of precipitation. Water quality within the Upper Des Plaines River will be improved through the restoration of natural landscape plant communities and the restoration of stream channel morphology. For example, conversion of Eurasian thickets would also remove the noxious chemical produced by such plants as European Buckthorn (*Rhamnus cathartica*) which has been shown to harm or kill amphibians.

Alternative plans C through E would add minor water quality improvements due to the very small scale of the project; however, F, G and H would approach the scale of restored land needed to begin naturally filtering through groundwater recharge, evapotranspiring, and absorbing and breaking down harmful pollutants and chemicals humans produce within the watershed. Implementation of Plans F, G or H would fulfill the USACE's role in supporting the Clean Water Act.

E.O. 11514 Protection and Enhancement of Environmental Quality (1970): The Federal Government shall provide leadership in protecting and enhancing the quality of the Nation's environment to sustain and enrich human life. Improvements to the quality of the Upper Des Plaines watershed include, but are not limited to, restoring ruderal plant communities to remove species such as Tiger mosquito that are potentially harmful to humans as well as poisonous/noxious plants, providing agricultural and urban buffers for healthy water, reducing floodwaters collecting harmful pollutants, providing a greater variety of edible plants for humans in case of disaster. Natural areas are of great importance to residents of the highly urbanized Chicago region, and restoration of natural landscapes and hydrology would improve the ability of the region to support native flora and fauna valuable to humans.

Alternative plans C through E would have benefits that improve the quality of the human environment; however plans F, G and H are the most beneficial in terms of converting ruderal and noxious habitats into human friendly and high quality natural areas for passive recreation. These plans would also greatly improve water quality due to ground water recharge, evapotranspiration, and the filtering abilities of certain native plant species. Implementation of Plans F, G or H would fulfill the USACE's role in supporting the E.O. 11514 for improving the quality of the human environment.

E.O. 11988 Floodplain Management (2012): Each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains. Reestablishing aquatic and terrestrial habitats as functioning, viable and sustainable ecosystems will restore the value of floodplains by minimizing impacts of floods through increases in stormwater storage capacity and improvement of water quality.

Alternative Plans C through E would provide minimal benefits to the watershed scale restoration of floodplains to their natural conditions, floodplain benefits require large tracts of floodplain. Plans F, G and H are the most beneficial in terms of providing natural floodplain areas to help evapotranspirative functions, infiltration, and the storing and attenuation of flood pulses. Larger naturalized floodplain and recharge areas supports a larger volume of water that is retained naturally, supporting the NED Plan. Implementation of Plans F, G or H would fulfill the USACE's role in providing floodplain management leadership.

E.O. 11990 Protection of Wetlands (1977): Each agency shall provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. There are 149-acres of high-quality wetland areas located within the study area, mostly mesic floodplain forest, sedge meadow, calcareous floating mat and marsh. The Illinois portion of the study area alone contains 12,140 acres of wetland, but most these areas have been impacted by increased sedimentation, erratic hydrology, agricultural practices (e.g., drainage tiles), increased nutrient loading, and invasive species infestation. Wetland restoration efforts will address these disturbances throughout the restoration of hydrologic, geomorphic and floristic features that were once characteristic of the Upper Des Plaines River watershed wetlands.

Alternative Plans C through E would minimally increase the quality and quantity of wetlands in the watershed. Plans F, G and H are would restore a much larger wetland footprint, providing more significant benefits. Implementation of Plans F, G or H would fulfill the USACE's role in supporting the E.O. 11990 by protecting and restoring wetlands across the watershed.

E.O. 13112 Invasive Species (1999): "Each Federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law…subject to the availability of appropriations, and within Administration budgetary limits, use relevant programs and authorities to: (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and (vi) promote public education on invasive species and the means to address them."

Alternative Plans C through E would have localized benefits added for reducing the richness and abundance of invasive plant and animal species. Plans F, G and H are the most beneficial in terms of reducing the watershed's spatial distribution of primarily invasive and noxious plant species. The removal of dams and restoration of riverine hydraulics would reduce abundance of the Asian Common Carp (*Cyprinus carpio*), which is validated from the Hofmann Dam Section 206 Monitoring Results. Implementation of Plans F, G or H would fulfill the USACE's role in supporting E.O.13112, with Plan

H maximizing the reduction in spatial distribution of invasive plant and animal species, while preventing viable population recolonization via hydrologic, geomorphic and native plant community restoration.

Institutional Significance Summary: Considering the above institutional recognition and its nexus with the suite of best buy plans, all of the considered alternative ecosystem plans would benefit the Upper Des Plaines River watershed. However, Ecosystem Plans F, G, and H would be most significant since they provide for and maximize watershed recovery for migratory bird habitat, Federally listed species, more habitat area throughout the watershed, and better quality habitat to support these institutional principles with an efficient use of funds.

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.

The Upper Des Plaines watershed is rich with areas that offer hiking, picnicking, boating, and other recreational opportunities. The 22-mile long Des Plaines River Trail is a popular hiking/biking trail that weaves past many of the watershed's natural areas. Several nature centers such as the River Trail Nature Center are well received within the study area. The second oldest continual canoe race in the United States, The Des Plaines River Canoe Marathon, began in 1957 and occurs on 18.5 miles of the Des Plaines River. An ecosystem restoration movement is well established within the Chicago Region and is rapidly growing. Many groups including volunteers dedicated to the preservation and restoration of the Des Plaines watershed exist and perform such tasks as monitoring native ecosystems and their rare or endangered/threatened flora and fauna, providing educational opportunities, creating work days to remove invasive species and collect native seed, conducting guided nature walks and bird watching, and maintaining detailed yearly surveys on populations of rare flora and fauna. The strong public involvement in outdoor recreation and restoration work within the study area directly relates to the importance of an environmental resource for a growing population involved in protecting their natural areas.

These upper Des Plaines River natural areas are a part of a nationally recognized network of 370,000 acres of protected natural areas within the Chicago Region.

National Plans

C2000 Program Nationally Recognized Conservation Plan: In 2004, the C2000 Program was nationally recognized, which includes the upper Des Plaines ecosystem within Illinois. The National Association of Resource Conservation and Development Councils awarded the C2000 Ecosystems Program as the National Supporting Organization of the Year. To date, 41 Ecosystem Partnerships cover 86% of the state and represent 98% of the state's population. These coalitions of local stakeholders are united by a common interest in protecting the natural resources of their watershed. The program is unique in that anyone can volunteer to be a member of an Ecosystem Partnership. By being a designated Partnership, C2000 provides financial and technical support to assist in addressing

local watershed concerns. The largest component of the C2000 program is the Ecosystem Project Grants. These grants are awarded annually in the following categories: Habitat, Land Acquisition, Research, Outreach, Planning, and Resource Economics.

Northeastern Illinois Invasive Plant Partnership (NIIPP): The Des Plaines River watershed is included in the NIIPP, which coordinates efforts to manage invasive plant species across the region. NIIPP coordinates with the North American Invasive Species Network that is a national program aimed at combating and controlling invasive species. The Recommended Plan addresses the national goals of control and management of invasive species.

The North American Bird Conservation Initiative (NABCI): The NABCI was created in recognition that many bird species, across taxa and habitats, are experiencing significant and in some cases severe population declines. A variety of bird conservation partnerships (see above) have been initiated to address the needs of various bird groups. While these individual partnerships have generated many notable successes, overlap in effort was apparent, thus common interests of all may be achieved more effectively through integrated national planning and delivery. In short, the goal of NABCI is to better coordinate the efforts of multiple bird conservation partnerships on a national landscape level. In order to facilitate the integrated conservation of all bird species at a regional scale, NABCI developed a geographical network of Bird Conservation Regions (BCRs), or Joint Ventures, based on similar landscape cover types and associated bird species.

The Upper Des Plaines watershed is part of the Oaks and Prairies Joint Venture. A Joint Venture (JV) is a collaborative, regional partnership of government agencies, non-profit organizations, corporations, tribes, and individuals that conserves habitat for priority bird species, other wildlife, and people. Joint Ventures bring these diverse partners together under the guidance of national and international bird conservation plans to design and implement landscape-scale conservation efforts. Joint Ventures have been widely accepted as the model for collaborative conservation in the 21st century. They use state of the art science to ensure that a diversity of habitats is available to sustain migratory bird populations for the benefit of those species, other wildlife, and the public. JV actions include:

- biological planning, conservation design, and prioritization;
- project development and implementation;
- monitoring, evaluation, and research;
- communications, education, and outreach; and
- funding support for projects and activities.

Nationwide, 18 habitat-based JVs address the bird habitat conservation issues found within their geographic area. Additionally, three species-based Joint Ventures, all with an international scope, work to further the scientific understanding needed to effectively manage specific bird species. JVs have a 25-year history of success in leveraging public and private resources to bring together partners and focus on regional conservation needs.

Regional & Local Recognition

The Upper Des Plaines River Ecosystem Partnership: The Upper Des Plaines River Ecosystem Partnership is a nonprofit organization dedicated to restoring and protecting the Upper Des Plaines River Watershed through collaboration, stakeholder education, and technical assistance, while

also providing annual watershed tours, rain garden workshops, annual meetings that celebrate their conservation achievements, and lunchtime gatherings that feature speakers and updated news about the watershed.

Plants of Concern: Plants of Concern is another organization devoting time to many sites within the Upper Des Plaines watershed, engaging citizen scientists to monitor the area's rarest plants, document trends in their populations, and provide valuable data used to help preserve and restore areas with rapidly declining rare and listed species.

RiverWatch: RiverWatch is a program developed to train and certify volunteers to collect scientific data on streams and watersheds, which then can be used by professionals and the general public to gauge long-term trends in stream health, identify degraded waters, develop land management strategies, and assess the effectiveness of restoration projects. The very successful RiverWatch Discovery Program provides youth with an outdoor educational opportunity to learn about, care for, and protect local streams by integrating stream sampling with stewardship activities such as plantings and cleanups.

"Friends of ____": There are many "Friends of" groups , one example is the Friends of Ryerson Woods, like many other community and landowner based non-profit groups within the watershed, assemble restoration workdays and work to educate individuals and organizations to preserve, restore and protect native plant and animal communities.

Public Recognition Summary: Considering the above points on National, Regional and Local Public recognition, Alternative Plans C through E would garner minimal interest from National Groups and Plans; whereas, regional and local groups would be interested in any ecosystem restoration projects to support their plans. Plans F, G and H would be the most supported by a National Plan due to the contributions not only to the Des Plaines River watershed ecosystem, but the Mississippi Flyway and adjacent Fox River and Chicago River watersheds. Implementation of Plans F, G or H would fulfill the USACE's role in supporting the three identified National Plans and the many local and regional restoration and watershed groups/plans; however, Plan G is provides a the best return on environmental investment for the watershed..

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 vary based on differences across geographical areas and spatial scale. While technical significance of a resource may depend on a local, regional, or national perspective is undertaken, typically a watershed or larger (e.g., ecosystem, landscape, or ecoregion) scalet 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: 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.

The study area contains nine sites that are dedicated as Illinois Nature Preserves, totaling 1,475.7 acres. Nature preserves exist to protect and preserve significant natural features for the purposes of conserving biodiversity, scientific research, education, and aesthetic enjoyment. These nature preserves as well as other natural areas are vital to the Upper Des Plaines watershed as there is no state or federally owned park, conservation area, fish and wildlife area, or state or federally owned forest preserve. The Nature Serve conservation status system rated several habitats within the study area as either critically imperiled globally (G1), imperiled globally (G2), and very rare globally (G3). G1 habitats within the study area include dry-mesic and wet-mesic savanna; G2 habitats include wet prairie and mesic prairie, while sedge meadows are considered to be globally rare and nationally significant.

The remaining natural areas have suffered a considerable amount of human induced disturbances including fire suppression, high nutrient input, and altered hydrology. The altered natural areas created a functional loss to natural processes that facilitated natural and human induced disturbances including the establishment of non-native, invasive species and changes in landuse. The significant reduction in natural area acreage coupled with altered natural processes and declining biodiversity makes the Des Plaines watershed a scarce and significant resource in need of ecological restoration.

Representativeness: Representativeness 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 representativeness as does the presence of undisturbed habitat.

Areas currently designated as nature preserves represent a tiny, fragmented portion of what once existed within the Des Plaines watershed. If restored, historic natural communities with a diverse array of native species would have the opportunity to establish or expand in areas now dominated by invasive species, unnatural woody succession, old fields, and abandoned or unproductive agricultural land. Current high quality habitats would have the opportunity to expand and increase connectivity, while seed banks of remnant natural communities could germinate following the completion of restoration measures.

The restoration plan will restore hydrology and natural processes and improve water quality as the restored riverine wetlands and floodplains interact with surface water, floodwater and groundwater of surrounding habitats. These riparian areas have great potential for buffering streamwaters entering the watershed from human activities by lowering nutrient content, reducing rapid flooding and drying cycles, and acting as a deposition for eroded soils.

Areas not directly impacted by surface water serve as critical habitats for federally and state endangered and threatened flora and fauna. Therefore, these existing intact, high-quality areas need to be protected from human induced disturbances such as high nutrient input, altered hydrology, and sediment deposition. The restoration of riverine wetlands and floodplains of the Des Plains watershed, in conjunction with invasive species removal and reintroduction of fire, will create favorable conditions for a healthy establishment of natural areas that will support a watershed of restored ecosystem structure and function characterized by stable hydrologic regimes and nutrient cycling, high

biodiversity, and reoccurrence of fire - allowing for symbiotic relationships between native fauna and flora to exist in areas where such interactions had been lost.

Status and Trend: Status and Trend is an evaluation of the occurrence and extent of the resource over time, how it has changed, and why. Historically, the Upper Des Plaines River watershed was dominated by several naturally occurring cover types such as wetlands, forests, savannas and prairies. By the late 1800s, most of these cover types, particularly prairies, savannas and wetlands, were converted to agricultural, urban or industrial use. Subsequently, there was a significant loss of biodiversity within the last one hundred years. Biodiversity decreased through the loss of hydrogeomorphic function, fluvialgeomorphic function, and land use change, which in turn has lead to a reduction in ecosystem complexity. Biogeochemical processes are functional within the Upper Des Plaines River watershed; however, they have been degraded through alteration of habitat. Function of the riverine system (erosion, transportation, deposition) has been altered through the construction of dams, channelization, and the rivers restricted use of its natural floodplain. These are manifested through a decreased level of natural services such as flood moderation, maintenance of adequate water quality, wildlife habitat, etc. Furthermore, the remnant parcels of natural cover types are under pressure from continued human activities. Nearly 90,000 acres of prairie are believed to have been present in 1840, of which currently only about 18 acres are considered as high-quality. Human induced disturbances to the remaining natural areas include fire suppression, altered hydrology, increase colonization of invasive species, and fragmentation. The recommended plan would significantly increase the footprint of nationally and globally rare ecosystems.

Connectivity: Connectivity is the measure of the potential for movement and dispersal of species throughout a given area or ecosystem. Connectivity within the Upper Des Plaines River watershed has been aided through the formation of the Des Plaines Greenway in Lake County, Illinois. Approximately 3,025 acres of land divided into 10 forest preserves, portions of which comprise the Des Plaines River floodplain, are maintained by the Lake County Forest Preserve as part of the greenway. Restoration of adjacent parcels of land within the watershed will provide additional high quality habitat for wildlife. Furthermore, fragmentation of natural areas would be reduced providing unimpeded dispersal routes between habitats for wildlife.

Aquatic life will benefit greatly through the restoration of connectivity within the Upper Des Plaines River. Removal of small dams will aid reducing impediments to fish movement as well as macroinvertebrates. The river will also be reconnected with portions of its natural floodplain, in turn providing nursery grounds for larval fish species. Finally, with the addition of in-stream habitat within the system, available habitat to niche specific species will improve as well as the overall function of the river.

As noted earlier in the discussion of Institutional Recognition, the Mississippi River flyway is ideal for all migratory birds. It is uninterrupted by mountains, dotted with tens of thousands of lakes, wetlands, ponds, streams and rivers, and is well timbered in certain reaches. However, the Mississippi River Flyway portion in and adjacent to Upper Des Plaines River is significantly urbanized with few productive stopover sites needed for essential foraging, nesting, and resting habitat. As a result, this portion of the flyway is one of North America's most important flyways for migrant songbirds per the Bird Conservation Network. Ornithologists at the Chicago Field Museum estimate on average more than five million migrating songbirds pass through this heavily urbanized area during the migration season. The five million birds are a noticeable fraction of the total number of migrant songbirds

moving through the entire North American continent per the Bird Conservation Network. The Upper Des Plaines Watershed when restored will provide essential foraging, nesting and resting habitat in addition to connectivity that is globally significant.

Limiting Habitat: Limiting habitat, habitat that is essential for the conservation, survival, or recovery of one or more species, exists within the Upper Des Plaines River watershed. Federally-threatened and endangered species as well as numerous state rare, endangered, and threatened species would benefit from restoration measures. Project features would be beneficial to the federally-endangered butterfly Karner blue butterfly (*Lycaeides melissa samuelis*) and the prairie white-fringed orchid (*Platanthera leucophaea*), including the Federal candidate species eastern massasauga (*Sisturus catenatus*). There are also over 89 state endangered and threatened species within 1 mile of the study area including the Illinois state endangered short-eared owl (*Asio flammeus*); yellow-headed blackbird (*Xanthocephalus xanthocephalus*); sandhill crane (*Grus Canadensis*); yellow rail (*Coturnicops noveboracensis*); blacknose shiner (*Notropis heterolepis*); slippershell mussel (*Alasmidonta viridis*); hoary elfin (*Incisalia polia*); swamp metalmark (*Calephelis mutica*); eastern massasauga (*Sistrurus catenatus*); Tuckerman's sedge (*Carex tuckermanii*); ; white-stemmed pondweed (*Potamogeton praelongus*); and purple fringed orchid (*Platanthera psycodes*). Illinois state threatened species include the double-crested cormorant (*Phalarocorax auritus*); great egret (*Ardea albus*); loggerhead shrike (*Lanius ludovicianus*); elephant ear (*Elliptio crassidens*); ironcolor shiner (*Notropis chalybaeus*); ottoe skipper (*Hesperia ottoe*); kirtland's water snake (*Clonophis kirtlandii*); American dog violet (*Viola conspersa*); beaked rush (*Rhynchospora alba*); crawe's sedge (*Carex crawei*); and dwarf raspberry (*Rubus pubescens*). Wisconsin state endangered species include the common tern (*Sterna hirundo*); forster's tern (*Sterna forsteri*); blanchard's cricket frog (*Acrid crepitans blanchardi*); and purple milkweed (*Asclepias purpurascens*). Wisconsin state threatened species include sullivant's milkweed (*Asclepias sullivantii*); prairie Indian plantain (*Cacalia tuberosa*); Acadian flycatcher (*Empidonax virescens*); cerulean warbler (*Dendroica cerulea*); blanding's turtle (*Emydonidea blandingi*); and redfin shiner (*Lythrurus umbratilis*). The Chicago region is a very important biodiversity hotspot within the Midwest (Chicago Wilderness Biodiveristy Recovery Plan).The restoration plans would directly and indirectly benefit an array of valued species found in the Midwest. For example, the section 206 Aquatic Ecosystem Restoration project, Orland Tract Grassland, now supports two small populations of the Crawe's sedge (*Carex crawei*). Orland Tract Grassland is located in the Lower Des Plaines River watershed, in Cook County, IL.

National Significance Metrics & Summary: Based on the above discussions, Plans F, G and H qualify as Nationally Significant Plans, with Plan G representing the most cost-effective restoration plan. The purpose of this study is to determine the most effective manner in providing improved habitats within a highly agricultural and urbanized watershed that is part of a Nationally Significant Migratory Bird Flyway and possesses the potential to restore critical habitat for several federally-endangered species. The project(s) would also eradicate invasive plant species from sites and maintain native plant community structure. The following metrics are assigned to a project based upon the site meeting the requirements identified in the Corps Budget Guidance EC 11-2-206:

- **Habitat Scarcity:** The loss of 88% of natural habitats within the Upper Des Plaines River watershed is documented. The restoration plan proposes to restore scarce high quality habitats, reduce fragmentation within the riparian corridor and connected floodplains to provide habitat for native species including 3 federally listed and 89 state listed species.

- **Connectivity:** This is supported by the removal of five dams, removing inhospitable habitats that fragment certain low vagility species and adds patches of critical habitat within the a major north-south riverine system which is also a component of the Mississippi Flyway.
- **Special Species Status:** Several critical habitats are being restored that would support Federally-listed species. Coordination ongoing with USFWS regarding habitat and species requirements for these species. There are 3 federally listed and 89 state listed species within the study area.
- **Hydrologic Character:** One of the main impairments to the Upper Des Plaines River watershed ecosystems is alteration/degradation of wetland and floodplain hydrology. All Plans currently have a component to restore hydrology back to natural hydro-periods and spatial coverage.
- **Geomorphic Condition:** Another main impairment to the Upper Des Plaines River watershed is the channelization of streams and grading out of micro-topography. All Plans currently have a component to restore fluvialgeomorphic and hydrogeomorphic features back to natural configurations and processes.
- **Plan Recognition:** The Upper Des Plaines River watershed is recognized by three National Plans and many regional and local plans as well.
- **Self Sustaining:** All Plans currently utilize natural sources of hydrology, follow geomorphic patterns and utilize plant genetic material within the regionally accepted radius to maintain local genetic heterogeneity. Since the use of locally adapted species and resurgence of hydrogeomorphic features, O&M will require a small investment. The primary O&M requirements relate to invasive species management and would include annual spot treat of individuals or small patches invasive plant species. Once established, these areas should be self-sustaining, and only minimal effort would be needed in the future to maintain these sites as high quality and critical habitat areas.

5.4.7.3 Acceptability, Completeness, Effectiveness and Efficiency

Acceptability, completeness, effectiveness, and efficiency are the four evaluation criteria 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.

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.

Preliminary coordination with state and Federal resource agencies indicate that ecosystem restoration within the Upper Des Plaines River watershed is a priority and will benefit threatened and endangered species and their critical habitats. Not only was coordination part of agency support, but a multi-agency team was established to develop habitat models and restoration alternatives specifically for this study. This team was termed the E-Team, and consisted of members from the USFWS, USEPA,

USACE, NRCS, Illinois Geological Survey, IDNR, WDNR, South Eastern Wisconsin Planning Commission, Kenosha County, Lake County SMC, Lake County Forest Preserve District, and the Forest Preserve District of Cook County. The ecosystem restoration measures were developed in conjunction with this team to develop alternative plans that would improve habitat quality throughout the Upper Des Plaines River watershed in line with preliminary studies conducted by several of these agencies as master plans or watershed assessments.

The primary non-Federal sponsors for this study and subsequent projects are the Lake County Forest Preserve, Kenosha County, Forest Preserve District of Cook County and the IDNR. These agencies would ultimately hold the responsibility for providing real estate and easements, and perform O&M of these sites once restored. Ecosystem Plans F, G and H were acceptable to the non-Federal sponsors as they would provide restoration in each county and within areas that provide the highest environmental benefits; however, Ecosystem Plan G provides a more balanced plan and is in line with the master plans and acquisition capabilities of all partnering agencies across the watershed. Overall, the No Action Plan and Ecosystem Plan C, which only restores habitat in Cook and Kenosha Counties, is unacceptable to the listed agencies and non-Federal sponsors above, while Ecosystem Plan G is the most acceptable for performing ecological restoration at a watershed scale and with the most efficient use of funds.

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 long term functioning of certain restoration features, and an adaptive management plan has been proposed, it must be accounted for in the plan. The recommended Ecosystem Plan G is considered complete since it restores a significant portion of the Upper Des Plaines River watershed and the proposed sites are located in areas where the highest benefits will be derived. The recommend sites and restoration alternatives per site were formulated with the exact same restoration techniques that were previously planned or implemented by federal, state and local agencies. For instance, the Lake County Forest Preserve District has restored several important tracts of land, such as Rollins and Wadsworth Savannas, and the plans presented in this study will be invaluable additions to them in terms of connectivity and hydrology. In the winter of 2010/2011, the Ryerson Woods Dam on the Des Plaines River was removed by the Lake County Forest Preserve District. In addition, the planning and design phases have been completed for the removal of the Dan Wright and MacArthur Woods dams. The IDNR, Forest Preserve District of Cook County and USACE have notched the largest dam and biggest impediment to fishes recolonizing the Upper Des Plaines River watershed in the Hoffman dam, along with two smaller dams, the Armitage and Fairbanks dams. The WDNR and SEWRPC have also completed several small fish passage projects and wetland restorations along the Des Plaines River that will result in the same benefits as proposed in Ecosystem Plan G.

As stated in the Acceptability section above, the primary non-Federal sponsors for project implementation will be the Lake County Forest Preserve District, Kenosha County, Forest Preserve District of Cook County and the IDNR. These agencies would ultimately hold the responsibility for providing real estate and easements, and perform O&M of these sites once restored. Ecosystem Plans

F, G and H were acceptable to the non-Federal sponsors across the watershed; however, Ecosystem Plans G and H also provides projects that are in line with the master plans and acquisition capabilities of Kenosha County sponsors. All of the agencies and non-Federal sponsors intend on monitoring the results of any implemented restoration plans under this study.

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 objectives developed for this study were directed at alleviating the watershed problems that may be addressed under the given ecosystem authority and USACE policies. The following is a discussion of how plans meet the study objectives:

Increase species richness, abundance and health: This objective will specifically look to increase total native species richness of restoration sites. This may be monitored using the HEP and HGM data collection techniques used to derive habitat suitability curve values. These assessment procedures and indices are calibrated for the region of study and are sensitive enough to capture improvements in quality. All alternative ecosystem plans would be effective at increasing species richness and abundance within the Upper Des Plaines River watershed. The removal of the last five dams on the Des Plaines River would allow for species to disperse from and recolonize from the lower Des Plaines River, such as silver redhorse (*Moxostoma anisurum*), skipjack herring (*Alosa chrysochloris*), freckled madtom (*Noturus nocturnus*) and sauger (*Sander canadense*). Thousands of acres would be restored that would reestablish hundreds of species of native plants back to the landscape. These healthy plant and stream communities would then attract a diverse array of resident and migratory birds and local insect, reptile, amphibian and mammal species. Results of past restoration activities of lesser extent in the region has shown a remarkable unassisted resurgence of regionally and nationally important wildlife species (e.g., Rollins Savanna, Orland Tract Grassland, Eugene Field, Wadsworth Savanna and Wet Prairie, etc.). These restoration projects used the same techniques that are described in the Recommended Plan that will be applied over a greater extent of the landscape. Since the techniques rely to a great extent on unaided natural processes, which are facilitated and reestablished during construction to maintain ecosystem structure and function. These techniques have been shown to be very cost efficient in restoring self-sustaining target ecosystems.

Increase connectivity of natural areas: Through creating high quality large contiguous tracts of native habitat, high functioning riparian corridors and stepping stones between remaining natural areas, this objective seeks to connect fragmented habitat patches, whether they are currently in a healthy state or they are in need of restoration. Ecosystem Plan G is the most effective and efficient at meeting the connectivity objective (Plate 41). All sites are located along the mainstem or major tributaries of the Upper Des Plaines River, which are major dispersal corridors for numerous vagile (i.e., able to move around in a landscape) species within the region. This has been proven to be a very effective and cost efficient method of restoring connectivity of within the landscape. Sites are also located near to other open/natural areas, allowing a greater chance of successful dispersal between fragmented native species populations. Increased dispersal along major riparian corridors and between isolated populations ensures these remaining native species populations have a greater likelihood of remaining genetically diverse and able to adapt to and persist during periods of environmental change.

Increase acreage of native community types: The increase in overall acreage of natural areas within a given subwatershed is not only beneficial to the targeted ecosystems, but also aids in alleviating hydrology and hydraulic problems for in-stream and wetland dependent species. For example, a subwatershed that is primarily agricultural land would see improvements in ecological function (e.g., hydrologic regime) if drain tiles were disabled and natural wetland plant communities were restored. Ecosystem Plan G is effective at meeting the need for increased size of native communities and subsequent hydrologic improvements. To improve hydrology, an estimated 17,900 feet of unnatural ditch would be filled along with hundreds of thousands of feet of drain tiles disabled. Natural stream sinuosity would be restored increasing total length from 68,400 feet to 85,500 feet and 7,000 feet of stream would receive instream habitat treatments. Over 6,800 acres of native aquatic community types would be restored including: marsh, sedge meadow, wet prairie, wet savanna, floodplain forest, and woodland ephemeral depressions. Riparian and buffering communities of prairie, savanna, woodland, and forest would also be restored to ensure sustainability and provide connectivity for multi-habitat life cycle species (i.e. Eastern Newt (*Notophthalmus viridescens*) require connectivity between marsh and woodland habitats). Ecosystem Plan G increases the quality of watershed ecosystem communities by 32% of what currently exists, an increase of almost 10% over the next smaller plan (Figure 5.6).

Reduce/control/eradicate non-native plant and animal species: This objective looks to ease the impacts of non-native and invasive species, particularly plant species. It is very difficult to eradicate invasive species; however, with hydrologic restoration, long-term maintenance and reintroduction of prescription burns that mimic per-settlement frequencies, local impacts from invasive plant species may be greatly minimized. Overall, all alternative ecosystem plans are effective at reducing the impacts of non-native plant species. The proposed plan would return hundreds of acres, ranging from sites that are 416 acres to over 1,000- acres in size, of land back to native communities free of invasive species effects. Ecosystem Plan G would be the most effective, restoring over 2,000 acres more than the next smaller plan. Based on previous restoration efforts within the study area that were aimed at controlling invasive species, there is good evidence that invasive species can be controlled and managed at low levels of effort in the years after completion of construction in community types that have a high native species richness. By allowing natural competitive interactions to occur within restoration areas, by establishing species rich native communities, these restoration techniques provide a cost effective way to ensure greater control of invasive species with minimal long term effort.

Preserve existing natural resources: This objective seeks to preserve acres of existing natural areas and sources of natural resources. This may be accomplished through simple procurement of land, restoration, management and by adding buffers to existing natural areas (i.e. riparian corridors). Ecosystem Plan G is more efficient at providing connectivity by including sites throughout the watershed. Ecosystem Plan G connects a total of 85,000-feet of greenway on the mainstem Des Plaines River.

Improve water quality for aquatic organisms: This objective seeks to reduce non-point source runoff, point source discharge and CSOs, and up-grade water quality use designations throughout mainstem and tributaries of the Upper Des Plaines River watershed. As identified in the increase of native community type objective, returning native vegetation, disabling drain tiles, filling in ditches and restoring streams for the purpose of habitat restoration has positive effects on water quality. Returning water into the ground through retention and groundwater infiltration, and

reestablishing naturally meandering streams will provide the means for filtering out nutrients and particulate matter that currently foul the waters of the Upper Des Plaines River. Although this is not a solution to the watershed's water quality issues, it is a starting point for projects to set an example how water quality can be restored through utilizing natural ecosystem functions. Ecosystem Plan G would be effective at achieving this initial level of water quality improvement.

The following are points of how plans comply with planning constraints:

Compatibility with flood damage reduction plans: All proposed alternative ecosystem plans compliment flood damage reduction projects since they would assist in attenuating water leaving the sites, infiltrate water back into the ground, provide a significant amount of acres for native plant evapotranspiration, and removes hydraulic impediments from the Upper Des Plaines River.

Compatibility with local watershed development plans: Watershed plans and initiatives within the Upper Des Plaines River watershed discuss opportunities for ecological restoration and preserving open space. All proposed alternative ecosystem plans were initially based off of their concepts and have the potential to bring them to fruition.

Avoid increases in flood damages, Avoid adverse effects to existing flood damage reduction projects and Minimize adverse affects to local drainage districts: The proposed alternative ecosystem plans all require additional site specific analyses during the PED Phase. Water budgets, hydraulic analyses, infiltration and evapotranspiration analyses would be completed to determine the fate of water that enters and leaves the restoration sites. Based on current information and past studies, it is likely that these restoration projects will complement FRM projects.

Efficiency

An ecosystem restoration plan must represent a cost-effective means of addressing the ecological 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 cost effectiveness of alternatives and sites were analyzed using IWR-Plan software and are presented in Section 5.4.6. As presented, the most cost effective alternatives were chosen per site, then the most cost efficient sites were identified, then the best of the best sites were screened in order to identify those sites that most effectively address problems and opportunities identified within the watershed for the given costs. These eight sites were then allowed to be developed into the alternative ecosystem plans. All inefficient alternatives and sites were removed from consideration and only "best buys" (plans A-H) were retained for further consideration. In addition to the CE/ICA, the efficiency of the specific restoration techniques described in the Recommended Plan has a long history of refinement in the region. Enabling regional practitioners to be reasonably assured of the results of these specific restoration techniques. Long-term past and ongoing restoration projects within the area (e.g., Somme Prairie) has served as examples of these techniques in providing physical evidence that they are effective and cost efficient.

5.4.7.4 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, the selection of a recommended alternative becomes more complex. It is essential to document the assumptions made and uncertainties encountered during the

course of the 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. Numerous successful examples of this technique are located within the watershed. Other activities may have higher associated risks such as restoration of a coastal marsh in an area subject to hurricanes. When identifying the NER 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.

Overall, there is very low risk associated with the selected NER plan not performing as predicted. Investigations appropriate for the level of project complexity were performed to ensure that the restored plant communities would not revert to invasive, weedy species again by a) gathering lessons learned from similar completed projects such as Orland Tract Section 206, Orland Perimeter 506, Calumet Prairie 506, and Red Mill Pond 506; b) designing plant communities compatible with the hydrology and geomorphology instead of fighting it, i.e. the overall design replicates plant communities indicative of the Upper Des Plaines River system as dictated by the historic vegetation maps and soil series; c) restoring hydrologic, hydraulic and fire processes to sustain and facilitate native plant communities; d) planting enough native plant material to prevent or lessen the ability of invasive and weedy plant species to effect the native plants; and e) implementing the projects in partnership with dedicated non-Federal sponsors that have natural area programs and protocols that will maintain the project as constructed with the intended ecological benefits.

Control of invasive species always presents a certain level of risk and uncertainty as the chances of reinvasion are likely without proper management, increasingly so when native species have not yet established. A prominent issue is that invasive plant species are adapted for colonizing areas that are disturbed and have altered soils (e.g., high nutrient content or unconsolidated urban fill). Ruined soil properties maybe alleviated by adding leaf litter compost to the top 6” of soil during late summer or early fall. Incorporating soil amendments decreases bulk density, holds moisture longer, and increases organic matter and microbial activity. This furthers the soil’s ability to provide for native plants and reduces the vulnerability of the plant community to noxious weed invasion. This measure has been effective on several Chicago District habitat restoration projects where the soils were physically altered. Where soils with very high organic content are encountered, inorganic substrates (e.g., free carbon) are added to balance the soil properties.

Native plantings also have an associated risk of not establishing due to a variety of unforeseen events. Predation from herbivorous animals is likely since common carp and Canada geese are quite abundant in the area. Weather also plays a large role in the establishment success of new plantings. Periods of drought, flood or early frost can alter the survival percentage of plantings. To mitigate these risks, planting over several years, overplanting and/or adaptive management and monitoring will be incorporated into the overall plan. In addition, climate change may or may not affect project outcomes. Consideration of climate change was incorporated in the study forecasting and alternative analysis as discussed in Section 5.3.2. In addition, effects of climate change on populations of native plants may be moderated by choosing a diversity of source material (different populations with different genetic

characteristics), selecting a high number of species (high species richness) and increasing the functional redundancy of the community by choosing many species that perform a similar role. All of these decisions will increase the ability of the native plant community to effectively respond, adapt and persist during periods of environmental change.

5.4.7.5 Partnership Context

The ecosystem restoration portion of this project was planned in cooperation with Federal, state and local resource agencies, termed the E-Team. This plan includes an opportunity for public comment, a description of the work to be undertaken, the methods to be used for ecological restoration, the roles and responsibilities of the Secretary and non-Federal sponsors, and the identification of funding sources. Similarly, this restoration project makes a significant contribution to regional, national, and international programs under the North American Waterfowl Management Plan. This project was coordinated and is in congruence with the Upper Des Plaines River Ecosystem Partnership, the Kenosha / Racine Land Trust, Openlands, the Chicago Wilderness, etc. There are over 50 entities with a stake in restoring ecosystems within the Upper Des Plaines River watershed http://upperdesplainesriver.org/links.htm#nonprofit1.

5.4.8 Selection of the Recommended Plans

When selecting a single alternative plan for recommendation from those that have been considered, the criteria used to select the plan include all the evaluation criteria discussed above. Plan selection 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. Table 5.20 is a summary of the preceding Trade-off analysis to determine the recommended Ecosystem Plan. The plan that maximizes net NER benefits and has shown great merit in the trade-off analysis is Ecosystem Plan G.

Table 5.20 – Alternative Plan Trade-off Analysis

Trade-Off Criteria	Ecosystem Plan A	Ecosystem Plan C	Ecosystem Plan F	Ecosystem Plan G	Ecosystem Plan H
Ecological Benefits	medium	medium	medium	high	highest
Output Significance					
Institutional	minimally	moderately	moderately	very	very
Public	minimally	moderately	moderately	very	very
Technical	minimally	moderately	moderately	very	very
Planning Criteria					
Acceptability	low	medium	medium	high	high
Completeness	high	high	high	high	high
Effectiveness	medium	medium	medium	high	high
Efficiency	high	high	high	highest	high
Risk	low	low	low	low	low
Uncertainty	low	low	low	low	low
Partnership Context	full support	full support	full support	full support	full support
Cost Reasonableness	reasonable	reasonable	reasonable	reasonable	reasonable

The authorization for this study directs USACE to "not exclude from consideration and evaluation flood damage reduction measures based on restrictive policies regarding the frequency of flooding, the drainage area, and the amount of runoff." (WRDA 1999, Sec. 419.b). Although certain FRM projects are not policy compliant as discussed in Section 4.6.5, all proposed ecosystem restoration projects are fully compliant with current USACE guidance. However, certain projects could reasonable be implemented under the USACE CAP. To respond to the study authority while also considering existing policy and guidance, three distinct plans have been formulated:

1. **Comprehensive Plan:** A plan that fully responds to the study authority and includes all cost-effective, environmentally acceptable separable projects evaluated during the course of the study. The CAP Plan and NER Plan are subsets of the Comprehensive Plan.
2. **CAP Plan:** All policy compliant, cost-effective, environmentally acceptable separable projects of such scope that they could reasonably be implemented under the CAP.
3. **NER Plan:** All policy compliant, cost-effective, environmentally acceptable projects of such scope that they could not be implemented under CAP.

All of the recommended Ecosystem Plan elements are policy compliant. However, some of the plan elements could reasonably be implemented under the CAP program. The NER Plan and CAP Plans are subsets of this Comprehensive Plan as detailed below. Aquatic Ecosystem Restoration projects may be implemented under CAP if the total Federal cost is less than $5,000,000. Sites that meet this criteria are identified as part of the CAP Plan. The remaining sites are part of the NER Plan.

5.5 Description of the Ecosystem Restoration Plans*

Restoration measures to be implemented per site under the Ecosystem Plan G are detailed in Table 5.21 and estimated costs for each site are presented in Table 5.22. Detailed descriptions of each site's restoration plan are provided in Section 10. The plan formulation process was fashioned so that site selection and restoration activities would fall within Corps aquatic ecosystem restoration policy. The formulation was geared towards restoring those sites that were in most need of hydrologic-hydraulic, geomorphic, and aquatic native plant structure repair, all of which interact with each other to provide stream, wetland, and riparian habitat for higher level organisms such as fish, amphibians, reptiles, birds and mammals. Also, it is imperative for the Corps and non-Federal sponsors to recommend sites and restoration methodologies that would lead to sustainable and functioning ecosystems that would require limited operations and maintenance. Benefits include:

1. Naturalize watershed hydrology, hydraulics and geomorphology
2. Increase acreage of native community types
3. Reduce/control/eradicate non-native plant and animal species
4. Increase connectivity of natural areas
5. Increase watershed biodiversity
6. Preserve existing natural resources via adding adjacent habitat acres, not through acquisition
7. Incidental improvements in water quality for aquatic organisms
8. Increase naturalized open space and recreational opportunities

9. Aid in naturalization of main stem and tributary flood pulses

A period of monitoring and, if needed, adaptive management will follow initial construction at each site. The structural sustainability and biological response of the restored ecosystem will be assessed to determine whether the project is meeting the planning goals and objectives.

Once the projects have been established, sites will be maintained by the non-Federal sponsors according to detailed OMRR&R plans developed for each site. Maintenance will include activities such as prescribed burns, periodic mowing, control of herbaceous and woody invasive species, and additional seeding to build species richness.

Table 5.21 – Summary of Ecosystem Restoration Plan Components.

	Site						
Measure	**C09**	**C15**	**L31**	**L39**	**L43**	**K41**	**K47**
Stream Remeander				X		X	X
Bank Grading 20:1				X		X	
Swale Grading							
Cobble Riffles				X		X	
Fill Ditch				X			X
Drain Tile Survey	X	X	X	X	X	X	X
Drain Tile Valves	X	X	X	X	X	X	X
Tree & Understory Trimming	X	X	X	X	X		X
Tree Removal	X	X	X		X	X	X
Herbaceous Management		X	X	X	X	X	X
Native Plant Establishment	X	X	X	X	X	X	X

Table 5.22 – Preliminary Ecosystem Restoration Costs

County	ID	Plan	Total Implementation[1]	Preliminary Lands and Damages[2]	Total Project Cost	Annual OMRR&R
Kenosha	K47	NER				
	K41	NER				
Lake	L43	NER				
	L39	NER				
	L31	NER				
Cook	C09	NER				
	Dam #1	CAP				
	Dam #2	CAP				
	C15	NER				
	Dempster Ave Dam	CAP				
	Touhy Ave Dam	CAP				
	Dam #4	CAP				
NER Plan Total						
CAP Total						
Comprehensive Plan Total						

[1]Total Implementation includes construction; planning, engineering and design; construction management; monitoring and adaptive management.

[2] Corps ecosystem restoration policy requires that land acquisition in ecosystem restoration plans be kept to a minimum. Project proposals that consist primarily of land acquisition are not appropriate. As a target, land value should not exceed 25 percent of total project costs. Projects with land costs exceeding this target level are not likely to be given a high priority for budgetary purposes.

(FY2015 Price Level)

Additional Studies Needed: Additional focused studies are needed at the beginning of the design phase to ensure that adequate data is available for design plans and specifications development. This is a list of possible future studies, this list is not exhaustive:

- Hydrologic and hydraulic modeling for stream restoration and dam removal projects. This would provide information for proper placement and sizing of in-stream structures to remeander streams.
- Drain tile surveys would entail finding the location and condition of all drain tiles within previous and current agriculture fields and provide a valve installation plan
- Site assessments and floristic surveys would include but not limited to locating trees and shrubs and/or invasive species to be removed, verifying areas to be seeded and special areas (remnant patches) of flora diversity to be preserved.

6 Interdependence Analysis

6.1 Introduction

The combined plan developed for the Upper Des Plaines and Tributaries Feasibility Study (Phase II Study) has been formulated to build on and extend the benefits achieved by the Upper Des Plaines River Flood Damage Reduction Feasibility Study (Phase I Study). The authorized plan developed through the Phase I Study addressed flood risk within the Upper Des Plaines River watershed in Illinois. This Phase II Study recommends a plan that further manages flood risk on the Des Plaines mainstem in both Illinois and Wisconsin, manages flood risk on tributaries to the mainstem, and, additionally, restores degraded ecosystems within the study area.

The watershed scale of the study has allowed for a systems approach, by evaluating the basin-wide flood risk management (FRM) and ecosystem restoration (ER) potential, evaluating individual sites by purpose and then evaluating sites in combination with each other. As discussed in Sections 2 through 5, separate plans were formulated to meet the FRM and ecosystem restoration study purposes resulting in distinct FRM and ER plans. These plans have been combined into a multipurpose FRM/ER combined plan, as discussed in this section.

To formulate the combined plan, an evaluation of the effects of the FRM and ER plans with respect to the other was conducted. The Comprehensive FRM and ER Plans include all features of the Comprehensive, NED, NER, and CAP Plans. The single-purpose plans can be compared to determine if any components are interdependent. Interdependent elements share the same physical location, resources, or functions and have the potential to either negatively impact each other or compete for the same resources. When interdependence occurs, the outputs from the elements that cause impacts or are in competition with each other must be traded off. If the elements are independent – there is no competition for the resources – and do not impact each other, trade-offs are not necessary. If the plans are independent, the combined plan will simply include each element identified in the single purpose plans. This process is illustrated in Figure 6.1.

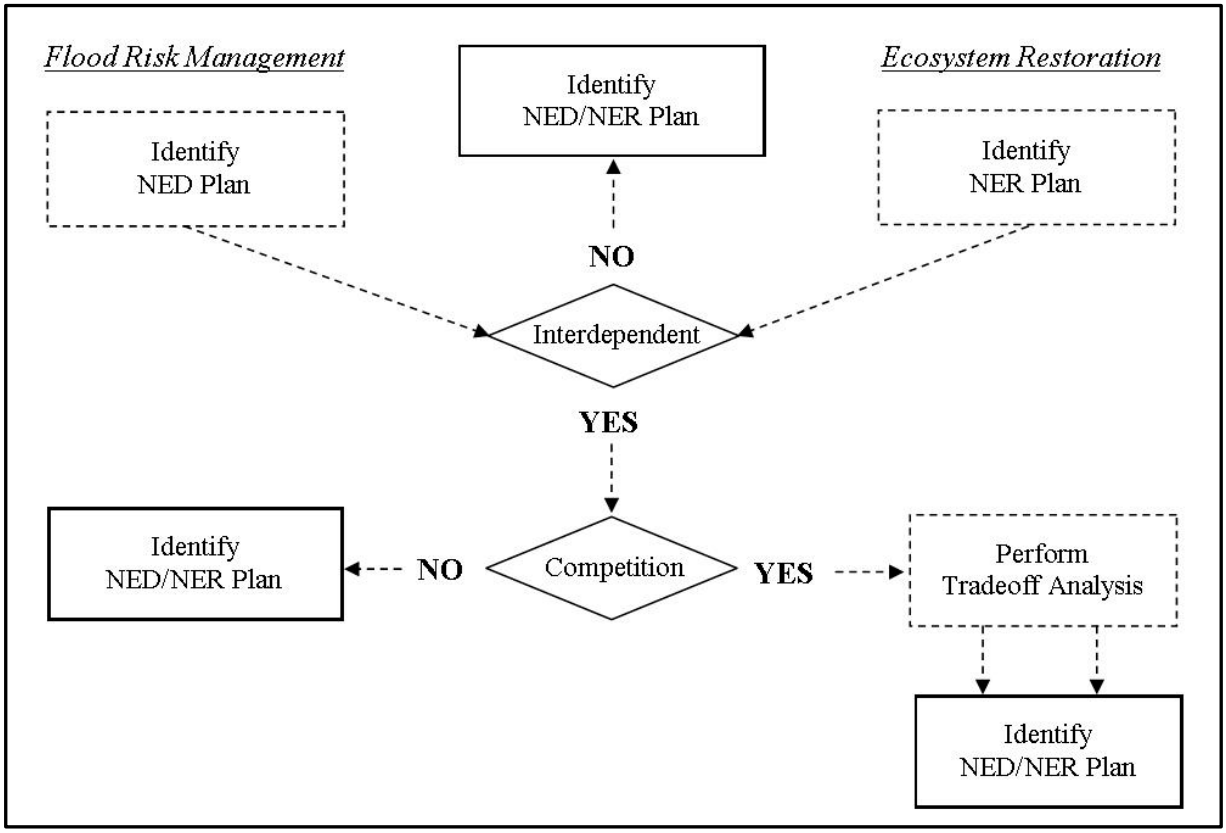

Figure 6.1 – Plan Formulation Process for Determining Combined FRM/ER Plan

6.2 Interdependence Analysis

The recommended FRM and ER plans identified in Sections 4 and 5 each identified several measures and sites throughout the watershed. The locations of each site are shown in Plate 42. The FRM Plan was formulated to manage flood risk on both the mainstem Upper Des Plaines River and along its tributaries. The ER Plan was formulated to naturalize the primary ecosystem drivers of hydrology, hydraulics and geomorphology and the secondary drivers of native plan communities. Naturalizing these drivers would restore functioning, viable and sustainable ecosystems within the watershed of the Upper Des Plaines River and its tributaries. After each plan was independently developed, maximizing the benefits within each study purpose, a comparison was conducted to determine interdependence between plan elements.

Both plans were formulated considering the existing hydrologic and hydraulic conditions and evaluated use of all open and vacant land in the watershed. Each plan identified the most effective and efficient sites for implementation of the FRM and ER plans. The most complete plan will be the plan that implements both the FRM and ER plans while accounting for any interdependence between sites.

Interdependency between plan elements can be either physical or functional. The FRM and ER plans are physically independent, with no measures selected for implementation on overlapping sites. Analysis is required, however, to determine whether there is other interdependency or if functional competition exists between sites. Since the NED, NER, and CAP Plans are all subsets of the Comprehensive Plan for each purpose, the analysis was conducted between the FRM and ER Comprehensive Plans. If interdependence were found, the process would be repeated for the additional plans.

The potential impacts of one site on another are dependent on the distance between the sites. The primary cause of interdependence would be the hydraulic impacts of implemented projects. The hydraulic analyses conducted in conjunction with the development of the single purpose plans showed that the hydraulic impacts of a site do not extend more than a few miles from the project location. To allow for variation and add a buffer to the estimate, a distance of 10 miles was selected as the maximum distance over which the hydraulic impacts of a site could be felt.

Nearby sites, however, could impact the functional output of one another. To determine any potential impacts between nearby sites, the hydraulic distance in river miles between FRM sites and the nearest ER site was determined using GIS mapping. Potential impacts were then assessed for each site according to the type of sites and the distance between them. Where an FRM site is adjacent to or within ten miles of an ER site, nearby sites were assessed for potential impacts.

Four types of impact assessments resulted from the analysis:

- D Hydrologic and hydraulic modeling of the study area indicates that the effects of proposed projects are insignificant at distances greater than 10 miles. Therefore, where the hydraulic distance between sites is over 10 river miles, sites will not impact each other. (Shown as D in Table 6.1)
- L The levees included in the FRM plan are not expected to impact the water surface profile. Stage increases that could be caused by the levees will be mitigated by construction of a compensatory storage reservoir. Hydraulic analysis conducted as part of FRM plan formulation showed that DPLV01 would not cause stage increases. (Shown as L in Table 6.1)
- R Sites such as dam removals and road raises are not expected to alter the hydrology or hydraulics of the system. The dams are all low head run of the river type structures. Dam removals are not expected to have any adverse hydraulic impacts; however, local hydraulic changes of turning lentic habitat into lotic habitat are highly beneficial for riverine specialist species. The road raise site, DPBM04, will be designed to extend the bridge to prevent stage impacts. (Shown as R in Table 6.1)
- S Nominal benefits will be accrued by ecosystem restoration sites downstream of a floodwater storage reservoir due to reductions in the depth and duration of flooding. These benefits, however, were not quantified and are not part of the habitat assessment conducted as part of the ER plan formulation process. The justification of restoration, therefore, is not dependant on these nominal benefits. (Shown as S in Table 6.1)

The results of the comparison are shown in Table 6.1. This analysis shows that the only expected impacts are nominal and the two plans are independent. The combined plan, therefore, includes all elements identified as part of the FRM and ER plans.

Table 6.1 – FRM/ER Site Interdependence Analysis

FRM Site	Watershed	Nearby ER Site	Approximate Location of ER Site	Potential Impacts
FPCI01	Farmer-Prairie Creek	Dempster Ave Dam	2 miles downstream to mainstem, 1/2 mile upstream to dam removal	R
	Farmer-Prairie Creek	Touhy Ave Dam	4 miles downstream to dam removal	R
WLRS04	Des Plaines River[1]	Touhy Avenue Dam	3 miles downstream to dam removal	R
	Des Plaines River[1]	C15	1 1/2 miles upstream to restoration site	S
DPLV09	Des Plaines River	Touhy Ave Dam	less than 1 mile downstream	R,L
	Des Plaines River	Dempster Ave Dam	less than 1 mile upstream	R,L
DPLV05	Des Plaines River	Dam #4	3 1/2 miles upstream	R,L
DPLV04	Des Plaines River	Dam #4	5 miles upstream	R,L
DPRS04	Des Plaines River	Dam #4	6 miles upstream	R
DPBM04	Des Plaines River	Dam #4	6 miles upstream	R
DPLV01	Des Plaines River	Dam #4	over 10 miles upstream	D

[1] WLRS04 is located in the Weller Creek watershed, but will be hydraulically connected to the Des Plaines River through a constructed channel.

Potential Impacts:
D Sites are over 10 miles apart, therefore no impact
L Levee does not impact water surface profile, therefore no impact
R Dam removals and road raises do not impact hydraulics; therefore no impact
S Nominal benefits to ER site due to reduction of depth and duration of flooding from floodwater storage

7 Water Quality*

7.1 Water Quality Inventory and Forecasting

Various factors in both urban and rural watersheds can impact water quality. States are required by Section 303(d) of the Clean Water Act to list impaired waters that within the state. The 303(d) water quality assessments identify not only impairments, but also the sources of the impairments and potential causes. Table 7.1 presents the sources and potential causes of listed impairments on tributaries to the Upper Des Plaines River. Table 7.2 presents the sources and potential causes of listed impairments on the Upper Des Plaines River mainstem.

Although the Des Plaines River and its tributaries in Wisconsin are not listed as 303(d) impaired waters by the state of Wisconsin, water quality in this portion of the watershed was investigated by the SWRPC in 2003. The investigation found that dissolved oxygen, phosphorus, and fecal coliform parameters were in excess of recommended standards at least some of the time. Low dissolved oxygen levels caused violations of warmwater fishery water quality standards and the levels of fecal coliform caused violations of recreational water use objectives.

In the more rural, northern parts of the watershed, a major cause of impairments are crop production and livestock feeding operations. Runoff, storm sewers, combined sewer overflows, and contaminated sediments in the waterway are commonly identified causes in the southern urban areas. Municipal point source, or wastewater treatment plant, discharges and hydrostructure flow regulation and modification are potential causes for impairments in both urban and rural areas.

Table 7.1 – Tributary 303d Water Quality Impairments

Waterway	Impairment	Source	Potential Cause
Mill Creek	Aquatic Life	Oxygen, Dissolved	Municipal Point Source Discharge
		Phosphorus (Total)	Municipal Point Source Discharge
		Sedimentation/Siltation	Crop Production
Indian Creek	Aquatic Life	Endrin	Contaminated Sediments
		Methoxychlor	Contaminated Sediments
		Nitrogen (Total)	Municipal Point Source Discharge
			Contaminated Sediments
		Phosphorus (Total)	Municipal Point Source Discharge
		Sedimentation/Siltation	Channelization
		Total Suspended Solids	Agricultural Practices
		Manganese	Petroleum, Natural Gas Activities
		Oxygen, Dissolved	Urban Runoff / Storm Sewers
Buffalo Creek	Aesthetic Quality	Phosphorus (Total)	Unknown
		Total Suspended Solids	Unknown
	Aquatic Life	Manganese	Urban Runoff / Storm Sewers
		Silver	Urban Runoff / Storm Sewers
		Oxygen, Dissolved	Unknown
		Phosphorus (Total)	Municipal Point Source Discharge
		Total Suspended Solids	Unknown
		Heptachlor	Contaminated Sediments
		pH	Unknown
	Primary Contact Recreation	Fecal Coliform	Urban Runoff / Storm Sewers
Willow Creek	Aesthetic Quality	Phosphorus (Total)	Unknown
		Total Suspended Solids	Unknown
	Aquatic Life	Phosphorus (Total)	Municipal Point Source Discharge
		Total Dissolved Solids	Urban Runoff / Storm Sewers
Higgins Creek	Aquatic Life	Total Dissolved Solids	Municipal Point Source Discharge
		Chloride	Urban Runoff / Storm Sewers
			Municipal Point Source Discharge
		Fluoride	Municipal Point Source Discharge
		Nickel	Municipal Point Source Discharge
		Nitrogen (Total)	Municipal Point Source Discharge
		Phosphorus (Total)	Municipal Point Source Discharge
			Urban Runoff / Storm Sewers
		Silver	Municipal Point Source Discharge
		Total Dissolved Solids	Municipal Point Source Discharge
			Urban Runoff / Storm Sewers
		Zinc	Municipal Point Source Discharge
		Oxygen, Dissolved	Urban Runoff / Storm Sewers
	Primary Contact Recreation	Fecal Coliform	Urban Runoff / Storm Sewers
			Municipal Point Source Discharge

Note: The remaining tributaries have either not been assessed for water quality impairments or are not impaired.

Table 7.2 – Des Plaines River Mainstem Water Quality Impairments

Source	Potential Causes
Cadmium	Combined Sewer Overflows, Urban Runoff/Storm Sewers
Chloride	Combined Sewer Overflows, Urban Runoff/Storm Sewers, Municipal Point Source Discharge, Highway/Road/Bridge Runoff
Copper	Industrial Point Source Discharge, Municipal Point Source Discharge, Urban Runoff/Storm Sewers
DDT	Contaminated Sediments
Hexachlorobenzene	Contaminated Sediments
Lindane	Contaminated Sediments
Methoxychlor	Contaminated Sediments
Nickel	Contaminated Sediments, Municipal Point Source Discharge, Combined Sewer Overflows, Urban Runoff/Storm Sewers
Nitrogen (Total)	Municipal Point Source Discharge, Combined Sewer Overflows, Contaminated Sediments
Oxygen, Dissolved	Combined Sewer Overflows, Hydrostructure flow regulation/modification, Municipal Point Source Discharge, Urban Runoff/Storm Sewers, Crop Production
pH	Combined Sewer Overflows, Urban Runoff/Storm Sewers, Municipal Point Source Discharge, Crop Production
Phosphorus (Total)	Municipal Point Source Discharge, Combined Sewer Overflows, Contaminated Sediments
PCBs	Contaminated Sediments
Sedimentation/Siltation	Urban Runoff/Storm Sewers, Combined Sewer Overflows, Hydrostructure flow regulation/modification, Crop Production, Site Clearance
Silver	Combined Sewer Overflows, Municipal Point Source Discharge, Urban Runoff/Storm
Total Dissolved Solids	Combined Sewer Overflows, Highway/Road/Bridge Runoff, Urban Runoff/Storm Sewers
Total Suspended Solids	Combined Sewer Overflows, Urban Runoff/Storm Sewers, Site Clearance, Crop
Zinc	Combined Sewer Overflows, Urban Runoff/Storm Sewers, Municipal Point Source

7.2 Sources

The following is a summary of water quality impairments identified within the Upper Des Plaines watershed. Based on data collected and analyzed by SEWRPC (2003), wet weather conditions generally had a much greater impact on the mass of pollutants transported from the watershed to the river system than on the concentration of pollutants being transported within the river system.

7.2.1 General Water Quality Parameters

Temperature: Temperature is one of the most important factors affecting the rate of chemical reaction and biological activities (growth) in an aquatic environment. Unnatural temperatures stem from impervious surface runoff and removal of riparian and catchment vegetation.

Dissolved Oxygen: Concentrations of oxygen in water are controlled by temperature and biological activity. Higher dissolved oxygen (DO) concentrations are found in cooler water. Photosynthesis as a result of biological activity increases DO and decreases respiration.

pH: The pH value, or hydrogen ion concentration, is a measurement of the acidity or alkalinity of water. It is generally considered that pH values above 8.0 in natural waters are produced by photosynthesis when a plant's use of CO_2 exceeds the production of CO_2 respiration and decomposition. The pH is also controlled by the presence of minerals, mainly carbonates, in the sediment that buffer changes in pH by solution and precipitation. Any chemicals, salts, or metals entering a stream or lake can unnaturally affect pH.

Sedimentation: Sediment is a natural part of riverine functions; however, when natural land cover has been converted to agricultural and urban uses, the amounts that enter the stream from non-point sources increase and change in composition, resulting in a higher proportion of fine sediments. These fine sediments such as silts, clays, and "urban dirt" smother habitat for fish and aquatic macroinvertebrates and bind contaminants such as phosphorus, PCBs, and heavy metals.

Fecal Coliform: Fecal coliform impairments originate from combined sewer and sanitary sewer overflows as well as agricultural runoff. The presence of this bacteria is considered and indicator for pathogens in water.

Total Solids (TS): The amount of TS in a water sample is the sum of the total dissolved solids (TDS) and the total suspended solids (TSS). TS can affect water clarity impacting photosynthesis and water temperature. TDS can affect the water balance in aquatic organisms causing them to migrate to water elevations to which they are not adapted. High concentrations of TSS can act as carriers for contaminants which readily attach to the suspended particles.

Chlorides: Chloride in surface waters can be attributed to the use of chloride compounds for street de-icing during the winter. Exposure to elevated levels of chloride in water can impair the survival, growth, and reproduction of aquatic organisms.

7.2.2 Nutrients

Ammonia: Ammonia usually results from the decomposition of nitrogenous organic matter. They also can result from municipal and industrial waste discharges to streams and lakes. Ammonia is toxic to fish and other aquatic organisms.

Nitrogen: The forms of Nitrogen found in surface waters are Nitrates and Nitrites. Nitrite is the end product of the aerobic stabilization of organic nitrogen and is found in polluted waters that have undergone self-purification or aerobic treatment processes. Nitrite can also occur in discharging ground waters. Nitrite has adverse physiological effects on bottle-fed infants and traditional water treatment processes are not able to remove it. Nitrates are a major ingredient of farm fertilizers and can stimulate the growth of plankton and other aquatic plants. Excessive growth can limit oxygen levels in the water, impacting fish and other aquatic organisms.

Phosphorus: Phosphorus and phosphate may occur in surface water or ground water as a result of leaching from minerals or ores, natural processes of degradation, or agricultural and urban drainage. Phosphorus is an essential nutrient for plant and animal growth and, like nitrogen, can stimulate the growth of plankton and other aquatic plants. Excessive growth can limit oxygen levels in the water, impacting fish and other aquatic organisms.

7.2.3 Metals

Cadmium: Cadmium is a known teratogen and carcinogen, a probable mutagen, and has been implicated as the cause of severe deleterious effects on fish and wildlife.

Chromium: At high environmental concentrations, chromium is a mutagen, teratogen, and carcinogen, although sensitivity to chromium varies widely, even among closely related species.

Copper: Long-term exposure to copper can cause irritation of the nose, mouth and eyes and it causes headaches, stomachaches, dizziness, vomiting and diarrhea. Intentionally high uptakes of copper may cause liver and kidney damage and even death. Whether copper is carcinogenic has not been determined.

Mercury: Mercury and its compounds have no known biological function, and the presence of the metal in the cells of living organisms is undesirable and potentially hazardous. Forms of mercury with relatively low toxicity can be transformed into forms of very high toxicity, such as methylmercury, through biological and other processes. Mercury is a mutagen, teratogen, and carcinogen and causes embryocidal, cytochemical, and histopathological effects.

Nickel: Nickel is a dietary requirement for many organisms, but may be toxic in larger doses. Metallic nickel and some other nickel compounds are teratogenic and carcinogenic to mammals.

Zinc: Zinc is not attributed a water hazard class, because it is not considered a hazard. However this only concerns elementary zinc; some zinc compounds, such as zinc arsenate and zinc cyanide may be extremely hazardous.

Silver: Silver ions are very toxic to microorganisms. Free silver ion has been found lethal to representative species of sensitive aquatic plants, invertebrates, and fishes.

Lead: Lead is neither essential nor beneficial to living organisms. All measured effects are adverse, including those on survival, growth, reproduction, development, behavior, learning, and metabolism. Exposure to waterborne lead has adverse effects on aquatic biota such as reduced survival, impaired reproduction, and reduced growth.

7.2.4 Organic Compounds

Pesticides and Insecticides: This category includes compounds such as Aldrin, alpha-BHC / Hexachlorobenzene, DDT, Endrin, Heptachlor, Lindane, and Methoxychlor. These compounds have various biologic and toxic effects in wildlife and humans including birth defects, reproductive failure, liver damage, nervous system damage, tumors, and even death. Although most of these compounds are no longer in use, they persist in water and sediments.

Polychlorinated biphenyls (PCBs): PCBs are a group of 209 synthetic halogenated aromatic hydrocarbons. PCBs elicit a variety of biologic and toxic effects including death, birth defects, reproductive failure, liver damage, tumors, and a wasting syndrome. Although virtually all uses of PCBs as well as their manufacture have been prohibited in the United States since 1979, the compound is very stable and persists in water and sediments.

7.3 Potential Causes

7.3.1 Agricultural Practices

The USEPA ranks agricultural activities as the most significant cause of impaired water quality in streams and lakes. Studies indicate that agricultural activities can impact both surface and ground water. For instance, long-term tributary monitoring programs throughout the US clearly document agricultural impacts (e.g. high nutrient loads) on the water resources. Excessive applications of animal manure and agricultural chemicals on cropland deteriorate ground water quality in intensively farmed areas. Research throughout North America suggests that agricultural practices can deteriorate surface and ground water quality resulting in significant public health and environmental impacts. Agricultural production can generate contaminants that can have many negative effects on surface or ground water supplies. Impairment sources are associated with cropping and livestock practices include sedimentation, nutrients (nitrogen and phosphorus) from inorganic fertilizers and organic livestock wastes, crop protection chemicals such as herbicides and insecticides, microorganisms from livestock wastes, and salts and trace elements from irrigation residues. Contaminants are transported, either bound to sediment or dissolved in water, to surface and ground water through all phases of the water or hydrologic cycle. Impaired water quality can restrict water uses for livestock watering, irrigation, drinking water supplies, sport fisheries, aquatic life, and recreation.

Livestock practices that can cause impacts to water quality include both intensive and non-intensive operations. Intensive operations include feedlots (>500 head of cattle), dairies and wintering sites while non-intensive operations include pasture, cow-calf operations and watering sites for cattle. Waste management and disposal can also impact water quality. Livestock density is not the only factor affecting water quality as sitting and management are also important considerations. Water quality parameters related to livestock production include nutrients (nitrogen and phosphorus), microorganisms (e.g. bacteria, fecal coliform, *Cryptosporidium*, *Giardia*) and organic material such as livestock wastes. Water quality concerns include impacts on receiving streams and aquatic life, and reuse of the water downstream for agricultural, recreational and drinking water purposes.

Cropping practices that can impact water quality include the use of organic and inorganic fertilizers, herbicides, insecticides, tillage, and irrigation and drainage practices. The amount, timing, and placement of fertilizer, herbicide, and insecticide applications can impact water quality. Other factors that can influence water quality include row or non-row cropping, the sequence of crop rotations, soil characteristics and weather conditions. Agricultural contaminants related to cropping practices include nutrients (nitrogen and phosphorus), herbicides and insecticides, sediments, salts and trace elements.

The following impairment parameters are attributed to agricultural practices within the Upper Des Plaines River watershed:

- pH
- Dissolved Oxygen
- Total Phosphorus
- Total Nitrogen
- Total Suspended Solids
- Sedimentation/Siltation

7.3.2 Urban Runoff and Storm Sewers

Impervious Surfaces

The amount of runoff generated within a watershed increases steadily with development. The presence of impervious areas such as roofs, parking lots and highways limits the volume of rain water infiltrated into the soil, and increases the amount of runoff generated. Urbanizing areas also tend to have reduced storage capacities for runoff because of regrading, paving, and the removal of vegetative cover. Decreases in infiltration and evapotranspiration and an increase in runoff are the result of urbanization, with runoff volume linked to the percent of impervious area.
Impacts on stream quality usually become apparent when the portion of impervious surfaces within a watershed exceeds 10% (Schueler 1994). Impervious surfaces such as roads, parking lots, sidewalks, and rooftops cause a rapid increase in the rate at which water is transported through the watershed to its stream channels. Common impacts include more variable steam flows, increased erosion from runoff, channel instability, increased non-point source pollutant loading, elevated temperatures, and excessive nutrient loading. Other stressors resulting from urbanization include the loss of natural vegetation throughout the watershed, particularly riparian vegetation, which supports many important stream processes. Effects on sensitive species may occur at levels even below this threshold. With even more impervious surface, most notably at 25-30% of the catchment area, numerous aspects of the stream quality may become degraded including biological integrity, water quality, and physical habitat quality (Schueler 1994, Miltner et al 2004, Walton et al 2006). Based on the watershed land use characteristics discussed in Section 3.1.1.5, it is estimated that over 47% of the Upper Des Plaines River watershed is covered with impervious surfaces.

Storm Sewers
Separate storm sewer systems convey only storm water runoff. In a municipality with a separate storm sewer system, sanitary sewer flows are conveyed in a distinct sanitary sewer system to municipal wastewater treatment plants. Storm water is funneled to storm sewers from parking lots, roofs, roads, highways, bridges, lawns, parks, etc and this urban runoff is discharged, untreated, to the waterways.

Site Clearance

Also associated with development is the practice of clearing sites of vegetation or existing structures for the construction of new buildings. These activities can lead to significant erosion if controls are not instituted, causing sedimentation and an increase in total suspended solids.

The following impairment parameters are attributed to urban runoff and storm sewers as well as runoff from highways, roads, and bridges within the Upper Des Plaines River watershed:

- pH
- Dissolved Oxygen
- Fecal Coliform
- Sedimentation/Siltation
- Total Suspended Solids
- Total Dissolved Solids
- Total Phosphorus
- Manganese
- Zinc
- Silver
- Nickel
- Cadmium
- Copper
- Chloride

7.3.3 Municipal Point Sources

A major portion of flows in the Des Plaines River basin, approximately 25%, consists of effluent from wastewater treatment plants. In the Upper Des Plaines River mainstem, treated water accounts for roughly 50% and 95% of flow during medium and low flow conditions, respectively. Although the effluent is treated and permitted by the appropriate regulating agency, the Illinois Environmental Protection Agency or WDNR, the plants add to the TSS and carbonaceous biochemical oxygen demand in the receiving water bodies. In addition, municipal point sources are identified as potential causes of a number of impairment sources in the watershed including metals, sediment and silt accumulation, phosphorus, and nitrogen.

The following impairment parameters are attributed municipal point sources within the Upper Des Plaines River watershed:

- pH
- Dissolved Oxygen
- Fecal Coliform
- Total Suspended Solids
- Total Dissolved Solids
- Total Phosphorus
- Total Nitrogen
- Manganese
- Zinc
- Silver
- Nickel
- Copper
- Chloride
- Fluoride

7.3.4 Industrial Point Sources

In addition to the wastewater treatment plants operated by local and countywide agencies, several commercial and industrial facilities treat wastewater and discharge to the waterways in the study area. The following impairment parameters are attributed to industrial point sources and industrial practices within the Upper Des Plaines River watershed: Copper and Manganese

7.3.5 Combined Sewer Overflows

In a combined sewer system, storm water runoff is combined with sanitary sewer flows for conveyance. Flows from combined sewers are treated by municipal wastewater treatment plants prior to discharge to receiving streams. During large rainfall events however, the volume of water conveyed in combined sewers can exceed the storage and treatment capacity of the wastewater treatment system. As a result, discharges of untreated storm water and sanitary wastewater directly to receiving streams can frequently occur in these systems. These types of discharges are known as CSOs.

During the period of major development in the Upper Des Plaines watershed, construction of separate sanitary and storm sewer systems was not common practice. As society and science matured, the practice of sanitary treatment rather than dilution became more widespread. In the early days of sanitary treatment, only “primary treatment” was conducted, consisting of removing solids and discharging the remaining effluent into receiving water bodies. During this early period in sanitary engineering, the sewer system collected both sanitary waste and storm water from roads and buildings. Interceptor basins were constructed within the sewer systems to direct dry weather sanitary waste to a

collection and treatment facility. During a significant rainfall event, however, the comingled rainfall runoff and sanitary waste would flow over the dry weather weir and be directed into the receiving water body. This method collected the majority of the sanitary waste for treatment prior to its discharge into a receiving water body. However, the pollution created from a combined sewer overflow event would still create environmental problems.

Legislation to address public health issues related to these practices began as early as 1912 with the creation of the Public Health Services Act. In 1948, Congress enacted the Federal Water Pollution Control Act which authorized the Surgeon General, in cooperation with other Federal, state and local entities, to create programs to eliminate and/or reduce pollution in interstate waters and to improve the sanitary condition of surface and ground water. The 1965 amendment to the Act, also known as the Water Quality Act, established the first water standards and mandated water quality assessment programs for the nation's waters. These standards, however, were not enforced.

By the time this act was made law, the practice of combined sanitary system design was no longer common practice. However, urban development had already occurred in within the Upper Des Plaines River Watershed and a number of communities have combined sewer systems. The MWRDGC, providing wastewater collection and treatment for most of the study area communities in Cook County, has increased the capacity of its system to reduce the frequency of CSO events. However, combined sanitary and sewer waste continues to discharge in the study area during extreme storm events.

The following impairment parameters are attributed to CSOs within the Upper Des Plaines River watershed:

- pH
- Chloride
- Total Nitrogen
- Dissolved Oxygen
- Total Phosphorus
- Total Dissolved Solids
- Total Suspended Solids
- Fecal Coliform
- Zinc
- Silver
- Nickel
- Cadmium
- Sedimentation/Siltation

7.3.6 Hydraulic Structures

Various modifications to the natural hydraulics of the watershed impact water quality. Manmade structures that are purposefully placed within a stream or river to manipulate hydraulics or flow are termed hydrostructures. The Des Plaines River watershed hydrostructures include dams, weirs, and on-line reservoirs. These hydrostructures are often constructed in conjunction with FRM measures or to improve agricultural production. It has been well documented that these structures can impair water quality as well as other ecological functions.

Dams

There are ten mainstem and twelve tributary dams in the Upper Des Plaines watershed. These run-of-the river, low-head structures have water quality impacts as well as the ecosystem impacts as

discussed in Section 5. Increased temperature and reduced dissolved oxygen are among the major impacts. A list of dams in the watershed is presented in Table 7.3. Additional fragmentation of the river occurs throughout the watershed at road crossings.

Table 7.3 – Dams in Study Area

County	Tributary	Dam
Kenosha	Brighton Creek	East Lake Dam
		Paddock Lake Dam
		Hooker Lake Dam
Kenosha/Lake	Mill Creek	Lake Shangri-La
		Lake George
		Third Lake
		St. Rollins Savanna
		Rasmussen Lake
		Temple/Smith Reservoirs
Lake	Bull Creek	Lach Lombard
		St. Mary's Lake
		Butler Lake
	Indian Creek	Reservoir Dam
Kenosha/Lake/Cook	Des Plaines River Mainstem	Dam #4
		Touhy Avenue Dam
		Dempster Street Dam
		Dam #2
		Dam #1
		Ryerson Dam
		Wright Forest Preserve Dam
		Wagon Trails Dam
		Hollister Dam

Drain Tile Systems

Drain tile is installed to make land available for agricultural use by lowering and removing subsurface water. This subsurface drainage is used where the soil is permeable enough to allow economical spacing of the drains and productive enough to justify the investment. A drain tile system consists of a surface or subsurface outlet and subsurface main drains and laterals. Water is carried into the outlet by main drains, which receive water from the laterals. Sub-mains are sometimes used off the main drain to collect water. Much of the Upper Des Plaines River watershed is or was in agricultural production. Based on the soil types, it is estimated that over 40,000 acres are artificially drained by these tile systems in order to provide appropriate conditions for growing crops of choice. Draining 40,000 acres of agricultural land results in an estimated 300 cfs of average daily flow, contributing to the discharge of nutrients and pollutants into the watershed's streams. Directly draining soils and not allowing natural filtering processes to occur continually allows the unnatural discharge of phosphorus, nitrogen and organic compounds into the watershed's streams.

Channelization

Channelizing small streams and creating ditches where no waterway previously existed is another way to aid in draining land for agricultural purposes or expediting floodwaters downstream. Most drain tile systems work in conjunction with these ditches. About 85-90% of the streams in the Upper Des Plaines River watershed are channelized for conveyance of agricultural water and to expedite floodwaters downstream; some are actually placed within a subsurface pipe. Additionally, these ditches are designed to contain large floods and not allow waters to reach formerly associated floodplains. A significant decrease in retention time and altering abiotic and biotic interactions within the floodplain adds to the poor water quality of the basin. Thusly, these ditches are merely conduits for nutrient and pollutant loaded water.

The following impairment parameters are attributed to hydrostructures within the Upper Des Plaines River watershed:

- Dissolved oxygen
- Sedimentation/Siltation
- Flow regime alteration
- Temperature increase
- Gas exchange alteration
- Nutrient entrapment
- Concentration of pollutants

7.3.7 Contaminated Sediment

Impairment sources that exist in the sediment in a waterway are often transmitted to the water itself. Although some water quality impairments will improve over time if the sources are addressed, some metals and organic compounds persist in sediments and continue to impact the surrounding water.

The following impairment parameters are attributed to the presence of contaminated sediments in the waterways:

- Endrin
- Methoxychlor
- Heptachlor
- Hexachlorobenzene
- Lindane
- DDT
- PCBs
- Nickel
- Total Phosphorus
- Total Nitrogen

7.4 Water Quality Analysis

7.4.1 Hydraulics

The volume and flow rate of stormwater discharges and runoff can have significant impacts on receiving streams. In many cases, the impacts on receiving streams due to high stormwater flow rates or volumes can be more significant than those attributable to the contaminants found in the discharges. While studies linking increased stormwater flows due to urbanization to stream degradation are generally lacking in quantitative data, there are a number of studies that support this hypothesis. EPA summarized studies which contain documented evidence of impacts on steams due to urbanization.

Stream bank erosion is a natural phenomenon and source of both substrates and nutrients. However, urbanization can greatly accelerate the process of stream bank erosion. As the amount of impervious area increases, a greater volume of stormwater is discharged directly to receiving waters, often at a much higher velocity. The increased volume and velocity of the runoff can overwhelm the natural carrying capacity of the stream network. In addition, streams in urbanized areas can experience an increase in bankfull flows. Since bankfull flows are highly erosive, substantial alterations in stream channel morphology can result. Excessive bank erosion occurs as streams become wider and straighter to accommodate greater flows. Watershed sediment inputs can lead to deposition in areas where the water slows, causing the degradation of benthic habitat. This ultimately results in a greater potential for further erosion.

7.4.2 Ground Water Recharge

Urbanization and hydrostructures such as drain tile can have a major impact on ground water recharge. As the watershed is altered, both shallow and deep infiltration decrease and ground water recharge is reduced, lowering the water table. This change in watershed hydrology alters the baseflow contribution to stream flow and is most pronounced during dry periods. Ferguson (1990) points out that “base flows are of critical environmental and economic concern for several reasons. Base flows must be capable of absorbing pollution from sewage treatment plants and non-point sources, supporting aquatic life dependent on stream flow, and replenishing water-supply reservoirs for municipal use in the seasons when water levels tend to be lowest and water demands highest.”

7.4.3 Aquatic Ecosystem Impacts

Natural ecosystems are a complex arrangement of interactions between the land, water, plants, and animals. Habitat is impacted by changes in both water quality and quantity, and the volume and quality of sediment. As reported by Schueler (1987), “no single factor is responsible for the progressive degradation of stream ecosystems. Rather, it is probably the cumulative impacts of many individual factors such as sedimentation, scouring, increased flooding, lower summer flows, higher water temperatures, and pollution.”

The loss in riverine diversity is related in part to the degradation of water quality in the watershed (IDNR 1998; Arnold et al. 1999). For example, there are limited riparian buffers along the Des Plaines River and associated tributaries in the urbanized areas of this system. Riparian buffers are major determinants of fish and in-stream biotic integrity (Wang et al. 1997; Stewart et al. 2001; Roth et al. 1996). Changes to surface water characteristics such as temperature, dissolved oxygen, and sedimentation as well as introduction of pollutants such as nutrients, metals, and organic compounds result from urbanization and increased point and non-point source discharges. Therefore, it is very likely that the fishery communities within the Upper Des Plaines River watershed are responding to the reduction in water quality associated with increased urbanization in this watershed (Harris et al. 2005).

As discussed in Section 5, a survey of stream fish communities and habitat was conducted in the Upper Des Plaines River watershed to determine the current status of species distribution, and to evaluate the effects of urbanization and multiple low-head dams on fish community diversity and

species composition. Based on the Qualitative Habitat Evaluation Index there were two sites on Bull Creek (BLC-03 and BLC-01) classified as a Unique Aquatic Resource. These sites had excellent habitat and stream morphology although bank erosion and down cutting may indicate potential hydraulic problems. Five sites in the Upper Des Plaines basin (10%) were classified as a Highly Valued Resource, 22 sites (46%) were classified as a Moderate Aquatic Resource, 17 sites (35%) were classified as Limited Aquatic Resource and 2 sites (4%) were classified as an Imperiled Aquatic Resource. The average QHEI score of 44 classifies the Upper Des Plaines River system as a "moderate aquatic resource" habitat wise.

7.4.4 Public Health Impacts

Public health impacts associated with water quality occur when humans ingest or come in contact with pathogens. While these impacts are not widely reported, they do occur, and some impacts have been documented. CSO events, discharges from municipal point sources, agricultural runoff and point sources can all contribute to the presence of pathogens. In addition, the presence of contaminants such as metals, pesticides, and PCBs can adversely impact human health.

7.5 Water Quality Plan Formulation

While all activities in which USACE participates or partners comply with Clean Water Act regulations, improvements for the sole purpose of water quality do not fall under USACE authority. Water quality planning for this study, therefore, is confined to an evaluation of the incidental water quality benefits resulting from the combined FRM/ER plans and recommendations for implementation by the study non-Federal sponsors.

7.5.1 Impacts of the FRM and ER Plans

Ecosystem Restoration: Implementation of the ecosystem restoration sites will benefit water quality by restoring the hydrology and native plant communities and the hydraulics of meandering streams that had been channelized. Improved hydrology will reduce stormwater flows, increase base flows, and provide natural filtration through soils. These naturalized hydraulics will positively affect parameters such as temperature, dissolved oxygen, total suspended solids, and sediment distribution.

Dam Removals: Implementation of the five dam removals along the mainstem Des Plaines River will improve fish passage and riverine functions. Hydrostructures in the watershed have been linked to adverse sediment transport, habitat impairments, and water quality impairments. With the dams removed from the waterway, the bed load of cobble, gravel, and sand will no longer be trapped behind the structures. The wash load, fine silts and clays, typically move over the existing low-head dams during storm events.

Reservoirs: Reservoirs DPRS04 and WLRS04 would both benefit water quality by trapping sediment and excessive flows from two highly urbanized watersheds. Such watersheds generally have high nutrient and contaminant levels due to everyday practices, including but not limited to automotive use and maintenance, lawn care, impervious surfaces, etc. The sediments and any associated pollutants may be collected within the reservoir site, preventing further water quality impairment downstream of the two reservoirs.

Levees: The configuration of the levees may actually halt some urban runoff from entering the Des Plaines River. Flow of runoff will be constrained by the levee's interior drainage structures. The contaminants carried in this runoff such as chlorides, metals, dissolved solids, and suspended solids will also be constrained, thus helping to improve water quality.

7.5.2 Law and Ordinance Enforcement

Section 303 of the Clean Water Act (CWA) delegates the responsibility for the development of interstate water quality standards to states. Under this program, states must review and update water quality standards every three years. CWA Section 510 requires that these standards meet Federal minimums, but does not preclude states from setting higher standards.

7.5.2.1 Point Source Regulations

At the state level, the IEPA and the WDNR administer the National Pollution Discharge Elimination System (NPDES). This program prohibits the discharge of pollutants to waters of the U.S. through a point source without a permit. Industrial and commercial facilities including animal feeding operations, municipal point sources, combined sewer systems, and construction sites are all required to obtain permits documenting their pollution prevention activities and limiting discharge of pollutants.

7.5.2.2 Non-point Source Controls

Counties and municipalities participate in water quality improvement by modernizing infrastructure, regulating land use, and updating stormwater ordinances. Agencies such as MWRDGC and LCSMC as well as local governments are actively partnering with communities to promote stormwater best management practices (BMPs) to improve the quality of water entering watershed streams and rivers. BMPs are promoted through the development of watershed plans and revisions to local stormwater management ordinances.

8 Recreation

8.1 USACE Recreation Planning and Development

It is USACE policy to fully consider the recreation potential that may be afforded at civil works projects and to capitalize on that potential for the benefit and enjoyment of the public on a sustained basis. Projects must:

1. Fully consider potential opportunities that may be afforded for both recreation and fish and wildlife enhancement
2. Respond to public input and consider a range of activities and their compatibility with the regional setting and the project's natural and cultural resources
3. Be consistent with the State Comprehensive Outdoor Recreation Plan (SCORP)
4. Ensure that project resources are considered as an integrated whole with continuing concern for environmental quality
5. Be coordinated with other Federal, state, regional and local agencies and other groups and organizations as appropriate
6. Be prepared cooperatively by USACE and the project non-Federal sponsors
7. Be maintained for the benefit of the general public

For this study, recreation is a secondary purpose. All recreation features must be compatible with primary project purposes. As a secondary project purpose, recreation benefits are considered incidental and are not considered in project justification.

8.2 Recreation Inventory and Forecasting

Existing recreational facilities in the study area, summarized in Section 3.1.6, are spread throughout the watershed. Plate 9 shows the distribution of open lands and recreation areas throughout the watershed.

Illinois and Wisconsin have both developed SCORPs. The most recent SCORPs were published in 2009 for Illinois and 2005 for Wisconsin. An updated SCORP for Wisconsin is currently in development. A prominent feature of these plans is an assessment of interest in and need for recreation features. In both Illinois and Wisconsin "pleasure walking" is the most popular outdoor recreation activity. This activity is very important to 80% of the population in Illinois and is an activity in which 85% of the state population participates in Wisconsin. Both plans emphasize the need for natural resource conservation and the development of greenways and trails.

Regional plans developed by the CMAP and the SEWRPC have similar emphases. The plans identify a need for increasing the amount of conservation open space and greenways as well as the development of extended trail networks.

8.3 Recreation Analysis

The Combined FRM/ER Plan includes several types of measures with varying opportunities for implementation of recreation features. Ecosystem restoration, reservoir, and levee sites offer the greatest opportunity for recreation, as these are the most land intensive types of measures. Dam removals impact only a small area and, in general, are already within publicly accessible forest preserves. Structure modifications and road raise sites are at previously developed locations where public safety concerns would preclude use of the sites for recreation. Non-structural measures will be implemented at private properties where recreation features would not be appropriate. The types of measures and opportunities at each are summarized in Table 8.1.

Table 8.1– Recreation Opportunities at Incrementally Justified Sites

Measure	Recreation Opportunities
Ecosystem Restoration	Multipurpose trails, walkways, and canoe launches
	Picnic tables and benches
	Educational/informational signs and displays
Reservoirs	Multipurpose trails and walkways, picnic facilities
Levees	Multipurpose trails and walkways
Dam Removals	none
Structure Modifications	none
Road Raises	none
Non-structural Buyout	Multipurpose trails and walkways

8.4 Recreation Plan Formulation and Evaluation

The goal of this recreation plan is to optimize public use of project sites in harmony with the primary project purposes, the capacity of project resources, and the interests of the non-Federal sponsors and the public.

8.4.1 Flood Risk Management Site Recreation Opportunities

Three FRM sites at which interest in recreation features were identified. For these sites, an economic analysis was conducted and benefits were associated with the projects as discussed below. Estimated costs for the proposed recreation features are shown in Table 8.2.

Touhy-Miner Levee (DPLV09)

As discussed in Section 4, recreation opportunities were investigated as a part of site evaluation at the Touhy-Miner Levee (DPLV09). A segment of multipurpose trail along the floodwall between Oakton Street and Algonquin Road was identified for implementation. This trail would provide safe and scenic access to the 50 mile Des Plaines River trail system for local residents.

To determine the economic benefits associated with the proposed trail, an estimate of the annual use at the site and the unit day value (UDV) of that use was determined according to procedures outlined in ER 1105-2-100, Appendix E and EGM 14-03. For the FWOP condition, where existing sidewalks are used to access the trail, an estimated 500 users will walk along Des Plaines River Road to get to the

Des Plaines River Trail. The UDV assigned to current conditions is $5.47 providing total FWOP condition benefits of $3,000. With improved safety, capacity, and accessibility, the number of users would increase to 22,000. This projection is based on counts of trail users at a nearby Forest Preserve District site. The improved experience is reflected in an increase in UDV to $8.17, providing total with project condition benefits of $180,000 and an incremental benefit of $177,000. The estimated annualized cost for the trails, including operations, maintenance, repair, rehabilitation, and replacement (OMRR&R) costs, is $7,000. The trails would therefore provide $170,000 in net benefits. A detailed discussed of the analysis is presented in Section 4.2 of Appendix E (Economic Analysis).

Fullerton Woods Reservoir (DPRS04)

As discussed in Section 4, recreation opportunities were investigated as a part of site optimization at the Fullerton Woods Reservoir (DPRS04). This site, although part of the Cook County Forest Preserve District, was previously deforested and used as a stone storage site. Currently, the site is not well maintained and is difficult to access. The proposed recreation features would include a parking area, multipurpose trails allowing for walking, running, and bicycling around the site, and picnic facilities.

To determine the economic benefits associated with the proposed trail, an estimate of the annual use at the site and the unit day value (UDV) of that use was determined according to procedures outlined in ER 1105-2-100, Appendix E and EGM 14-03. Because the site is currently difficult to access, the UDV assigned to the existing conditions at the site, $4.06, was very low and attributed to the presence of other similar recreation sites in the vicinity of the project area (availability of opportunity). However, since the site is not currently used, the without project condition benefits are $0. The with project UDV, $7.06, accounts for improved access and quality of experience for users of the site. Projected usage is estimated to similarly to that for the trails at DPLV09. With 22,000 average annual users, the total estimated benefits are $155,000. The estimated annualized cost for the recreation facilities, including OMRR&R costs, is $45,000. The site would therefore provide $110,000 in net benefits. A detailed discussed of the analysis is presented in Section 4.2 of Appendix E (Economic Analysis).

Des Plaines Floodway/Big Bend Drive Area

At the Des Plaines Floodway/Big Bend Drive Area, there are currently no recreation facilities. Therefore, any recreational facilities developed at the site would be new rather than modification of existing features. The proposed recreation features include approximately 4,000 feet of asphalt trail connecting to existing roads and the Des Plaines River trail network on the opposite bank.

To determine the economic benefits associated with the proposed trail, an estimate of the annual use at the site and the unit day value (UDV) of that use was determined according to procedures outlined in ER 1105-2-100, Appendix E and EGM 14-03. For the FWOP condition, there was assume to be non-existent or limited recreational experience, opportunity, capacity, or accessibility because the land is occupied by private residential homes. As such, a low UDV of $4.06 was assigned to the current conditions which when applied to zero assumed users (due to limited access) provides zero FWOP conditions benefits. With the recreation features, the number of users would increase to 22,000. The improved experience, availability, accessibility, and environmental quality is reflected in an increase in UDV to $7.78, providing total with project condition benefits of $171,000. The estimated annualized cost for the trails, including OMRR&R costs, is $10,000. The trails would therefore

provide $161,000 in net benefits. A detailed discussed of the analysis is presented in Section 4.2 of Appendix E (Economic Analysis).

Table 8.2 – Estimated Costs of Recreation Features

Site ID	Site Name	Total Project Cost ($1,000)	Recreation Feature Cost ($1,000)
DPLV09	Touhy-Miner Levee	[redacted]	[redacted]
DPRS04	Fullerton Woods Reservoir	[redacted]	[redacted]
NS	Des Plaines Floodway/Big Bend Drive Area	[redacted]	[redacted]

(FY2014 Price Level)

8.4.2 Ecosystem Restoration Site Recreation Opportunities

Preliminary coordination has been conducted with the study non-Federal sponsors to evaluate interest in the additional recreation opportunities afforded by the Combined FRM/ER Plans. There was significant interest in the development of features such as trails at ecosystem restoration sites. The benefits associated with these wood chip trails would be incidental to project benefits and the there would be no incremental cost associated with providing these trails. Therefore a detailed cost/benefit analysis was not conducted. A summary of site conditions and available local resources at these sites is presented below.

Bristol Marsh (K47). Development of trails within this site connecting to the planned regional hiking and biking trail network is compatible with the ecosystem restoration features of the site and with non-Federal recreation development interest.

Dutch Gap Forested Floodplain (K41). Development of trails within this site connecting to the planned regional hiking and biking trail network is compatible with the ecosystem restoration features of the site and with non-Federal recreation development interest.

Red Wing Slough and Deer Lake Wetland Complex (L43). Development of trails within this site is compatible with the ecosystem restoration features and with non-Federal recreation development interest and regional plans for development of a trail network along greenway corridors connected by rivers and streams.

Pollack Lake and Hastings Creek Riparian Wetlands (L39). Development of trails within this site is compatible with the ecosystem restoration features and with non-Federal recreation development interest and regional plans for development of a trail network along greenway corridors connected by rivers and streams.

Gurnee Woods Riparian Wood Land (L31). Development of trails within this site is compatible with the ecosystem restoration features and with non-Federal recreation development interest and regional plans for development of a trail network along greenway corridors connected by rivers and streams.

Northbrook Floodplain and Riparian Complex (C09). A substantial trail system along the Des Plaines River has already been developed by the Forest Preserve District of Cook County. Additional trails will improve access to natural areas at the site by users of the trail system.

Beck Lake Meadow and Floodplain Forest (C15). A substantial trail system along the Des Plaines River has already been developed by the Forest Preserve District of Cook County. Additional trails will improve access to natural areas at the site by users of the trail system.

8.5 Description of Recreation Plan*

Based on site compatibility and non-Federal interest, recreation features will be incorporated at the sites listed in Table 8.2, to consist primarily of multipurpose trails and educational signage for use by the public. Detailed plans for these features will be developed in partnership with the non-Federal sponsors for those sites and based on public interest. As required by USACE guidance, the Federal cost for sites where recreation features are implemented will not exceed the Federal cost of the project without recreation features by more than 10%. The non-Federal sponsors must assume at least one-half of the separable first costs of construction of recreation facilities, including project lands acquired specifically for recreation and access, and all cost and full responsibility for the operation, maintenance, replacement, and management of recreation lands, areas, and facilities.

Table 8.3 – Recreation Plan Summary

Site ID	Site Name	Recreation Features	Cost ($1,000)
K47	Bristol Marsh	Maintenance of woodchip trails installed during project construction.	Incidental
K41	Dutch Gap Forested Floodplain	Maintenance of woodchip trails installed during project construction.	Incidental
L43	Red Wing Slough and Deer Lake Wetland Complex	Maintenance of woodchip trails installed during project construction.	Incidental
L39	Pollack Lake and Hastings Creek Riparian Wetlands	Maintenance of woodchip trails installed during project construction.	Incidental
L31	Gurnee Woods Riparian Wetland	Maintenance of woodchip trails installed during project construction.	Incidental
C09	North Brook Marsh	Maintenance of woodchip trails installed during project construction.	Incidental
C15	Beck Lake Meadow and Floodplain Forest	Maintenance of woodchip trails installed during project construction.	Incidental
DPLV09	Touhy-Miner Levee	Asphalt trails connecting existing segments of the Des Plaines River trail.	[redacted]
DPRS04	Fullerton Woods Reservoir	Trails, picnic area, and parking facilities to support use of site.	[redacted]
NS	Des Plaines Floodway/Big Bend Drive Area	Asphalt trails connecting existing segments of the Des Plaines River trail	[redacted]

(FY2014 Price Level)

9 Environmental Assessment*

9.1 Coordination

Consistent with USACE's Engineering Regulation 1105-2-100, Appendix B the feasibility study included comprehensive public involvement, collaboration and coordination, in addition to compliance with applicable Federal statues and executive orders. The President's Council on Environmental Quality (CEQ) requires that the environmental impacts of a project are identified and made available to the public and decision makers before decisions are made and actions are taken. CEQ's implementing regulations and the USACE procedures for implementing the NEPA provided the process for public participation in conjunction with the preparation of this EA.

9.1.1 Notice of Intent

The non-Federal sponsors and the USACE initiated the NEPA requirements of a public notice inviting the participation of affected agencies and the public after the Project Management Plan was finalized and the Feasibility Cost Sharing Agreement was approved for the Phase II feasibility study. Finalization and approval of a communications plan was followed by preparation of a newsletter, fact sheet, and poster generally describing the feasibility study process for flood damage reduction and ecological restoration within the Upper Des Plaines River watershed. These materials, along with updates, were distributed to local citizens and interested parties by mailing, internet postings, and were handed out at public meetings. As a kick-off for the feasibility study, a series of informational meetings were presented to provide background on the watershed and the feasibility study process.

The Chicago District prepared a Notice of Intent to Prepare a Draft Environmental Impact Statement, which appeared in the 31 May 2002 Federal Register. Public scoping meetings (held as part of the NEPA process) were announced in letters (dated 15 May 2002) sent to the governors of Illinois and Wisconsin; to 26 United States senators and representatives from Illinois and Wisconsin; and to over 220 state and local elected officials, state and local agencies, libraries, organizations, and interested individuals from Illinois and Wisconsin.

The Chicago District also sent a press release in May-June 2002 to the Kenosha News (Kenosha; WI); Bulletin (Salem; WI); Milwaukee Journal Sentinel (Sturtevant; WI); Racine Reporter (Racine; WI); Journal-Times (Racine; WI); News-Sun (Waukegan; IL); Daily Herald (Vernon Hills; IL); Arlington Heights Journal (Des Plaines; IL); Mt. Prospect Journal (Des Plaines; IL); Des Plaines Journal (Des Plaines; IL); Wheeling Journal & Topics (Des Plaines; IL); Libertyville Review (Libertyville; IL); Franklin Park Herald-Journal (Oak Park; IL); and Forest Park Review (Oak Park, IL).

The Notice of Intent submitted to the Federal Register on May 31, 2002 indicated the USACE would be pursuing an Environmental Impact Statement (EIS). However, after further development of the alternative plans, USACE determined that significant impacts were not obvious. Therefore, it was more appropriate to perform an environmental assessment to determine if significant impacts would result from the proposed alternatives and to issue a Finding of No Significant Impact if warranted rather than an EIS and Record of Decision as noted in the May 31, 2002 Federal Register.

While the benefits provided by the NER portion of the proposed project are significant in terms of USACE policy via providing regional habitat for migratory water fowl and neo tropical birds, as well as local fish and wildlife (See Section 5.4.7.2 for USACE Significance for decision making purposes), the changes to watershed processes and functions are not spatially large enough to cause change to the human environment. In terms of significance to the human environment as cited from CEQ, the resulting effects from the proposed NER and NED plans would be negligible not only to the human environment, but for example the riverine environment as well. Riverine biological integrity is grossly spoiled once a watershed reaches 8 – 20% impervious surfaces (Schuler 1994, Karr and Chu 2000), and is thought by some to be beyond repair between 25 – 60% (Karr & Chu 2000). Miltner et al (2004) found that there is significant decline when impervious surfaces exceed 14% and complete loss in aquatic life attainment at 27% in the Columbus, Ohio metro area.

Section 3.1.1.5 provides the current land use percentage of about 12% for remaining natural plant communities; conversely 88% of the watershed would be considered ecologically spoiled by literature cited. Based on these assessments, significant effects would then be noticed if the NER plan provided enough acres to restore between 50 - 70% of the watershed acres to natural plant communities. The preferred NER plan proposes to restore about 6,800 acres, or about 1.5% of the watershed. This increase in watershed natural habitats provide significance in terms of USACE benefits by increasing watershed AAHUs by 32%, but is not significant in terms of CEQ guidance on affects to the human environment supported by peer reviewed published journals cited here and provided by reference in Appendix C.

9.1.2 Scoping Meetings

2002 Scoping

Public scoping meetings for the Upper Des Plaines River and Tributaries Feasibility Study were held in June 2002. The evening meetings included a slide show, public comment opportunity, and question-answer session; the agency panel included staff from the USACE, IDNR, WDNR, Cook County Highway Department, LCSMC, and Kenosha County Planning & Development.

- June 4, 2002, 7–9 PM - Kenosha County Center, 19600 75th Street, Bristol, WI.
- June 5, 2002, 7–9 PM - Byron Colby Barn at Prairie Crossing, Jones Point Road west of Route 45, Grayslake, IL.
- June 6, 2002, 7–9 PM - Oakton Community College Conference Center, 1600 E. Golf Road, Des Plaines, IL.

2009 Scoping

The study was rescoped in 2009 when it was determined that an EA rather than an Environmental Impact Statement would be prepared. Notification letters were set out to regulatory agencies and public officials in Illinois and Wisconsin. No public meetings were held in conjunction with this 2009 scoping.

2013 Public Review

A series of meetings were held as part of the public review of the draft EA in the fall of 2013. A PowerPoint presentation was and each meeting included a public comment period and question and answer session.

- September 23, 2013, Mt. Prospect Village Hall, Mt. Prospect, IL
- September 24, 2013, LCSMC, Libertyville, IL
- September 25, 2013, Kenosha County Building, Bristol, WI

As part of the public review, the public was provided with several methods for submitting scoping comments or suggestions on the draft EA: an online comment form on the project Website; standard mail; or in person at the public meetings, either by testifying or submitting written comments. Nearly 600 individuals, organizations, and state and local government agencies provided scoping comments.

Based on the comments received a FRM project, ACRS08, was removed and two alternative sites were added, WLRS04 and DPRS04. This change was coordinated with the public release of the revised Draft Integrated Feasibility Report and Environmental Appendix. To support the public review, documentation of the changes was prepared and is provided as Appendix N. This EA has been updated to incorporate the changes and reflect the revised proposed plan. The Documentation of Changes was provided to the public for review in January of 2014. Three comment letters were received as a result of the review.

9.1.3 Upper Des Plaines Advisory Committee

As discussed in Section 1.1.3, an Advisory Committee was established to support the study process. This committee includes the study non-Federal sponsors, communities from within the watershed, state and Federal government representatives, and interested parties and resource agency personnel. The committee meets four times a year to review the feasibility study status and progress including discussion of the formulation process and preliminary results. The meetings are coordinated by the Northwest Municipal Conference (NMC). Prior to each meeting, the NMC sends an invitation to all advisory committee members along with a meeting agenda and minutes from the previous meeting. These served as a reminder and a communication tool to all of the members that might not be able to make it to the meeting. There were also newsletters written to give further updates. The Advisory Committee provided a forum for engagement with and feedback from stakeholder agencies. The Advisory Committee also provided expertise on study team, with participation by several representatives from member organizations.

9.2 Affected Environment

The affected environment for this study is detailed in Section 3 and in Appendix C.

9.3 Alternative Plans

The analysis resulting in the determination of alternative plans is detailed in Section 4 for Flood Risk Management and Section 5 for Ecosystem Restoration. Section 6 discusses the selection of a combined plan considering effects of Flood Risk Management and Ecosystem Restoration sites on each other. Section 8 details the analysis used to select recreation features. This plan formulation is also discussed in Appendices B and C.

This report presents three plans: a "Comprehensive Plan" which includes all economically justified, environmentally acceptable separable projects evaluated during the course of the study; a "NED/NER Plan" which includes all policy compliant, economically justified, environmentally acceptable separable projects of such scope that they could not reasonable be implemented under the CAP; and a "CAP Plan" which includes all policy compliant, economically justified, environmentally acceptable separable projects of such scope that they could reasonable be implemented under CAP. The assessment of direct, indirect and cumulative effects as presented is comprehensive of these plans.

9.4 Direct and Indirect Effects

9.4.1 Ecosystem Restoration Plan Assessment

This section evaluates the direct and indirect effects of the Ecosystem Restoration Plan. An evaluation of the Flood Risk Management Plan is included in Section 9.4.2. The interaction of the restored hydrology-hydraulics, modified geomorphology-soils and plant-fungus-microbe structures will help restore the 6,800 acres of habitat by improving the plant species richness and reducing invasive species. This will provide the necessary structure for a wider variety and increased number of fish, amphibians, reptiles, birds and mammals, helping ensure a sustainable resource. Each of the seven restored sites will increase connectivity among the existing restored, remnant and remaining sites in the Des Plaines River Study area. The restored sites can provide a seed source for adjacent sites increasing the footprint of restoration. Many of the estimated 300 species of birds recorded in the Chicagoland area will benefit. Migratory birds will benefit substantially from the restoration because these restored sites will provide the right kind of high calorie, high protein foods such as seeds, fruits, and insects along with places to rest and hide from predators and the extremes of weather. The migratory bird benefit is not restricted to the Upper Des Plaines River and Chicago Metro area; the western shoreline of Lake Michigan is a globally significant portion of the Mississippi River Flyway. A significant portion of the total North American population of neo-tropic migrants (estimated at 5,000,000) use it as their north-south sight line during migration. The lack of significant habitat from north of Milwaukee, WI to east of Gary, IN for migratory birds to rest, refuel, and seek shelter makes the restoration in the Upper Des Plaines River very significant. Some migratory birds along this portion of the flyway fly from as far south as the tip of South America to as far north as the Arctic Circle.

9.4.1.1 Physical Resources

Climate

The minor scale of the recommended ER projects in the Comprehensive Plan would not 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 will result to climate from implementing the ER projects are expected.

Geology

The ER projects would have beneficial preservation effects associated with implementation. Geologic features and deposits would be preserved through restoring the site to native plant communities and disallowing development to occur, which would have the potential to change the surficial geology at those particular sites. Since implementation of the ER projects does not disturb geologic features or deposits, no significant adverse effects resultant from implementing the ER projects are expected.

Hydrology, Hydraulics & Land Use

Hydrology: Implementation of the ER projects would result in beneficial effects to watershed hydrology. Water that currently falls on these sites is immediately drained into ditches, then streams and ultimately the Upper Des Plaines River, with no chance of ever establishing a natural hydroperiod for wetlands and native aquatic vegetation to occur, and in turn compounds the environmental impacts associated with abnormal flooding. Through restoring the native aquatic vegetation at each of these sites and disabling drain tile systems and small ditches, groundwater would be recharged as well as surficial waters that are typical of wetland habitats. During the design phase a water budget would be developed to determine the amount of water each site would retain to ensure local flooding would not result and to provide the proper hydroperiods for wetland and native aquatic plant community reestablishment. As a result, no significant adverse effects from implementing the ER projects are expected.

Riverine Hydraulics: Implementation of the ER projects would result in beneficial effects to riverine hydraulics within the watershed. Currently, dams and channelized streams prevent proper hydraulics to support diverse and native riverine communities. Through stream remeandering and increasing channel roughness (cobble riffles, woody debris), the proper hydraulics would be restored for these riverine communities to increase species richness and abundance. Temporary disturbance of the waterways would be necessary and may cause a short term adverse condition for the tolerant organisms that occupy the restoration areas; however, several years after the restoration, the aquatic assemblage would be more species rich and abundant than the existing assemblage. Since the ER plan would be implemented in a fashion as to not increase local flooding, to attenuate flood waters and to provide the proper channel roughness for riverine organisms, no significant long-term adverse effects are expected from implementing the ER projects.

Land Use: Implementation of the ER projects would result in beneficial effects to land use within the watershed. Currently, about 90% of the land use of the preferred plan sites is in agricultural production, with the remaining 10% as degraded habitat in the form of non-native and invasive plant species plots. The ecological perspective of land use for these sites is that they are of minimal quality and ineffective in terms of habitat structure. The human perspective of land use for these sites is that they produce minimal amounts of food crop (as compared with more productive farmlands in southern and middle Illinois) (USDA 2010), and provide a small amount of open space for passive recreational activities. Since the ER projects would be implemented in a fashion as to return land use to its natural condition, no significant adverse affects resultant from implementing the ER projects are expected.

Fluvial Geomorphology & Topography

Implementation of the ER projects would result in beneficial effects to fluvial geomorphology and natural topography within the watershed. Currently, 90% of the streams and rivers are channelized to some degree, with the greater part of these as extremely incised and inactive in terms of fluvial processes (cut and fill alluviation, sediment transport, helical flow, etc.). Restoring fluvial geomorphic processes of streams that flow through large sites is very practical, since active floodplains would be contained within hundreds of feet and stay within the site boundaries. Each site during the design phase would have a hydraulic analysis completed to ensure local flooding would not result. Intact topography would not be altered from its natural state. It is important to design an ecological restoration to the hydrology and topography that exists on a particular site, since this is what drives plant community position on the landscape. Any grading performed would be to assist in returning natural geomorphology and topography characteristic of Des Plaines River watershed landscapes, and not done with the intention of creating non-functional detention basins. Since the ER projects would be implemented to return riverine segments to its natural physical form and plant communities to their natural position on the landscape, no significant adverse effects are expected from implementing the ER projects.

Soils

Implementation of the ER projects would result in beneficial effects to natural soils within the watershed. Currently at the restoration sites, natural soils are still intact, with exception of disruption to their A horizons due to years of tilling, fertilization, carbon stripping, removal of microbe-fungi interaction, and unnatural drainage. Through the reestablishment of groundwater and surficial hydrology, returning native plant communities, and the return of mycorrihizzal fungi/bacterial interactions, over time the top layer or A horizons of the soils would heal, thus feeding back to diversify the native plant and animal assemblages of those restored sites. Since the ER projects would be implemented in a fashion as to facilitate the return of natural soil structure, no significant adverse soil effects resultant from implementing the ER projects are expected.

Air Quality

Implementation of the ER projects would result in negligible effects to air quality within the watershed and regionally. Mobile source emissions were estimated using USEPA guidance and models, and were found to be *de minimis* for criteria air pollutants. General recommendations to be considered during the construction phase are post-construction stabilization of earth areas to prevent water or wind erosion and dust control during construction. Based on these findings, the proposed Upper Des Plaines River and Tributaries project Feasibility Study demonstrates conformity. The project as proposed is compliant with the Clean Air Act, and will not result in significant or long-term adverse affects on air quality.

Water Quality

Implementation of the ER projects would result in beneficial effects to water quality within the watershed. Major portions of the Des Plaines River and confluent streams are not supportive of aquatic life, fish consumption, or primary contact 303(d) designated uses. The potential causes include elevated levels of chloride, nitrogen, phosphorous, total dissolved and suspended solids, zinc, and

silver, and excessive sedimentation and siltation caused primarily from combined sewer overflows, municipal point source discharges, urban runoff, storm sewers, highway/ road/bridge runoff, site clearance and land development, hydrostructure flow regulation, and the presence of sediment contaminated with various chemicals. Elevated levels of fecal coliform, resulting from combined sewer overflows, urban runoff, and storm sewers have impaired primary contact recreation in many areas. Through the resurgence of hydrology, hydraulics, and native plant communities, water quality will benefit; however, the brunt of the water quality impairment stems from urban conditions of impervious surfaces and chemicals associated with these (i.e. gasoline, oils, salts from roads and parking lots). Since the ER projects would be implemented in a fashion as to facilitate the reduction of water discharging overland directly into streams, no significant adverse effects resultant from implementing the ER projects are expected.

9.4.1.2 Ecological Resources

The primary objective of any ecosystem restoration project is to return the structure and function of habitat types as close as possible to the original conditions before human disturbance. Any ecosystem restoration project that has associated significant effects stemming from implementation would not be acceptable. All trees removed in the restoration sites will likely be cut at ground level with the stumps remaining and trees in the flood risk management sites will be cut and grubbed. There will be some loss to native trees, but we do not anticipate any losses to high quality or remnant woodlands. Additionally, the impacted sites will be restored with native plants that will be sustainable based upon the best scientific information, along with sound engineering and design. The following ecological community types are the focus of the Upper Des Plaines River watershed restoration project, all of which are slated to provide beneficial effects to the ecosystem as a whole and the human environment through floodwater attenuation, addition of open space and aesthetics, education opportunities, carbon sequestering, urban heat island reduction, etc.

Native Plant Communities

Implementation of the ER projects would result in the restoration of over 6,800 acres of native community types including: marsh, sedge meadow, wet and dry prairie, wet and dry savanna, woodland and forest. Converting agricultural fields, old field, and successional woodlands to native plant communities has beneficial effects to themselves and to each other. Remnant parcels of native habitat would be delineated and protected. Local seed genotypes, to the extent possible, would be used, and seed would only be acquired from sources within 250-miles of the restoration site. Site maintenance to ensure native species diversity and eradication of invasive species would be implemented to ensure sustainability of restored community types. Since the ER projects would be implemented in a fashion as to increase quantity and quality of these native plant communities, no significant adverse effects are expected from implementing the ER projects.

Riverine

Implementation of the ER projects would result in the restoration of about 85,500 feet (16.2-miles) of prairie slough, stream and river habitat. Converting ditches and restoring impaired streams has beneficial effects to themselves to each other, as well as the riparian hydrology. Any functioning reaches of riverine habitat would be delineated and protected. Site maintenance to ensure native species diversity and eradication of invasive species would be implemented to ensure sustainability of

restored community types. Since the ER projects would be implemented in a fashion as to increase quantity and quality of riverine communities, no significant adverse effects resultant from implementing the ER projects are expected.

Threatened & Endangered Species

Threatened and endangered species are discussed in 3.1.2 within the cover type (habitats) that they live. A complete list of threatened and endangered species is found in Appendix C.

Preliminary coordination with the USFWS and plan formulation methodologies have recognized and considered threatened and endangered species from the study's onset. USFWS and State involvement in the project has assured that the plan formulation process would be in compliance with Section 7 of the Endangered Species Act. USFWS participated early in the project as a cooperating agency and has therefore provided significant input on the plan formulation. Formulation was formally reviewed and critiqued by the agency through a Fish & Wildlife Coordination Act Report.

Since the ER projects would be implemented in a fashion to transform agricultural and oldfield land use into critical habitats for several of the listed T&E species within the watershed, no significant adverse effects are expected from implementing the ER projects. Site specific surveys, if warranted, for T&E species will commence under PED phase before any restoration activities would be implemented. These surveys would be coordinated with the USFWS and State DNRs.

9.4.1.3 Social, Cultural & Archaeological Resources

Kenosha County Sites K47 and K41

Archaeological & Historical Properties

Two archaeological sites are the only properties in Kenosha County listed on the National Register of Historic Places that are located within the Des Plaines River drainage basin. These will be avoided.

The project areas are primarily former farm and dairy land. Drainage tiles have been installed across large areas and some slopes have been graded for farming and livestock grazing. Intact cultural deposits may be present in undisturbed areas. However, no ground disturbing activities are planned for undisturbed areas. The planned restoration work at K41, & K47 will have no direct or indirect adverse effects on cultural resources.

Social Properties

Schools: There will be no direct or indirect adverse effects to local Pleasant Prairie schools [Somers Elementary School and Shoreland Lutheran High School] or direct or indirect adverse affects to Bristol schools [Paris Elementary School & Provenance Catholic School, and Pikeville School (K41 & K47)].

Hospitals: There will be no direct adverse affect on Kenosha hospitals, Bonaventure Medical Group (K), and United Hospital System and Paddock Lake Medical Clinic (K41, & K47).

Prime Farmland: The project area is not Prime Farmland since K9 is incorporated within the Pleasant Prairie village limits, and K41, & K47 are incorporated within the Bristol village limits.

Lake County Sites: L43, L39 & L31

Archaeological & Historical Properties

No properties or historical districts listed on the National Register of Historic Properties in Lake County are located within or near the project area. The L31, L43 and L39 project areas are lands recently acquired by the Lake County Forest Preserve District.

L39 is now known as the Raven Glen Forest Preserve. Portions of these project locations are former farm land. Drainage tiles have been installed in some areas, and some slopes have been graded for farming and livestock grazing. Intact cultural deposits may be present in undisturbed areas. However no ground disturbing activities are planned for undisturbed areas.

The L31 project area is Gurnee Woods Forest Preserve, owned by the Lake County Forest Preserve District. This area is primarily flood plain and is unlikely to contain cultural deposits except possibly on higher elevations.

Planned ecological restoration at L43, L39, & L31 will have no direct or indirect adverse affects on cultural resources.

Social Properties

Schools: There will be no direct or indirect adverse effects to local schools in Lake County: Wilmot Elementary School, Kipling Elementary School, and Caruso Junior High School (L01); St. Mary's School, Goddard School, and Park West School in Round Lake Park, and Grayslake St. Gilberts School, Woodlawn Elementary School, and Westlake Christian Academy (L19).

Hospitals: There will be no direct or indirect adverse effects on Lake County hospitals, Condell Hospital, Northwestern Lake Forest Hospital, & United Health Systems.

Prime Farmland: None of the project area is prime farmland. Sites L43, L39, & L31 have been established as public parks.

Cook County Sites C09 & C15

Archaeological & Historical Properties

No properties or historical districts listed on the National Register of Historic Properties in Cook County are located within or near the project area.

The C09 and C15 project areas are primarily low flood plain and are not likely to contain cultural deposits. Intact cultural deposits may be present in undisturbed areas. However no ground disturbing activities are planned for undisturbed areas. Planned ecological restoration at C09 and C15 will have no direct or indirect adverse affects on cultural resources.

Social Properties

Schools: There will be no direct or indirect adverse affects to local schools in Walt Whitman Elementary School and Oliver Wendell Holmes Elementary School in Wheeling and Wood Oaks Junior High School in Northbrook (C09), or West Northfield, Apollo Elementary School, and Glen Grove Elementary School in Glenview, St. Emily Elementary School in Mount Prospect, and Indian Grove School in Prospect Heights (C15)

Hospitals: There will be no direct or indirect adverse affects on local hospitals, Holy Family Medical Center and Northwest Community Hospital (C09), and Glenbrook Hospital and Children's Memorial Hospital (C15)

Prime Farmland: The project area is not Prime Farmland since CO9 is incorporated within the Wheeling village limits and C15 is incorporated within the village limits of Prospect Heights, and Glenview.

Dams: Dam # 2, Dempster Dam, Touhy Dam, and Dam #4- Because of its severely impacted integrity Dam #2 is not eligible for the national register. The dam has subsided and extensive erosion at both ends has undermined the ends causing portions of the structure to collapse and its removal will not be an adverse affect. Removal of all of these dams will have no direct or indirect adverse effects on cultural resources.

Hazardous, Toxic, & Radioactive Wastes

Hazardous, toxic, and radioactive waste investigations included a preliminary screening followed by full Phase I investigations. The preliminary HTRW site screening is included in Appendix H. The preliminary site screening, complete in March 2010, assessed whether FRM and ecosystem restoration sites considered for implementation during alternative development were enrolled in any regulatory remedial program. Data obtained from the IEPA, the WDNR, and the USEPA suggested that none of the sites under investigation were currently, or had previously been, enrolled in any regulatory remedial program. Due to the limited scope of the preliminary HTRW screening, Phase I HTRW investigations were recommended for project sites recommended for implementation during the final stages of the feasibility study.

A Phase I HTRW investigation for the ecosystem restoration, completed in accordance with ER 1165-2-132, is included in Appendix H. Results of the investigation were based on an existing information review, database research, historical topographic map and aerial photograph review, and a site visit. The level of review conducted at each individual site considered the scope of the project, the amount of information available for review at each site, and the time and cost constraints of completing a Phase I HTRW investigation. Results reduce the uncertainty regarding the potential to encounter HTRW at any given site. A list of unresolved issues, short-term actions, and future project recommendations to resolve potential environmental concerns are provided for the ecosystem restoration sites, summarized in Table 9.1. The short term data needs will be addressed early in the design phase.

Table 9.1 – HTRW Results and Recommendations for Future Action: Restoration Sites

Site	Issue	Short-Term Data Needs	Potential Future Actions
Dam Removals (Touhy Dam, Dam#4, Dempster Dam, Dam #1, Dam #2)	Sediment within project limits *(fine-grained sediments in DP River contain elevated PNAs, metals, &PCB)*	None	1. Conduct sediment investigations during design to determine the volume of fine-grained sediment impounded upstream of the dams. 2. If significant quantities of fine-grained sediment are present and cannot be stabilized prior to dam removal, sediment sampling and geotechnical/ environmental analysis may be necessary to determine disposal options for sediments.
Beck Lake Meadow and Floodplain Forest (C15)	John Sexton Landfill	Revise the restoration limits to exclude the landfill area on the southwest quadrant of the site from the USACE restoration area	
	Camp Pine Woods POW FUDS	None	1. Confirm design/excavation assumptions. 2. Conduct additional phase II investigations, if required.
Bristol Marsh (K47)	USTs adjacent	None	Confirm the location of adjacent USTs during design phase to avoid disturbance of utilities during restoration.
Northbrook Floodplain and Riparian Complex (C09)	Historical topographic maps indicate business present along Willow Road 1953 and 1972 with foundations remaining onsite	Confirm the scope and scale of activity with land owner	1. Collect all demolition debris during restoration and dispose in accordance with Federal, State, and local laws and regulations. 2. Perform phase II investigation to determine scope and scale of site impacts from regulated activities, if required.
Gurnee Woods Riparian Wetland (L31)	Two LUSTs (EDR #1 and B13/14) within recommended search distance with unknown status	Confirm scope and scale of the LUST incidents with	1. Confirm design/excavation assumptions 2. Perform phase II investigation to determine scope and scale of site impacts from adjacent regulated LUST activities, if required.
	SRP Site (EDR #21) adjacent to the restoration site with 2 acres of groundwater use restriction.	None	1. Confirm design/excavation assumptions. 2. Perform phase II investigation to determine scope and scale of site impacts from adjacent regulated LUST activities, if required.
Gurnee Woods Riparian Wetland (L31), Red Wing Slough and Deer Lake Wetland Complex (L43)	Inadequate historical aerial photograph coverage	None	More comprehensive historical aerial photograph coverage must be obtained and reviewed to determine if there are any isolated RECs onsite that may impact project implementation.
All Ecosystem Restoration Sites	Site Visit	None	More intensive field visits should be conducted when the restoration design is identified to determine if there are any isolated RECs onsite that may impact project implementation.
	USTs adjacent	None	Confirm the location of adjacent USTs during design phase to avoid disturbance of utilities during restoration.

9.4.2 Flood Risk Management Assessment

9.4.2.1 Physical Resources

Climate

The small scale of the Flood Risk Management (FRM) projects contained within the Comprehensive Plan would not be able to affect the regional climate. The increase in acreage of standing water would increase evaporation in a minor way, but still not great enough to affect weather patterns or rainfall within the region. No significant adverse effects to the regional climate are expected from implementing the Comprehensive Plan.

Geology

The FRM projects contained within the Comprehensive Plan would have no detrimental effects on local geology upon implementation. Construction needed to implement these projects would not disturb any significant geologic features or deposits or disrupt any geologic processes from their natural states. Most of the area in the project area has already been disturbed over the last 150-years and the current project will not alter the geology further. Because implementation of these projects will not disturb significant geologic features or deposits, it is expected that no significant adverse effects to geology would result from implementing the Comprehensive Plan.

Hydrology & Hydraulics

The hydrology and hydraulics of the Des Plaines River watershed have been drastically altered by human modifications to the landscape. Most of the watershed is now urbanized or agricultural, which allows rainfall to immediately runoff to streams instead of draining into the soil and recharging groundwater. In order to alleviate some of the adverse cultural effects associated with watershed development, three reservoirs, four levees, modifications to existing hydraulic structures and several small scale non-structural flood proofing measures have been recommended for implementation. These elements are intended to reduce the risk of overbank flooding within the Upper Des Plaines River watershed.

Reservoirs: Two reservoirs are included in the Comprehensive Plan. These structures would capture and store floodwaters until the flood pulse recedes to a non-threatening level. These reservoirs provide additional storage that naturally was contained in the floodplain areas and have been lost due to development. Since the affected tributaries have been channelized, and their watersheds dominated by impervious surface, it has lead to an unnatural flow regime that is unhealthy for both man and ecosystem. While the constructed reservoirs will help stabilize the surficial hydrology and hydraulics, there may be adverse effects to groundwater in the immediate area where the reservoirs will be constructed. It is expected that a cone of depression would form around the reservoirs; however, there are no significant natural areas within this influence to be affected. It is expected that groundwater wells would not be affected either. No significant adverse effects to the regional hydrology or hydraulics are expected to result from implementing the reservoirs identified in the Comprehensive Plan.

Levees: Four levees are included as part of the Comprehensive Plan. These structures would protect existing homes, businesses and roadways from overbank flooding. Levees remove inundation floodplain areas from the river by essentially channelizing the stream and creating an artificially incised channel. Flood waters that would naturally exceed normal bank full levels are not allowed to inundate the floodplain and are conveyed downstream. Scour and erosion can occur due to the increased flow velocities; however, the areas where the levees are to be constructed currently hold no or very little ecological value. Inundation of the floodplain in these areas would not benefit aquatic organisms since the floodplain has been developed. To address the changes in the hydrology and hydraulics upstream and downstream of the constructed levees, compensatory storage reservoir projects are included as needed. It is, therefore anticipated that there would be no significant adverse effects to hydrology and hydraulics as a result of constructing the levees identified in the Comprehensive Plan.

Road Raises: One bridge modification is included as part of the Comprehensive Plan. Raising this bridge would allow for additional conveyance of flood waters downstream. It is anticipated that there would be no significant adverse effects to downstream hydrology and hydraulics as a result of constructing the planned road raise. No significant adverse effects to the regional hydrology or hydraulics are expected to result from implementing the road raises identified in the Comprehensive Plan.

Structure Modifications: One modification to an existing hydraulic structure is included as part of the Comprehensive Plan and would take place on a facility that already has flood management functions. No significant adverse effects to the regional hydrology or hydraulics are expected to result from implementing the structure modification identified in the Comprehensive Plan.

Non-Structural: The non-structural flood proofing projects included as part of the Comprehensive Plan would be implemented on existing structures or adjacent areas that have already had their land use altered from the natural state. No significant adverse effects to the regional hydrology or hydraulics are expected to result from implementing the non-structural measures identified in the Comprehensive Plan.

Land Use

Whenever there is construction of new features, there is a possibility of a change in land use. Some of these changes can be detrimental to the environment, even if the new structures are intended to protect human interests; however, when features are built on ecologically degraded lands, then effects are usually negligible.

Reservoirs: The two reservoirs included in the Comprehensive Plan are located on lands currently owned by the Cook County Forest Preserve District and are currently used for recreational purposes. These reservoirs will be constructed to ensure existing recreational activities are still possible at WLRS04 and to promote recreation at DPRS04. Only short-term impacts to recreation will occur during flooding events. The construction of a reservoir in these areas will not have an impact to current land use.

Levees: The four levees included as part of the Comprehensive Plan would be built in urban areas to protect existing homes and businesses. No significant adverse effects to land use are expected to result from implementing the levees identified in the Comprehensive Plan.

Road Raises: No significant adverse effects to land use are expected to result from implementing the road raise project identified in the Comprehensive Plan.

Structure Modifications: No significant adverse effects to land use are expected to result from implementing structure modification identified in the Comprehensive Plan.

Non-Structural: No significant adverse effects to land use are expected to result from implementing non-structural flood proofing projects identified in the Comprehensive Plan.

Fluvial Geomorphology & Topography

The fluvial geomorphology of the Des Plaines River watershed has been negatively impacted for over a century due to human development and agricultural practices. Impacts to geomorphology include installing dams, stream channelization, mass earth moving and grading, draining and filling of wetlands, development within floodplains, urban and agricultural runoff, etc. All of the measures proposed by the FRM projects included as part of the Comprehensive Plan will not have major adverse affects on fluvial geomorphology and topography since the scale is minute in relation to watershed functions and the features actually aid in reducing large, unnatural flood events that ruin stream geomorphology that has formed over time.

Reservoirs: The two reservoirs included in the Comprehensive Plan would be constructed on highly developed and channelized sections of the Des Plaines River and will not impact fluvial geomorphic function. No significant adverse effects to fluvial geomorphology and topography are expected to result from implementing the reservoirs identified in the Comprehensive Plan.

Levees: In naturally functioning rivers, construction of levees would be detrimental to the fluvial geomorphology of a stream; however, these levees are being placed in highly urban areas where the stream is not allowed to meander freely within its active floodplain. No significant adverse effects to fluvial geomorphology and topography are expected to result from implementing the levees identified in the Comprehensive Plan.

Road Raises: The one road raise project will improve conveyance of flood waters and thus prevent more damage to fluvial geomorphology. No significant adverse effects to fluvial geomorphology and topography are expected to result from implementing the road raise identified in the Comprehensive Plan.

Structure Modifications: No significant adverse effects to fluvial geomorphology and topography are expected to result from implementing the one structure modification identified in the Comprehensive Plan.

Non-Structural: No significant adverse effects to fluvial geomorphology and topography are expected to result from implementing the non-structural flood proofing projects identified in the Comprehensive Plan.

Soils

Whenever there is construction of new features, there is a possibility of soils becoming modified from their natural state through grading, digging and filling. Some of these changes can be detrimental to the environment, even if the new structures are intended to protect human interests; however, when features are built on already modified lands, then effects are usually negligible.

Reservoirs: The two reservoirs included in the Comprehensive Plan are located within highly urbanized areas where the soils are already highly degraded. The construction of these reservoirs would modify the soils; however, the action would be negligible in terms of the extent of soil modification that has already occurred in the watershed.

Levees: Soils in the area where the levees would be built have been adversely affected and/or modified by decades of urbanization and industrial development. No significant adverse effects to soils are expected to result from implementing the levees identified in the Comprehensive Plan.

Road Raises: No significant adverse effects to soils are expected to result from implementing the road raise identified in the Comprehensive Plan.

Structure Modifications: No significant adverse effects to soils are expected to result from implementing the structure modification identified in the Comprehensive Plan.

Non-Structural: No significant adverse effects to soils are expected to result from implementing the non-structural flood proofing projects identified in the Comprehensive Plan.

Air Quality

Implementation of the FRM projects included as part of the Comprehensive Plan would result in negligible effects to air quality within the watershed and regionally. Mobile source emissions were estimated using USEPA guidance and models, and were found to be *de minimis* for criteria air pollutants. General recommendations to be considered during the construction phase are post-construction stabilization of earth areas to prevent water or wind erosion and dust control during construction.

Water Quality

Overall water quality in the Upper Des Plaines River is impaired for aquatic life, fish consumption, or primary contact 303(d) designated uses. The potential causes include elevated levels of chloride, nitrogen, phosphorous, total dissolved and suspended solids, zinc, and silver, and excessive sedimentation and siltation caused primarily from combined sewer overflows, municipal point source discharges, urban runoff, storm sewers, highway/road/bridge runoff, site clearance and land development, hydro structure flow regulation, and the presence of sediment contaminated with various chemicals. Elevated levels of fecal coliform, resulting from combined sewer overflows, urban runoff, and storm sewers have impaired primary contact recreation in many areas.

Reservoirs: The two reservoirs included in the Comprehensive Plan may actually have benefits to water quality since it will trap sediment and excessive flows from impervious surfaces, which may have high nutrient levels. No significant adverse effects to water quality are expected.

Levees: The configuration of the levees may actually halt some urban run-off from entering the Upper Des Plaines River, thus helping to improve water quality given there is no instance where the levees are cutting off natural floodplain; therefore, nutrient absorption is not being lost. No significant adverse effect to water quality is expected to result from implementing the levees identified in the Comprehensive Plan.

Road Raises: No significant adverse effects to water quality is expected to result from implementing the road raise identified in the Comprehensive Plan.

Structure Modifications: No significant adverse effects to water quality is expected to result from implementing structure modifications identified in the Comprehensive Plan.

Non-Structural: No significant adverse effects to water quality is expected to result from implementing non-structural measures identified in the Comprehensive Plan.

9.4.2.2 Ecological Resources

The primary objective of any FRM project is to protect human lives, as well as lessen or eliminate costly damages to infrastructure or business practices. Flood risk management can be accomplished with either structural or non-structural measures. When implementing structural measures, ecological resources can be compromised; however, if the ecological structure and function has already been compromised, then effects are usually considered negligible.

Plant Communities

Reservoirs: The existing conditions for reservoirs DPRS04 (Fullerton Woods Forest Preserve) and WLRS04 (Harry Semrow Driving Range Reservoir) are severely degraded, as discussed below. The sites were assessed through a field survey in October 2013.

Fullerton Woods Forest Preserve is approximately 43 acres in size. The site has very little existing ecological resources. The site was previously used for spoil storage and stone stockpiling for the deep tunnel project. The storage activities effectively destroyed the hydrogeomorphic conditions of the site. While the materials have been removed, the habitat remains degraded. The area used for spoil storage is now overgrown with invasive plant species. The perimeter of the site is dominated by tree and shrub species with an abundant population of Common Buckthorn. Overall, the site is listed as a degraded plant community with approximately 32% of the species non-native and a mean C of 2.6 and FQI of 15.4 for native species. As an ecosystem, this site is most likely dominated by tolerant mammal, reptile, bird and insect species that are common in heavily urbanized areas.

Harry Semrow Driving Range is approximately 37 acres. The ecological resources at this site are also degraded. The site is used as a driving range for the public and the majority of the area is mowed lawn. Mowed lawn provides no structure or function for native species. Within the driving range, a small pond exists and is dominated by Cattail and the invasive Common Reed. Much of the perimeter of the area is forested. These forested areas contain a number of non-native species mixed with some mature native trees. Pockets of mature White and Burr Oak are located within the property. However, the site is still considered a degraded ecosystem with approximately 45% of the plant species found within the study site listed as non-native and a mean C of 1.8 and FQI of 6.4 for native species. Tolerant organisms found within highly urbanized areas are expected to inhabit the study site.

Based on these assessments, no significant adverse effects to native plant communities are expected to result from implementing these reservoirs. Because the perimeters of the proposed reservoirs will be seeded, plant communities will be more diverse and consist of native plants after construction. Due to the degraded condition of the sites, no habitat mitigation would be required. This assessment is currently being coordinated with USFWS.

Levees: Minor tree clearing would need to take place, but these are in residential areas where the trees are non-native and provide minimal functional habitat. Any areas of earth disturbance and the levees themselves would be planted with native prairie grasses to ensure soil stability and prevent non-native and invasive species from colonizing. Recreational trails would be designed to run within the levee footprints, which would not require additional clearing and grubbing of plant communities to implement. No significant adverse effects to native plant communities are expected to result from implementing the levees.

Road Raises: Any areas of earth disturbance would be planted with native prairie grasses to ensure soil stability and prevent non-native and invasive species from colonizing. No significant adverse effects to native plant communities are expected to result from implementing road raises.

Structure Modifications: Any areas of earth disturbance would be planted with native prairie grasses to ensure soil stability and prevent non-native and invasive species from colonizing. No significant adverse effects to native plant communities are expected to result from implementing structure modifications.

Non-Structural: Any areas of earth disturbance would be planted with native prairie grasses to ensure soil stability and prevent non-native and invasive species from colonizing. No significant adverse effects to native plant communities are expected to result from implementing non-structural measures.

Riverine

Reservoirs: DPRS04 would be constructed adjacent to the Des Plaines River. Floodwater will be pumped into the reservoir and slowly released; therefore, operations would not impact the riverine channel. The storage and slow release of flood waters may assist in enhancing riverine function. No adverse impacts to riverine habitats are expected from the construction of this reservoir.

WLRS04 is in between the Des Plaines River and the tributary, Weller Creek. The reservoir could be connected to either the river or creek or to both. This would result in the construction of a pipe or ditch to connect the reservoir to the Des Plaines River watershed. Weller Creek is already highly channelized and surrounded by urban development with very little riverine function. Connecting to Weller will not result in any impact to riverine function or resources. In addition, connecting to the Des Plaines River will not impact riverine function. The reservoir will assist with minimizing the impacts from flooding events.

Levees: Any areas of earth disturbance along banks or riparian corridors would be planted with native grasses to ensure soil stability and prevent non-native and invasive species from colonizing. No significant adverse effects to riverine habitats are expected to result from implementing road raises.

Road Raises: Any areas of earth disturbance along banks or riparian corridors would be planted with native grasses to ensure soil stability and prevent non-native and invasive species from colonizing. No significant adverse effects to riverine habitats are expected to result from implementing road raises.

Structure Modifications: Any areas of earth disturbance along banks or riparian corridors would be planted with native grasses to ensure soil stability and prevent non-native and invasive

species from colonizing. No significant adverse effects to riverine habitats are expected to result from implementing structure modifications.

Non-Structural: Any areas of earth disturbance along banks or riparian corridors would be planted with native grasses to ensure soil stability and prevent non-native and invasive species from colonizing. No significant adverse effects to riverine habitats are expected to result from implementing non-structural measures.

Threatened & Endangered Species

Threatened and endangered species are discussed in Section 3.1.2. Threatened & Endangered Species within the cover type (habitats) that they live. A complete list of threatened and endangered species is found in Appendix C.

Coordination with the USFWS and plan formulation methodologies have recognized and considered threatened and endangered species from the study's onset. USFWS participated early in the planning process as a cooperating agency and has therefore provided significant input on the plan formulation. Formulation was formally reviewed and critiqued by the agency through a Fish & Wildlife Coordination Act Report.

Since the plan formulation of the FRM plan took threatened and endangered species' presence and critical habitats into consideration within the watershed, significant adverse effects resultant from implementing the FRM plan have been avoided. No significant adverse effects to threatened and endangered species are expected to result from implementing any features.

9.4.2.3 Social, Cultural & Archaeological Resources

Archaeological & Historic Properties

Reservoirs: Initial assessment of DPRS04 and WLRS04, conducted in coordination with the Illinois State Historic Preservation Agency, determined that a Phase II Archaeological Survey will be required for both sites prior to construction. Any archaeological sites found during this survey will be avoided where possible. If avoidance of any known archaeological site is not possible, consultations will be conducted with the Illinois Historic Preservation Agency (IHPA) and if needed, a Section 106 mitigation plan will be developed that meets IHPA requirements. In the event of accidental discovery of intact archaeological or cultural features or deposits during construction, work will cease and consultations will be conducted with the Illinois Historic Preservation Agency.

Levees: Four levees (DPLV01, DPLV04, DPLV05 & DPLV09) are planned for this project. Initial assessments indicate that all four levee locales have previously been surveyed for cultural resources, and that no archaeological or historical resources are present. None of the levees will have a direct significant affect on cultural resources.

Road Raises: One road raise (DPBM04) is planned for this project. This locale is within the existing road right-of-way. This right-of-way area has been heavily modified by blading, grading, and filling connected with repeated road construction and maintenance. Based on Illinois Historic Preservation Agency (IHPA) records, no intact archaeological or historical deposits are present. This planned road raise will have no direct or indirect adverse affects on cultural resources.

Structure Modifications: Structure modification is planned at one site, FPCI01. Modification will take place within the existing site footprint on areas that have been heavily modified by construction and maintenance. Initial assessment indicates that no intact archaeological or historical deposits are present. The planned structural modification will have no direct or indirect adverse affects to cultural resources.

In the event of accidental discovery of intact archaeological or cultural features or deposits, work will cease and consultations will be conducted with the Illinois State Historic Preservation Agency.

Social Properties

Schools

Reservoirs: There will be no direct or indirect adverse affects on local area schools from the construction of the reservoirs (DPRS04 and WLRS04).

Levees: There will be no direct or indirect adverse affects on local schools from the construction of the levees.

Road Raises: There will be no direct or indirect adverse affects to schools in the general project areas from the road raise (DPBM04).

Structure Modifications: The Planned structural modification (FPCI01) will have no direct or indirect adverse affects on local schools in the general project areas.

Hospitals

Reservoirs: There will be no direct or indirect adverse affects on local area hospitals from the construction of the reservoir (DPRS04 and WLRS04).

Levees: There will be no direct or indirect adverse affects on local hospitals from the construction of the levees.

Road Raises: There will be no direct or indirect adverse affects to hospitals in the general project areas from the road raise (DPBM04).

Structure Modifications: The planned structural modification (FPCI01) will have no direct or indirect adverse affects on hospitals in the general project areas.

Hazardous, Toxic, & Radioactive Wastes

The HTRW investigations included a preliminary screening followed by full Phase I investigations. The preliminary hazardous, toxic, and radioactive waste (HTRW) site screening is included in Appendix H. The preliminary site screening, complete in March 2010, assessed whether FRM and ecosystem restoration sites considered for implementation during alternative development were enrolled in any regulatory remedial program. Data obtained from the IEPA, the WDNR, and the USEPA suggested that none of the sites under investigation were currently, or had previously been, enrolled in any regulatory remedial program. Due to the limited scope of the preliminary HTRW screening, Phase I HTRW investigations were recommended for project sites recommended for implementation during the final stages of the feasibility study.

A Phase I HTRW investigation for the FRM sites (reservoir, levee/floodwall, and structural modification project sites), completed in accordance with ER 1165-2-132, is included in Appendix H. Results of the investigation were based on an existing information review, database research, historical topographic map and aerial photograph review, and a site visit. The level of review conducted at each individual site considered the scope of the project, the amount of information available for review at each site, and the time and cost constraints of completing a Phase I HTRW investigation. Results reduce the uncertainty regarding the potential to encounter HTRW at any given site. A list of unresolved issues, short-term actions, and future project recommendations to resolve potential environmental concerns are provided for the reservoir, levee/floodwall, and structural modification sites, summarized in Table 9.2, Table 9.3, Table 9.4,and Table 9.5. The short term data needs will be addressed early in the design phase.

Table 9.2 – HTRW Results and Recommendations for Future Action: Road Raises

Site	Issue	Short-Term Data Needs	Potential Future Actions
First Ave Bridge Modification (DPBM04)	Historical aerial photographs suggest that between 1999 & 2007 property adjacent to Des Plaines River Rd (staging area) are highly disturbed and vegetation removed. Current topographic maps indicate filling; it is unclear where the fill materials originated.	The landowner should be identified and past and current uses of the property identified.	Phase II investigation may be required at the project site if the project activities disturb the property where fill has been placed.

Table 9.3 – HTRW Results and Recommendations for Future Action: Structure Modifications

Site	Issue	Short-Term Data Needs	Potential Future Actions
Lake Mary Anne Pump Station (FPCI01)	Site debris *(debris generally consists of roadside garbage, construction debris, and old structures associated with commercial activities at Dude Ranch Pond)*	None	Collect all debris during construction and dispose in accordance with Federal, State, and local laws and regulations

Table 9.4 – HTRW Results and Recommendations for Future Action: Reservoirs

Site	Issue	Short-Term Data Needs	Potential Future Actions
Fullerton Woods Reservoir (DPRS04)	Database entries suggest that the site contains an unauthorized landfill, but this information could not be replicated, nor did historical maps and photographs indicate the site has ever been used for landfill.	Confirm that the landfill was mismapped and is not present onsite (FOIA request through IEPA).	Perform phase II investigation to determine scope and scale of site impacts from landfill, if confirmed present.
	Site Visit suggests that all limestone from Deep Tunnel construction has been removed from the site, but could not be confirmed.	None	Conduct borings onsite to determine the type and quality of soils present onsite, and confirm that limestone has been removed from site.
	Spoil generated for reservoir construction	None	Due to the volume of material that will be generated and the unknown quality of the excavated material, management of spoil materials on-site is advised. If spoil will be removed from project site, phase II investigations may be necessary to determine the quality of the soils and disposal options.
Harry Semrow Driving Range Reservoir (WLRS04)	There are multiple LUST sites with the ASTM search distance with unknown status (EDR #L43, L44, and 52). Several of the LUSTs are presumed to be down gradient of the reservoir site; but one appears to be up gradient.	Confirm scope and scale of the LUST incidents with IEPA (FOIA request)	Perform phase II investigation to determine scope and scale of site impacts from adjacent regulated LUST activities, if required.
	Spoil generated for reservoir construction	None	Due to the volume of material that will be generated and the unknown quality of the excavated material, management of spoil materials on-site is advised. If spoil will be removed from project site, phase II investigations may be necessary to determine the quality of the soils and disposal options.

Table 9.5 – HTRW Results and Recommendations for Future Action: Levees

Site	Issue	Short-Term Data Needs	Potential Future Actions
Touhy-Miner Levee/Floodwall (DPLV09)	Site debris *(debris generally consists of roadside garbage, construction, or landscape debris)*	None	Collect all debris during construction and dispose in accordance with Federal, State, and local laws and regulations
	Three LUSTs up gradient	Confirm scope & scale of the LUST incidents w IEPA	Perform phase II investigation to determine scope and scale of site impacts from adjacent regulated LUST activities, if required
Groveland Ave Levee (DPLV01)	None	None	None
Belmont-Irving Park Levee (DPLV04)	Several historical gas stations, and one SRP site with groundwater use restrictions, located hydraulically up gradient to project with multiple SPILL and LUST actions	None	1. Confirm design/excavation assumptions and groundwater handling requirements 2. Confirm status of all LUST and SPILL actions 3. Perform phase II investigation to determine scope and scale of site impacts from adjacent regulated activities, if required.
	Landfill located adjacent to staging area	None	Confirm the limits of the staging area and the limits of the landfill to determine if areas overlap. Insert any contractual restrictions required to prevent disturbance of the landfill area.
	Site Visit	None	Site visits must be conducted to determine if there are any isolated RECs onsite that may impact project implementation.
	Database Search review	None	Additional review of database results of all sites within the ASTM search limits (beyond the limits of the levee/floodwall alignment documented herein) should be conducted to identify a comprehensive list of RECs that may impact project implementation.
Fullerton-Grand Levee (DPLV05)	Four SRP sites with groundwater use restrictions, located hydraulically up gradient to project	None	1. Confirm design/excavation assumptions and groundwater handling requirements 2. Perform phase II investigation to determine scope and scale of site impacts from adjacent regulated activities, if required
	Site Visit	None	Site visits must be conducted to determine if there are any isolated RECs onsite that may impact project implementation.
	Database Search review	None	Additional review of database results of all sites within the ASTM search limits (beyond the limits of the levee/floodwall alignment documented herein) should be conducted to identify a comprehensive list of RECs that may impact implementation.

9.4.3 17 Points of Environmental Quality

As specified by Section 122 of Rivers, Harbors & Flood Control Act of 1970 (P.L. 91-611), seventeen environmental quality categories of impacts were reviewed and considered in arriving at the final determination. As laid out in Table 9.6, the following categories were considered: noise, displacement of people, aesthetic values, community cohesion, desirable community growth, tax revenues, property values, public facilities, public services, desirable regional growth, employment, business and industrial activity, displacement of farms, man-made resources, natural resources, air and water. Long term significant impacts from the preferred alternative plan to these identified points are not expected. Temporary minor impacts from constructions activities would occur on some categories.

Table 9.6 – 17 Points of Environmental Quality Affects Considered

Points of Environmental Quality	ER Affects	FRM Affects
Noise	Minor & Temporary	Minor & Temporary Negative
Displacement of people	No Affects	No Affects
Aesthetic values	Long Term Beneficial	See Below
Community cohesion	No Affects	No Affects
Desirable community growth	No Affects	No Affects
Tax revenues	No Affects	No Affects
Property values	No Affects	No Affects
Public facilities	No Affects	No Affects
Public services	No Affects	No Affects
Desirable regional growth	No Affects	No Affects
Employment	No Affects	No Affects
Business and industrial activity	No Affects	Beneficial Affects
Displacement of farms	No Affects	No Affects
Man-made resources	No Affects	No Affects
Natural resources	Long Term Beneficial	Minor & Temporary Negative
Air and water	Long Term Beneficial	Minor & Temporary Negative
Water	Long Term Beneficial	Minor & Temporary Negative

Environmental Justice

The proposed ER and FRM 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 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.

Aesthetics

Natural resources, landforms vegetation and man-made structures that generate one or more sensory reactions and evaluations by the observer, particularly in regard to pleasurable response, are required

to be assessed for adverse effects. These sensory reactions are traditionally categorized as visual, auditory and olfactory responses.

All components under the ER and FRM Plans have minimal affect on sight, sound and smells. Visual improvements at the reservoir site would include the use of native vegetation and designing the reservoir to be more park-like, than just a "hole-in-the-ground".

The proposed levees would make the adjacent forest preserve lands have more of a sense of solace, since they would block the site of homes and human activities from the Forest Preserve's perspective; however, from a home owner's perspective, the levee may impair the visual line of sight to the Forest Preserve.

Road raises and structural modifications have minimal affect on sight, sound and smell since these structures are maintaining their characteristics and are just being elevated. Elevating of these structures is not expected to impair any scenic or visual vistas.

9.5 Cumulative Effects Assessment

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 (ER) and FRM 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 Upper Des Plaines Phase II ecosystem restoration and FRM project is considered to be beneficial environmentally, socially and economically.

The ecological restoration portion of this project would improve hydrology by filling an estimated 17,900 feet of unnatural ditch would be filled along with hundreds of thousands of feet of drain tiles disabled. Natural stream sinuosity would be restored increasing total length from 68,400 feet to 85,500 feet and 7,000 feet of stream would receive instream habitat treatments. Over 6,800 acres of native aquatic community types would be restored including: marsh, sedge meadow, wet prairie, wet savanna, floodplain forest, and woodland ephemeral depressions. Riparian and buffering communities of prairie, savanna, woodland and forest would also be restored to ensure sustainability and provide connectivity for multi-habitat life cycle species (i.e. Eastern Newt (*Notophthalmus viridescens*) require connectivity between marsh and woodland habitats). Ecosystem Plan G increases the quality of watershed ecosystem communities by 34% of what currently exists.

The FRM portion of this project would provide $8,636,000 net economic benefits through implementing two reservoirs, four levees, one road raise, one structural modification, and a vast array of non-structural components. Minor ecological improvements resulting from the FRM plans include reducing the flashiness of the Des Plaines River watershed and minor water quality improvements.

9.5.1 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 significantly 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 of the whole Upper Des Plaines River watershed. 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. For this analysis, the spatial boundary is the entire Upper Des Plaines River watershed.
Three temporal boundaries were considered:

- *Past* –1830s because this is the approximate time that the landscape was in its natural state, a vast prairie/wetland/woodland mosaic
- *Present* – 2014 when the decision is being made on the most beneficial ecological restoration and FRM projects
- *Future* – 2064, 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 and FRM) 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. Some future projections were taken from completed watershed plans by the Lake County Stormwater Management and Southeastern Wisconsin Planning Commission. In this case, reasonably foreseeable future actions include:

- Stable growth in both population and water consumption within the watershed
- Continued urban development within the watershed
- Continued increase in tourism/recreation within open space and natural lands
- Continued application of environmental requirements such as those under the Clean Water Act
- Implementation of various programs and projects to reduce runoff, erosion and sewer overflows
- Increased value placed not only the open space but the biodiversity and water quality of the watershed

9.5.2 Cumulative Effects on Resources

The plan formulation process took into account existing and planned FRM projects, watershed studies and known ecological restoration projects in the study area. Prior studies and reports, listed in Section 1.1.5, were reviewed to ensure that the modeled conditions are the best possible representation of actual conditions. In Section 3.1.1.5, Table 3.4 provides a list of existing major watershed modifications, including FRM projects. The detailed hydrologic and hydraulic models used in this study include the listed modifications. The study team also worked with state and local agencies to coordinate ongoing FRM planning to address additional flood damages in the watershed. Upon approval and implementation of a Recommended Plan, the with-project conditions will be used to evaluate the effectiveness of future projects.

Physical Resources: The past has brought much alteration to the physical resources of the Upper Des Plaines River watershed. Geology, soils, topography, hydrology, and fluvial geomorphology have all been modified to suit man's needs for purposes of habitation, commerce and recreation. Over 86% of the landscape has been modified from its natural form and the rate of land reclamation vs. development is almost equal. As a result, water and sediment quality are impacted due to site-specific and watershed-scale alterations, as well as daily activities such as road salting, industrial and municipal discharge, poor agricultural practices and the untidy nature of transportation/vehicles.

It is reasonably foreseeable that agricultural land will be converted to small residential subdivisions or purchased by conservation organization for ecological restoration purposes. In some cases this can potentially improve water quality in terms of nutrient loading, but in other instances it may introduce other types of contaminants such as oils and grease, surfactants and other nutrients (sewage and lawn fertilizers). Municipalities have adopted development and stormwater management ordinances; however, they are not always utilized to their full intentions. Best management practices are not numerous enough to prevent the influx of nutrients into streams and wetlands from existing agricultural land. Given the past, current and future condition of the Upper Des Plaines River watershed, the implementation of the ecosystem restoration and FRM projects are minor repairs in terms of the vast array and quantity of adverse effects caused by development and agriculture; however, they are significant in terms of beginning to address all the human induced problems the watershed suffers. There are no irrecoverable loss of resources identified in terms of geology, soils, topography, hydrology, water quality and fluvial geomorphology due to implementation of the preferred ER and FRM Plans. Cumulative beneficial effects to the Upper Des Plaines River are anticipated in terms of geology, soils, topography, hydrology, water quality and fluvial geomorphology.

Ecological Resources: The ecological diversity of the Upper Des Plaines River watershed has suffered greatly as a result of previous significant physical resource alterations. The watershed was once a diverse mosaic of marsh, prairie, savanna, woodland, glacial ponds and lakes and streams that had a steady and dependable hydrology. Extreme landscape modification has caused about 86% of the natural land use to be converted into agriculture or residential/commercial land uses. It is estimated that only about 2% of the remaining 14% of open space is considered high quality ecosystem, and that this 2% also suffers from fragmentation. No longer is there enough natural landscape to provide enough natural lands for fish and wildlife habitat or to attenuate large rainfall events. Considering these past, current and future conditions of the Upper Des Plaines River watershed, the

implementation of the ecosystem restoration and FRM projects are minor repairs in terms of the vast array and quantity of significant effects caused by development and agriculture; however, they are instrumental in beginning to address the human induced problems the watershed suffers. Therefore, there are no irrecoverable losses of resources identified in terms of plant, insect, fish, amphibian, reptile, bird, mammal taxa or to their habitats they occupy due to implementation of the preferred ER and FRM Plans. Cumulative beneficial effects to the Upper Des Plaines River are anticipated in terms of fish and wildlife and their preferred habitats.

Archaeological & Cultural Resources: Cumulative effects are not expected to archaeological or cultural resources.

9.5.3 Cumulative Effects Summary

Along with direct and indirect effects, cumulative effects of the preferred combined ER and FRM Plans were assessed. There have been numerous effects to resources from past and present actions, and reasonably foreseeable future actions can also be expected to produce both beneficial and adverse affects. In this context, the increments of effects from the proposed project are relatively minor. Assessment of cumulative effects indicates that long-term healing of the Upper Des Plaines River watershed resources is beneficial with the implementation of the preferred alternative plan; however, it will take considerable time for counties, municipalities and local organizations to continue to repair and mitigate losses caused by past hydrologic, hydraulic, and ecologic adverse effects. Based on the expectation of continued sustainability of all resources, and the magnitude of the watershed circumstances, cumulative effects are not considered significant or adverse, but highly beneficial to the environment, its people, and the economy.

9.6 Compliance Determination

9.6.1 Federal Statues and Regulation Compliance

This feasibility study complies with applicable environmental laws, regulations, and Executive Orders for the current stage of the study. Table 9.7 provides a summary of the compliance status for the primary environmental requirements associated with the study.

Table 9.7 – Compliance with Environmental Statutes and Executive Orders

Reference	Environmental Regulation	Compliance Status*
16 USC 1531, et seq.	Endangered Species Act, as amended	C
16 USC 460 (L),(12)	Federal Water Project Recreation Act, as amended	C
16 USC 4601-4, et seq.	Land and Water Conservation Fund Act, as amended	C
16 USC 470a, et seq.	National Historic Preservation Act (NHPA), as amended	C
16 USC 661	Fish and Wildlife Coordination Act, as amended	C
16 USC 703 et seq.	Migratory Bird Treaty Act of 1918,as amended	C
16 USC469, et seq.	Archaeological and Historical Preservation Act as amended	C
25 USC 3001, et seq.	Native American Graves Protection and Repatriation Act	C
33 USC. 1251 et seq.	Clean Water Act, of 1977, as amended	C
42 USC 1962	Water Resources Planning Act of 1965	C
42 USC 1996	American Indian Religious Freedom Act of 1978	C
42 USC 201	Safe Drinking Water Act of 1986 as amended	C
42 USC 4321, et seq.	NEPA, as amended	C
42 USC 4901, et seq.	Quiet Communities Act of 1978	C
42 USC 6901, et seq.	Resource Conservation and Recovery Act of 1976, as amended	C
42 USC 7401	Clean Air Act (CAA) of 1970 as amended	C
42 USC 9601	CERCLA of 1980	C
7 USC 4201, et seq.	Farmland Protection Policy Act	C
CEQ Memo 08-11-80	Prime or Unique Agricultural Lands NEPA	C
E.O. 11514	Protection and Enhancement of Environmental Quality	C
E.O. 11593	Protection and Enhancement of the Cultural Environment	C
E.O. 11988 (1977)	Floodplain Management	C
E.O. 11990 (1977)	Protection of Wetlands	C
E.O. 12088 (1978)	Federal Compliance with Pollution Control Standards	C
E.O. 12898 (1994)	Federal Actions to Address EJ in Minority and Low-Income Populations	C
E.O. 13007 (1996)	Indian Sacred Sites	C
E.O. 13045 (1997)	Protection of Children from Environmental Health Risks & Safety Risks	C
E.O. 13186	Responsibilities of Federal Agencies to Protect Migratory Birds	C
E.O. 13340	Great Lakes Designation of National Significance to Promote Protection	C
PL 79-525, 60 Stat 634	Rivers and Harbors Act of 1946	C

*Compliance Status indicated as compliant (C), non-compliant (N), or pending (P).

The NEPA (40 CFR 1501.6) requires the action agency to establish a cooperating agency relationship with other Federal agencies that have jurisdiction by law or special expertise relevant to the project. The USACE established a cooperating interagency agreement with the USFWS, in which they are serving as a member on the PDT, and have significantly contributed to the study.

9.6.2 Implementation of Environmental Operating Principles

In assessing environmental effects, the USACE implemented the following Environmental Operating Principles as part of this feasibility study.

Foster sustainability as a way of life throughout the organization: Development of feasibility level measures and alternatives took into consideration sustainability over time. Ecosystem features were developed to use natural hydrology and processes to sustain their integrity and functions as opposed to relying on hard engineered solutions that require continual maintenance. Allowing streams, wetlands and plant communities to both ebb and wan along with the natural processes that sustain them (fire, stream meandering, flood pulses), maintenance costs and activities are invariable reduced to minor activities (invasive species spot treatments). The projects were designed to ensure that the restored plant communities would not revert to invasive, weedy species again by 1) incorporating lessons learned from similar completed projects such as Orland Tract Section 206, Orland Perimeter 506, Calumet Prairie 506, Red Mill Pond 506 and 63rd Street Beach and Dune 506; 2) designing plant communities compatible with the restored hydrology and geomorphology, i.e. the overall design replicates plant communities indicative of the Upper Des Plaines River system as dictated by the historic soils; 3) restoring hydrologic, hydraulic and fire processes to sustain and drive native plant communities; 4) planting enough native plant material to prevent and/or reduce the potential for the invasion of invasive and weedy plant species; and 5) implementing the projects in partnership with dedicated non-Federal sponsors that have natural area programs and protocols that will maintain the project as constructed with the intended ecological benefits.

Proactively consider environmental consequences of all Corps activities and act accordingly: Potential impacts of engineering projects were considered during the planning process and, where impacts were identified, alternatives to avoid, minimize, rectify, reduce, eliminate, or compensate for the impacts were incorporated in alternative plans. The planning process attempted to avoid and/or minimize adverse affects to all critical, unique, and diverse fish and wildlife areas where large scale engineering projects were proposed. Flood Risk Management Planning accounted for valued fish, wildlife and habitat through a preliminary screening process, which ruled out those areas of ecological significance. The preferred plan addresses existing watershed habitat degradation in a manner to allow long-term recovery of the ecosystem. Maximizing the amount of ecological restoration within an extremely modified watershed not only aids in reversing trends that are both adverse to the ecological environment, but also the human environment. Ecosystem restoration components inherently reverse or prevent adverse human environmental consequences, such as water quality degradation, disease, flooding, carbon emissions, uncontrollable wild fires, food shortages, economics of invasive species, etc.

Create mutually supporting economic and environmentally sustainable solutions: The multi-purpose planning process used for this study considered potential conflicts and any necessary trade-offs to between the plans maximizing NED and National Environmental Restoration benefits. Opportunity was sought to design risk management features to provide incidental riverine and wetland habitat. Reestablishing these habitat features would benefit the natural environment by providing a low-cost and judicious method of habitat restoration. In addition, ecosystem restoration measures were

developed in concert with our Local Sponsors and Study Partners that currently engage in natural area management. This mutual partnership has been a source of information during the feasibility phase such that their long term efforts of natural area management has resulted in the latest and most cost effective methods for maintaining a sustainable native biodiversity.

Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps which may impact human and natural environments: Potential impacts of the proposed project were considered as documented in this EA. These potential impacts were assessed by reviewing existing data and through coordination with the public and with resource agencies.

Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs: Monitoring and adaptive management plans are an integral part of ecosystem restoration project implementation. Flood risk management projects will include robust O&M plans that incorporate sustainable practices.

Leverage scientific, economic, and social knowledge to understand the environmental context and effects of Corps actions in a collaborate manner: Many scientific and ecological studies have been initiated in advance of and during this study, which provide the public and resource agencies with a valuable insight of the historic and current diversity, and its positive affects once the project is complete. The USACE, Chicago District will also develop a long-term monitoring program in conjunction with USFWS and the non-Federal sponsors that will continually add information to these baseline studies. A GIS database was developed to allow the study team, as well as other users, to access and apply the scientific information.

Employ an open, transparent process that respects views of individuals and groups interested in Corps activities: The study team has met numerous times with the resource agencies, local industry, and environmental interests through scoping, teleconference calls, public meetings and has attempted to be responsive in addressing concerns. All problems were addressed as they arose and solutions were developed. The USACE agrees with the resource agencies that long-term monitoring and adaptive management will be required.

9.6.3 Discussion of Major Environmental Compliance

Section 404 of the Clean Water Act: All projects proposed under the preferred plan would comply with the regulations and statutes set forth in Section 404 of the Clean Water Act and do not impact any wetlands. There are no outstanding reasons to believe that Section 404 would not be in compliance for any given project. A preliminary 404(b)(1) analysis has been completed for the Recommended Plan, included in Appendix L. However, each feature that requires 404 compliance would complete a Section 404(b)(1) analysis and provide the information on a per project basis during the design phase to regulating agencies. No project requiring 404 compliance would begin construction without the completion of the analysis.

Section 401 of the Clean Water Act: All projects proposed under the preferred plan would comply with the regulations and statutes set forth in Section 401 of the Clean Water Act. There are no outstanding reasons to believe that 401 WQ Certification would not be granted for any given project, seeing that they all restore the environment and subsequently water quality, or they beneficially quell those adverse water quality affects associated with unnatural flooding. Currently, the Chicago District

has about 15 ecosystem restoration projects similar to the projects recommended by this study under construction or being implemented. All of these projects have been granted Section 401 certification or fall under the Regional 401 Program. Each project that requires Section 401 Certification would complete appropriate applications and provided information on a per project basis during the design phase when plan sheets are suitable for review. No project requiring Section 401 Certification would begin construction without the certificate issued.

Endangered Species Act and Fish and Wildlife Coordination Act: Preliminary coordination with the USFWS and plan formulation methodologies have recognized and considered threatened and endangered species from the study's onset. USFWS and State involvement in the project has assured that the preferred plan would be in compliance with Section 7 of the Endangered Species Act. USFWS participated early in the planning process as a cooperating agency and has therefore provided significant input on the plan formulation. However, formulation that has occurred since that time will be formally reviewed and critiqued by the agency through a Fish & Wildlife Coordination Act Report.

Section 106 of the National Historic Preservation Act: Preliminary coordination with the State SHPOs and plan formulation methodologies have recognized and considered archaeological and cultural resources from the study's onset. The preferred plan was not identified to have adverse affects on historic or archaeological resources.

Clean Air Act Conformity Rule: The Clean Air Act (42 U.S.C. §7401 et seq.), as amended in 1977 and 1990 was established to protect and enhance the quality of the nation's air resources to promote public health and welfare and the productive capacity of its population. The Act authorizes the USEPA to establish National Ambient Air Quality Standards to protect public health and the environment. The Act establishes emission standards for stationary sources, volatile organic compound emissions, hazardous air pollutants, and vehicles and other mobile sources. The Act requires the states to develop implementation plans applicable to particular industrial sources. Title IV of the Act includes provisions for complying with noise pollution standards.

The preferred alternative is expected to be in compliance with the Act. Clean Air Act general conformity analysis (Appendix N) suggests that the proposed Upper Des Plaines River and Tributaries project will have minimal impact on air quality in the project area. Mobile source emissions were estimated using USEPA guidance and models, and were found to be de minimis for criteria air pollutants. Based on these findings, the proposed Upper Des Plaines River and Tributaries project Feasibility Study demonstrates conformity.

Farmland Protection Policy Act: Unique and prime farmland was not identified as being part of the preferred plan's project footprint.

Environmental Justice E.O. 12898: Analysis of census and EPA environmental justice data indicates this project will have no adverse affects on minority or low income populations. No low-income agricultural communities are present in the general tri-county study area. Low-income minority populations do exist within the tri-county project area; however none are located along the Des Plaines River or in major flood zone areas; these areas consist of middle-class to upper middle-case suburban residential communities. All ecosystem projects are slated for public property, or property that would be acquired by a non-Federal public entity. The planned ecological restoration and flood management improvements will benefit everyone in the region equally. The preferred plan would not cause adverse human health effects or adverse environmental effects on minority populations or low-income populations.

Executive Order 11988: Floodplain Management: The Recommended Plan complies with and supports this executive order. Under this order, USACE is directed to avoid development in the floodplain, reduce the hazard and risk associated with floods, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values of the floodplain. The FRM components of the Recommended Plan reduce flood hazards in the study area by providing floodwater storage, flood barriers to protect potentially flooded structures, non-structural measures to avoid damages to structures, and other measures that reduce flood impacts to homes and businesses at risk of flooding. The ER components of the Recommended Plan restore natural floodplain structure and function and prevent development by using lands for ecosystem restoration. During the design phase, USACE will ensure that all components of the Recommended Plan continue to comply with this order and all other applicable laws and regulations.

Compliance with EO11988 is demonstrated through an 8-step process that agencies should carry out as part of their decision-making on projects that have potential impacts to or within the floodplain. The eight step process and the District's determination of compliance are listed below:

1. ***Determine if a proposed action is in the base floodplain.*** The proposed action consists of several projects located throughout the watershed. Many of them are either entirely or partly located in the base floodplain. All of the ecosystem restoration sites incorporate actions in the base floodplain. The levees, structure modification, road raise, and non-structural measures are also located in the base floodplain. One reservoir site is in the base floodplain, the other is outside of this area.

2. ***Conduct early public review, including public notice.*** The general public was advised/ informed of the proposed action through public meetings, the distribution of the NEPA document for public review, Public Notice, and the District website. Comments have been reviewed and considered as documented in Appendix L.

3. ***Identify and evaluate practicable alternatives to locating in the base floodplain, including alterative sites outside of the floodplain.*** For projects located in the base floodplain, no practicable alternatives were identified that would locate the action outside of the base floodplain. The purpose of the project is to reduce the risk of flood hazards and to restore the natural floodplain. Because the damages occur in the floodplain, it cannot be accomplished through actions located outside the base floodplain.

4. ***Identify impacts of the proposed action.*** Beneficial economic impacts of the proposed action include reduced flood hazards by providing floodwater storage, constructing flood barriers, and implementing non-structural measures. Beneficial ecological impacts would be the restoration of natural floodplain structure and function and the prevention of future floodplain development at restoration sites and non-structural buyout areas. Any adverse impacts to the existing base flood elevation would be mitigated through design modifications or the construction of compensatory storage. Structural FRM projects are located in a fully developed urban area, therefore the benefits provided by the project are only to existing development. Ecosystem restoration projects would enhance the base floodplain by restoring more natural hydrologic conditions and preventing development at these sites.

5. ***Minimize threats to life and property and to natural and beneficial floodplain values. Restore and preserve natural and beneficial floodplain values.*** The proposed action will reduce the

hazard and risk associated with floods; minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values of the floodplain. Since the structural FRM projects are located in a fully developed area, significant new development is not anticipated behind proposed flood barriers. Non-structural measures will manage flood risk at existing structures without impacting the floodplain and, in the case of buyouts, provide opportunities to restore and preserve natural and beneficial floodplain values. The establishment of restoration sites across the watershed will restore and preserve natural and beneficial floodplain values and further prevent future adverse impacts to the floodplain.

6. ***Reevaluate alternatives.*** The proposed action could not be relocated outside of the base floodplain and still meet the purpose, needs, goals, and objectives of the project.

7. ***Present the findings and a public explanation.*** The public has remained informed throughout the study process in accordance with NEPA. Information was disseminated through public meetings, the distribution of the NEPA document, public notices, and the District website.

8. ***Implement the action.*** The Recommended Plan is the most responsive to the planning objectives established by the study and consistent with this E.O. The proposed project would be in full compliance with EO11988.

Hazardous Wildlife Attractants on or Near Airports: In 2003, the Assistant Secretary of the Army for Civil Works entered into a Memorandum of Agreement (MOA) with the Federal Aviation Administration (FAA) along with Air Force, US Department of Agriculture (USDA), and the US Fish and Wildlife Service (USFWS). The purpose of the MOA is to try to diminish aircraft-wildlife strikes. Under the MOA, the Secretary has agreed to avoid "the establishment of land uses attractive to hazardous wildlife" within 5,000 feet of airports serving piston-powered aircraft and 10,000 feet of airports serving turbine powered aircraft. The definition of "hazardous wildlife" includes geese, crows, hawks, sparrows, ducks, and many other birds species. However, exceptions to these separation zone provisions are considered for "habitats that provide unique ecological functions or values (e.g., critical habitat for federally-listed endangered or threatened species, ground water recharge)."

The proximity of airports was considered in the identification of potential sites where proposed measures would result in a change in land use. Of particular concerns are sites that could result in additional open water areas or that could attract populations of hazardous wildlife. Sites that were within 10,000 feet of local airports were only retained if it was determined that the proposed measures would not increase the attractiveness of the site to hazardous wildlife. Proposed floodwater storage sites within existing airspace operation areas (AOA) were eliminated during formulation. Proposed reservoirs outside the AOA will remain dry and only retain water during and immediately after flood events. Restoration projects within existing AOA were reviewed to determine whether restoration activities would result in an increased hazard.

Two NER Plan elements are located within 10,000 feet of the Chicago Executive Airport; C-09, Northbrook Marsh and C15, Beck Lake Meadow and Floodplain Forest. Both sites are existing natural areas/forest preserves, owned by the Forest Preserve District of Cook County. Restoration will include the protection of habitat for threatened and endangered species and the restoration of scarce and unique sedge meadow habitat. An analysis of the restoration plans in accordance with FAA

Advisory Circular (USDOT/FAA AC No. 150/5200-33B, Hazardous Wildlife Attractants on or near Airports, August 2007) determined that the NER Plan should not be considered an attractive nuisance for high hazard wildlife for airports within the study area. Coordination with FAA, as per the MOA is underway.

Wetland Mitigation Bank Regulations: Two historic wetland mitigation banks are within the boundaries of the ecosystem restoration area under the NER plan. The NER plan does not violate any regulations pertaining to wetland mitigation banks, since compatible uses, such as enhancing the quality of the wetland, are allowed. See 33 C.F.R. § 332.7(a)(2). In addition, these historic wetland mitigation banks are not actively generating credits and no longer require active monitoring. Thus, ecosystem restoration enhancing these mitigation banks does not conflict with the prohibitions against use of federal funds to generate mitigation bank credits, 33 C.F.R. § 332.3(j)(2). USACE has engaged in preliminary coordination with the Interagency Review Team (IRT) with regard to the NER plan. The IRT consists of USACE, USEPA and USFWS. Although USACE is the lead agency on review and authorization of mitigation banking instruments, USACE utilizes the IRT to coordinate with USEPA and USFWS on review and decision-making regarding mitigation banks. Based on preliminary coordination, the IRT does not object to the NER plan, and the IRT will review and approve the final plan to ensure that there is no conflict with the mitigation bank requirements. At a minimum, the NER plan shall maintain at least the same number of quality wetland acres already existing within the bank to ensure no net loss of wetland acres previously used to offset impacts to waters of the US.

Cumulative Effects: Based on the expectation of continued sustainability of all resources, and the magnitude of the watershed circumstances, cumulative effects are not considered significant or adverse.

Public Interest: Public scoping meetings were held in 2002 in which public comment was sought on what the study scope should include. This information was utilized in the formulation of a preferred plan. This preferred plan was presented to the public and comments and concerns identified by the public through letters, e-mails, and orally during public meetings have been addressed.

9.7 Conclusion

In accordance with the NEPA of 1969 and Section 122 of the River and Harbor and Flood Control Act of 1970, the U.S. Army Corps of Engineers (Chicago District) 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 preferred plan.

The assessment process indicates that this project would not cause significant effects on the quality of the human environment in the areas of construction and have only beneficial impacts upon the ecological, biological, social, cultural, or physical resources of the Upper Des Plaines River watershed 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.

10 Combined Plans

The projects in the combined plans are distributed throughout the watershed. A summary of the combined plan elements is presented below. Plate 42 shows the location of the FRM and ER sites within the study area.

10.1 Description of Combined Plans

The study area includes two states, four counties, and numerous municipalities. Table 10.1 presents a summary of the plan elements. Each element is described below, grouped by county and listed in order from upstream to downstream within the watershed. Plate 42 shows the location of each site. The individual sites within each plan are shown on Plate 16 through Plate 22 and Plate 29 through Plate 40.

This report presents three plans: a "NED/NER Plan" which includes all policy compliant, economically justified, environmentally acceptable separable projects of such scope that they could not reasonable be implemented under the CAP; a "CAP Plan" which includes all policy compliant, economically justified, environmentally acceptable separable projects of such scope that they could reasonable be implemented under CAP; and a "Comprehensive Plan" which includes all economically justified, environmentally acceptable separable projects evaluated during the course of the study;.

Combined NED/NER Plan: The projects in this plan, designated as "NED/NER" in Table 10.1, include a structural FRM system consisting of three levee/floodwalls and two floodwater storage reservoirs providing compensatory storage and additional flood risk management benefits as well as non-structural measures to be implemented in two counties (Lake and Cook) and seven ER projects throughout the watershed where aquatic ecosystems will be restored to more natural conditions. The *Combined NED/NER Plan* is recommended for Congressional authorization.

CAP Plan: The policy compliant projects that could reasonably be implemented under CAP are designated as "CAP" in Table 10.1. This program allows USACE to plan, design, and construct smaller projects using delegated program authorities provided by Congress. Small FRM projects with a Federal cost under $7 million are authorized by Section 205 of the Flood Control Act of 1948, as amended. Small Ecosystem Restoration projects with a Federal cost under $5 million are authorized by Section 206 of the WRDA of 1996, as amended. Individual projects within the *CAP Plan* are recommended for implementation by USACE under these existing authorities. There are 6 projects in the *CAP Plan*. The projects in this plan include one FRM project consisting of a levee/floodwall and five ER projects consisting of dam removals along the Des Plaines River. Projects included in the *CAP Plan* will be converted to this program upon approval by the Division Engineer.

Comprehensive Plan: The Comprehensive Plan is the most inclusive plan. The Comprehensive Plan projects include projects for which USACE will seek congressional authorization for implementation, projects that will be implemented under CAP, and projects that are not compliant with current USACE policy and will therefore be recommended for implementation by the appropriate state and local agencies. All of the sites shown in Table 10.1 would be included in the Comprehensive Plan. Projects that are only included in the Comprehensive Plan are designated as "Comprehensive" in the table. The additional projects in this plan include the First Avenue Bridge Modification (DPBM04), Lake Mary Anne Pump Station (FPCI01), and economically justified non-structural projects that are in portions of tributaries not meeting the minimum flow criteria.

Table 10.1 – Summary of Projects included in Combined Plans

County	ID	Site Name	Purpose	Plan	Measure	Municipality
Kenosha	K47	Bristol Marsh	ER	NED/NER	Restoration, Rural Alternative 9	Bristol
	K41	Dutch Gap Forested Floodplain	ER	NED/NER	Restoration, Rural Alternative 6	Bristol
		Kenosha County Non-structural (Comp Plan)[1]	FRM	Comprehensive	Elevation, Floodproofing, Buyouts	Salem, Somers
Lake	L43	Red Wing Slough & Deer Lake Wetland Complex	ER	NED/NER	Restoration, Rural Alternative 2	Antioch
	L39	Pollack Lake &Hastings Creek Riparian Wetlands	ER	NED/NER	Restoration, Rural Alternative 6	Antioch
	L31	Gurnee Woods Riparian Wetland	ER	NED/NER	Restoration, Rural Alternative 4	Wadsworth
		Lake County Non-structural	FRM	NED/NER	Elevation, Floodproofing, Nonstructural berms, Buyouts	Gurnee , Riverwoods, Long Grove, Lincolnshire, Vernon Township
Cook	C09	Northbrook Floodplain and Riparian Complex	ER	NED/NER	Restoration, Urban Alternative 8	Wheeling
	--	Dam #1 Removal	ER	CAP	Dam Removal	Wheeling
	--	Dam #2 Removal	ER	CAP	Dam Removal	Des Plaines
	C15	Beck Lake Meadow and Floodplain Forest	ER	NED/NER	Restoration, Urban Alternative 8	Des Plaines/Glenview
	--	Dempster Ave Dam Removal	ER	CAP	Dam Removal	Des Plaines
	FPCI01	Lake Mary Anne Pump Station[1]	FRM	Comprehensive	Structure Modification	Des Plaines
	WLRS04	Harry Semrow Driving Range Reservoir	FRM	NED/NER	Floodwater Storage Reservoir	Des Plaines
	DPLV09	Touhy-Miner Levee	FRM	NED/NER	Levee/Floodwall	Des Plaines
	--	Touhy Ave Dam Removal	ER	CAP	Dam Removal	Park Ridge
	--	Dam #4 Removal	ER	CAP	Dam Removal	Park Ridge
	DPLV05	Belmont-Irving Park Levee	FRM	NED/NER	Levee/Floodwall	Schiller Park
	DPLV04	Fullerton-Grand Levee	FRM	NED/NER	Levee/Floodwall	River Grove
	DPRS04	Fullerton Woods Reservoir	FRM	NED/NER	Floodwater Storage Reservoir	River Grove
	DPBM04	First Ave Bridge Modification[1]	FRM	Comprehensive	Bridge Modification	River Grove
	DPLV01	Groveland Ave Levee	FRM	CAP	Levee/Floodwall	Riverside
	--	Cook County Non-structural	FRM	NED/NER	Elevation, Floodproofing, Nonstructural berms, Buyouts	Des Plaines, Rosemont, Wheeling, Wheeling Township
	--	Cook County Non-structural (Comp Plan)[1]	FRM	Comprehensive		Buffalo Grove, Leyden Township, Wheeling

[1]Road Raises formulated to solely address transportation damages, such as DPBM04, and projects that accrue benefits in portions of watersheds where 10% ACE flows are less than 800 cfs, such as FPCI01 and some non-structural measures, are non-policy compliant. These projects would be implemented by the appropriate non-Federal agency and would not be cost-shared with USACE.

10.1.1 Kenosha County, Wisconsin

Bristol Marsh (NER K47 Rural Alternative 9), Bristol (Plate 30)

Bristol Marsh would restore native plant communities of open water, marsh, wet prairie, mesic and dry prairie, wet and dry oak savanna, wet forest, flat woods and open woodland. Once agricultural practices cease, the hydrology, geomorphology would be naturalized. This allows for the restoration and establishment of native plant and animal species over the 1,619 acre site.

Hydrology and hydraulics would be repaired through the disablement of the drain tile system, filling of unnatural waterways, manipulation of geomorphic conditions, and native plant community establishment. Drain tile valves would be strategically placed across the 1,619 acre site. The purpose for this during the PED phase is to determine if there would be off-site impacts and to improve the understanding where plant communities would reside on the landscape. Once the boundary conditions are acceptable for the resurged hydrology, the valves would be grouted with bentonite to ensure they could not be opened again. The resulting condition is that the drain tiles would fill with soil over time and, due to hydrostatic pressure build-up, collapse on themselves.

The main waterway that is conduit for water through the site is Dutch Gap Canal (9,400-feet). To return this segment back into its naturally marsh-like flow conditions, banks would be removed to allow water flowing into the site to be spread out and re-form the flowage. Banks would be graded out and ditch plugs placed at points in the channel to disable draining effects the ditch may have once its banks removed. About 2,500-feet of waterway would be excavated to drain several depressions, which would be filled in before the drain tile system is disabled. Further, about 251 acres of trees would be removed and about 253 acres of woodland would be established to help resurge hydrology since trees significantly drain the water table.

Various activities would repair geomorphology to the wetland flowage and surrounding riparian landforms, including drain tile disablement, ditch disablement, other minor grading, and native vegetation reestablishment. Native vegetation would be restored through repairing hydrology and geomorphology, removing invasive and non-native species, and sowing native seed and live plugs.

To remove soil compaction, light disking could be implemented or other methods such as alfalfa cropping to botanically break up the soils and remove nutrients at the same time. There may be a need to add organic carbon to soils in order to establish former plant communities. This would be accomplished through the use of organic leaf litter compost as a soil amendment. Another alternative for soil amendments could be pine sawdust if soils are overly nitrified. The sawdust would activate bacteria whose metabolic processes begin to denitrify the soils.

Due to the dramatic drying out of the former wetland communities, weedy tree species have taken over about 251 acres and would be removed. Woodland communities have also been impaired by hydrologic regime shifts and have become riddled with invasive tree, shrub, and herbaceous plant species. About 253 acres of woodland community would be thinned and cleared of these noxious species. About 150 acres of oldfield and old wetland patches would need herbaceous management to rid them of weeds. All other acres of plant communities would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for the site would be to keep invasive plant species from recolonizing. Once the site becomes more robust with native plant diversity and densities, the upkeep on invasive plant species recolonization should decline. Considerations for the stream would focus on entry and exit from the site. Keyed in stone riffles would be used to ensure the stream exits the site through the existing road bridge culvert properly. Occasional adjustment or replenishment of these stones may be required.

Costs associated with this project are identified in Table 10.2 at the end of this section.

Dutch Gap Forested Floodplain (NER K41 Rural Alternative 6), Pikesville (Plate 29)

Dutch Gap Forested Floodplain would restore native plant communities of marsh, wet prairie, mesic and dry prairie, wet and dry oak savanna, wet forest, flat woods and open woodland. Once agricultural practices cease, the hydrology, geomorphology would be naturalized. This would allow for the restoration and establishment of native plant and animal species over the 689 acre site.

Hydrology and hydraulics would be restored by placing drain tile valves over the 689 acre site. The purpose and methods are the same as those described for Site K47. The main waterway that is conduit for water through the site is Dutch Gap Canal (5,500-feet). To return this segment to a naturally functioning stream, the water would be put back in motion over the landscape. The site has sufficient space within a defined stream valley to confine the meandering stream within the site boundaries. The ditch banks would be graded to a slope of 20:1 and cobble riffles would be placed at various points within the channel. A 3,000-foot segment of small tributary flowing into the creek would also be restored, utilizing the same methods. To further resurge hydrology, about 251 acres of trees would be removed and about 253 acres of woodland would be thinned to allow surface water wetlands to resurge.

The geomorphology of the site was modified from its natural condition to support agricultural use of land. To restore the site to wetland basins, stream channel, and active floodplain, various activities including drain tile disablement, ditch filling or plugging, bank grading, riffle placement, minor grading and native vegetation reestablishment would be implemented as described under Site K47.

Native vegetation would be restored through repairing hydrology and geomorphology, removing invasive/non-native species and sowing native seed and live plugs. To remove soil compaction, light disking could be implemented or other methods such as alfalfa cropping to botanically break up the soils and remove nutrients at the same time. There may be a need to add organic carbon to soils in order to establish former plant communities. This would be accomplished through the use of organic leaf litter compost as a soil amendment. Another alternative for soil amendments could be pine sawdust if soils are overly nitrified. The sawdust would activate bacteria whose metabolic processes begin to denitrify the soils.

Trees would be removed from about 23 acres to remove old farm field windbreaks. About 48 acres of oldfield would be managed to remove herbaceous invasive species. All other acres of plant community would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period the site would be to keep invasive plant species from recolonizing. Once the site becomes robust with native plant diversity and densities,

the upkeep on invasive plant species recolonization should decline. Maintenance activities for the stream would focus on the stream's entry and exit of the site. Keyed in stone riffles would be used to ensure the stream exits the site through the existing road bridge culvert properly. Occasional adjustment or replenishment of these stones may be required.

Costs associated with this project are identified in Table 10.2.

Kenosha County Non-structural (Comprehensive)

The incrementally justified non-structural component of the FRM plan in Kenosha county would protect homes and businesses through a variety of measures. The non-structural measures would be implemented at structures at risk of flooding in Salem and Somers. The measure implemented at each site would be determined according to the feasibility and cost-effectiveness of implementation determined through a site specific evaluation of the structure. Implementation of non-structural measures at individual properties will be voluntary and dependant on verification of structure characteristics and first floor elevations.

The measures considered for implementation include:

- Elevation – the usable area raised above flood elevations
- Dry floodproofing – modifications prevent floodwaters from entering the structure
- Wet floodproofing – modifications to allow floodwaters to flow through the structure
- Fill/Removal of basement in combination with floodproofing – any utilities located in basements would be relocated to a new addition elevated above flood elevations and the basement would be filled and removed from use. Any flood damages above the first floor elevation would be addressed through floodproofing.
- Nonstructural berm – a low berm or floodwall encircling a structure or group of structures preventing flood damage
- Buyouts – removal of the structure from the floodplain was considered for structures where no other measures were feasible and significant damages occur during the 1% annual change of exceedance flood event

The identified non-structural measures in Kenosha county are all along portions of streams that do not meet the minimum flow criteria for USACE participation in FRM measures (800 cfs during the 10% annual change of exceedance flood event). These measures are therefore recommended for implementation by local FRM authorities as part of the Comprehensive Plan.

Costs associated with the non-structural measures are identified in Table 10.2.

Table 10.2 – Kenosha County Estimated Costs ($1,000)

ID	Plan	Prelim LERRDs[1]	Construction	PED	Construction Mgmt [2]	Total First Costs	Annual OMRR&R
K47	NED/NER	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
K41	NED/NER	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	9
Non-Structural	Comprehensive	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total Kenosha County Comprehensive Plan		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total Kenosha County NED/NER Plan		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[1] Includes Lands & Damages and Relocations
[2] Includes Construction Management, Monitoring, and Adaptive Management

(FY2015 Price Level)

10.1.2 Lake County, Illinois

Red Wing Slough and Deer Lake Wetland Complex, Antioch (NER L43 Rural Alternative 2) (Plate 31)

Red Wing Slough and Deer Lake Wetland Complex would restore native plant communities of lake, marsh, wet meadow, wet prairie, mesic and dry savanna, wet forest, flat woods and open woodland. Once agricultural practices cease, the hydrology, geomorphology would be naturalized. This would allow for the restoration and establishment of native plant and animal species over the 1,601 acre site.

Hydrology and hydraulics would be restored by placing drain tile valves at locations across 892 acres of the 1,601 acre site; the remaining acres are open water. The purpose and methods are the same as those described for Site K47. This restoration site does not have a typical stream flowing through it; however, the Red Wing Slough and Deer Lake wetlands form a huge sluggish flowage that eventually discharges into North Mill Creek. A 1,000-foot segment of stream drains Deer Lake and other flowage wetlands; however, drain tile disablement and vegetation restoration would drown the stream allow marsh communities would take over. Aside from identifying and disabling any present drain tiles, hydrology would be restored and naturalized through the removal of invasive and non-native trees. About 69 acres of trees would be removed from wetlands and wind breaks. In addition, 34 acres of woodland would have non-native trees removed, furthering hydrologic resurgence since trees have a significant impact on draining down the water table.

The topography and geomorphology of the site is largely intact. Repair to the geomorphology of floodplain forest complex would be needed, This repair would be accomplished through various activities including drain tile disablement, tree removal, minor grading and native vegetation reestablishment.

Native vegetation would be restored by repairing hydrology and geomorphology, removing invasive/non-native species, and sowing native seed and live plugs. To remove soil compaction, light disking could be implemented or other methods such as alfalfa cropping to botanically break up the soils and remove nutrients at the same time. There may be a need to add organic carbon to soils in order to establish former plant communities. This would be accomplished through the use of organic

leaf litter compost as a soil amendment. Another alternative for soil amendments could be pine sawdust if soils are overly nitrified. The sawdust would activate bacteria whose metabolic processes begin to denitrify the soils.

Trees would be removed from about 69 acres to restore wet meadows and flat woods. Non-native trees and shrubs would be removed from about 34 acres of woodland and flat woods. To restore oldfield, 252 acres would need herbaceous management. All other acres of plant community would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for the site would be to keep invasive plant, tree, and shrub species from recolonizing. Once the site becomes robust with native plant diversity and densities, the upkeep on invasive plant species recolonization should decline.

Costs associated with this project are identified in Table 10.3 at the end of this section.

Pollack Lake and Hastings Creek Riparian Wetlands, Antioch (NER L39 Rural Alternative 6) (Plate 32)

Pollack Lake and Hastings Creek Riparian Wetlands would restore native plant communities of lake, marsh, wet meadow, wet prairie, wet prairie, mesic and dry prairie, and open woodland. Once agricultural practices cease, the hydrology, geomorphology would be naturalized. This would allow for the restoration and establishment of native plant and animal species over the 429 acre site.

The hydrology would be restored by placing drain tile valves at locations across the site. The purpose and methods are the same as those described for Site K47. There are two small tributaries that flow through the site: a 3,000 foot prairie swale that drains Pollack Lake into Mill Creek and a 3,600 foot segment of Hastings Creek which has been channelized. Drain tile disablement and vegetation restoration would repair the hydrologic conditions of the prairie swale and no action would be recommended. To restore the segment of Hastings Creek, water would be set back in motion over the landscape. The ditch banks would be graded to a slope of 20:1. Cobble riffles would be placed at various points within the channel to engage the meandering process. If certain portions of the ditch are extremely incised, higher riffle crests may be necessary. Hydraulic modeling of the site would ensure riffles would not cause water to back up into neighboring parcels. The riffle stone would consist of natural glacial or fluvial stone.

Topography and geomorphology of the site has been modified from its natural condition to support agricultural use of the land. The hydrologic restoration activities would also repair the geomorphology to wetland basins, stream channel and active floodplain. These include drain tile disablement, ditch filling or plugging, bank grading, and riffle placement. Further geomorphic and soils repair would occur over time.

Native vegetation would be restored by repairing hydrology and geomorphology, removing invasive/non-native species, and sowing native seed and live plugs. To remove soil compaction, disking could be implemented or other methods such as alfalfa cropping could be used to both botanically break up the soils and remove nutrients. There may be a need to add organic carbon to the soils in order to establish former plant communities. This would be accomplished through the use of organic leaf litter compost as a soil amendment. Another alternative for soil amendments could be pine

sawdust if soils are overly nitrified. The sawdust would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

The main activity during the operations and maintenance period for the site would be to keep invasive plant species from recolonizing. Once the site becomes robust with native plant diversity and densities, the upkeep on invasive plant species management should decline. Maintenance activities for the stream should be minimal since the stream is already naturally meandering. Stream maintenance would focus on entry and exit from the site. Keyed in stone riffles would be used to ensure the stream exits the site through the existing road bridge culvert properly. Occasional adjustment or replenishment of these stones may be required.

Costs associated with this project are identified in Table 10.3 at the end of this section.

Gurnee Woods Riparian Wetlands (NER L31 Rural Alternative 4), Wadsworth (Plate 33)

Gurnee Woods Riparian Wetlands would restore native plant communities of open water, marsh, wet meadow, wet prairie, mesic and dry prairie, mesic and dry oak savanna, floodplain and wet forest, and open woodland. Once agricultural practices cease, the hydrology and geomorphology would be naturalized, allowing for restoration and establishment of native plant and animal species over the 698 acre site.

The hydrology would be restored by placing drain tile valves at locations across the site. The purpose and methods are the same as those described for Site K47. The main conduit for water through the site is the Des Plaines River (21,500-feet). This once marshy floodplain has been invaded by invasive trees due to the presence of drain tile systems across the site. Colonization by trees has further dried out the floodplain through evapotranspiration; therefore, the trees would be removed first, followed by drain tile disablement. These actions would allow hydrology to resurge within the floodplain and further resurge hydrology to the stream.

The topography and geomorphology of the site has been modified from its natural condition support agricultural use of the land. To repair geomorphology to the wetland floodplain and stream channel, various activities including drain tile disablement, minor grading, tree removal and native vegetation reestablishment would be implemented as described under Site K47.

Native vegetation would be restored by repairing hydrology and geomorphology, removing invasive/non-native species, and sowing native seed and live plugs. To remove soil compaction, disking could be implemented or other methods such as alfalfa cropping could be used to both botanically break up the soils and remove nutrients. There may be a need to add organic carbon to the soils in order to establish former plant communities. This would be accomplished through the use of organic leaf litter compost as a soil amendment. Another alternative for soil amendments could be pine sawdust if soils are overly nitrified. The sawdust would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

Trees would be removed over approximately 15 acres of former marshy areas. Invasive trees, shrubs, and herbaceous species would be thinned over approximately 516 acres of marsh and woodland. About 203 acres of oldfield would need herbaceous management, which could include herbicide

application, controlled burns, or mowing. All other acres of plant community would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for the site would be to prevent recolonization of invasive plant species. Once the site becomes robust with native plant diversity and densities, the upkeep on invasive plant species management should decline.

Costs associated with this project are identified in Table 10.3 at the end of this section.

Lake County Non-structural (NED)

The incrementally justified non-structural component of the FRM plan in Lake County would protect homes and businesses through a variety of measures. The non-structural measures would be implemented at structures at risk of flooding in the communities of Gurnee, Lincolnshire, Long Grove, Riverwoods, and Unincorporated Vernon Township. The measure implemented at each site will be determined according to the feasibility and cost-effectiveness of implementation determined through a site specific evaluation of the structure. Implementation of non-structural measures at individual properties will be voluntary and dependant on verification of structure characteristics and first floor elevations. With regard to the buyouts, to the extent practicable, acquisition would be on a willing seller basis, but eminent domain could be utilized when determined to be warranted.

The measures considered for implementation include:

- Elevation – the usable area raised above flood elevations
- Dry floodproofing – modifications prevent floodwaters from entering the structure
- Wet floodproofing – modifications to allow floodwaters to flow through the structure
- Fill/Removal of basement in combination with floodproofing – any utilities located in basements would be relocated to a new addition elevated above flood elevations and the basement would be filled and removed from use. Any flood damages above the first floor elevation would be addressed through floodproofing.
- Nonstructural berm – a low berm or floodwall encircling a structure or group of structures preventing flood damage
- Buyouts – removal of the structure from the floodplain was considered for structures where no other measures were feasible and significant damages occur during the 1% annual chance of exceedance flood event

Costs associated with the non-structural measures are identified in Table 10.3.

Table 10.3 – Lake County Estimated Costs ($1,000)

ID	Plan	Prelim LERRDs[1]	Construction	PED	Construction Mgmt [2]	Total First Costs	Annual OMRR&R
L43	NED/NER	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
L39	NED/NER	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
L31	NED/NER	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Non-Structural	NED/NER	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Total Lake County NED/NER Plan		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[1] Includes Lands & Damages and Relocations
[2] Includes Construction Management, Monitoring, and Adaptive Management

(FY2015 Price Level)

10.1.3 Cook County, Illinois

Northbrook Floodplain & Riparian Complex (NER C09 Urban Alternative 8), Wheeling (Plate 35)

Northbrook Floodplain and Riparian Complex would restore native plant communities of marsh, wet meadow, wet prairie, mesic and dry prairie, wet oak savannah, mesic and dry oak savannah, wet forest, flat woods, and open woodland. The hydrology and geomorphology would be naturalized, allowing for restoration and establishment of native plant and animal species over the 811 acre site.

The hydrology would be restored by placing drain tile valves at locations across the site. The purpose and methods are the same as those described for Site K47. This restoration site is in the floodplain and immediate riparian zone for the Des Plaines River. Once the hydrology is repaired, wetland swales would flow directly into the Des Plaines River. Aside from identifying and disabling any present drain tiles, hydrology would be restored and naturalized through the removal of invasive and non-native trees. About 479 acres of trees would be removed from prairie, wet sedge meadow, and marsh plots. In addition, non-native trees would be removed over 330 acres of woodland, furthering hydrologic resurgence. Trees have a significant impact on draining down the water table.

Topography and geomorphology of the site is for the most part intact. To repair the geomorphology of this floodplain complex, various activities would be implemented including drain tile disablement, tree removal, minor grading, and native vegetation reestablishment.

Native vegetation would be restored through repairing hydrology and geomorphology, removing invasive and non-native species, and sowing native seed and live plugs. To remove soil compaction, disking could be implemented or other methods such as alfalfa cropping could be used to both botanically break up the soils and remove nutrients. There may be a need to add organic carbon to the soils in order to establish former plant communities. This would be accomplished through the use of organic leaf litter compost as a soil amendment. Another alternative for soil amendments could be pine sawdust if soils are overly nitrified. The sawdust would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

Trees would be removed from about 88 acres to restore wet meadows and flat woods. Non-native trees and shrubs would be removed over about 330 acres of woodland and savanna. All other acres of plant community would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for site C09 would be to keep invasive plant species from recolonizing. Once the site becomes robust with native plant diversity and densities, the upkeep on invasive plant species management should decline.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Dam #1 Removal, (CAP) Wheeling (Plate 36)

This two foot high run-of-the-river dam would be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation would restore the habitat to a more natural condition.

Historical data indicates that the dam is made of reinforced concrete. Based on completed removals of similar dams along the Des Plaines River, it is expected that the dam will be demolished in-the-wet by driving excavators into the river to perform the work without the use of a coffer dam or water diversion structure.

Clearing and grubbing would be performed only in areas necessary to build temporary access road and staging areas need to access the dams and store construction equipment. The access roads and staging acres will be constructed with stone. Once construction is complete, all gravel will be removed from temporary access roads and the site will be returned to its original contours and revegetated and reforested appropriately.

Costs associated with this site are identified in Table 10.4 at the end of this section.

Dam #2 Removal (CAP), Des Plaines (Plate 37)

This two foot high run-of-the-river dam would be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation would restore the habitat to a more natural condition.

Historical data indicates that the dam is made of reinforced concrete. Based on completed removals of similar dams along the Des Plaines River, it is expected that the dam will be demolished in-the-wet by driving excavators into the river to perform the work without the use of a coffer dam or water diversion structure.

Clearing and grubbing would be performed only in areas necessary to build temporary access road and staging areas need to access the dams and store construction equipment. The access roads and staging acres will be constructed with stone. Once construction is complete, all gravel will be removed from temporary access roads and the site will be returned to its original contours and revegetated and reforested appropriately.

Costs associated with this site are identified in Table 10.4 at the end of this section.

Beck Lake Meadow & Floodplain Forest (NER C15 Urban Alt. 8), Des Plaines & Glenview (Plate 34)

Beck Lake Meadow and Floodplain Forest would restore native plant communities of marsh, wet meadow, wet prairie, mesic and dry prairie, wet oak savannah, mesic and dry oak savannah, wet forest, flat woods and open woodland. The hydrology and geomorphology would be naturalized, allowing for restoration and establishment of native plant and animal species over the 1,007 acre site.

The hydrology would be restored by placing drain tile valves at locations across the site. The purpose and methods are the same as those described for Site K47. This restoration site is the floodplain and immediate riparian zone for the Des Plaines River. Once the hydrology is repaired, wetland swales and woodland hollows would flow directly into the Des Plaines River. In addition to identifying and disabling any drain tiles on the site, hydrology would be restored through the removal of invasive and non-native trees. About 479 acres of trees would be removed from prairie, wet sedge meadow, and marsh plots. In addition, non-native trees would be removed from about 330 acres of woodland, furthering hydrologic resurgence, since trees have an impact on draining down the water table.

Topography and geomorphology of the site is for the most part intact. To repair geomorphology to this floodplain complex, various activities would be implemented including drain tile disablement, tree removal, minor grading, and native vegetation reestablishment.

Native vegetation would be restored by repairing hydrology and geomorphology, removing invasive/non-native species, and sowing native seed and live plugs. To remove soil compaction, disking could be implemented or other methods such as alfalfa cropping could be used to both botanically break up the soils and remove nutrients. There may be a need to add organic carbon to the soils in order to establish former plant communities. This would be accomplished through the use of organic leaf litter compost as a soil amendment. Another alternative for soil amendments could be pine sawdust if soils are overly nitrified. The sawdust would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

Non-native tree, shrub, and herbaceous species would be removed over about 396 acres of forest, woodland, and savanna. All other plant communities would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for the site would be to keep invasive plant species from recolonizing, especially during the early stages of site recovery. Once the site becomes more robust with native plant diversity and densities, the upkeep on invasive plant species management should decline.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Dempster Ave Dam Removal (CAP), Des Plaines (Plate 38)

This two foot high run-of-the-river dam would be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation would restore the habitat to a more natural condition.

Historical data indicates that the dam is made of reinforced concrete. Based on completed removals of similar dams along the Des Plaines River, it is expected that the dam will be demolished in-the-wet by driving excavators into the river to perform the work without the use of a coffer dam or water diversion structure.

Clearing and grubbing would be performed only in areas necessary to build temporary access road and staging areas need to access the dams and store construction equipment. The access roads and staging acres will be constructed with stone. Once construction is complete, all gravel will be removed from temporary access roads and the site will be returned to its original contours and revegetated and reforested appropriately.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Lake Mary Anne Pump Station (Comprehensive FPCI01), Maine Township (Plate 21)

Lake Mary Anne Pump Station would link existing storage at Lake Mary Anne and Dude Ranch Pond along the Farmer-Prairie Creek tributary to the mainstem. The pump station and a connector pipe routed under Golf Road would maximize storage capacity and lower flood stages downstream. The pump station would discharge into a pipe routed under Golf Road to Dude Ranch Pond. Additionally, discharge from two existing pumps would be directed to the Dude Ranch Pond through a pipe in the existing right overbank between the pond and the creek.

Two existing outlet pipes collect runoff from the adjacent Interstate 294 and direct flows to Lake Mary Anne. Implementation would include disconnection of these outlets and runoff from the toll way would no longer drain to Lake Mary Anne.

Operations and Maintenance activities at the pump station would include annual inspections and maintenance and removal of any accumulated debris. The pumps would be reconditioned and rehabilitated as needed, approximately every 20 years. The pump station would have a 50 year life expectancy and may require replacement after that time. Gate structures would be inspected annually and repaired or replaced as needed, approximately every 20 years.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Harry Semrow Driving Range Reservoir (NED WLRS04), Des Plaines (Plate 18)

The Harry Semrow Driving Range Reservoir would provide approximately 200 acre-feet of storage. Although the site is located in the Weller Creek Tributary watershed, the site would be connected to the mainstem Des Plaines River through a ditch extending east from the site. The reservoir, along with the Fullerton Woods Reservoir, would reduce stages on the mainstem, preventing increased flood stages that would otherwise be caused by Touhy-Miner Levee, Belmont-Irving Park Levee, and Fullerton-Grand Levee. The 22 acre site, located at Golf Road and Rand Road, is currently the Harry Semrow Driving Range. The reservoir design would allow for continued use of the Driving Range.

The reservoir would be excavated to a depth of 10 feet below grade and a berm would be constructed around the perimeter with a top elevation of 652 feet NAVD88, to establish a total depth of 20 feet. The berm would be constructed from impervious material excavated for the reservoir, covered with six

inches of topsoil, and seeded. The reservoir would be considered a Class III dam in accordance with IDNR regulations (17 IAC 3702), having a capacity more than 50 acre feet with a height greater than 6 feet. Appropriate permits and reporting would be obtained for construction and operations.

Stormwater would be pumped into the reservoir from the Des Plaines River from a intake ditch extending east from the site. After an event, stored water would be discharged through the same ditch by gravity.

Recreation facilities associated with the Driving Range that are impacted by project implementation would be incorporated in the site design and replaced, allowing for a return to use at the end of construction.

Operations and maintenance activities at the reservoir would include annual inspections and control of vegetation through moving, trimming of trees and brush, and removal of any accumulated debris. As needed, the berm would be filled or repaired. The inlet pump station would be regularly inspected and maintained, with reconditioning and rehabilitation as needed, approximately every 20 years. The pump station would have a 50 year life expectancy and may require replacement at that time. Gate structures would be inspected annually and repaired or replaced as needed, approximately every 20 years.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Touhy-Miner Levee (NED DPLV09), Des Plaines (Plate 19)

This 11,200 foot levee and floodwall would protect homes and businesses along the mainstem between Touhy Avenue and Miner Street in the City of Des Plaines. The crest elevation would be two feet above the 1% annual change of exceedance flood elevation. The probability that this levee would not be overtopped during 1% annual chance of exceedance flood event would be greater than 95%. The community may request the Corps to apply to FEMA for accreditation of the levees under the National Flood Insurance Program (NFIP) at the completion of construction. Increased flood stages and damages induced by the levee and floodwall would be mitigated by construction of the Harry Semrow Driving Range Reservoir and Fullerton Woods Reservoir.

The levee/floodwall would extend from Touhy Avenue to Miner Street along the west side of the Des Plaines River. The total length of levee and floodwall would be approximately 3,300 and 7,900 feet, respectively. The earthen levee would have a crest width of 10 feet. The crest of the levee and top of the floodwall range from 633.3 feet NAVD88 at the downstream end (Touhy Avenue) to 634.8 feet NAVD88 at the upstream end (Dempster Avenue). The project would also include two road closure structures where the line of protection crosses Oakton Street and Algonquin Road.

Asphalt trail along the levee alignment from Algonquin Road to Oakton Street would be built to provide recreation opportunities for area residents. The trail would connect to the existing Des Plaines River trail system on the east side of the river.

The levee and floodwall alignment would be inspected annually. Annual maintenance activities at levee segments would include landscaping, control of vegetation, fill and/or repair as needed, control of vermin that could comprise the structure. Toe drains will be inspected regularly and flushed as needed. Annual maintenance activities at floodwall segments would include cleaning and treating the

structure with repairs to waterstops, cracks, railings, and walkways as needed. Road closure structures would be inspected annually and periodic maintenance would include painting, cleaning, and repairs.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Touhy Ave Dam Removal (CAP), Park Ridge (Plate 39)

This two foot high run-of-the-river dam would be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation would restore the habitat to a more natural condition.

Historical data indicates that the dam is made of reinforced concrete. Based on completed removals of similar dams along the Des Plaines River, it is expected that the dam will be demolished in-the-wet by driving excavators into the river to perform the work without the use of a coffer dam or water diversion structure.

Clearing and grubbing would be performed only in areas necessary to build temporary access road and staging areas need to access the dams and store construction equipment. The access roads and staging acres will be constructed with stone. Once construction is complete, all gravel will be removed from temporary access roads and the site will be returned to its original contours and revegetated and reforested appropriately.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Dam #4 Removal (CAP), Park Ridge (Plate 40)

This two foot high run-of-the-river dam would be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation would restore the habitat to a more natural condition.

Historical data indicates that the dam is made of reinforced concrete. Based on completed removals of similar dams along the Des Plaines River, it is expected that the dam will be demolished in-the-wet by driving excavators into the river to perform the work without the use of a coffer dam or water diversion structure.

Clearing and grubbing would be performed only in areas necessary to build temporary access road and staging areas need to access the dams and store construction equipment. The access roads and staging acres will be constructed with stone. Once construction is complete, all gravel will be removed from temporary access roads and the site will be returned to its original contours and revegetated and reforested appropriately.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Belmont-Irving Park Levee (NED DPLV05), Schiller Park (Plate 20)

This 8,400 foot levee and floodwall would protect homes and businesses along the mainstem Des Plaines River in the city of Schiller Park. The crest elevation would be two feet above the 1% annual

chance of exceedance flood elevation. The probability that this levee would not be overtopped during the 1% annual chance of exceedance flood event will be greater than 95%. The community may request the Corps to apply to FEMA for accreditation of the levees under the National Flood Insurance Program (NFIP) at the completion of construction. Increased flood stages and damages induced by the levee and floodwall would be mitigated by construction of the Harry Semrow Driving Range Reservoir and Fullerton Woods Reservoir.

The levee/floodwall would extend along the east side of the Des Plaines River from Irving Park Road to south of Belmont Avenue. The total length of the levee and floodwall sections would be 5,100 and 3,300 feet, respectively. The earthen levee would have a 10 foot crest width. The levee crest and top of the floodwall would be at 629.3 feet NAVD88. The project would also include road closure structures where the line of protection crosses Belmont Avenue and at Irving Park Road and River Road.

The levee and floodwall alignment would be inspected annually. Annual maintenance activities at levee segments would include landscaping and control of vegetation, fill and/or repair as needed, and control of vermin that could comprise the structure. Toe drains would be inspected regularly and flushed as needed. Annual maintenance activities at floodwall segments would include cleaning and treating the structure with repairs to waterstops, cracks, railings, and walkways as needed. Road closure structures would be inspected annually and periodic maintenance would include painting, cleaning, and repairs.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Fullerton-Grand Levee (NED DPLV04), River Grove (Plate 21)

This 6,200 foot levee and floodwall would protect homes and businesses along the mainstem Des Plains River in the city of River Grove. The crest elevation would be two feet above the 1% annual chance of exceedance flood elevation. The probability that this levee will not be overtopped during the 1% annual chance of exceedance flood event would be greater than 95%. The community may request the Corps to apply to FEMA for accreditation of the levees under the National Flood Insurance Program (NFIP) at the completion of construction. Increased flood stages and damages induced by the levee and floodwall would be mitigated by construction of the Harry Semrow Driving Range Reservoir and Fullerton Woods Reservoir.

The levee/floodwall would extend from Franklin Street, north of Grand Avenue, Fifth Avenue at Palmer Street along the east side of River Road. The total length of the levee and floodwall sections would be 3,000 and 3,200, respectively. The earthen levee would have a crest width of 10 feet. The crest of the levee and top of the floodwall would be at 628.4 feet NAVD88. The project would also include a road closure structure where the line of protection crosses Grand Avenue and a road raise at Fifth Avenue and Palmer Street, allowing Fifth Avenue to remain open during a flood event.

The levee and floodwall alignment would be inspected annually. Annual maintenance activities at levee segments would include landscaping and control of vegetation, fill and/or repair as needed, and control of vermin that could comprise the structure. Toe drains would be inspected regularly and flushed as needed. Annual maintenance activities at floodwall segments would include cleaning and treating the structure with repairs to waterstops, cracks, railings, and walkways as needed. Road

closure structures would be inspected annually and periodic maintenance would include painting, cleaning, and repairs.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Fullerton Woods Reservoir (NED DPRS04), River Grove (Plate 22)

The Fullerton Woods Reservoir would provide approximately 150 acre-feet of storage. The 30 acre site is located south of River Road between First and Fifth Avenues in River Grove. The reservoir, in combination with the Harry Semrow Driving Range Reservoir, would reduce stages on the mainstem preventing increased flood stages that would otherwise be caused by Touhy-Miner Levee, Belmont-Irving Park Levee, and Fullerton-Grand Levee. The site would also be used for recreation. A parking area, picnic facilities, and asphalt trails would be incorporated into the design, providing for seasonal use of the site by area residents. Stormwater will be pumped into the reservoir from the Des Plaines River through an intake pipe. After an event, stored water would be discharged by gravity.

The reservoir would be excavated to a depth of 611.5 feet NAVD88 and a berm surrounding the reservoir would be constructed to a height of 635 feet NAVD88. The height of berm would range from four to twelve feet above the surrounding area. The berm would be constructed from impervious material excavated for the reservoir, covered with six inches of topsoil, and seeded. The reservoir would be considered a Class III dam in accordance with IDNR regulations (17 IAC 3702), having a capacity more than 50 acre feet with a height greater than 6 feet. Appropriate permits and reporting would be obtained for construction and operations.

Operations and Maintenance activities at the reservoir would include annual inspections and control of vegetation through moving, trimming of trees and brush, and removal of any accumulated debris. As needed the berm would be filled and/or repaired. The inlet pump station would also be regularly inspected and maintained, with reconditioning and rehabilitation as needed, approximately every 20 years. The pump station would have a 50 year life expectancy and may require replacement at that time. Gate structures would be inspected annually and repaired or preplaced as needed, approximately every 20 years.

Costs associated with this project are identified in Table 10.4 at the end of this section.

First Avenue Bridge Modification (Comprehensive DPBM04), River Grove (Plate 23)

The First Avenue Bridge crossing the mainstem Des Plaines River, which currently overtops during a 50% annual chance of exceedance (2-year) flood event, would be raised above the 1% annual chance of exceedance (100-year) flood elevation and provide greater conveyance capacity under the roadway. The site would be designed to prevent adverse impacts to surrounding structures.

First Avenue is a four lane highway with a design speed of 65 MPH, as documented in the as-built drawings for the existing roadway. The existing bridge is constructed from concrete with 3.5 feet deep beams and a 7.5 inch slab. Due to the high traffic volume, 2,501 vehicles per hour and 25,010 vehicles per day, traffic maintenance would be required during construction. The reconstruction would be performed in stages, with at least two lanes are open to traffic at all times.

The design pavement elevation for the bridge modification is 629.1 ft NAVD88. Existing storm drainage lines and inlets would be evaluated and the inlets would be raised as appropriate. Traffic signals at the intersection of River Rd and First Ave would also be evaluated and raised as appropriate.

Operation and maintenance of the roadway would continue according to current IDOT practices. The embankments would be inspected annually and filled and/or repaired as needed. Maintenance activities would include control of vegetation, debris removal, and cleaning and repair of retaining walls and culverts.

Costs associated with this project are identified in Table 10.4 at the end of this section.

Groveland Avenue Levee (CAP DPLV01), Riverside (Plate 24)

The existing Groveland Avenue levee would be extended horizontally to tie back the structure to high ground and vertically to provide additional protection to apartments and residences between Park and Pine Avenues. Two feet would be added to the existing levee height, with the levee tying in to existing high ground at elevation 618 ft NAVD88. The probability that this levee would not be overtopped during a 100 year flood event would be greater than 95%. The community may request the Corps to apply to FEMA for accreditation of the levees under the National Flood Insurance Program (NFIP) at the completion of construction.

The height of the existing levee at Groveland Avenue would be increased using a sheet pile wall along the levee, extending approximately 870 feet. At the north end, approximately 1,250 feet of Park Lane and Lincoln Avenue would be raised to connect the levee to high ground. At the south end of the existing levee, a floodwall would extend approximately 700 feet south from Forest Avenue to tie in to high ground, with a road closure structure connecting the segments at Forest Avenue.

The levee and floodwall alignment would be inspected annually. Annual maintenance activities at levee segments would include landscaping and control of vegetation, fill and/or repair as needed, control of vermin that could comprise the structure. Toe drains would be inspected regularly and flushed as needed. Annual maintenance activities at floodwall segments would include cleaning and treating the structure with repairs to waterstops, cracks, railings, and walkways as needed. Road closure structures would be inspected annually with and periodic maintenance would include painting, cleaning, and repairing the gates.

Costs associated with this project are identified in Table 10.4.

Cook County Non-structural (NED Plan and Comprehensive Plan Increment)

The incrementally justified non-structural component of the NED plan in Cook County would protect homes and businesses through a variety of measures. The non-structural measures would be implemented at structures at risk of flooding in the communities of Buffalo Grove, Rosemont, Des Plaines, Wheeling, Unincorporated Wheeling Township and Unincorporated Leyden Township. The measure implemented at each site will be determined according to the feasibility and cost-effectiveness of implementation determined through a site specific evaluation of the structure. Implementation of non-structural measures at individual properties would be voluntary and dependant on verification of structure characteristics and first floor elevations. With regard to the buyouts, to the

extent practicable, acquisition would be on a willing seller basis, but eminent domain could be utilized when determined to be warranted.

The measures considered for implementation include:

- Elevation – the usable area raised above flood elevations
- Dry floodproofing – modifications prevent floodwaters from entering the structure
- Wet floodproofing – modifications to allow floodwaters to flow through the structure
- Fill/removal of basement in combination with floodproofing – any utilities located in basements would be relocated to a new addition elevated above flood elevations and the basement would be filled and removed from use. Any flood damages above the first floor elevation would be addressed through floodproofing.
- Nonstructural berm – a low berm or floodwall encircling a structure or group of structures preventing flood damage
- Buyouts – removal of the structure from the floodplain was considered for structures where no other measures were feasible and significant damages occur during the 1% annual chance of exceedance flood event

A group of homes located in the floodway in the City of Des Plaines were identified for buyout and evacuation. Recreation trails constructed on the evacuated lands would connect to the existing Des Plaines River trail network.

Additional non-structural measures in Cook County are along portions of streams that do not meet the minimum flow criteria for USACE participation in FRM measures (800 cfs during the 10% annual change of exceedance flood event). Implementation of these measures in Buffalo Grove and Leyden Township are therefore recommended for implementation by local FRM authorities as part of the Comprehensive Plan. Costs associated with non-structural measures included in the NED/NER Plan as well as the additional structures included only in the Comprehensive Plan are identified in Table 10.4.

Table 10.4 – Cook County Estimated Costs ($1,000)

Project	Plan	Preliminary LERRDs[1]	Construction	PED	Construction Mgmt [2]	Total First Costs	Annual OMRR&R
C09	NED/NER						
Dam #1	CAP						
Dam #2	CAP						
C15	NED/NER						
Dempster Ave Dam	CAP						
WLRS04	NED/NER						
DPLV09	NED/NER						
Touhy Ave Dam	CAP						
Dam #4	CAP						
DPLV05	NED/NER						
DPLV04	NED/NER						
DPRS04	NED/NER						
DPLV01	CAP						
Non-Structural	NED/NER						
Non-Structural (Comp)	Comprehensive						
FPCI01	Comprehensive						
DPBM04	Comprehensive						
Total Cook County Comprehensive Plan							
Total Cook County NED/NER Plan							
Total Cook County CAP Plan							

[1] Includes Lands & Damages and Relocations
[2] Includes Construction Management, Monitoring, and Adaptive Mgmt

(FY2015 Price Level)

Ecosystem Restoration Measure Quantities

The ecosystem restoration plans will provide significant habitat to the Upper Des Plaines River watershed. Table 10.5 presents a summary of the measures to be implemented at each site. As shown in the table, thousands of feet of stream and acres of habitat will be restored.

Table 10.5 – Ecosystem Restoration Site Measure Quantities

Measure	Unit[1]	Site						
		K47	K41	L43	L39	L31	C09	C15
stream remeander	FT	9,400	8,500	0	0	0	0	0
bank grading 20:1	FT	9,400	8,500	0	0	0	0	0
swale grading	FT	10	30	0	0	0	0	0
cobble riffles	EA	2,500	0	0	0	0	0	0
fill ditch	FT	1,619	689	892	393	475	0	0
drain tile survey	AC	1,619	689	892	393	475	811	670
drain tile valves	AC	253	0	34	168	516	811	670
tree & understory thinning	AC	251	23	69	0	15	330	396
tree removal	AC	150	48	252	129	203	479	428
herbaceous management	AC	1,619	689	1,578	429	698	0	36
native plant establishment	AC	9	0	241	38	80	811	862
open water	AC	545	81	280	81	400	14	56
basin marsh	AC	101	130	0	0	0	26	50
side stream marsh	AC	0	0	166	15	20	160	0
sedge meadow	AC	247	2	87	49	12	93	320
wet prairie	AC	53	45	0	34	26	103	36
mesic/dry prairie	AC	76	65	0	0	0	94	0
wet savanna	AC	83	59	112	112	51	11	85
mesic/dry savanna	AC	0	0	0	0	5	165	17
floodplain forest	AC	3	8	22	22	73	0	0
wet forest	AC	69	154	5	5	0	122	263
flat woods	AC	434	145	664	664	33	0	0
open woodland	AC	0	0	0	0	0	25	35

[1] Units are presented in feet (FT), each (EA), and acres (AC).

10.2 Benefits Summary

Each element of the Recommended Plan was incrementally justified according to the plan purpose. The plan formulation and evaluation process are detailed in Section 4 (Flood Risk Management Plan Formulation) and Section 5 (Ecosystem Restoration Plan Formulation). Table 10.6, summarizes the benefits for each of the plans developed in this study.

Table 10.6 – Summary of Plan Benefits

Formulated Plan	Net Benefits
Comprehensive Plan. Includes 8 structural Flood Risk Management projects – FPCI01, DPLV09, DPLV05, DPLV04, DPRS04, WLRS04, DPBM04, DPLV01 – and non-structural measures in 13 communities in Cook, Lake and Kenosha Counties and 12 Ecosystem Restoration projects – K47, K41, L43, L39, L31, C09, C15, and five dam removals.	$8,636,000 NED net benefits 9,115 NER net HUs
NED/NER Plan Includes 5 structural Flood Risk Management projects – DPLV09, DPLV05, DPLV04, DPRS04, WLRS04 – and non-structural measures in 9 communities in Cook and Lake Counties and 7 ecosystem restoration projects –K47, K41, L43, L39, L31, C09, C15.	$4,641,000 NED net benefits 9,034 NER net HUs
CAP Plan Includes 1 structural Flood Risk Management project – DPLV01 – and 5 Ecosystem Restoration projects – removal of Dam #1, Dam #2, Dam #4, Touhy Ave Dam, and Dempster Ave Dam.	$193,000 NED net benefits 81 NER net HUs

(FY2015 Price Level, FDR 3.755%)

10.3 Design and Construction Considerations

Additional Studies Needed

Additional, focused studies are needed at the beginning of the design phase to ensure that adequate data are available for future design work and for plans and specifications development. The specific studies needed include:

- ***Hydrologic and Hydraulic Modeling*.** Stream restoration and dam removal features would require information for proper placement of in-stream structures and alignment of new stream channel and floodplain. Updated modeling of structural FRM projects will be conducted to ensure that the projects do not cause adverse flooding impacts. This modeling will also be completed in order to obtain State Floodway and Dam Removal Permits.
- ***Drain Tile and Hydrology Mapping*.** Drain tile surveys would entail finding the location and condition of all drain tiles within previous and current agriculture fields. Once the drain tiles are located and mapped, temporary valves would be placed strategically to allow hydrology to temporarily resurge in order to obtain an understanding of where the water will come back and how much. This will be utilized for planting schemes.
- ***Hydrology and Water Budgets*.** These include studies that determine if disabling drain tiles and ditches would have flooding effects outside of the project footprint. Also,

evapotranspiration and groundwater infiltration rates could be calculated for incidental floodwater retention and native vegetation restoration.

- ***Floristic Surveys*.** Site assessments and floristic surveys would include but not be limited to locating trees and shrubs and/or invasive species to be removed, verifying areas to be seeded and special areas of flora diversity to be preserved.
- ***In Depth Subsurface Investigation*.** Initial subsurface investigations were completed at several, but not all, sites to gather general information about the soils on site which assisted in the estimates for constructing new structures. Additional data is required to develop a final design. An average of 3 soil borings per 1,000 ft of levee/reservoir perimeter is the minimum amount recommended.
- ***Value Engineering and Future Work.*** Any large project represents multiple opportunities for innovation and cost savings, and this project is no exception. Although a Value Engineering (VE) study for the Recommended Plan was completed during the feasibility phase, VE studies for each feature of the plan will be conducted during the design phase. The VE study will be conducted in coordination with the Chicago District VE Coordinator.

10.4 Real Estate

The estimates for lands and damages were prepared by an appraiser. Projects that are likely to include utility relocations include an estimate for that cost. Two levee projects, DPLV01 and DPLV04, include road raise elements that are also included in the relocation estimate. For measures such as reservoirs resulting in significant spoils, disposal areas are included as part of the conceptual site plan. A Real Estate Plan has been developed to refine these assumptions and is included as Appendix I. The estimated costs are summarized in Table 10.7. These costs are subject to change.

Table 10.7 – Estimated LERRD Values

Program	Site ID	Site Name	County	Preliminary Lands & Damages[1]	Relocations[2]	Total Preliminary LERRDs
CAP 205	DPLV01	Groveland Ave Levee	Cook			
FRM	DPRS04	Fullerton Woods Reservoir	Cook			
	DPLV04	Fullerton-Grand Levee	Cook			
	DPLV05	Belmont-Irving Park Levee	Cook			
	WLRS04	Harry Semrow Driving Range	Cook			
	DPLV09	Touhy-Miner Levee	Cook			
	NSC	Cook County Non-Structural	Cook		-	
	NSL	Lake County Non-structural	Lake		-	
CAP 206	DR1	Dam #1 Removal	Cook		-	
	DR2	Dam #2 Removal	Cook		-	
	DRD	Dempster Ave Dam Removal	Cook		-	
	DRT	Touhy Ave Dam Removal	Cook		-	
	DR4	Dam #4 Removal	Cook		-	
ER	C09	Northbrook Marsh	Cook		-	
	L43	Red Wing Slough and Deer Lake Wetland Complex	Lake		-	
	C15	Beck Lake Meadow	Cook		-	
	L39	Pollack Lake and Hastings Creek Riparian Wetlands	Lake		-	
	L31	Gurnee Woods Riparian Wetland	Lake		-	
	K41	Dutch Gap Forested Floodplain	Kenosha		-	
	K47	Bristol Marsh	Kenosha		-	
Non-USACE	FPCI01	Lake Mary Anne Pump Station	Cook			
	DPBM04	First Avenue Bridge Modification	Cook			
	NSC (Comp)	Cook County Non-Structural (Comprehensive Plan)	Cook		-	
	NSK	Kenosha County Non-structural (Comprehensive Plan)	Kenosha		-	
Total Cost						

[1] Preliminary Lands and Damages estimate includes estimated value, administrative costs, and a cost contingency.
[2] Relocation costs include facility and utility relocations.

(FY2015 Price Level)

10.5 Operation and Maintenance

Site specific preliminary estimates of OMRR&R requirements were developed for both FRM and ER Plan elements. Requirements vary by the type of measure being implemented at the site. Table 10.8 presents the preliminary OMRR&R requirements for each type of measure. Based on these requirements and site specific considerations such as size and location, costs were developed for each site as detailed in Table 10.10. A detailed OMRR&R plan will be developed during the PED phase. The non-Federal sponsors will be responsible for OMRR&R as outlined in each site's plan.

The Dam Removal sites would not require OMRR&R. Implementation of the five dam removals involves removing the existing structures. Once they are removed, there would be no structure to operate or maintain. Monitoring at these sites, as with all ER sites, is part of implementation. Monitoring costs, however, are a shared Federal and non-Federal responsibility and are included in project costs.

OMRR&R of structures retrofitted by means of non-structural FRM measures shall be the responsibility of the individual property owner(s). Elevated and wet floodproofed structures, would typically have no additional costs to the property owner beyond normal maintenance requirements. Dry floodproofed structures would require normal maintenance of the structure as well as periodic inspection, maintenance and repair (if required) of the waterproof barrier and associated features and equipment such as closures, interior drainage, pumps, check valves and emergency generator or power supply. Nonstructural berms would require periodic inspection, maintenance and repair (if required) of the levee structure, including mowing and vegetation control, as well as maintenance and repair of associated features and equipment such as closures, interior drainage, pumps, check valves, and emergency generator or power supply. Costs associated with operation, maintenance, and repair of these dry floodproofed structures and nonstructural berms would be nominal. The non-Federal sponsors shall be responsible for conducting periodic inspections and floodplain management of sites and structures in the project area to ensure that use of mitigated properties comply with the Project Partnering Agreement (PPA), Floodproofing Agreement, restrictions on the property, the floodplain management plan, zoning regulations, and building codes. Project inspection and floodplain management activities are standard FRM project requirements and will incur minor costs.

The proposed levees would be entered into the Corps levee safety program and recorded in the National Levee Database (NLD). At the completion of construction, an initial periodic inspection would be performed to document the design and construction of the levee and to serve as a baseline report. The levee would also be screened into the Corps Levee Screening Tool. In addition, upon request of the community with O&M responsibility for the levee, the Corps would prepare a Levee System Evaluation for the National Flood Insurance Program to recommend FEMA to accredit the levee as part of remapping the floodplain and obtain relief from required flood insurance for the areas behind the levees.

All structural FRM features would be inspected regularly under the Inspection of Completed Works program to ensure they are being properly maintained and remain eligible for assistance under PL84-99 if any damage occurs during flood events.

Table 10.8 – Preliminary OMRR&R Requirements

Measure	OMRR&R Requirements
Ecosystem Restoration	Burning
	Mowing
	Invasive species control (herbaceous and woody)
	Additional Seeding to Build Species Richness
Dam Removal	No OMRR&R required
Reservoirs	Inspection
	Mowing
	Fill/Repair
	Debris and sediment removal
	Tree & brush trimming
	Pump station inspection & maintenance
	Pump station reconditioning/rehabilitation & replacement
	Gate inspection & maintenance
	Gate repair & replacement
Levees	Inspection
	Debris removal
	Fill/Repair
	Landscaping & vermin control
	Toe drain inspection & flushing
	Access road maintenance & repair
	Pump Station Inspection & Maintenance
	Pump station reconditioning/rehab & replacement
Floodwalls	Inspection
	Cleaning/Treating
	Repair to waterstops, cracks, railings & walkways
Road Raises	Inspection
	Debris Removal
	Embankment & retaining wall fill/repair
	Landscaping
	Culvert cleaning/flushing/repair
Elevation[1]	Maintain property and comply with property restrictions
	Floodplain management & enforcement of property restrictions by non-Federal sponsor
Wet Floodproofing[1]	Maintain property and comply with property restrictions
	Floodplain management & enforcement of property restrictions by non-Federal sponsor
Dry Floodproofing[1]	Maintain property and comply with property restrictions
	Periodic inspection of the retrofit features/equipment
	Maintain & repair waterproof barrier, closures, pumps, check valves, & emergency generator/power supply
Nonstructural Berm[1]	Floodplain management & enforcement of property restrictions by non-Federal sponsor
	Maintain property and comply with property restrictions
	Periodic inspection of berm to ensure structural integrity
	Maintain and repair berm structure, mowing and vegetation control
	Maintain & repair closures, pumps, check valves, & emergency generator/power supply
	Floodplain management and enforcement of property restrictions non-Federal sponsor

[1] OMRR&R at properties where non-structural FRM measures have been constructed is the responsibility of the individual property owner. The non-Federal sponsor is responsible for ensuring that the homeowner continues to comply with the terms of the floodproofing agreement.

Table 10.9 – Estimated Major OMRR&R Costs by Activity

Measure		Major OMRR&R Requirements	Recurrence Interval	Approx Unit Cost	Unit
Ecosystem Restoration		Burning & mowing	3 years	[redacted]	AC
		Invasive species control (herbaceous)	annual	[redacted]	AC
		Invasive species control (woody)	2 years	[redacted]	AC
		Additional seeding to build species richness	5 years	[redacted]	AC
Reservoirs	General	Perimeter inspection	annual	[redacted]	MI
		Mowing, debris, and sediment removal	annual	[redacted]	AC
		Tree & brush trimming	2 years	[redacted]	AC
		Fill/repair	5 years	[redacted]	MI
	Pump Station	Quarterly inspection and semi-annual report	semi-annual	[redacted]	YR
		Clean, oil, grease and maintain pump and gates	annual	[redacted]	EA
		Electrical supply	annual	[redacted]	YR
		Recondition/rehab pump, repair & replace gates	20 years	[redacted]	EA
		Replace pump	50 years	[redacted]	EA
Levees & Floodwalls	Levees & Overflow Embankments	Inspection	2 years	[redacted]	MI
		Fill/Repair	5 years	[redacted]	MI
		Tree & brush removal/trimming	5 years	[redacted]	MI
		Debris removal, litter control, vermin control	annual	[redacted]	MI
		Inspect toe drains	5 years	[redacted]	MI
		Flush toe drains	10 years	[redacted]	EA
		Regrade access roads	annual	[redacted]	MI
		Repair access roads	5 years	[redacted]	MI
		Survey access roads	10 years	[redacted]	MI
	Floodwalls	Inspection (per foot of height)	2 years	[redacted]	MI
		Clean and treat concrete (per foot of height)	10 years	[redacted]	MI
		Repair waterstops (replace 70%)	20 years	[redacted]	MI
		Repair cracks on walkways	10 years	[redacted]	MI
	Closure Structures	Inspect and clean	annual	[redacted]	EA
		Repair	6 years	[redacted]	EA
	Interior Drainage	Quarterly inspection and semi-annual report	semi-annual	[redacted]	YR
		Clean, oil, grease and maintain pump and gates	annual	[redacted]	EA
		Electrical supply	annual	[redacted]	YR
		Recondition/rehab pump, repair and replace gates	20 years	[redacted]	EA
		Replace pump	50 years	[redacted]	EA
Road Raises		Inspection	2 years	[redacted]	MI
		Fill/repair	5 years	[redacted]	MI
		Debris removal, litter control, vermin control	annual	[redacted]	MI
		Tree & brush removal/trimming	5 years	[redacted]	MI

(FY2014 Price Level)

Table 10.10 – Estimated OMRR&R Costs by Project

Site ID	Site Name	Purpose	Plan	County	Est. Annual OMRR&R
DPLV01	Groveland Ave Levee	FRM	CAP	Cook	[redacted]
	CAP 205 Total				[redacted]
DPRS04	Fullerton Woods Reservoir	FRM	NED/NER	Cook	[redacted]
DPLV04	Fullerton-Grand Levee	FRM	NED/NER	Cook	[redacted]
DPLV05	Belmont-Irving Park Levee	FRM	NED/NER	Cook	[redacted]
WLRS04	Harry Semrow Driving Range	FRM	NED/NER	Cook	[redacted]
DPLV09	Touhy-Miner Levee	FRM	NED/NER	Cook	[redacted]
NSC	Cook County Non-Structural	FRM	NED/NER	Cook	[redacted]
NSL	Lake County Non-structural	FRM	NED/NER	Lake	Nominal
	NED Plan Total				[redacted]
DR1	Dam #1 Removal	ER	CAP	Cook	$0
DR2	Dam #2 Removal	ER	CAP	Cook	$0
DRD	Dempster Ave Dam Removal	ER	CAP	Cook	$0
DRT	Touhy Ave Dam Removal	ER	CAP	Cook	$0
DR4	Dam #4 Removal	ER	CAP	Cook	$0
	CAP 206 Total				**$0**
C09	Northbrook Marsh	ER	NED/NER	Cook	[redacted]
L43	Red Wing Slough and Deer Lake Wetland	ER	NED/NER	Lake	[redacted]
C15	Beck Lake Meadow	ER	NED/NER	Cook	[redacted]
L39	Pollack Lake and Hastings Creek Riparian	ER	NED/NER	Lake	[redacted]
L31	Gurnee Woods Riparian Wetland	ER	NED/NER	Lake	[redacted]
K41	Dutch Gap Forested Floodplain	ER	NED/NER	Kenosha	[redacted]
K47	Bristol Marsh	ER	NED/NER	Kenosha	[redacted]
	NER Plan Total				[redacted]
FPCI01	Lake Mary Anne Pump Station	FRM	Comprehensive	Cook	[redacted]
DPBM04	First Avenue Bridge Modification	FRM	Comprehensive	Cook	[redacted]
NSC(Comp)	Cook County Non-Structural (Comprehensive)	FRM	Comprehensive	Cook	Nominal
NSK	Kenosha County Non-structural (Comprehensive)	FRM	Comprehensive	Kenosha	Nominal
	Non-USACE Total				[redacted]
	Comprehensive Plan Total				[redacted]

(FY2014 Price Level, FDR 3.5%)

10.6 Ecosystem Restoration Monitoring and Adaptive Management

Section 2039 of WRDA 2007 directs the Secretary of the Army to ensure, that when conducting a feasibility study for a project (or component of a project) under the Corps ecosystem restoration mission, that the recommended project includes a monitoring plan to measure the success of the ecosystem restoration. The implementation guidance for section 2039 requires a contingency or adaptive management plan in case the desired outputs/ results are not achieved during or after initial construction. This monitoring and adaptive management plan shall include a description of the monitoring activities, the criteria for success, and the estimated cost and duration of the monitoring as

well as specify that monitoring will continue until such time as the Division Commander determines that the success criteria have been met.

The adaptive management plan must be appropriately scoped to the scale of the project. The information generated by the monitoring plan will be used by the District in consultation with the Federal and State resources agencies and the MSC to guide decisions on operational or structural changes that may be needed to ensure that the ecosystem restoration project meets the success criteria.

An effective monitoring program is necessary to assess the status and trends of ecological health and biota richness and abundance on a per project basis, as well as to report on regional program success within the United States. Assessing status and trends includes both spatial and temporal variations. Gathered information under this monitoring plan will provide insights into the effectiveness of current restoration projects and adaptive management strategies, and indicate where goals have been met, if actions should continue, and/or whether more aggressive management is warranted.

Monitoring the changes at a project site is not always a simple task. Ecosystems, by their very nature, are dynamic systems where populations of macroinvertebrates, fish, birds, and other organisms fluctuate with natural cycles. Water quality also varies, particularly as seasonal and annual weather patterns change. The task of tracking environmental changes can be difficult, and distinguishing the changes caused by human actions from natural variations can be even more difficult. This is why a focused monitoring protocol tied directly to the planning objectives needs to be followed.

A monitoring and adaptive management plan is included as Appendix M. The plan accounts for monitoring the structural sustainability and biological response of the ecosystem restoration projects and provides a preliminary estimate of the level of effort required for the monitoring. During the design phase, a monitoring and adaptive management plan specific to each project will be developed.

Adaptive management measures are not the same as typical operation and maintenance activities. These measures are response actions to changes that adversely affect how the system was predicted to respond. Because they are adaptive to unknown future events, there are no absolute measures that can be defined prior to the issue arising. However, general concerns and examples of adaptive management processes can be identified at this stage. The primary concerns for this project is the success of the fluvial manipulation, primarily the remeandering of the stream channel, and the success of the native plantings. Once final designs are complete, potential adaptive management needs can be predicted. Primary concerns and examples are outlined in Appendix M. This is necessary since the adaptive management measures will need to be based upon final feature designs and predicted adverse responses.

11 Recommendation

This study tentatively recommends authorization of the NED/NER Plan. Sites that could reasonably be implemented under the CAP will be converted to that program for implementation as individual projects in accordance with ER 1105-2-100, Appendix F, paragraph F-8.c. Sites that are only included in the Comprehensive Plan are recommended for implementation by others.

11.1 Cost of Recommended Plan

A summary of the estimated cost of the NED/NER Plan and the CAP Plan and the cost sharing responsibilities for each site is presented in Table 11.1. Total project costs includes implementation; planning, engineering and design; construction management; and LERRDs. For ecosystem restoration sites only, the construction management costs include monitoring and adaptive management. All costs underwent a Cost and Schedule Risk Analysis and were certified by the Walla Walla Cost Engineering Mandatory Center of Expertise.

Section 11 Recommendation
January 2015

Table 11.1 – Summary of Project Costs

				Implementation					Lands, Easements, Relocations, Rights-of-way and Disposal Areas				
Program	**ID**	**Site Name**	**County**	**Construction**	**Recreation Features**	**Planning, Engineering, and Design**	**Construction Management[1]**	**Total**	**Lands & Damages**	**Relocations**	**Total**	**Total Project Cost[2]**	**Annual OMRR&R[3]**
CAP 205	DPLV01	Groveland Ave Levee	Cook	[redacted]									
		CAP 205 TOTAL											
FRM	DPRS04	Fullerton Woods Reservoir	Cook										
	DPLV04	Fullerton-Grand Levee	Cook										
	DPLV05	Belmont-Irving Park Levee	Cook										
	WLRS04	Harry Semrow Driving Range[1]	Cook										
	DPLV09	Touhy-Miner Levee	Cook										
	NSC	Cook County Non-Structural	Cook										
	NSL	Lake County Non-structural	Lake										
		NED PLAN TOTAL											
CAP 206	DR1	Dam #1 Removal	Cook										
	DR2	Dam #2 Removal	Cook										
	DRD	Dempster Ave Dam Removal	Cook										
	DRT	Touhy Ave Dam Removal	Cook										
	DR4	Dam #4 Removal	Cook										
		CAP 206 TOTAL											
ER	C09	Northbrook Floodplain and Riparian Complex	Cook										
	L43	Red Wing Slough and Deer Lake Wetland Complex	Lake										
	C15	Beck Lake Meadow and Floodplain Forest	Cook										
	L39	Pollack Lake and Hastings Creek Riparian	Lake										
	L31	Gurnee Woods Riparian Wetland	Lake										
	K41	Dutch Gap Forested Floodplain	Kenosha										
	K47	Bristol Marsh	Kenosha										
		NER PLAN TOTAL											
Non-USACE	FPCI01	Lake Mary Anne Pump Station	Cook										
	DPBM04	First Avenue Bridge Modification	Cook										
	NSC(Comp)	Cook County Non-Structural (Comprehensive Plan)	Cook										
	NSK	Kenosha County Non-Structural	Kenosha										
		NON-USACE TOTAL											
		TOTAL COST											

[1] Construction management includes monitoring and adaptive management for ER sites.

[2] Total project cost includes total implementation costs and total LERRD values.

[3] OMRR&R is a non-Federal responsibility.

(FY2015 Price Level)

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11.2 Federal and Non-Federal Responsibilities

Each site in the Recommended Plan will be cost shared between the Federal government and the non-Federal sponsors, with a minimum 35% contribution from the non-Federal sponsors as required by ER 1105-2-100, Planning Guidance Notebook. The estimated Federal and non-Federal share for the NED/NER and CAP Plans are detailed in Table 11.2 and Table 11.3.

For structural FRM sites, the non-Federal sponsors must provide a minimum cash contribution equal to 5 percent of total project costs allocated to structural FRM projects, as well as all LERRDs determined by the Government to be required for the project. If the sum of the sponsor's total cash and LERRD contributions is less than 35 percent of the costs assigned to FRM, the non-Federal sponsors will pay the difference in cash. If it is greater than 35 percent, total non-Federal costs shall not exceed 50 percent of total project costs assigned to flood control. Contributions in excess of 50 percent will be reimbursed by the Federal Government to the non-Federal sponsors, subject to the availability of funds. For non-structural FRM sites, there is no minimum non-Federal cash contribution and where LERRDs are more than 35% of total project costs, an agreement between the sponsor and the Federal Government on the most efficient and practical means for acquiring the excess LERRDs is required. (See ER 1105-2-100, Appendix E, Paragraphs E-21 a and b)

For Ecosystem Restoration sites, the non-Federal sponsors must provide a minimum 35% contribution in LERRDs, cash, or work-in-kind. Per ER 1105-2-100, LERRD contributions in excess of 35% of the total project cost, are to be reimbursed by the Federal government, subject to the availability of funds. However, EP 1165-2-502, Ecosystem Restoration - Supporting Policy Information, states that, as a general rule, land value should not exceed 25% of the total project cost. (See ER 1105-2-100, Appendix E, Paragraph E-31 and EP 1165-2-502, Paragraph 7m).

Due to the urban nature of the study area, land values are high and LERRDs for recommended ecosystem restoration projects exceed the 25% target set by EP 1165-2-502. The ecosystem restoration plans have been formulated so that only lands necessary to implement the project are included in the project requirements. The estimated value of all LERRD has been considered in comparison of alternatives for plan selection. The non-Federal sponsors for the ecosystem restoration projects have indicated in their Letters of Intent that they have voluntarily agreed to waive reimbursement for any LERRD value above 35% of the total project cost. The preliminary estimate of LERRD reimbursements that would be waived is $3,776,000.

Prior to initiation of the PED phase, the Federal government and the non-Federal sponsors will execute a PED agreement. The LERRDs and OMRR&R of the project will be the responsibility of the non-Federal sponsors for the proposed project. The costs, LERRD values, and OMRR&R costs provided above are estimated and are likely to change.

Table 11.2 – NED/NER Plan Cost Sharing Summary ($1,000)

Item	Federal Cost	Non-Federal Cost	Total Cost
Structural Flood Risk Management (FRM)			
Planning, Engineering, and Design	[redacted]	[redacted]	[redacted]
Construction Management	[redacted]	[redacted]	[redacted]
LERRD	[redacted]	[redacted]	[redacted]
Flood Risk Management Features (Structural)	[redacted]	[redacted]	[redacted]
Subtotal	[redacted]	[redacted]	[redacted]
Structural FRM Subtotal	[redacted]	[redacted]	[redacted]
Non-Structural Flood Risk Management (FRM)			
Planning, Engineering, and Design	[redacted]	[redacted]	[redacted]
Construction Management	[redacted]	[redacted]	[redacted]
LERRD	[redacted]	[redacted]	[redacted]
Flood Risk Management Features	[redacted]	[redacted]	[redacted]
Subtotal	[redacted]	[redacted]	[redacted]
Non-Structural FRM Subtotal	[redacted]	[redacted]	[redacted]
Ecosystem Restoration (ER)			
Planning, Engineering, and Design	[redacted]	[redacted]	[redacted]
Construction Management	[redacted]	[redacted]	[redacted]
LERRD	[redacted]	[redacted]	[redacted]
Ecosystem Restoration Features	[redacted]	[redacted]	[redacted]
Subtotal	[redacted]	[redacted]	[redacted]
ER Subtotal	[redacted]	[redacted]	[redacted]
Recreation			
Planning, Engineering, and Design	[redacted]	[redacted]	[redacted]
Construction Management	[redacted]	[redacted]	[redacted]
LERRD	[redacted]	[redacted]	[redacted]
Recreation Features	[redacted]	[redacted]	[redacted]
Subtotal	[redacted]	[redacted]	[redacted]
Recreation Subtotal	[redacted]	[redacted]	[redacted]
Total Project Costs	[redacted]	[redacted]	[redacted]

(FY2015 Price Level)

Table 11.3 – CAP Plan Cost Sharing Summary ($1,000)

Item	Federal Cost	Non-Federal Cost	Total Cost
Structural Flood Risk Management (FRM)			
Planning, Engineering, and Design			
Construction Management			
LERRD			
Flood Risk Management Features			
Subtotal			
FRM Subtotal			
Ecosystem Restoration (ER)			
Planning, Engineering, and Design			
Construction Management			
LERRD			
Restoration Features			
Subtotal			
ER Subtotal			
Total Project Costs			

(FY2015 Price Level)

Federal implementation of the recommended project would be subject to the non-Federal sponsors agreeing to comply with applicable Federal laws and policies, including but not limited to:

a. Provide a minimum of 35 percent, but not to exceed 50 percent of total flood damage reduction costs as further specified below:

   1. Provide the required non-Federal share of design costs allocated by the Government to flood damage reduction in accordance with the terms of a design agreement entered into prior to commencement of design work for the flood damage reduction features;

   2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to flood damage reduction;

   3. Provide, during construction, a contribution of funds equal to 5 percent of total flood damage reduction costs;

   4. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the flood damage reduction features;

   5. Provide, during construction, any additional funds necessary to make its total contribution for flood damage reduction equal to at least 35 percent of total flood damage reduction costs;

b. Provide 35 percent of total ecosystem restoration costs as further specified below:

   1. Provide the required non-Federal share of design costs allocated by the Government to ecosystem restoration in accordance with the terms of a design agreement entered into prior to commencement of design work for the ecosystem restoration features;

   2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to ecosystem restoration;

   3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the ecosystem restoration features;

   4. Provide, during construction, any additional funds necessary to make its total contribution for ecosystem restoration equal to 35 percent of total ecosystem restoration costs;

c. Provide 50 percent of total recreation costs as further specified below:

   1. Provide the required non-Federal share of design costs allocated by the Government to recreation in accordance with the terms of a design agreement entered into prior to commencement of design work for the recreation features;

   2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to recreation;

   3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the recreation features;

   4. Provide, during construction, any additional funds necessary to make its total contribution for recreation equal to 50 percent of total recreation costs;

d. Provide, during construction, 100 percent of the total recreation costs that exceed an amount equal to 10 percent of the sum of the Federal share of total flood damage reduction costs and the Federal share of total ecosystem restoration costs;

e. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;

f. Not less than once each year, inform affected interests of the extent of protection afforded by the flood damage reduction features;

g. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;

h. Comply with Section 402 of the WRDA of 1986, as amended (33 U.S.C.701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of the flood damage reduction features;

i. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood damage reduction features;

j. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the flood damage reduction features afford, reduce the outputs produced by the ecosystem restoration features, hinder O&M of the project, or interfere with the project's proper function;

k. Shall not use the ecosystem restoration features or lands, easements, and rights-of-way required for such features as a wetlands bank or mitigation credit for any other project;

l. Keep the recreation features, and access roads, parking areas, and other associated public use facilities, open and available to all on equal terms;

m. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C.4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

n. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

o. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

p. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

q. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

r. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C.2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C.3141- 3148 and 40 U.S.C.3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C.276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C.327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C.276c et seq.);

s. Perform, or ensure performance of, any 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), Public Law 96-510, as amended (42 U.S.C.9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

t. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

u. Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and

v. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C.1962d-5b), and Section 103(j) of the WRDA of 1986, Public Law 99-662, as amended (33 U.S.C.2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

11.3 Plan Effects and Accomplishments

The NED/NER Plan and the CAP Plan will provide ecosystem restoration, FRM, recreation, and incidental water quality benefits.

The ecological restoration portion of the NED/NER Plan would provide 9,115 net habitat units. Hydrology would be improved by filling an estimated 4,000 feet of unnatural ditch along with hundreds of thousands of feet of drain tiles dismantled. Natural stream sinuosity would be restored increasing the total length. Over 6,800 acres of native community types would be restored including: marsh (668 acres), sedge meadow (810 acres), prairie (532 acres), savanna (700 acres), woodland (1,450 acres) and forest (1,000 acres). This ecosystem restoration plan cumulatively increases the quality of watershed ecosystem communities by 32% of what currently exists.

The FRM portion of the NED/NER Plan would provide $4,641,000 net benefits through the implementation of two (2) reservoirs, three (3) levee/floodwall, and an array of non-structural components in Cook and Lake Counties of Illinois. Minor ecological improvements resulting from the NED plan include reducing the flashiness of the Des Plaines River watershed and water quality improvements.

The CAP Plan would provide $193,000 NED net benefits through implementation of one levee/floodwall and 81 net habitat units by restoring aquatic habitat. Five dams would be removed on the mainstem Des Plaines River, opening up a 16-mile stretch of the mainstem river.

Along with direct and indirect effects of each site, cumulative effects of the NED/NER Plan and CAP Plan were assessed. There have been numerous effects to resources from past and present actions, and reasonably foreseeable future actions can also be expected to produce both beneficial and adverse affects. In this context, the increments of effects from the proposed project are relatively minor. Assessment of cumulative effects indicates that long-term healing of the Upper Des Plaines River watershed resources is dependent on implementation of the preferred alternative plans; however, it will take considerable time for counties, municipalities and local organizations to continue to repair and mitigate losses caused by past hydrologic and ecologic adverse effects aside from this proposed plan. Based on the expectation of continued sustainability of all resources, and the magnitude of the watershed circumstances, cumulative effects are not considered significant or adverse.

11.4 Plan Implementation

11.4.1 Implementation Priority

Implementation priority will be established by site purpose and program. The four programs under which these project falls are the CAP Section 205 FRM; Specifically Authorized FRM; CAP Section 206 ER; and Specifically Authorized ER. Table 11.4 shows the implementation with projects grouped by program. Flood risk management sites will be implemented from highest net benefits to lowest, taking into consideration compensatory storage requirements for levees. Ecosystem restoration sites will be implemented according to the plan shown below. This plan assumes that all funding and Lands, Easements, Rights-of-Way, Relocations, and Disposal Areas (LERRDs) needed to accomplish each project would be provided prior to construction and that LERRD acquisition for subsequent projects would be ongoing.

Table 11.4 – Project Implementation Plan

Program	Site ID	Project	Engineering and Design Start	Real Estate Acquisition Start	Construction Start	Construction Completion
CAP 205	DPLV01	Groveland Avenue Levee	10/2014	4/2015	10/2016	10/2018
FRM	DPRS04	Fullerton Woods Reservoir	10/2014	10/2017	4/2018	4/2020
	DPLV04	Fullerton-Grand Levee	10/2016	10/2017	10/2019	10/2021
	DPLV05	Belmont-Irving Park Levee	10/2016	10/2017	10/2019	10/2021
	WLRS04	Harry Semrow Driving Range Reservoir	10/2019	10/2019	10/2020	10/2022
	DPLV09	Touhy-Miner Levee	10/2020	10/2018	10/2021	10/2023
		Cook County Non-structural	10/2017	10/2017	10/2019	10/2025
		Lake County Non-structural	10/2017	10/2017	10/2019	10/2025
CAP 206		Dam Removal #1	10/2017	12/2017	6/2018	12/2018
		Dam Removal #2	4/2018	12/2018	6/2019	12/2019
		Dempster Ave Dam Removal	4/2019	12/2019	6/2020	12/2020
		Touhy Ave Dam Removal	10/2020	12/2020	6/2021	12/2021
		Dam #4 Removal	10/2021	12/2021	6/2022	12/2022
ER	C09	North Brook Marsh	10/2017	4/2022	10/2023	10/2028
	L43	Red Wing Slough & Deer Lake Wetland Complex	4/2018	4/2026	10/2026	10/2031
	C15	Beck Lake Meadow and Floodplain Forest	4/2019	4/2024	10/2025	10/2030
	L39	Pollack Lake & Hastings Creek Riparian Wetlands	10/2019	4/2019	10/2019	10/2024
	L31	Gurnee Woods Riparian Wetland	10/2022	4/2021	10/2021	10/2026
	L05	Grainger Woods Floodplain Forest	10/2024	4/2022	10/2022	10/2027
	K41	Dutch Gap Forested Floodplain	10/2026	10/2024	10/2027	10/2032
	K47	Bristol Marsh	10/2027	10/2025	10/2028	10/2033
Non-USACE	FPCI01	Lake Mary Anne Pump Station	10/2014	4/2015	10/2015	10/2017
	DPBM04	First Avenue Bridge Modification	10/2014	4/2015	10/2015	10/2017
		Cook County Non-structural (Comprehensive Plan)	10/2017	10/2017	10/2019	10/2025
		Kenosha County Non-structural	10/2017	10/2017	10/2019	10/2025

11.4.2 Non-Federal Sponsors

Implementation will be accomplished by multiple non-Federal sponsors. The study's non-Federal sponsors plan to sponsor the implementation of the portions of the Recommended Plan that fall within their jurisdiction, along with other state and local agencies. The following agencies have submitted or plan to submit letters stating their intent to act as non-Federal sponsors for implementation of projects in the Recommended Plan as listed below along with financial self-certifications indicating that they would be able to finance the non-Federal portion of the costs: DNR, MWRDGC, the City of Des Plaines, FPDCC, LCFPD, and Kenosha County. The specific projects to be sponsored by each agency are summarized in Table 11.5.

In addition to providing letters of intent, each non-Federal sponsor has provided a self-certification of financial capability signed by the chief financial officer or equivalent of the sponsor. The letters clearly state that the sponsor understand the partnership requirements.

Table 11.5 – Non-Federal Sponsors

Program	Site ID	Project	Non-Federal Sponsor(s)
CAP 205	DPLV01	Groveland Avenue Levee	IDNR, MWRDGC
FRM	DPRS04	Fullerton Woods Reservoir	IDNR, MWRDGC, FPDCC[1]
	DPLV04	Fullerton-Grand Levee	IDNR, MWRDGC
	DPLV05	Belmont-Irving Park Levee	IDNR, MWRDGC
	WLRS01	Harry Semrow Driving Range Reservoir	IDNR, MWRDGC, Des Plaines
	DPLV09	Touhy-Miner Levee	INDR, MWRDGC, Des Plaines[1]
	NSC	Cook County Non-structural	IDNR, Des Plaines[1]
	NSL	Lake County Non-structural	IDNR
CAP 206	DR1	Dam Removal #1	FPDCC, IDNR
	DR2	Dam Removal #2	FPDCC, IDNR
	DRD	Dempster Ave Dam Removal	FPDCC, IDNR
	DRT	Touhy Ave Dam Removal	FPDCC, IDNR
	DR4	Dam #4 Removal	FPDCC, IDNR
ER	C09	North Brook Marsh	FPDCC
	C15	Beck Lake Meadow and Floodplain Forest	FPDCC
	L43	Red Wing Slough & Deer Lake Wetland Complex	LCFPD
	L39	Pollack Lake & Hastings Creek Riparian Wetlands	LCFPD
	L31	Gurnee Woods Riparian Wetland	LCFPD
	K41	Dutch Gap Forested Floodplain	Kenosha County
	K47	Bristol Marsh	Kenosha County

[1] FPDCC will be the sponsor of the recreation features at Fullerton Woods Reservoir. The City of Des Plaines with be the sponsor of the recreation features at Touhy-Miner Levee at for trails associated with non-structural floodway buyouts in Des Plaines.

11.4.3 Environmental Assessment

See Effects Assessment in Section 9. Final assessment is pending public review of the EA.

11.4.4 Public/Other Agency Views and Comments

Public scoping meetings for Phase II of the Upper Des Plaines River project were held in June 2002 at Bristol, WI (4 June at Kenosha County Center); at Grayslake, IL (5 June at Byron Colby Barn at Prairie Crossing); and at Des Plaines, IL (6 June at Oakton Community College Business Center). The evening meetings included a slide show, public comment opportunity, and question-answer session; the agency panel included staff from the USACE, IDNR, WDNR, Cook County Highway Department, LCSMC, and Kenosha County Planning & Development.

To date, assistance from agencies in terms of providing reports, studies, technical support, endangered species lists, etc has been completed. Appendix L is a collection of coordination letters to date with Federal, State and Local agencies. Through the NEPA process and 30-day public review the Feasibility Report and EA, public and agency coordination will be finalized.

11.4.5 Permits Required

Section 404 of the Clean Water Act – Since the projects identified under this study are all USACE Civil Works, a 404 Permit is not required. All projects proposed under the preferred plan would comply with the regulations and statutes set forth in Section 404 of the Clean Water Act. There are no outstanding reasons to believe that Section 404 would not be in compliance for any given project, seeing that they all restore the environment and subsequently water quality, or they beneficially quell those adverse water quality affects associated with unnatural flooding. A preliminary 404(b)(1) analysis has been completed for the Recommended Plan, in Appendix L. However, each feature that requires 404 compliance would complete a Section 404(b)(1) analysis and provide the information on a per project basis during the design phase to regulating agencies. No project requiring 404 compliance would begin construction without the analysis completed.

Section 401 of the Clean Water Act – All projects proposed under the preferred plan would comply with the regulations and statutes set forth in Section 401 of the Clean Water Act. There are no outstanding reasons to believe that 401Water Quality (WQ) Certification would not be granted for any given project, seeing that they all restore the environment and subsequently water quality, or they beneficially quell those adverse water quality affects associated with unnatural flooding. Each project that requires 401 WQ Certification would complete appropriate applications and provided information on a per project basis during the design phase. No project requiring 401 WQ Certification would begin construction without the certification issued.

Floodway Construction Permitting – All projects proposed under the preferred plan that involve construction in a regulatory floodway would comply with the rules set forth in 17 Ill. Adm. Code, Chapter I, Part 3708 (Floodway Construction in Northeastern Illinois). There are no outstanding reasons to believe that floodway construction permits would not be granted for any given project, seeing that one of the major objectives of the projects is to reduce flood risk. Every project that requires a floodway construction permit would complete appropriate engineering analysis and permit applications during the design phase. This information would be provided to the IDNR, OWR on a per

project basis unless the project qualified for a statewide or regional permit. No project requiring a floodway construction permit would begin construction without the permit issued.

Dam Removal Permitting: All dam removal projects proposed under the preferred plan would comply with the rules set forth 17 Ill. Adm. Code, Chapter I, Part 3702, Construction, Operation, and Maintenance of Dams. There are no outstanding reasons to believe that dam removal permits would not be granted for any given project, seeing that coordination with IDNR-OWR will occur during studies and the development of permit applications as recommended by the regulatory agency. Every project that requires a dam removal permit would complete appropriate engineering analysis and permit applications during the design phase. This information would be provided to IDNR-OWR on a per project basis. No project requiring a dam removal permit would begin construction without the permit issued.

Roadway Permitting: Any work performed within the IDOT Right-of-Way (ROW) requires a Highway Permit from IDOT. During the design phase, IDOT requires review of the proposed design plans and specifications. Coordination is required to ensure that all comments are adequately addressed prior to completion of the design. Permitting requirements include completion of the Highway Permit Form (BT-1045), Individual Highway Permit Bond Form (BT-1046) to include the owner's and contractor's signatures, and a bond in the amount of $1,000,000 submitted by the contractor.

Utility Coordination: Similar to the City of Chicago Office of Underground Coordination utility review requirements, some local municipalities require review of the proposed design for possible impacts to utilities. Local municipalities will be contacted to determine their requirements for addressing utility impacts.

11.5 Recommendation

I have considered all significant aspects of the problems and opportunities as they relate to the Flood Risk Management and Ecosystem Restoration in the watershed of the Upper Des Plaines River and its tributaries in the overall public interest. Those aspects include environmental, social, and economic effects, as well as engineering feasibility.

I recommend the approval and implementation of the NED/NER Plan as described above and the conversion of sites included in the CAP Plan to that program for implementation under appropriate authorities. These plans will provide FRM, ecosystem restoration, recreation, and incidental water quality benefits. The estimated cost for implementation of all elements of the NED/NER Plan is [redacted] with [redacted] for the NER portion and [redacted] for the NED portion. The estimated cost for implementation of all elements of the CAP Plan is [redacted].

Corps ecosystem restoration policy requires that land acquisition in ecosystem restoration plans be kept to a minimum. Project proposals that consist primarily of land acquisition are not appropriate. As a target, land value should not exceed 25 percent of total project costs. Projects with land costs exceeding this target level are not likely to be given a high priority for budgetary purposes.

This plan is being recommended with such modifications thereof as in the discretion of the Commander of the US Army Corps of Engineers may be advisable. The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Secretary of the Army as proposals for authorization and implementation funding. However, the non-Federal interests, the State of Illinois, interested Federal agencies, and other parties will be advised of any modification and will be afforded an opportunity to comment further.

In accordance with the NEPA of 1969 and Section 122 of the River and Harbor and Flood Control Act of 1970, the U.S. Army Corps of Engineers (Chicago District) has assessed the environmental impacts associated with this project. The purpose of this Environmental Assessment is to evaluate the impacts that would be associated with the preferred plan.

The assessment process indicates that this project would not cause significant effects on the quality of the human environment in the areas of construction and have only beneficial impacts upon the ecological, biological, social, cultural, or physical resources of the Upper Des Plaines River watershed as a whole. The findings indicate 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 is not required.

_____

Christopher T. Drew
Colonel, U.S. Army
District Commander

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13 Acronyms and Abbreviations

AAD	Average Annual Damages
AFB	Alternative Formulation Briefing
ASTM	American Society for Testing and Materials
ATR	Agency Technical Review
BCR	Benefit to Cost Ratio
BMP	Best Management Practices
CCHD	Cook County Highway Department
CE	Cost Effective
CELRB	USACE Buffalo District
CELRC	USACE Chicago District
CELRL	USACE Louisville District
CELRN	USACE Nashville District
CEMVR	USACE Rock Island District
CENWW	USACE Walla Walla District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMAP	Chicago Metropolitan Agency for Planning
C:N	Carbon to Nitrogen
CPI-U	Universal Consumer Price Indices
C-SELM	Chicago – South End of Lake Michigan Urban Water Damage Study
CSO	Combined Sewer Overflow
CWA	Clean Water Act
DNR	Department of Natural Resources
DFAL	Diverse Fish and Aquatic Life
DFIRM	Digital Flood Insurance Rate Maps
DO	Dissolved Oxygen
DP	Dissolved Phosphorus
EAD	Equivalent Annual Damages
ECO PCX	National Ecosystem Planning Center of Expertise
EGM	Engineering Guidance Memorandum
EOP	Environmental Operating Principle
EPA	Environmental Protection Agency
ER	Ecosystem Restoration
ERDC	Engineer Research and Development Center
E-Team	Interagency Ecosystem Assessment Team
FCI	Functional Capacity Index
FCU	Functional Capacity Units
FEMA	Federal Emergency Management Agency
FPDCC	Forest Preserve District of Cook County
LCFPD	Lake County Forest Preserve District
FQI	Floristic Quality Index
FRM	Flood Risk Management
FRM PCX	Flood Risk Management Planning Center of Expertise
FWOP	FWOP Conditions
FWP	Future With Project

GIS	Geographic Information Systems
HAZUS	FEMA Hazard Data
HCB	Hexachlorobenzene
HEC-1	USACE Hydrologic Engineering Center hydrologic model
HEC-2	USACE Hydrologic Engineering Center hydraulic model
HEC-FDA	Hydrologic Engineering Center Flood Damage Analysis Model
HEC-RAS	Hydrologic Engineering Center River Analysis System
HEP	Habitat Evaluation Procedure
HGM	Hydrogeomorphic Assessment
HSI	Habitat Suitability Index
HQUSACE	U.S. Army Corps of Engineers Headquarters
HTRW	Hazardous, Radioactive and Toxic Waste
HUs	Habitat Units
IBI	Index of Biotic Integrity
ICA	Incremental Cost Analysis
IDNR	Illinois Department of Natural Resources
IDNR-OWR	Illinois Department of Natural Resources-Office of Water Resources
IDOT	Illinois Department of Transportation
IEMA	Illinois Emergency Management Agency
IEPA	Illinois Environmental Protection Agency
INAI	Illinois Natural Areas of Inventory
ISWS	Illinois State Water Survey
IWR	Institute for Water Resources
LCFPD	Lake County Forest Preserve District
LCDOT	Lake County Department of Transportation
LCSMC	Lake County Stormwater Management Commission
LER	Lands, Easements, and Rights-of-way
LERRDs	Lands, Easements, Right-of-Way, Relocations, and Disposal Areas
LIDAR	Light Detection and Ranging
LRR	Limited Reevaluation Report
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NFIP	National Flood Insurance Program
NIPC	Northern Illinois Planning Commission
NAVD 1988	North American Vertical Datum 1988
NGVD 1929	National Geographic Vertical Datum 1929
NPDES	National Pollution Discharge Elimination System
NRCS	National Resources Conservation Service
O&M	Operation and Maintenance
OMRR&R	Operation, Maintenance, Repair, Rehabilitation and Replacement
P&G	Principles & Guidelines
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenals
PED	Preconstruction Engineering and Design
PDT	Project Delivery Team

P.L.	Public Law
PPA	Project Partnership Agreement
QHEI	Qualitative Habitat Evaluation Index
SC-RB	Separable Cost-Remaining Benefit
SCS	Soil Conservation Service
SEWRPC	Southeastern Wisconsin Regional Planning Commission
SI	Suitability Index
SMC	Stormwater Management Commission
TDS	Total Dissolved Solids
TP	Total Phosphorus
TS	Total Solids
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VISTA	Visual Interactive System for Transportation Algorithms
WDNR	Wisconsin Department of Natural Resources
WQ	Water Quality