Upper Des Plaines River and Tributaries, Illinois and Wisconsin

Integrated Feasibility Report and Environmental Assessment

August 2013 (Draft)

Study Partnership

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

US Army Corps of Engineers®
Chicago District

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I. 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 484 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 69 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 of Lake County in Illinois and Kenosha and Racine Counties in Wisconsin, land use changes have impacted the entire study area. 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 (Phase I Study) formulated plans to address severe overbank flooding along the Upper Des Plaines River. Two particularly severe events in 1986 and 1987, together causing over $100 million in damages, prompted initiation of the study. Federal interest in flood risk management 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, if all projects are built, 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 Water Resources Development Act (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 in the Upper Des Plaines River watershed and the degraded watershed ecosystem. 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 are the primary purposes of the study. Secondary purposes are improving water quality and enhancing recreational opportunities throughout the basin. 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 significant flood risk of overbank flooding exists in the watershed and that the aquatic ecosystem is degraded. Expected annualized without project condition flood damages across the watershed for the fifty year period of analysis total $54,932,000. Approximately 39,000 acres of natural areas were evaluated for this study. Several communities types were evaluated – prairie, savanna, woodland, isolated wetlands, and floodplain wetlands.

The need for additional flood risk management 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.

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, and road raises and non-structural measures such as floodproofing and elevating structures were evaluated individually to determine whether they were economically justified. Justified sites were then combined to form an incrementally justified plan, optimizing benefits throughout the watershed. To develop the ER plan, open 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 any competition between the 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, discussed below, are tentatively recommended by this study: an NED/NER Plan, a CAP Plan, and a Full Plan. A National Economic Development/National Ecosystem Restoration (NED/NER) plan is tentatively recommended for congressional authorization. Projects that could reasonably be implemented under the Continuing Authorities Program (CAP) are recommended for conversion to that program for implementation. Other features which are economically justified but not policy compliant, are included in the Full Plan and are recommended for implementation by the appropriate state and local agencies.

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 (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 measures such as road raises for the sole purpose of addressing flood induced road closures have not traditionally been included in the USACE mission. 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 "Full Plan" – this is the plan that includes all economically justified flood risk management features and cost-effective restoration features evaluated during the course of the study, regardless of policy compliance or implementation authority.

The Full Plan is the most inclusive plan and includes 26 features as shown in Table I.1. All of the sites shown in the table below would be included in the Full Plan. The plan includes 18 ecosystem restoration projects – 13 ecosystem restoration sites and 5 dam removals – and 10 Flood Risk Management projects – 1 floodwater storage reservoir, 4 levees/floodwalls, 1 road raise, 1 modification to an existing structure, and 3 non-structural flood risk management plans (non-structural measures to be implemented in Kenosha, Lake, and Cook Counties). Features in the Full Plan that are not compliant with current USACE policy, and therefore not included in the CAP or NED/NER Plans, 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 flood risk management or transportation agencies.

A "CAP Plan," shown in Table I.2, has also been identified that includes all policy compliant, separable features that are economically justified (for flood risk management features) or cost-effective (for restoration features) and of such scope that they could reasonably be implemented under the USACE Continuing Authorities Program (CAP). This program allows USACE to plan, design, and construct smaller projects using existing program authorities provided by Congress. Small Flood Risk Management 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 Water Resources Development Act of 1996, as amended. Individual features of the CAP Plan are recommended for implementation by USACE under these existing authorities.

The policy compliant features that could reasonably be implemented under CAP are included in the CAP Plan. This plan includes: 7 Ecosystem Restoration Projects – 5 dam removals and 2 ecosystem restoration site – and 1 Flood Risk Management project – a levee/floodwall. Features included in the CAP Plan will be converted to this program upon approval by the Division Engineer.

Policy compliant features that are economically justified (for flood risk management features) or cost-effective (for restoration features) 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," shown in Table I.3. This plan, upon approval by the Chief of Engineers, will be recommended for specific authorization by Congress.

There are 16 separable features in the NED/NER Plan. The features of this plan include: 12 ecosystem restoration sites and 6 Flood Risk Management projects – 1 floodwater storage reservoir, 3 levee/floodwall, and 2 non-structural flood risk management plans (non-structural measures to be implemented in Lake, and Cook Counties). The NED/NER Plan will be recommended for Congressional authorization.

Overall, the cumulative impact of the flood risk management project is beneficial economically, environmentally and socially. The proposed full plan would restore over 10,900 acres of native community types including: marsh (2,850 acres), meadow (808 acres), prairie (2,491 acres), savanna (1,048 acres), woodland (2,912 acres) and forest (805 acres), and restore natural hydrology by filling an estimated 13,400 feet of unnatural ditch along with disabling hundreds of thousands of feet of agricultural drain tiles. These measures would provide approximately 27,222 net average annual habitat units (AAHU). The flood risk management features of the proposed Full Plan would provide $9,702,000 in annual net economic benefits in the watershed.

The NED/NER Plan would provide $6,039,000 in annual net economic benefits and 26,573 net AAHU. The CAP Plan would provide $157,000 in annual net economic benefits and 649 net AAHU. Minor ecological improvements resulting from the FRM plans include reducing the flashiness of the Des Plaines River watershed and minor water quality improvements. The proposed floodwater storage site would impact habitat by inundating or excavating existing natural areas. However, these impacts will be mitigated through the restoration of marsh and wet prairie habitat at nearby sites.

The total costs for the NED/NER Plan and CAP plan, along with the Federal and non-Federal shares, are presented in Table I.4. Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) 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 tentatively selected flood risk management and ecosystem restoration plans is presented in Table I.5.

Table I.1 – Full Plan

Site ID	Site Name	Purpose	Measure	Municipality	Total First Cost ($1,000)	Annual OMRR&R ($1,000)
Racine County, WI						
R04	Mt. Pleasant Wet Prairie	ER	Restoration	Sturtevant	[redacted]	[redacted]
Kenosha County, WI						
K09	Somers Marsh	ER	Restoration	Somers	[redacted]	[redacted]
K33	Paris Wet Prairie	ER	Restoration	Union Grove	[redacted]	[redacted]
K47	Bristol Marsh	ER	Restoration	Bristol	[redacted]	[redacted]
K41	Dutch Gap Forested Floodplain	ER	Restoration	Pikesville	[redacted]	[redacted]
--	Kenosha County Non-structural	FRM	Non-structural	Various	[redacted]	[redacted]
Lake County, IL						
L41	Dutch Gap Aquatic Complex	ER	Restoration	Antioch	[redacted]	[redacted]
L43	Red Wing Slough & Deer Lake Wetland Complex	ER	Restoration	Antioch	[redacted]	[redacted]
L39	Pollack Lake &Hastings Creek Riparian Wetlands	ER	Restoration	Antioch	[redacted]	[redacted]
L33	Mill Creek Riparian Woodland	ER	Restoration	Old Mill Creek	[redacted]	[redacted]
L31	Gurnee Woods Riparian Wetland	ER	Restoration	Wadsworth	[redacted]	[redacted]
L05	Granger Woods Floodplain Forest	ER	Restoration	Mettawa	[redacted]	[redacted]
ACRS08	Aptakisic Creek Reservoir	FRM	Reservoir	Buffalo Grove	[redacted]	[redacted]
--	Lake County Non-structural	FRM	Non-structural	Gurnee	[redacted]	[redacted]
Cook County, IL						
C09	Northbrook Marsh	ER	Restoration	Wheeling	[redacted]	[redacted]
--	Dam #1 Removal	ER	Dam Removal	Wheeling	[redacted]	[redacted]
--	Dam #2 Removal	ER	Dam Removal	Des Plaines	[redacted]	[redacted]
C15	Beck Lake Meadow	ER	Restoration	Des Plaines/ Glenview	[redacted]	[redacted]
--	Dempster Ave Dam Removal	ER	Dam Removal	Des Plaines	[redacted]	[redacted]
FPCI01	Lake Mary Anne Pump Station	FRM	Structure Mod.	Maine	[redacted]	[redacted]
DPLV09	Ashland-Fargo Levee	FRM	Levee/Floodwall	Des Plaines	[redacted]	[redacted]
--	Touhy Ave Dam Removal	ER	Dam Removal	Park Ridge	[redacted]	[redacted]
--	Dam #4 Removal	ER	Dam Removal	Park Ridge	[redacted]	[redacted]
DPLV05	Belmont Irving Park Levee	FRM	Levee/Floodwall	Schiller Park/Franklin Park	[redacted]	[redacted]
DPLV04	Fifth Canadian National Levee	FRM	Levee/Floodwall	River Grove	[redacted]	[redacted]
DPBM04	First Ave Bridge Modification	FRM	Bridge Mod.	River Grove	[redacted]	[redacted]
DPLV01	Groveland Ave Levee	FRM	Levee	Riverside	[redacted]	[redacted]
--	Cook County Non-structural	FRM	Non-structural	Various	[redacted]	[redacted]

Table I.2 – CAP Plan

Site ID	Site Name	Purpose	Measure	Municipality	Total First Cost ($1,000)	Annual OMRR&R ($1,000)
Lake County, IL						
L33	Mill Creek Riparian Woodland	ER	Restoration	Old Mill Creek	[redacted]	[redacted]
L05	Granger Woods Floodplain Forest	ER	Restoration	Mettawa	[redacted]	[redacted]
Cook County, IL						
--	Dam #1 Removal	ER	Dam Removal	Wheeling	[redacted]	[redacted]
--	Dam #2 Removal	ER	Dam Removal	Des Plaines	[redacted]	[redacted]
--	Dempster Ave Dam Removal	ER	Dam Removal	Des Plaines	[redacted]	[redacted]
--	Touhy Ave Dam Removal	ER	Dam Removal	Park Ridge	[redacted]	[redacted]
--	Dam #4 Removal	ER	Dam Removal	Park Ridge	[redacted]	[redacted]
DPLV01	Groveland Ave Levee	FRM	Levee	Riverside	[redacted]	[redacted]

Table I.3 – NED/NER Plan

Site ID	Site Name	Purpose	Measure	Municipality	Total First Cost ($1,000)	Annual OMRR&R ($1,000)
Racine County, WI						
R04	Mt. Pleasant Wet Prairie	ER	Restoration	Sturtevant	[redacted]	[redacted]
Kenosha County, WI						
K09	Somers Marsh	ER	Restoration	Somers	[redacted]	[redacted]
K33	Paris Wet Prairie	ER	Restoration	Union Grove	[redacted]	[redacted]
K47	Bristol Marsh	ER	Restoration	Bristol	[redacted]	[redacted]
K41	Dutch Gap Forested Floodplain	ER	Restoration	Pikesville	[redacted]	[redacted]
Lake County, IL						
L41	Dutch Gap Aquatic Complex	ER	Restoration	Antioch	[redacted]	[redacted]
L43	Red Wing Slough & Deer Lake Wetland Complex	ER	Restoration	Antioch	[redacted]	[redacted]
L39	Pollack Lake &Hastings Creek Riparian Wetlands	ER	Restoration	Antioch	[redacted]	[redacted]
L31	Gurnee Woods Riparian Wetland	ER	Restoration	Wadsworth	[redacted]	[redacted]
ACRS08	Aptakisic Creek Reservoir	FRM	Reservoir	Buffalo Grove	[redacted]	[redacted]
--	Lake County Non-structural	FRM	Non-structural	Gurnee	[redacted]	[redacted]
Cook County, IL						
C09	Northbrook Marsh	ER	Restoration	Wheeling	[redacted]	[redacted]
C15	Beck Lake Meadow	ER	Restoration	Des Plaines/ Glenview	[redacted]	[redacted]
DPLV09	Ashland-Fargo Levee	FRM	Levee/Floodwall	Des Plaines	[redacted]	[redacted]
DPLV05	Belmont Irving Park Levee	FRM	Levee/Floodwall	Schiller Park/Franklin Park	[redacted]	[redacted]
DPLV04	Fifth Canadian National Levee	FRM	Levee/Floodwall	River Grove	[redacted]	[redacted]
--	Cook County Non-structural	FRM	Non-structural	Various	[redacted]	[redacted]

Table I.4 – NED/NER and CAP Plans: Total Costs

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

Table I.5 – Summary of Annualized Costs and Benefits

		Full Plan	NED/NER Plan	CAP Plan
Flood Risk Management	First Cost	[redacted]	[redacted]	[redacted]
	Annualized OMRR&R	[redacted]	[redacted]	[redacted]
	Total Annualized Cost	$5,510,000	$4,332,000	$275,000
	Annual Benefits	$15,213,000	$10,371,000	$432,000
	Net Benefits	$9,702,000	$6,039,000	$157,000
	BCR	2.8	2.4	1.6
Ecosystem Restoration	First Cost	[redacted]	[redacted]	[redacted]
	Annualized OMRR&R	[redacted]	[redacted]	[redacted]
	Total Annualized Cost	$14,644,645	$13,853,055	$837,890
	Net Habitat Units	27,222	26,572	649

1 Study Overview

1.1 Introduction

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

Section 1 – Study Overview
Section 2 – Planning Overview
Section 3 – Study Area Inventory and Forecast
Section 4 – Flood Risk Management
Section 5– Ecosystem Restoration
Section 6 – Combined FRM/ER Plans
Section 7 – Water Quality
Section 8 – Recreation
Section 9 – Environmental Assessment
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Appendix A – Hydrology & Hydraulics
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Appendix H – HTRW Report
Appendix I – Real Estate
Appendix J – Value Engineering Study
Appendix K – External Peer Review
Appendix L – Coordination
Appendix M – Monitoring Plan
Appendix N – Clean Air Act General Conformity Analysis

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 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 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 flood risk management 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 Upper Des Plaines River and Tributaries, Illinois and Wisconsin Feasibility Study (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 study authorization directs the Secretary to develop plans that also address environmental restoration and protection, water quality, recreation, and related purposes.

The Phase II Study has two primary purposes: further reduction of flooding along the mainstem and tributaries, and environmental restoration of degraded ecosystems within the basin. Secondary purposes are improving water quality and enhancing recreational opportunities throughout the basin. The study will consider sites located within tributary watersheds and along the mainstem for both Flood Risk Management (FRM) and Ecosystem Restoration (ER) potential. The effects of FRM sites within tributary watersheds on mainstem flooding will also be 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 broader group of stakeholders, interested parties and resource agency personnel who advise the non-federal entities of the Project Delivery Team (PDT). Participants in the Advisory Committee include 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), 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 are acting as non-federal sponsors with the USACE for this study. The partnering agencies are the Illinois Department of Natural Resources (IDNR), Cook County Highway Department (CCHD), Lake County Stormwater Management Commission (LCSMC), and Kenosha County, Wisconsin. A Feasibility Cost Sharing Agreement was signed between the sponsors and the USACE in 2002.

As the Alliance has agreed, 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 flood risk management 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 goals 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 484 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 69 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, represented by the noted members of the 113th U.S. Congress: WI-1 (Ryan-R) and IL-8 (Duckworth-D), IL-10 (Schneider-D), IL-6

(Roskam-R), IL-9 (Schakowsky-D), IL-5 (Quigley-D), IL-4 (Gutierrez-D), IL-14 (Hultgren-R) and IL-7 (Davis-D) as shown in Plate 2.

1.1.5 Prior Studies and Reports

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.

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 hydraulic conditions of the Upper Des Plaines River and its tributaries.

The Illinois Department of Transportation Office of Water Resources (now the Illinois Department of Natural Resources 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 Department of Water Resources; *Report on the Regulations of Construction within the Floodplain of the Des Plaines River, Cook and Lake Counties*; 1978.

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 Illinois Department of Natural Resources) conducted a number of studies investigating natural resources in the Upper Des Plaines River watershed:

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

<u>Soil Conservation Service/Natural Resources Conservation Service</u>

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:

- Soil Conservation Service and Metropolitan Water Reclamation District of Greater Chicago; *Floodwater Management Plan, Des Plaines River*; 1976.
- Soil Conservation Service and Illinois Division of Water Resources; *Flood Hazard Analysis, Des Plaines River Tributaries*; 1981.
- Soil Conservation Service, Metropolitan Water Reclamation District of Greater Chicago, and Illinois Division of Water Resources; *Final Watershed Plan and Environmental Impact Statement, Lower Des Plaines Tributaries Watershed*; 1985 and 1987.
- Soil Conservation Service, Metropolitan Water Reclamation District of Greater Chicago, and Illinois Division of Water Resources; *Lower Des Plaines Tributaries Watershed, Floodplain Information Maps and Profiles*; 1987.

Regional and Local Organizations

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

- Metropolitan Water Reclamation District of Greater Chicago; *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.
- Lake County Stormwater Management Commission; *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 Lake County Stormwater Management Commission is conducting several studies investigating opportunities for ecological restoration in the study area:

- Lake County Stormwater Management Commission; *Des Plaines River Wetland Restoration Study – DRAFT;* 2000. This report, funded by a USEPA Region 5 Grant, prioritizes wetland restoration opportunity sites in Lake County and assesses flood flow reduction possibilities.
- Lake County Stormwater Management Commission and Northeastern Illinois Planning Commission; *Des Plaines Water Resources Action Strategy*. This report outlines multi-objective action priorities for watershed restoration.
- Lake County Stormwater Management Commission; *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.
- Lake County Stormwater Management Commission; 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.
- Lake County Stormwater Management Commission; *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 Southeastern Wisconsin Regional Planning Commission has conducted several studies investigating restoration opportunities in the Wisconsin portion of study area and has collected comprehensive rainfall and groundwater data:

- Southeastern Wisconsin Regional Planning Commission; *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.
- Southeastern Wisconsin Regional Planning Commission; *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.
- Southeastern Wisconsin Regional Planning Commission; *Community Assistance Planning Report No. 66, A Park and Open Space Plan for the City of New Berlin*; 2003. This report was led to the development of a new plan for a part 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.
- Southeastern Wisconsin Regional Planning Commission; *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.
- Southeastern Wisconsin Regional Planning Commission; *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.

1.1.6 USACE Authorized Projects

Six flood risk management projects within the Upper Des Plaines River watershed were authorized by Section 419 of the Water Resources Development Act (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

Further discussion of the Phase I projects can be found in Section 4.2.2.1.

A levee for flood risk management at North Libertyville Estates was constructed as authorized under Section 205 of the Continuing Authorities Program. 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. A mitigation plan is being implemented to mitigate for the loss of habitat for the levee construction.

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 will be 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 Project Delivery Team which conducts the actual work of the study. The Project Delivery Team 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	
	U.S. Army Corps of Engineers, Chicago District (USACE)
	Illinois Department of Natural Resources (IDNR)
	Lake County Stormwater Management Commission (LCSMC)
	County of Cook, Illinois
	County of Kenosha, Wisconsin
Advisory Groups	
	Wisconsin Department of Natural Resources (WDNR)
	Southeastern Wisconsin Regional Planning Commission (SEWRPC)
	Chicago Metropolitan Agency for Planning (CMAP)
	Lake County Forest Preserve District (LCFPD)
	Forest Preserve District of Cook County (FPDCC)
	Northwest Municipal Conference (NWMC)
	Upper Des Plaines River Partnership (UDPREP)
Project Delivery Team	
	U.S. Army Corps of Engineers, Chicago District (USACE)
	Illinois Department of Natural Resources (IDNR)
	Lake County Stormwater Management Commission (LCSMC)
	Cook County Highway Department (CCHD)
	County of Kenosha, Wisconsin
	Southeastern Wisconsin Regional Planning Commission (SEWRPC)
	Forest Preserve District of Cook County (FPDCC)
	Lake County Forest Preserve District (LCFPD)
	Metropolitan Water Reclamation District of Greater Chicago (MWRDGC)
	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.

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 unique 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 flood risk management 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 flood risk management 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 elements that serve both flood risk management and ecosystem restoration purposes depend on whether elements within the plan are physically or functionally interdependent versus independent. Combined plans that have interdependent elements either share the same physical location or functions. Interdependent elements can sometimes negatively impact each other or compete for the same resources. In those cases, the outputs from the elements that impact each other or are in competition with each other must be traded off. Trade offs are not necessary for outputs from those elements that do not impact or even benefit each other. Plans that have independent elements will include all elements 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 flood risk management 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 (say, NER) can only be obtained by accepting less of another (say, 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 be 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 flood risk management 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 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 single use
Index of Biotic Integrity (IBI)	Quantifies response of the in-stream fish community to disturbance and/or restoration.	Final coordination of review process underway with ECO-PCX
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.	Final coordination of review for study specific use underway with ECO-PCX
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	Final coordination of review underway with ECO-PCX
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.	Under review for study-specific use

2.3 Problems and Opportunities*

The problems associated with the Upper Des Plaines River watershed are system-wide; therefore, a watershed approach to flood risk management 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 the development of system-wide 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 structures along the subwatershed, but also 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 flood risk management, 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:

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.

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.

Lack of Open Spaces Available to Natural Plant and Wildlife Communities As agriculture and urban communities occupied lands, the natural ecosystems 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.

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:

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.

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 was 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.

Restore Connections Between Natural Spaces Reconnecting aquatic and upland natural lands will allow for greater interaction between species populations to improve genetic heterogeneity, provide for dispersal routes of native plant and animal species, lessening the adverse effects of sink/source populations of native plants and animals. While four dams fragmenting the watershed riverine system have been removed, there are remaining dams along the Des Plaines mainstem that continue to fragment the system.

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 flood risk management 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 National

Ecosystem Restoration (NER) by restoring degraded 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 flood risk management. 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 flood risk management 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 nesting plan formulation within 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 should be addressed.

4. Increase acreage of native community types – Currently, very little natural land cover remains in the 484 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 the scale of thousands of acres.

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 chemical. Once the hydrologic and geomorphic impairments are remedied, invasive plant species may be addressed quite effectively, often keeping invasive plant species cover to less than 1% of the site. Plans should, at a minimum, keep invasive plant species cover at less than 5%.

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 – This objective seeks to increase biodiversity, or the total native species richness, abundance, genetic heterogeneity, and population health of study area land parcels 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; however, the abundance and health of these species/populations have been dramatically impaired. Agricultural and other highly disturbed land parcels within the watershed have only tens of native macro species present, and sometimes even less. Once hydrology, hydraulics, geomorphology and invasive species issues are addressed, these sites would have the potential to provide life requisites for thousands of native fungi, plant, insect, fish, amphibian, reptile, bird, and mammal species. The major increases in biodiversity would be apparent through abundance and population health. Any restoration measures, alternatives or plans selected should provide life requisites per plant community type, which would drive the return of hundreds, if not thousands of native species. It is expected, based on previous hydrologic and hydraulic restoration projects 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 have resulted through the disablement of drain tiles under several Chicago District projects. These benefits are primarily expected for those parcels of land that are restored; however, trickle effects could be expected up and downstream for riverine work, and in any natural area parcels that are adjacent to the restored sites.

8. <u>Preserve existing natural resources</u> – 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 flood risk management plans that change natural land use, will also serve this objective. The USACE is not able to participate in the acquisition of land for the sole purpose of ecosystem preservation; 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. <u>Improve water quality for aquatic organisms</u> – 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 flood risk management features would support this objective.

10. <u>Increase open space and recreational opportunities</u> – This objective seeks to incorporate passive recreation into ecosystem 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. Through the creation of natural areas and open spaces, people can enjoy the solace of nature and escape from everyday city life. There may also be 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 models were maintained in NGVD 1929 and data used from these models for the design of features was carefully reviewed and converted for NAVD 1988. NAVD 1988 will be used in the design of all recommended features as required by EC 1110-2-6070, Comprehensive Evaluation of Project 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 future without project 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 form 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 to pass 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. A watershed-wide, integrated approach is necessary to control these problems and to protect sensitive habitats. One of the most important factors affecting soils of the study area is extensive urbanization. Many soils in Cook County are affected by human activities, which 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 the most recent data collected by Southeastern Wisconsin Regional Planning Commission (SEWRPC) and Northern Illinois Planning Commission (NIPC), now the Chicago Metropolitan Agency for Planning (CMAP), in 1995 and 2001 respectively and Plate 5 shows a map of existing land use. 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%

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 in conjunction with urban development. Table 3.4 lists the existing major watershed modifications and the years the projects were completed. Plate 7 shows the locations of the modifications 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	114 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
	Willow-Higgins Reservoir	1200 ac-ft	
	Willow-Higgins Channel Improvement	1.0 mile	
Crystal Creek	Lake O'Hare Reservoir	1120 ac-ft	1965
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.

Channel modifications and reservoirs were constructed within the study area to combat flooding caused by urban development. Despite the presence of these structures, flood risks continue 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 the six flood risk management projects recommended by the Phase I study that were 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 these six 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 the six flood risk management 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

Flood Event (Percent Chance)	Peak Flow at USGS Gage (cfs)			
	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 Illinois Department of Natural Resources (IDNR) and the Federal Emergency Management Agency (FEMA) 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.

A series of new hydrologic and hydraulic models were developed for 15 of 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 (HSPF) 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 influences 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 exact 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. Unnatural erosion due to increased discharge from urbanized areas may require engineered solutions.

3.1.1.7 **Air Quality**

The Illinois Environmental Protection Agency (IEPA) and the Wisconsin Department of Natural Resources (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 to 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 were 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 populated 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 types of the Upper Des Plaines River Watershed

Community / Habitat Type	Tier 1	Tier 2
Prairie	Fine-textured-soil	dry-mesic; mesic; wet-mesic; wet
Savanna	Fine-textured-soil	dry-mesic; mesic; wet-mesic; wet
Woodland	Upland	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
	Cultural	urbanland; cropland; pastureland; successional fields

Four of the above listed communities provide habitat associated with the plant species. The two most dominant types of habitat based on the plant community were oak savanna and prairie, with lesser amounts of woodland and wetland. 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.

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

Community /	Wisconsin		Illinois	
Habitat Type	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. 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 restoration efforts should focus on hydrologic restoration, removal of invasive species and burn management. 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 depending on the level of moisture to form wetland prairie complexes.

<u>Dry-mesic prairie</u> 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.

<u>Mesic prairie</u> communities occur on crests on 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. 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.

<u>Wet-mesic prairie</u> communities occur between mesic prairie and wet-mesic 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 poise 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 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*).

<u>Wet prairie</u> 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 poise a larger threat to this system then dry prairie communities. The Federally endangered prairie-fringed orchid (*Platanthera leucophaea*) is associated with wet prairie. Within one 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 (*Phragmites australis*), reed canary grass (*Phalaris arundinacea*), and cattail (*Typha* sp.) with encroaching stands of opportunistic and invasive woody species including sandbar willow (*Salix interior*), quaking aspen (*Populus tremuloides*), and glossy buckthorn (*Frangula lanceolata*). 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 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, 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 soil type and moisture.

Dry-mesic savanna communities would have been located on well-drained upland 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 Melissa blue. 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 (*Fraxinus lanceolata*), sugar maple (*Acer saccharum*), common buckthorn (*Rhamnus cathartica*), and non-native honeysuckle species (*Lonicera* sp.) have shaded the once open canopy that herbaceous savanna flora depend on.

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 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 threatened pale vetchling 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 small patches of remnant herbaceous savanna flora.

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 listed in the state of Wisconsin, 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. Forest restoration efforts should focus on invasive species removal, reestablishing a natural hydrology and implementing burn management.

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 upland forest*, *mesic upland forest*, *wet-mesic upland forest, mesic floodplain forest, wet-mesic floodplain forest, wet floodplain forest,* and *northern flatwoods* based on topographical location, soil type and moisture.

<u>Dry-mesic upland forest</u> 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 upland forest located in the study area, which is approximately 8% of the total undegraded dry-mesic upland 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 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 threatened species associated with the dry-mesic upland forest are the Acadian flycatcher and cerulean warbler. Community synonyms of the dry-mesic upland 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 (*Fraxinus lanceolata*), sugar maple (*Acer saccharum*), common buckthorn (*Rhamnus cathartica*), and non-native honeysuckle species (*Lonicera* sp.) have established within this community and prevent favorable oaks and other fire tolerant trees to establish along with their associative conservative flora.

<u>Mesic upland forest</u> 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 upland 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 upland 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 upland 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 upland forest located in the study area, approximately 4.5% of the total undegraded dry-mesic upland forest remaining. Species listed in the state of Illinois associated with the mesic upland forest community within the study area are the northern grape fern (*Botrychium multifidum*), pretty sedge (*Carex woodii*), pale vetchling (*Lathyrus ochroleucus*), 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 upland forest include North-central maple-basswood forest (The Nature Conservancy).

<u>Wet-mesic upland forest</u> 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 upland 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 upland forest community within the study area.

<u>Mesic floodplain forest</u> 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.

<u>Wet-mesic floodplain forest</u> 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 less upland species then 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 massasauga rattlesnake, barred owl, red-shouldered hawk, Acadian flycatcher, yellow-throated vireo and prothonotary warbler. Illinois and Wisconsin listed snake species within the

study area are the eastern massasauga and 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 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 massasauga rattlesnake, 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 communities are located in level uplands 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 restoration efforts should include maintaining and improving natural hydrologic cycles, removal of invasive species and protection of remaining wetland areas through buffers. 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. The Blanding's turtle and the Great egret are listed as threatened in the study area and are associated with wetland communities.

Marsh communities are characterized as having water at or near the surface during most of the growing season and 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 practices 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, Blanding's turtle, muskrat, yellow-headed blackbird, least bittern, sora, Virginia rail, map turtle, green heron and central mudminnow. Illinois state listed species associated with marsh communities listed include beaked sedge (*Carex rostrata*), marsh speedwell (*Veronica scutellata*) and *Scirpus hattorianus*. Within one 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 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 one 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 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 a 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 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 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 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. 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 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 depravation, 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*. Plant species associated with the graminoid fen community listed as threatened or endangered 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).

<u>Sedge meadow</u> 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. Graminoid fens are composed of a mix of prairie, sedge meadow, and seep species. Disturbance 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 cane, 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 (*Carex rostrata*) and prairie white-fringed orchid (*Platanthera leucophaea*, also federally threatened). Community synonyms of the sedge meadow community include lake sedge meadow and tussock sedge wet meadow (The Nature Conservancy).

<u>Seep</u> 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 possibly 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).

<u>Calcareous seep</u> 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 Hine's emerald, pickerel frog and blacknose dace (*Rhinichthys obtusus*). 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 unnatural 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 Illinois Environmental Protection Agency (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 communities are characterized by open water and 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 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 endangered grass-leaved pondweed grass-leaved pondweed (*Potamogeton gramineus*) is associated with lake communities. Two other plant species listed as endangered and found within one mile of the study boundary are the fern pondweed (*Potamogeton robbinsii*) and white-stemmed pondweed (*Potamogeton praelongus*). State 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 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.

Cultural communities 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 and State involvement in the project has assured that the recommended plan would be in compliance with Section 7 of the Endangered Species Act. Official coordination and correspondence is expected to be closed via the finalization of this document and the ultimate signing of a FONSI for the recommended plan. Since the USFWS was part of the PDT, there will be no Fish & Wildlife Coordination Act Report produced; however, a letter from the USFWS indicates that we are still performing due diligence and coordinating as appropriate (letter dated 03 December 2012).

The following Federally listed species and their critical habitats are identified by the U.S. Fish and Wildlife Service (USFWS) as occurring within Cook and Lake Counties, Illinois and Kenosha and Racine Counties, Wisconsin:

- 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)

- Eastern prairie fringed orchid (*Platanthaera leucophaea*) – Threatened – Moderate to high quality wetlands, sedge meadow, marsh, and mesic to wet prairie.

- Hine's emerald dragonfly (*Somatochlora hineana*) - Endangered – Spring fed wetlands, wet meadows, and marshes.

- Leafy-prairie clover (*Dalea foliosa*) – Endangered – Prairie remnants on 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.

- Prairie bush clover (*Lespedeza leptostachya*) – Threatened – Dry to mesic prairies with gravelly soil.

- 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

- Pitcher's thistle (*Cirsium pitcheri*) – Threatened – Lakeshore dunes

- Whooping crane(*Grus americanus*) – Experimental Population – Open wetlands and lakeshores

- Eastern prairie fringed orchid (*Platanthera leucophaea*) – Threatened - Wet grasslands

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. Area recommended for prairie restoration will be selected to avoid known prehistoric archeological sites. A number of burial mounds and hilltop cemeteries were reported during the last half of the 19^{th} 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 (or possibly remote sensing) in wetlands is advisable, 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 contained 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 being 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 1890's 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 one 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 contains 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. However, 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 – Population Trends in Primary Upper Des Plaines River Basin Communities

State	County	Municipality	2000 Population[1]	2010 Population[2]	% Change 2000-2010	2020 Population[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%
	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 - Northeastern Illinois Planning Commission endorsed 2030 forecasts interpolated down to 2020 and Southeastern Wisconsin Regional Planning Commission 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 that the Des Plaines River runs through 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 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, completed in March 2010, assessed whether flood risk management and ecosystem restoration sites considered for implementation during alternative development were enrolled in any regulatory remedial program. Data obtained from the Illinois Environmental Protection Agency (IEPA), the Wisconsin Department of Natural Resources (WDNR), and the U.S. Environmental Protection Agency (EPA) 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 tentatively selected for implementation during the final stages of the feasibility study.

Phase I HTRW investigations for all tentatively selected 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.

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 Illinois Environmental Protection Agency (IEPA) and Wisconsin Department of Natural Resources (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 (FCMP). 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 Illinois Environmental Protection Agency (IEPA) 2006 Integrated Water Quality Report and 303(d) list (IEPA 2006) due to an inability to achieve and reach 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, 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. 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 aquatic life impaired due the presence of contaminated sediment containing endrin, methoxychlor, and nitrogen above 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 Wisconsin Department of Natural Resources (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 3.1 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 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 Preserves. The Lake County 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 Future Without-Project Conditions

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 the 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. 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 Southeastern Wisconsin Regional Planning Commission (SEWRPC) and Chicago Metropolitan Agency for Planning (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.

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

	Cook/DuPage County			Lake County		
	Baseline	Future	Diff	Baseline	Future	Diff
	2001	2020		2001	2020	
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	Future	Diff	Baseline	Future	Diff
	1995	2020		1995/2001	2020	
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 134-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 Cook County Forest Preserve District 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 future without-project 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 forest, grassland, and wetland 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, future without-project 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 future without-project 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. The increased water stages and velocities during flood events result in erosion and transport of pollutants within the waterways. During extreme events, combined sewer overflows (CSOs) also introduce untreated sewer and stormwater directly to the waterways. In the future without project 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 future without-project 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 future without-project 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 flood risk management 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, 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 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 U.S. Army Corps of Engineers (USACE) is to support the flood risk management activities of communities in both urban and rural areas throughout the United States.

The goal of the USACE Flood Risk Management (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, 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 (FPMS) 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 flood risk management 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 flood risk management (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 conditions 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 Illinois Department of Natural Resources (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 Water Resources Development Act (WRDA) of 1999 authorized a Locally Preferred Plan (LPP) consisting of six structural flood risk management components.

The need for additional flood risk management 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 state of the art 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 (VTG), 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:

a. Mainstem overbank flooding
b. Tributary overbank flooding caused by backwater flood stages on mainstem
c. Tributary overbank flooding (non-mainstem backwater)
d. Storm sewer backup due to downstream stages on mainstem and tributaries
e. Combined sewer backup due to downstream stages on mainstem and tributaries
f. 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.

Table 4.1 – Historical flooding 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	10%
	Des Plaines River near Gurnee, IL	662.30	3,530	5%
	Buffalo Creek near Wheeling, IL	665.40	581	20%
	Des Plaines River near Des Plaines, IL	637.20	4,900	5%
	Des Plaines River at Riverside, IL	603.55	7,625	5%
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	20%
	Weller Creek at Des Plaines, IL	648.92	1,490	5%
	Des Plaines River at Riverside, IL	604.58	9,770	0.5%
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	11%
	Mill Creek at Old Mill Creek, IL	680.06	1,090	13%
	Des Plaines River near Gurnee, IL	660.19	2,370	20%
1996	Des Plaines River at Russell, IL	670.31	1,200	25%
	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	17%
1997	Mill Creek at Old Mill Creek, IL	679.9	1,000	17%
	Des Plaines River near Des Plaines, IL	634.36	3,540	20%
	Weller Creek at Des Plaines, IL	644.47	1,040	20%
	Des Plaines River at Riverside, IL	603.13	6,990	10%
1999	Des Plaines River at Russell, IL	670.38	1,250	25%
	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	20%
	Des Plaines River at Riverside, IL	602.34	5,680	25%
2000	Des Plaines River at Russell, IL	671.95	2,130	9%
	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	17%
2004	Des Plaines River at Russell, IL	673.09	3,500	1.7%
	Des Plaines River near Gurnee, IL	662.06	3,890	9%
	Des Plaines River near Des Plaines, IL	634.82	3,760	17%
2007	Des Plaines River at Russell, IL	672.57	1,610	14%
	Des Plaines River at Gurnee, IL	660.15	2,390	17%
	Des Plaines River at Des Plaines, IL	634.91	3,780	17%
	Des Plaines River at Riverside, IL	602.41	5,790	25%
2008	Des Plaines River at Russell, IL	671.47	1,910	9%
	Des Plaines River at Gurnee, IL	659.29	1,900	33%
	Des Plaines River at Des Plaines, IL	636.31	3,010	33%
	Des Plaines River at Riverside, IL	604.55	9,560	0.03%
2010	Des Plaines River at Riverside, IL	602.96	6,720	10%
2013	Des Plaines River at Russell, IL	671.96	2,240	6%
	Des Plaines River at Gurnee, IL	661.73	3,460	9%
	Des Plaines River at Des Plaines, IL	637.24	4,970	3%
	Des Plaines River at Riverside, IL	605.25	12,400	0.03%

Major flood events that have occurred in the Upper Des Plaines River watershed over the past 25 years are listed below in Table 4.1, including the two largest flood events recorded on the system in 1986 and 1987. 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.

4.2.2 Summary of Previously Reported Flood Damages

4.2.2.1 **Phase I Study**

The 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 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, below, 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	Design
Levee 37	Prospect Heights/Mount Prospect, IL	N/A	Construction
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.

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 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 six 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

Damage Category	Expected Annual Damages ($1,000)		Damage Increase (1995-2010)
	Baseline (1995)	Future (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, including tributaries.

In addition to results from the Phase I Study, previous estimates of average annual flood damages (AAD) 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. This information can be used as a comparison to the current flood damage estimates presented here.

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 Consumer Price Index (CPI-U) for 2012 is 223.23
[2] Illinois Department of Transportation Division of Water Resources; Strategic Planning Study for Flood Control, Des Plaines River, Gurnee, Illinois; 1989
[3] USDA Soil Conservation Service; Lower Des Plaines Tributaries Final Watershed Plan and Environmental Impact Statement; June 1985.
[4] Illinois Department of Natural Resources Office of Water Resources; Strategic Planning Study for Farmers/Prairie Creek, Cook County, Illinois; 2007. (unpublished)
[5] Illinois Department of Transportation, Division of Water Resources, Strategic Planning Study for Flood Control, Crystal Creek, March 1991 as amended.

4.3 Flood Risk Analysis

A comprehensive flood risk analysis was performed for the watershed. Categories accounted for in the analysis include 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 National Economic Development (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. The majority of 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 (DFIRMs) across the watershed. In Wisconsin, a detailed mapping of the floodplain was performed by Southeastern Wisconsin Regional Planning Commission (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. The 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 Illinois Department of Transportation 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	Watershed	Crossings
Newport Drainage Ditch	4	Weller Creek	2
Mill Creek	13	Farmer-Prairie Creek	6
Bull Creek	4	Willow-Higgins Creek	7
Indian Creek	6	Silver Creek	7
Buffalo Creek	13	Des Plaines River Mainstem[1]	62
McDonald Creek	2	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 without project conditions incorporate benefits accrued by implementation of various flood risk management projects throughout the watershed, including the six 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 all considered in the without project conditions. 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 flood risk management 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 flood risk management 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 average annual damages 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. 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 Average Annual Damages). Table 4.7 shows without-project equivalent annual damage by reach and damage category.

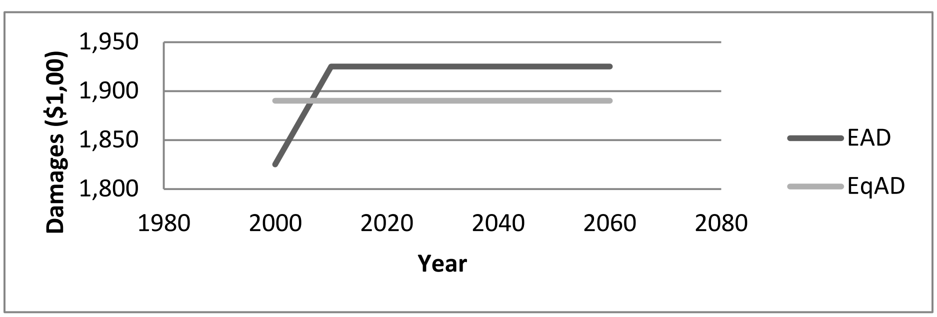

Figure 4.1 – Computation of Average Annual Damages

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 Project Delivery Team (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 Continuing Authorities Program 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 most complex aggregation of damages is on the Des Plaines River mainstem. As shown in Table 4.7, this watershed comprises the greatest portion of the damages. 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	$138	$0	$138
	Dutch Gap Canal	Kenosha	WI	$32	$0	$32
	Center Creek	Kenosha	WI	$3	$0	$3
	Kilbourn Road Ditch	Kenosha/Racine	WI	$43	$0	$43
	Jerome Creek	Kenosha	WI	$31	$0	$31
	Des Plaines River Mainstem (WI)	Kenosha/Racine	WI	$42	$160	$202
	Newport Ditch	Lake	IL	$0	$0	$0
	Mill Creek	Lake	IL	$190	$77	$267
	Bull Creek	Lake	IL	$125	$16	$141
	Indian Creek	Lake	IL	$38	$48	$87
	Buffalo-Wheeling Creek	Cook/Lake	IL	$364	$8	$371
	McDonald Creek	Cook	IL	$0	$0	$0
	Weller Creek	Cook	IL	$147	$3	$150
	Farmer-Prairie Creek	Cook	IL	$148	$4	$152
	Willow-Higgins Creek	Cook/DuPage	IL	$22	$21	$43
	Silver Creek	Cook/DuPage	IL	$934	$218	$1,151
DS	Des Plaines River Mainstem (IL)	Cook/Lake	IL	$7,385	$41,996	$49,381
TOTALS				$9,642	$42,551	$52,192

[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.
(FY2013 Price Level, FDR 3.75%)

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 flood risk management (FRM) presents a challenge because the evaluation of alternative plans involves estimating both project costs and flood risk management 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, below.

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.

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 below.

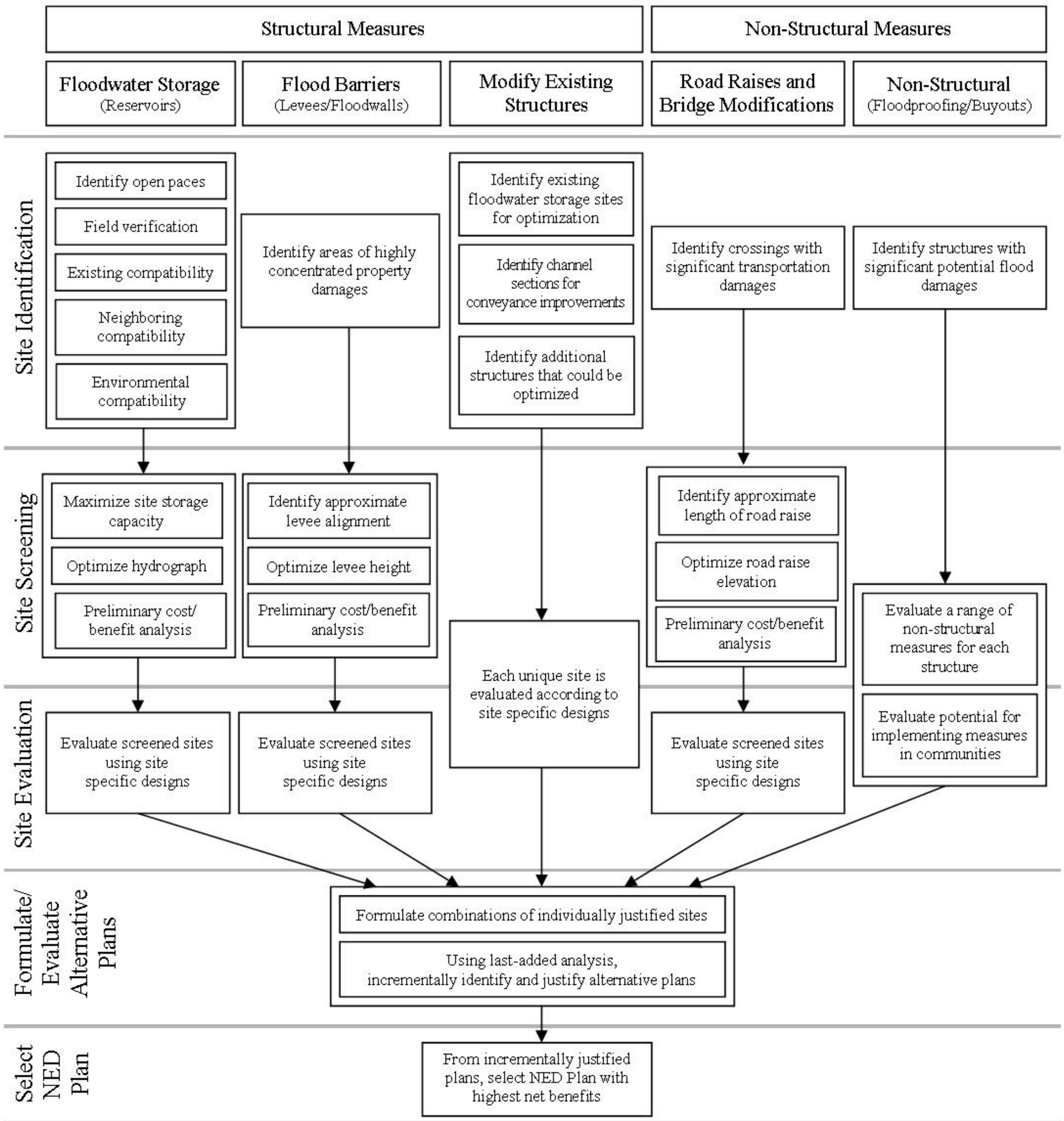

Figure 4.2 – Plan Formulation Process for Determining Flood Risk Management Plans

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 consideration of the hydraulic effects to the watershed as a whole. Additionally, there are existing flood risk management 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 flood risk management 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 flood risk management 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.

<u>Manage Risk at Individual Homes and Businesses</u>

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.

<u>Manage Risk within Communities</u>

Flood Insurance

All communities are required to participate in the National Flood Insurance Program (NFIP) in order to qualify for Federal investment in flood risk management 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 (FWP) 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 FWP elements include plans for recovery and plan improvement based on post flood lessons learned.

Public Awareness

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

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 flood risk management 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 Chicago Metropolitan Agency for Planning (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 Struct.	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 into 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 flood risk reduction sites were screened based on the development of preliminary benefit to cost ratios (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 factored to all measures 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 (Hydrology & Hydraulics).

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 (Civil Design) and F (Cost Engineering).

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 benefit to cost ratio 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	3	1
SC	Silver Creek	Cook/DuPage	IL	1	1	0
DP	Des Plaines River	Cook/Lake/Kenosha	IL/WI	16	14	2
				70	61	9

Table 4.13 – Summary of Retained Floodwater Storage Sites

Site ID	Storage Volume (acre-ft)	Total Equivalent Annual Damages Reduced	Equivalent Annual Costs	Benefit to Cost Ratio ($/$)
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
WHRS06	586	$35,774,841	$1,049,881	34.1
DPRS07	1,000	$2,523,600	$1,890,603	1.3
DPRS23	330	$1,388,200	$914,274	1.5

(FY2010 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)	Approx. Grade (ft)	1% Annual Chance Flood Elevation (ft NGVD29)	Optimized Crest Elevation (ft NGVD29)
DPLV01	$769,000	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.
(FY2010 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	12	2
			TOTAL	20	18	2

4.5.3.3 **Road Raises and Bridge Modifications**

Road raises and bridge modifications at high transportation damage sites were screened for flood risk management potential in coordination with the Illinois Department of Transportation (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. Capacity, age, and soundness of the structure are the primary factors. IDOT does monitor reports of flooding and maintain 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 sites. 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 ($1,000)	Annual Costs ($1,000)	Max Net Benefits ($1,000)	1% Annual Chance Flood Elevation (ft NGVD29)	Lowest Existing Pavement Elevation (ft NGVD29)	Optimized Pavement Elevation (ft NGVD29)	Approximate Extent (ft)
DPBM04	$5,339	$235	$5,104	626.0	620.0	625.5	1,900
DPBM06	$1,182	$618	$564	634.5	632.0	634.2	3,000
DPBM13	$736	$151	$586	665.1	661.5	664.7	1,000

(FY2010 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 ring levees, 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. Benefits and costs for the measures 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.

Detailed discussion of the procedures used to screen the non-structural sites can be found in Appendix B (FRM Plan Formulation). Discussion of the procedures used to develop screening level costs can be found in Appendix F (Cost Engineering). A summary of retained non-structural measures in the watershed is shown in Table 4.18. As shown in the Tables, approximately 690 total sites were retained. These sites are in the communities of Riverside, River Grove, Schiller Park, Rosemont, Des Plaines, Prospect Heights, and Gurnee in Illinois and Salem, Bristol, Somers, and Paddock Lake in Wisconsin. The proposed measures would include approximately 200 structure elevations, dry floodproofing at 65 structures, wet floodproofing at 50 structures, 118 structures where the basement would be filled and any portion of the first floor at risk of flooding would be floodproofed, construction of ring levees at 70 structures, and 185 buyouts.

Participation in the non-structural plan would be voluntary and implementation would be subject to verification of the structure characteristics, first floor elevation, and low water entry point.

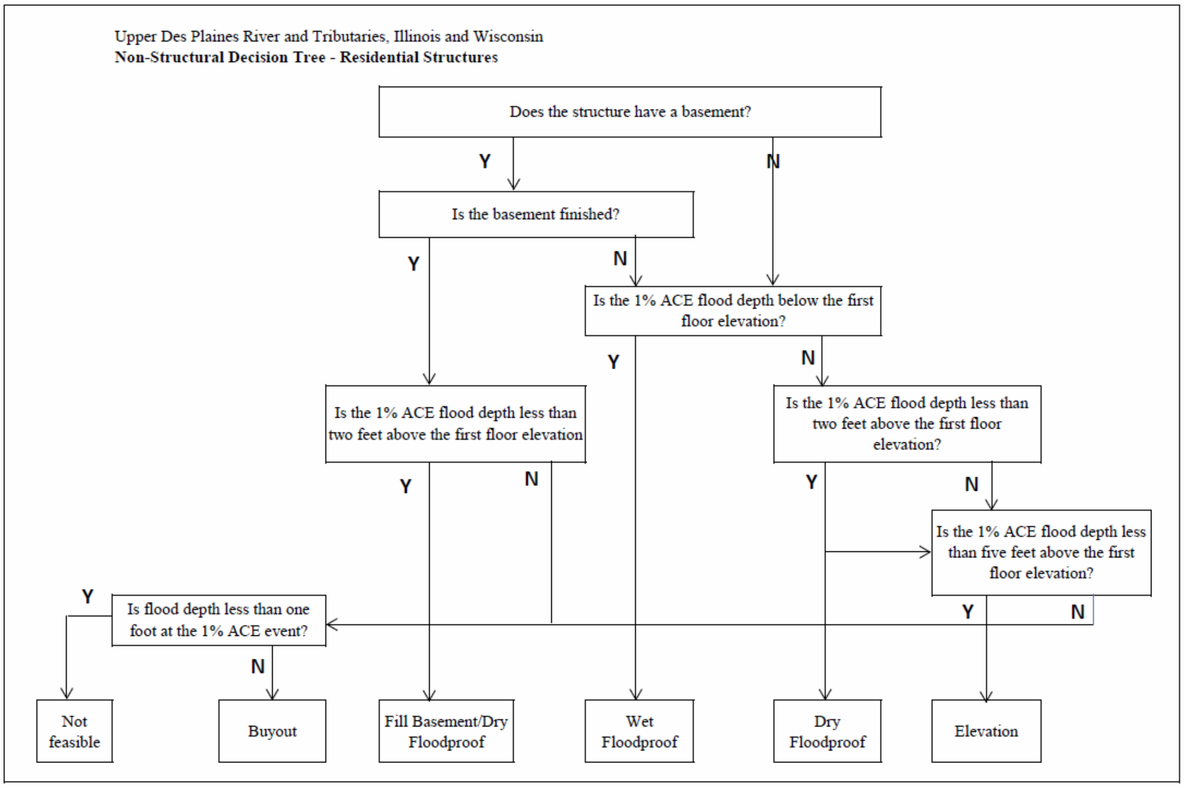

Figure 4.3 – Residential Non-Structural Measure Decision Tree

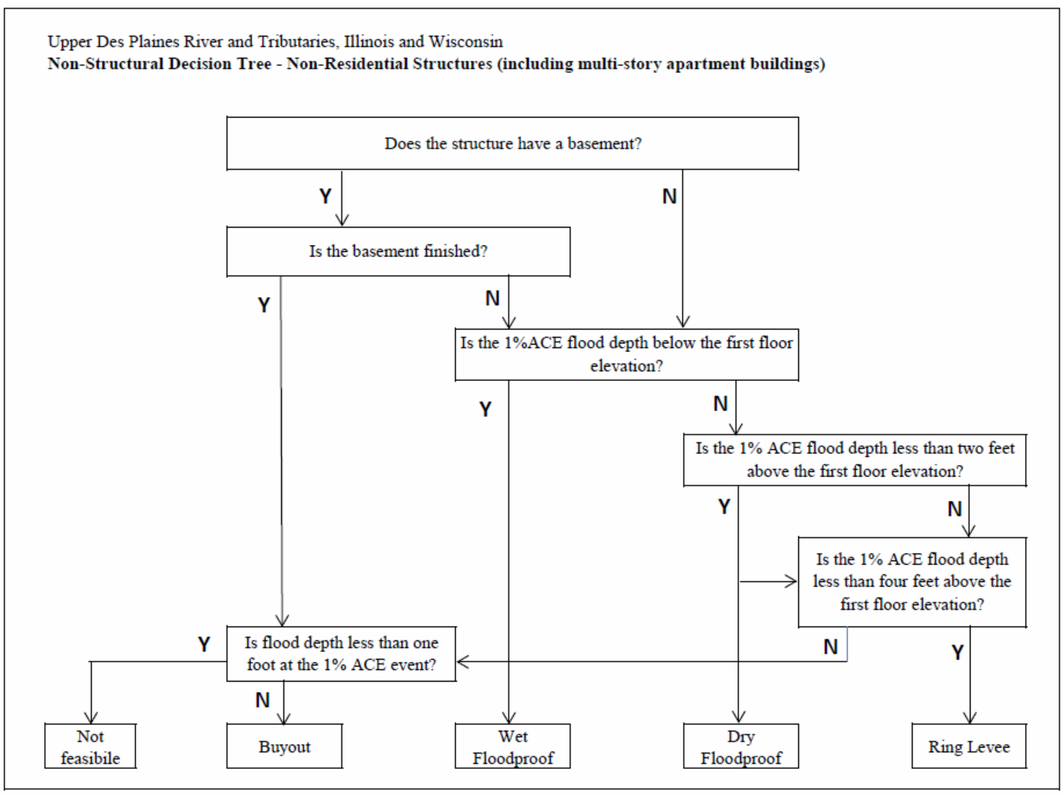

Figure 4.4 - Non-residential Non-structural Decision Tree

Table 4.17 - Summary of Non-structural Screening Result

County	Municipality	Structures in Municipality	WOP Damages ($1,000)	Optimized Floodproofing Measures				
				Number	%	Benefits ($1,000)	Annualized Costs ($1,000)	Net Benefits ($1,000)
Cook	Riverside	4	$22.8	2	50%	$21.5	$7.2	$14.3
	River Forest	22	$54.5	20	91%	$51.7	$61.7	($10.0)
	Elmwood Park	54	$101.9	48	89%	$97.3	$210.2	($112.9)
	River Grove	2	$102.0	2	100%	$102.0	$15.3	$86.8
	Franklin Park	119	$168.0	54	45%	$104.9	$156.2	($51.3)
	Rosemont	2	$278.5	2	100%	$278.5	$25.7	$252.8
	Des Plaines	273	$1,254.9	210	77%	$1,187.7	$476.9	$710.8
	Prospect Heights	9	$24.6	8	89%	$22.9	$43.2	($20.3)
	Wheeling	239	$351.6	185	77%	$329.0	$328.9	$0.1
	Park Ridge	47	$120.2	11	23%	$41.0	$21.1	$19.9
	Melrose Park	16	$7.3	15	94%	$7.0	$22.4	($15.4)
	Franklin Park	130	$193.0	65	50%	$129.8	$183.7	($53.8)
	Buffalo Grove	34	$23.9	31	91%	$22.1	$34.1	($12.0)
Lake	Riverwoods	55	$215.3	49	89%	$209.5	$105.3	$104.2
	Buffalo Grove	30	$95.2	28	93%	$93.9	$49.4	$44.5
	Lincolnshire	50	$69.8	46	92%	$68.7	$98.3	($29.6)
	Mettawa	2	$2.9	2	100%	$2.9	$3.6	($0.7)
	Libertyville	198	$344.7	173	87%	$260.5	$301.3	($40.8)
	Gurnee	50	$990.0	40	80%	$834.2	$169.3	$664.9
Kenosha	Pleasant Prairie	16	$81.3	10	63%	$14.7	$17.8	($3.0)
	Salem	6	$52.1	6	100%	$52.1	$4.5	$47.6
	Bristol	12	$44.9	8	67%	$34.0	$20.0	$14.0
	Somers	1	$59.3	1	100%	$59.3	$6.5	$52.8
	Paddock Lake	23	$85.1	23	100%	$85.1	$24.4	$60.7

(FY2013 Price Level, FDR 3.75%)

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

County	Total Structures	Benefits ($1,000)	Project Costs ($1,000)	Annual Costs ($1,000)	Net Benefits ($1,000)
Cook	412	$1,960	[redacted]	$875	$1,085
Lake	117	$1,138	[redacted]	$324	$814
Kenosha	38	$231	[redacted]	$55	$175
Total	567	$3,328	[redacted]	$1,255	$2,073

(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).

The two sites which still had positive net benefits after this more detailed analysis were retained for inclusion in formulated flood risk management plans. The retained floodwater storage sites are presented in Table 4.19. Once economic justification had been 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 project implementation 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 would include 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 Volume (acre-ft)	Annual Damages Reduced	Total Costs	Annual O&M	Equivalent Annual Costs	Net Benefits	Benefit to Cost Ratio ($/$)
BCRS02	177	$1,502,000	[redacted]	[redacted]	$1,317,000	$185,000	1.1
ACRS08	420	$928,000	[redacted]	[redacted]	$923,000	$5,000	1.0

(FY2010 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 summary below presents the magnitude of induced damages for each levee. The goal of the screening and evaluation steps is to identify economically justified features that can be combined to form alternative plans. Because the flood barrier sites would likely be combined with other features, it was determined that mitigation requirements would be determined based on the tentatively selected plan. Where possible, induced damages would be accounted for and mitigated.

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	6,400	6,000	11,000
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 four 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.
(FY2010 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

Site ID	Elevation		Total Equivalent Annual Damages Reduced	Equivalent Annual Costs	Net Benefits	Benefit to Cost Ratio ($/$)
	Feet NGVD 29	Annual % Chance Flood				
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

(FY2010 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 benefit to cost ratio 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 measures. 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	Benefit to Cost Ratio ($/$)
FPCI01	$105,000	$79,000	$26,000	1.3

(FY2010 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 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 flood risk management 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.

To reflect the most current information and policy, two additional changes were made to the input calculations. The majority of the screening and evaluation work had been conducted in Federal Fiscal Year (FY) 2010. At that time the Federal discount was 4.375%. At this final stage, the discount rate was updated to the rate for the current year, FY13, and a discount rate of 3.75% was used to update both benefits and costs. In addition, price levels used in the economic analysis were updated to October 2012.

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, below. 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

Site	Miti-gation	Benefits				Total Benefits	Annual Costs	Net Benefits	BCR
		Flood Damage Reduced	FIA Savings	Flood Fighting Prevented	Recreation				
DPBM04		$4,287				$4,287	$767	$3,520	5.6
DPLV09		$2,029	$190	$60	$187	$2,466	$1,281	$1,184	1.9
DPLV04									
DPLV05									
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	L22	$433				$433	$895	($462)	0.5

Note: All Benefits and Costs shown in $1,000
(FY2013 Price Level, FDR 3.75%)

4.6 Formulation of Flood Risk Management Plans

4.6.1 Tributary Minimum Flows

In evaluating benefits for flood risk management (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.

Table 4.24 – Tributary Drainage Areas and Flows

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

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.

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 Continuing Authorities Program (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 flood risk management 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 will serve as the decision document for these projects. The conversion to CAP will occur at the start of the Preconstruction Engineering and Design (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 mitigation alternatives so that the levees would be permissible according to state rules and regulations.

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 combined levees resulted in compounded impacts resulting in more significant stage increases and induced damages. 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. 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.

Two compensatory storage alternatives were evaluated for mitigating for the induced damages:

1. 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 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.
2. Site ACRS08 is individually justified as a 420 acre-foot 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 levees were modeled in combination with the reservoir expanded to 550 acre-feet 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. The estimated value of flowage easements for the area of induced flooding is $1,000. The annualized cost of constructing the expanded reservoir, $819,000, is less than the total induced damages for DPLV04, DPLV05, and DPLV09 together. The net benefits of the levees when combined as a system with ACRS08 are greater than for any of the sites individually. This mitigation alternative was therefore retained for incorporation in the flood risk management plans. The benefits, costs, and net benefits are presented in Table 4.25.

Table 4.25 – ACRS08 Compensatory Storage Evaluation

Site	Benefits ($1,000)					Annual Costs ($1,000)	Net Benefits ($1,000)	BCR
	Total Flood Damage Reduced[1]	FIA Savings	Flood Fighting Prevented	Recreation	Total Benefits			
DPLV04	$2,144	$35			$2,179	$557	$1,622	3.9
DPLV09	$2,068	$155	$60	$187	$2,470	$1,044	$1,426	2.4
DPLV05	$1,591	$38			$1,629	$490	$1,139	3.3
ACRS08	$1,290				$1,290	$819	$471	1.6
Levees & ACRS08	$5,772	$228	$60	$187	$6,247	$2,910	$3,337	2.1

[1] For DPLV04, DPLV05, and DPLV09, total flood damages reduced incorporates induced damages which are subtracted from the total.
(FY 2013 Price Level, FDR 3.75%)

This analysis demonstrates that the induced stages caused by the levees can be addressed through implementation of compensatory storage. The increased storage capacity at ACRS08 is economically justified by the reduction in flood losses (mitigated damages) at the project site. Economically justified mitigation at ACRS08 or another local government sponsored site will be required for implementation of the proposed levees. Appropriate environmental mitigation at this site or another site may be required for implementation of the proposed levees. Impacts to significant environmental resources will be avoided, minimized, rectified or reduced to the extent possible and if necessary, appropriate mitigation would be implemented to compensate for those impacts.

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. *Full Plan:* A plan that fully responds to the study authority and includes all economically justified, environmentally acceptable separable features evaluated during the course of the study. This plan includes features the USACE recommends be implemented by appropriate non-Federal agencies, features that USACE may address under its Continuing Authorities Program (CAP), and features for which USACE will seek congressional authorization for implementation. The CAP Plan and NED Plan are subsets of the Full Plan.
3. *CAP Plan:* All policy compliant, economically justified, environmentally acceptable separable features of such scope that they could reasonably be implemented under CAP.
4. *NED Plan:* All policy compliant, economically justified, environmentally acceptable separable features of such scope that they could not be implemented under CAP.

Table 4.26 – Summary of Individually Justified Structural Projects

Site	Description	Plan[1]	Total Benefits[2,3]	Annual Costs[2]	Net Benefits	BCR
DPBM04	First Ave Bridge Modification	Full	$4,287	$770	$3,517	5.6
DPLV04	Belmont-Irving Levee	NED	$6,247	$2,910	$3,337	2.1
DPLV09	Ashland-Fargo Levee					
DPLV05	Fifth-CN Railroad Levee					
ACRS08	Aptakisic Creek Reservoir					
DPLV01	Groveland Avenue Levee	CAP	$441	$275	$166	1.6
FPCI01	Lake Mary Anne Pump Station	Full	$107	$72	$35	1.5

[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 continuing authorities program (CAP), and sites for implementation under CAP. Full, 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 3.75% 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.
(FY 2013 Price Level, FDR 3.75%)

As required by USACE policy and guidance, a No Action plan, synonymous with the future without project condition will be evaluated in comparison to other identified plans. The No Action plan assumes that no 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: Full Plan

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 site 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 sites 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.

Flood risk management plans are formulated to maximize National Economic Development 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. The last added analysis evaluates measures in combination with each other, ensuring that each site added to the plan is justified as an increment of the formulated plan and benefits are counted only once.

The individually justified or “first added” sites are shown in Table 4.26. The locations of these sites within the watershed are shown in Plate 15. The last added analysis was performed to successively rank the sites and formulate plans with the highest net benefits. The annualized benefits and costs shown in Table 4.23 reflect the current (FY13) Federal discount rate of 3.75%.

Site FPCI01, the connection of Lake Mary Anne to Dude Ranch Pond via a pump station and connector pipe, was not included in the last added analysis as its benefits are only on Farmer-Prairie Creek. Since the project is individually justified and the benefits are independent of those for all mainstem projects, the site was retained as incrementally justified and is included in the Full Plan.

A summary of the mainstem formulated plans is presented in Table 4.27. As shown in Table 4.23, the mainstem project with the highest net benefits is DPBM04, the modification of First Avenue Bridge to raise the roadway above flood stages. This site was paired with each of the remaining sites to determine the combination with the highest net benefits. This was determined to be DPBM04 paired with the DPLV04, DPLV05, DPLV09 and ACRS08, resulting in net benefits of $2,018,000. The remaining sites were then paired with this formulated plan to determine the combination that would result in the highest net benefits. This process was repeated until all sites had been added to the plan. The analysis showed that all sites remain justified in combination with each other.

Table 4.27 – Summary of Full Plan Last Added Analysis for Mainstem Structural Sites

Round of Last Added Analysis	Alternative With Highest Net Benefits	Total Benefits ($1,000)	Total Costs ($1,000)	Cumulative Net Benefits ($1,000)
--	DPBM04 – First Avenue Bridge Modification	$4,287	$736	$3,545
1	DPBM04 – First Avenue Bridge Modification DPLV04 – 6,400 ft floodwall and levee DPLV05 – 7,400 ft floodwall and levee DPLV09 – 11,100 ft floodwall and levee ACRS08 – 550 acre-foot Reservoir	$10,400	$3,646	$6,754
2	DPBM04 – First Avenue Bridge Modification DPLV04 – 6,400 ft floodwall and levee DPLV05 – 7,400 ft floodwall and levee DPLV09 – 11,100 ft floodwall and levee ACRS08 – 550 acre-foot Reservoir DPLV01 – 2,800 ft floodwall and levee	$10,832	$3,921	$6,911
+ Tributary	DPBM04 – First Avenue Bridge Modification DPLV04 – 6,400 ft floodwall and levee DPLV05 – 7,400 ft floodwall and levee DPLV09 – 11,100 ft floodwall and levee ACRS08 – 550 acre-foot Reservoir DPLV01 – 2,800 ft floodwall FPCI01 – Pump station at Lake Mary Anne	$10,939	$4,816	$4,947

(FY2013 Price Level, FDR 3.75%)

The incremental justification for screened non-structural sites was also evaluated. Screened sites were reevaluated using expected equivalent annual damages at each structure remaining after implementation of all structural plan elements. A summary of the non-structural part of the Full Plan is presented in Table 4.28. The non-structural portion of the plan would include approximately 147 structure elevations, dry floodproofing at 64 structures, wet floodproofing at 51 structures, 118 structures where the basement would be filled and any portion of the first floor at risk of flooding would be floodproofed, construction of ring levees at 70 structures, and 183 buyouts.

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.

The 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, Park Ridge and some of the structures in Wheeling fall in this category, and are therefore would only be included in the Full Plan. By including the structures in Wheeling outside the minimum flow area, however, benefits were less than costs so non-structural measures outside the minimum flow areas in Wheeling were eliminated from the Full Plan.

Table 4.28 – Summary of Full FRM Plan Non- Structural Measures

County	Total Structures	Benefits ($1,000)	Project Costs ($1,000)	Annual Costs ($1,000)	Net Benefits ($1,000)	BCR
Cook	403	$2,406	[redacted]	$826	$1,581	2.9
Lake	292	$1,637	[redacted]	$638	$999	2.6
Kenosha	38	$231	[redacted]	$55	$175	4.2
Total	733	$4,274	[redacted]	$1,519	$2,755	2.8

(FY2013 Price Level, FDR 3.75%)

4.6.7 Last Added Analysis: NED and CAP Plans

A last added analysis was also conducted for features meeting the criteria for inclusion in the NED and CAP plans. DPBM04 and FPCI01 were not considered in this analysis. Using the same procedures, the site with the highest benefits – DPLV09 – was combined with the remaining sites to determine the combination with the highest net benefits.

Table 4.29 – Summary of NED and CAP Last Added Analysis for Mainstem Structural Sites

Round of Last Added Analysis	Alternative With Highest Net Benefits	Total Benefits ($1,000)	Total Costs ($1,000)	Cumulative Net Benefits ($1,000)
--	DPLV04 – 6,400 ft floodwall and levee DPLV05 – 7,400 ft floodwall and levee DPLV09 – 11,100 ft floodwall and levee ACRS08 – 550 acre-foot Reservoir	$6,209	$2,910	$3,299
1	DPLV04 – 6,400 ft floodwall and levee DPLV05 – 7,400 ft floodwall and levee DPLV09 – 11,100 ft floodwall and levee ACRS08 – 550 acre-foot Reservoir DPLV01 – 2,800 ft floodwall and levee (CAP)	$6,641	$3,185	$3,456

(FY2013 Price Level, FDR 3.75%)

The incremental justification for screened non-structural sites was also evaluated. Screened sites were reevaluated using expected equivalent annual damages at each structure remaining after implementation of all NED and CAP structural plan elements. A summary of the non-structural part of the NED Plan is presented in Table 4.30. The non-structural portion of the NED plan would include approximately 144 structure elevations, dry floodproofing at 60 structures, wet floodproofing at 38 structures, 114 structures where the basement would be filled and any portion of the first floor at risk of flooding would be floodproofed, construction of ring levees at 68 structures, and 160 buyouts.

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.

Table 4.30 – Summary of NED Plan Non-structural Measures

County	Total Structures	Benefits ($1,000)	Project Costs ($1,000)	Annual Costs ($1,000)	Net Benefits ($1,000)	BCR
Cook	337	$2,294	[redacted]	$729	$1,566	3.1
Lake	292	$1,637	[redacted]	$638	$999	2.6
Total	629	$3,932	[redacted]	$1,367	$2,565	2.9

(FY2013 Price Level, FDR 3.75%)

4.7 Description of Flood Risk Management Plans

4.7.1 Plan Elements

The incrementally justified flood risk management sites include two reservoirs, two 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.

The sites below are the individual elements of the Flood Risk Management Plans, listed from upstream to downstream according to their locations within the watershed. The sites are components of the three plans formulated as discussed above and shown in Table 4.31. 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 Full Plan. In addition, the full plan includes projects that would not be implemented by USACE, but rather by local flood risk management or transportation agencies. These additional features are economically justified, but do not meet current USACE policy and guidance.

Table 4.31 – Summary of Flood Risk Management Plans

Plan	Sites	Benefits ($1,000)	Costs ($1,000)	Net Benefits ($1,000)	BCR
Full	DPBM04 + DPLV04 + DPLV05 + DPLV09 + ACRS08 + DPLV01 + FPCI01 + non-structural measures (15 communities)	$15,213	$5,510	$9,702	2.2
NED	DPLV04 + DPLV05 + DPLV09 + ACRS08 + non-structural measures (10 communities)	$10,371	$4,332	$6,039	2.4
CAP	DPLV01	$432	$275	$157	1.6

(FY2013 Price Level, FDR 3.75%)

Plate 15 shows the location of the sites in the watershed. Plate 16 through Plate 23 shows conceptual site plans for each structural measure.

ACRS08 (NED) is on a 94 acre site in Buffalo Grove currently used for agriculture. The proposed 550 acre-ft reservoir will provide benefits by preventing roadway flooding and protecting structures on the mainstem, particularly residential and commercial. Recommended for authorization and implementation by USACE.

FPCI01 (Full) will 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. Recommended for authorization and implementation by local flood risk management agencies.

DPLV09 (NED) is a floodwall and levee along the west bank of the Des Plaines from Ashland Avenue to Fargo Avenue in Des Plaines. The floodwall and levee will have a greater than 95% chance of not being overtopped during a 100 year flood event. Multi-purpose recreation trails will 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. Recommended for authorization and implementation by USACE.

DPLV05 (NED) is a 7,400 foot levee and floodwall along the west bank of the Des Plaines River in Schiller Park. The structure will protect homes and businesses along the mainstem Des Plaines River from Belmont to Irving Park Road. The crest elevation is 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 will be greater than 95%.

DPLV04 (NED) is a 6,400 foot levee and floodwall along the west bank of the Des Plaines River in River Grove. The structure will protect homes and businesses along the mainstem Des Plains River from the Palmer Street and Fifth Avenue along Fifth Avenue and River Road to the Canadian North Railroad. The crest elevation is 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 will be greater than 95%.

DPBM04(Full) will raise the pavement elevation of First Avenue Bridge in River Grove above the 1% annual chance of exceedance flood elevation The site will be designed to prevent adverse impacts to surrounding structures by extending the bridge length, providing greater conveyance capacity under the roadway. Recommended for authorization and implementation by local transportation agency.

DPLV01 (CAP) will raise and extend an existing levee in Riverside, tying back the structure to high ground. The levee will have a greater than 95% chance of not being overtopped during a 100 year flood event. This levee does not impact the water surface profile and will not require compensatory storage. Recommended for authorization and implementation under the USACE Continuing Authorities Program (CAP).

Non-structural (Full) measures will be implemented at structures in municipalities where benefits for a non-structural program exceed the costs. These communities include Riverside, River Grove, Schiller Park, Rosemont, Des Plaines, Prospect Heights, Park Ridge, Wheeling, Riverwoods, Buffalo Grove, and Gurnee in Illinois and Salem, Bristol, Somers, and Paddock Lake in Wisconsin. Participation would be on a voluntary basis and structure eligibility will be verified prior to implementation. Recommended for implementation by local flood risk management agencies.

Non-structural (NED) measures in areas meeting the tributary minimum flow criteria are a subset of the Full Plan non-structural measures. As with the full plan, these would be implemented at structures in municipalities where a benefits for a non-structural program exceed the costs. These municipalities include Riverside, River Grove, Schiller Park, Rosemont, Des Plaines, Prospect Heights, Riverwoods, Buffalo Grove, and Gurnee in Illinois. Participation will be on a voluntary basis and structure eligibility will be verified prior to implementation. Recommended for authorization and implementation by USACE.

4.7.2 Costs of Plan Elements

The costs used to compare plan elements are annualized over the 50 year period of analysis. This first costs are implementation; supervision and administration (S&A); lands, easements, rights of way, relocations, and disposal areas (LERRDs); and interest during construction (IDC). These costs, annualized at the current federal discount rate (3.75%), together with the annual operation and maintenance (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 O&M	Average Annual Costs
ACRS08	NED	[redacted]	[redacted]	$819,000
FPCI01	Full	[redacted]	[redacted]	$70,000
DPLV09	NED	[redacted]	[redacted]	$1,044,000
DPLV04	NED	[redacted]	[redacted]	
DPLV05	NED	[redacted]	[redacted]	
DPBM04	Full	[redacted]	[redacted]	$736,000
DPLV01	CAP	[redacted]	[redacted]	$275,000
Kenosha County Non-Structural	Full	[redacted]	[redacted]	$55,000
Lake County Non-structural	NED	[redacted]	[redacted]	$638,000
Park Ridge (Cook County) Non-structural	Full	[redacted]	[redacted]	$21,000
Cook County Non-structural	NED	[redacted]	[redacted]	$1,566,000

[1]The NED and CAP Plans only include indicated sites. The Full Plan includes all NED, CAP, and Full sites.
[2] Economic Costs include implementation, preconstruction engineering and design, supervision and administration, estimated lands and damages, and Interest During Construction

(FY2013 Price Level, FDR 3.75%)

4.7.3 Long-Term Risk

The flood risk management (FRM) measures identified for inclusion in the tentatively selected 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.

Table 4.32 also shows the risk associated with the reservoir design. The risk associated with the reservoir project is interpreted in a similar manner. In the prior paragraph the target criteria was the crest of the levee. A reservoir effects downstream stage reductions by modifying the volume of water in the stream or the timing of the flood wave. The impact on damage reduction for a reservoir can be far more extensive. The project performance criteria for a reservoir is the project's ability to reduce residual damages at the 1% annual exceedance probability. The target stage, per reach, is determined as that stage at which there is a 5% residual damage at the 1% annual exceedance probability. Site ID ACRS08 shows that the reservoir has 31% probability of not increasing the 5% residual damages for reach DP22B for the 10% annual exceedance storm event.

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.

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

		Site ID				
		DPLV01	DPLV04	DPLV05	DPLV09[2]	ACRS08[1]
Annual Probability of Flooding	Median	0.01%	0.01%	0.01%	0%	13%
	Expected	0.00%	0.00%	0.00%	0%	13%
Long-Term Risk of Flooding (years)	10	0.02%	0.02%	0.02%	0%	75%
	30	0.05%	0.05%	0.07%	1%	98%
	50	0.09%	0.09%	0.12%	2%	100%
Conditional Probability of Flood Avoidance by Events (Annual Percent Chance of Exceedance)	10%	100.00%	100%	100%	100%	31%
	4%	100.00%	100%	100%	100%	2%
	2%	100.00%	100%	100%	100%	0%
	1%	99.98%	100%	100%	99%	0%
	0.40%	99.88%	99%	99%	97%	0%
	0.20%	99.85%	99%	99%	95%	0%

1. Data reflects information at Reach DP22B at the confluence of the Des Plaines River and Aptakisic Creek; HEC-FDA default parameters of 0.01 Event Exceedance Probability and Percent Residual Damage of 5.
2. HEC-FDA Reach DP10R, DP11R, DP12R, and DP13R report the same values

4.7.4 Residual Risk

Implementation of a 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.

Flood warning and response plans will be developed to identify appropriate local entities responsible for project operation and monitoring during a flood event. 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 the Operations and Maintenance manual.

The Full Plan would reduce mainstem flood damages by approximately 29%. The NED Plan would only reduce those damages by 20% and the CAP Plan would add an additional 1% increment to the NED damage reduction. 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 extirpation 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 sixteen amphibian, twenty-three 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 of the Upper Des Plaines River Watershed

Plant Community	Tier 1	Tier 2
Prairie	Fine-textured-soil	dry-mesic; mesic; wet-mesic; wet
Savanna	Fine-textured-soil	dry-mesic; mesic; wet-mesic; wet
Woodland	Upland	dry-mesic; mesic; wet-mesic; northern flatwoods
	Floodplain	mesic; wet-mesic; wet
Riverine	Stream	medium gradient; low gradient
	River	medium gradient; low gradient
Wetland	Isolated depression / floodplain depression	marsh; shrub swamp; calcareous floating mat
		fen; graminoid fen; sedge meadow; seep
Other	Lake	glacial; artificial
	Ponds	vernal; artificial
	Cultural	urbanland; cropland; pastureland; successional fields

The two most dominant types of habitat were oak savanna and prairie, with lesser amounts of 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.

Plant Community	Wisconsin		Illinois	
	1800s	Present	1800s	Present
Prairie	26%	5.30%	34%	9%
Savanna	17%	0.00%	27%	~0%
Woodland	43%	5.60%	13%	18%
Wetland	14%	8.00%	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 upland forest, and dry-mesic upland 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 (IDNR1998).

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 future without-project conditions of the Upper Des Plaines River watershed's biological and human environment.

In order to derive the current, future without project and future with project 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 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.

<u>Fishes</u>

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 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.

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 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.

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, future without project 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:

- Southeastern Wisconsin Regional Planning Commission (SEWRPC)
- Lake County Storm water Management (SMC)
- Forest Preserve District of Cook County (FPDCC)
- Lake County Forest Preserve District (LCFPD)
- Illinois State Water Survey (ISWS)
- Illinois Department of Natural Resources (ILDNR)
- Natural Resource Conservation Service (NRCS)
- US Fish & Wildlife Service (USFWS)
- US Army Corps of Engineers (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, Illinois and Wisconsin.

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	**Covertype**	**Community Type**	**Assessment Method**
LAKEGLACL	glacial lakes	Natural	Not Assessed
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 upland forests & woodlands	Natural	HEP Woodland Model
LAKEARTIFC	artificial lakes	Anthropogenic	Not Assessed
DETENTION	detention ponds & borrow pits	Anthropogenic	Not Assessed
AGCROPLAND	agricultural croplands	Anthropogenic	Not Assessed
PARKS	parks, open recreation	Anthropogenic	Not Assessed
PASTURES	pastures, haylands and urban fields	Anthropogenic	Not Assessed
URBAN	urban lands (residential, roads, etc)	Anthropogenic	Not Assessed

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 24). 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 s show 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 ten 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 Conditions (FWOP)

The future without-project 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. 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. 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.

Future forecasting of increased populations would include continued land conversion from agriculture/open areas to urban uses. Most of the growth projected to occur in Lake County, north of Cook County (Chicago metropolitan region) with some conversion to occur across the state line in Kenosha County. Future without project conditions for urban dominated areas of the watershed are not predicted to change significantly because the southern half of the watershed is already fairly well developed. Therefore, the urban areas of the watershed are expected to see only minimal land use changes. Small areas may experience restoration of ecosystem function; however system-wide restoration of function is unlikely. Future without project conditions in the more rural north of the watershed is predicted to lose ecological function as land use changes. In addition to land conversion losses, the ecological integrity of the remaining open areas of the rural north is predicted to persist in the low quality range.

Analysis focusing on the streams and rivers of the watershed suggests the future without project 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 future without project 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 future without-project 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 (FWOP) 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 future with project (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 riparian zone and provide benefits to the environment.

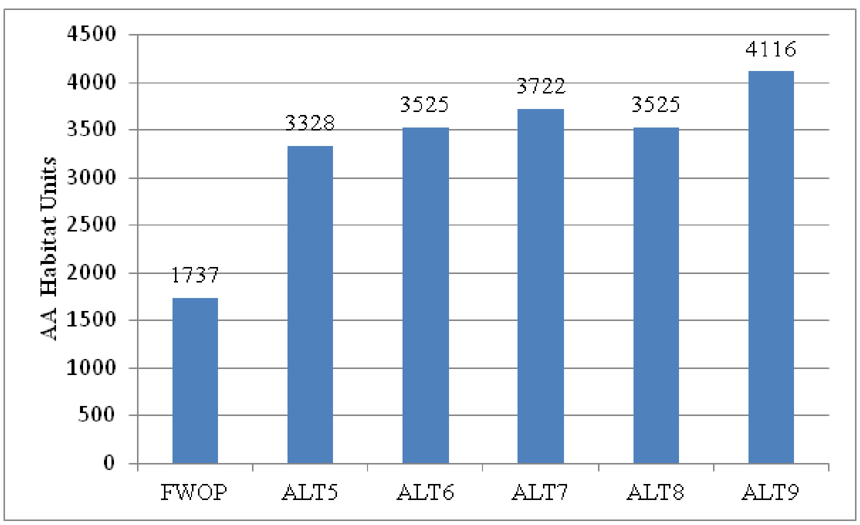

Figure 5.1 – Riverine FWOP vs. FWP Model Output Comparison.

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 may 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 feasible for implementation.

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

1. Identify a primary project purpose. For this portion of the study, ecosystem restoration (ER) is identified as the primary purpose.
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 need 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.

The combinability and dependability of these measures were addressed when the alternatives in Section 5.4.4 were developed. No dependency / combinability settings were engaged within the IWR-planning software because all of the measures are independent.

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.

<u>H1 Tile Disablement</u> – 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 uplands 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 every few hundred feet or yards. 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.

<u>H2 Ditch Filling / Plugging</u> – Agricultural ditches are located throughout the Des Plaines River watershed. These effectively disrupt the natural hydrologic regimes of uplands, wetlands, and riverine systems, especially when natural streams were excavated. Ditch filling and plugging is another cost effective method of hydrologic restoration. This is because it typically recreates the natural hydrologic regime and landscape of the site and does not require periodic maintenance. It thus is the most likely to maximize biodiversity and minimize 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 below.

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 on 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. There are very few sites that 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. Through dam removal, both fish passage and riverine function may be restored, which have benefits of fish passage, habitat restoration and water quality improvement. 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 would 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 on 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 plan 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.

<u>P1 Invasive Woody Vegetation Removal</u> – 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 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 favorable 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 against 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 is set but after the plant has invested energy into flowering 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, which are adapted to grazing and browsing, 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 will 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 graminoid species must be present to carry 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 rotational basis for longer-term maintenance of the restored area.

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 20cm 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 in question 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 artifact of 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.

<u>P6 Plugging</u> – 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.

<u>P7 Tree/Shrub Planting</u> – 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 25).

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.

Table 5.5 – Ecosystem Restoration Site Selection Criteria.

#	Screening Criteria	Score	Description
A	Potential Restoration Acreage (based on site polygon size)	3	greater than 100 acres
		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
		2	4 - 5
		1	2 - 3
		0	0 - 1
C	Proximity to a Stream (based on USGS streams coverage)	3	direct riparian zone
		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%
		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
		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
		2	between ¼ & ½ mile buffer
		1	between ½ & 1 mile buffer
		0	over 1 mile buffer
Maximum Points		18	
Minimum Points		0	

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 continuing human intervention. 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 was 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 endangered species, and provide connectivity to other natural areas. Each of the objectives and criteria for this study was designed to demonstrate that a selected restoration plan makes is in accord and contributes to the

Civil Works objectives and the Ecosystem Restoration goal. 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

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 2 for 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 retained. These sites are shown in Plate 26.

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. Average project 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 stub. 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 – Monitoring includes the systematic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain project benefits. Monitoring will be 3% of total project estimate and will be cost shared. Monitoring will commence once the construction phase of the project is complete and will end within ten years of the start of monitoring activities. Depending on the project measures required per proposed alternative, the monitoring period will be from 3 to 5 years in duration. Again, based on the nature of the restoration project a combination of the following variables will be measured per project:

Vegetation (data can be collected once a year)
1. Native species richness and evenness (abundance, frequency)
2. Invasive species abundance or coverage
3. Plant community conservativeness (Floristic Quality Index-FQI score)
4. Woody species structure (height, coverage)

Fish, Mussels and Macroinvertebrates (data can be collected once or twice a year)
1. Community structure
2. Native species richness and abundance
3. Non-native species abundance and influence

Wildlife (data can be collected at various frequencies throughout the year)
1. Native species richness
2. Native species breeding success

Riverine Physical Structure (can be collected once a year):
1. Proper Cut and Fill Alluviation
    a. erosion and sediment transport
    b. stream sinuosity
    c. stream complexity (substrates, woody debris, etc.)
2. Depth, frequency and duration of flooding

Annual OMRR&R – Planning Level Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) costs 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, below. 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 three 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 location of the site (urban or rural).

Table 5.6 – OMRR&R Unit Costs

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

(FY2010 Price Level, FDR 4.125%)

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.

<u>Total Annualized Cost</u> – 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. LERRDs value will be incorporated in the second cut of CE/ICA when sites are compared against each other. LERRDs were not used for the first cut since comparing alternatives within the same site is not affected by the site's own worth.

PED Phase – Pre-construction, Engineering and Design Costs are set at a standard of 7% of the total construction cost 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 (Table 5.7)**

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, with recolonization of the native plant community relying on the natural rate of distribution from nearby source populations. The plant community would be allowed to follow an unmanaged albeit unnatural successional pathway.

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 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**

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								
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 Vegetation Removal	P1	X	X	X	X	X	X	X	X	X
Invasive Herbaceous Vegetation 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

* 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 "future with project" conditions over the entire 50-year life of the project 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 Engineer Research and Development Center (ERDC)), and for riverine benefits, IBI was used. The future without project 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 below.

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

		Cook	S Lake	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**

*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 alternatives and various-sized alternatives are evaluated to arrive at a best level of output within the limits of both the sponsor's and the USACE 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 for sites located in the rural north (R) and one set of nine for sites located in the urban south (U) of the watershed. Because the alternatives were constructed from the described measures presented in Section 5.4.3 in order to meet specific restoration benefit thresholds, alternatives were not combinable. This first cut of 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				

(FY2010 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	L10	7	254	$1,891,131
C2	8	392	$1,300,362	L11	8	271	$1,104,410
C3	8	486	$2,120,141	L12	9	37	$357,661
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
C12	8	666	$2,197,919	L20	6	120	$385,098
C13	6	7	$145,712	L21	6	184	$1,308,821
C14	6	20	$151,182	L22	6	514	$2,910,666
C15	8	1494	$3,989,931	L23	9	1015	$3,496,017
C16	8	329	$1,518,097	L24	6	434	$2,440,174
C17	8	153	$695,152	L25	8	294	$1,069,665
C18	6	20	$222,966	L26	8	160	$816,937
L01	7	235	$567,103	L27	6	253	$904,758
L02	9	475	$2,120,227	L28	9	812	$4,553,527
L03	6	504	$1,901,600	L29	9	400	$3,061,277
L05	8	234	$87,329	L30	6	254	$1,275,340
L06	9	777	$3,440,622	L32	6	437	$1,501,488
L09	7	366	$1,551,920	L44	8	652	$1,478,842

(FY2010 Price Level, FDR 4.125%)

Site per County CE/ICA

Once the best buy alternatives were identified per site, the 131 sites were grouped by county to run the second cut CE/ICA. There are two reasons for grouping sites by county to perform the second tier analysis. One is the large difference between real estate costs between Illinois counties vs. Kenosha/Racine counties. A preliminary real estate analysis indicated that average cost per acre among the three counties were approximately $50,000 for Cook, $48,000 for Lake and $5,000 for Kenosha and Racine. Since the cost of real estate is included in the average annual cost per alternative plan per site, this extreme disparity biases the cost effective/incremental cost analysis in favor of sites located in Wisconsin where the real estate is of lower value. This is not the intended outcome of the planning process. The biasing effect of real estate costs violates the intent of the watershed planning process in terms of the decision-making criteria such as ecological outputs, significance of outputs and efficiency. By implementing the standard process of combining all sites across the watershed with no respect to real estate costs within one cost analysis, the results would not indicate the most suitable sites for restoration, but would in fact indicate where real estate is less costly. As a way to complete the planning process in an acceptable, complete, effective and significant manner, sites that are indicated to be cost effective per county were used to formulate the NER plan by performing a plan trade-off analysis. The cost effective analysis per county is presented below in Figure 5.2 through Figure 5.4 and the results are presented in Table 5.12 through Table 5.14.

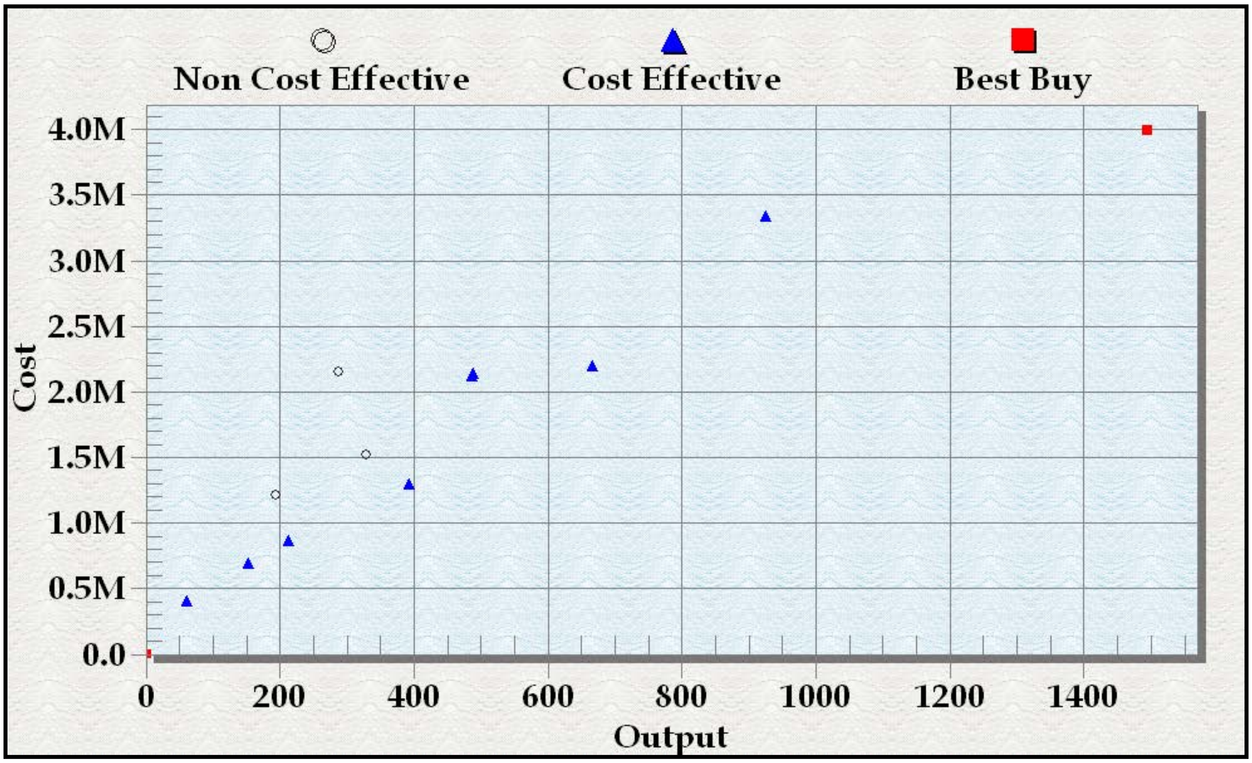

Figure 5.2 – Cook County Cost Effective Analysis.

Table 5.12 – Cook County Cost Effective Sites.

Sites	Alt#	Net AAHUs	AA Cost	Average Cost / HUs
C15	8	1494	$ 3,989,931	$2,671
C12	8	666	$ 2,197,919	$3,300
C02	8	392	$ 1,300,362	$3,317
C09	8	925	$ 3,345,753	$3,617
C07	3	212	$ 871,299	$4,110
C03	8	486	$ 2,120,141	$4,362
C11	8	488	$ 2,144,591	$4,395
C17	8	153	$ 695,152	$4,543
C16	8	329	$ 1,518,097	$4,614
C05	4	194	$ 1,216,424	$6,270
C04	6	61	$ 406,552	$6,665
C01	6	287	$ 2,153,102	$7,502

(FY2010 Price Level, FDR 4.125%)

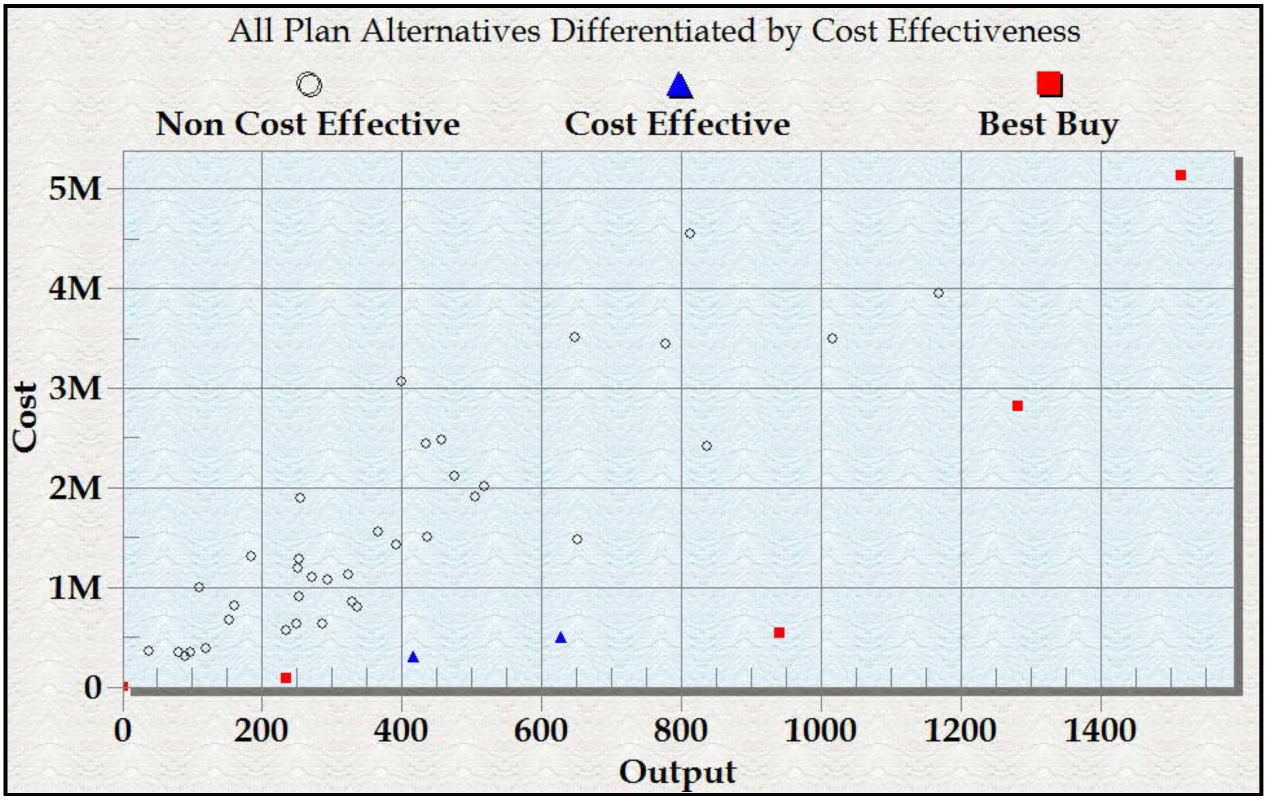

Figure 5.3 – Lake County Cost Effective Analysis.

Table 5.13 – Lake County Cost Effective Sites.

Sites	Alt#	Net AAHUs	AA Cost	Average Cost / HUs
L05	8	234	$ 87,329	$373
L33	4	415	$ 311,916	$751
L39	6	626	$ 497,067	$794
L31	4	939	$ 537,474	$572
L41	9	1281	$ 2,819,167	$2,201
L43	2	1513	$ 5,130,113	$3,390

(FY2010 Price Level, FDR 4.125%)

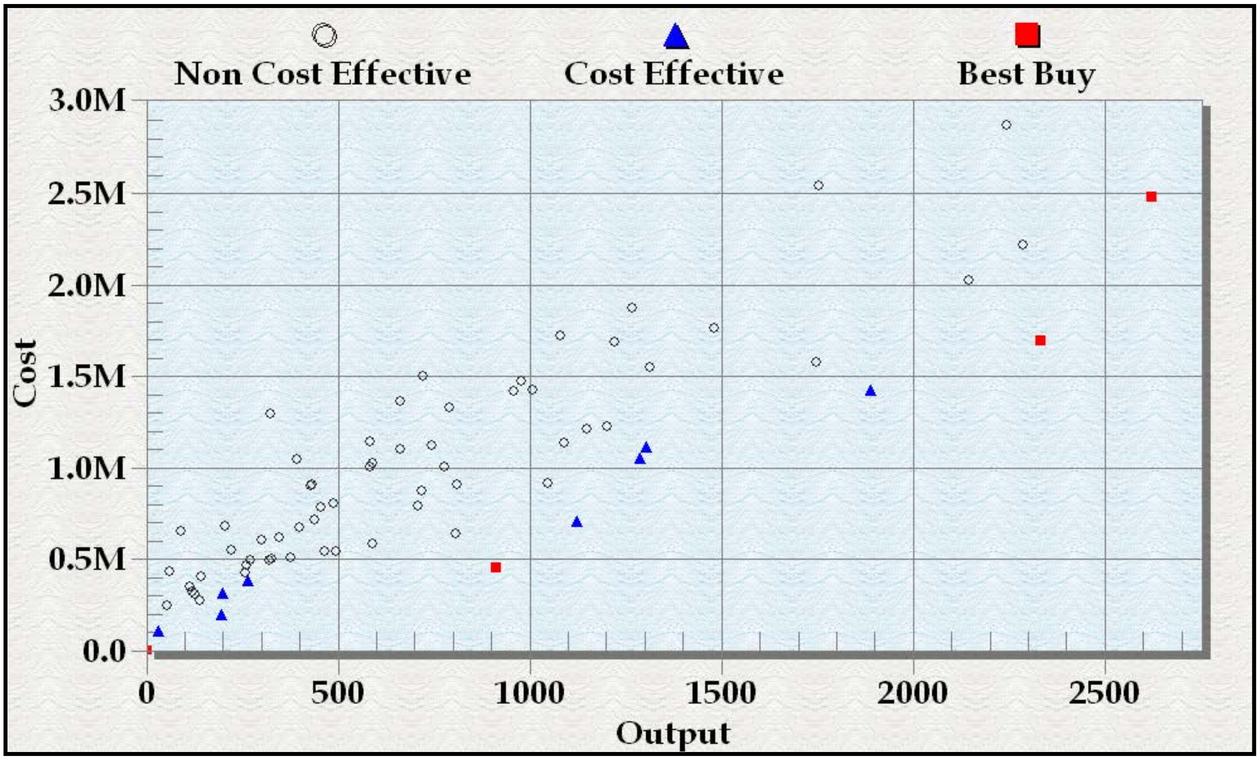

Figure 5.4 – Kenosha & Racine Counties Cost Effective Analysis.

Table 5.14 – Kenosha/Racine County Cost Effective Sites.

Sites	Alt#	Net AAHUs	AA Cost	Average Cost / HUs
R04	5	912	$ 454,626	$ 498
K09	9	1124	$ 710,010	$ 632
K47	9	2332	$ 1,695,581	$ 727
K64	9	1890	$ 1,426,074	$ 755
K41	6	1286	$ 1,050,026	$ 817
K62	9	1303	$ 1,115,051	$ 856
K33	9	2621	$ 2,479,799	$ 946
K17	2	195	$ 196,168	$1,006
K14	9	264	$ 382,385	$1,448
K01	3	199	$ 311,032	$1,563
K13	2	31	$ 106,890	$3,448

(FY2010 Price Level, FDR 4.125%)

The cost effective sites presented above were then assessed with an ICA. Each county group of sites was run independently again to avoid real estate costs from driving plan selection, and to allow habitat units and construction costs to be compared in their respective parts of the watershed. Incremental costs and outputs are displayed to guide decision makers to choose how much benefit is worth the cost. Note that when a cost effective site is not identified as a "best buy" this does not constrain the additional trade-off analysis, utilizing the decision criteria, from indicating the site would be valuable for implementation to attain project goals and objectives. Based on this ICA, restoring 7 sites and removing 5 small dams would be a good investment for the Upper Des Plaines River watershed ecosystem; however, other factors play an important role in selecting a plan, such as the significance of the outputs, risk of failure, and various measures of environmental and economic consideration that will be discussed in subsequent sections. The ICA per county is presented below in Figure 5.5 through Figure 5.7 and the results are presented in Table 5.15 through Table 5.17.

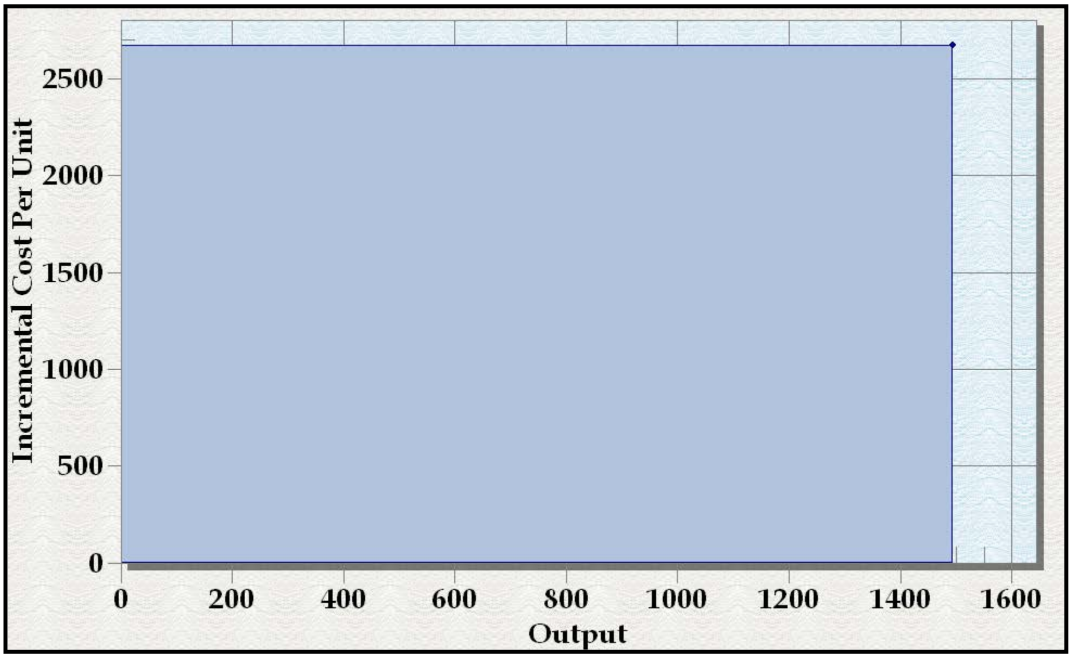

Figure 5.5 – Cook County Best Buy Incremental Analysis

Table 5.15 – Cook County Best Buy Sites.

Site	Alt #	Net AAHUs	AA Cost	Cost/HU	Inc. Cost	Inc. HUs	Inc. Cost/HU
NA	-	-	-	-	-	-	-
C15	8	1,494	$3,989,931	$2,671	$3,989,931	1,494	$2,671

(FY2010 Price Level, FDR 4.125%)

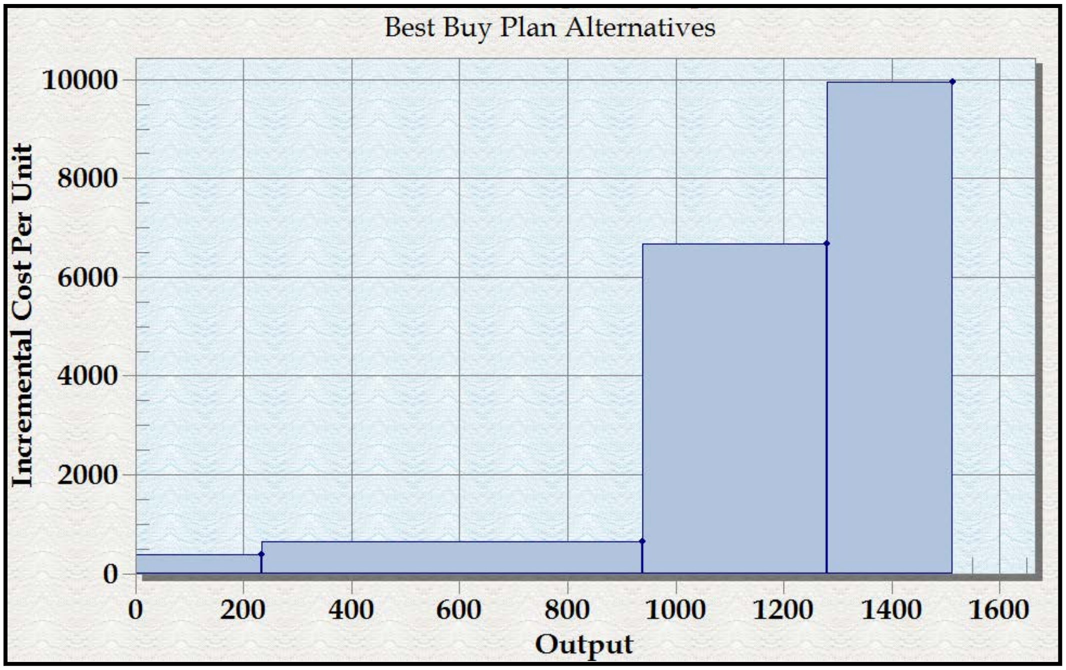

Figure 5.6 – Lake County Incremental Cost Analysis.

Table 5.16 – Lake County Best Buy Sites.

Site	Alt #	Net AAHUs	AA Cost	Cost/HU	Inc. Cost	Inc. HUs	Inc. Cost/HU
NA	-	-	-	-	-	-	-
L05	8	234	$87,329	$373	$87,329	234	$373
L31	4	934	$537,474	$572	$450,145	705	$638
L41	9	12,801	$2,819,167	$2,201	$2,281,692	342	$6,672
L43	2	1,513	$5,130,113	$3,390	$2,310,947	232	$9,946

(FY2010 Price Level, FDR 4.125%)

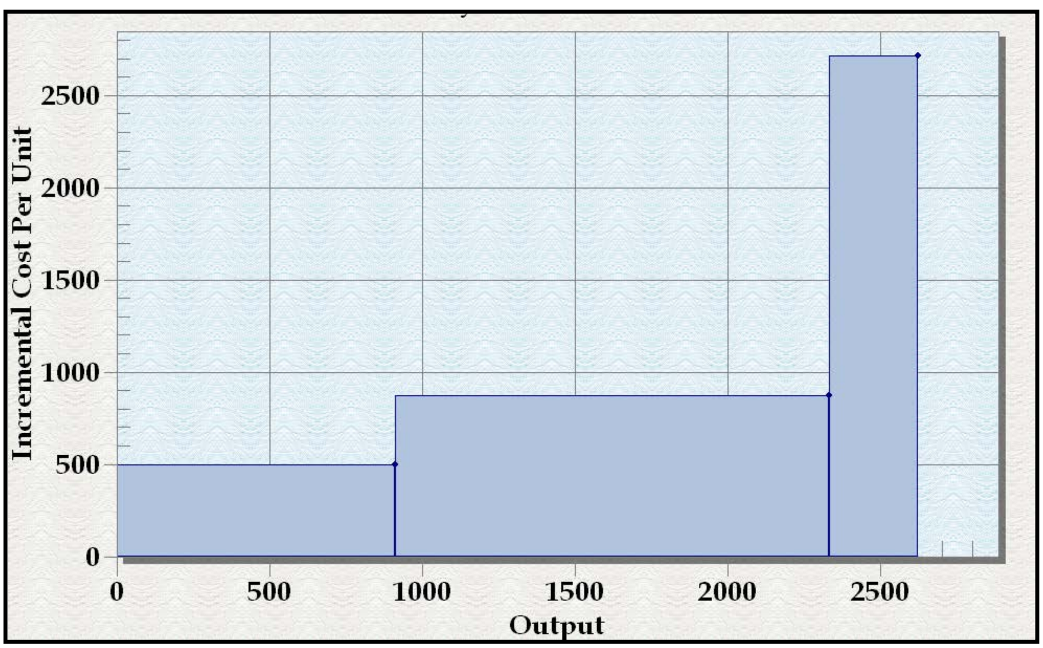

Figure 5.7 – Kenosha/Racine Incremental Cost Analysis.

Table 5.17 – Kenosha/Racine Best Buy Sites.

Site	Alt #	Net AAHUs	AA Cost	Cost/HU	Inc. Cost	Inc. HUs	Inc. Cost/HU
NA	-	-	-	-	-	-	-
R04	5	912	$ 454,626	$ 498	$ 454,626	912	$ 498
K47	9	2,332	$1,695,581	$ 727	$1,240,955	1,420	$ 874
K33	9	2,621	$2,479,799	$ 946	$ 784,218	289	$2,714

(FY2010 Price Level, FDR 4.125%)

5.4.7 Alternative Plan Trade-Off Analysis

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

Two Ecosystem Plans and the No Action Plan are discussed in the following sections. One plan that is always considered and required by NEPA is the No Action Plan. The two action plans are: Ecosystem Plan 1, which is comprised of just the "Best Buy" sites and Ecosystem Plan 2, which are the "Best Buy" sites with five additional cost effective sites, two in Kenosha County, one in Cook County and two in Lake County (Table 5.16). The addition of the two sites in Kenosha County, K09 and K41, were requested by the county, a stakeholder and non-Federal sponsor, to be added to a plan since these sites were part of their master plan (Planning Report No. 44, A Comprehensive Plan for the Des Plaines River Watershed; 2003.). Site C09 was requested by Cook County to be added to a plan since it would mesh nicely with the removal of Dam #1, which is within the site, just as the removal of Dam #2 corresponds with C15. Sites L33 and L39 were requested by Lake County, also a stakeholder and non-Federal sponsor, to be added to the plan because restoration of these sites are a part of their long-term vision for their forest preserve properties.

Table 5.18 – Ecosystem Plans Considered for Implementation

Site	Alternative	Ecosystem Plan 1	Ecosystem Plan 2	CE/ICA
C09	8		X	Cost Eff
C15	8	X	X	Best Buy
K09	9		X	Cost Eff
K33	9	X	X	Best Buy
K41	6		X	Cost Eff
K47	9	X	X	Best Buy
L05	8	X	X	Best Buy
L41	9	X	X	Best Buy
L43	2	X	X	Best Buy
L31	4	X	X	Best Buy
L33	4		X	Cost Eff
L39	6		X	Cost Eff
R04	5	X	X	Best Buy

(FY2010 Price Level, FDR 4.125%)

5.4.7.1 **Ecological Benefits of Identified Plans**

The total with and without project ecological benefits per plan are displayed in Table 5.18 and Figure 5.8. The future without project 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 plan is Ecosystem Plan 2 since it is able to increase the overall habitat quality of the entire Upper Des Plaines River watershed by 54%. Ecosystem Plan 1 provides a 39% increase to overall habitat quality and the No Action Plan provides no improvement.

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

Plan	FWOP	Net FWP	Total FWP	% Improvement
No Action	28,881	0	28,881	0%
Ecosystem 1	28,881	11,326	40,207	39%
Ecosystem 2	28,881	15,702	44,583	54%

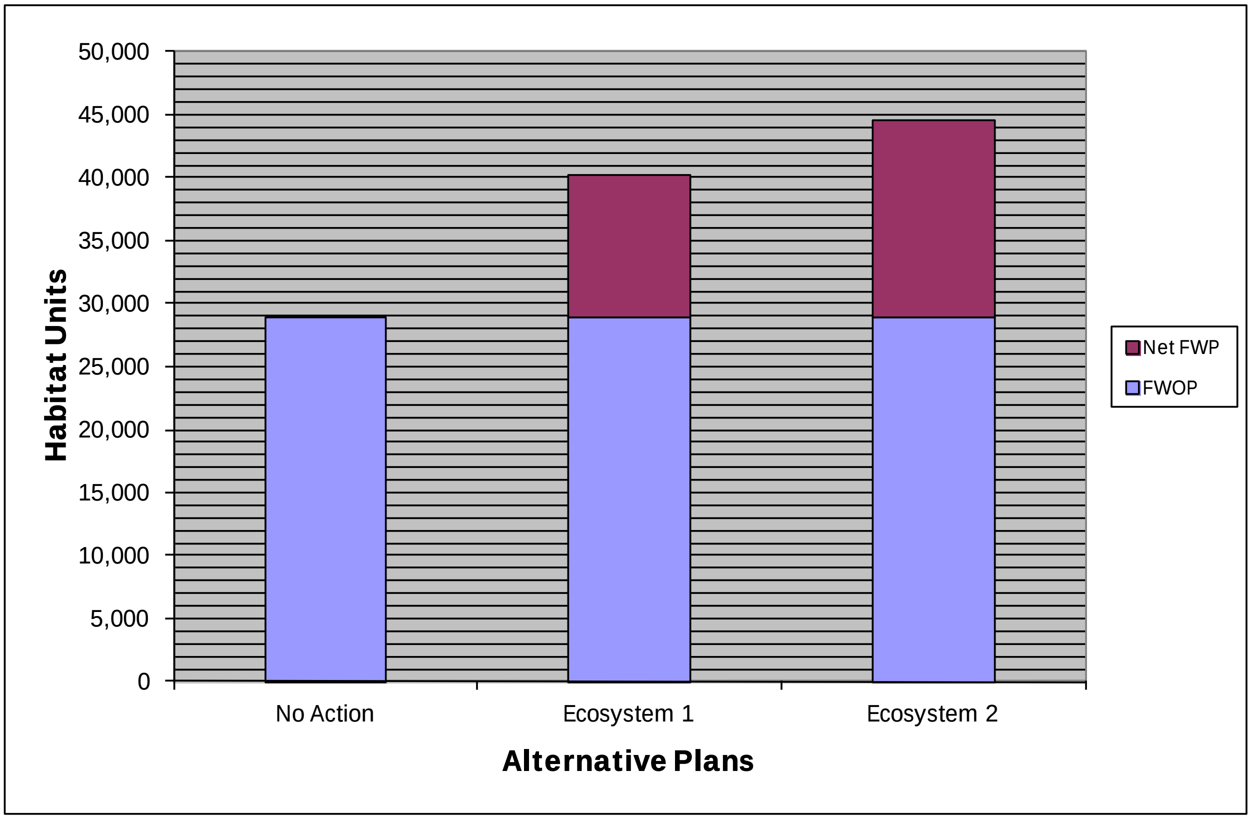

Figure 5.8 – Upper Des Plaines River Watershed Total With & Without Project Habitat Units

5.4.7.2 **Significance of Ecosystem Habitat Units**

Because of the challenge of dealing with non-monetized benefits, the concept of output significance plays an important role in ecosystem restoration evaluation. Along with information from cost effectiveness and incremental cost analyses, information on the significance of ecosystem 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 help decision makers evaluate whether the value of the resources of any given restoration alternative are worth the costs incurred to produce them. The significance of the habitat units provided by the two Ecosystem Plans is herein recognized in terms of institutional, public, and/or technical importance. The No Action Plan is not discussed here since doing nothing would not create significant habitat improvement within the watershed.

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.

Clean Water Act – Restore 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 processes important in the filtering of precipitation and runoff. Water quality within the Des Plaines River will be improved through the restoration of natural land cover, the removal of small dams and the addition of instream structure. It is inherent that the more land is reverted back to natural conditions and able to absorb and filter water; the more water quality would improve. The recommended measures are very cost effective in terms of allowing natural processes to provide long term benefits.

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 be beneficial to the Federally endangered butterfly Melissa blue (*Plebejus Melissa*) and the federally threatened prairie white-fringed orchid (*Platanthera leucophaea*). There are also over one hundred state endangered and threatened species within one 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 indirectly benefit an array of valued species found in the Midwest.

Fish and Wildlife Conservation Act of 1980 – All Federal departments and agencies to the extent practicable and consistent with the agencies authorities should conserve and promote conservation of non-game fish and wildlife, and their habitats. Restoring the vegetative structure of the Upper Des Plaines watershed and increasing the native plant growth will increase the habitat diversity of the system. Restoring the connectivity of the river and providing instream habitat will decrease impediments to native fish migration as well as increase habitat structure and availability. Removal of unnatural habitats would reduce the abundance ratio of exotic to native species. All habitat improvements would benefit plants, invertebrates, fish, birds, amphibians, reptiles and other wildlife.

EO 11514 Protection and Enhancement of Environmental Quality – The Federal Government shall provide leadership in protecting and enhancing the quality of the Nation's environment to sustain and enrich human life. Improving the quality of the Upper Des Plaines watershed would help to restore an area with numerous community types supporting rare flora and fauna. Because of the importance of the Chicago Region in terms of biodiversity, the recommended measures would increase the overall region's ability to support valuable native flora and fauna.

E.O. 11988 Floodplain Management - 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.

E.O. 11990 Protection of Wetlands - 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. Overall, the study area within Illinois contains 12,140-acres of wetland, most of which had been impacted by increased sedimentation, erratic hydrology, agricultural practices, and invasive species infestation. Wetland restoration efforts will address disturbances linked to anthropogenic development with restoration of hydrologic, geomorphic and botanical features that were characteristic of the Upper Des Plaines River watershed. The amount of wetlands that would be reestablished and restored through the recommended plan is a significant increase to the overall region.

EO 13186 Responsibilities of Federal Agencies to Protect Migratory Birds – Federal agencies shall restore or enhance the habitat of migratory birds and prevent or abate pollution or detrimental alteration of the environment for migratory birds. This project will restore native riverine and upland communities, thus providing forage and shelter to numerous migratory bird species. The Upper Des Plaines River watershed provides an important stopover for the Great Lakes migratory flyway, especially for birds that fly along the southern rim of Lake Michigan. 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.

Considering the above discussion on institutional recognition, both Ecosystem Plans would significantly benefit the Upper Des Plaines River watershed. Ecosystem Plan 2 would be more beneficial since it provides more area and better quality habitat to support these institutional principles.

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 and the Little Red Schoolhouse 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 watershed and is rapidly growing. Many groups 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 volunteer 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 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 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 area’s with rapidly declining rare and listed species. 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 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. The strong public involvement in outdoor recreation within the study area directly relates to the importance of an environmental resource for a growing population involved in protecting their natural areas. These natural areas are a part of a nationally recognized network of open areas (370,000 acres of protected natural areas in the Chicago Region) that has set the standard for conservation of open lands in developed areas. Additionally, the watershed is included in the Northeastern Illinois Invasive Plant Partnership (NIIIP), which coordinates efforts to manage invasive plant species across the region. NIIP 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.

Considering the above discussion on public recognition, both Ecosystem Plans would significantly benefit the Upper Des Plaines River watershed. Ecosystem Plan 2 would be more beneficial since it provides more area and better quality habitat to support the efforts of these groups.

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 whether a local, regional, or national perspective is undertaken, typically a watershed or larger (e.g., ecosystem, landscape, or ecoregion) context should be considered. Technical significance should be described in terms of one or more of the following criteria or concepts: scarcity, representation, status and trends, connectivity, limiting habitat, and biodiversity.

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

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. Several habitats within the study area are also considered to be 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 historically provided a healthy response to natural and human induced disturbances. 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.

Representation is a measure of a resource’s ability to exemplify the natural habitat or ecosystems within a specified range. The presence of a large number and percentage of native species, and the absence of exotic species, implies representation as does the presence of undisturbed habitat.

Areas currently designated as nature preserves represent a 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, woody succession, old fields, and abandoned or unproductive agricultural land. Current areas of high quality would have the opportunity to expand and increase connectivity, while seed banks of remnant natural communities would germinate following the completion of restoration measures.

The opportunity for restoring hydrology and natural processes and improving water quality is high in riverine wetlands and floodplains as they interact extensively with both surface water and groundwater of surrounding upland habitats as well as water coming from upstream. These riparian areas have great potential for buffering streamwaters entering the watershed from upland activities by lowering nutrient content, reducing rapid flooding and drying cycles, and acting as a deposition for eroded upland 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 historic 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.

<u>Status and Trend</u> – 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, much 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 has 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. Half of Lake County alone used to be covered by savanna; today's acreage of high quality savanna is almost non-existent. Human induced disturbances to the remaining natural areas include fire suppression, altered hydrology, increase colonization of invasive species, and fragmentation. The recommended plans would significantly increase the footprint nationally and globally rare ecosystems.

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 vertical and horizontal structure within the system, available habitat to niche specific species will improve as well as the overall function of the river.

Limiting Habitat 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.

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, Illinois DNR, Wisconsin DNR, South Eastern Wisconsin Planning Commission, Kenosha County, Lake County SMC, Lake County Forest Preserve District, and the Cook County Forest Preserve District. Ecosystem Plan 2 was developed in conjunction with this team as another alternative plan that would increase benefits to the Upper Des Plaines River watershed, which is more 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, Cook County Forest Preserve and the Illinois DNR. These agencies would ultimately hold the responsibility for providing real estate and easements, and perform operation and maintenance of these sites once restored. Ecosystem Plan 1 was acceptable to the non-Federal sponsors; however, Ecosystem Plan 2 was more in line with their master plans and acquisition capabilities.

Overall, the No Action Plan is unacceptable to listed agencies and non-Federal sponsors above, while Ecosystem Plan 2 is the most acceptable for performing ecological restoration at a watershed scale.

Completeness

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

Ecosystem Plan 1 and 2 are considered complete since they restore a significant portion of the Upper Des Plaines River watershed. These two Plans recommend sites and alternatives that align with projects 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; the plans presented in this study will be invaluable additions to them in terms of connectivity and hydrology. The Lake County Forest Preserve is also in the planning and design phases of removing the Dan Wright, Ryerson and Rasmussen Lake dams. The Illinois DNR, Cook County Forest Preserve 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 Wisconsin DNR and SEWRPC have also completed several small fish passage projects and wetland restorations along the Des Plaines River that add to the importance of Ecosystem Plans 1 or 2.

As stated in the Acceptability section above, the primary non-Federal sponsors for this study and subsequent projects are the Lake County Forest Preserve, Kenosha County, Cook County Forest Preserve and the Illinois DNR. These agencies would ultimately hold the responsibility for providing real estate and easements, and perform operation and maintenance of these sites once restored. Ecosystem Plan 1 was acceptable to the non-Federal sponsors; however, Ecosystem Plan 2 was more in line with their master plans and acquisition capabilities. 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:

<u>Increase species richness, abundance and health</u> – This objective will specifically look to increasing total native species richness of restoration sites. This may be monitored using the HEP and HGM techniques. These assessment procedures and indices are calibrated for the region of study and are sensitive enough to capture improvements in quality. Ecosystem Plans 1 and 2 both would be effective at increase 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 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. These restoration projects used the same techniques that are described in the recommended plan that will be applied over greater extent of the landscape. Since the techniques rely to a great extent on unaided natural processes, after construction is complete, to maintain ecosystem structure and function, these have been shown to be a very cost efficient methods of restoring self-sustaining target species.

<u>Increase connectivity of natural areas</u> – Through creating greenways, riparian corridors and/or removing dams, this objective seeks to connect fragmented habitat parcels, whether they are currently in a healthy state or they are in need of restoration. Ecosystem Plan 2 is most effective at meeting the connectivity objective (Plate 46). The plan calls for removal of the last five dams that fragment the mainstem Des Plaines River. In addition, this plan connects site R04 to K09, K41 to L41, Redwing Slough and Mud Lake Sedge Meadow, L01 with Ryerson Conservation Area, and C15 with Carle Woods. Results from previous dam removals have all been proven to have successfully increased aquatic species richness and abundance in reaches above the dam (e.g., Brewster Creek and Hofmann Dam removal projects). This has been proven to be a very effective and cost efficient method of restoring connectivity of the landscape.

<u>Increase acreage of native community types</u> – The increase in overall acreage of natural areas within a given subwatershed is not only beneficial to the ecosystems, but also aids in alleviating hydrology and hydraulic problems. For example, a subwatershed that is primarily agricultural land would see improvements in ecological function and hydrology if drain tiles were broken and natural plant communities were restored. Ecosystem Plan 2 is effective at meeting the increased size of native communities and subsequent hydrology 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 9,800-acres of native community types would be restored including: marsh (2,525-acres), meadow (615 acres), prairie (3,315-acres), savanna (900-acres), woodland (1,450-acres) and forest (1,000-acres). Ecosystem Plan 2 increases the quality of watershed ecosystem communities by 50% of what currently exists, whereas Ecosystem Plan 1 would be effective at an increase of 37% (Figure 5.8).

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 and long-term maintenance, local impacts from invasive plant species may be minimized. Overall, Ecosystem Plans 1 and 2 are effective at reducing the impacts of non-native plant species. Ecosystem Plan 1 would return 7,475-acres of land back to native communities free of invasive species effects, whereas Ecosystem Plan 2 would do the same for about 9,800-acres. 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 2 is more efficient at providing connectivity and the addition of buffers to sites that are to be restored and existing nature preserves. Ecosystem Plan 1 does not provide for the buffers identified in the above connectivity objective. Also, Ecosystem Plan 2 provides and connects 35,000-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 combined sewer overflows (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 dramatic positive effects on water quality. Returning water into the ground and natural meandering streams will provide the means for filtering out nutrients and particulate matter that currently foul the waters of the 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 Plans 1 and 2 would be effective at achieving this cursory level of water quality restoration.

The following are points of how plans comply with planning constraints:

Compatibility with flood damage reduction plans – Ecosystem Plans 1 and 2 compliment flood damage reduction projects since they both would assist in attenuating water leaving the sites, infiltrate water back into the ground, provide a significant amount of acres for native plant evapo-transpiration, and removes hydraulic impediments from the 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. Ecosystem Plans 1 and 2 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 – Ecosystem Plans 1 and 2 both require additional site specific analyses during the PED Phase. Water budgets, hydraulic analyses, infiltration and evapo-transpiration 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 flood risk management 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 in providing benefits for the given costs were developed into Ecosystem Plans 1 and 2. All inefficient alternatives and sites were removed from consideration and only "best buys" and cost efficient sites were retained for further consideration. The efficiency of the specific techniques described in the recommended plan has a long history of trial and error in the region. Past restoration projects within the area has served to refine these techniques to ensure 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, which may often be the case, the selection of a recommended alternative becomes more complex. It is essential to document the assumptions made and uncertainties encountered during the course of 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. Other activities may have higher associated risks such as restoration of 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.

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 tentatively selected Ecosystem Plan. The plan that maximizes net NER benefits and has shown great merit in the trade-off analysis is Ecosystem Plan 2.

Table 5.20 – Alternative Plan Trade-off Analysis.

Trade-Off Criteria	Ecosystem Plan 1	Ecosystem Plan 2
Ecological Benefits	medium	high
Output Significance		
Institutional	moderately	very
Public	moderately	very
Technical	moderately	very
Planning Criteria		
Acceptability	low	high
Completeness	high	high
Effectiveness	medium	high
Efficiency	high	high
Risk	low	low
Uncertainty	low	low
Partnership Context	full support	full support
Cost Reasonableness	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 flood risk management features are not policy compliant as discussed in Section 4.6.5, all proposed ecosystem restoration features are fully compliant with current USACE guidance. However, certain projects could reasonable be implemented under the USACE Continuing Authorities Program (CAP). To respond to the study authority while also considering existing policy and guidance, three distinct plans have been formulated:

1. *Full Plan:* A plan that fully responds to the study authority and includes all cost-effective, environmentally acceptable separable features evaluated during the course of the study. The CAP Plan and NER Plan are subsets of the Full Plan.
2. *CAP Plan:* All policy compliant, cost-effective, environmentally acceptable separable features of such scope that they could reasonably be implemented under the Continuing Authorities Program (CAP).
3. *NER Plan:* All policy compliant, cost-effective, environmentally acceptable features of such scope that they could not be implemented under CAP.

All of the tentatively selected 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 Full 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 (Ecosystem Plan 2) are detailed in Table 5.21 and preliminary project costs 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 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 very limited 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

Table 5.21 – Summary of Ecosystem Restoration Plan Components.

Measure	**C09**	**C15**	**L05**	**L31**	**L33**	**L39**	**L41**	**L43**	**K09**	**K33**	**K41**	**K47**	**R04**
stream remeander						X	X		X	X	X	X	X
bank grading 20:1						X			X	X	X		X
swale grading										X			
cobble riffles						X	X		X	X	X		X
fill ditch						X			X			X	X
drain tile survey	X	X	X	X	X	X	X	X	X	X	X	X	X
drain tile valves	X	X	X	X	X	X	X	X	X	X	X	X	X
tree & understory thinning	X	X	X	X	X	X	X	X				X	X
tree removal	X	X	X	X	X		X	X			X	X	X
herbaceous management		X		X	X	X	X	X	X		X	X	X
native plant establishment	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 5.22 – Preliminary NER Plan Costs

County	ID	Plan	Total Implementation[1]	Preliminary Lands and Damages[2]	Total Project Cost	Annual OMRR&R
Racine	R04	NER	[redacted]			
Kenosha	K09	NER				
	K33	NER				
	K47	NER				
	K41	NER				
Lake	L41	NER				
	L43	NER				
	L39	NER				
	L33	CAP				
	L31	NER				
	L05	CAP				
Cook	C09	NER				
	Dam #1	CAP				
	Dam #2	CAP				
	C15	NER				
	Dempster Ave Dam	CAP				
	Dam #4 Removal	CAP				
	Touhy Ave Dam	CAP				
NER Plan Total						
CAP Total						
Full Plan Total						

[1]Total Implementation includes construction, preconstruction engineering and design, supervision and administration, and 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.

(FY2013 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 features. 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 Combined Plan

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 and ecosystem restoration 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 flood risk management and ecosystem restoration study purposes resulting in distinct flood risk management (FRM) and ecosystem restoration (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 Full FRM and ER Plans include all features of the Full, 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, below.

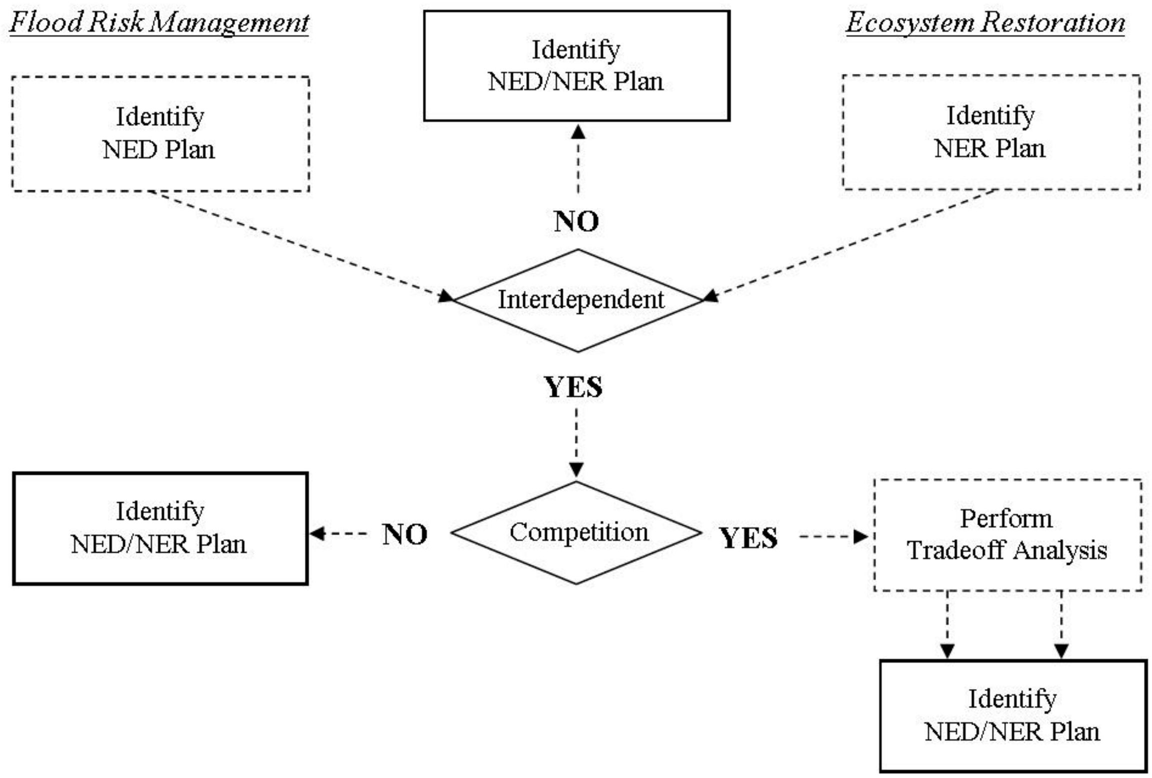

Figure 6.1 – Plan Formulation Process for Determining Combined FRM/ER Plan

6.2 Interdependence Analysis

The tentatively selected 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 47. 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 Full Plan for each purpose, the analysis was conducted between the FRM and ER Full 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 features 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 two levees included in the FRM plan are not expected to impact the water surface profile. Stage increases that could be caused by DPLV09 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 with 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
ACRS08	Aptakisic Creek	L01	4 1/2 miles to confluence with mainstem and 2 miles downstream to site	S
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
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
DPBM04	Des Plaines River	Dam #4	6 miles upstream	R
DPLV01	Des Plaines River	Dam #4	over 10 miles upstream	D

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 Southeastern Wisconsin Regional Planning Commission 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 Sewers
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 Production
Zinc	Combined Sewer Overflows, Urban Runoff / Storm Sewers, Municipal Point Source Discharge

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 Wisconsin Department of Natural Resources, the plants add to the total suspended solids (TSS) and carbonaceous biochemical oxygen demand (CBOD) 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
- 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 combined sewer overflows (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

Metropolitan Water Reclamation District of Greater Chicago (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 Hydrostructures

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 flood risk management 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	Armitage Avenue Dam
		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 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 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 inputs 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. As well, these ditches are designed to contain large floods and not allow waters to reach formerly associated floodplains. A significant decrease in retention time and negating floodplain interactions 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 sediment 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 and an excess number of erosion-causing events. Sediments from eroding banks (and upland construction) are deposited in areas where the water slows, causing buildup, destruction of benthic habitat, and a decreased stream capacity for flood waters. 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 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 Reservoir ACRS08 may benefit water quality by trapping sediment and excessive flows from a nearby golf course pond. Such ponds generally have high nutrient levels. The sediments and any associated pollutants will be contained within the reservoir site, preventing adverse impacts along the Aptakisic Creek tributary and the mainstem.

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 Illinois Environmental Protection Agency (IEPA) and the Wisconsin Department of Natural Resources (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 sponsor
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 Statewide Comprehensive Outdoor Recreation Plans (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 Chicago Metropolitan Agency for Planning (CMAP) and the Southeastern Wisconsin Regional Planning Commission (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, below.

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
Levees	Multipurpose trails and walkways
Dam Removals	none
Structure Modifications	none
Road Raises	none
Non-structural	none

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 sponsor(s) and the public.

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 multipurpose trails at ecosystem restoration sites. These benefits associated with these wood chip trails would be incidental to project benefits and a details cost/benefit analysis was not conducted. A summary of site conditions and available local resources at these sites is presented below. The only flood risk management site at which interest in recreation features was identified was Ashland-Fargo Levee. For this site, an economic analysis was conducted and benefits were associated with the project as discussed below.

Ashland-Fargo Levee (DPLV09)

As discussed in Section 4, recreation opportunities were investigated as a part of site optimization at the Ashland-Fargo 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 12-03. For the future without project 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 $5.41 providing total future without project condition benefits of $3,000. With improved safety, capacity, and accessibility, the number of users would increase to 22,000. The improved experience is reflected in an increase in UDV to $8.64, providing total with project condition benefits of $190,000 and an incremental benefit of $187,000. The estimated annualized cost for the trails; including operations, maintenance, repair, rehabilitation, and replacement costs; is $8,000. The trails would therefore provide $179,000 in net benefits. A detailed discussed of the analysis is presented in Section 4.2 of Appendix E (Economic Analysis).

Mt. Pleasant Wet Prairie (R04)
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.

Somers Marsh (K09)
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.

Paris Wet Prairie (K33)
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.

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.

Dutch Gap Aquatic Complex (L41)
Development of trails within this site is compatible with the ecosystem restoration features 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.

Mill Creek Riparian Woodland (L33)
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.

Granger Woods Floodplain Forest (L05)
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 Marsh (C09)
A substantial trail system along the Des Plaines River has already been developed by the Cook County Forest preserve. There is no non-Federal interest in additional recreation features at this site.

Beck Lake Meadow (C15)
A substantial trail system along the Des Plaines River has already been developed by the Cook County Forest preserve. There is no non-Federal interest in additional recreation features at this site.

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 sponsor 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.

Based on the length of trail per acre on similar sites in the region, an estimated cost for wood-chip trails per acre of restoration was added to the cost estimate for sites included in the ecosystem restoration plan. These estimated costs, as well as the cost of asphalt trails at DPLV09 are shown in Table 8.2, below.

Table 8.2 – Estimated Cost of Recreation Features

Site ID	Site Name	Total Site Area (acres)	Construction Cost (Without Recreation) ($1,000)	Recreation Feature Cost ($1,000)	Total Construction Cost ($1,000)
R04	Mt. Pleasant Wet Prairie	721	[redacted]	[redacted]	[redacted]
K09	Somers Marsh	627	[redacted]	[redacted]	[redacted]
K33	Paris Wet Prairie	2,133	[redacted]	[redacted]	[redacted]
K47	Bristol Marsh	1,619	[redacted]	[redacted]	[redacted]
K41	Dutch Gap Forested Floodplain	689	[redacted]	[redacted]	[redacted]
L41	Dutch Gap Aquatic Complex	680	[redacted]	[redacted]	[redacted]
L43	Red Wing Slough and Deer Lake Wetland Complex	892	[redacted]	[redacted]	[redacted]
L39	Pollack Lake and Hastings Creek Riparian Wetlands	393	[redacted]	[redacted]	[redacted]
L33	Mill Creek Riparian Woodland	230	[redacted]	[redacted]	[redacted]
L31	Gurnee Woods Riparian Wetland	475	[redacted]	[redacted]	[redacted]
L05	Granger Woods Floodplain Forest	260	[redacted]	[redacted]	[redacted]
C09	North Brook Marsh	811	[redacted]	[redacted]	[redacted]
C15	Beck Lake Meadow	670	[redacted]	[redacted]	[redacted]
DPLV09	Ashland Fargo Levee	--	[redacted]	[redacted]	[redacted]

(FY2013 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 National Environmental Policy Act (NEPA) provided the process for public participation in conjunction with the preparation of this Environmental Assessment (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 2003 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 the further development of the alternative plans, the USACE and the non-Federal sponsors made a determination that the overall environmental impact would not be significant and therefore the appropriate NEPA document would be a environmental assessment (EA) and Finding of No

Significant Impact (FONSI) rather than an environmental impact statement (EIS) and record of decision (ROD) 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 ~10,000-acres, or 3.2% of the watershed. This increase in watershed natural habitats provide significance in terms of USACE benefits by increasing watershed AAHUs by 49%, 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

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, Illinois DNR, Wisconsin DNR, Cook County Highway Department, Lake County Stormwater Management Commission, and Kenosha County Planning & Development.

<u>(1) June 4, 2002, 7–9 PM - Kenosha County Center, 19600 75th Street, Bristol, WI.</u>

Attendees included about 25 of the public and 15 from the cooperating agencies. The audience included representatives of the Town of Bristol, Pheasants Forever, Ducks Unlimited, Des Plaines Watershed Team, the Kenosha Water Utility, and the Lake County Stormwater Management Commission. Copies of sign-in sheets, summary of the questions, comments, and responses made at the meeting are available.

Comments – Nearly two dozen question and concerns were addressed by attendees. A summary of the questions asked primarily fall within several main issues. These issues include zoning and regulatory issues, structural solutions in the headwaters, cleaning tiles and other benefits for farmers, and sedimentation. Another issue raised by the attendees is that they have a perception that Illinois will get the bulk of the benefits.

<u>(2) June 5, 2002, 7–9 PM - Byron Colby Barn at Prairie Crossing, Jones Point Road west of Route 45, Grayslake, IL.</u>

Attendees included about 21 people (a few representing the general public and the majority representing various agencies). The audience included representatives of the Village of Old Mill Creek, Upper Des Plaines Partnership, Lake County Forest Preserve District, Fremont Township Highway Department, USEPA, Des Plaines River Wetland Alliance, Lake County Stormwater Management Commission, Illinois DNR, Indian Creek Watershed Project, Lake County Conservation Alliance, Long Grove Park District, Prairie Crossing, and Illinois Natures Preserves Commission. Copies of sign-in sheets are available.

Comments – Seven written comments were provided at the Grayslake meeting. Jerry Kolar of Gurnee suggested that the project's sponsors obtain a 37-acre parcel near Rt. 120. David Kiefer of Zion suggested the USACE investigate removing five homes in a flood-prone area on Russell Road. Jero Swansom (Sylvan Lake Improvement Association) expressed concern regarding future development near Sylvan Lake and the need for retention of runoff in new developments. Paul Culhane (Des Plaines Wetland Alliance) suggested that alternatives address municipal-level regulatory policies, and the need to control runoff from new developments, and the need for incentives (such as credit for regulatory actions) to encourage municipalities to resist pressure for unregulated development. Nancy Williamson (IDNR) suggested that the study investigate groundwater-recharge areas. Tori (unknown) (Indian Creek Watershed Project) suggested that the study investigate the watershed's capacity to handle detention ponds, the need for additional retention to decrease flows in the river, and pressure which growing development and population will put on drinking water supplies. Susan Zingle of Wadsworth expressed concern regarding the impacts of proposed lateral storage areas in forest preserves.

<u>(3) June 6, 2002, 7–9 PM - Oakton Community College Conference Center, 1600 E. Golf Road, Des Plaines, IL.</u>

Attendees included about 25 people, representing the public and various cooperating agencies. The audience included representatives from the Daily Herald, the Des Plaines Times, Des Plaines Flood Committee, Des Plaines Watershed, Village of Wheeling, City of Des Plaines, the office of State Representative Rosemary Mulligan, Cook County Forest Preserve District, Mount Prospect Public Works Department, North Cook County Soil & Water Conservation District, Wheeling Township Highway Commission, and Federal Emergency Management Agency (FEMA). Agency panel included representatives of USACE, Illinois Department of Natural Resources, and Cook County Highway Department. Copies of sign-in sheets, a summary of questions, comments, and responses made at the meeting are available.

Comments – Three written comments were provided at the Des Plaines meeting (copies are attached). Maria Ivek of Mount Prospect suggested dredging and cleaning the channel of the Des Plaines River, building detention reservoirs, controlling stormwater runoff, and prohibiting development in the floodplain. Irene Serwa had questions regarding the levee 50 construction schedule; regulation of floodplain filling; and the enforcement of regulations regarding construction in the floodplain. Scott Saewart (Wheeling Township Highway Commissioner) described persistent flooding problems in residential areas along the river, and asked that those problems be considered in the development of alternative plans.

9.2 Affected Environment

The affected environment for this study is detailed in Section 3 and in Appendix C and Plates 28 through 48.

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 “Full Plan” which includes all economically justified, environmentally acceptable separable features evaluated during the course of the study; a “NED/NER Plan” which includes all policy compliant, economically justified, environmentally acceptable separable features of such scope that they could not reasonable be implemented under the Continuing Authorities Program (CAP); and a “CAP Plan” which includes all policy compliant, economically justified, environmentally acceptable separable features of such scope that they could reasonable be implemented under CAP. The assessment of direct, indirect and cumulative affects as presented is comprehensive of these plans.

9.4 Direct and Indirect Effects

9.4.1 Ecosystem Restoration Plan Assessment

9.4.1.1 **Physical Resources**

Climate

The minor scale of the tentatively selected ER 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 plan are expected.

Geology

The ER Plan 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 the implementation of the ER plan does not disturb geologic features or deposits, no significant adverse effects resultant from implementing the ER plan are expected.

Hydrology, Hydraulics & Land Use

Hydrology: Implementation of the ER plan would result in beneficial effects to watershed hydrology. Water that currently falls on these sites is immediately drained into ditches, streams and ultimately the Des Plaines River, with no chance of ever establishing a natural hydroperiod for wetlands and native vegetation to occur, and in turn compounds the ill effects associated with abnormal flooding. Through restoring the native 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 marsh 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 plant community reestablishment. As a result, no significant adverse effects from implementing the ER plan are expected.

Riverine Hydraulics: Implementation of the ER plan 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 dam removal, 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 resultant from implementing the ER plan are expected.

Land Use: Implementation of the ER plan 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 plan would be implemented in a fashion as to return land use to its natural condition, no significant adverse affects resultant from implementing the NER plan are expected.

Fluvial Geomorphology & Topography

Implementation of the ER plan 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 plan would be implemented in a fashion as to return riverine segments to its natural physical form and plant communities to their natural position on the landscape, no significant adverse effects resultant from implementing the ER plan are expected.

Soils

Implementation of the ER plan 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 overwatering. 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 plan 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 plan are expected.

Air Quality

Implementation of the ER 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. 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 plan 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 plan 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 plan 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 man had disturbed them. Any ecosystem restoration project that has associated significant effects stemming from implementation is either not a restoration project. 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 plan would result in the restoration of about 2,491 acres of prairie, 1,048 acres of savanna, 2,912 acres of woodland, 805 acres of forest, 808 acres of sedge meadow, and 2,890 acres of marsh. 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 plan would be implemented in a fashion as to increase quantity and quality of these native plant communities, no significant adverse effects resultant from implementing the ER plan are expected.

Riverine

Implementation of the ER plan 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 and upland 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 plan would be implemented in a fashion as to increase quantity and quality of riverine communities, no significant adverse effects resultant from implementing the ER plan are expected.

Threatened & Endangered Species

Threatened and endangered species are discussed in Volume 3, Section 2.2.2 Ecological Resources 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 preferred plan would be in compliance with Section 7 of the Endangered Species Act. Official coordination and correspondence is expected to be closed via the finalization of this document and the ultimate signing of a FONSI for the preferred plan. Since the USFWS was part of the PDT, there will be no Fish & Wildlife Coordination Act Report produced; however, a letter from the USFWS indicates that we are still performing due diligence and coordinating as appropriate (letter dated 03 December 2012).

Since the ER plan 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 resultant from implementing the ER plan are expected. 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. At this point, there is no indication that Federal T&E species or their critical habitats occur at any of the NER plan sites.

9.4.1.3 **Social, Cultural & Archaeological Resources**

Racine County Site R04

<u>Archaeological & Historical Properties</u>

No properties or historic districts within Racine County that are listed on the National Register of Historic Places are located within, or near, the project area.

The Project area is 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 so there will be no adverse affect and no archaeological survey is required. The planned ecosystem restoration work at R04 will have no direct or indirect adverse effects on cultural resources. We will consult with the Wisconsin State Historic Preservation Officer (SHPO) and expect them to concur. In the event of inadvertent discovery of cultural materials or deposits, work will cease, the SHPO will be notified, and additional consultations will take place.

Social Properties

Schools – There will be no direct or indirect adverse effects to local schools in Sturtevant, Racine County.

Hospitals – There will be no direct or indirect adverse effects to local Racine hospitals, Aurora Health Center in Union Grove, or Aurora Surgery in West Racine

Prime Farmland – The project area is not Prime Farmland since the area is incorporated within the Mount Pleasant village limits.

Kenosha County Sites K09, K33, K41 & K47

Archaeological & Historical Properties

Two archaeological sites are the only properties listed on the National Register of Historic Places in Kenosha County that are located within the Des Plaines River drainage. 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 K09, K33, 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 (K9)] or direct or indirect adverse affects to Bristol schools [Paris Elementary School & Provenance Catholic School (K33), 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 (K33, K41, & K47).

Prime Farmland – The project area is not Prime Farmland since K9 is incorporated within the Pleasant Prairie village limits, and K33, K41, & K47 are incorporated within the Bristol village limits.

Lake County Sites – L05, L41, L43, L39, L33 & 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 L05 project area is modified golf course and country club land and is not likely to contain intact cultural features or deposits.

The L41, L43, L39 and L33 project areas are lands recently acquired by the Lake County Forest Preserve District.

L39 is now known as the Glen Raven 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 L05, L41, L43, L39, L33, & L31 will have no direct or indirect adverse affects on cultural resources.

<u>Social Properties</u>

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, Northwestern Community Hospital (K01), and Condell Hospital, Northwestern Lake Forest Hospital, & United Health Systems (L19).

Prime Farmland - None of the project area is prime farmland. L05 is incorporated within the Village of Lake Forest village limits, and L41, L43, L39, L33, & L31 have been established as public parks.

Cook County Sites C09 & C15

<u>Archaeological & Historical Properties</u>

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

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 flood risk management and ecosystem restoration sites considered for implementation during alternative development were enrolled in any regulatory remedial program. Data obtained from the Illinois Environmental Protection Agency (IEPA), the Wisconsin Department of Natural Resources (WDNR), and the U.S. Environmental Protection Agency (EPA) 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 tentatively selected 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. 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.

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, and 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	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.
Mt. Pleasant Wet Prairie, Somers Marsh, Paris Wet Prairie, Bristol Marsh	USTs adjacent	None	Confirm the location of adjacent USTs during design phase to avoid disturbance of utilities during restoration.
Northbrook Marsh	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	Two LUSTs (EDR #1 and B13/14) within recommended search distance with unknown status	Confirm scope and scale of the LUST incidents with IEPA	1. Confirm design/excavation assumptions2. 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 & Red Wing Slough and Deer Lake Wetland Complex	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 minor scale of the preferred flood risk management (FRM) 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 FRM plan.

Geology

The FRM plan would have no detrimental effects on local geology upon implementation. The minor construction needed to implement the FRM plan 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 the FRM plan will not disturb significant geologic features or deposits, it is expected that no significant adverse effects to geology would result from implementing the FRM 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 watersheds are now urbanized or agricultural, which allows run-off to immediately reach streams instead of draining into the soil and recharging groundwater. In order to alleviate some of the adverse cultural effects associated with this, three reservoirs, four levees and many other small scale / low impact measures have been recommended for implementation. These all manipulate local hydrology and hydraulics to reduce economic damage to those people affected.

<u>Reservoirs</u> – The reservoir included in the FRM plan will provide flood relief by holding back unnatural flows until the flood pulse recedes to a non-threatening level. Because of the flashiness of the current system, the creation of reservoirs will help stabilize the hydrology and hydraulics of the watershed. 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 FRM plan.

<u>Levees</u> – Four levees would be constructed as part of the FRM plan. These structures would be constructed to protect existing homes, businesses and roadways. Anytime structures are built to

keep a stream in its banks, hydrologic and hydraulic functions are compromised. Building levees essentially channelize the stream and create an artificially incised channel. Flood waters that would naturally exceed normal bank full levels are not allowed to inundate the floodplain and are instead moved quickly downstream. Negative hydraulic functions such as severe scour and erosion can occur due to the increase flow and loss of dissipation of energy into the floodplain; 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. Increased flooding downstream of the constructed levees was not identified in the hydraulic and hydrological modeling completed for these projects. It is anticipated that there would be no significant adverse effects to hydrology and hydraulics as a result of constructing the planned levees.

Road Raises –These modifications would actually allow easier conveyance of flood waters downstream, as the water will be able to flow freely instead being forced through small apertures that causes scouring and erosion. It is anticipated that there would be no significant adverse effects as a result of constructing the planned road raises. No significant adverse effects to the regional hydrology or hydraulics are expected to result from implementing the road raises identified in the FRM plan.

Structure Modifications –These measures would take place on preexisting structures and facilities that already have flood management functions. No significant adverse effects to the regional hydrology or hydraulics are expected to result from implementing the structure modifications identified in the FRM plan.

Non-Structural –These measures will take place in upland areas, mostly backyards and parking lots 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 FRM 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 – One reservoir would be constructed as part of the FRM plan. ACRS08 will be constructed in an area used exclusively for agriculture. This area is not considered to be prime farmland, thus is not be considered significant. A major change to land use is expected to result from implementing this reservoir but is not considered a significant impact to the human environment and does not warrant mitigation.

Levees – Construction of levees as part of the FRM plan would have no adverse affect on land-use. Levees would be built in urban areas to protect existing homes and businesses. Not building the levees may actually lead to a change in current land-use because of continuous flooding to existing structures. No significant adverse effects to land use are expected to result from implementing the levees identified in the FRM plan.

Road Raises – No significant adverse effects to land use are expected to result from implementing the road raises identified in the FRM plan.

Structure Modifications – No significant adverse effects to land use are expected to result from implementing structure modifications identified in the FRM plan.

Non-Structural – No significant adverse effects to land use are expected to result from implementing non-structural measures identified in the FRM 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 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 – Reservoir ACRS08 will be constructed as an on-line reservoir on a tributary that has already had its fluvialgeomorphic function and floodplain topography highly modified. Under natural conditions, this would have adverse effects on the stream; however, this tributary is severely channelized and only drains a golf course and roads. No significant adverse effects to fluvial geomorphology and topography are expected to result from implementing this reservoir identified in the FRM plan.

Levees – In natural conditions, 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 FRM plan.

Road Raises – Raising these structures 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 raises identified in the FRM plan.

Structure Modifications – No significant adverse effects to fluvial geomorphology and topography are expected to result from implementing structure modifications identified in the FRM plan.

Non-Structural – No significant adverse effects to fluvial geomorphology and topography are expected to result from implementing non-structural measures identified in the FRM 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. Agricultural practices also have adverse effects to the top layer or A horizon of soils through carbon stripping, chemical modification and microrhizzal eradication.

Reservoirs – Reservoir ACRS08 will be constructed in an agricultural field. Although soils in this area have been impacted for many years due to continuous cultivation, these would still be able to eventually support native vegetation; however, the extreme urban nature of the surrounding lands would never lend this site to being restored to its natural condition. The construction of this reservoir would modify the soils; however, the action would be negligible in terms of what damage has already occurred in the watershed.

Levees – Soils in the area where the levees would be built have been adversely affected and/or ecologically ruined for many years due to urbanization and industrial development. No significant adverse effects to soils are expected to result from implementing the levees identified in the FRM plan.

Road Raises – No significant adverse effects to soils are expected to result from implementing the road raises identified in the FRM plan.

Structure Modifications – No significant adverse effects to soils are expected to result from implementing structure modifications identified in the FRM plan.

Non-Structural – No significant adverse effects to soils are expected to result from implementing non-structural measures identified in the FRM plan.

Air Quality

Implementation of the FRM 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 Des Plaines River is not at a level to support 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: Reservoir ACRS08 may actually have benefits to water quality since it will trap sediment and excessive flows from a golf course pond, 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 Des Plaines River, thus helping to improve water quality. 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 FRM plan.

Road Raises – No significant adverse effects to water quality is expected to result from implementing the road raise identified in the FRM plan.

Structure Modifications – No significant adverse effects to water quality is expected to result from implementing structure modifications identified in the FRM plan.

Non-Structural – No significant adverse effects to water quality is expected to result from implementing non-structural measures identified in the FRM plan.

9.4.2.2 **Ecological Resources**

The primary objective of any flood risk management project is to protect human lives and infrastructure, as well as lessen or eliminate costly damages to said 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, than effects are usually considered negligible.

Plant Communities

Reservoirs – The current plant communities of the proposed reservoir ACRS08 are those associated with agriculture and have no current ecological value in terms of vegetation and riparian zone. The small tributary to Aptakisic Creek within the footprint is channelized with little or no ecological value, and the construction of this reservoir will help stabilize hydrology in this section of the watershed. 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 this reservoir.

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 – Reservoir ACRS08 would be constructed online on a tributary; however, this tributary to Aptakisic Creek has lost all riverine ecologic value already due to channelization and removal of riparian vegetation. Natural streams and wetlands have been obliterated from this tributary's watershed, which is now situated in the highly urbanized Buffalo Grove, IL. There would be no effects in terms of stream connectivity loss since the ditch originates in a golf course detention pond, with no further stream channel upstream. Beneficial effects include attenuating large amounts of unnatural flood waters that would remove riverine habitat within Aptakisic Creek and the Des Plaines River. No significant adverse effects to riverine habitats are expected to result from implementing this reservoir.

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 Volume 3, Section 2.2.2 Ecological Resources 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 preferred plan would be in compliance with Section 7 of the Endangered Species Act. Official coordination and correspondence is expected to be closed via the finalization of this document and the ultimate signing of a FONSI for the preferred plan. Since the USFWS was part of the PDT, there will be no Fish & Wildlife Coordination Act Report produced; however, a letter from the USFWS indicates that we are still performing due diligence and coordinating as appropriate (letter dated 03 December 2012).

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 – One reservoir (ACRS08) is planned for this project. This area has not been surveyed for archaeological or historical resources. Prior to project construction, a Phase 1 archaeological survey will be conducted of any portions of the project area that have not been heavily disturbed by previous construction, and that have not been previously surveyed for cultural resources. Any archaeological sites found during this survey will be avoided if possible. If avoidance of any known archaeological sites is not possible, consultations will be conducted with the Illinois Historic Preservation Agency (IHPA) and a Section 106 mitigation plan, if needed, will be developed that meets IHPA requirements.

Levees **–** Four levees (DPLV01, DPLV04, DPLV05 & DPLV09) are planned for this project. All four levee locales have previously been surveyed for cultural resources. 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. All of these are within existing road right-of-ways. These right-of-way areas have 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. There planned road raises 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. No intact archaeological or historical deposits are present. None of these bridges are eligible for the National Register of Historical Places. 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 reservoir (ACRS08).

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 (ACRS08).

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 flood risk management and ecosystem restoration sites considered for implementation during alternative development were enrolled in any regulatory remedial program. Data obtained from the Illinois Environmental Protection Agency (IEPA), the Wisconsin Department of Natural Resources (WDNR), and the U.S. Environmental Protection Agency (EPA) 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 tentatively selected for implementation during the final stages of the feasibility study.

A Phase I HTRW investigation for the flood risk management sites (reservoir, levee/floodwall, and structural modification project sites), completed in accordance with ER 1165-2-132, is included in Appendix H. These sites were considered a higher risk for HTRW due to the more extensive project work that is proposed. Results of the investigation were based on an existing information review, database research, historical topographic map and aerial photograph review, and a site visit. 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.

Table 9.2- HTRW Results and Recommendations for Future Action: Reservoirs

Site	Issue	Short-Term Data Needs	Potential Future Actions
Aptakisic Creek Reservoir (ACRS08)	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 9.3- HTRW Results and Recommendations for Future Action: Road Raises

Site	Issue	Short-Term Data Needs	Potential Future Actions
First Avenue Bridge Modification (DPBM04)	Historical aerial photographs suggest that between 1999 and 2007 property adjacent to Des Plaines River Road (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 9.4- HTRW Results and Recommendations for Future Action: Levees

Site	Issue	Short-Term Data Needs	Potential Future Actions
Ashland-Fargo 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 and scale of the LUST incidents with IEPA	Perform phase II investigation to determine scope and scale of site impacts from adjacent regulated LUST activities, if required
Groveland Avenue 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	Intensive 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.
Fifth-CN Railroad Levee (DPLV05)	Four SRP site 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	Intensive 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.

Table 9.5- 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

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 flood risk management (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 flood risk management project is considered to be beneficial environmentally, socially and economically.

The ecological restoration portion of this project would improve hydrology by filling an estimated 13,400 feet of unnatural ditch along with disabling hundreds of thousands of feet of drain tiles dismantled. Natural stream sinuosity would be restored increasing the total length. Five dams would be removed on the mainstem Des Plaines River. Over 10,900 acres of native plant community types would be restored including: marsh (2,850 acres), meadow (808 acres), prairie (2,491 acres), savanna (1,048 acres), woodland (2,912 acres) and forest (805 acres). Ecosystem Plan 2 increases the quality of watershed ecosystem communities by 50% of what currently exists.

The flood risk management portion of this project would provide $6,825,000 net benefits through implementing (1) reservoir, two (2) levees, one (1) road raise, one (1) 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 flood risk management features
- *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 flood risk management) 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 flood risk management 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 flood risk management 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 flood risk management 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 flood risk management 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 flood risk management 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.	National Environmental Policy Act (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 Aug 11, 1980	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 complaint (C), non-compliant (N), or pending (P).

The National Environmental Policy Act (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 Project Development Team (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 process 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).

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 National Economic Development 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.

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 Environmental Assessment.

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 features will include robust operation and maintenance 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 watershed 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 as Attachment B. 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. Official coordination and correspondence is expected to be closed via the finalization of this document and the ultimate signing of a FONSI for the preferred plan. Since the USFWS was part of the PDT, there will be no Fish & Wildlife Coordination Act Report produced; however, a letter from the USFWS indicates that we are still performing due diligence and coordinating as appropriate (letter dated 03 December 2012).

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 affects on historic or archaeological resources. Official coordination and correspondence is expected to be closed via the finalization of this document and the ultimate signing of a FONSI for the preferred plan.

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 EO 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 tentatively selected 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 tentatively selected 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 tentatively selected 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 tentatively selected plan continue to comply with this order and all other applicable laws and regulations.

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 is now in public circulation and comments and concerns will be sequestered from the public during the 30-day review period and scheduled public meetings.

9.7 Conclusion

In accordance with the National Environmental Policy Act of 1969 and Section 122 of the River and Harbor and Flood Control Act of 1970, the U.S. Army Corps of Engineers (Chicago District) has assessed the environmental impacts associated with this project. The purpose of this Environmental Assessment (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 features of the combined plans are distributed throughout the watershed. A summary of the combined plan elements is presented below. Plate 47 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 47 shows the location of each site. The individual sites within each plan are shown on Plate 16 through Plate 23 and Plate 28 through Plate 45.

This report presents three plans: a “Full Plan” which includes all economically justified, environmentally acceptable separable features evaluated during the course of the study; a “NED/NER Plan” which includes all policy compliant, economically justified, environmentally acceptable separable features of such scope that they could not reasonable be implemented under the Continuing Authorities Program (CAP); and a “CAP Plan” which includes all policy compliant, economically justified, environmentally acceptable separable features of such scope that they could reasonable be implemented under CAP.

Full Plan: The Full Plan is the most inclusive plan. The Full Plan features include sites for which USACE will seek congressional authorization for implementation, projects that will be implemented under CAP, and projects that are recommended for implementation by state and local agencies. All of the sites shown in Table 10.1 would be included in the Full Plan. Features that are only included in the Full Plan are designated as “Full” in the table. The plan features include:

18 Ecosystem Restoration projects including
- 13 ecosystem restoration sites and
- 5 dam removals;

10 Flood Risk Management projects including
- 1 floodwater storage reservoir,
- 4 levees/floodwalls,
- 1 road raise,
- 1 modification to an existing structure, and
- 3 Non-structural flood risk management plans (non-structural measures to be implemented in Kenosha, Lake, and Cook Counties).

NED/NER Plan: Some of the measures included in the Full plan are not policy compliant. In addition, some of the Full Plan features could reasonably be implemented under CAP. There are 16 separable features of the NED/NER plan. The features of this plan, designated as "NED/NER" in Table 10.1, include:

11 Ecosystem Restoration Projects including
- 11 ecosystem restoration sites

6 Flood Risk Management projects including
- 1 floodwater storage reservoir,
- 3 levee/floodwalls
- 2 Non-structural flood risk management plans (to be implemented in Lake and Cook Counties).

CAP Plan: The policy compliant features that could reasonably be implemented under CAP are designated as "CAP" in Table 10.1. The CAP Plan includes:

7 Ecosystem Restoration Projects including
- 2 ecosystem restoration site
- 5 dam removals

1 Flood Risk Management project including
- 1 levee/floodwall

Table 10.1 – Summary of Sites included in Combined Plans

Site ID	Site Name	Purpose	Plan	Measure	Municipality
Racine County, WI					
R04	Mt. Pleasant Wet Prairie	ER	NED/NER	Restoration, Rural Alternative 5	Sturtevant
Kenosha County, WI					
K09	Somers Marsh	ER	NED/NER	Restoration, Rural Alternative 9	Somers
K33	Paris Wet Prairie	ER	NED/NER	Restoration, Rural Alternative 9	Union Grove
K47	Bristol Marsh	ER	NED/NER	Restoration, Rural Alternative 9	Bristol
K41	Dutch Gap Forested Floodplain	ER	NED/NER	Restoration, Rural Alternative 6	Pikesville
	Kenosha County Non-structural	FRM	Full	Elevation, Floodproofing, Ring Levees, Buyouts	Salem, Britsol, Somers, Paddock Lake
Lake County, IL					
L41	Dutch Gap Aquatic Complex	ER	NED/NER	Restoration, Rural Alternative 9	Antioch
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
L33	Mill Creek Riparian Woodland	ER	NED/NER	Restoration, Rural Alternative 4	Old Mill Creek
L31	Gurnee Woods Riparian Wetland	ER	NED/NER	Restoration, Rural Alternative 4	Wadsworth
ACRS08	Aptakisic Creek Reservoir	FRM	NED/NER	Reservoir	Buffalo Grove
L05	Granger Woods Floodplain Forest	ER	CAP	Restoration, Urban Alternative 8	Mettawa
	Lake County Non-structural	FRM	NED/NER	Elevation, Floodproofing, Ring Levees, Buyouts	Riverwoods, Buffalo Grove, Gurnee
Cook County, IL					
C09	Northbrook Marsh	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	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	FRM	Full	Structure Modification	Maine
DPLV09	Ashland-Fargo 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	Fifth-CN Railroad Levee	FRM	NED/NER	Levee/Floodwall	River Grove
DPBM04	First Ave Bridge Modification	FRM	Full	Bridge Modification	River Grove
DPLV01	Groveland Ave Levee	FRM	CAP	Levee	Riverside
	Cook County Non-structural	FRM	NED/NER	Elevation, Floodproofing, Ring Levees, Buyouts	Riverside, River Grove, Rosemont, Des Plaines, Wheeling
	Park Ridge (Cook County) Non-structural	FRM	Full		Park Ridge

10.1.1 Racine County, Wisconsin

Mt. Pleasant Wet Prairie (NER R04 Rural Alternative 5), Sturtevant (Plate 28)

The site would have plant communities of marsh, wet prairie, mesic and dry prairie, wet and dry oak savanna and open woodland reestablished. Trees removed from a future plot of marsh (2-acres) and oldfield (4-acres) would need herbaceous management. Woodland (46-acres) would need to be thinned of invasive trees, shrubs and herbaceous undergrowth.

Once the non-Federal sponsor obtains rights to the lands for restoration, heavy agricultural practices should cease and a light farming operation could be implemented. Agricultural fields could be planted with alfalfa which would repair soils by fixing nitrogen, removing soil compaction, adding organic carbon, and begin returning soil porosity. The crops could be sold to support invasive species issues in other non-farmed areas. The continuation of farming on the land would prevent invasive plant species from overrunning any agricultural oldfields.

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.

A drain tile survey would be conducted over the 721-acre site. This survey would determine where to strategically place drain tile valves. The purpose of the valves is three-fold; one to allow site hydrology to be manipulated during the PED and construction phases, second to allow for the final disablement of the system and third to avoid massive disturbance which is associated with removing or crushing drain tiles. The valves can be turned on or off to either resurge hydrology or to drain hydrology away. The purpose for this during the PED phase is to determine if there would be off-site impacts and to be able to have a much better idea of 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 overtime and due to hydrostatic pressure build-up, collapse on themselves.

There is about 4,400-feet of excavated waterway where there was previously a side stream and basin marsh. These ditches would be filled in before the valves are closed to avoid the situation of large machinery working in very wet conditions. Based on the soils and topography these ditches were not former swales, therefore they would be filled to bank full width to remove unnatural draining of the basins. If the surrounding area of the ditches is too wet even before the drain tiles are disabled, then ditch plugs placed at strategic points would be utilized to remove draining effects from the ditch. Ditch plugs range from pushing enough soil into one spot on the ditch that disallows flow-through, to more involved plugs that are created out of stone or engineered structures. Earthen plugs would be used at this site so when the ditch fills in with sediment and soils. If adverse, off-site hydrologic impacts are identified during the PED phase, ditch disablement design would be modified to ensure neighboring parcels can drain freely into the site and to eliminate offsite impacts.

The name of the main waterway that is a conduit for water through the site is Kilbourn Road Ditch. This ditch is currently about 5,500-feet of former natural stream that was channelized. When streams first formed from glacial melt waters, the coupling of helical flow and paths of least resistance within the freshly deposited alluvium caused a meandering channel to form. Floodplains eventually formed from the stream moving back and forth over the landscape. Although sediment and soils were ultimately pushed downstream, a good deal of it was pushed sideways, forming point bars and eventually floodplain. Sharp elevation changes caused riffles to form due to increased flow velocities because stronger current washed away fine sediment but could not move larger cobbles and boulder so well. To return this segment of Kilbourn Road Ditch into Kilbourn Creek, the preferred methodology is to set the water back in motion over the landscape as the glaciers once did. There is sufficient space within a well defined stream valley that will confine the newly meandering stream well within the site boundaries.

The first task would be to grade the ditch banks back to a slope of 20:1. The reason for grading the banks to 20:1 is to reduce the amount of erosion necessary to put the stream back in motion and to allow for plant communities to greatly assist in regulating and slowing the meandering process. Also, when the ditch was created, the floodplain was also recontoured and filled in and as a result the 20:1 grading would remedy a portion of that past impact. Then cobble riffles would be placed at various points within the channel that are slightly angled to the left or right to engage the meandering process. These riffles would generally be about 1-foot high and have a secondary intent of raising the stream bed. Raising the stream bed would begin to remove channel incision and aid in resurging hydrology to the floodplain and riparian communities. If certain portions of the ditch are extremely incised, it may be necessary to install higher riffle crests. Hydraulic modeling would be completed to ensure riffles would not induce offsite impacts on neighboring parcels. The riffle stone will consist of natural glacial or fluvial stone that would be properly sized via hydraulic calculations during the PED phase. Ultimately these riffles are sacrificial because the intent is for the stream to begin moving again. The McHenry County Conservation District has successfully accomplished this task on various segments of the Nippersink Creek.

Constructing a new meander path would be a massive excavation process and would have significant costs and significant disturbance to soils, glacial till and plant and animal communities. This action for site R04 would not restore fluvial functions, but would create a sinuous ditch, which over time would incise due to lateral energy dissipation by placing toe stone or riprap in the meander bends. This action would seem to cause less erosion because the water course is being dictated where to go and erode; however, trying to fight the water's desired course would cause more erosion problems that stem from armoring, channel incision and mass wasting of steeper banks. To avoid this situation, not only the channel would need to be excavated, but the floodplain as well, just as the banks are proposed to be graded in the preferred methodology. The action of excavating a new stream channel would be necessary if the entire stream channel was removed from the former active floodplain; however, site R04 does not have this issue. So this active excavation is not being recommended for this site.

Vegetation also plays a key role in both subsurface and surface hydrology, and laminar hydraulics. Native plant root systems create micro fissures that increase soil porosity and its ability to absorb water. Compacted soils would cause more laminar flow than subsurface percolation, which causes soils to be rilled, rutted and lost into drainage ways. Also, the persistence of native plant communities overtime will return organic carbon to the soils which greatly increase their ability to absorb and retain water; this is critical for attenuating floods and storing water during drought. It is well known that plants also affect the ground water via evapotranspiration. This process is always pulling water from the soils and some species have deep enough roots to penetrate and pull water from the glacial till. The balance between plants causing higher soil porosity, higher organic carbon content, dense protective groundcover and evapotranspiration, they have the ability to regulate flooding without the need for traditional flood control features; the problem is that enough land within the watershed at this point could not be converted to natural lands due to current land use needs and restrictions. However, localized beneficial effects affects within the site and a small distance downstream would most likely be noticed from a 724-acre hydrologic restoration.

Geomorphology would be repaired through filling in unnatural waterways, setting the stream back into motion within its floodplain, and the reestablishment of native vegetation cover.

Topography and geomorphology of site R04 was modified from its natural condition in order to have a functioning agricultural plot of land. These actions included channelization of the Kilbourn Creek, stripping of native vegetation communities, grading and filling of floodplain and floodplain depressions, excavation and grading over the entire site to install drain tile networks, and excavation of several ditches to drain floodplain marshes. The soils were also impaired via compaction, organic carbon stripping, inorganic nutrient loading, microbial sterilization, and physical mixing of soil horizons. Along with this comes affects to ground water infiltration and the ability for soils to hold and attenuate rain/floodwaters and nutrients.

To repair geomorphology to the wetland basins, stream channel and active floodplain, various activities would be implemented as described in the above discussion on hydrologic restoration. These include drain tile disablement, ditch filling or plugging, bank grading, and riffle placement. Further geomorphic and soils repair would occur over time. The disablement of the drain tile and ditch system would allow soils to purge excess nutrients and to recover redox and microbial activities. The resurgence of surface hydrology would cause new rivulets and prairie swales to form, thusly restoring geomorphic micro habitats. Native vegetation establishment would further restore geomorphology and soils by stabilizing soil movement, regulating stream and prairie swale movement, returning organic carbon to the soil, and removing nitrates from the soils and fluvequents. Fluvequents are defined as organic and inorganic sediment forming on unconsolidated alluvium that has been recently deposited by streams and is subject to frequent changes through stream flood pulses. Due to locations along water courses, this soil is considered Hydric and important for stream health and denitrification and should not be considered as adverse substrate.

Based on qualitative investigations at various Chicago District ecosystem restoration projects, non-native vegetation, especially European buckthorn (*Rhamnus cathartica*) and reed canary grass (*Phalaris arundinacea*), cause great turmoil to fluvial geomorphic processes and instream habitat conditions. Buckthorn thickets have been observed at various sites to allow the stream banks to experience mass wasting in which the stream channel then becomes clogged with an unhealthy amount of woody debris. Buckthorn excludes native herbaceous and woody species from their foot print due to overcrowding and allelopathy. Allelopathy is a biological phenomenon by which an organism produces one or more biochemicals that influence the growth, survival, and reproduction of other organisms. It is thusly imperative to exclude certain invasive species from the floodplain and other minor prairie swales and woodland hollows to restore geomorphic features.

Native vegetation would be restored through repairing hydrology and geomorphology, removing invasive/non-native species and sowing native seed and live plugs.

The ultimate result of any aquatic ecosystem restoration project 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 is dependent on the three fold interaction between hydrology-hydraulics, geomorphology-soils, and plant-fungus-microbe structure. Once the water has been restored and the geomorphology set on course for repair, the current conditions of the soils would be observed before planting. Newly abandoned agricultural fields may have a good deal of relict nutrients left in the soil which may or may not warrant depletion before sowing native seed and live plugs. Also, as discussed above, agricultural practices strip organic carbons from the soils and compacts them. To remove soil compaction, light disking could be implemented or other methods such as alfalfa cropping to botanically break the soils up and at the same time remove excessive nutrients. There also 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, which is readily available within the Chicago Region. Another consideration for soil amendments would be pine saw dust in the case of overly nitrified soils. The pine saw dust would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

Based on the soil types present within the site, remnant plant communities within the watershed, and topography, site R04 would have former plant communities of marsh, wet prairie, mesic and dry prairie, wet and dry oak savanna and open woodland reestablished. Two acres would have trees removed from a future plot of marsh and about 4-acres of oldfield would need herbaceous management, which could include herbicide application, controlled burns or mowing. There is about 46-acres of woodland that would need to be thinned of invasive trees, shrubs and herbaceous undergrowth, but aside from this plot, all plant communities would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for site R04 would be to keep invasive plant species from recolonizing. Once the site becomes robust with native plant diversity and densities, the up keep on invasive plant species recolonization should decline. Considerations for the stream would focus on the stream’s entry and exit of the site, but more so the exit. Keyed in stone riffles would be used to ensure the stream exits the site through the existing road bridge culvert properly. These stones may need to be adjusted or added to every so often. Riprap and filter fabric would not be used since this would actually increase O&M expenditures and repair events.

Costs associated with this alternative are identified in Table 10.2.

Table 10.2 – Mt. Pleasant Wet Prairie Estimated Costs (Full Plan & NED/NER Plan)

Activity	Cost
Preliminary LERRDs	[redacted]
Construction	[redacted]
PED	[redacted]
S&A	[redacted]
Monitoring & Adaptive Management	[redacted]
Total Estimated Cost	[redacted]
Annual Operation, Maintenance, Repair, Replacement and Rehabilitation	[redacted]

(FY2013 Price Level)

10.1.2 Kenosha County, Wisconsin

Somers Marsh (NER K09 Rural Alternative 9), Somers (Plate 29)

Somers Marsh will restore native plant communities of marsh, wet prairie, mesic and dry prairie, wet and dry oak savanna, and open woodland. Once agricultural practices cease, the hydrology, geomorphology will be naturalized. This will allow for the restoration and establishment of native plant and animal species over the 627-acre site.

Once the non-Federal sponsor obtains rights to the lands for restoration, heavy agricultural practices should cease and a light farming operation could commence. Agricultural fields could be planted with alfalfa which would begin to repair soils by fixing nitrogen, removing soil compaction, adding organic carbon and begin returning soil porosity. The crops could be sold to support invasive species issues in non-farmed areas. The continuation of farming the land would preclude invasive plant species from overrunning any agricultural oldfields.

The hydrology would be restored by placing drain tile valves at locations across the 627-acre site. The purpose and methods are the same as those described for Site R04. There is about 6,000-feet of excavated waterway on the site. These ditches would be filled in or plugged to resurge hydrology. The purpose and methods are the same as those described for Site R04. Water would then be set in motion over the landscape to return Kilbourn Road Ditch (8,150 feet) into Kilbourn Creek. Somers Marsh has sufficient space to confine the meandering stream within the site boundaries. The ditch banks would be graded to a slope of 20:1. Cobble riffles would be placed at points within the channel to engage the meandering process.

To repair geomorphology to the wetland basins, stream channel and active floodplain, various activities would be implemented as described under Site R04. These include drain tile disablement, ditch filling or plugging, bank grading, riffle placement, minor grading and native vegetation reestablishment. To remove soil compaction, light disking could be implemented or other methods such as alfalfa cropping to botanically break the soils up and at the same time remove nutrients from them. Organic carbon may need to be added to the soils to establish former plant communities. This would be accomplished through the use of organic leaf litter compost as a soil amendment. Another consideration for soil amendments would be to apply pine saw dust in the case of overly nitrified soils.

The main activity during the operations and maintenance period for site K09 would be to keep invasive plant species from recolonizing, especially during the early stages of the site's recovery. Once the site becomes robust with native plant diversity and densities, the up keep on invasive plant species recolonization should decline. Considerations 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.

Costs associated with this site are identified in Table 10.3 at the end of this section.

Paris Wet Prairie (NER K33 Rural Alternative 9), Union Grove (Plate 30)

Paris Wet Prairie will restore native plant communities of open water, marsh, wet prairie, mesic and dry prairie, wet and dry oak savanna, floodplain forest, wet forest, flat woods and open woodland reestablished. Once agricultural practices cease, the hydrology, geomorphology will be naturalized. This will allow for the restoration and establishment of native plant and animal species over the 2,133-acre site.

Once the non-Federal sponsor obtains rights to the lands for restoration, heavy agricultural practices should cease and a light farming operation could be implemented. Agricultural fields could be planted with alfalfa which would begin to repair soils by fixing nitrogen, removing soil compaction, adding organic carbon and begin returning soil porosity. Crops could be sold to support invasive species issues in other non-farmed areas. Also, the continuation of farming the land would preclude invasive plant species from overrunning any agricultural oldfields

The hydrology would be restored by placing drain tile valves at locations across the 2,133-acre site to resurge or drain hydrology. The purpose and methods are the same as those described for Site R04. The main waterway that is conduit for water through the site is the Des Plaines River (about 15,000-feet of former natural stream that was channelized). Water would be set back in motion over the landscape to return this segment of the river back into a naturally flowing stream. Paris Wet Prairie has sufficient space within a stream valley that would confine the meandering stream within the site boundaries. Ditch banks would be graded to a slope of 20:1. Cobble riffles would be placed at points in the channel engage the meandering process. There is also about 40,200-feet of prairie slough that was converted to small ditches that aid the drain tile system in drying the land. These would be graded to remove impacts to natural hydrology and turned back into prairie sloughs, which would have a bowl like configuration with slopes not greater than 30:1.

To repair geomorphology to the wetland basins, stream channel and active floodplain, various activities would be implemented as described under Site R04. These include drain tile disablement, prairie slough contouring, main stem bank grading, riffle placement, 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 the soils up and at the same time remove nutrients from them. There also 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 consideration for soil amendments would be pine saw dust in the case of overly nitrified soils, which 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 site K33 would be to keep invasive plant species from recolonizing, especially during the early stages of the site's recovery.

Once the site becomes robust with native plant diversity and densities, the up keep on invasive plant species recolonization should decline. Considerations 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. These stones may need to be adjusted or added to every so often.

Costs associated with this site are identified in Table 10.3 at the end of this section.

Bristol Marsh (NER K47 Rural Alternative 9), Bristol (Plate 32)

Bristol Marsh will 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 reestablished. Once agricultural practices cease, the hydrology, geomorphology will be naturalized. This will allow for the restoration and establishment of native plant and animal species over the 1,619-acre site.

Once the non-Federal sponsor obtains rights to the lands for restoration, heavy agricultural practices should cease and a light farming operation could be implemented. Agricultural fields could be planted with alfalfa which would begin to repair soils by fixing nitrogen, removing soil compaction, adding organic carbon and begin returning soil porosity. The crops could then be sold to support minor invasive species issues in other non-farmed areas. The continuation of farming the land would preclude invasive plant species from overrunning any agricultural oldfields.

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 and methods are the same as those described for Site R04.

The main waterway that is conduit for water through the site is North Mill Creek (9,400-feet). To return this segment back into its naturally marsh like flowage, banks would be removed to allow water flowing into the site to be spread out and form the flowage again. Banks would be graded out and ditch plugs placed at points in the channel to disable draining affects the ditch may have after having its banks removed. There is also about 2,500-feet of excavated waterway aimed at draining several depressions, which would be filled in before the drain tile system would be disabled. Further, about 251-acres of trees would be removed and about 253-acres of woodland to help resurge hydrology since trees have a significant impact on draining down the water table,

To repair geomorphology to the wetland flowage and surrounding riparian landforms, various activities would be implemented which include: 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 the soils up and at the same time remove nutrients from them.

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 consideration for soil amendments would be pine saw dust in the case of overly nitrified soils, which would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

Due to the dramatic drying out of the former wetland communities, about 251-acres of weedy tree species have taken over and need to be removed. Woodland communities also have been impaired by hydrologic regimes shifts and have become riddled with invasive tree, shrub and herbaceous plant species. About 253-acres of woodland community would need to be thinned and cleared of these noxious species. There is about 150-acres of oldfield and old wetland patches that 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 site K47 would be to keep invasive plant species from recolonizing. Once the site becomes more robust with native plant diversity and densities, the up keep on invasive plant species recolonization should decline. Considerations 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. These stones may need to be adjusted or added to every so often.

Costs associated with this site are identified in Table 10.3 at the end of this section.

Dutch Gap Forested Floodplain (NER K41 Rural Alternative 6), Pikesville (Plate 31)

Dutch Gap Forested Floodplain will restore native plant communities of marsh, wet prairie, mesic and dry prairie, wet and dry oak savanna, wet forest, flat woods and open woodland reestablished. Once agricultural practices cease, the hydrology, geomorphology will be naturalized. This will allow for the restoration and establishment of native plant and animal species over the 689-acre site.

Once the non-Federal sponsor obtains rights to the lands for restoration, heavy agricultural practices should cease and a light farming operation could be implemented. Agricultural fields could be planted with alfalfa which would begin to repair soils by fixing nitrogen, removing soil compaction, adding organic carbon and begin returning soil porosity. The crops could then be sold to support invasive species issues in non-farmed areas. The continuation of farming the land would preclude invasive plant species from overrunning any agricultural oldfields.

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 R04. The main waterway that is conduit for water through the site is North Mill Creek (5,500-feet). To return this segment to a naturally functioning stream, the water would be put back in motion over the landscape. K41 has sufficient space within a defined stream valley that would confine the meandering stream within the site boundaries. The ditch banks would be graded to a slope of 20:1. 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 by utilizing the same methodologies. To further resurge hydrology, about 251-acres of trees would be removed and about 253-acres of woodland would be thinned. Trees have a significant impact on draining down the water table which would allow for surface water wetlands were to resurge.

Geomorphology of Site K41 was modified from its natural condition in order to have an agricultural plot of land. To repair it to the wetland basins, stream channel and active floodplain, various activities would be implemented as described under Site R04. These include drain tile disablement, ditch filling or plugging, bank grading, riffle placement, minor grading and native vegetation reestablishment.

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, disking could be implemented or alfalfa cropping to botanically break the soils up and at the same time remove nutrients from them. 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 consideration for soil amendments would be pine saw dust in the case of overly nitrified soils, which would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

Trees would be removed from about 23-acres to remove old farm field windbreaks. About 48-acres of oldfield would be managed for herbaceous invasive species. All other acres of plant community would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for site K41 would be to keep invasive plant species from recolonizing. Once the site becomes robust with native plant diversity and densities, the up keep on invasive plant species recolonization should decline. Considerations 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. These stones may need to be adjusted or added to every so often.

Costs associated with this site are identified in Table 10.3.

Kenosha County Non-structural (Full)

The incrementally justified non-structural component of the flood risk management 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 Bristol, Salem, Somers, and Paddock Lake. 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.

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.
- Ring Levee – 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 flood risk management measures (800 cfs during the 10% annual change of exceedance flood event). These measures are therefore recommended for implementation by local flood risk management authorities as part of the Full Plan.

Costs associated with the non-structural measures are identified in Table 10.3.

Table 10.3 – Kenosha County Estimated Costs (Full & NED/NER Plans)

Activity	Cost per Site			
	K09 (NED/NER)	K33 (NED/NER)	K47 (NED/NER)	K41 (NED/NER)
Preliminary LERRDs	[redacted]			
Construction				
Preconstruction Engineering & Design				
Supervision & Administration				
Monitoring & Adaptive Management				
Total Estimated Cost				
Annual OMRR&R				

Activity	Kenosha County Non-Structural (Full Plan)	Total Kenosha County (Full Plan)	Total Kenosha County (NED/NER Plan)
Preliminary LERRDs	[redacted]		
Construction			
Preconstruction Engineering & Design			
Supervision & Administration			
Monitoring & Adaptive Management			
Total Implementation			
Annual OMRR&R			

(FY2013 Price Level)

10.1.3 Lake County, Illinois

Dutch Gap Aquatic Complex (NER L41 Rural Alternative 9), Antioch (Plate 33)

Dutch Gap Aquatic Complex will restore native plant communities of marsh, wet meadow, wet prairie, mesic and dry prairie, mesic and dry oak savanna, wet forest, flat woods and open woodland reestablished. Once agricultural practices cease, the hydrology, geomorphology will be naturalized. This will allow for the restoration and establishment of native plant and animal species over the 680-acre site.

Once the non-Federal sponsor obtains rights to the lands for restoration, heavy agricultural practices should cease and a light farming operation could be implemented. Agricultural fields could be planted with alfalfa. This plant would begin to repair soils by fixing nitrogen, removing soil compaction, adding organic carbon and begin returning soil porosity. The crops could then be sold to support minor invasive species issues in other non-farmed areas. Also, the continuation of farming the land would preclude invasive plant species from overrunning any agricultural oldfields.

Drain tile valves would be placed across 680-acre site. The purpose and methods are the same as those described for Site R04. The main waterway that is conduit for water through the site is North Mill Creek (5,900-feet). To return this segment to a naturally functioning stream, the water would be set back in motion over the landscape. L41 has sufficient space within a stream valley that would confine the meandering stream within the site boundaries. Ditch banks would be graded to a slope of 20:1. Cobble riffles would be placed at various points within the channel that are slightly angled for this site. To further resurge hydrology, about 64-acres of trees would be removed and about 45-acres of woodland would be thinned since trees have a significant impact on draining down the water table.

Topography and geomorphology of site L41 was modified from its natural condition in order to have a functioning agricultural plot of land. To repair geomorphology to the wetland basins, stream channel and active floodplain, various activities would be implemented as described under Site R04, which include drain tile disablement, bank grading, riffle placement, minor grading and native vegetation reestablishment.

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, disking could be implemented or other methods such as alfalfa cropping to botanically break the soils up and at the same time remove nutrients from them. There may be a need to add organic carbon to the soils in order to establish former plant communities. This would be accomplished by the use of organic leaf litter compost as a soil amendment. Another consideration for soil amendments would be pine saw dust in the case of overly nitrified soils, which would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

Trees would be removed from about 64-acres to restore sidestream marsh. About 45-acres of woodland would have non-native trees and shrubs removed. About 154-acres of oldfield would be managed for herbaceous invasive species. All other acres of plant community would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for site L41 would be to keep invasive plant species from recolonizing. Once the site becomes robust with native plant diversity and densities, the up keep on invasive plant species recolonization should decline. Considerations 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. These stones may need to be adjusted or added to every so often.

Costs associated with this site are identified in Table 10.4 at the end of this section.

Red Wing Slough and Deer Lake Wetland Complex, Antioch (NER L43 Rural Alternative 2) (Plate 34)

Red Wing Slough and Deer Lake Wetland Complex will restore native plant communities of lake, marsh, wet meadow, wet prairie, mesic and dry savanna, wet forest, flat woods and open woodland reestablished. Once agricultural practices cease, the hydrology, geomorphology will be naturalized. This will allow for the restoration and establishment of native plant and animal species over the 1,578-acre site.

Once the non-Federal sponsor obtains rights to the lands for restoration, heavy agricultural practices should cease and a light farming operation could be implemented. Agricultural fields could be planted with alfalfa, which would begin to repair soils by fixing nitrogen, removing soil compaction, adding organic carbon and begin returning soil porosity. The crops could be sold to support invasive species issues in non-farmed areas. The continuation of farming the land would preclude invasive plant species from overrunning any agricultural oldfields.

Hydrology and hydraulics would be restored by placing drain tile valves at locations across 892-acres of the 1578-acre site; the difference in acres is open water. The purpose and methods are the same as those described for Site R04. 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. There is a 1,000-foot segment of stream that drains Deer Lake into more flowage wetlands; however, when the drain tiles are disabled and vegetation restored, this stream would be drowned and 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.

Topography and geomorphology of site L43 is intact for the most part. To repair geomorphology to this floodplain forest 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/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 to botanically break the soils up and at the same time remove nutrients from them. 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 consideration for soil amendments would be pine saw dust in the case of overly nitrified soils, which would activate bacteria that begin to denitrify the soils as part of their metabolic processes. Trees would be removed from about 69-acres to restore wet meadows and flat woods. About 34-acres of woodland and flat woods would have non-native trees and shrubs removed. 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 site L43 would be to keep invasive plant, tree and shrub species from recolonizing. Once the site becomes robust with native plant diversity and densities, the up keep on invasive plant species recolonization should decline.

Costs associated with this site are identified in Table 10.4 at the end of this section.

Pollack Lake and Hastings Creek Riparian Wetlands, Antioch (NER L39 Rural Alternative 6) (Plate 35)

Pollack Lake and Hastings Creek Riparian Wetlands will restore native plant communities of lake, marsh, wet meadow, wet prairie, wet prairie, mesic and dry prairie, and open woodland reestablished. Once agricultural practices cease, the hydrology, geomorphology will be naturalized. This will allow for the restoration and establishment of native plant and animal species over the 429-acre site.

Once the non-Federal sponsor obtains rights to the lands for restoration, heavy agricultural practices should cease and a light farming operation could be implemented. Agricultural fields could be planted with alfalfa, which would begin to repair soils by fixing nitrogen, removing soil compaction, adding organic carbon and begin returning soil porosity. The crops could be sold to support invasive species issues in other non-farmed areas. The continuation of farming the land would preclude invasive plant species from overrunning any agricultural oldfields.

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 R04. There are two small tributaries that flow through the site; one is a 3,000-foot prairie swale that drains Pollack Lake into Mill Creek. The other is a 3,600-foot segment of Hastings Creek, which was channelized. No action is recommended for the prairie swale since drain tile disablement and vegetation restoration would repair its hydrologic conditions. To return the segment of ditch back into 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 points within the channel to engage the meandering process. If certain portions of the ditch are extremely incised, it may be necessary for higher riffle crests. Hydraulic modeling would be completed to ensure riffles would not back up water into neighboring parcels. The riffle stone would consist of natural glacial or fluvial stone.

Topography and geomorphology of site L39 was modified from its natural condition in order to have a functioning agricultural plot of land. To repair geomorphology to the wetland basins, stream channel and active floodplain, various activities would be implemented as described in the above discussion on hydrologic restoration. 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 through 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 to botanically break the soils up and at the same time remove nutrients from them. 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 consideration for soil amendments would be pine saw dust in the case of overly nitrified soils, which would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

About 168-acres of woodland would need thinning of invasive trees, shrubs and herbaceous plant species. About 129-acres of oldfield 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 site L33 would be to keep invasive plant species from recolonizing. Once the site becomes robust with native plant diversity and densities, the up keep on invasive plant species recolonization should decline. Considerations for the stream should be minimal since the stream is already naturally meandering. Considerations 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. These stones may need to be adjusted or added to every so often.

Costs associated with this site are identified in Table 10.4 at the end of this section.

Mill Creek Riparian Woodland (NER L33 Rural Alternative 4), Old Mill Creek (Plate 36)

Mill Creek Riparian Woodland will restore native plant communities of marsh, wet meadow, wet and dry oak savanna, wet forest and open woodland reestablished. Once agricultural practices cease, the hydrology, geomorphology will be naturalized. This will allow for the restoration and establishment of native plant and animal species over the 276-acre site.

Once the non-Federal sponsor obtains rights to the lands for restoration, heavy agricultural practices should cease and a light farming operation could be implemented. Agricultural fields could be planted with alfalfa which would repair soils by fixing nitrogen, removing soil compaction, adding organic carbon and begin returning soil porosity. The crops could then be sold to support invasive species issues in other non-farmed areas. The continuation of farming the land would preclude invasive plant species from overrunning any agricultural oldfields.

The hydrology would be restored by placing drain tile valves across the 276-acre site. The purpose and methods are the same as those described for Site R04. The main waterway that is conduit for water through the site is Mill Creek (11,500-feet). This marshy floodplain was invaded by invasive trees due to drain tile systems drying out the earth. The colonization of the trees has further dried out the floodplain through evapotranspiration; therefore, if the trees are removed first, then the drain tile system disabled, hydrology would resurge within the floodplain. Also, through disabling the drain tiles throughout the whole site coupled with additional invasive tree thinning would further resurge hydrology to the stream which will greatly aid during droughty periods during summer months via slow ground water discharge to the stream.

Topography and geomorphology of site L33 was modified from its natural condition in order to have agricultural land. To repair geomorphology to the wetland floodplain, stream channel and woodland hollows, various activities would be implemented as described under Site R04. These include drain tile disablement, minor grading, tree removal and native vegetation reestablishment.

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, disking could be implemented or other methods such as alfalfa cropping to botanically break the soils up and at the same time remove nutrients from them. 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 consideration for soil amendments would be pine saw dust in the case of overly nitrified soils, which would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

Approximately 43- acres would have trees removed from the former marshy areas and about 58-acres of woodland would require thinning of invasive trees, shrubs and herbaceous plant species. About 14-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 site L33 would be to keep invasive plant species from recolonizing. Once the site robust with native plant diversity and densities, the up keep on invasive plant species recolonization should decline. Considerations for the stream should be minimal since the stream is already naturally meandering.

Costs associated with this site are identified in Table 10.4 at the end of this section.

Gurnee Woods Riparian Wetlands (NER L31 Rural Alternative 4), Wadsworth (Plate 37)

Gurnee Woods Riparian Wetlands will 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 reestablished. Once agricultural practices cease, the hydrology, geomorphology will be naturalized. This will allow for the restoration and establishment of native plant and animal species over the 698-acre site.

Once the non-Federal sponsor obtains rights to the lands for restoration, heavy agricultural practices should cease and a light farming operation could be implemented. Agricultural fields could be planted with alfalfa, which would begin to repair soils by fixing nitrogen, removing soil compaction, adding organic carbon and begin returning soil porosity. The crops could be sold to support invasive species issues in other non-farmed areas. The continuation of farming the land would preclude invasive plant species from overrunning any agricultural oldfields.

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 R04. The main waterway that is conduit for water through the site is the Des Plaines River (21,500-feet). This once marshy floodplain has been invaded by trees invasive trees due to drain tile systems drying out the earth. The colonization of the trees has further dried out the floodplain through evapotranspiration, thusly if the trees are removed first, then the drain tile system disabled, hydrology would resurge within the floodplain. Also, through disabling the drain tiles throughout the whole site coupled with additional invasive tree thinning would further resurge hydrology to the stream.

Topography and geomorphology of site L31 was modified from its natural condition in order to have an agricultural land. To repair geomorphology to the wetland floodplain, stream channel, various activities would be implemented as described under Site R04. These include drain tile disablement, minor grading, tree removal and native vegetation reestablishment.

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, disking could be implemented or other methods such as alfalfa cropping to botanically break the soils up and at the same time remove nutrients from them. There may be a need to add organic carbon to the soils in order to establish former plant communities. Another consideration for soil amendments would be pine saw dust in the case of overly nitrified soils, which would activate bacteria that begin to denitrify the soils as part of their metabolic processes.

Approximately 15-acres would have trees removed from the former marshy areas. About 516-acres of marsh and woodland would need thinning of invasive trees, shrubs and herbaceous plant species. 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 site L31 would be to keep invasive plant species from recolonizing. Once the site becomes robust with native plant diversity and densities, the up keep on invasive plant species recolonization should decline.

Aptakisic Creek Reservoir (NED ACRS08), Buffalo Grove (Plate 17)

Aptakisic Creek reservoir will provide approximately 550 acre-feet of storage on the Aptakisic Creek tributary to the mainstem Des Plaines River, reducing flood stages downstream of the reservoir within the tributary and downstream of the confluence of Aptakisic Creek along the mainstem. The 94 acre site is located at Aptakisic Road and Buffalo Grove Road.

The reservoir will be excavated to a depth of 4.5 feet deep providing capacity for 25 % to 1% annual chance of exceedance flood events. The bottom elevation varies between 676 and 682 ft NAVD88. A levee around the reservoir will be constructed to establish a top elevation of 688 ft NAVD88. The levee will be constructed from impervious material excavated for the reservoir, covered with six inches of topsoil and seeded.

Stormwater is pumped into the reservoir from Aptakisic Creek through a reinforced concrete pipe. A sluice gate at an existing ditch (bottom elevation 678.5 feet NAVD88) will prevent stored water from flowing to the creek. After an event, the sluice gate will be opened allowing water to drain into the ditch. The remaining water will removed through a pump station.

Suitable material from the reservoir excavation will be used for construction of the levee surrounding the site. Excess material will be stored on the site in two spoil areas. The estimated height of the spoil areas are 12 and 10 feet with side slopes of 1 vertical to11 horizontal and 1 vertical to 15 horizontal, respectively. The spoil piles will be covered with six inches of topsoil and seeded.

Operations and Maintenance activities at the reservoir will include annual inspections and control of vegetation through mowing, trimming of trees and brush, and removal of any accumulated debris. As needed, the levee will be filled and/or repaired. The outlet pump station will 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 after that time. Gate structures would be inspected annually and repaired or replaced as needed, approximately every 20 years.

This reservoir is included in both the Full and NED Plans. Costs associated with this site are identified in Table 10.4 at the end of this section.

Granger Woods Floodplain Forest (CAP L05 Urban Alternative 8), Mettawa (Plate 38)

Granger Woods Floodplain Forest will restore native plant communities of marsh, wet meadow, mesic and dry savanna, wet forest, flat woods and open woodland reestablished. Once agricultural practices cease, the hydrology, geomorphology will be naturalized. This will allow for the restoration and establishment of native plant and animal species over the 322-acre site.

Once the non-Federal sponsor obtains rights to the lands for restoration, heavy agricultural practices should cease and a light farming operation could be implemented. Agricultural fields could be planted with alfalfa, which would begin to repair soils by fixing nitrogen, removing soil compaction, adding organic carbon and begin returning soil porosity. The crops could be sold to support invasive species issues in non-farmed areas. The continuation of farming would preclude invasive plant species from overrunning any agricultural oldfields.

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 R04. This restoration site does not have a major waterway flowing through it; however, there are wet meadow swales and woodland hollows that flow down into the Des Plaines River. This site is also entirely within the floodplain and riparian zone of the Des Plaines River. Aside from disabling any present drain tiles, hydrology would be restored and naturalized through the removal of invasive and non-native trees. About 88-acres of trees would be removed from wet sedge meadow and flat woods plots. In addition, 151-acres of woodland would have non-native trees removed, furthering hydrologic resurgence since trees have a significant impact on draining down the water table.

Topography and geomorphology of site L05 is intact for the most part. To repair geomorphology to this floodplain forest 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 to botanically break the soils up and at the same time remove nutrients from them. 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 consideration for soil amendments would be pine saw dust in the case of overly nitrified soils, which 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. About 151-acres of woodland and flat woods would have non-native trees and shrubs removed. All other acres of plant community would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for site L05 would be to keep invasive plant, tree and shrub species from recolonizing, especially during the early stages of the site's recovery. Once the site becomes older and more robust with native plant diversity and densities, the up keep on invasive plant species recolonization should decline.

Costs associated with this site are identified in Table 10.4.

Lake County Non-structural (NED)

The incrementally justified non-structural component of the flood risk management 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 Riverwoods, Buffalo Grove, Libertyville, and Gurnee. 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.

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.
- Ring Levee – 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 10.4.

Table 10.4 – Lake County Estimated Costs

Activity	Cost per Site			
	L41 (NED/NER)	L43 (NED/NER)	L39 (NED/NER)	L33 (CAP)
Preliminary LERRDs	[redacted]	[redacted]	[redacted]	[redacted]
Construction	[redacted]	[redacted]	[redacted]	[redacted]
Preconstruction Engineering & Design	[redacted]	[redacted]	[redacted]	[redacted]
Supervision & Administration	[redacted]	[redacted]	[redacted]	[redacted]
Monitoring & Adaptive Management	[redacted]	[redacted]	[redacted]	[redacted]
Total Estimated Cost	[redacted]	[redacted]	[redacted]	[redacted]
Annual OMRR&R	[redacted]	[redacted]	[redacted]	[redacted]
Activity	Cost per Site			
	L31 (NED/NER)	L05 (CAP)	ACRS08 (NED/NER)	Lake County Non-structural (NED/NER)
Preliminary LERRDs	[redacted]	[redacted]	[redacted]	[redacted]
Construction	[redacted]	[redacted]	[redacted]	[redacted]
Preconstruction Engineering & Design	[redacted]	[redacted]	[redacted]	[redacted]
Supervision & Administration	[redacted]	[redacted]	[redacted]	[redacted]
Monitoring & Adaptive Management	[redacted]	[redacted]	[redacted]	[redacted]
Total Estimated Cost	[redacted]	[redacted]	[redacted]	[redacted]
Annual OMRR&R	[redacted]	[redacted]	[redacted]	[redacted]

Activity	*Total Lake County (Full Plan)*	*Total Lake County (NED/NER Plan)*	*Total Lake County (CAP Plan)*
Preliminary LERRDs	[redacted]	[redacted]	[redacted]
Construction	[redacted]	[redacted]	[redacted]
Preconstruction Engineering & Design	[redacted]	[redacted]	[redacted]
Supervision & Administration	[redacted]	[redacted]	[redacted]
Monitoring & Adaptive Management	[redacted]	[redacted]	[redacted]
Total Estimated Cost	[redacted]	[redacted]	[redacted]
Annual OMRR&R	[redacted]	[redacted]	[redacted]

(FY2013 Price Level)

10.1.4 Cook County, Illinois

Northbrook Floodplain & Riparian Complex (NER C09 Urban Alternative 8), Wheeling (Plate 40)

Northbrook Floodplain and Riparian Complex will restore native plant communities of marsh, wet meadow, wet prairie, mesic and dry prairie, wet savanna, mesic and dry savanna, wet forest, flat woods and open woodland reestablished. The hydrology, geomorphology will be naturalized. This will allow for the 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 R04. This restoration site is 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, 330-acres of woodland would have non-native trees removed, furthering hydrologic resurgence. Trees have a significant impact on draining down the water table.

Topography and geomorphology of site C09 is intact for the most part. 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 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 to botanically break the soils up and at the same time remove nutrients from them. 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 consideration for soil amendments would be pine saw dust in the case of overly nitrified soils, which 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. About 330-acres of woodland and savanna would have non-native trees and shrubs removed. 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 up keep on invasive plant species recolonization should decline.

Costs associated with this site are identified in Table 10.5 at the end of this section.

Dam #1 Removal, (CAP) Wheeling (Plate 41)

This two foot high run-of-the-river dam will be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation will restore the habitat to a more natural condition.

Costs associated with this site are identified in Table 10.5 at the end of this section.

Dam #2 Removal (CAP), Des Plaines (Plate 42)

This two foot high run-of-the-river dam will be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation will restore the habitat to a more natural condition.

Costs associated with this site are identified in Table 10.5 at the end of this section.

Beck Lake Meadow & Floodplain Forest (NER C15 Urban Alt. 8), Des Plaines & Glenview (Plate 39)

Beck Lake Meadow and Floodplain Forest will restore native plant communities of marsh, wet meadow, wet prairie, mesic and dry prairie, wet savanna, mesic and dry savanna, wet forest, flat woods and open woodland reestablished. the hydrology, geomorphology will be naturalized. This will allow for the 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 R04. 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. Aside from identifying and disabling any present drain tiles, 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, 330-acres of woodland would have non-native trees removed, furthering hydrologic resurgence, since trees have an impact on draining down the water table.

Topography and geomorphology of site C15 is intact for the most part. 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 through 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 to botanically break the soils up and at the same time remove nutrients from them. 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 consideration for soil amendments would be pine saw dust in the case of overly nitrified soils, which would activate bacteria that begin to denitrify the soils as part of their metabolic processes. Trees would be removed from about 428-acres to restore marsh, wet meadow and wet prairie. About 396-acres of forest, woodland and savanna would have non-native tree, shrub and herbaceous species removed. All other acres of plant community would be rejuvenated from agricultural lands.

The main activity during the operations and maintenance period for site C15 would be to keep invasive plant species from recolonizing, especially during the early stages of the site's recovery. Once the site becomes older and more robust with native plant diversity and densities, the up keep on invasive plant species recolonization should decline.

Costs associated with this site are identified in Table 10.5 at the end of this section.

Dempster Ave Dam Removal (CAP), Des Plaines (Plate 43)

This two foot high run-of-the-river dam will be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation will restore the habitat to a more natural condition.

Costs associated with this site are identified in Table 10.5 at the end of this section.

Lake Mary Anne Pump Station (Full FPCI01), Maine Township (Plate 21)

Lake Mary Anne Pump Station will 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 will maximize storage capacity and lower flood stages downstream. The pump station will discharge into a pipe routed under Golf Road to Dude Ranch Pond. Additionally, discharge from two existing pumps will 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 will 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 will include annual inspections and maintenance and removal of any accumulated debris. The pumps will 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.

This structure modification is a component of the Full Plan. Costs associated with this site are identified in Table 10.5 at the end of this section.

Ashland-Fargo Levee (NED DPLV09), Des Plaines (Plate 18)

This 11,100 foot levee and floodwall will protect homes and businesses along the main stem in the City of Des Plaines between Touhy Avenue and Miner Street. The crest elevation is two feet above the 1% annual change of exceedance flood elevation. The probability that this levee will not be overtopped during 1% annual chance of exceedance flood event will be greater than 95%.

The levee/floodwall extends from Touhy Avenue to Miner Street along the west side of the Des Plaines River. The total length of levee and floodwall are approximately 1,800 and 9,300 feet, respectively. The earthen levee will 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 will also include six road closure structures where the line of protection crosses Cedar Street, River Road (twice), Oakton Street, Algonquin Road, and White Street.

Asphalt trail along the levee alignment from Algonquin Road to Oakton Street will be built to provide recreation opportunities for area residents. The trail will connect to the existing Des Plaines River trail system on the east side of the river.

The levee and floodwall alignment will be inspected annually. Annual maintenance activities at levee segments will include landscaping and 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 will include cleaning and treating the structure with repairs to waterstops, cracks, railings, and walkways as needed. Road closure structures will be inspected annually with and periodic maintenance will include painting, cleaning, and repairing the gates.

The levee is a component of the Full and NED Plans. Costs associated with this site are identified in Table 10.5 at the end of this section.

Touhy Ave Dam Removal (CAP), Park Ridge (Plate 44)

This two foot high run-of-the-river dam will be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation will restore the habitat to a more natural condition.

Costs associated with this site are identified in Table 10.5 at the end of this section.

Dam #4 Removal (NER), Park Ridge (Plate 45)

This two foot high run-of-the-river dam will be removed. The dam currently fragments the riverine habitat and prevents fish passage during low flows. Project implementation will restore the habitat to a more natural condition.

Costs associated with this site are identified in Table 10.5 at the end of this section.

Belmont-Irving Park Levee (NED DPLV05), Schiller Park (Plate 19)

This 7,400 foot levee and floodwall will protect homes and businesses along the mainstem Des Plaines River in the city of Schiller Park. The crest elevation is 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 will be greater than 95%.

The levee/floodwall extends from Belmont Avenue to Irving Park Road along the east side of the Des Plaines River. The total length of the levee and floodwall sections are 5,576 and 1,782 feet, respectively. The earthen levee will have a crest width of 10 feet. The crest of the levee and top of the floodwall will be at 629.3 feet NAVD88. The project will also include road closure structures where the line of protection crosses River Road north of Irving Park Road, at Irving Park Road, and at Elm Street and River Road.

The levee and floodwall alignment will be inspected annually. Annual maintenance activities at levee segments will include landscaping and 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 will include cleaning and treating the structure with repairs to waterstops, cracks, railings, and walkways as needed. Road closure structures will be inspected annually with and periodic maintenance will include painting, cleaning, and repairing the gates.

The levee is a component of the Full and NED Plans. Costs associated with this site are identified in Table 10.5 at the end of this section.

Fifth-CN Railroad Levee (NED DPLV04), River Grove (Plate 20)

This 6,400 foot levee and floodwall will protect homes and businesses along the mainstem Des Plains River in the city of River Grove. The crest elevation is two feet about 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 will be greater than 95%.

The levee/floodwall extends from the Palmer Street and Fifth Avenue along Fifth Avenue and River Road to the Canadian North Railroad. The total length of the levee and floodwall sections are 4,240 and 2,190, respectively. The earthen levee will have a crest width of 10 feet. The crest of the levee and top of the floodwall will be at 628.4 feet NAVD88. The project will also include road closure structures where the line of protection crosses Grand Avenue and at the intersection of Des Plaines River Road and Fifth Avenue. The project also includes a road raise at Fifth Avenue and Palmer Street, allowing Fifth Avenue to remain open during a flood event.

The levee and floodwall alignment will be inspected annually. Annual maintenance activities at levee segments will include landscaping and 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 will include cleaning and treating the structure with repairs to waterstops, cracks, railings, and walkways as needed. Road closure structures will be inspected annually with and periodic maintenance will include painting, cleaning, and repairing the gates.

The levee is a component of the Full and NED Plans. Costs associated with this site are identified in Table 10.5 at the end of this section.

First Avenue Bridge Modification (Full DPBM04), River Grove (Plate 23)

The First Avenue Bridge crossing the mainstem Des Plaines River, which currently overtops during a 50% annual change of exceedance (2-year) flood event, will be raised above the 1% annual chance of exceedance (100-year) flood elevation and provide greater conveyance capacity under the roadway. The site will 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 will be required during construction. The reconstruction should 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 will be evaluated and the inlets will be raised as appropriate. Traffic signals at the intersection of River Rd and First Ave will also be evaluated and raised as appropriate.

Operation and maintenance of the roadway will continue according to current Illinois Department of Transportation practices. The embankments will be inspected annually and filled and/or repaired as needed. Maintenance activities will include control of vegetation, debris removal, and cleaning and repair of retaining walls and culverts.

The road raise is a component of the Full Plan. Costs associated with this site are identified in Table 10.5 at the end of this section.

Groveland Avenue Levee (CAP DPLV01), Riverside (Plate 22)

The existing Groveland Avenue levee will 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 will 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 will not be overtopped during a 100 year flood event will be greater than 95%.

The height of the existing levee at Groveland Avenue will be increased using a sheet pile wall along the levee, extending approximately 870 feet. At the north end of the existing levee, Park Lane and Lincoln Avenue will be raised over approximately 1,250 feet to tie the levee in to high ground. At the south end of the existing levee, a floodwall extending approximately 700 feet south from Forest Avenue will tie in to high ground. A road closure structure at Forest Avenue will connect these segments.

The levee and floodwall alignment will be inspected annually. Annual maintenance activities at levee segments will include landscaping and 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 will include cleaning and treating the structure with repairs to waterstops, cracks, railings, and walkways as needed. Road closure structures will be inspected annually with and periodic maintenance will include painting, cleaning, and repairing the gates.

The levee is a component of the Full Plan and the CAP Plan. Costs associated with this site are identified in Table 10.5.

Cook County Non-structural (NED)

The incrementally justified non-structural component of the flood risk management 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 Riverside, River Grove, Rosemont, Des Plaines, and Prospect Heights. 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.

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.

- Ring Levee – 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

Additional non-structural measures in Cook County are along portions of streams that do not meet the minimum flow criteria for USACE participation in flood risk management measures (800 cfs during the 10% annual change of exceedance flood event). These measures, in the community of Park Ridge, are therefore recommended for implementation by local flood risk management authorities as part of the Full Plan. Costs associated with non-structural measures included in the NED/NER Plan as well as the additional structures included only in the Full Plan are identified in Table 10.5.

Table 10.5 – Cook County Estimated Costs

Activity	Cost per Site			
	C09 (NED/NER)	Dam #1 (CAP)	Dam #2 (CAP)	C15 (CAP)
Preliminary LERRDs	[redacted]	[redacted]	[redacted]	[redacted]
Construction	[redacted]	[redacted]	[redacted]	[redacted]
Preconstruction Engineering & Design	[redacted]	[redacted]	[redacted]	[redacted]
Supervision & Administration	[redacted]	[redacted]	[redacted]	[redacted]
Monitoring & Adaptive Management	[redacted]	[redacted]	[redacted]	[redacted]
Total Implementation	[redacted]	[redacted]	[redacted]	[redacted]
Annual OMRR&R	[redacted]	[redacted]	[redacted]	[redacted]

Activity	Cost per Site			
	Dempster Ave Dam (CAP)	FPCI01 (Full)	Touhy Ave Dam (CAP)	Dam #4 (CAP)
Preliminary LERRDs	[redacted]	[redacted]	[redacted]	[redacted]
Construction	[redacted]	[redacted]	[redacted]	[redacted]
Preconstruction Engineering & Design	[redacted]	[redacted]	[redacted]	[redacted]
Supervision & Administration	[redacted]	[redacted]	[redacted]	[redacted]
Monitoring & Adaptive Management	[redacted]	[redacted]	[redacted]	[redacted]
Total Implementation	[redacted]	[redacted]	[redacted]	[redacted]
Annual OMRR&R	[redacted]	[redacted]	[redacted]	[redacted]

Activity	Cost per Site			
	DPLV09 (NED/NER)	DPLV05 (NED/NER)	DPLV04 (NED/NER)	DPBM04 (Full)
Preliminary LERRDs	[redacted]	[redacted]	[redacted]	[redacted]
Construction	[redacted]	[redacted]	[redacted]	[redacted]
Preconstruction Engineering & Design	[redacted]	[redacted]	[redacted]	[redacted]
Supervision & Administration	[redacted]	[redacted]	[redacted]	[redacted]
Total Implementation	[redacted]	[redacted]	[redacted]	[redacted]
Annual OMRR&R	[redacted]	[redacted]	[redacted]	[redacted]

Activity	Cost per Site		
	DPLV01 (CAP)	Cook County Non-structural (NED/NER)	Cook County Non-structural (Full)
Preliminary LERRDs	[redacted]	[redacted]	[redacted]
Construction	[redacted]	[redacted]	[redacted]
Preconstruction Engineering & Design	[redacted]	[redacted]	[redacted]
Supervision & Administration	[redacted]	[redacted]	[redacted]
Total Implementation	[redacted]	[redacted]	[redacted]
Annual OMRR&R	[redacted]	[redacted]	[redacted]

Activity	*Total Cook County (Full Plan)*	*Total Cook County (NED/NER Plan)*	*Total Cook County (CAP Plan)*
Preliminary LERRDs	[redacted]	[redacted]	[redacted]
Construction	[redacted]	[redacted]	[redacted]
Preconstruction Engineering & Design	[redacted]	[redacted]	[redacted]
Supervision & Administration	[redacted]	[redacted]	[redacted]
Monitoring & Adaptive Management	[redacted]	[redacted]	[redacted]
Total Implementation	[redacted]	[redacted]	[redacted]
Annual OMRR&R	[redacted]	[redacted]	[redacted]

(FY2013 Price Level)

10.1.5 Ecosystem Restoration Measure Quantities

The ecosystem restoration plans will provide significant habitat to the Upper Des Plaines River watershed. Table 10.6 below 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 10.6 – Ecosystem Restoration Site Measure Quantities

Measure	Unit[1]	Quantity per Site						
		R04	K09	K33	K47	K41	L41	L43
stream remeander	FT	5,500	8,150	55,200	9,400	8,500	5,900	0
bank grading 20:1	FT	5,500	8,150	15,000	9,400	8,500	0	0
swale grading	FT	30	40	40,200	10	30	40	0
cobble riffles	EA	4,350	6,000	30	2,500	0	0	0
fill ditch	FT	721	627	0	1,619	689	680	892
drain tile survey	AC	721	627	2,133	1,619	689	680	892
drain tile valves	AC	46	0	2,133	253	0	45	34
tree & understory thinning	AC	2	0	0	251	23	64	69
tree removal	AC	4	50	0	150	48	154	252
herbaceous management	AC	721	627	0	1,619	689	680	1,578
native plant establishment	AC	0	2	2,133	9	0	0	241
open water	AC	166	175	1	545	81	75	280
basin marsh	AC	75	102	223	101	130	0	0
side stream marsh	AC	0	0	95	0	0	129	166
wet meadow	AC	132	122	0	247	2	45	87
wet prairie	AC	141	130	828	53	45	31	0
mesic/dry prairie	AC	14	10	407	76	65	0	0
wet savanna	AC	15	1	174	83	59	50	112
mesic/dry savanna	AC	3	0	15	0	0	0	0
floodplain forest	AC	0	0	65	3	8	50	22
wet forest	AC	20	0	2	69	154	21	5
flat woods	AC	155	84	187	434	145	279	664
open woodland	AC	0	0	137	0	0	0	0

Table 10.6 – Ecosystem Restoration Site Measure Quantities (cont.)

Measure	Unit[1]	Quantity per Site					
		L39	L33	L31	L05	C09	C15
fill ditch	FT	393	230	475	260	0	0
drain tile survey	AC	393	230	475	260	811	670
drain tile valves	AC	168	58	516	151	811	670
tree & understory thinning	AC	0	43	15	88	330	396
tree removal	AC	129	14	203	0	479	428
herbaceous management	AC	429	276	698	322	0	36
native plant establishment	AC	38	8	80	3	811	862
open water	AC	81	45	400	4	14	56
basin marsh	AC	0	0	0	0	26	50
side stream marsh	AC	15	4	20	60	160	0
wet meadow	AC	49	4	12	0	93	320
wet prairie	AC	34	0	26	0	103	36
mesic/dry prairie	AC	0	15	0	0	94	0
wet savanna	AC	112	21	51	9	11	85
mesic/dry savanna	AC	0	0	5	0	165	17
floodplain forest	AC	22	24	73	157	0	0
wet forest	AC	5	0	0	36	122	263
flat woods	AC	664	155	33	53	0	0
open woodland	AC	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 10.7, below, summarizes the benefits for each of the plans developed in this study.

Table 10.7 – Summary of Plan Benefits

Formulated Plan	Net Benefits
Full Plan Includes 8 Flood Risk Management features –ACRS08, FPCI01, DPLV09, DPLV05, DPLV04, DPBM04, DPLV01, and non-structural measures in 13 communities in Cook, Lake and Kenosha Counties – and 18 Ecosystem Restoration features – R04, K09, K33, K47, K41, L41, L43, L39, L33, L31, L05, C09, C15, and five dam removals.	$9,702,000 NED net benefits 27,222 NER net HUs
NED/NER Plan Includes 5 Flood Risk Management features – ACRS08, DPLV09,DPLV05, DPLV04 and non-structural measures in 9 communities in Cook and Lake Counties – and 12 ecosystem restoration features – R04, K09, K33, K47, K41, L41, L43, L39, L31, C09, and C15.	$6,039,000 NED net benefits 26,573 NER net HUs
CAP Plan Includes 1 Flood Risk Management features – DPLV01 – and 7 Ecosystem Restoration Sites – L05, L33 and 5 dam removals.	$157,000 NED net benefits 649 NER net HUs

(FY2013 Price Level, FDR 3.75%)

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. 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, evapo-transpiration 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 will be 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 Value Engineering Coordinator.

10.4 Real Estate

Due to the large number of sites under consideration for each study purpose and measures within those purposes, generalized estimates of the values of lands, easements, rights of way, relocations, and disposal areas (LERRDs) were used. For measures such as reservoirs resulting in significant spoils, disposal areas are included as part of the conceptual site plan. A preliminary Real Estate Plan has been developed to refine these assumptions and is included as Appendix I and summarized in Table 10.8, below. These costs are tentative and subject to change. A Real Estate Plan and Gross Appraisal will be developed for each site recommended for implementation.

Table 10.8 – Estimated LERRD Values

Site ID	Site Name	Purpose	Plan	County	Preliminary Lands and Damages[1] ($1,000)	Relocations ($1,000)	Total Prelim. LERRDs ($1,000)
R04	Mt. Pleasant Wet Prairie	ER	NED/NER	Racine	[redacted]	[redacted]	[redacted]
K09	Somers Marsh	ER	NED/NER	Kenosha	[redacted]	[redacted]	[redacted]
K33	Paris Wet Prairie	ER	NED/NER	Kenosha	[redacted]	[redacted]	[redacted]
K47	Bristol Marsh	ER	NED/NER	Kenosha	[redacted]	[redacted]	[redacted]
K41	Dutch Gap Forested Floodplain	ER	NED/NER	Kenosha	[redacted]	[redacted]	[redacted]
--	Kenosha County Non-structural	FRM	Full	Kenosha	[redacted]	[redacted]	[redacted]
L41	Dutch Gap Aquatic Complex	ER	NED/NER	Lake	[redacted]	[redacted]	[redacted]
L43	Red Wing Slough and Deer Lake Wetland Complex	ER	NED/NER	Lake	[redacted]	[redacted]	[redacted]
L39	Pollack Lake and Hastings Creek Riparian Wetlands	ER	NED/NER	Lake	[redacted]	[redacted]	[redacted]
L33	Mill Creek Riparian Woodland	ER	NED/NER	Lake	[redacted]	[redacted]	[redacted]
L31	Gurnee Woods Riparian Wetland	ER	NED/NER	Lake	[redacted]	[redacted]	[redacted]
L05	Granger Woods Floodplain Forest	ER	NED/NER	Lake	[redacted]	[redacted]	[redacted]
ACRS08	Aptakisic Creek Reservoir	FRM	NED/NER	Lake	[redacted]	[redacted]	[redacted]
--	Lake County Non-structural	FRM	NED/NER	Lake	[redacted]	[redacted]	[redacted]
C09	North Brook Marsh	FRM	NED/NER	Cook	[redacted]	[redacted]	[redacted]
	Dam #1 Removal	ER	CAP	Cook	[redacted]	[redacted]	[redacted]
	Dam #2 Removal	ER	CAP	Cook	[redacted]	[redacted]	[redacted]
C15	Beck Lake Meadow	ER	NED/NER	Cook	[redacted]	[redacted]	[redacted]
	Dempster Ave Dam Removal	ER	CAP	Cook	[redacted]	[redacted]	[redacted]
FPCI01	Lake Mary Anne Pump Station	FRM	Full	Cook	[redacted]	[redacted]	[redacted]
DPLV09	Ashland Fargo Levee	FRM	NED/NER	Cook	[redacted]	[redacted]	[redacted]
	Touhy Ave Dam Removal	ER	CAP	Cook	[redacted]	[redacted]	[redacted]
	Dam #4 Removal	ER	CAP	Cook	[redacted]	[redacted]	[redacted]
DPLV05	Belmont-Irving Park Levee	FRM	NED/NER	Cook	[redacted]	[redacted]	[redacted]
DPLV04	Fifth-CN Railroad Levee	FRM	NED/NER	Cook	[redacted]	[redacted]	[redacted]
DPBM04	First Ave Bridge Modification	FRM	Full	Cook	[redacted]	[redacted]	[redacted]
DPLV01	Groveland Ave Levee	FRM	CAP	Cook	[redacted]	[redacted]	[redacted]
	Cook County Non-structural (NED)	FRM	NED/NER	varies	[redacted]	[redacted]	[redacted]
	Cook County Non-structural (Full)	FRM	Full	varies	[redacted]	[redacted]	[redacted]
				NED/NER Plan Total	[redacted]	[redacted]	[redacted]
				CAP Total	[redacted]	[redacted]	[redacted]
				Full Plan Total	[redacted]	[redacted]	[redacted]

[1] Land Values based on Informal Value Estimates. Formal Gross Appraisal Estimates will be included in the final Feasibility Report.
(FY2013 Price Level)

10.5 Operation and Maintenance

Site specific preliminary estimates of Operation, Maintenance, Repair, Replacement, and Rehabilitation (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 10.9 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, below.

Certain sites will not require OMRR&R. Implementation of Rural Alternative 5 at site R04 involves restoration of the site's hydrology only. No invasive species control or native plantings are included in the plan. Removal of disturbance to the site's hydrology ensures long term benefits from increased hydrological function. No maintenance is required after initial disablement of disturbance to the hydrological function of a site. Increased hydrological function results in increased structure and overall biodiversity, although at lower levels then sites with periodical control of invasive species. This is the trade-off between higher levels of biodiversity through long term commitment of maintenance efforts vs. no maintenance that results in lower levels of biodiversity but with self-sustainable levels of hydrological function. Implementation of the five Dam removals involves removing the existing structures. Once they are removed, there will 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.

A detailed OMRR&R plan will be developed during the Preconstruction Engineering and Design (PED) phase. The non-Federal sponsor(s) will be responsible for OMRR&R as outlined in each site's plan.

The proposed levees will 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 will be performed to document the design and construction of the levee and to serve as a baseline report. The levee will 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 will 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 FRM features levees will 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 10.9 – Preliminary OMRR&R Requirements

Measure	OMRR&R Requirements
Ecosystem Restoration	Burning
	Mowing
	Invasive Species Control (herbaceous)
	Invasive Species Control (woody)
	Additional Seeding to Build Species Richness
Reservoirs	Inspection
	Mowing
	Fill/Repair
	Debris Removal
	Tree & Brush Trimming
	Pump Station Inspection & Maintenance
	Pump Station Reconditioning/Rehab
	Pump Station Replacement
	Gate Inspection & Maintenance
	Gate Repair & Replacement
Levees	Inspection
	Debris Removal
	Fill/Repair
	Vermin Control
	Landscaping
	Toe Drain Inspection & Flushing
	Access Road Maintenance & Repair
Floodwalls	Inspection
	Cleaning/Treating
	Repair to waterstops, cracks, railings & walkways
Road Raises	Inspection
	Debris Removal
	Embankment Fill/Repair
	Landscaping
	Retaining Wall Cleaning/Repair
	Culvert Cleaning/Flushing/Repair
Dam Removal	No OMRR&R required
Elevation	TBD
Wet Floodproofing	TBD
Dry Floodproofing	TBD
Ring Levees	TBD

Table 10.10 – Estimated OMRR&R Costs

Site ID	Site Name	Purpose	Plan	County	Estimated Annual OMRR&R ($1,000)
R04	Mt. Pleasant Wet Prairie	ER	NED/NER	Racine	[redacted]
K09	Somers Marsh	ER	NED/NER	Kenosha	[redacted]
K33	Paris Wet Prairie	ER	NED/NER	Kenosha	[redacted]
K47	Bristol Marsh	ER	NED/NER	Kenosha	[redacted]
K41	Dutch Gap Forested Floodplain	ER	NED/NER	Kenosha	[redacted]
L41	Dutch Gap Aquatic Complex	ER	NED/NER	Lake	[redacted]
L43	Red Wing Slough and Deer Lake Wetland Complex	ER	NED/NER	Lake	[redacted]
L39	Pollack Lake and Hastings Creek Riparian Wetlands	ER	NED/NER	Lake	[redacted]
L33	Mill Creek Riparian Woodland	ER	NED/NER	Lake	[redacted]
L31	Gurnee Woods Riparian Wetland	ER	NED/NER	Lake	[redacted]
L05	Granger Woods Floodplain Forest	ER	NED/NER	Lake	[redacted]
ACRS08	Aptakisic Creek Reservoir	FRM	NED/NER	Lake	[redacted]
C09	North Brook Marsh	FRM	NED/NER	Cook	[redacted]
	Dam #1 Removal	ER	CAP	Cook	[redacted]
	Dam #2 Removal	ER	CAP	Cook	[redacted]
C15	Beck Lake Meadow	ER	NED/NER	Cook	[redacted]
	Dempster Ave Dam Removal	ER	CAP	Cook	[redacted]
FPCI01	Lake Mary Anne Pump Station	FRM	Full	Cook	[redacted]
DPLV09	Ashland Fargo Levee	FRM	NED/NER	Cook	[redacted]
	Touhy Ave Dam Removal	ER	CAP	Cook	[redacted]
	Dam #4 Removal	ER	CAP	Cook	[redacted]
DPLV05	Belmont-Irving Park Levee	FRM	NED/NER	Cook	[redacted]
DPLV04	Fifth-CN Railroad Levee	FRM	NED/NER	Cook	[redacted]
DPBM04	First Ave Bridge Modification	FRM	Full	Cook	[redacted]
DPLV01	Groveland Ave Levee	FRM	CAP	Cook	[redacted]
				NED/NER Plan Total	[redacted]
				CAP Total	[redacted]
				Full Plan Total	[redacted]

[1]The measure selected for site R04 includes restoration of the site's hydrology only. The measure does not include invasive species control or plantings.
[2]Project implementation at Dam Removal sites consists of removing the existing structure. No invasive species control or plantings are required.
(FY2013 Price Level, FDR 3.75%)

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, the recommended project includes a monitoring plan to measure the success of the ecosystem restoration and dictate the direction adaptive management, if needed, should proceed. This monitoring and adaptive management plan shall include a description of the monitoring activities, the criteria for success, and the estimated cost and duration. Additionally, the plan will specify that monitoring will continue until such time as the Secretary determines that the success criteria have been met. A detailed monitoring plan will be fashioned for each NER project component during the PED Phase once the projects are authorized by Congress. Since monitoring is a fixed, cost-shared item under the 2039 guidance, each monitoring plan developed in the PED phase will identify the associated costs per site. This comprehensive feasibility study is using 3% of the estimated construction costs as conservative estimate of the anticipated monitoring costs. Each monitoring plan will utilize the NER Objectives as success criteria. For example, success may be measure by:

- Critical flow of stream restoration riffles: ~ 1.0
- Sinuosity of channel produces helical flow: (observation) yes or no
- Restore physical riverine and riparian corridor habitat as measured by the Qualitative Habitat Evaluation Index: Target QHEI Score = ≥75
- Improve native fish species richness, abundance and assemblage structure as measured by the Illinois Region 4 Index of Biotic Integrity: Target IBI Score = ≥40
- Improve native plant species richness and assemblage structure as measured by coefficient of conservatism of the Chicago Region Floristic Quality Index: Target Overall Mean C Score = ≥4
- Eradicate / reduce the presence of non-native and invasive species: Target Invasive Species Eradication Percentage = <1% Areal Coverage

11 Recommendation

This study tentatively recommends authorization of the NED/NER Plan. Sites that could reasonably be implemented under the Continuing Authorities Program (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 Full 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 include Preconstruction Engineering and Design (PED); Supervision and Administration (S&A) which include engineering and design during construction and construction management; lands, easements, rights-of-way and disposal areas (LERRDs); and, for restoration sites only, monitoring and adaptive management.

PED costs are estimated as 6% of the construction costs. S&A costs include Engineering and Design During Construction and Construction Management and are estimated as 10% of construction costs. Monitoring and adaptive management, included for ER sites, is estimated as 3% of construction costs, which is a conservative estimate until specific monitoring plans are fashioned for each authorized/approved project.

Table 11.1 – Projected NED/NER and CAP Plan Costs and Cost Sharing Responsibilities

ID	Site Name	Purpose	Plan	County	Construction ($1,000)	PED[1] ($1,000)	S&A[1] ($1,000)	M&AM[2] ($1,000)	Total Implementation ($1,000)	Preliminary Lands & Damages[3] ($1,000)	Relocations ($1,000)	Total Preliminary LERRDs[5] ($1,000)	Preliminary Total Project Cost[4]	Federal Share	Non-Federal Share			Annaul OMRR&R ($1,000)
															Total	Preliminary LERRD Credit	Cash/ WIK[6]	
R04	Mt. Pleasant Wet Prairie	ER	NED/NER	Racine	[redacted]													
K09	Somers Marsh	ER	NED/NER	Kenosha	[redacted]													
K33	Paris Wet Prairie	ER	NED/NER	Kenosha	[redacted]													
K47	Bristol Marsh	ER	NED/NER	Kenosha	[redacted]													
K41	Dutch Gap Forested Floodplain	ER	NED/NER	Kenosha	[redacted]													
L41	Dutch Gap Aquatic Complex	ER	NED/NER	Lake	[redacted]													
L43	Red Wing Slough and Deer Lake Wetland Complex	ER	NED/NER	Lake	[redacted]													
L39	Pollack Lake and Hastings Creek Riparian Wetlands	ER	NED/NER	Lake	[redacted]													
L33	Mill Creek Riparian Woodland	ER	CAP	Lake	[redacted]													
L31	Gurnee Woods Riparian Wetland	ER	NED/NER	Lake	[redacted]													
L05	Granger Woods Floodplain Forest	ER	CAP	Lake	[redacted]													
ACRS08	Aptakistic Creek Reservoir	FRM	NED/NER	Lake	[redacted]													
	Lake County Non-structural	FRM	NED/NER	Lake	[redacted]													
C09	North Brook Marsh	ER	NED/NER	Cook	[redacted]													
	Dam #1 Removal	ER	CAP	Cook	[redacted]													
	Dam #2 Removal	ER	CAP	Cook	[redacted]													
C15	Beck Lake Meadow	ER	NED/NER	Cook	[redacted]													
	Dempster Ave Dam Removal	ER	CAP	Cook	[redacted]													
DPLV09	Ashland Fargo Levee	FRM	NED/NER	Cook	[redacted]													
	Touhy Ave Dam Removal	ER	CAP	Cook	[redacted]													
	Dam #4 Removal	ER	CAP	Cook	[redacted]													
DPLV05	Belmont Irving Park Levee	FRM	NED/NER	Cook	[redacted]													
DPLV04	Fifth Canadian National Levee	FRM	NED/NER	Cook	[redacted]													
DPLV01	Groveland Ave Levee	FRM	CAP	Cook	[redacted]													
	Cook County Non-Structural	FRM	NED/NER	Cook	[redacted]													
	NED/NER Plan Total				[redacted]													
	CAP Total				[redacted]													

[1] Preconstruction Engineering and Design (PED) and Supervision and Administration (S&A) costs are estimated as a percentage of construction costs. 6% and 10%.
[2] Monitoring & Adaptive Management is included for restoration sites only and is estimated as 3% of construction costs.
[3] Land Values based on Informal Value Estimates. Formal Gross Appraisal Estimates will be included in the final Feasibility Report.
[4] Total project cost includes total implementation cost and total LERRD values.
[5] LERRD totals include Relocations/Modifications and Lands and Damages.
[6] Structural FRM projects require a minimum 5% cash contribution by the non-federal sponsor(s).
[7] Only non-structural measures in areas meeting minimum flow requirements (800 cfs during the 10% ACE flood) are included in the NED/NER Plan.
(FY2013 Price Level, FDR 3.75%)

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 sponsor(s), with a minimum 35% contribution from the non-Federal sponsor(s) as required by ER 1105-2-100, Planning Guidance Notebook. The estimated Federal and non-Federal share for each site is detailed in Table 11.1.

For structural FRM sites, the non-Federal sponsor must provide a minimum cash contribution equal to 5 percent of total project costs allocated to structural flood risk management features, 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 flood risk management, 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 sponsor, 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 sponsor 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.

Prior to initiation of the Preconstruction Engineering and Design (PED) phase, the Federal government and the non-federal sponsor(s) will execute a PED agreement. The LERRDs and OMRR&R of the project will be the responsibility of the non-Federal sponsor(s) for the proposed project. The costs, LERRD values, and OMRR&R costs provided above are estimated and are likely to change.

Federal implementation of the recommended project would be subject to the non-Federal sponsor 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 25 percent 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 25 percent 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 25 percent 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 Water Resources Development Act 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 operation and maintenance 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 Water Resources Development Act 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 Financial Capability of Sponsor(s)

Prior to completion of the feasibility phase, the non-Federal sponsor(s) will submit a self-certification of financial capability signed by the chief financial officer or equivalent of the sponsor(s).

11.4 Plan Effects and Accomplishments

The NED/NER Plan and the CAP Plan will provide ecosystem restoration, flood risk management, recreation, and incidental water quality benefits.

The ecological restoration portion of the NED/NER Plan would improve hydrology by filling an estimated 13,400 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. Five dams would be removed on the mainstem Des Plaines River. Over 10,600 acres of native community types would be restored including: marsh (2,887 acres), meadow (747 acres), prairie (2,491 acres), savanna (1,039 acres), woodland (2,832 acres) and forest (648 acres). This ecosystem restoration plan cumulatively increases the quality of watershed ecosystem communities by 50% of what currently exists.

The flood risk management portion of the NED/NER Plan would provide $6,039,000 net benefits through the implementation of one (1) 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 $157,000 NED net benefits through implementation of one levee/floodwall and 649 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. An additional 300 acres of native community types would be restored including: marsh (4 acres), meadow (60 acres), savanna (9 acres), woodland (89 acres), and forest (157 acres).

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.

11.5 Plan Implementation

11.5.1 Implementation Priority

Implementation priority will be established by site purpose. Flood risk management sites will be implemented from highest net benefits to lowest. Aptakisic Creek Reservoir would be first, followed by the Ashland-Fargo Levee. Ecosystem restoration sites will be implemented according to the plan shown in Table 11.2. This plan assumes that all funding and LERRD's needed to accomplish each project would be provided prior to construction and that LERRD acquisition for subsequent projects would be ongoing.

Table 11.2 – Project Implementation Plan

Project Feature	Engineering and Design Start	Real Estate Acquisition Start	Construction Start	Construction Completion
ACRS08 – Aptakisic Creek Reservoir	Jan 2014	Oct 2015	Oct 2017	Oct 2019
DPLV09 – Ashland-Fargo Levee	Oct 2017	Oct 2015	Oct 2018	Oct 2020
L43 – Red Wing Slough & Deer Lake Wetland Complex	Oct 2017	Apr 2018	Oct 2018	Oct 2023
Dam Removal #1	Oct 2017	Dec 2017	Jun 2018	Dec 2018
DPLV01 – Groveland Avenue Levee	Oct 2018	Apr 2018	Oct 2019	Oct 2021
L39 – Pollack Lake & Hastings Creek Riparian Wetlands	Oct 2018	Apr 2019	Oct 2019	Oct 2024
Dam Removal #2	Oct 2018	Dec 2018	Jun 2019	Dec 2019
DPLV05 – Belmont Irving Levee	Oct 2019	Oct 2018	Oct 2020	Oct 2022
Dempster Ave Dam Removal	Oct 2019	Dec 2019	Jun 2020	Dec 2020
L33 – Mill Creek Riparian Woodland	Oct 2019	Apr 2020	Oct 2020	Oct 2025
DPLV04 – Fifth-CN Railroad Levee	Oct 2020	Oct 2019	Oct 2021	Oct 2023
Touhy Ave Dam Removal	Oct 2020	Dec 2020	Jun 2021	Dec 2021
L31 – Gurnee Woods Riparian Wetland	Oct 2020	Apr 2021	Oct 2021	Oct 2026
Non-Structural	Oct 2020	Oct 2018	Oct 2021	Oct 2026
Dam #4 Removal	Oct 2021	Dec 2021	Jun 2022	Dec 2022
L05 – Granger Woods Floodplain Forest	Oct 2021	Apr 2022	Oct 2022	Oct 2027
C09 – North Brook Marsh	Oct 2022	Apr 2022	Oct 2023	Oct 2028
C15 – Beck Lake Meadow	Oct 2024	Apr 2024	Oct 2025	Oct 2030
L41 – Dutch Gap Aquatic Complex	Oct 2025	Apr 2026	Oct 2026	Oct 2031
K41 – Dutch Gap Forested Floodplain	Oct 2026	Oct 2024	Oct 2027	Oct 2032
K47 – Bristol Marsh	Oct 2027	Oct 2025	Oct 2028	Oct 2033
K33 – Paris Wet Prairie	Oct 2028	Oct 2026	Oct 2029	Oct 2034
K09 – Somers Marsh	Oct 2029	Oct 2027	Oct 2030	Oct 2035
R04 – Mt. Pleasant Wet Prairie	Oct 2030	Oct 2028	Oct 2031	Oct 2036

11.5.2 Non-Federal Sponsors

Implementation will be accomplished by multiple non-Federal sponsors. The study 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. Non-federal project sponsors will be identified for each project feature recommended for Corps implementation.

11.5.3 Environmental Assessment

See Effects Assessment in Section 9. Final assessment is pending public review of draft report.

11.5.4 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, Illinois DNR, Wisconsin DNR, Cook County Highway Department, Lake County Stormwater Management Commission, 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 Environmental Assessment, public and agency coordination will be finalized.

11.5.5 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, included as Attachment B of Volume 5 (Environmental Assessment). 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 Illinois Department of Natural Resources, Office of Water Resources (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 Illinois Department of Transportation (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.

11.5.6 Preliminary Schedule

The preliminary schedule will be completed after the cost risk analysis is conducted.

11.6 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 flood risk management, 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 $140,184,000 for the NED portion. The estimated cost for implementation of all elements of the CAP Plan is $19,589,000.

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 National Environmental Policy Act of 1969 and Section 122 of the River and Harbor and Flood Control Act of 1970, the U.S. Army Corps of Engineers (Chicago District) has assessed the environmental impacts associated with this project. The purpose of this Environmental Assessment (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 the proposed action is not a major Federal action significantly affecting the quality of the human environment. Therefore, I have determined that an Environmental Impact Statement (EIS) is not required.

Frederic A. Drummond, Jr.
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
CBOD	Carbonaceous Biochemical Oxygen Demand
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
FPDLC	Forest Preserve District of Lake County
FPMS	Floodplain Management Services
FQI	Floristic Quality Index
FRM	Flood Risk Management
FRM PCX	Flood Risk Management Planning Center of Expertise
FWOP	Future Without-Project Conditions
FWP	Flood Warning Plan
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
HIS	Habitat Suitability Index
HQUSACE	U.S. Army Corps of Engineers Headquarters
HSPF	Hydraulic Simulation Fortran
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
LPP	Locally Preferred Plan
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
NWMC	Northwest Municipal Conference
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
S&A	Supervision and Administration
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
UDPREP	Upper Des Plaines River Partnership
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
VTG	VISTA Transportation Group
WDNR	Wisconsin Department of Natural Resources
WQ	Water Quality