Final Report

Detailed Watershed Plan for the Calumet-Sag Channel Watershed: Volume 1

Prepared for

Metropolitan Water Reclamation District of Greater Chicago

August 2009

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Executive Summary

Background

The Metropolitan Water Reclamation District of Greater Chicago (District) has authority for regional stormwater management within Cook County as granted by the Illinois General Assembly in Public Act 93-1049 (the Act). The Act requires the District to develop watershed plans for six Cook County watersheds, which include the North Branch of the Chicago River, Lower Des Plaines River, Calumet-Sag Channel, Little Calumet River, Poplar Creek, and Upper Salt Creek. The District published the *Cook County Stormwater Management Plan* (CCSMP) in February 2007 to identify stormwater management goals and to outline the District's approach to watershed planning. Chapter 6 of the CCSMP defines the District's approach to and standards for Detailed Watershed Plans (DWPs), which address regional stormwater problems in Cook County. The six major watersheds for which DWPs are being developed cover approximately 730 square miles in Cook County. The primary goals of the DWPs are as follows:

- Document stormwater problem areas.
- Evaluate existing watershed conditions using hydrologic and hydraulic (H&H) models.
- Produce flow, stage, frequency, and duration information about flood events along regional waterways.
- Estimate damages associated with regional stormwater problems.
- Evaluate potential solutions to regional stormwater problems.

The Calumet-Sag Channel DWP was developed to meet the goals for the Calumet-Sag Channel Watershed as described in the CCSMP. The Act required the formation of Watershed Planning Councils (WPCs) to advise the District during development of its countywide stormwater management program; therefore, the DWPs were developed in coordination with the WPCs. Membership of the WPCs consists of the chief elected official of each municipality and township in each watershed, or their designees. Many municipalities and townships are represented by engineers, elected officials, or public works directors. WPC meetings are also open to the public. Frequent coordination with WPCs was performed to ensure that local knowledge is integrated into the DWP and the DWP reflects the communities' understanding of watershed issues as well as the practicability of proposed solutions.

Detailed Watershed Plan Scope

The scope of the Calumet-Sag Channel DWP includes the development of stormwater improvement projects to address regional problem areas along open waterways. Regional problems are defined as problems associated with waterways whose watersheds encompass multiple jurisdictions and drain an area greater than 0.5 square miles. Problems arising from capacity issues on local systems, such as storm sewer systems and minor open channel ditches, even if they drain more than one municipality, were considered local and beyond the scope of this study. Erosion problems addressed in this plan were limited to active erosion along regional waterways that pose an imminent risk to structures or critical infrastructure. Interstate

Highways, U.S. Highways, state routes, county roads with four or more lanes, and smaller roads providing critical access that are impacted by overbank flooding of regional waterways at depths exceeding 0.5 feet were also considered regional problems.

Watershed Overview

The Calumet-Sag Channel Watershed is located in southwestern Cook County and drains an area of 151 square miles that includes 27 communities. Figure ES.1 is an overview of the Calumet-Sag Channel Watershed. The watershed area north of the Calumet-Sag Channel is heavily developed and characterized by low relief. It is drained principally by the East and West branches of Stony Creek, which both discharge into the Calumet-Sag Channel. Several smaller streams discharge westward into the I&M Canal or southward into the Calumet-Sag Channel. The watershed area south of the Calumet-Sag Channel is less intensely developed and characterized by greater topographic relief. Spring Creek, Long Run Creek, and Marley Creek all drain southwest into Will County and are tributary to Hickory Creek, which drains to the Lower Des Plaines River. These streams are included, along with tributaries that flow north to the Calumet-Sag Channel and several tributaries that flow west to the I&M Canal, within the scope of the Calumet-Sag Channel DWP.

Existing Conditions Evaluation

Locations with historic flooding and stream bank erosion problems on regional waterways exist throughout the watershed. Information on existing problem areas was solicited from WPC members as well as federal and state agencies and other stakeholders during the data collection and evaluation phase of the DWP development, which also included the collection of data regarding the watershed and evaluation of the data's acceptability for use. Responses from stakeholders were used to help identify locations of concern, and where field assessment or surveys were needed to support hydrologic and hydraulic modeling.

Hydrologic models were developed to represent runoff generated by rainfall throughout the Calumet-Sag Channel Watershed. The runoff was then routed through hydraulic models, which were created for the major open channel waterways within the watershed. Design rainfall events were simulated for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval events based upon Bulletin 71 rainfall data (ISWS, 1992). The simulated water surface profiles were overlaid upon a ground elevation model of the study area to identify structures at risk of flooding.

Property damages due to flooding were estimated using a methodology consistent with the U.S. Army Corps of Engineers (USACE) Flood Damage Assessment program. Estimated flood damage resulting from a storm was considered in combination with the probability of the event occurring to estimate an expected annual damage. Erosion damages were assessed for structures or infrastructure at risk of loss due to actively eroding stream banks. Damages reported within this document refer to economic damages estimated over a 50-year period of analysis that result from regional overbank flooding or erosion of a regional waterway. Additional damages throughout the watershed exist, including damages due to flooding from local waterways and storm sewer systems, and also damages not easily quantified in financial terms such as water quality, wetland, riparian, and habitat impact, loss of emergency access, and loss of business or operations due to limited transportation access.

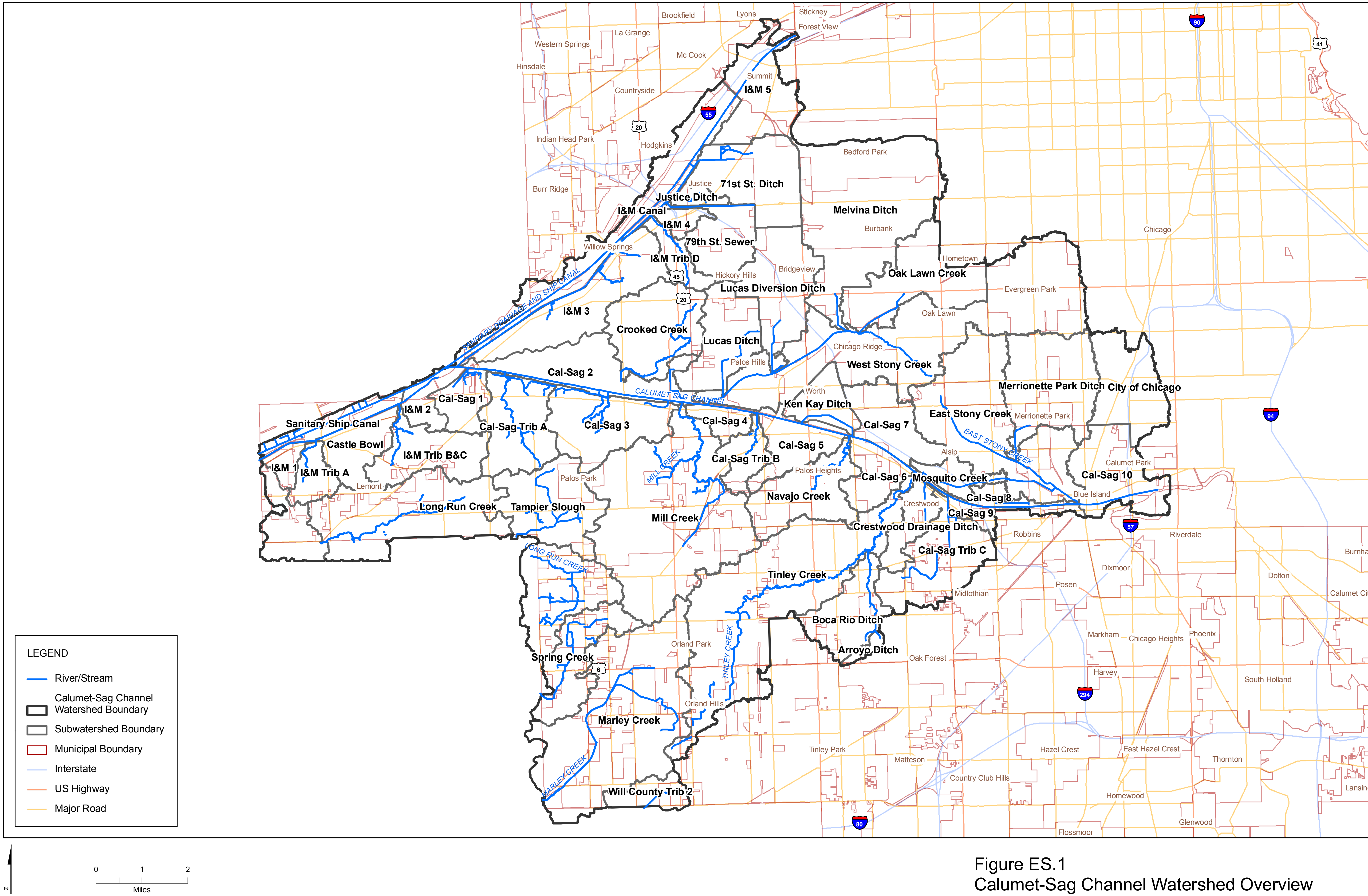

Figure ES.1
Calumet-Sag Channel Watershed Overview

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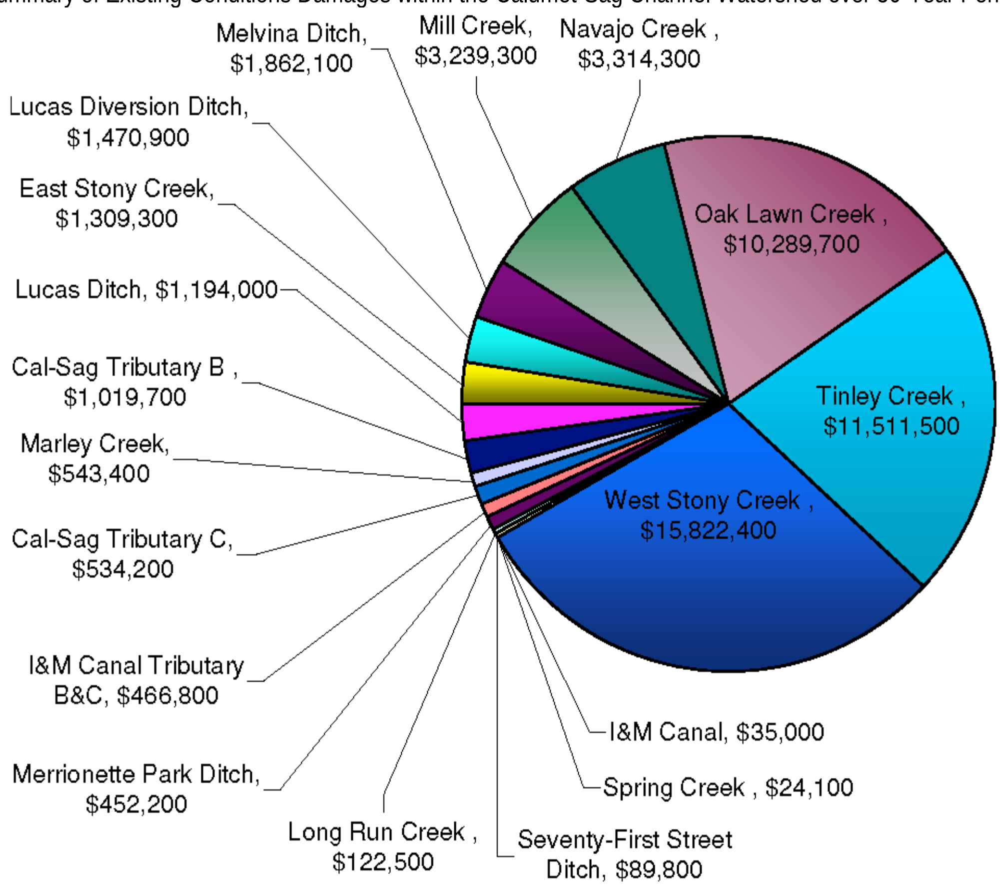
Figure ES.2 summarizes the distribution of existing conditions damages within the Calumet-Sag Channel Watershed over a planning period of analysis of 50 years. Stony Creek and its tributary waterways comprise roughly 61 percent of the existing conditions damage within the watershed. The Stony Creek system has the largest tributary area within the watershed, and the relatively dense development within the area subject to flooding combined with the very flat topography of the area resulted in significant damages.

The estimated damages summarized in Figure ES.2 include calculated regional damages related to overbank flooding, erosion problems on regional waterways that threaten structures, and transportation damages. Localized problems, such as storm-sewer capacity related problems, are not included in this estimate. Reported problems classified as local are presented in Table 2.2.1 in Section 2.2.1. Also provided in Table 2.2.1 is the reasoning behind classifying the problems as local or regional.

FIGURE ES.2
Summary of Existing Conditions Damages within the Calumet-Sag Channel Watershed over 50-Year Period of Analysis



Evaluation of Alternatives

Stormwater improvements, or alternatives, were developed to address regional stormwater problems along intercommunity waterways. WPC members participated in the alternative development process by providing input on possible solutions and candidate sites for new stormwater infrastructure. It should be noted that the alternatives presented in the DWP are developed at a conceptual level of feasibility.

Hydrologic and hydraulic models were used to determine the benefit of alternative stormwater improvement projects. Models were run and damages were calculated for the existing conditions evaluation. Benefits were calculated for each project as the difference between existing and alternative conditions damages. Only regional financial benefits (e.g., relief of flooding due to a regional problem as defined above) were considered. Local benefits (e.g., improved sewer drainage due to reduced outlet elevation) and non-economic benefits (e.g. improved emergency access, improved wetland, riparian, and habitat, and improved access to businesses) are not included in the benefits. The alternative stormwater improvement projects may have significant local and non-economic benefits. Local benefits are not reported in the DWP, which focuses on regional benefits.

Conceptual level cost estimates were produced to represent the estimated costs for design, construction, and maintenance of each alternative over a 50-year period of analysis. The cost estimates were developed using standard unit cost items within a District database used for all six watershed plans. In addition, standard markups on the estimated capital costs, such as utility relocation, design and engineering costs, profit and contingency were included.

A benefit-to-cost (B/C) ratio was developed for each alternative, which represents the ratio of estimated benefits to costs. The B/C ratios calculated may be used to rank the alternatives in a relative manner as the District's Board of Commissioners prioritizes the implementation of recommended stormwater improvement projects. Only regional financial benefits were considered in determination of the B/C ratios. The B/C ratios do not include local and non-economic benefits and should not be interpreted to be the sole measure of justification of an alternative. In addition to the B/C ratio, noneconomic criteria such as water-quality impact, number of structures protected, and the impact on wetland and riparian area were noted for each alternative. These criteria may also be considered along with the calculated B/C ratios as the District's Board of Commissioners prioritizes the implementation of recommended stormwater improvement projects.

Recommendations

Alternatives were recommended based upon consideration of their ability to reduce stormwater damages and to address problems reported by communities. Table ES.1 lists the recommended alternatives, their costs, and regional financial benefits.

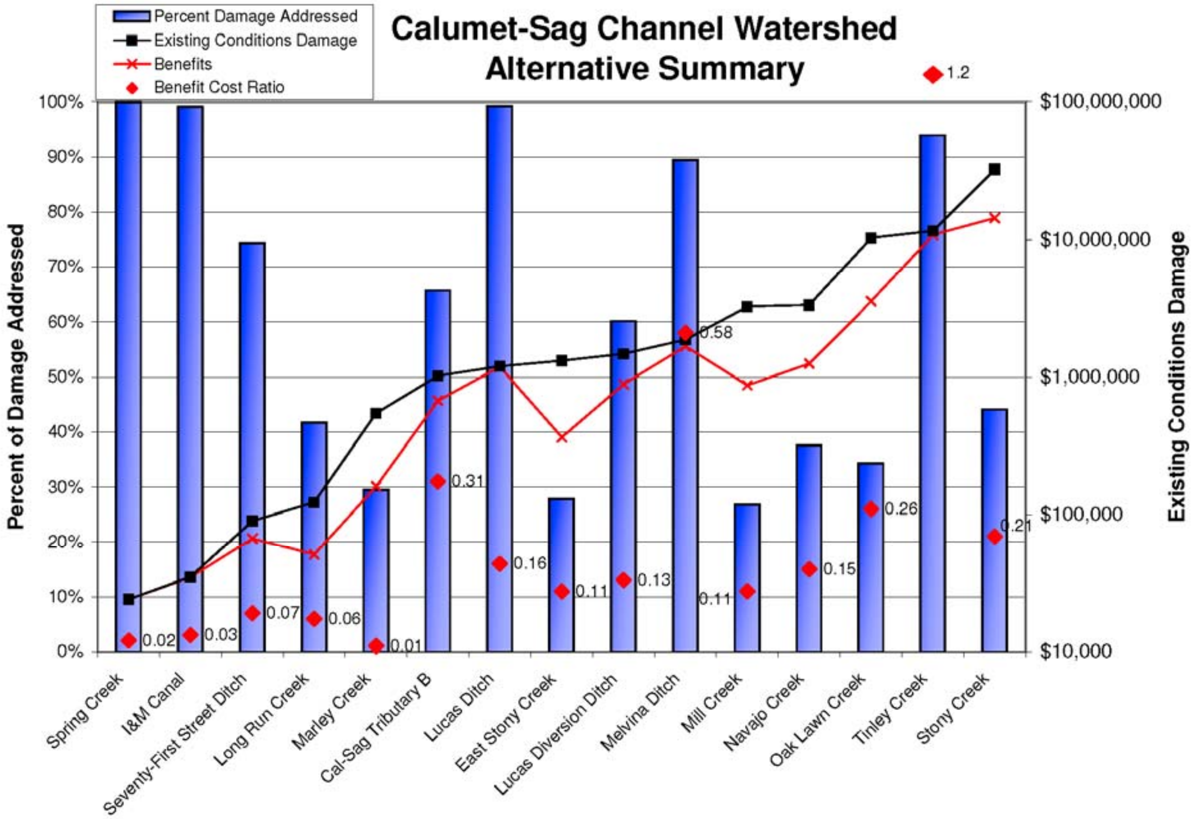
Figure ES.3 summarizes the extent to which recommended alternatives address existing regional financial damages within each tributary, ordered by increasing existing conditions damages. A logarithmic scale is used so that the wide range of estimated damages, ranging from $24,100 for Spring Creek to $32,400,500 for Stony Creek, can be displayed on a single graph. The columns indicate the extent to which recommended alternatives address estimated damages, while the red B/C symbols indicate the B/C ratio. As an example, the recommended Stony Creek alternatives address roughly 45 percent of estimated damages (indicated by the column), which corresponds to a benefit of $14,498,600 (this excludes benefits from projects on tributaries to Stony Creek). In contrast, roughly 66 percent of the damages along Calumet-Sag Tributary B are addressed, but this results in only $669,700 of benefit, or 4.6 percent of benefits of the recommended Stony Creek alternatives. Stated simply, areas with lower existing regional financial damages show lower benefits from flood control projects.

TABLE ES.1
Recommended Alternatives Summary for the Calumet-Sag Channel Watershed

Project	Category	Description	B/C Ratio	Total Benefits	Total Project Cost	Probable Construction Cost	Cumulative Structures Protected	Communities Involved
SFDT-1	Detention	60 ac-ft Detention Pond	0.07a	$395,400	$5,452,100	$3,635,800	12	Justice, Bridgeview, Hickory Hills, Bedford Park
SFDT-2	Conveyance	Additional outlet to I&M Canal	0.04	$31,400	$716,700	$434,600	14	Justice, Bridgeview, Hickory Hills, Bedford Park
CSTB-3	Detention/Conveyance	Add 10 ac-ft of additional detention and increase conveyance	0.31	$669,700	$2,131,500	$786,600	6	Palos Park
IMCA-1	Conveyance	Construct new outlets to Chicago Sanitary and Shipping Canal	0.03	$34,700	$1,043,800	$707,300	3	Lemont
LRCR-5	Conveyance	Raise 143rd Street	0.06	$51,100	$862,700	$590,900	0	Orland Park
LDDT-3	Detention/Conveyance	Three detention basins with 63 ac-ft of storage and channel clearing south of 103rd St	0.13	$885,200	$6,765,000	$4,499,800	56	Bridgeview, Palos Hills
LUDT-5	Levee	Levee at confluence with Stony Creek and compensatory storage	0.27	$845,200	$3,136,900	$1,961,500	4	Palos Hills
LUDT-7	Detention/Conveyance	Dredge Lucas Ditch upstream of 103rd Street and provide roughly 60 ac-ft of detention on golf course	0.08	$340,200	$4,472,600	$813,000	54	Palos Hills, Hickory Hills, Bridgeview
MACR-1	Detention	Construct 117 ac-ft detention basin	0.01	$160,100	$15,985,700	$8,990,000	3	Orland Park
MEDT-1	Erosion Stabilization	Hard-armoring of eroding streambank	0.58	$1,665,900	$2,854,500	$1,564,200	8	Chicago Ridge, Oak Lawn
MICR-2	Levee	Levee and storage	0.20	$409,600	$2,003,400	$1,404,700	6	Palos Park
MICR-4	Detention/Conveyance	32 ac-ft of storage and increased downstream conveyance	0.10	$459,000	$5,918,100	$4,208,200	2	Orland Park
NVCR-3	Detention	Raise Lake Arrowhead berm three feet to provide one-foot of additional storage and two feet of freeboard	0.69	$98,700	$143,900	$96,800	15	Palos Heights
NVCR-5	Conveyance	Harlem Avenue channel diversion	0.15	$1,148,300	$7,903,100	$4,581,300	29	Palos Heights
OLCR-1	Detention	Expand Lake Oak Lawn by 30 ac-ft	0.07	$450,000	$6,306,100	$4,971,300	35	Oak Lawn
OLCR-3	Erosion Stabilization	Stabilize Oak Lawn Creek between Mayfield Ave and Central Ave	0.42	$3,081,000	$7,299,200	$4,306,800	15	Oak Lawn
SPCR-1	Conveyance	Raise 157th street	0.02	$24,100	$1,053,800	$738,300	0	Orland Township
STCR-2	Detention	400 ac-ft detention pond at St. Casimir Cemetery	0.25	$12,203,700	$48,496,800	$30,267,700	666	Alsip, Oak Lawn, Chicago
STCR-3	Detention	87 ac-ft detention pond at Wolfe Wildlife Refuge	0.10	$735,100	$7,691,000	$6,537,600	55	Alsip, Oak Lawn, Chicago
STCR-4	Detention	39 ac-ft detention pond at K-Mart site	0.05	$206,600	$4,327,300	$3,179,500	20	Alsip, Oak Lawn, Chicago
STCR-7	Conveyance	Enlarge California Avenue culvert	0.11	$364,200	$3,428,900	$2,007,300	86	Palos Hills
STCR-8	Conveyance	Construct closed-conduit diversion along ComEd ROW	0.18	$1,146,600	$6,286,400	$3,413,200	44	Palos Hills
STCR-10	Erosion Stabilization	Stabilization of erosion problem area near Stony Creek and Oak Lawn Creek confluence	b	b	$2,754,800	$1,658,000	0	Oak Lawn
TICR-3	Levee	Levees on both sides of TICR just upstream of the crossing of Central Ave, and flood easement from Cook County Forest Preserve	0.72	$1,982,000	$2,764,400	$1,536,300	42	Crestwood, Alsip, Unincorporated Cook County
TICR-5	Conveyance	Dredge sediment in channel between 88th Avenue and Lake Lorin	1.26	$142,600	$112,800	$94,600	4	Orland Hills, Orland Park
TICR-7	Erosion Stabilization	Stabilize Tinley Creek between Oriole Court and 151st Street to prevent erosion	1.03	$1,524,700	$1,479,700	$873,021	6	Orland Park
TICR-8	Erosion Stabilization	Stabilize Tinley Creek between 160th Street and 86th Avenue to prevent erosion	1.55	$7,164,900	$4,627,200	$2,730,486	8	Orland Park

a- Benefits include 6 acres of wetland restoration
b- Project does not include existing regional financial benefits, but is recommended as a preventative measure because further bank failure risks a severe channel flow restriction within Stony Creek.

FIGURE ES.3
Calumet-Sag Channel Watershed Alternative Summary



Note: Stony Creek includes entire Stony Creek system as some alternative projects reduce damages on tributaries.

The Calumet-Sag Channel DWP integrated stormwater data from a large number of sources in order to identify and prioritize solutions to existing stormwater problems. An extensive data collection effort undertaken for the DWP development included surveying of streams, bridges, and culverts throughout the entire watershed. Field reconnaissance was performed throughout the watershed to understand conditions unique to the watershed. This compilation of current, accurate data was used by the District to document and identify existing stormwater problems throughout the study area.

A large number of alternatives were developed and evaluated for their effectiveness in reducing regional damages within the Calumet-Sag Channel Watershed. The alternatives listed in Table ES.1 were identified as the most effective improvements for reducing expected damages due to flooding within the watershed. In some tributaries, greater opportunities to reduce regional flooding were identified than in others. Factors such as the lack of availability of land and location of structures relative to stream channels limited the practicality of alternative projects to eliminate all flooding damages for all design storms evaluated.

The data provided in the Calumet-Sag Channel DWP will be used by the District, along with consistently developed data in DWPs for the other five major Cook County Watersheds, to prioritize the implementation of stormwater improvement projects.

Contents

Tables

Figures

Note: Figures not embedded in the chapters are contained in Volume 2.

Appendices

Acronyms and Abbreviations

ABM	Articulated Block Mat
AMC	Antecedent Moisture Conditions
B/C	Benefit to Cost Ratio
CCHD	Cook County Highway Department
CCSMP	Cook County Stormwater Management Plan
CCTA	Cook County Tax Assessor
CFS	cubic feet per second
CIP	Capital Improvement Program
CMAP	Chicago Metropolitan Agency for Planning
CN	Curve Number
CSSC	Chicago Sanitary and Shipping Canal
CWA	Clean Water Act
CWS	Chicago Waterway System
DEM	Digital Elevation Model
DFIRM	Digital Flood Insurance Rate Map
District	Metropolitan Water Reclamation District of Greater Chicago
DTM	Digital Terrain Model
DWP	Detailed Watershed Plan
FEMA	Federal Emergency Management Agency
FFE	First Floor Elevation
FGCS	Federal Geodetic Control Subcommittee
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
GIS	Geographic Information System
GPS	Geographic Positioning System
H&H	Hydrologic and Hydraulic
HARN	High Accuracy Reference Network
HEC-DSS	Hydrologic Engineering Center Data Storage System
HEC-HMS	Hydrologic Engineering Center Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center River Analysis System
I&M	Illinois and Michigan
IDNR	Illinois Department of Natural Resources
IDOT	Illinois Department of Transportation
IEPA	Illinois Environmental Protection Agency
IMTT	International-Matex Tank Terminals
ISWS	Illinois State Water Survey
LiDAR	Light Detection and Ranging
LOMR	Letter of Map Revision
L-PTIII	Log-Pearson Type III
M&O	Maintenance and Operations
NAVD 88	North American Vertical Datum, 1988

NFIP	National Flood Insurance Program
NFIRA	National Flood Insurance Reform Act of 1994
NGS	National Geodetic Survey
NIPC	Northeastern Illinois Planning Commission
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NWI	National Wetlands Inventory
OWR	Office of Water Resources
PCB	Polychlorinated Biphenyl
ROW	Right-of-Way
SCS	Soil Conservation Service
SFHA	Special Flood Hazard Area
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WPC	Watershed Planning Council
WSEL	Water Surface Elevation
WSP	Water Surface Profile

1. Introduction

The Calumet-Sag Channel Watershed in southwestern Cook County drains an area of 151 square miles that includes 27 communities. Figure ES.1 shows an overview of the Calumet-Sag Channel Watershed. The watershed area north of the Calumet-Sag Channel generally is heavily developed and characterized by low relief and is drained principally by the East and West branches of Stony Creek and their tributaries. Both East and West Stony Creek discharge into the Calumet-Sag Channel. The area north of the Calumet-Sag Channel also has several smaller streams that discharge westward into the Illinois and Michigan (I&M) Canal, or southward-into the Calumet-Sag Channel. The watershed area south of the Calumet-Sag Channel is less developed and characterized by greater topographic relief. Spring, Long Run, and Marley creeks all drain southwest into Will County and are tributary to Hickory Creek which eventually discharges into the Des Plaines River. These streams are included, along with tributaries that flow north to the Calumet-Sag Channel and several tributaries that flow west to the I&M Canal, within the scope of the Calumet-Sag Channel Detailed Watershed Plan (DWP). Locations with historic flooding and stream bank erosion problems due to regional waterways exist throughout the watershed.

The Calumet-Sag Channel DWP was developed by the Metropolitan Water Reclamation District of Greater Chicago (District) with the participation of the Calumet-Sag Channel Watershed Planning Council (WPC) which provided local input to the District throughout the development process. The DWP was developed to accomplish the following goals:

- Document stormwater problem areas.
- Evaluate existing watershed conditions using hydrologic and hydraulic (H&H) models.
- Produce flow, stage, frequency, and duration information along regional waterways.
- Estimate damages associated with regional stormwater problems.
- Evaluate solutions to regional stormwater problems.

Regional problems are defined as problems associated with waterways whose watersheds encompass multiple jurisdictions and drain an area greater than 0.5 square miles. Problems arising from capacity issues on local systems, such as storm sewer systems and minor open channel ditches, even if they drain more than one municipality, were considered local and beyond the scope of a regional stormwater management program. Erosion problems addressed in this plan were limited to active erosion along regional waterways that pose an imminent risk to structures or critical infrastructure. Interstate Highways, U.S. Highways, state routes, county roads with four or more lanes, and smaller roads providing critical access that are impacted by overbank flooding of regional waterways at depths exceeding 0.5 feet were also considered regional problems.

1.1 Scope and Approach

The Calumet-Sag Channel DWP scope included data collection and evaluation, H&H modeling, development and evaluation of alternatives, and recommendation of alternatives. The data collection and evaluation task included collection and evaluation of existing H&H

models, geospatial data, previous studies, reported problem areas, and other data relevant to the watershed plan. H&H models were developed to produce inundation mapping for existing conditions for the 100-year storm event and to evaluate stormwater improvement project alternatives. Stormwater improvement project alternatives were developed and evaluated to determine their effectiveness in addressing regional stormwater problems. Estimates of damage reduction, or benefits, associated with proposed projects were considered along with conceptual cost estimates and noneconomic criteria to develop a list of recommended improvement projects for the Calumet-Sag Channel Watershed.

1.2 Data Collection and Evaluation

The data collection and evaluation phase (Phase A) of the DWP focused on obtaining data regarding the watershed and evaluation of the material's acceptability for use. The District contacted all WPC members as well as federal and state agencies and other stakeholders requesting relevant data. Coordination with WPC members to support the DWP took place throughout development of the DWP. Existing and newly developed data was evaluated according to use criteria defined in Chapter 6 of the *Cook County Stormwater Management Plan* (CCSMP), included in Appendix B. Where data was unavailable or insufficient to complete the DWP, additional data was collected. This report includes information on all data collected and evaluated as a part of the Calumet-Sag Channel DWP development. Table 1.3.1 lists key dates of coordination activities including meetings with WPC members prior to and throughout DWP development.

1.3 Hydrologic and Hydraulic Modeling

This section of the report provides a description of H&H modeling completed to support the DWP development. H&H models were developed for all tributaries within the watershed containing open waterways. Most models were developed independent of any past H&H modeling efforts. In one case (East and West Stony Creek), data from previously developed models was used to support development of the Calumet-Sag Channel DWP. Hydraulic model extent was defined based upon the extent of detailed study for effective Flood Insurance Rate Maps (FIRMs). Revised Digital Flood Insurance Rate Map (DFIRM) data produced by the Federal Emergency Management Agency's (FEMA's) Map Modernization Program was unavailable at the time of model definition. Models extended further, where appropriate, to aid evaluation of damages associated with regional stormwater problems. Appendix A includes a comparison of FEMA's revised DFIRM panels with inundation areas developed for DWP modeling purposes. Tables comparing DWP inundation area to FEMA floodplain mapping by community and subwatershed are also included in Appendix A.

H&H models were developed to be consistent with the protocols defined in Chapter 6 of the CCSMP. In numerous instances, models included additional open channel or other drainage facilities not strictly required by Chapter 6, to aid the evaluation of community reported problem areas. Available monitoring data, including USGS stream gage data, District facility data and high water marks observed following storm events were used to perform model verification and calibration consistent with Chapter 6 guidelines. All H&H modeling data and documentation of the data development are included in the appendixes referenced in the report sections below.

TABLE 1.3.1
Calumet-Sag Channel DWP WPC Coordination Activities

Description of Activity		Date
06-712-5C Calumet-Sag Channel Detailed Watershed Plan - Phase A - Contract start date		October 19, 2006
07-713-5C Calumet-Sag Channel Detailed Watershed Plan - Phase B - Contract start date		May 17, 2007
Information Gathering		
Data Request (Forms A and B) sent out as part of Phase A		November 24, 2006
Watershed field visit and meetings with various municipalities		January 23, 2007
Open meetings with Watershed representatives during Phase A to discuss Forms A and B		February 14, 2007
District phone calls to communities after the September 13th and 14th, 2008 storm event		September 15, 2008
Calumet-Sag Channel Watershed Planning Council Meetings (16)		March 29, 2006
June 26, 2006	September 12, 2006	November 29, 2006
January 30, 2007	April 30, 2007	July 30, 2007
September 25, 2007	November 29, 2007	January 30, 2008
April 29, 2008	July 29, 2008	September 30, 2008
November 24, 2008	January 28, 2009	April 29, 2009
Modeling Results and Alternatives Review Meetings		
Calumet-Sag Channel / Little Calumet River coordination		April 2, 2008
Initial Model Review Workshop		June 4 and 5, 2008
Preliminary Alternatives Review Workshop		August 14 and 15, 2008
Final Alternatives Presentation Workshop		September 24, 2008
MWRDGC Board of Commissioners' Study Sessions		
January 10, 2006	April 27, 2006	October 2, 2008

1.3.1 Model Selection

H&H models were developed within the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) Version 3.1.0 modeling application and Hydrologic Engineering Center-River Analysis System (HEC-RAS) Version 4.0. These applications were identified as acceptable in Tables 6.10 and 6.11 of the CCSMP. The Soil Conservation Service (SCS) curve number (CN) loss module was used with the SCS Unit hydrograph methodology within HEC-HMS to model basin hydrology. The dynamic unsteady flow routing methodology was used within HEC-RAS. Both applications have an extensive toolkit to interface with geographic information systems (GIS) software to produce input data and display model results.

1.3.2 Model Setup and Unit Numbering

1.3.2.1 Hydrologic Model Setup

Hydrologic model data was primarily developed within the GeoHMS extension to Arc GIS Version 9.2. The extension provides an interface to geoprocessing functions used to characterize subbasin parameters within the hydrologic model. GeoHMS was used to calculate the CN for each basin; to define the longest flow path, basin slope, and longest flow path slope; and to establish a network connecting hydrologic elements (e.g., subbasins, reservoirs, reaches, and inflow locations) to the outlet of the system. HEC-HMS was used to create and sometimes route stormwater runoff hydrographs to the upstream extent of hydraulic models developed within HEC-RAS. Hydrologic model data was transferred between HEC-HMS and HEC-RAS through HEC-DSS files.

Subbasin Delineation. Each major tributary model (Tinley Creek, Melvina Ditch, etc.) was subdivided into subbasins roughly 100 acres in size to form the basis of the hydrologic model and modeled assuming a unified response to rainfall based on land use characteristics and soil type. Elevation data provided by Cook County, described in Section 2.3.4, was the principal data source used for subbasin delineation. Drainage divides were established based upon consideration of the direction of steepest descent from local elevation maxima, and refined in some instances to reflect modifications to topographic drainage patterns caused by stormwater management infrastructure (storm sewer systems, culverts, etc.). Subbasin boundaries were modified to encompass areas with similar development patterns. Finally, boundaries were defined to most accurately represent the area tributary to specific modeled elements, such as constrictions caused by crossings, and reservoirs. GIS data was developed for all subbasins delineated and used for hydrologic model data development.

Runoff Volume Calculation. The SCS CN loss model uses the empirical CN parameter to calculate runoff volumes based on landscape characteristics such as soil type, land cover, imperviousness, and land use development. Areas characterized by saturated or poorly infiltrating soils, or impervious development, have higher CN values, converting a greater portion of rainfall volume into runoff. The SCS methodology uses Equation 1.1 to compute stormwater runoff volume for each time step:

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \qquad (1.1)$$

Where:

Q	=	runoff volume (in.)
P	=	precipitation (in.)
S	=	storage coefficient (in.)
I_a	=	initial abstractions (in.)

Rainfall abstractions due to ponding and evapotranspiration can be simulated using an initial abstractions (I_a) parameter. In the Calumet-Sag Channel DWP, the commonly used default value of I_a, estimated as 0.2 × S, where S is the storage coefficient for soil in the subbasin. S is related to CN through Equation 1.2:

$$S = \frac{1000}{CN} - 10 \qquad (1.2)$$

where:

CN	=	curve number (dimensionless)
S	=	storage coefficient (in,)

Table 1.3.2 describes the input data used to develop the CN values throughout the watershed.

TABLE 1.3.2
Description of Curve Number Input Data

Variable Used to Determine CN	Approach for Definition of Variable for Calumet-Sag Channel Watershed Hydrologic Modeling
Ground cover	Chicago Metropolitan Agency for Planning (CMAP) 2001 land use inventory (v.1.2 2006) is used to define land use. A lookup table was developed to link CMAP categories to categories for which CN values have been estimated.
Soil type	The Natural Resources Conservation Service (NRCS) publishes county soil surveys that include a hydrologic classification of A, B, C, or D. If a soil group's infiltration capacity is affected by a high water table, it is classified as, for instance, "A/D," meaning the drained soil has "A" infiltration characteristics, undrained "D." It was assumed that half of these soil groups (by area) are drained.
Antecedent moisture condition	Antecedent Moisture Conditions (AMC) reflect the initial soil storage capacity available for rainfall. For areas within Northeastern Illinois, it is typical to assume an AMC of II.

Specific combinations of land use and soil type were linked to CN values using a lookup table based on values recommended in Table 1.3.3 excerpted from *TR-55: Urban Hydrology for Small Watersheds* (U.S. Department of Agriculture [USDA], 1986). The CN matrix includes assumptions about the imperviousness of land use classes, and therefore, percent impervious does not need to be explicitly considered as the SCS runoff volume calculation. Since the CMAP land-use data does not correspond to the categories in Table 1.3.3, a mapping between TR-55 land use categories and CMAP land use categories was necessary. This process is detailed in Appendix C, which includes a technical memorandum detailing the process used to develop CN values for the Calumet-Sag Channel Watershed.

The GeoHMS tool was used to develop an area-weighted average CN for each subbasin.

Runoff Hydrograph Production. The runoff volume produced for a subbasin is converted into a basin-specific hydrograph by using a standard unit hydrograph and an estimate of basin lag time. The lag time is defined as the time elapsed between the centroid, by mass, of the precipitation event and the peak of the runoff hydrograph at the outlet of the subbasin. The lag time was estimated according to Equation 1.3, provided in the HEC-HMS Technical Reference Manual (USACE, 2006):

$$T_{lag} = 0.6T_c \qquad (1.3)$$

where:

T_{lag}	=	Lag time
T_c	=	Time of Concentration

TABLE 1.3.3
Runoff Curve Numbers for Urban Areas

Cover Type and Hydrologic Condition	Avg. % Impervious Area	A	B	C	D
Fully developed urban areas (vegetation established)					
Open Space (lawns, parks, golf courses, cemeteries, etc.)					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50 to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious Areas					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western Desert Urban Areas					
Natural desert landscaping (pervious areas only)		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin barriers		96	96	96	96
Urban Districts					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential Districts by Average Lot Size					
1/8 acre or less	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing Urban Areas					
Newly Graded Areas (pervious areas only, no vegetation)		77	86	91	94

Note: Average runoff condition, and $I_a = 0.2S$.

Note: Table Source is *TR-55: Urban Hydrology for Small Watersheds* (U.S. Department of Agriculture, 1986)

The time of concentration is the time it takes for a drop of water to travel from the hydraulically furthest point in a watershed to the outlet. The time of concentration is estimated as the sum of the travel time for three different segments of flow, split-up by flow type in each subbasin.

Thus Equation 1.4:

$$T_c = T_{sheet} + T_{shallow} + T_{channel} \qquad (1.4)$$

Where:

T_{sheet} = sheet flow; flow occurring across the land area headwater areas prior to flow accumulation

$T_{shallow}$ = shallow flow; occurs where sheet flow begins to accumulate into more concentrated patterns, but prior to transitioning into open channel flow

$T_{channel}$ = flow within natural or manmade drainage facilities within each subwatershed prior to the point of discharge

GeoHMS-derived T_c estimates were not considered accurate; however, GeoHMS also produced a definition of the longest flow path, its length, and slope. The basin parameter estimates were exported to a spreadsheet to support calculation of T_c.

An alternative method of lag time calculations is the CN-based method, characterized in Equation 1.5 (SCS, 1978):

$$T_{lag} = L^{.8} \frac{(S+1)^{.7}}{(1900Y^{.5})} \qquad (1.5)$$

Where:

L = hydraulic length of the subbasin
Y = subbasin slope
S = storage coefficient (in.)

These two approaches to calculation of lag time were performed for each subbasin and reviewed. The quasi-physical estimate of lag time described in Equation 1.4 was generally used for most subbasins. For some subbasins with very low relief, the CN-based method was used as it was considered most representative of the runoff response of the watershed.

Rainfall Data. Observed and design event rainfall data was used to support modeling evaluations for the DWP. Monitored rainfall data is described in Section 2.3.1. Design event rainfall data was obtained from Bulletin 71, *Rainfall Frequency Atlas of the Midwest* (Huff, 1992). Design event rainfall depths obtained from Bulletin 71 were used to support design event modeling performed for existing and proposed conditions assessment.

1.3.3 Storm Duration

A critical-duration analysis was performed to determine the storm duration that generally results in higher water surface estimates for a range of tributary sizes within the Calumet-Sag Channel Watershed. The 12-hour duration storm was identified as the critical duration for streams within the Calumet-Sag Channel Watershed. A second quartile storm is recommended for storms of this duration (Huff, 1992). Table 1.3.4 summarizes rainfall depths for the 12-hour duration storm.

1.3.4 Areal Reduction Factor

The rainfall depths presented in Table 1.3.4 summarize expected point rainfall accumulation for modeled recurrence intervals. The probability of uniform rainfall across a subwatershed decreases with increasing watershed size. Table 21 in Bulletin 71 relates areal mean rainfall depth to rainfall depth at a point (Huff, 1992). Subwatersheds in the Calumet-Sag Channel watershed that were large enough to warrant use of an areal reduction factor are Tinley, Long Run, and Stony Creeks. Modeled rainfall depths were multiplied by approximately 0.98 to account for the expected decrease in probability of uniform rainfall. In addition, the rainfall distribution was modified to the Quartile II distribution for basins 10 to 50 square miles in area, as recommended in Bulletin 71 (Huff, 1992).

TABLE 1.3.4
Rainfall Depths

Recurrence Interval	12-hr Duration Rainfall Depth
2-year	2.64
5-year	3.31
10-year	3.89
25- year	4.79
50- year	5.62
100-year	6.59
500-year	8.96[a]

[a]500-year rainfall depth was determined based on a logarithmic relationship between rainfall depth and recurrence interval.

1.3.5 Hydrologic Routing

Stormwater runoff hydrographs were sometimes routed within HEC-HMS in upstream areas where the resolution of subbasins defined was greater than the hydraulic model extent. In areas where a channel cross section could be identified from topographic data, Muskingum-Cunge routing was performed using the approximate channel geometry from a representative cross section of the modeled hydrologic reach. In most of the watershed, it was impossible to identify channel cross sections in upstream areas. In those cases, a kinematic wave routing approximation was performed.

1.3.6 Hydraulic Model Setup

Hydraulic model data typically was developed through field surveys with some additional definition of channel overbank areas and roadway crests defined using Cook County topographic data. Cross section locations were developed in HEC GeoRAS, and surveyed channel geometry were inserted into topographically generated cross-sectional data. Cross sections were generally surveyed at intervals of 500 to 1,000 feet. Interpolated cross sections were added at many locations to the models to increase stability and reduce errors. Bridges, culverts, and other major hydraulic structures were surveyed within the hydraulic model extent. The locations of all surveyed and modeled cross sections, bridges, culverts, and other structures are shown in a figure within Appendix D.

The Stony Creek hydraulic model was developed using data from a model developed by the USACE in 2001. USACE calibrated the model, which is considered representative of existing conditions along Stony Creek. As part of the DWP, several cross sections were surveyed at locations where the USACE model had cross sections to compare and confirm that the model data reflected current conditions. This comparison concluded that the survey data in the USACE model of Stony Creek was generally consistent, and that the USACE model was valid for defining inundation areas and evaluation of alternative improvement projects.

1.3.6.1 Bridges, Culverts, and Hydraulic Structures

Bridges, culverts, and hydraulic structures were surveyed consistent with FEMA mapping protocol as identified in *Guidelines and Specifications for Flood Hazard Mapping Partners*, "Guidance for Aerial Mapping and Surveying" (FEMA 2003). A State of Illinois licensed professional land surveyor certified each location as FEMA compliant. Documentation of certifications is provided in Appendix D. Bridges, culverts, and hydraulic structures were surveyed consistent with the NAVD 1988 datum using 5-centimeter or better GPS procedures (as specified in NGS-58 for local network accuracy) or third-order (or better) differential leveling, or trigonometric leveling for short distances. In a few cases, information from construction plans was used for recently constructed bridges in lieu of surveying. Ineffective flow areas were placed at cross sections upstream and downstream of crossings, generally assuming a contraction ratio of 1:1 and an expansion ratio of 2:1. Contraction and expansion coefficients generally were increased to 0.3 and 0.5, respectively, at cross sections adjacent to crossings.

1.3.6.2 Cross-Sectional Data

Cross-sectional data was surveyed consistent with FEMA mapping protocol as identified in *Guidelines and Specifications for Flood Hazard Mapping Partners*, "Guidance for Aerial Mapping and Surveying" (FEMA 2003).

All survey work, including survey of cross sections, was certified as compliant to FEMA mapping protocol by a State of Illinois licensed professional land surveyor. Documentation of certifications is provided in Appendix D. Cross sections were surveyed consistent with the North American Vertical Datum, 1988 (NAVD 1988) using 5-centimeter or better GPS procedures (as specified in NGS-58 for local network accuracy) or third-order (or better) differential leveling, or trigonometric leveling for short distances. Cross sections were interpolated at many locations within the hydraulic models, to aid model stability and reduce errors.

1.3.6.3 Boundary Conditions

Estimated water surface elevations along the major receiving systems were compared to normal depth of tributaries at the confluence. In most instances, normal depth estimates exceeded the elevation of the receiving system (i.e., Calumet-Sag Channel or Chicago Sanitary Ship Canal). This indicates that the downstream water surface elevation for the waterways is not controlled by the receiving system, as often occurs at stream confluences, but by the ability of the tributary to convey the flows produced in the upstream tributary area. The fact that both the Chicago Sanitary Ship Canal (CSSC) and the Calumet-Sag Channel are manmade, controlled waterways likely contributes to their relatively lower stage compared to their tributaries. Levels of the CSSC and the Calumet-Sag Channel are controlled by the District as required to support navigation and control flooding through operation of the Lockport Lock and Dam.

In cases where the estimated water surface elevation of a channel was required, this data was taken from the Chicago Waterway System (CWS) UNET model, which was obtained from the USACE and converted to HEC-RAS to support DWP development. The I&M Canal was assumed to be represented by water surface elevations along the CSSC as the two water bodies are parallel and directly connected. The specific boundary conditions used for each model are summarized in the tributary sections. Appendix E contains a detailed summary of the Calumet-Sag Channel hydraulic conditions and methods used to estimate water surface elevation along the CSSC and Calumet-Sag Channel.

1.3.7 Model Run Settings

All hydraulic model simulations were carried out using the fully dynamic, unsteady flow simulation settings within HEC-RAS. The Saint-Venant equations, or the continuity and momentum balance equations for open channel flow, were solved using implicit finite difference scheme. HEC-RAS has the ability to model storage areas and hydraulic connections between storage areas and between stream reaches. The computational time step for model runs varied between 10 and 60 seconds, as necessary for model stability.

1.3.8 Model Calibration and Verification

Model calibration and verifications were performed for tributaries where monitoring data was available to ensure that the hydrologic and hydraulic models accurately predict stormwater runoff response for a range of storm magnitudes. Available monitoring data used for calibration is described in Section 2.3.1. Initial model runs were performed for Tinley Creek, Stony Creek, Mill Creek, Calumet-Sag Tributary B, and Navajo Creek subwatersheds using hydrologic and hydraulic parameters estimated from available GIS data (land-use, soils, topography) and field reconnaissance. Stages (or peak water surface elevation) and runoff volumes were compared to modeled values for a variety of storms. Then, hydrologic and hydraulic parameters with uncertainty were modified within a reasonable range to better represent monitored parameters. Stage was used as the primary calibration variable, since stage directly impacts stormwater damages due to flooding. Stage is also the measured value, both for high-water marks and the USGS gage, which uses a field-measured stage-flow relationship to calculate flow. Runoff volume was also considered, where monitoring data was available.

Initial calibration model results generally over-predicted stage, volume and peak flow rates for Stony Creek and Tinley Creek. Modification to lag time and curve number estimates, in the hydrologic model, and the roughness coefficient in the hydraulic model, were considered to address observed differences. Modification of the lag time was observed to have a minor impact on model results. While discrepancies in stage could be addressed by lowering the roughness coefficient on Tinley Creek, this would increase the over-prediction of peak flow, and would not address the over-prediction of runoff volume. Furthermore, stage was also over-predicted on Stony Creek for its initial calibration runs, and the Stony Creek roughness coefficients were already at the lower end of the acceptable range of values. Although no flow data was available, initial roughness coefficients were considered relatively low. For these reasons, the reduction of curve number values was considered the best method of achieving better correspondence between observed and modeled parameters. A 10 percent curve number reduction from the originally calculated values resulted in the best fit with monitored values for the storms considered.

Detailed calibration results are presented in subwatershed subsections, including hydrographs and comparisons of stage and, where available, runoff volume. Subwatersheds with available calibration data represent a subset of the Calumet-Sag Channel Watershed. Calibration data was available for both the northern part of the watershed, with its flatter topography and higher-density development, and the southern part of the watershed with more varied topography and less dense suburban development. The 10 percent reduction of curve number was applied to un-gaged subwatersheds since it was found to be necessary for similar gaged areas of the watershed.

1.3.9 Flood Inundation Mapping

Flood inundation maps were produced to display the inundation areas associated with the 100-year event. The flood inundation maps were produced by overlaying the results of the hydraulic modeling on the ground elevation model of the watershed, which was derived from Cook County LiDAR data.

1.3.10 Discrepancies Between Inundation Mapping and Regulatory Flood Maps

Discrepancies may exist between inundation mapping produced under this DWP and regulatory flood maps. Discrepancies may be the result of updated rainfall data, more detailed topographic information, updated land use data, and differences in modeling methodology. A discussion of discrepancies is included in Appendix A.

1.3.11 Model Review

The hydrologic and hydraulic models developed under this DWP were independently reviewed by Christopher B. Burke Engineering, Ltd (CBBEL). CBBEL's review of the hydrologic models included a general verification of drainage areas, sub-basin divides, and hydrologic model parameters such as Curve Number and Time of Concentration. CBBEL's review of the hydraulic models included a general verification of roughness values, bank stations, ineffective flow areas, hydraulic structures, boundary conditions and connectivity with the hydrologic model output files. A significant recommendation from the independent review was to calibrate the models to a large storm event which occurred in the Calumet-Sag Channel watershed over the period September 13th to 14th, 2008. This and other recommendations from the independent review have been addressed in the hydrologic and hydraulic models developed to support the Calumet-Sag Channel DWP.

1.4 Development and Evaluation of Alternatives

1.4.1 Problem Area Identification

Problem area data for the Calumet-Sag Channel Watershed was generated from two sources. The first was community response data that identified flooding, erosion, water quality, and maintenance problems recognized by the communities to be problems. In addition, problem areas were identified by overlaying the results of H&H modeling on the ground elevation model of the watershed to identify structures at risk of flooding along regional waterways. Modeled flood problems generally corroborated the communities' reported problems; however, in many instances, the model results also showed additional areas at risk of flooding for larger magnitude events. A secondary source of problem area identification was the existing FEMA FIRM panel maps. Areas shown within FEMA floodplain were carefully considered in H&H modeling and communication with communities in order to identify problem areas.

1.4.2 Economic Analysis

1.4.2.1 Flood Damages

Property damages due to flooding were assessed based upon the intersection of inundation areas for modeled recurrence intervals (2-, 5-, 10-, 25-, 50-, and 100-year) with the Cook County parcel data, considering ground elevation data, to calculate estimated flood depths. Damages were estimated using a methodology consistent with one developed by the USACE that estimates structure and contents damage as a fraction of structure value and based upon the estimated depth of flooding (USACE 2003). The general procedure estimating property damage due to flooding is outlined in Appendix F of the CCSMP. This method of damage calculation requires estimating a number of parameters for properties at risk of flooding which are detailed below.

The foundation for property damage values due to flooding is derived from the 2006 Cook County Tax Assessor (CCTA) data multiplied by a standard factor derived from a statistical analysis comparing recent sales data to the CCTA property values. The CCTA data includes tax assessed value of land, improvements, total tax assessed value, structure class (residential single family, multi-family, industrial etc.), number of stories, basement information, land area (square footage), and other data fields not relevant to this study.

1.4.2.2 Identification of Parcels at Risk of Flooding

Parcel boundaries were converted to points within the GIS application, and then the points were moved to the low side of structures at risk of flooding. Intersection of floodplain boundaries with parcel data was then performed for each modeled recurrence interval storm and used to identify parcels within the subwatershed that may, based upon their zero-damage elevations, be subject to property damage due to flooding for a particular recurrence interval.

1.4.2.3 Parcel Zero Damage Elevation

Structures do not incur damage due to flooding until the water surface exceeds the *zero-damage elevation,* at which water is assumed to begin flowing into the structure and cause damages. For most structures, the zero-damage elevation is the ground surface. Floodwaters exceeding the ground surface may enter the structure through doorways, window wells, and other openings within the structure. The zero-damage elevation was assumed to be the ground elevation for all parcels within the Calumet-Sag Channel Watershed. The ground elevation estimate was obtained at the point representing the parcel, generally on the lower, stream-side of the actual structure.

1.4.2.4 Parcel First Floor Elevation

USACE depth-damage curves relate flooding depths to the first floor elevation of the structure, a value not provided within the CCTA data. First floor elevations (FFE) generally were not surveyed for the Calumet-Sag Channel DWP, as that would require several thousand measurements. A sample of several hundred field measurements of the FFE offset from ground elevation were collected in the Calumet-Sag Channel Watershed to document expected values and variability of this component of the damage analysis. Based upon review of the collected first floor elevations, it was not possible to identify a pattern to predict the first floor elevation based upon factors such as subwatershed, estimated age of structure, or structure type. Furthermore, it was noted that the average first floor elevation offset was roughly 18 inches, or slightly lower for structures that did not have basements. Based upon the data collected, first floor elevation offsets from ground elevation were estimated throughout the watershed as 18 inches for structures with basements, and 12 inches for structures without. This is consistent with the elevation offsets used by the USACE in its study of Stony Creek (USACE, 1996).

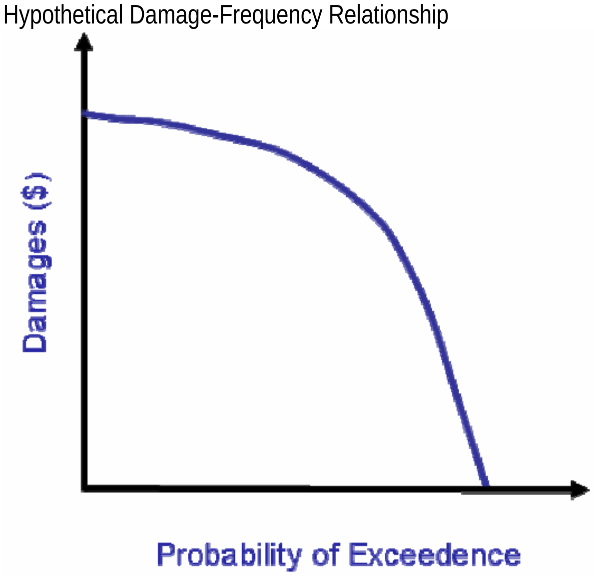
1.4.2.5 Structure Estimated Value

The estimated value of flooded structures is an input to damage calculations. The CCTA data included data that identified values for the land value as well as the improvement value (i.e., building, garage, etc.). The values in the CCTA data are assessed valuations of the estimated property value, which require a factor to bring the value, depending on the structure's use, to the CCTA estimation of property value. For example, residential structures receive an assessed valuation of 16 percent, thus the value identified by CCTA is the CCTA estimated value divided by a standardized 0.16. The adjusted CCTA data (reported values divided by the assessed valuation factor) was then compared with recent sales data throughout the county to statistically derive a multiplier that brings the 2006 CCTA estimated value of the properties to 2008 market value of properties. This multiplier was calculated to be 1.66. Since this plan analyzes damage to the structure, the land component of the property value was removed from the analysis by applying the assessed valuation multiplier and the District calculated market value multiplier to the improvement value identified in the CCTA data to produce a value of the structure. This method was used on all property types to generate information to be used in the damage calculations.

1.4.2.6 Depth-Damage Curves

Six residential depth-damage curves were obtained from the USACE technical guidance memorandum EGM 04-01 (USACE, 2003) to relate estimated structure and contents damage to structure replacement value as a function of flooding depth. These damage curves are one story, two-story, and split-level resident structures, either with or without basements. For nonresidential structures, a depth-damage curve representing the average of structure and contents depth damage curves for a variety of structure types, generated by the Galveston District of the USACE was selected for use. Appendix F contains the depth-damage curves used to calculate property damage due to flooding. CCTA data was analyzed to identify the number of stories on residential structures and the presence or absence of a basement.

FIGURE 1.4.1
Hypothetical Damage-Frequency Relationship



1.4.2.7 Property Damage Calculation

The estimated structure value, flooding depth, and depth-damage curve information were used to estimate the property damage from flooding for a specific structure due to a storm of given recurrence interval. Higher magnitude events, such as the 100-year event, cause higher damages for flooded properties but also have a lower likelihood of occurring in a given year. Figure 1.4.1 shows the hypothetical relationship between expected damage and modeled recurrence interval. Estimated annual damages were calculated according to Appendix F of Chapter 6 of the CCSMP, essentially weighting the expected annual damages by their annual probability of occurrence. Damages were then capitalized over a 50-year period of analysis, consistent with the period of analysis over which maintenance and replacement costs were calculated, using the federal discount rate for 2008 of 4.875 percent.

1.4.2.8 Erosion Damages

Locations of potential erosion risk were identified through community response data. The CCSMP contains direction that erosion damages be estimated as the full value of structures at "imminent risk" of damage due to stream bank erosion, and that erosion damages not be assessed for loss of land. Field visits to areas identified as erosion problems were performed. Properties and infrastructure were judged to be at imminent risk if they were located within 30 feet of a site of *active erosion*, characterized by exposed earth, lack of vegetation, or collapsing banks. The estimated market value of the structure derived from CCTA data was used to estimate erosion damages for structures deemed at imminent risk. For infrastructure at risk other than property, such as roads and utilities, an estimate of the replacement value of these structures was used to assess erosion damages.

1.4.2.9 Transportation Damages

Transportation damage generally was estimated as 15 percent of property damage due to flooding. In some specific instances, significant transportation damages may occur in absence of attendant property damage due to flooding. For the Calumet-Sag Channel Watershed, specific transportation damages were calculated when flooding fully blocked all access to a specific area in the watershed and these damages were not adequately captured as a fraction of property damages. In such instances, transportation damages were calculated according to FEMA guidance in the document "What Is a Benefit?" (FEMA, 2001). The duration of road closure was estimated for the modeled storms, and transportation damage was calculated according to a value of $32.23 per hour of delay per vehicle based on average traffic counts.

1.4.3 Alternative Development and Evaluation

Potential stormwater improvements, referred to within the DWP as alternatives, were developed using a systematic procedure to screen, develop, and evaluate technologies consistently throughout the Calumet-Sag Channel Watershed. Tributary-specific technologies were screened and evaluated in consideration of the stormwater problems identified through community response data and modeling. An alternative is a combination of the technologies developed to address the identified stormwater problems. In many instances, communities had ideas or suggestions regarding potential resolution of their stormwater problems, and these ideas were solicited during workshops and subsequent comment periods and were considered during alternative development.

Alternatives were evaluated with respect to their ability to reduce flooding, erosion, and other damages under existing conditions. The reduction in expected damages for an alternative is called a *benefit.* Conceptual level costs were developed for each alternative using countywide unit cost data that considered expected expenses such as excavation, land-acquisition, pipe costs, channel lining, etc. Standard countywide markups were used to account for the cost of utility relocation, profit, design engineering and construction management costs, and contingency. Expected maintenance and replacement costs were considered over a 50-year design period. Detailed design studies are required to confirm the details associated with the feasibility of construction and precise configuration of proposed facilities.

Additional non-economic factors, such as the number of structures protected, the expected water-quality benefit, and the impact on wetland or riparian areas were considered in alternative development and evaluation.

1.4.3.1 Flood Control

Flood control technologies were considered during the development of alternatives for addressing flooding problems, as summarized in Table 1.4.1. After selection of an appropriate technology or technologies for a problem area, and review of information provided by communities and obtained from other sources (such as aerial photography and parcel data) regarding potentially available land, conceptual alternatives were developed.

Hydrologic or hydraulic models for alternative conditions were created to analyze the effect of the conceptual alternatives. Initial model runs were performed to determine whether an alternative significantly affected water surface elevation (WSEL) near the target problem area, or had negative impacts in other parts of the tributary area. For models that resulted in significant reduction in WSEL, a full set of alternative conditions model runs was performed, and expected damages due to flooding were evaluated for the alternative conditions. Benefits were calculated based on damages reduced from existing to proposed conditions.

1.4.3.2 Floodproofing and Acquisition

Alternatives consisting of structural flood control measures may not feasibly provide a 100-year level of protection for all structures. The DWP identifies areas that will experience flooding at the 100-year event, even if recommended alternatives are implemented. Floodproofing and/or acquisition of such structures are nonstructural flood control measures that may reduce or eliminate damages during flood events, which is why these measures are listed in Table 1.4.1. However, due to the localized nature of implementing such solutions, the District may look to address structures that are candidates for nonstructural flood control measures under separate initiatives, outside of the Capital Improvement Program (CIP).

1.4.3.3 Erosion Control

Erosion control alternatives were developed to address problem areas where erosion problems on regional waterways were determined to threaten structures. Damages were calculated based on the value of the threatened structures. Erosion control alternatives considered a full range of alternative technologies as summarized in Table 1.4.2.

1.4.3.4 Water Quality

The potential effect of alternatives on water quality was considered qualitatively. Most detention basins built for flood control purposes have an ancillary water quality benefit because pollutants in sediment will settle out while water is detained. Sediments can be removed as a part of maintenance of the detention basin, preventing the pollutants from entering the waterway. Detention basins typically have a sediment forebay specifically designed for this purpose. Some detention basins could be designed as created wetland basins with wetland plants included which could naturally remove pollutants and excess nutrients from the basin. Erosion control alternatives can help address water quality problems through reduction of sedimentation.

TABLE 1.4.1
Flood Control Technologies

Flood Control Option	Description	Technology Requirements
Detention/Retention		
Detention facilities (Dry basins)	Impoundments to temporarily store stormwater in normally dry basins.	Open space, available land. Only an upstream option.
Retention facilities (Wet basins)	Impoundments that include a permanent pool which stores stormwater and removes it through infiltration and evaporation. Retention facilities generally have an outfall to the receiving waterway that is located at an elevation above the permanent pool.	Open space, available land. Only an upstream option.
Pumped detention	Similar to detention or retention facilities, but includes a portion of the impoundment which cannot be drained by gravity and must be pumped out.	Open space, available land. Only an upstream option. Best applied when significant area is available to allow for filling only during large storms.
Underground detention	A specialized form of storage where stormwater is detained in underground facilities such as vaults or tunnels. Underground detention may also be pumped.	Space without structures, available land. Only an upstream option. Significantly more expensive than above ground facilities. Surface disruption must be acceptable during construction.
Bioretention	Decentralized microbasins distributed throughout a site or watershed to control runoff close to where it is generated. Runoff is detained in the bioretention facilities and infiltrated into the soil and removed through evapotranspiration.	Open space, multiple available opportunities for various sizes of open space.
Conveyance Improvement		
Culvert/bridge replacement	Enhancement of the hydraulic capacity of culverts or bridges through size increase, roughness reduction, and removal of obstacles (for example, piers).	Applicable only if restricted flow and no negative impact upstream or downstream. May require compensatory storage to prevent negative downstream impact. Permitting requirements and available adjacent land.
Channel improvement	Enhancement of the hydraulic capacity of the channels by enlarging cross sections (for example, floodplain enhancement), reducing roughness (for example, lining), or channel realignment.	No negative upstream or downstream impact of increased conveyance capacity. Permitting requirements and available adjacent land. Permanent and/or construction easements.

TABLE 1.4.1
Flood Control Technologies

Flood Control Option	Description	Technology Requirements
Flood Barriers		
Levees	Earth embankments built along rivers and streams to keep flood waters within a channel.	Permitting requirements and available adjacent land. Wide floodplains will be analyzed. Requires 3 feet of freeboard to remove structures behind levees from regulatory floodplain. Often requires compensatory storage.
Floodwalls	Vertical walls typically made of concrete or other hard materials built along rivers and streams to keep flood waters within a channel.	Permitting requirements and available adjacent land. Permanent and/or construction easements.
Acquisition	Acquisition and demolition of properties in the floodplain to permanently eliminate flood damages. In some cases, acquired property can be used for installation of flood control facilities.	Severe flooding, repetitive losses, other alternatives are not feasible.
Floodproofing		
Elevation	Modification of a structure's foundation to elevate the building above a given flood level. Typically applied to houses.	Severe flooding, repetitive losses, other alternatives are not feasible
Dry Floodproofing	Installation of impermeable barriers and flood gates along the perimeter of a building to keep flood waters out. Typically deployed around commercial and industrial buildings that cannot be elevated or relocated.	Better suited for basement or shallow flooding. Need the ability to provide closure of openings in walls or levees. Plan for emergency access to permit evacuation.
Wet Floodproofing	Implementation of measures that do not prevent water from entering a building but minimize damages; for example, utility relocation and installation of resistant materials.	Most applicable for larger buildings where content damage due to flooding can be minimized. Waterproofing sealant applied to walls and floors, a floor drain and sump pump.

TABLE 1.4.2
Erosion Control Technologies

Erosion Control Option	Description	Technology Requirements
Natural (vegetated or bioengineered) stabilization	The stabilization and protection of eroding overland flow areas or stream banks with selected vegetation using bioengineering techniques. The practice applies to natural or excavated channels where the stream banks are susceptible to erosion from the action of water, ice, or debris and the problem can be solved using vegetation. Vegetative stabilization is generally applicable where bankfull flow velocity does not exceed 5 ft/sec and soils are more erosion resistant, such as clayey soils. Combinations of the stabilization methods listed below and others may be used.	Requires stream bank slopes flat enough to prevent slope failure based upon underlying soils. Channels with steep banks with no room for expansion or high bank full velocities (> 5 ft/sec) should avoid these technologies.
Vegetating by sodding, seeding, or planting	Establishing permanent vegetative cover to stabilize disturbed or exposed areas. Required in open areas to prevent erosion and provide runoff control. This stabilization method often includes the use of geotextile materials to provide stability until the vegetation is established and able to resist scour and shear forces.	

TABLE 1.4.2
Erosion Control Technologies

Erosion Control Option	Description	Technology Requirements
Vegetated armoring (joint planting)	The insertion of live stakes, trees, shrubs, and other vegetation in the openings or joints between rocks in riprap or articulated block mat (ABM). The object is to reinforce riprap or ABM by establishing roots into the soil. Drainage may also be improved through extracting soil moisture.	
Vegetated cellular grid (erosion blanket)	Lattice-like network of structural material installed with planted vegetation to facilitate the establishment of the vegetation, but not strong enough to armor the slope. Typically involves the use of coconut or plastic mesh fiber (erosion blanket) that may disintegrate over time after the vegetation is established.	
Reinforced grass systems	Similar to the vegetated cellular grid, but the structural coverage is designed to be permanent. The technology can include the use of mats, meshes, interlocking concrete blocks, or the use of geocells containing fill material.	
Live cribwall	Installation of a regular framework of logs, timbers, rock, and woody cuttings to protect an eroding channel bank with structural components consisting of live wood.	
Structural stabilization	Stabilization of eroding stream banks or other areas by use of designed structural measures, such as those described below. Structural stabilization is generally applicable where flow velocities exceed 5 ft/sec or where vegetative stream bank protection is inappropriate.	Applicable to areas with steep stream bank slopes (> 3:1) and no room for channel expansion, or areas with high velocities (> 5 ft/sec) can benefit from this technology.
Interlocking concrete	Interlocking concrete may include A-Jacks®, ABM, or similar structural controls that form a grid or matrix to protect the channel from erosion. A-Jacks armor units may be assembled into a continuous, flexible matrix that provides channel toe protection against high velocity flow. The matrix of A-Jacks can be backfilled with topsoil and vegetated to increase system stability and to provide in-stream habitat. ABM can be used with or without joint planting with vegetation. ABM is available in several sizes and configurations from several manufacturers. The size and configuration of the ABM is determined by the shear forces and site conditions of the channel.	
Riprap	A section of rock placed in the channel or on the channel banks to prevent erosion. Riprap typically is underlain by a sand and geotextile base to provide a foundation for the rock, and to prevent scour behind the rock.	
Gabions	Gabions are wire mesh baskets filled with river stone of specific size to meet the shear forces in a channel. Gabions are used more often in urban areas where space is not available for other stabilization techniques. Gabions can provide stability when designed and installed correctly, but failure more often is sudden rather than gradual.	
Grade Control	A constructed concrete channel designed to convey flow at a high velocity (greater than 5 ft/sec) where other stabilization methods cannot be used. May be suitable in situations where downstream areas can handle the increase in peak flows and there is limited space available for conveyance.	
Concrete channels	Prevent stream bank erosion from excessive discharge velocities where stormwater flows out of a pipe. Outlet stabilization may include any method discussed above.	

1.4.3.5 Potential Funding Sources

Projects identified in the Calumet-Sag Channel DWP may be eligible for funding through one of several different USACE programs. The following is a summary of the USACE programs that may be available for DWP identified flood and erosion control projects:

- Section 205 of the Water Resources Development Act of 2005 allows the USACE to participate in funding small flood control projects of up to $7,000,000 (in federal costs), with a local cost-share requirement of 35 percent of the total project cost. USACE funding beyond the maximum limit set for Section 205 projects is possible, but would require study authority and specific authorization for construction.
- Section 219 of the Water Resources Development Act of 2005 allows the USACE to participate in environmental infrastructure projects. Section 219 does not have a maximum project cost limit and requires a 25 percent local share of cost participation.
- Section 14 of the 1946 Flood Control Act allows the USACE to participate in projects to make emergency streambank repairs up to an amount of $1.5 million. Section 14 requires a 35 percent local share of cost participation and can only be used to protect public infrastructure. Private property is not eligible for Section 14 funding.

In addition to the USACE, FEMA is also a potential federal partner for funding projects. The Flood Mitigation Assistance (FMA) program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). FEMA provides FMA funds to assist States and communities in implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program. Project grants are available to states and communities to implement measures to reduce flood losses, such as elevation, acquisition, or relocation of NFIP-insured structures. States are encouraged to prioritize FMA funds for applications that include repetitive loss properties; these include structures with 2 or more losses each with a claim of at least $1,000 within any 10-year period since 1978. More information about FMA funding is available at http://www.fema.gov/government/grant/fma/index.shtm

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2. Watershed Characteristics

2.1 General Watershed Description

The Calumet-Sag Channel Watershed is in the southwestern part of Cook County. The major receiving water body for the watershed—the Calumet-Sag Channel—was constructed in 1922 and later widened to improve shipping capacity. It connects in Calumet Park with the Little Calumet River and in Lemont with the CSSC. The largest tributaries to the Calumet-Sag Channel include Tinley Creek, Mill Creek, and Stony Creek. The District has established boundaries of the Calumet-Sag Channel Watershed for purposes of its stormwater management program. Figure ES.1 shows the location and the District's established boundaries of the Calumet-Sag Channel Watershed. It should be noted that in some areas, the boundaries established by the District differ with natural watershed boundaries. For example, the boundary extends to the Cook-Will County line, which includes the upstream parts of Spring Creek, Long Run Creek, Marley Creek, and Tampier Slough, although these waterways drain southwest into Will County, and are tributary to the Hickory Creek Watershed which eventually drains to the Des Plaines River. The scope of the Calumet-Sag Channel DWP includes these waterways and also some that drain to the I&M Canal, in addition to those draining to the Calumet-Sag Channel.

Figure ES.1 shows the municipal boundaries and the major streams within the Calumet-Sag Channel Watershed. Figure ES.1 also shows the subwatershed divides for the major streams within the Calumet-Sag Channel Watershed. Table 2.1.1 lists the municipalities within the Calumet-Sag Channel Watershed. Table 2.1.2 lists the major streams and tributaries to the Calumet-Sag Channel and stream lengths. Each stream is briefly described with a narrative in the following subsection.

TABLE 2.1.1
Municipalities in the Calumet-Sag Channel Watershed

Municipality	% of Municipality Area within Calumet-Sag Channel Watershed	% of Calumet-Sag Channel Watershed Area by Municipality	Municipality	% of Municipality Area within Calumet-Sag Channel Watershed	% of Calumet-Sag Channel Watershed Area by Municipality
Alsip	100	4.2	Midlothian	19	0.4
Bedford Park	98	3.8	Oak Forest	27	1.0
Blue Island	71	1.9	Oak Lawn	100	5.7
Bridgeview	100	2.7	Orland Hills	82	0.6
Burbank	100	2.8	Orland Park	92	11.6
Chicago	3	4.9	Palos Heights	100	2.5
Chicago Ridge	100	1.5	Palos Hills	100	2.7
Crestwood	96	1.9	Palos Park	100	2.5
Evergreen Park	98	2.0	Robbins	23	0.2
Hickory Hills	100	1.9	Summit	76	1.0
Hometown	53	0.2	Tinley Park	6	0.6
Justice	99	1.9	Willow Springs	48	1.2
Lemont	85	3.6	Worth	100	1.6
Merrionette Park	100	0.3			

TABLE 2.1.2
Calumet-Sag Channel Watershed Open Channel Stream Lengths

Open Channel Name	Length (miles)	Open Channel Name	Length (miles)
Calumet-Sag Channel	15.8	Calumet-Sag Tributary C	1.6
I & M Canal	15.4	I & M Canal Tributary A	1.6
Tinley Creek	9.3	Oak Lawn Creek	1.4
Mill Creek	6.7	Ken Kay Ditch	1.4
West Stony Creek	5.9	I & M Canal Tributary B	1.4
Marley Creek[a]	5.9	Boca Rio Ditch	1.1
Long Run Creek [a]	4.4	Melvina Ditch	1.0
East Stony Creek	4.0	Calumet-Sag Tributary B	1.0
Spring Creek[a]	3.3	Justice Ditch	0.9
Crooked Creek	2.9	Crestwood Drainage Ditch	0.9
Calumet-Sag Tributary A	2.5	I & M Canal Tributary D	0.8
Tampier Slough[a]	2.4	Merrionette Park Ditch	0.7
Mosquito Creek	2.4	71st Street Ditch	0.6
Lucas Ditch	2.1	Calumet-Sag Tributary AA	0.6
Navajo Creek	2.1	I & M Canal Tributary C	0.5
Mill Creek West Branch	1.9	Arroyo Ditch	0.2
Lucas Diversion Ditch	1.7	**Total**	**104.4**

[a]Stream drains southwest into Will County.

Table 2.1.3 lists the subwatersheds each municipality drains to, with subwatersheds listed in decreasing order based upon the area within the municipality. Although municipalities contribute stormwater to the listed subwatersheds, the actual stream may not be included within the municipality's boundaries.

TABLE 2.1.3
Municipality and Subwatersheds within the Municipality Boundary

Municipality	Subwatersheds within Municipality Boundary (square miles)
Alsip	Stony Creek East(3.21), Cal-Sag 7(1.49), Mosquito Creek(0.91), Cal-Sag 8(0.51), Cal-Sag 6 (0.24), Cal-Sag 9[b], Merrionette Park Ditch[bc], Ken Kay Ditch[b], Stony Creek[b], Tinley Creek[b]
Bedford Park	Stony Creek(2.57), Melvina Ditch(2.57[c]), I&M Canal(1.17), I&M 5(0.93), 71st St. Ditch(0.42)
Blue Island	Cal-Sag 10(1.77), Stony Creek East(1.14), Merrionette Park Ditch(0.14[c]), Cal-Sag 9[b], Cal-Sag 8[b]
Bridgeview	Stony Creek(2.14), 71st St. Ditch(1.93), Lucas Diversion Ditch(1.9[c]), Melvina Ditch(0.21[c]), 79th St. Ditch[b], I&M 5[b]
Burbank	Stony Creek(4.12), Melvina Ditch(3.76[c]), Oak Lawn Creek(0.36[c])
Calumet Park	Cal-Sag 10(0.81)
Chicago	Stony Creek East(4.12), Merrionette Park Ditch(3.07[c]), City of Chicago Combined Sewer(2.9), Stony Creek(0.91), Melvina Ditch[bc], I&M 5[b], Cal-Sag 10[b]
Chicago Ridge	Stony Creek(2.2), Melvina Ditch(0.18[c]), Oak Lawn Creek(0.18[c]), Cal-Sag 7[b], Lucas Diversion Ditch[bc]
Crestwood	Cal-Sag Trib C(1.56), Crestwood Drainage Ditch(0.76), Cal-Sag 9(0.25), Tinley Creek(0.14), Cal-Sag 6[b], Cal-Sag 8[b]
Evergreen Park	Stony Creek(3.09), Merrionette Park Ditch[bc], Stony Creek East[b]
Forest View	I&M 5[b]

TABLE 2.1.3
Municipality and Subwatersheds within the Municipality Boundary

Municipality	Subwatersheds within Municipality Boundary (square miles)
Hickory Hills	Stony Creek(1.46), 79th St. Ditch(1.07), Lucas Diversion Ditch(0.96[c]), Lucas Ditch(0.5[c]), I&M Trib D(0.22), Crooked Creek[b]
Hodgkins	I&M Canal(0.49)
Hometown	Stony Creek[b], Oak Lawn Creek[bc]
Justice	71st St. Ditch(1.08), 79th St. Ditch(0.91), Justice Ditch(0.3), I&M Canal(0.26), I&M 4(0.18), Stony Creek(0.12), Lucas Diversion Ditch(0.12[c])
Lemont	Long Run Creek(1.69), Castle Bowl(1.5), I&M Trib A(0.9), I&M Trib B&C(0.6), Sanitary Ship Canal (0.58), Cal-Sag 1(0.3), I&M 2(0.27), I&M 1(0.22), I&M Canal[b], Cal-Sag 2[b], I&M 3[b], Tampier Slough[b]
Lyons	I&M 5[b]
Matteson	Boca Rio Ditch(0.1), Arroyo Ditch[b]
Mc Cook	I&M 5[b], I&M Canal[b]
Merrionette Park	Stony Creek East(0.39), Merrionette Park Ditch(0.38[c])
Midlothian	Cal-Sag Trib C(0.85)
Oak Forest	Boca Rio Ditch(1.0), Cal-Sag Trib C(0.45), Arroyo Ditch(0.17)
Oak Lawn	Stony Creek(7.47), Oak Lawn Creek(3.08[c]), Melvina Ditch(1.51[c]), Stony Creek East(1.05), Lucas Diversion Ditch[bc], Cal-Sag 7[b]
Orland Hills	Tinley Creek(0.86), Marley Creek[b]
Orland Park	Marley Creek(6.12), Tinley Creek(4.16), Mill Creek(3.4), Spring Creek(1.75), Long Run Creek(1.56), Will County Trib 2(0.38), Boca Rio Ditch(0.21), Tampier Slough(0.13), Navajo Creek[b]
Palos Heights	Navajo Creek(2.21), Cal-Sag 5(1.44), Cal-Sag 6(0.51), Tinley Creek(0.13), Cal-Sag 7[b], Cal-Sag Trib B[b], Ken Kay Ditch[b]
Palos Hills	Stony Creek(3.96), Lucas Ditch(2.0[c]), Lucas Diversion Ditch(0.38[c]), Crooked Creek(0.32), Cal-Sag 5[b], Cal-Sag 4[b], Cal-Sag 2[b]
Palos Park	Mill Creek(1.52), Cal-Sag Trib B(0.97), Tampier Slough(0.46), Cal-Sag 4(0.32), Cal-Sag 5(0.19), Cal-Sag 3[b], Navajo Creek[b]
Riverdale	Cal-Sag 10(0.15)
Robbins	Cal-Sag 9(0.25), Cal-Sag Trib C[b]
Summit	I&M 5(1.18), I&M Canal[b]
Tinley Park	Tinley Creek(0.59), Will County Trib 2(0.17), Arroyo Ditch[b], Boca Rio Ditch[b]
Unincorporated/ ForestPres	Mill Creek(5.7), Long Run Creek(5.02), Tinley Creek(4.53), Cal-Sag 2(3.38), I&M 3(3.32), Cal-Sag 3(3.21), Marley Creek(3.2), Crooked Creek(3.13), Cal-Sag Trib A(2.96), Tampier Slough(2.9), I&M Trib B&C(1.94), Stony Creek East(1.23), Boca Rio Ditch(1.08), Cal-Sag 1(0.94), Spring Creek(0.85), Cal-Sag 6(0.69), Stony Creek(0.66), I&M Canal(0.61), Navajo Creek(0.56), Merrionette Park Ditch(0.54[c]), I&M 2(0.51), I&M Trib D(0.49), Crestwood Drainage Ditch(0.49), Sanitary Ship Canal(0.47), Cal-Sag Trib C(0.46), Cal-Sag 4(0.46), Cal-Sag 7(0.41), Will County Trib 2(0.39), I&M 1(0.32), Lucas Ditch(0.28c), Cal-Sag 10(0.2), Castle Bowl(0.19), Melvina Ditch(0.13c), Justice Ditch(0.11), Cal-Sag Trib B(0.11), Cal-Sag 5[b], I&M 4[b], Cal-Sag 9[b], Cal-Sag 8[b], I&M Trib A[b], 79th St. Ditch[b], Ken Kay Ditchb, I&M 5[b]
Willow Springs	I&M Canal(1.34), I&M 3(0.66), I&M 4(0.27), I&M Trib D(0.19), 79th St. Ditch[b]
Worth	Ken Kay Ditch(1.21), Stony Creek(0.82), Cal-Sag 7(0.2), Cal-Sag 5(0.12)

[a]Subwatersheds are ordered in decreasing order of area within municipality
[b]Less than 0.1 square miles within municipality contributes to subwatershed
[C]Subwatershed area also included in Stony Creek system

2.2 Stormwater Problem Data

To support DWP development, the District solicited input from stakeholders within the watershed. Municipalities, townships, and countywide, statewide, and national agencies such as Cook County Highway Department (CCHD), Illinois Department of Natural Resources (IDNR), Illinois Department of Transportation (IDOT), and the USACE, for example, were asked to fill out two forms with information to support DWP development. Organizations such as ecosystem partnerships were also contacted by the District as part of this information-gathering effort. Form A included questions on stormwater data and regulations, Form B questions on known flooding, erosion, and stream maintenance problem areas. In addition to problem areas reported by municipalities, townships, public agencies and other stakeholders, results of H&H modeling performed as a part of DWP development identified stormwater problem areas. The H&H modeling process is described in general in Section 1.3 and specifically for each modeled tributary in Section 3.

Figure 2.2.1 and Table 2.2.1 summarize the responses to Form B questions about flooding, erosion, and stream maintenance problem areas. As noted, the scope of the DWP addresses regional problems along open channel waterways. The definition of regional problems was provided in Section 1.

2.3 Watershed Analysis Data

2.3.1 Monitoring Data

2.3.1.1 USGS Gage Data

The U.S. Geological Survey (USGS) owns and maintains a nationwide network of stream gages used to record real-time measurements of the monitored stream's water surface elevations. Rating curves developed through periodic paired stage and flow measurements are used to develop rating curves for the stream, relating estimated flow to measured stage. There are two USGS surface water data monitoring sites within the Calumet-Sag Channel Watershed: "05536500" located on Tinley Creek near Palos Park, Illinois, and "05537500" located on Long Run near Lemont, Illinois. Table 2.3.1 summarizes the data available from these sites.

The Tinley Creek gage is located in the downstream part of the watershed, near the crossing of 135th Street. The Long Run Creek gage is located at Long Run Creek's crossing of State Street, just north of the Will County border.

TABLE 2.2.1
Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
AL1	Alsip	Bank erosion, sedimentation	115th St. and Stony Creek culvert, just west of Cicero Ave.	Severe erosion at northeast embankment, wing wall partially restricting opening of east barrel of culvert	Regional	1
AL2	Alsip	Pavement flooding	Route 50 (Cicero Ave.) at 119th St.	IDOT reported pavement flooding	Local	4, 5
AL3	Alsip	Storm sewer flow restriction, bank erosion, sedimentation	113th St. and Lamon Ave.	Siltation of East Stony Creek from 115th St. north to 11200 South interferes with drainage of a dry detention pond contributing to a mosquito breeding problem	Regional	1
BR1	Bremen Township	Maintenance	Ridgeland Avenue from 135th St. to 147th St.	Debris and siltation of box culvert due to alignment of Tinley Creek (CCHD)	Regional	1
BR2	Bremen Township	Maintenance	143rd St. from 82nd Ave. to Harlem Ave.	Overbank flooding due to lack of maintenance in Forest Preserve	Local	3, 4
BR3	Bremen Township	Basement flooding, ponding, water quality, storm sewer capacity	Linder Ave. between Midlothian Pike and 143rd St.	Natural basin collects stormwater, flooding yards and houses and causing septic system failure	Local	4
BR4	Bremen Township	Maintenance, ponding	Ridgeland Ave. 1/8 mile north of 147th St.	Culvert box submerged (CCHD)	Local	3, 4
BU1	Burbank	Overbank flooding, storm sewer capacity	87th St. and Natchez Ave.	Overbank flooding and ponding has historically occurred surrounding the Melvina Ditch Reservoir. District made improvements to reservoir and coordination with Bedford Park, with no problems at the reservoir reported since.	Local	5
BU2	Burbank	Pavement flooding	Route 50 (Cicero Ave.) at Keller Dr. (77th Street Viaduct)	IDOT reported pavement flooding	Local	4, 5
BV1	Bridgeview	Overbank flooding, pavement flooding, storm sewer capacity	Route 43 (Harlem Ave.) at 86th St.	IDOT reported flooding problems (southbound)	Local	4, 5

TABLE 2.2.1
Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
BV2	Bridgeview	Basement flooding, ponding, storm sewer capacity	100th Pl. between 76th Ave. and Harlem Ave.	Excessive ponding occurs at 100th Place between 76th Ave. and Harlem Ave. due to drainage problems.	Local	5
BV3	Bridgeview, Burbank	Pavement flooding	Route 43 (Harlem Ave.) at 79th St.	IDOT reported pavement flooding	Local	4, 5
BV4	Justice, Bridgeview	Storm sewer capacity	Roberts Rd. between 79th St. and 83rd St.	Frequent roadway flooding due to under-sized storm sewer Roberts Road storm sewer lacking sufficient capacity	Local	4, 5
BV5	Bridgeview, Chicago Ridge	Pavement flooding	Route 43 (Harlem Ave.) at I-294	IDOT reported pavement flooding	Local	5
CP1	Calumet Park	Pavement flooding	I-57 at 127th St. (Burr Oak Ave.)	IDOT reported pavement flooding	Local	5
CP2	Calumet Park, Chi-cago	Pavement flooding	I-57 at 119th St.	IDOT reported pavement flooding	Local	4, 5
CR1	Chicago Ridge	Maintenance, pond-ing	Melvina Ditch at West Stony Creek	Maintenance problem at Melvina Ditch con-fluence with Stony Creek. Previously re-ported maintenance request (Nov. 2006) at confluence with Stony Creek	Regional	1
CR2	Chicago Ridge, Oak Lawn	Bank erosion, sedi-mentation	Melvina Ditch along Chicago Ridge Mall (between 95th St. and West Stony Creek)	Sediment and erosion problems, lack of maintenance, High flows released from res-ervoir cause erosion.	Regional	1
CR3	Chicago Ridge	Overbank flooding	Confluence of Melvina Ditch with Stony Creek	The adverse confluence angle of Melvina Ditch with Stony Creek is perceived to con-tribute to higher flood stages along West Stony Creek	Regional	1
CW1	Crestwood	Pavement flooding	Route 50 (Cicero Avenue) at 135th St.	IDOT reported pavement flooding	Local	5
CW2	Crestwood	Maintenance	Central Ave. from 127th St. to 135th St.	Embankments need repair and debris in embankment and waterway	Regional	1

TABLE 2.2.1
Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
CW3	Alsip, Crest-wood, Worth Township	Overbank flooding, basement flooding	Between 129th St. and Calumet-Sag Channel, west of Central Ave.	Overbank flooding during heavy rain, attrib-uted in part to double bend in Tinley Creek just downstream of Central Ave.	Regional	1
FP1	Forest Pre-serve District	Overbank flooding, ponding, water qual-ity, wetland and ripar-ian area degradation	LaGrange and 167th St.	High runoff and salt from roads has de-graded habitat and water quality	Local	4
HH1	Hickory Hills	Overbank flooding, basement flooding, ponding, bank ero-sion, maintenance	98th St. at 7700 West	Drainage ditches have insufficient capacity to convey storm flows, resulting in ponding and basement flooding. Possible mainte-nance issues related to Lucas Ditch.	Regional	1
HH2	Hickory Hills, Justice	Overbank flooding, basement flooding, ponding, storm sewer capacity, pavement flooding	85th St. at 8900 West	During heavy rains there is insufficient storm sewer capacity in Justice resulting in yard flooding.	Local	4, 5
HH3	Hickory Hills	Basement flooding, ponding, storm sewer capacity	85th St to 83rd St at 8600 West	Insufficient downstream capacity in Justice backs up flow	Local	4, 5
HH4	Hickory Hills	Basement flooding, ponding, storm sewer capacity	Roberts Road between 90th and 95th St.	Roberts Road storm sewer has insufficient capacity to convey moderate floods. Cook County will not allow additional connections to the Roberts Road storm sewer	Local	4, 5
HH5	Hickory Hills	Ponding, storm sewer capacity, mainte-nance	91st Pl. at Kean Ave.	The storm sewer to the forest preserve is typically full, and during rainfall events, the catch basin ponds back up to a property in the subwatershed. Maintenance issue re-lated to a ditch in Forest Preserve. The storm sewer to the forest preserve is ha-bitually inundated, but during rainfall events, the catch basin starts ponding, backing up to one resident’s front door. Maintenance issue related to ditch in Forest Preserve.	Regional	1

TABLE 2.2.1
Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
HH6	Hickory Hills	Overbank flooding, basement flooding, ponding, bank erosion	95th St. at 84th Ct. (Flamingo Apartments)	Runoff from forest preserves exceeds outflow drains and thus results in flooding two apartment buildings to the first floor. Erosion on forest preserve property.	Local	4
JU1	Justice	Pavement flooding	Route 171 (Archer) at I-294 (Ramp to SB)	IDOT reported pavement flooding	Local	4, 5
JU2	Justice	Ponding	East of Cork Avenue between 73rd Pl. and 75th St.	Depressional area has no natural outlet. Drains to 71st Street Ditch through undersized storm sewer.	Local	4, 5
JU3	Justice	Overbank flooding, basement flooding, ponding, storm sewer capacity	71st Street Ditch	Insufficient capacity in 71st Street Ditch to convey flows from upstream communities	Regional	1
JU4	Justice	Storm sewer capacity	Under Tri-State Tollway between 86th and 87th Ave.	Storm sewer under Tri-State Tollway has insufficient capacity to convey flows from Hickory Hills and Justice	Local	4, 5
LE1	Lemont	Ponding	Cass Street and Lemont St., downtown Lemont	During major storm events, sewer system in downtown Lemont surcharges and overflows, flooding basements, and first floors of commercial buildings, industrial buildings, and residences	Local	5
LT1	Lemont Township	Pavement flooding	Route 171 (Archer Ave.) between Castlewood and Route 83	IDOT reported pavement flooding	Local	2, 4
LT3	Lemont Township	Pavement flooding	Route 171 (Archer Ave.) at 131st St.	IDOT reported pavement flooding	Local	2, 4
LT4	Lemont Township	Bank erosion, sedimentation	Stephen St. and north of Talcott St.	Tree branches and limbs are fallen in to I&M Canal and block flowage	Regional	1
LT5	Lemont Township	Pavement flooding, ponding	McCarthy Rd. between Bell Rd. and Will-Cook Rd., near Equestrian Estates neighborhood	McCarthy Road and nearby yards flood, including property that contains large pond. Pond has insufficient storage volume and/or outlet capacity to contain flows.	Local	2, 4

TABLE 2.2.1
Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
LYT1	Lyons Township	Overbank flooding	Tributary to I&M Canal Crossing La Grange Rd.	Pavement flooding due to high stages in the channel, 8 known occurrences	Regional	1, 3
ME1	Merrionette Park, Chicago	Pavement flooding	Kedzie between 119th St. to 126th St.	IDOT reported pavement flooding	Local	4, 5
OF3	Oak Forest	Maintenance, overbank flooding, sedimentation, bank erosion	Property just north of 151st St. and Boca Rio Dr.	Private property owner in Bremen Township denies access to allow Oak Forest to maintain channel, resulting in significant sedimentation and upstream flooding	Regional	1
OH1	Orland Hills	Overbank flooding, ponding, water quality, bank erosion, wetland and riparian area degradation	Tinley Creek at 88th Ave.	Culvert and channel downstream of 88th Avenue have sediment and vegetation which reduces conveyance	Regional	1
OH2	Orland Hills	Overbank flooding, ponding, water quality, bank erosion, wetland and riparian area degradation	Lake Lorin and along 167th Street between 91st Ave. and Haven Ave.	Lake Lorin vegetation, sedimentation, and outlet condition reduces Tinley Creek conveyance in this area	Regional	1
OL1	Oak Lawn	Maintenance	Central Ave., 1/4 mile south of 103rd St.	Siltation observed in south culvert barrel	Regional	1
OL2	Oak Lawn	Bank erosion	Stony Creek between 103rd St. and Central Ave.	Resident reports erosion, District field staff observed several exposed outfalls	Regional	1
OL3	Oak Lawn, Chicago	Pavement flooding	Pulaski Road and 102nd St.	IDOT reported pavement flooding	Local	4, 5
OL4	Oak Lawn, Chicago	Pavement flooding	Pulaski Rd. and 104th St.	IDOT reported pavement flooding	Local	4, 5
OL5	Oak Lawn	Overbank flooding, basement flooding, ponding, water quality, storm sewer capacity	99th Street to 103rd St. between Cicero Ave. and Central Ave.	High water elevations on West Stony Creek may limit drainage capacity of Oak Lawn sewers	Local	5

TABLE 2.2.1
Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
OL6	Oak Lawn	Sedimentation, bank erosion, maintenance	102nd St. and Merrimac Ave. (near Metra tracks)	Severe bank erosion, bank collapse, and sedimentation at confluence of Oak Lawn Creek and Stony Creek	Regional	1
OL7	Oak Lawn	Severe bank erosion, sedimentation, maintenance, water quality	Oak Lawn Creek between Mayfield Ave. and Central Ave. (near 99th St. and Menard Ave.)	Severe bank erosion such that residential structures are threatened along Oak Lawn Creek	Regional	1
OL8	Oak Lawn	Storm sewer capacity, bank erosion, sedimentation, water quality	Oak Lawn Lake along East and West Shore Dr.	Severe bank erosion such that shorelines, adjacent walks, and structures risk failing. Poorer water quality and loss of wildlife habitat due to increased sedimentation from bank erosion.	Regional	1
OL9	Oak Lawn	Overbank flooding, storm sewer capacity, bank erosion, sedimentation, water quality	Wolfe Wildlife Refuge (from Cicero Ave. and 111th St. to Central Ave. and 105th St.)	Bank erosion along Stony Creek West in wildlife preserve causes additional sedimentation, reducing storm sewer capacity and contributing to overbank flooding in the area	Regional	1
OP1	Orland Park	Pavement flooding	Southwest Highway and 135th St.	Flooding several times per year	Regional	1, 3
OP2	Orland Park	Pavement flooding	Route 43 (Harlem Ave.) between 151st St. and 153rd St.	IDOT reported pavement flooding	Local	3, 4
OP3	Orland Park	Overbank flooding, bank erosion, sedimentation, maintenance, wetland and riparian area degradation	Marley Creek at Cameron Parkway and Norfolk Southern R.R.	Flooding on Wolf Road due to restricted conveyance in Marley Creek, seems to be caused primarily by debris and sedimentation causing blockages in conveyance	Regional	1
OP4	Orland Park	Pavement flooding	Southwest Highway at 151st St.	IDOT reported pavement flooding	Local	2, 4
OP5	Orland Park	Bank erosion, sedimentation	151st Street and Orland Brook Dr.	Significant erosion and sedimentation results in flow restriction	Regional	1

TABLE 2.2.1
Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
OP6	Orland Park	Maintenance, sedimentation, bank erosion	Marley Creek at Anthony Dr. to Meade St.	Flooding on 104th Avenue due to restricted conveyance in Marley Creek, seems to be caused primarily by debris and sedimentation causing blockages in conveyance	Regional	1
OP7	Orland Park	Ponding	Strawberry Lane (Parkview Estates)	Flooding due to offsite flows from outside village	Regional	1
OP8	Orland Park	Overbank flooding	Tinley Creek at 82nd Avenue	Overbank flooding due to undersized culvert along Tinley Creek and lack of maintenance downstream	Regional	1
OP9	Orland Park	Overbank flooding	Long Run Creek Crossing 143rd Street (West of Wolf Road)	Pavement flooding due to high stages in the channel, 18 known occurrences	Regional	1
OP10	Orland Park	Bank erosion, sedimentation	Deluga Woods subdivision between 155th and 159th St.	Lack of maintenance in unincorporated area results in overbank flooding	Regional	1
OP11	Orland Park	Bank erosion, sedimentation	143rd St. and Wolf Rd.	Erosion/sedimentation causes flow restriction resulting in flooding	Regional	1
OP12	Orland Park	Bank erosion, sedimentation	108th Ave. at Marley Creek crossing	Silt in three 10-foot by 8-foot box culvert where Marley Creek crosses 108th Avenue	Regional	1
OP13	Orland Park	Pavement flooding	Route 7 (Southwest Hwy) at Route 45 (La Grange Rd.)	IDOT reported pavement flooding	Regional	1
OP14	Orland Park	Pavement flooding	Route 7 at 145th St. to 148th St.	IDOT reported pavement flooding	Local	2, 4
OP15	Orland Park	Sedimentation, overbank flooding	167th St. and 88th Ave. (Fernway area)	Sedimentation and culvert restrictions result in frequent overbank flooding of the Fernway area. Village has contracted engineering for culvert replacement and sediment removal	Regional	1
OT1	Orland Township	Overbank flooding, ponding	114th Court and 157th Street	Heavy rains cause overflow of Spring Creek into adjacent subdivision	Regional	1
OT2	Orland Township	Bank erosion, sedimentation	Will-Cook Road at Long Run Creek crossing	Silt in culvert, and severe erosion along southeast embankment	Regional	1

TABLE 2.2.1
Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
PH1	Palos Heights	Overbank flooding	135th St. from Harlem Avenue to Ridgeland Avenue	Pavement flooding due to high stages in the channel, 28 known occurrences	Local	2, 4
PH2	Palos Heights	Ponding	12605 Melvina Avenue	Ponding in ROW about 2 to 5 times a year	Local	4
PH3	Palos Heights	Ponding	Palos Meadows Subdivision near 131st Street and 71st Ave-nue (includes 13013 Oak Park Avenue)	Flooding throughout neighborhood 2 to 5 times a year	Regional	1
PH4	Palos Heights	Ponding	12500 McCarthy Rd. and on Carmichael Dr. west of 76th Ave.	Storm sewer restriction at McCarthy Rd. and ponding at nearby school detention pond	Local	4
PH5	Palos Heights	Ponding	21 Country Squire Court near 76th Avenue and College Drive	Ponding in ROW and front yard, 2 to 5 times a year	Local	4
PH6	Palos Heights	Ponding	12601 Harold Ave., 12542 74th Ave., and 12542 75th Ave.	Ponding in ROW 2 to 5 times a year	Local	4, 5
PH7	Palos Heights	Ponding	124th Avenue and 69th Court; and 12217 68th Court	Ponding in ROW 2 to 5 times a year	Local	4, 5
PH8	Palos Heights	Basement flooding, ponding	12002 Harold Avenue	Basement and backyard flooding due to narrow conveyance of overflow from 76th Avenue	Local	4
PH9	Palos Heights	Ponding	12102,12232, 12303, and 12312 71st Avenue	Ponding in ROW 2 to 5 times a year	Local	5
PH10	Palos Heights	Ponding	12333 69th Avenue near Navajo Creek and Oak Park Avenue and College Drive	Flooding in street right-of-way (ROW) in front of residence, about 2 to 5 times a year	Local	4, 5
PH11	Bremen Township, Palos Heights	Pavement flooding	Route 43 (Harlem Avenue) at 135th Street	IDOT reported pavement flooding	Local	4, 5

TABLE 2.2.1
Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
PH12	Palos Heights	Ponding	12911 71st Court	Sewer backup caused by high Navajo Creek elevation 2 to 5 times a year	Local	5
PH13	Palos Heights	Ponding	13032 71st Avenue	Flooding in backyard 2 to 5 times a year	Regional	1
PH14	Palos Heights	Ponding	6843 Evergreen Avenue	Ponding in right-of-way (ROW) 2 to 5 times a year	Local	4, 5
PH15	Palos Heights	Ponding	Approximately 150 ft west of 76th Avenue on north side of McIntosh Drive	Flooding 2 to 5 times a year	Local	4
PH16	Palos Heights	Flooding	11938 68th Court	Flooding in ROW 2 to 5 times a year	Local	4
PH17	Palos Heights	Overbank flooding, basement flooding	Nashville Avenue and 125th Street	Flooding in ROW 2 to 5 times a year	Regional	1
PH18	Palos Heights	Flooding	127th Street and 70th Avenue	Navajo Creek elevation affects this area	Regional	1
PH19	Palos Heights	Basement flooding, ponding, storm sewer capacity	Approximately 150 ft north of 131st Street on west side of Cypress Lane	Flooding 2 to 5 times a year	Local	5
PH20	Palos Heights	Ponding, pavement flooding	12001 73rd Ct., 12151 73rd Ave., and 12412 73rd Ave.	Flooding in ROW 2 to 5 times a year	Local	5
PH21	Palos Heights	Storm sewer capacity	7350 Choctaw Rd.	Flooding in backyard 2 to 5 times a year	Local	5
PH22	Palos Heights	Ponding	12224 Cheyenne Dr.	Ponding in ROW 2 to 5 times a year	Local	5
PH23	Palos Heights	Ponding	12250 76th Ave. and 12223 Richard Ave.	Ponding in ROW 2 to 5 times a year	Local	5
PHI1	Palos Hills	Overbank flooding, basement flooding, ponding	100th Place and 78th Avenue	Lucas Diversion Ditch has insufficient capacity, overflowing into existing undersized detention area and nearby homes.	Regional	1

TABLE 2.2.1
Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
PHI2	Palos Hills	Ponding, storm sewer capacity	82nd Avenue and Eleanor Avenue	Sedimentation in Lucas Ditch upstream of 103rd Street restricts Lucas Ditch capacity.	Regional	1
PHI3	Palos Hills	Overbank flooding, basement flooding, bank erosion	111th Street and 86th Avenue (11118 Spathis Drive)	Lucas Ditch floods adjacent buildings when Stony Creek is high, sometimes resulting in erosion as well. Former study recommended building a levee wall to isolate the floodplain.	Regional	1
PHI4	Palos Hills, Bridgeview	Basement flooding, ponding, storm sewer capacity, bank erosion, maintenance	Lucas Diversion Ditch from 102nd Street to 105th Street	Debris and sediment build up restricts flow in Lucas Diversion Ditch causing basement flooding north of 103rd Street in Bridgeview/ Palos Hills	Regional	1
PHI5	Palos Hills	Overbank flooding, ponding	Kean Avenue and Los Palos Lane	Flows in Hickory Hills have no retention, and the Los Palos Hills reservoir has insufficient capacity to capture larger storms. Overflows flood the intersection. In 100-year floodplain. Palos Hills wants larger outlet to forest preserve.	Regional	1
PHI6	Palos Hills	Bank erosion, sedimentation	101st Street and Roberts Road	Debris at upstream end of culvert, far upstream portion of Lucas Ditch, where it crosses Roberts Road	Local	4, 5
PHI7	Palos Hills	Overbank flooding, ponding	88th Avenue and 99th Street	Localized flooding in sewered headwaters of Lucas Ditch. Previous studies have identified need for additional storage and increased conveyance.	Local	4, 5
PHI8	Palos Hills	Overbank Flooding, storm sewer capacity, bank erosion, wetland and riparian area degradation	96th Street and Arrowhead Drive	Flooding and erosion problems due to high flows. The buildings threatened by erosion are actually in Hickory Hills. Plan developed to address erosion, increase conveyance, and add retention in Forest Preserve	Local	4, 5
PHI9	Palos Hills, Bridgeview	Basement flooding, ponding, storm sewer capacity, bank erosion, maintenance	Lucas Diversion Ditch from 103rd Street to 105th Street	Sediment and debris buildup in Lucas Diversion Ditch	Regional	1

TABLE 2.2.1
Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
PP1	Palos Park	Overbank flooding, ponding, storm sewer capacity, bank erosion, wetland and riparian area degradation	McCarthy Road, between Oak Ridge and 79th Avenue	Floodwaters exceed capacity, damaging homes, 2+ times per year	Local	4
PP2	Palos Park	Overbank flooding, basement flooding, ponding, storm sewer capacity, bank erosion	80th Ave. between 126th St. and 127th St.	Floodwaters exceed capacity resulting in damage to homes. Occurs 2+ times per year	Local	4
PP3	Palos Park	Overbank flooding, basement flooding, storm sewer capacity, bank erosion	119th Street and Timber Lane	Floodwaters exceed capacity of box culvert under 119th Street	Regional	1, 2
PP4	Palos Park	Overbank flooding, basement flooding, storm sewer capacity, bank erosion	SW Hwy between S. Woodland Trail and 121st Street	Diversion from Mill Creek is conveyed along RR ROW. This flow leaves RR ROW and spills into SW Hwy at this location. Closes SW Hwy, and flooding several homes along RR ROW	Regional	1, 3
PP5	Palos Park	Overbank flooding, basement flooding, water quality, storm sewer capacity, bank erosion, wetland and riparian area degradation, maintenance	123rd Street between Hobart Avenue and Elm Street	Floodwater exceeds conveyance capacity, also erosion affecting northern Groundhog Slough	Regional	1, 2
PP6	Palos Park	Overbank flooding, basement flooding, ponding, storm sewer capacity, bank erosion	Southwest Highway between 131st Street and 135th Street	Flooding due to insufficient capacity reduces or prevents access to businesses in this area	Regional	1, 2

TABLE 2.2.1
Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
PP7	Palos Park	Overbank flooding, storm sewer capacity, bank erosion	127th Street and 86th Avenue	Mill Creek diverts to RR ROW ditch at this location. Insufficient capacity to convey water under 86th Avenue results in flooding of SW Hwy	Regional	1, 2
PP8	Palos Park	Overbank flooding, basement flooding, storm sewer capacity, bank erosion	Kinvarra Drive and Wild Cherry Lane (9845 Wild Cherry Lane)	Excessive floodwaters result in flooding of a number of houses at least 3 times in the last 10 years. Stream maintenance is required downstream to address sedimentation and debris.	Regional	1, 2
PP9	Palos Park	Pavement flooding	Route 7 at 123rd Street	IDOT reported pavement flooding	Local	2, 4
PP10	Palos Park	Overbank flooding, basement flooding, storm sewer capacity, bank erosion	116th Avenue and 123rd Street	Floodwaters exceed capacity, 1 time per year	Local	4
PT1	Palos Township	Ponding	127th Street and Deerwood Drive	Ponding	Local	4
PT2	Palos Township	Ponding	Halfway between 104th Ave. and Indian Trail Dr. on Lakeland Dr.	Ponding	Local	4
PT3	Palos Township	Ponding	West end of Bernice Drive near 104th Avenue and 131st Street	Ponding	Local	4
PT4	Palos Township	Ponding	Intersection of Stephen Drive and Walter Drive	Ponding	Local	4
PT5	Palos Township	Pavement flooding	Kean Ave. at 100th Street to 111th Street	IDOT reported pavement flooding	Regional	1, 2
PT6	Palos Township	Overbank flooding, water quality, wetland and riparian area degradation	U.S. Route 45 at Crooked Creek	Flooding overtops the banks and decreases water quality	Regional	1, 3
PT7	Palos Township	Ponding	Intersection of Bernice Drive and Adsit Road	Ponding	Local	4

TABLE 2.2.1
Summary of Responses to Form B Questionnaire

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Reason for Classification
PT8	Palos Township	Maintenance	North and East of intersection of 111th Street (Route 83) and 104th Avenue	CCHD reported flooding due to debris blockages within a poorly maintained ditch on Forest Preserve property	Local	4
SU1	Chicago, Village of Summit	Pavement flooding	Route 43 (Harlem Avenue) at 63rd Street to 65th Street	IDOT reported pavement flooding	Local	3, 4
SU4	Summit	Pavement flooding	Route 171 at 63rd Street	IDOT reported pavement flooding	Local	4, 5
WO1	Worth	Pavement flooding	Ridgeland Avenue at 111th Street	IDOT reported pavement flooding	Local	4
WO2	Worth	Bank erosion	Stony Creek between Oak Lawn and 76th Avenue	Stream bank is in need of stabilization and debris removal to restore the natural conveyance of Stony Creek	Regional	1
WO3	Worth	Ponding, bank erosion	Ken Kay Ditch at 116th Street and Harlem Avenue	Creek is in need of sediment removal. Ponding occurs in the village and within IDOT ROW adjacent to the creek.	Local	4
WO4	Worth	Ponding, pavement flooding	75th Avenue at 109th Street	Pavement flooding and property flooding	Local	4, 5
WS1	Willow Springs	Pavement flooding	Archer Avenue at LaGrange Road	IDOT reported pavement flooding	Local	4
WS2	Willow Springs	Overbank flooding	I&M Canal Crossing Rte 171	Pavement flooding due to high stages in the channel, three known occurrences	Local	5
WS3	Willow Springs	Overbank flooding, ponding	Willow Drive and Archer Road	Channel draining Renaissance Development along Metra tracks near I&M Canal does not drain sufficiently	Local	4, 5

Reasons for Regional / Local Classifications:
1. Located on a regional waterway with greater than 0.5 square mile drainage area
2. Roadway culvert (two-lane road)
3. Roadway culvert (greater than two-lane road)
4. Located in headwater area (less than 0.5 square mile drainage area)
5. Located within storm sewer system (regardless of drainage area)

TABLE 2.3.1
USGS Gage Data in the Calumet-Sag Channel Watershed

Description	USGS 5536500		USGS 05537500	
Location	Tinley Creek near Palos Park		Long Run near Lemont	
Latitude	41°38'48"		41°38'33"	
Longitude	87°45'59" NAD27		87°59'57" NAD27	
	Cook County, Hydrologic Unit 07120004: Des Plaines Watershed		Cook County, Hydrologic Unit 07120004: Des Plaines Watershed	
Contributing drainage area:	11.20 square miles		20.9 square miles	
Datum of gauge:	607.40 ft above sea level NGVD29		637.20 ft above sea level NGVD29	
Data Type	**Begin Date**	**End Date**	**Begin Date**	**End Date**
Real-time	This is a real-time site.		This is a real-time site.	
Peak stream flow	09/26/1951	04/25/2007	09/27/1951	08/24/2007
Daily Data				
Discharge, cubic ft per second (ft^3/sec)	07/11/1951	09/30/2008	07/01/1951	03/30/2009
Gage height, ft	10/1/1993	03/30/2009	10/01/1991	03/30/2009
Daily Statistics				
Discharge, ft^3/sec	07/11/1951	09/30/2008	07/01/1951	09/30/2007
Gage height, ft	10/01/1993	09/30/2008	10/01/1991	09/30/2007
Monthly Statistics				
Discharge, ft^3/sec	1951–07	2008–09	1951–07	2007–09
Gage height, ft	1993–10	2008–09	1991–10	2007–09
Annual Statistics				
Discharge, ft^3/sec	1951	2008	1951	2007
Gage height, ft	1994	2008	1992	2007
Field/lab water quality samples	10/09/1974	07/13/2000	10/09/1974	08/30/1983

2.3.1.2 Rainfall Data

The Illinois State Water Survey (ISWS) owns and maintains 25 rain gages in or near Cook County. Nine ISWS rain gages—11, 12, 13, 15, 16, 17, 18, 20, and 21—cover the Calumet-Sag Channel Watershed. Rainfall is recorded continuously at 10-minute intervals, processed by the ISWS to ensure quality, and available for purchase. ISWS rainfall data was obtained for specific gages and dates to support calibration of the Tinley Creek model and model verification for streams for which high water mark information was available. The District owns and maintains two rain gages in the Calumet-Sag Channel Watershed that record rainfall at 10-minute intervals. One gage is located in Lemont, and the other is located at the Melvina Ditch Reservoir. District rainfall data was used for qualitative comparison against ISWS gage data. Figure 2.3.1 shows locations where rainfall gage data was available to support the Calumet-Sag Channel Watershed DWP. The Tinley Creek subbasins are shown on Figure

2.3.1 color-coded to indicate which subbasins were associated with which rainfall gages during the calibration process, which is discussed in detail in Section 3.29.2.

2.3.1.3 Stage Data

The wet well elevation of Melvina Ditch Reservoir is recorded continuously on paper charts. These charts were obtained for the storms on September 11, 2000, August 23, 2007, and September 13-14, 2008, to support model calibration efforts for the Melvina Ditch model. Figure 2.3.1 shows locations where monitoring data was available to support the Calumet-Sag Channel Watershed DWP. It shows the subbasins in the Tinley Creek watershed color-coded to identify the ISWS rain gage used in the hydrologic model used for calibration. Thiessen polygons, which divide the watershed into areas closest to each ISWS rain gage, are also shown.

2.3.2 Subwatershed Delineation

The Calumet-Sag Channel Watershed was divided into subwatersheds representing areas tributary to the waterways in the study area. Elevation data provided by Cook County, described further in Section 2.3.4, was the principal data source used for subwatershed delineation. Drainage divides were established based upon consideration of the direction of steepest descent from local elevation maxima. Occasionally, Cook County elevation data contains constructed structures that do not represent surface hydrology, for instance, raised roadways that do not restrict overland flow. The delineation in these areas was modified to best represent surface hydrology. The storm-sewer network was also considered in the delineation of some areas, particularly in the low gradient areas north of the Calumet-Sag Channel where ground slope was slight or inconclusive. Finally, reference of previous studies and consultation with community representatives helped resolve subwatershed boundaries in areas of question.

Following the definition of subwatersheds, tributaries studied in detail were divided into smaller subbasins, represented in the hydrologic model as having a unified response to rainfall. The size of subbasins varied based upon the drainage network density and proximity to the hydraulically modeled waterway. Subbasin boundaries were modified to generally encompass areas with similar development patterns. Boundaries were defined to most accurately represent the actual area tributary to specific modeled elements, such as constrictions caused by crossings, and reservoirs.

Figure 2.3.2 shows the subwatersheds and subbasins developed for the DWP. Subbasins were not defined for areas that were not modeled in detail.

2.3.3 Drainage Network

The principal waterways of the Calumet-Sag Channel Watershed were defined during Phase A of the watershed study. Initial identification of the stream centerline was made using planimetry data obtained from Cook County. Stream centerlines were reviewed against aerial photography and Cook County contour data at a 1:500 scale, and modified to best represent existing conditions. These streamlines were included in the topographic model of the Calumet-Sag Channel Watershed (see Section 2.3.4), and collect runoff from upland drainage areas. Secondary drainageways that were not modeled were identified based upon review of contour data. In flat, heavily sewered areas, consultation of sewer atlases and discussion with community representatives helped to identify significant drainage paths. Secondary drainageways were used to help define flow paths in the hydrologic models for individual tributaries. Figure 2.3.3 shows the major drainageways within the Calumet-Sag Channel Watershed superimposed upon an elevation map of the watershed.

2.3.4 Topography and Benchmarks

The topography of the Calumet-Sag Channel Watershed boundary is defined by the geologic history of the area. The southernmost extent of glacial Lake Chicago extended roughly to the location of the Calumet-Sag Channel. The Stony Creek drainage system, which comprises both natural and constructed waterways, exists upon the very topography of the former lake plain. Moraine formations to the west of the Stony Creek system, and in the south portion of the watershed, demarcate the southernmost boundary of the most recent glacial extent. Areas south of the Calumet-Sag Channel are characterized by greater topographic relief.

Topographic data for the Calumet-Sag Channel watershed was developed from Cook County light detection and ranging (LiDAR) data generated from a 2003 LiDAR mission (Cook County, 2003). The LiDAR data was obtained along with break lines from Cook County. A digital elevation model (DEM) was developed for the Calumet-Sag Channel Watershed model based upon a subset of filtered elevation points. Figure 2.3.3 shows elevations within the watershed.

Stream channel cross section and stream crossing structure (such as bridge and culvert) topographic data was collected during field survey work conducted primarily between August 2007 and February 2008 to support the DWP. (Some additional field survey work was performed between March 2008 and June 2008, and in January 2009.)

The reference benchmarks created during the Cook County aerial mapping project completed in 2003 were used to establish first-order control for field survey work. One hundred thirty-five control points were established during the mapping project. Of those, 25 are National Geodetic Survey (NGS)/High Accuracy Reference Network (HARN) control stations within Cook County and environs. The remaining points were either existing or new points identified as photo control specifically for the mapping project. Twelve NGS monuments within the region surrounding the Calumet-Sag Channel Watershed were observed, referenced to HARN, and used to establish first-order control, meeting the horizontal and vertical accuracy standards specified in FEMA's *Guidelines and Specifications for Flood Hazard Mapping,* "Guidance for Aerial Mapping" (FEMA 2003). The horizontal ground control was established by GPS technology, and horizontal positioning accuracy meets the specifications of the Federal Geodetic Control Subcommittee (FGCS) Second Order Class One.

2.3.5 Soil Classifications

NRCS soil data representative of 2002 conditions was obtained for Cook County except for unmapped areas (which include the City of Chicago and some portions of nearby communities). Morley silt loam is the predominating soil type in the study area, which has a clayey and silty subsoil. Along Stony Creek, the Muskego and Houghton mucks were also identified, which are poorly drained, organic soils. Other types of silt loams and urban altered soils are also found in the watershed.

The NRCS soil data includes hydrologic soil group, representing the minimum infiltration rate of the soil after wetting. Table 2.3.2 summarizes the hydrologic soil groups.

TABLE 2.3.2
Hydrologic Soil Groups

Hydrologic Soil Group	Description	Texture	Infiltration Rates (in./hr)
A	Low runoff potential and high infiltration rates even when wetted	Sand, loamy sand, or sandy loam	> 0.30
B	Moderate infiltration rates when wetted	Silt loam or loam	0.15–0.30
C	Low infiltration rates when wetted	Sandy clay loam	0.05–0.15
D	High runoff potential and very low infiltration when wetted	Clay loam, silty clay loam, sandy clay, silty clay, or clay	0–0.05

All data from *Technical Release 55, Urban Hydrology for Small Watersheds*, NRCS, June 1986

Soil groups with drainage characteristics affected by a high water table are indicated with a "/D" designation, where the letter preceding the slash indicates the hydrologic group of the soil under drained conditions. Thus, an "A/D" indicates that the soil has characteristics of the A soil group if drained but the D group if not. Because of the difficulty of establishing the extent of drainage of these soils for each mapped soil polygon, it was assumed that 50 percent (by area) of the soil types are drained. Table 2.3.3 summarizes the distribution of hydrologic soil type throughout the Calumet-Sag Channel Watershed. Figure 2.3.4 shows the distribution of soil types throughout the watershed.

TABLE 2.3.3
Hydrologic Soil Group Distribution

Hydrologic Soil Group	% of Calumet-Sag Channel Watershed
Unmapped	51.4
A	0.3
A/D	1.6
B	4.6
B/D	9.2
C	31.5
C/D	0.2
D	1.2

2.3.6 Land Use

Land use has a significant effect on basin hydrology, affecting the volume of runoff produced by a given area and the speed of runoff delivered to the receiving system. Impervious areas restrict infiltration and produce more runoff, which is often delivered to receiving systems more rapidly through storm sewer networks. Land use was one of two principal inputs into the calculation of CN for the Calumet-Sag Channel Watershed, detailed more extensively in Section 1.3.2.

A 2001 land use inventory for the Chicago metropolitan area was received from CMAP in GIS format. The data was used to characterize existing conditions land use within the Calumet-Sag Channel Watershed. The data include 49 land use classifications, grouped into seven general categories for summarizing land use within the DWP. Table 2.3.4 summarizes the land use distribution within the Calumet-Sag Channel Watershed. Figure 2.3.5 shows the distribution of general land use categories throughout the watershed.

2.3.7 Anticipated Development and Future Conditions

Anticipated development within the Calumet-Sag Channel Watershed was analyzed using population projection data. Projected future conditions land use data for the Calumet-Sag Channel Watershed are unavailable from CMAP or other regional agencies. Projected 2030 population data for Cook County was obtained from CMAP. Population data was overlaid upon subwatershed boundaries to identify the potential for increases in subwatershed populations. Table 2.3.5 shows subwatersheds with a projected population increase from the year 2000 population. Projected increases in population along with current subwatershed land use conditions make it likely that there will also be a corresponding increase in impervious surface area. This potential change in impervious surface area could contribute to higher flow rates and volumes of stormwater runoff drained by those tributaries.

TABLE 2.3.4
Land Use Distribution within the Calumet-Sag Channel Watershed

Land Use Type	Area (mi^2)	Area (%)
Residential	63	40
Forest/Open Land	52	33
Commercial/Industrial	16	10
Water/Wetland	7	5
Agricultural	7	5
Transportation/Utility	5	3
Institutional	5	3

TABLE 2.3.5
Projected Population Increase by Subwatershed

Name	2000 Population	2030 Population	% Change	Population Change
71st St. Ditch	10,120	10,385	3	265
79th St. Ditch	13,654	14,036	3	383
Cal-Sag 1	167	707	324	540
Cal-Sag 10	19,209	19,586	2	377
Cal-Sag 2	69	73	6	4
Cal-Sag 3	129	248	92	119
Cal-Sag 4	1,406	1,433	2	27
Cal-Sag 5	4,364	5,159	18	795
Cal-Sag 6	4,496	4,784	6	288
Cal-Sag 7	2,366	2,731	15	365
Cal-Sag 8	1,032	1,201	16	168
Cal-Sag 9	1,643	1,740	6	97
Cal-Sag Trib A	1,166	3,937	238	2,771
Cal-Sag Trib B	1,913	2,008	5	95
Cal-Sag Trib C	10,656	11,704	10	1,048
Castle Bowl	5,188	7,194	39	2,006
City of Chicago	22,185	23,931	8	1,746

TABLE 2.3.5
Projected Population Increase by Subwatershed

Name	2000 Population	2030 Population	% Change	Population Change
Crestwood Drainage Ditch	4,446	5,088	14	642
Crooked Creek	1,436	1,504	5	67
I&M 1	634	1,381	118	747
I&M 2	15	533	3,423	518
I&M 3	1,312	1,894	44	582
I&M 4	739	1,068	44	329
I&M Canal	2,136	2,646	24	510
I&M Trib A	3,072	3,363	9	291
I&M Trib B&C	2,094	4,373	109	2,279
Justice Ditch	2,018	2,156	7	139
Ken Kay Ditch	5,333	5,562	4	229
Long Run Creek	14,041	19,675	40	5,634
Lucas Ditch	10,353	10,591	2	238
Marley Creek	15,296	22,457	47	7,161
Merrionette Park Ditch	28,435	28,818	1	383
Mill Creek	17,103	19,518	14	2,415
Mosquito Creek	2,399	2,638	10	240
Navajo Creek	7,574	8,529	13	955
Oak Lawn Creek	21,446	22,633	6	1,187
Sanitary Ship Canal	545	2,173	299	1,627
Spring Creek	2,235	5,669	154	3,434
Stony Creek	152,749	153,960	1	1,211
Stony Creek East	61,251	63,945	4	2,693
Tampier Slough	1,350	1,697	26	347
Tinley Creek	32,882	34,780	6	1,898
Will County Trib 2	960	2,545	165	1,585

Management of future development may be regulated through both local ordinances and the WMO as described below in Section 2.3.9. This regulation would be an effort to prevent an increase in peak flows, via the construction of site-specific stormwater controls. The impact of the modified hydrologic and hydraulic characteristics of the subwatersheds due to changing land use over time may require the recommended projects to be re-evaluated under the conditions at the time of implementation to refine the details of the final design. To accomplish this, it is recommended that at the time projects are implemented, if updated land use and topographic information is available, the H&H models be rerun incorporating this new data.

2.3.8 Wetland and Riparian Areas

Wetland areas within the Calumet-Sag Channel Watershed were identified using National Wetlands Inventory (NWI) mapping. NWI data includes approximately 9.9 square miles of wetland areas in the Calumet-Sag Channel Watershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provide flood management, habitat, and water quality enhancement. Identified riparian areas defined as part of the DWP offer potential opportunities for restoration. Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed.

2.3.9 Management of Future Conditions through the Regulations of Site Stormwater Management

The District regulates the discharge of stormwater runoff from development projects located within separate sewer areas within the District's corporate boundaries through its Sewer Permit Ordinance. Currently, development projects meeting certain thresholds must provide stormwater detention in an effort to restrict the post-development flow rate to the pre-development flow rate. A number of communities enforce standards beyond the District's currently required standards and thresholds. This DWP supports the continued regulation of future development through countywide stormwater management.

The Cook County Watershed Management Ordinance (WMO) is under development and is proposed to provide uniform minimum countywide standards for site stormwater runoff for events up to and including the 100-year event that are appropriate for Cook County. This effort seeks to prevent post-development flows from exceeding pre-development conditions. The WMO is proposed to be a comprehensive ordinance addressing site runoff, floodplains, floodways, wetlands, soil erosion and sedimentation, water quality, and riparian environments.

3. Tributary Characteristics and Analysis

3.1 71st Street Ditch

The 71st Street Ditch is a manmade waterway in the northwestern part of the Calumet-Sag Channel Watershed that discharges into the I&M Canal. The 71st Street Ditch is about 5,000 feet long, draining an area of 3.43 square miles. Table 3.1.1 lists the communities draining to the 71st Street Ditch. Although the Village of Hickory Hills is not included in the drainage area in Table 3.1.1, a maximum discharge of 7.5 cubic feet per second (cfs) is pumped from the Hickory Hills Reservoir to the 71st Street Ditch through the Roberts Road Storm Sewer.

TABLE 3.1.1
Communities Draining to 71st Street Ditch

Community	Tributary Area (mi^2)
Bridgeview	1.93
Justice	1.08
Bedford Park	0.42

Table 3.1.2 summarizes the land use distribution within the 71st Street Ditch subwatershed. Figure 3.1.1 is an overview of the tributary area of the subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

TABLE 3.1.2
Land Use Distribution for 71st Street Ditch

Land Use Category	Area (acres)	%
Residential	883.9	40.3
Forest/Open Land	689.6	31.4
Commercial/Industrial	523.7	23.9
Institutional	49.6	2.3
Transportation/Utility	43.4	2
Agricultural	4	0.2

3.1.1 Sources of Data

3.1.1.1 Previous Studies

The IDNR completed a study focusing on flooding problems in the Cork Avenue localized depressional area (IDNR 2000). H&H analyses were performed along with a damage analysis of the flooded properties. The principal recommendation of the study was to increase the size of the storm sewer from the Cork Avenue depressional area to the 71st Street Ditch and to construct a larger culvert under the Illinois Central Railroad for conveying the additional flows to the I&M Canal. The B/C ratio of the project as determined by IDNR for its study is 0.34. The Village of Justice has noted the following concerns with the proposed project:

- Ground cover at the northern end of Cork Avenue may be insufficient for installing a 48-inch pipe.
- The increase in pipe size at the railroad crossing is constrained by existing utilities and may require village land acquisition.

A study by Patrick Engineering to investigate the drainage capabilities of the Roberts Road storm sewer from Archer Avenue to 111th Street revealed that the sewer is significantly undersized for much of the part draining north to the 71st Street Ditch (Patrick Engineering

2006). Replacement of the system with an upsized, larger proposed system was recommended.

3.1.1.2 Water Quality Data

The Illinois Environmental Protection Agency (IEPA) does not have any sites in the Ambient Water Quality Monitoring Network on the 71st Street Ditch. There are also no reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the Clean Water Act (CWA) 303(d) and 305(b) lists. No total maximum daily loads (TMDLs) have been established for the 71st Street Ditch. According to a water permit discharge query by the U.S. Environmental Protection Agency (USEPA), there are no National Pollutant Discharge Elimination System (NPDES) permits issued by IEPA for discharges to the 71st Street Ditch. Municipalities discharging to the 71st Street Ditch are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was instituted to improve water quality by requiring that municipalities develop six minimum control measures for limiting runoff pollution to receiving systems.

3.1.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 24.5 acres of wetland areas in the 71st Street Ditch subwatershed. Restoration and enhancement of wetlands were included as part of alternatives described below. Approximately 21.3 acres of private property in Bedford Park, immediately north of 71st Street Ditch, has been identified by WPC participants as wetland habitat. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.1.1.4 Floodplain Mapping

Flood inundation areas supporting the National Flood Insurance Program (NFIP) were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. Localized Letters of Map Revisions (LOMRs) were incorporated into revised floodplain areas.

The 71st Street Ditch is mapped in detail in the DFIRM mapping update, with Zone AE floodplain shown across the length of the 71st Street Ditch. The original H&H analysis was performed in 1979 using TR-20 and HEC-2.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.1.1.5 Stormwater Problem Data

Table 3.1.3 summarizes reported problem areas reviewed as a part of the DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities, agencies, and stakeholders to the District. Problems are classified in Table 3.1.3 as regional or local. This classification is based on a process described in Section 2.2 of this report.

3.1.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the 71st Street Ditch subwatershed.

TABLE 3.1.3
Community Response Data for the 71st Street Ditch

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
BV3	Bridgeview, Burbank	Pavement flooding	Route 43 (Harlem Ave.) at 79th St.	IDOT reported pavement flooding	Local	Problem not located along intercommunity waterway.
BV4	Justice, Bridgeview	Storm sewer capacity	Roberts Rd. between 79th St. and 83rd St.	Frequent roadway flooding due to undersized storm sewer, Roberts Road storm sewer lacking sufficient capacity	Local	Although this is a local problem, recommended alternative SFDT-1 may provide additional capacity for upsizing Roberts Rd. storm sewer in the future.
JU2	Justice	Overbank flooding, basement flooding, ponding, storm sewer capacity	East of Cork Ave between 73rd Pl. and 75th St.	Depressional area has no natural outlet. Drains to 71st Street Ditch through undersized storm sewer	Local	Although this is a local problem, recommended alternative SFDT-2 provides additional discharge capacity to I&M Canal, which is a component of IDNR plan to address local problem.
JU3	Justice	Overbank flooding, basement flooding, ponding, storm sewer capacity	71st Street Ditch	Insufficient capacity in 71st Street Ditch to convey flows from upstream communities	Regional	Recommended alternative SFDT-1 and SFDT-2 reduce stage along 71st Street Ditch

3.1.2 Watershed Analysis

3.1.2.1 Hydrologic Model Development

Subbasin Delineation. The 71st Street Ditch drainage area was delineated based upon LiDAR topographic data developed by Cook County in 2003. Through review of past studies and discussion with representatives from the Village of Bridgeview, the southern extent of the 71st Street Ditch tributary area in Bridgeview was defined as 83rd Street. The oil plant north of 71st Street Ditch has its own collection system for treating and discharging stormwater to the I&M canal. The depressional area around problem JU2 was included in the 71st Street

Ditch watershed, since it drains to the ditch through a 24-inch storm sewer. Twenty-two subbasins, averaging 99.8 acres in size, were identified for the 71st Street Ditch.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon Natural Resources Conservation Service (NRCS) soil data and 2001 Chicago Metropolitan Agency for Planning (CMAP) land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

The depressional area near JU2 just east of Cork Avenue was modeled as a reservoir within HEC-HMS with a 24-inch outlet. A simulated overland flow outlet at an elevation of 596.5 feet was included in the model to represent the interbasin flow to Justice Ditch. This flow was loaded to the Justice Ditch hydraulic model.

3.1.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. Surveys of 71st Street Ditch and all crossings were performed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficients along the modeled stream length.

Boundary Conditions. The I&M Canal, which the 71st Street Ditch discharges into, was assumed to be hydraulically connected to the CSSC and to have roughly the same stage as the CSSC. Modeled elevation of the CSSC for the modeled recurrence interval storms is summarized in Appendix E. The estimated elevation for the 100-year storm at the outlet of the 71st Street Ditch was 585.37 feet NAVD 88, roughly 2.2 feet above the invert of the 71st Street Ditch near its confluence with the I&M Canal. This relatively shallow depth indicates that the downstream stage of 71st Street Ditch is controlled not by the receiving system, but by its own capacity to convey flows received from its tributary area. Therefore, normal depth, assuming a friction slope of 0.001, was used as a downstream boundary condition for the 71st Street Ditch.

3.1.2.3 Calibration and Verification

No monitored or observed data was available for the 71st Street Ditch. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.1.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.1.1 shows inundation areas along the 71st Street Ditch produced by the hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the 71st Street Ditch system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.1.3 Development and Evaluation of Alternatives

3.1.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.1.4 summarizes problem areas identified through hydraulic modeling of the 71st Street Ditch.

TABLE 3.1.4
Modeled Problem Definition for 71st Street Ditch

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Form B	Resolution in DWP
MPA31	Along 71st Street Ditch to the south, west of Cork Ave.	25, 50, 100	JU3	Recommended alternatives SFDT-1 and SFDT-2 reduce stage along 71st Street Ditch
MPA32	Along 71st Street Ditch to the south, east of Cork Ave.	100	JU3	Recommended alternatives SFDT-1 and SFDT-2 reduce stage along 71st Street Ditch

3.1.3.2 Damage Assessment

Damages were assessed for the 71st Street Ditch over a 50-year period using the methodology outlined in Section 1.4.2 of this report and Section 6.6 of the CCSMP. Estimated damages are listed in Table 3.1.5.

TABLE 3.1.5
Estimated Damages for 71st Street Ditch

Damage Category	Estimated Damage	Note
Property	$78,100	
Erosion	0	
Transportation	$11,700	Assumed as 15% of property damage due to flooding
Recreation	0	

3.1.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate for addressing the flooding problems along the 71st Street Ditch. Increased conveyance, storage, and levees were identified as potential technologies for addressing flooding problems along the 71st Street Ditch.

3.1.3.4 Alternative Development

Flood Control Alternatives. Two flood control alternatives were developed to address overbank flooding problems from the 71st Street Ditch. The alternatives are summarized in Table 3.1.6.

Erosion Control Alternatives. No erosion control alternatives were developed for the 71st Street Ditch.

TABLE 3.1.6
Flood Control Alternatives for 71st Street Ditch

Alternative	Location	Description
SFDT-1	Between Archer Ave. and Roberts Rd.	Construct a 60-acre-foot detention pond including some wetland habitat on the northeast corner of Resurrection Cemetery between Archer Avenue and Roberts Road.
SFDT-2	71st St. extended along underneath railroad tracks	Jack additional 48-inch outlet beneath railroad tracks to convey additional flow to I&M Canal.

3.1.3.5 Alternative Evaluation and Selection

SFDT-1 proposes a 60 acre-foot detention basin on the northern corner of Resurrection Cemetery, north of the existing 71st Street Ditch drainage channel from Bridgeview. It is proposed that the site grading for the proposed SFDT-1 improvement be designed to support wetlands. Inclusion of wetland in the detention area would provide water quality and habitat benefits in addition to helping address downstream flooding.

SFDT-2 proposes that an additional 48-inch outlet from the 71st Street Ditch be jacked beneath the existing railroad, providing additional conveyance to the I&M Canal. Although this alternative lowers the WSEL more than SFDT-1 in the vicinity of the crossing, its upstream impacts are less, resulting in fewer benefits than SFDT-1.

Damages shown in Table 3.1.5 are associated only with regional overbank flooding. They do not include localized damages that may also be reduced through the construction of the alternatives summarized in Table 3.1.6. Both SDFT-1 and SFDT-2 have the potential to improve local problem areas. As described in Section 3.1.1.1, the IDNR previously recommended a flood control alternative that consisted of a 48-inch storm sewer relieving the depressed area adjacent to problem location JU2 and discharging to the 71st Street Ditch. It also included a new outlet to the I&M Canal, which is consistent with SFDT-2 summarized in Table 3.1.6. The average annual damages computed by the IDNR were $16,100 ($299,700 over 50 years using the discount rate of this study) and include local and regional damages. The recommended alternative for the 71st Street Ditch may facilitate the implementation of the IDNR proposed plan. Only regional benefits are reported in Table 3.1.8, however, for consistency in countywide prioritization of stormwater improvements.

Alternative SFDT-1, shown in Figure 3.1.2, may also help to address local flooding of the Roberts Road storm sewer reported by both Justice and Bridgeview in Problem BV4. If the storm sewer were upsized, as recommended in the Patrick Engineering report referenced in Section 3.1.1.1, without compensatory storage, overbank flooding along the 71st Street Ditch would worsen. Construction of SFDT-1 would enable increasing conveyance along the Roberts Road sewer without exacerbating existing flooding problems along the 71st Street Ditch.

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

Recommended alternatives result in reduced stage and/or flow along the modeled waterway. Table 3.1.7 provides a comparison of the modeled maximum WSEL, and modeled flow at the time of peak at representative locations along the waterway.

TABLE 3.1.7
71st Street Ditch Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		SFDT-1		SFDT-2	
Location	**Station**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**
Arbor Ln and Skyline Dr.	4783	594.11	52.07	594.11	52.07	594.11	52.07
71st St. and 86th Ave.	3373	591.44	329.99	591.26	312.17	591.40	331.20
Cork Ave.	1978	589.65	466.50	589.43	427.35	589.33	474.08
200-ft downstream of Blackstone and Oak Grove Ave.	822	589.00	211.62	588.72	188.45	588.27	154.26
Confluence with I&M Canal	152	587.73	210.84	587.52	188.19	587.18	154.02

3.1.3.6 Data Required for Countywide Prioritization of Watershed Project

Appendix I presents conceptual level cost estimates for the recommended alternatives. Table 3.1.8 lists the total estimated cost, benefits, and B/C ratio for each alternative. Figures 3.1.2 and 3.1.3 show the recommended alternatives for the 71st Street Ditch and a comparison of the existing conditions inundation mapping and inundation mapping for recommended alternative SFDT-1 and SFDT-2, respectively.

TABLE 3.1.8
71st Street Ditch Project Alternative Matrix to Support District Capital Improvement Program (CIP) Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
SFDT-1	60 ac-ft Detention Pond	0.07a	395,400	5,452,100	12		Positive	Yes	Justice, Bridgeview, Hickory Hills
SFDT-2	Additional outlet to I&M Canal	0.04	31,400	716,700	14	IDNR	No Impact	Yes	Justice, Bridgeview, Hickory Hills, Bedford Park

[a]B/C ratio includes estimated benefits of $60,000 per acre for additional wetland area associated with detention facility.
Note: Net Benefits values do not include local benefits or non-economic benefits.

3.2 79th Street Sewer

The 79th Street Sewer is located in southwestern Cook County, near the northwestern boundary of the Calumet-Sag Channel Watershed. The primary conveyance within this tributary area is the 79th Street Sewer, which begins at Roberts Road and flows west, paralleling I-294 for 0.6 mile before discharging into the I&M canal. The sewer drains 2.08 square miles of tributary area. Closed conduit systems, such as the 79th Street Ditch, were not modeled or evaluated for stormwater improvements as a component of the Calumet-Sag Channel DWP. Table 3.2.1 summarizes the communities that are tributary to the 79th Street Sewer. Land use within the drainage area of the 79th Street Sewer is predominately residential as shown in Table 3.2.2.

TABLE 3.2.1
Communities Draining to 79th Street Sewer

Community/Tributary	Tributary Area (mi^2)
Hickory Hills	1.07
Justice	0.91
Unincorporated/Forest Preserve	0.05
Bridgeview	0.03
Willow Springs	0.02

TABLE 3.2.2
Land Use Distribution for 79th Street Sewer

Land Use Category	Area (acres)	%
Residential	996.8	75.3
Forest/Open Land	125.9	9.5
Commercial/Industrial	82	6.2
Transportation/Utility	56.6	4.3
Institutional	38.9	2.9
Water/Wetland	24.9	1.9

An area of 0.8 square mile of Hickory Hills drains to the 203 acre-foot Hickory Hills Reservoir. This reservoir was sized to provide 100-year flood protection (Stanley Consultants, 1987). Discharges from the reservoir are limited to 15 cfs, which is generally split equally between the 79th Street Sewer and the Roberts Road Sewer (discharging into 71st Street Ditch) depending on the capacity of each sewer, which is monitored by telemetry.

Figure 3.2.1 provides an overview of the tributary area of the subwatershed and reported stormwater problem areas.

3.2.1 Sources of Data

3.2.1.1 Previous Studies

The report entitled *Project Planning for Flood Control*, developed by Stanley Consultants in 1987, summarized the final design for the Hickory Hills reservoir. The volume elevation relationship for the reservoir, confirmation of tributary area, and discharge characteristics were obtained from this report and included in the hydrologic model.

3.2.1.2 Water Quality Data

The 79th Street Sewer is an enclosed waterway, and therefore, it is not eligible for IEPA's Ambient Water Quality Network, the *Integrated Water Quality Report*, or NPDES point source discharge permits. Municipalities discharging to the 79th Street Sewer are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.2.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the watershed. Wetland areas were identified using NWI mapping. NWI data includes roughly 20.5 acres of wetland area in the 79th Street Sewer watershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.2.1.4 Floodplain Mapping

Floodplain mapping for the 79th Street Sewer includes the Hickory Hills Reservoir, as well as 10 acres of Zone AH flooding west of the Hickory Hills Reservoir. Effective flooding results are based on modeling from 1978, although hydrologic or hydraulic modeling methods are not specified in the Flood Insurance Study (FIS). Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.2.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Table 3.2.3 lists reported problems within the 79th Street Sewer subwatershed.

TABLE 3.2.3
Community Response Data for the 79th Street Sewer

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
BV4	Justice, Bridgeview	Storm sewer capacity	Roberts Rd. between 79th St. and 83rd St.	Frequent roadway flooding due to undersized storm sewer. Roberts Rd. storm sewer lacking sufficient capacity.	Local	Although this is a local problem, alternative SFDT-1 may provide capacity for upsizing Roberts Rd. storm sewer in the future.
HH3	Hickory Hills	Basement flooding, ponding, storm sewer capacity	85th St to 83rd St at 8600 West	Insufficient downstream capacity in Justice backs up flow.	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
JU1	Justice	Pavement flooding	Route 171 (Archer) at I-294 (ramp to southbound)	IDOT reported pavement flooding.	Local	Problem not located along intercommunity waterway.
JU4	Justice	Storm sewer capacity	Under tollway between 86th and 87th Ave.	Storm sewer under tollway has insufficient capacity for conveying flows from Hickory Hills and Justice.	Local	Problem not located on a regional waterway. This is a local storm sewer system problem

3.2.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the 79th Street Sewer subwatershed.

3.2.2 Watershed Analysis

3.2.2.1 Hydrologic Model Development

Subbasin Delineation. The 79th Street Sewer drainage area was delineated based upon LiDAR topographic data developed by Cook County in 2003. Plans of the IDOT storm sewer along 79th Street were not available, and assumptions were made to define subwatershed boundaries for this area. Sixteen (16) subbasins, averaging 82.94 acres in size, were delineated within the 79th Street Sewer subwatershed area.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.2.2.2 Hydraulic Model Development

No hydraulic model was developed for the closed conduit drainage system of the 79th Street Sewer.

3.2.2.3 Calibration and Verification

No measured or observed flows or stage data was available for the 79th Street Sewer subwatershed. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.2.2.4 Existing Conditions Evaluation

No flood inundation areas or hydraulic models were developed for the 79th Street Sewer.

3.2.3 Development and Evaluation of Alternatives

The 79th Street Sewer, as well as several storm sewers discharging to it, is reported to be undersized and contributing to flooding within the communities of Justice and Hickory Hills. The scope of the Calumet-Sag Channel DWP does not include evaluating of storm sewer networks. A hydraulic analysis of the 79th Street Sewer, and the tributary local sewers, would be required to calculate damages created by a lack of conveyance and to develop and evaluate alternative improvement projects. No alternatives were developed for the 79th Street Sewer.

3.3 Arroyo Ditch

Arroyo Ditch is a small manmade waterway, about 0.2 mile long, tributary to Boca Rio Ditch in the Tinley Creek subwatershed, south of the Calumet-Sag Channel in southwestern Cook County. Three communities have areas tributary to Arroyo Ditch, as described in Table 3.3.1. The area tributary to Arroyo Ditch is principally residential, with a significant amount of open land and forest preserve property as listed in Table 3.3.2.

TABLE 3.3.1
Communities Draining to Arroyo Ditch

Community/Tributary	Tributary Area (mi^2)
Oak Forest	0.17
Matteson	0.07
Tinley Park	0.01

TABLE 3.3.2
Land Use Distribution for Arroyo Ditch

Land Use	Area (acres)	%
Residential	101.6	64.8
Forest/Open Land	52.3	33.3
Commercial/Industrial	3	1.9

Figure 3.3.1 provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and flood inundation areas are also shown on the figure and discussed in the following subsections.

As a tributary to Boca Rio Ditch, Arroyo Ditch is a component of the Tinley Creek system. Despite its small tributary area, development of a hydraulic model for Arroyo Ditch was necessary to properly represent peak stormwater flows in this area.

3.3.1 Sources of Data

3.3.1.1 Previous Studies

No studies of Arroyo Ditch were identified for consideration as a component of DWP development.

3.3.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Arroyo Ditch. There are also no reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report,* which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for Arroyo Ditch. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to the Arroyo Ditch. Municipalities discharging to Arroyo Ditch are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.3.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 1.4 acres of wetland areas within the Arroyo Ditch subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.3.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised per updated Cook County topographic information. However, the effective models, which are used to estimate flood levels, generally were not updated. LOMRs were incorporated into the revised floodplains. Arroyo Ditch is not mapped in detail in the DFIRM mapping update, although backwater from Boca Rio Ditch is extended as Zone AE flooding along Arroyo Drive. Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.3.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted District Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. No Form B responses related to Arroyo Ditch were submitted.

3.3.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Arroyo Ditch subwatershed.

3.3.2 Watershed Analysis

3.3.2.1 Hydrologic Model Development

Subbasin Delineation. The Arroyo Ditch tributary area was delineated based primarily upon LiDAR topographic data developed by Cook County in 2003. The topographic delineation generally was representative of drainage patterns in the Arroyo Ditch basin; however, some modifications were required to reflect manmade modifications to drainage patterns. Part of the basin is adjacent to the Little Calumet Watershed. The Calumet-Sag and Little Calumet boundaries were compared, and minor discrepancies were identified. Discrepancies were resolved through additional review of topographic data, consultation with local communities, and coordination with other watershed planning consultants.

Table 3.3.3 summarizes the total drainage area, number of subbasins, and average subbasin size for Arroyo Ditch and its tributaries.

TABLE 3.3.3
Arroyo Ditch Subbasin Summary

Drainage Area (mi^2)	Number of Modeled Subbasins	Average Modeled Subbasin Size (acres)
0.25	1	156.87

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for each subwatershed.

3.3.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that meet District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. The open channel of Arroyo Ditch and all crossings were surveyed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign Manning's *n* roughness coefficients along the modeled stream length.

Boundary Conditions. The Arroyo Ditch hydraulic model was run as a component of the larger Tinley Creek hydraulic model, with downstream water surface elevations defined by the Boca Rio Ditch tributary model.

3.3.2.3 Calibration and Verification

No measured or observed flows or stage data was available for Arroyo Ditch for comparison with modeled values. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.3.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.3.1 shows inundation areas produced by the hydraulic model for the 100-year, 12-hour duration Huff Quartile II design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Arroyo Ditch system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.3.3 Development and Evaluation of Alternatives

No regional stormwater problems were identified in the Arroyo Ditch subwatershed. The hydraulic model of Arroyo Ditch does not predict any overbank property damage due to flooding for any of the modeled design events. Flooding along Arroyo Drive and Las Flores Drive was predicted for events of a 25-year magnitude or greater, but did not extend to homes along those drives. No stormwater improvements were developed for Arroyo Ditch. Alternative improvements to address regional problems are not recommended for Arroyo Ditch.

3.4 Boca Rio Ditch

Boca Rio Ditch is a tributary to Tinley Creek located south of the Calumet-Sag Channel in the southeastern portion of the Calumet-Sag Channel Watershed. The drainage area of Boca Rio Ditch is roughly 2.3 square miles. Table 3.4.1 lists the communities draining to Boca Rio Ditch. Table 3.4.2 summarizes the land use distribution within the Boca Rio Ditch tributary area. The upstream part of Boca Rio Ditch generally is residential, with the downstream part draining through Cook County Forest Preserve property. Figure 3.4.1 is an overview of the tributary area of the subwatershed. Reported stormwater problem areas and flood inundation areas are also shown on the figure, and are discussed in the following subsections.

TABLE 3.4.1
Communities Draining to Boca Rio Ditch

Community/Tributary	Tributary Area (mi^2)
Unincorporated/Forest Preserve	1.0
Oak Forest	1.0
Orland Park	0.2
Matteson	0.1

TABLE 3.4.2
Land Use Distribution for Boca Rio Ditch

Land Use Category	Area (acres)	%
Forest/Open Land	696.1	47.3
Residential	563.5	38.3
Commercial/Industrial	96.1	6.5
Agricultural	55	3.7
Institutional	32	2.2
Water/Wetland	21.6	1.5
Transportation/Utility	7.5	0.5

3.4.1 Sources of Data

3.4.1.1 Previous Studies

No studies of Boca Rio Ditch were identified for consideration as a component of DWP development.

3.4.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on the Boca Rio Ditch. There are also no reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report,* which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for Boca Rio Ditch. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to the Boca Rio Ditch. Municipalities discharging to Boca Rio Ditch are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.4.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 67.3 acres of wetland areas in the Boca Rio Ditch subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.4.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information, however, the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated in the revised floodplains. Regression equations from 1973 and WSP-2 were used for the effective hydrologic and hydraulic Boca Rio Ditch models, respectively. The models were developed in 1977. Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.4.1.5 Stormwater Problem Data

Communities, regional agencies (e.g., IDOT, CCHD), and stakeholders submitted District Form B questionnaire response data summarizing known stormwater problems within their jurisdictions. Stormwater problems were classified as regional or local based upon the criteria described in Section 1 of the report. Table 3.4.3 summarizes Form B data for Boca Rio Ditch.

TABLE 3.4.3
Community Response Data for Boca Rio Ditch

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
BR4	Bremen Township	Maintenance, ponding	Ridgeland Avenue 1/8 mile north of 147th Street	Culvert box submerged (CCHD)	Local	Problem not located along a regional waterway
OF3	Oak Forest	Maintenance, overbank flooding, sedimentation, bank erosion	Property just north of 151st Street and Boca Rio Drive	Property owner in Bremen Township denies access to allow Oak Forest to maintain channel, resulting in significant sedimentation and upstream flooding.	Regional	Access to private property must be granted to allow Oak Forest to perform stream maintenance in this area. Capital improvement project not created for this area.

Problem OF3 is a continuing maintenance concern for the Village of Oak Forest, which has repeatedly been denied access to 1,800 feet of Boca Rio Ditch by the property owner. Routine maintenance to remove debris and other obstructions is important for preserving the conveyance capacity of streams and to avoid causing upstream damages. Although not included as a capital project within the DWP, it is imperative that the Village of Oak Forest or the District be granted access to the property to perform stream maintenance. Failure to properly maintain this waterway will ultimately result in severe flow restriction and may cause upstream property damage during a significant rain event.

3.4.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Boca Rio Ditch subwatershed.

3.4.2 Watershed Analysis

3.4.2.1 Hydrologic Model Development

Subbasin Delineation. The Boca Rio Ditch tributary area was delineated based primarily upon LiDAR topographic data developed by Cook County in 2003. The topographic delineation was generally representative of drainage patterns in the Boca Rio Ditch subwatershed; however, subwatersheds sometimes were split or modified to reflect manmade modifications to topographic drainage patterns.

Part of the Boca Rio Ditch basin is adjacent to the Little Calumet Watershed. Initial boundaries of the Calumet-Sag and Little Calumet Watersheds were compared, and discrepancies identified. Discrepancies were generally minor and were resolved by manual review of topographic data and consultation with local communities.

Table 3.4.4 summarizes the total drainage area, number of subbasins, and average subbasin size for Boca Rio Ditch and its tributaries.

TABLE 3.4.4
Boca Rio Ditch Subbasin Summary

Subbasin	Drainage Area (mi^2)	Number of Modeled Subbasins	Average Modeled Subbasin Size (acres)
Boca Rio Ditch	2.30	13	112.85
Major Tributaries to Boca Rio Ditch			
Arroyo Ditch	0.25	1	156.87
Total	2.55	14	115.99

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.4.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met the District criteria for use in the DWP, as identified in Section 6.3.3.2 of the CCSMP, were identified as available to directly contribute to the development of the Calumet-Sag Channel DWP. Surveys of the open channel part of the Boca Rio Ditch and all crossings were performed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficients along the modeled stream length.

Boundary Conditions. The Boca Rio Ditch model was run as a component of the Tinley Creek system model, with downstream water surface elevations defined by the dynamic modeled water surface of the Tinley Creek hydraulic model developed as a part of the Calumet-Sag Channel DWP.

3.4.2.3 Calibration and Verification

No measured or observed flows or stage data was available for Boca Rio Ditch for comparison with modeled values. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.4.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.4.1 shows inundation areas along Boca Rio Ditch produced by the hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Boca Rio Ditch system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.4.3 Development and Evaluation of Alternatives

No regional stormwater problems were identified in the Boca Rio Ditch subwatershed. The hydraulic model of Boca Rio Ditch does not predict any overbank property damage due to flooding for any of the modeled design events. Flooding is predicted along 151st Street and Las Flores Drive, but is confined to roadways. No stormwater improvements were developed for Boca Rio Ditch. Alternative improvements to address regional problems are not recommended for Boca Rio Ditch.

3.5 Calumet-Sag Tributary A

Calumet-Sag Tributary A is located in southwestern Cook County, south of the Calumet-Sag Channel, in the western part of the Calumet-Sag Channel Watershed. Table 3.5.1 summarizes the areas of communities that drain to Calumet-Sag Tributary A. Calumet-Sag Tributary A is a natural open-channel stream draining 2.96 square miles that discharges into the Calumet-Sag Channel. The Calumet-Sag Tributary A subwatershed contains a mix of suburban development and available open land. Most of the open land within the watershed is Cook County Forest Preserve property. Table 3.5.2 lists the land use breakdown by area within the Calumet-Sag Tributary A subwatershed.

TABLE 3.5.1
Communities Draining to Calumet-Sag Tributary A

Community	Tributary Area (mi^2)
Unincorporated/ Forest Preserve	2.96

TABLE 3.5.2
Land Use Distribution for Calumet-Sag Tributary A

Land Use	Area (acres)	%
Forest/Open Land	1,055.8	55.8
Residential	612.4	32.3
Agricultural	119.8	6.3
Water/Wetland	85.9	4.5
Institutional	17	0.9
Commercial/Industrial	2.9	0.2

Figure 3.5.1 is an overview of the tributary area of the subwatershed. Reported stormwater problem areas and flood inundation areas are also shown on the figure, and are discussed in the following subsections.

3.5.1 Sources of Data

3.5.1.1 Previous Studies

No studies of Calumet-Sag Tributary A were identified for consideration as a component of DWP development.

3.5.1.2 Water Quality Data

The IEPA does not have any site in the Ambient Water Quality Monitoring Network for Calumet-Sag Tributary A. There are also no reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the 303(d) and 305(b) lists. No TMDLs have been established for Calumet-Sag Tributary A. According to a USEPA water permit discharge query, one point source discharge location was identified on Calumet-Sag Tributary A at the Holy Family Villa Nursing Home in Lemont Township (IL0024678). Municipalities discharging to the Calumet-Sag Channel are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which seeks to improve water quality by requiring that municipalities develop six minimum control measures for limiting runoff pollution to receiving systems.

3.5.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 209.8 acres of wetland areas in the Calumet-Sag Tributary A subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.5.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated in the revised floodplains.

Calumet-Sag Tributary A is mapped in detail in the DFIRM mapping update, with Zone AE floodplain defined for the length of Calumet-Sag Tributary A. According to the FIS, the original hydrologic and hydraulic analysis was performed in 1976. The hydrologic modeling was performed using Regression Equations 73 and 75 and Log-Pearson Type III (L-PTIII). Hydraulic routing performed was steady state and used the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.5.1.5 Stormwater Problem Data

Communities, regional agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Stormwater problems were classified as regional or local based upon the criteria described in Section 1. Table 3.5.3 shows reported problems along Calumet-Sag Tributary A.

TABLE 3.5.3
Community Response Data for Calumet-Sag Tributary A

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
LT5	Lemont Township	Pavement flooding, ponding	McCarthy Rd. between Bell Rd. and Will-Cook Rd., near Equestrian Estates neighborhood	McCarthy Rd. and nearby yards flood, including property that contains a large pond. Pond has insufficient storage volume and/or outlet capacity to contain flows.	Local	Problem not located on a regional waterway. This is a local problem.

3.5.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Calumet-Sag Tributary A subwatershed.

3.5.2 Watershed Analysis

3.5.2.1 Hydrologic Model Development

Subbasin Delineation. The Calumet-Sag Tributary A tributary area was delineated based upon LiDAR topographic data developed by Cook County in 2003. Eighteen subbasins were delineated for the Calumet-Sag Tributary A area, with an average subbasin area of 105.3 acres and a total drainage area of 2.96 square miles.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data, described further in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin. The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.5.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. The open channel of Calumet-Sag Tributary A and all crossings were surveyed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficient to the stream.

Boundary Conditions. Boundary condition elevations for the Calumet-Sag Channel are based on output from the CWS model and are included in Appendix E. The elevation produced by the CWS model for the 100-year storm at the outlet of Calumet-Sag Tributary A was 584.22 feet (NAVD 88), which is higher than the water surface elevation generated using a normal depth based upon the channel slope. The downstream stages from the CWS model were used for the downstream boundary conditions of the various storms.

3.5.2.3 Calibration and Verification

No measured or observed stages were available for Calumet-Sag Tributary A to compare model results to observed flows or stage. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.5.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.5.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Calumet-Sag Tributary A system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.5.3 Development and Evaluation of Alternatives

No regional stormwater problems were identified in the Calumet-Sag Tributary A sub-watershed. The hydraulic model of Calumet-Sag Tributary A does not predict any overbank property damage due to flooding for any of the modeled design events. No stormwater improvements were developed for Calumet-Sag Tributary A. Alternative improvements to address regional problems are not recommended for Calumet-Sag Tributary A.

3.6 Calumet-Sag Tributary B

Calumet-Sag Tributary B is a regional waterway in southwestern Cook County, south of the Calumet-Sag Channel and in the central part of the Calumet-Sag Channel Watershed. The total drainage area for Calumet-Sag Tributary B is 1.1 square miles. Table 3.6.1 provides a summary of the communities draining to the Calumet-Sag Tributary B subwatershed. The Calumet-Sag Tributary B subwatershed is largely residential. Table 3.6.2 provides a summary of the land use distribution within the Calumet-Sag Tributary B subwatershed.

TABLE 3.6.1
Communities Draining to Calumet-Sag Tributary B

Community	Tributary Area (mi^2)
Palos Park	0.97
Unincorporated/Forest Preserve	0.11
Palos Heights	0.03

TABLE 3.6.2
Land Use Distribution for Calumet-Sag Tributary B

Land Use Category	Area (acres)	%
Residential	662.5	92.9
Institutional	16.6	2.3
Transportation/ Utility	13.7	1.9
Commercial/ Industrial	10	1.4
Forest/Open Land	5.7	0.8
Water/Wetland	4.4	0.6

Figure 3.6.1 is an overview of the tributary area of the subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

3.6.1 Sources of Data

3.6.1.1 Previous Studies

No previous studies of Calumet-Sag Tributary B were identified for use in the development of DWPs.

3.6.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Calumet-Sag Tributary B. No reaches are identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for Calumet-Sag Tributary B. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Calumet-Sag Tributary B. Municipalities discharging to Calumet-Sag Tributary B are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.6.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes 12.4 acres of wetland area in the Calumet-Sag Tributary B subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.6.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, generally were not updated. LOMRs were incorporated into revised floodplain areas.

Calumet-Sag Tributary B is mapped in detail in the DFIRM mapping update, with Zone AE floodplain shown from Southwest Highway in Palos Park to the Calumet-Sag Channel. The original hydrologic and hydraulic analysis was performed in 1976. Hydrologic modeling was performed using Regression Equations 73 and 75. Hydraulic routing performed was steady state and used the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.6.1.5 Stormwater Problem Data

Communities, regional agencies (IDOT, CCHD), and stakeholders submitted District Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Stormwater problems were classified as regional or local based upon the criteria described in Section 1 of the report. Table 3.6.3 summarizes the Form B data for Calumet-Sag Tributary B.

3.6.1.6 Near-Term Planned Project

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Calumet-Sag Tributary B subwatershed.

3.6.2 Watershed Analysis

3.6.2.1 Hydrologic Model Development

Subbasin Delineation. The Calumet-Sag Tributary B subwatershed area was delineated based primarily upon LiDAR topographic data developed by Cook County in 2003. The area was reviewed and area southeast of Southwest Highway was added to the original delineation based on contour data and aerials. Nine subbasins were delineated for the Calumet-Sag Tributary B tributary area, with an average subbasin area of 80 acres.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

TABLE 3.6.3
Community Response Data for Calumet-Sag Tributary B

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
PP3	Palos Park	Overbank flooding, basement flooding, storm sewer capacity, bank erosion	119th St. and Timber Ln.	Floodwaters exceed capacity of box culvert under 119th St.	Regional	Proposed alternative CSTB-3 addresses flooding in this area.
PP4	Palos Park	Overbank flooding, basement flooding, storm sewer capacity, bank erosion	SW Hwy between S. Woodland Trail and 121st St.	Diversion from Mill Creek is conveyed along RR Row. This flow leaves RR ROW and spills into SW Hwy at this location. Closes SW Hwy, and flooding several homes along RR ROW.	Regional	Field assessment identified no structural damages associated with bank erosion. Project MICR-4 will reduce flow to the railroad ditch from MICR to this area.
PP7	Palos Park	Overbank flooding, storm sewer capacity, bank erosion	127th St. and 86th Ave.	Mill Creek diverts to RR ROW ditch at this location. Insufficient capacity to convey water under 86th Avenue results in flooding of SW Hwy.	Regional	Project MICR-4 addresses this problem.
PP9	Palos Park	Pavement flooding	Route 7 at 123rd St.	IDOT reported pavement flooding.	Local	Problem not located on a regional waterway. This is a local problem.

Flow Diversions. There is a flow diversion located southwest of the intersection of 86th Avenue and 127th Street that can result in stormwater from the Mill Creek subwatershed overtopping the subwatershed divide and flowing into the Calumet-Sag Tributary B subwatershed under some conditions. A railway ditch intersects what was once a natural drainage divide between the Mill Creek and Calumet-Sag Tributary B subwatersheds at this location. When water surface elevations in Mill Creek reach an elevation of approximately 667 feet NAVD 88, Mill Creek overflows into the railroad ditch, which flows to Calumet-Sag

Tributary B. The overflow hydrograph generated in the Mill Creek hydraulic model was used as input to Calumet-Sag Tributary B hydrologic model to properly represent existing conditions. This flow diversion results in an inundation area crossing the subwatershed divide in this location as shown on Figure 3.6.1.

3.6.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met the District criteria for use in the DWP, as identified in Section 6.3.3.2 of the CCSMP, were identified for the Calumet-Sag Tributary B subwatershed. The open channel of Calumet-Sag Tributary B and all crossings were surveyed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's n roughness coefficients along the modeled stream length.

Boundary Conditions. Appendix E contains boundary condition elevations determined for the Calumet-Sag Channel based on output from the CWS model. The elevation produced by the CWS model for the 100-year storm at the outlet of Calumet-Sag Tributary B was 584.83 feet NAVD 88, less than 2 feet above the invert of Calumet-Sag Tributary B near its confluence with the Calumet-Sag Channel. The shallow depth indicates that the downstream stage on Calumet-Sag Tributary B is controlled not by the receiving system but by its own capacity to convey flow received from its tributary area. Normal depth assuming a friction slope of 0.0216 was used as a downstream boundary condition for Calumet-Sag Tributary B.

3.6.2.3 Calibration and Verification

In the hours following the August 20, 2007 storm, a high water elevation mark was observed at the downstream side of the Autobahn Drive South bridge at the downstream end of Calumet-Sag Tributary B. The rainfall data from ISWS gage 16, which is the rainfall gage closest to the observed high water elevation, was obtained for this time period. Gage 16 recorded 1.2 inches of rainfall over a 7-hour period.

Table 3.6.4 lists the location and elevation of the field-observed water surface elevation and the peak modeled water surface elevation. The model results are listed for both initial (pre-calibration) model results and calibrated model results (with the 10 percent reduction applied to the curve number values). The difference between the observed and calibrated model water surface elevations are generally considered to be acceptable due to the margin of error associated with high water mark elevation data. High water elevations were taken at a point in time when it is not certain that the peak water elevation occurred.

TABLE 3.6.4
Comparison of Observed and Model Result Water Surface Elevations for August 20, 2007 Storm Event

Location	Observed High Water Surface Elevation (ft)	Initial Model Results Water Surface Elevation (ft)	Calibrated Model Results Water Surface Elevation (ft)
Autobahn Drive South	598.7	600.89	599.81

3.6.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Flood inundation areas were developed based on HEC-RAS water surface elevations and Cook County topographic data. Figure 3.6.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Calumet-Sag Tributary B system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.6.3 Development and Evaluation of Alternatives

3.6.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.6.5 provides a summary of major problem areas identified through modeling of Calumet-Sag Tributary B.

TABLE 3.6.5
Modeled Problem Definition for Calumet-Sag Tributary B

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Form B	Resolution in DWP
MPA1	Area southeast of culvert, at 119th Street and Timber Lane	25, 50, 100, 500	PP-3	Proposed alternative CSTB-3 addresses flooding in this area.
MPA2	Area east of tributary near Autobahn Drive South crossing	25, 50, 100, 500		Sufficient land was not available in the area for potential capital projects that could address problem. Such properties are candidates for protection using nonstructural flood control measures, such as floodproofing or acquisition.
MPA3	Area upstream of Timber Lane near 121st Street and Southwest Hwy	2, 5, 10, 25, 50, 100, 500	PP-4	Field assessment identified no structural damages associated with bank erosion. Project MICR-4 will reduce flow to the railroad ditch from MICR to this area.

3.6.3.2 Damage Assessment

Damages due to flooding were calculated for Calumet-Sag Tributary B in accordance with the methodology described in Section 1.4.2 and are listed in Table 3.6.6.

3.6.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate to address the flooding problems in Calumet-Sag Tributary B. Storage and increased conveyance were the two primary alternatives considered. Levees were not considered because of proximity of structures to the channel.

TABLE 3.6.6
Estimated Damages for Calumet-Sag Tributary B

Damage Category	Estimated Damage ($)	Note
Property	886,700	
Erosion	0	
Transportation	133,000	Assumed as 15% of property damage due to flooding
Recreation	0	

3.6.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions for regional flooding were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Table 3.6.7 summarizes the flood control alternatives developed for Calumet-Sag Tributary B. Potential stormwater detention basin sites under Alternatives CSTB-2, CSTB-3, and CSTB-5 require buyouts of developed and undeveloped residential properties that are within inundation areas for the site of the proposed alternatives.

Stormwater detention alternatives were modeled for Calumet-Sag Tributary B with the goal of reducing flood damages upstream of 119th Street. Sufficient land was not found to be available for detention alternatives that would address the flooding downstream of 119th Street.

TABLE 3.6.7
Flood Control Alternatives for Calumet-Sag Tributary B

Alternative Number	Location	Description
CSTB-1	Calumet-Sag Tributary B downstream of Timber Ln.	Construct 3 ac-ft stormwater detention basin
CSTB-2	Calumet-Sag Tributary B upstream of Timber Ln.	Construct 2.1 ac-ft stormwater detention basin. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
CSTB-3	Calumet-Sag Tributary B between Southwest Hwy and 119th St.	Construct two detention basins for a total of 10 ac-ft of storage; expand one existing detention basin, and increase conveyance capacity of two culvert crossings
CSTB-4	119th St. and Calumet-Sag Tributary B	Enlarge culvert size. This alternative caused increased downstream water surface elevations, thus benefits and costs were not developed.
CSTB-5	Timber Ln. and Calumet-Sag Tributary B	Total of 14 ac-ft of detention basins both upstream and downstream of Timber Lane. This alternative did not effectively reduce water surface elevations in the flooding problem area to any greater extent than CSTB-3, thus benefits and costs were not developed.

Erosion Control Alternatives. No erosion alternatives have been developed for Calumet-Sag Tributary B. An erosion problem was reported as PP4, but since it does not threaten any structures, it does not have any damages.

3.6.3.5 Alternative Evaluation and Selection

Alternatives included in Table 3.6.7 were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. Modeling analysis concluded that CSTB-2 did not effectively lower water surface elevations, primarily because it is located too far upstream of problem areas. CSTB-4 caused downstream water surface elevations to increase. CSTB-5 did not lower water surface elevations significantly more than CSTB-3.

For these reasons, benefits and costs were calculated only for Alternatives CSTB-1 and CSTB-3. Alternative CSTB-3 was most effective in lowering flood depths and damages. Table 3.6.9 provides a summary of B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, and thus costs were not calculated for these alternatives.

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

Recommended alternatives result in reduced stage and/or flow along the modeled waterway. Table 3.6.8 provides a comparison of the modeled maximum WSEL, and modeled flow at the time of peak at representative locations along the waterway.

TABLE 3.6.8
Calumet-Sag Tributary B Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		CSTB-3	
Location	Station	Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
40-ft upstream of Timber Ln.	4086	619.56	172.89	619.50	160.70
100-ft upstream of 119th St.	2858	614.34	278.56	612.91	279.36
150-ft downstream of Calumet-Sag Rd.	1803	609.03	406.10	609.03	405.95
Confluence with Calumet-Sag Channel	194	586.60	430.94	586.59	429.59

3.6.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternatives. Table 3.6.9 lists the total estimated cost, benefits, and B/C ratio for each alternative.

Table 3.6.9 summarizes the alternatives analyzed. Figure 3.6.2 shows the location of recommended alternative CSTB-3 and a comparison of the inundation mapping for existing conditions and with the recommended alternative CSTB-3.

TABLE 3.6.9
Calumet-Sag Tributary B Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
CSTB-1	Construct a detention basin just DS of Timber Ln.	0.03	18,100	649,100	1		Slightly Positive	No	Palos Park
CSTB-3	Add 10 ac-ft of additional detention and increase conveyance	0.31	669,700	2,131,500	6		Slightly Positive	Yes	Palos Park

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.7 Calumet-Sag Tributary C

The Calumet-Sag Tributary C is located in southwestern Cook County, south of the Calumet-Sag Channel and in the eastern part of the Calumet-Sag Channel Watershed. Table 3.7.1 lists the areas of communities draining to the subwatershed. The drainage area is 3.35-square-miles. Calumet-Sag Tributary C is a natural open-channel stream until it reaches the Midlothian Turnpike, where it enters a storm sewer system that conveys flow along Cicero Avenue and discharges into the Calumet-Sag Channel. Table 3.7.2 lists the land use breakdown by area within the subwatershed.

TABLE 3.7.1
Communities Draining to Calumet-Sag Tributary C

Community	Tributary Area (mi^2)
Crestwood	1.56
Midlothian	0.85
Unincorporated/Forest Preserve	0.46
Oak Forest	0.45
Robbins	0.03

Figure 3.7.1 is an overview of the tributary area of the subwatershed. It also shows reported stormwater problem areas and flood inundation areas, which are discussed in the following subsections.

TABLE 3.7.2
Land Use Distribution for Calumet-Sag Tributary C

Land Use	Area (acres)	%
Residential	1,035.5	48.3
Commercial/Industrial	486.7	22.7
Forest/Open Land	471.5	22
Institutional	59.6	2.8
Agricultural	57.8	2.7
Transportation/Utility	30.7	1.4

3.7.1 Sources of Data

3.7.1.1 Previous Studies

No studies of Calumet-Sag Tributary C were identified for consideration as a part of the Calumet-Sag Channel DWP development.

3.7.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Calumet-Sag Tributary C. No reaches are identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for Calumet-Sag Tributary C. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Calumet-Sag Tributary C. Municipalities discharging to Calumet-Sag Tributary C are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.7.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using NWI mapping. NWI data includes roughly 23.6 acres of wetland areas in the Calumet-Sag Tributary C subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.7.1.4 Floodplain Mapping

Floodplain areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated in the revised floodplains. The Calumet-Sag Tributary C is mapped in detail in the DFIRM mapping update, with Zone AE floodplain defined for the length of Calumet-Sag Tributary C.

According to the FIS, the original hydrologic and hydraulic analysis was performed in 1976. The hydrologic modeling was performed using Regression Equations 73 and 75. Hydraulic routing performed was steady state and used the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.7.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Table 3.7.3 lists problems reported along Calumet-Sag Tributary C.

TABLE 3.7.3
Community Response Data for Calumet-Sag Tributary C

Problem ID	Municipality	Problems List	Location	Problem Description	Local/ Regional	Resolution in DWP
BR3	Bremen Township	Basement flooding, ponding, water quality, storm sewer capacity	Linder Ave. between Midlothian Pike and 143rd St.	Natural basin collects stormwater, flooding yards and houses and causing septic system failure	Local	Problem not located on a regional waterway. This is a local problem.
CW1	Crestwood	Pavement flooding	Route 50 (Cicero Ave.) at 135th St.	IDOT reported pavement flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

3.7.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Calumet-Sag Tributary C subwatershed.

3.7.2 Watershed Analysis

3.7.2.1 Hydrologic Model Development

Subbasin Delineation. The Calumet-Sag Tributary C area was delineated based upon LiDAR topographic data developed by Cook County in 2003. Twenty-one subbasins were delineated for the Calumet-Sag Tributary C area, with an average area of 102 acres each, and a total drainage area of 3.4 square miles. Part of the basin is adjacent to the Little Calumet Watershed. The Calumet-Sag and Little Calumet boundaries were compared, and minor discrepancies were identified. Discrepancies were resolved through additional review of topographic data, consultation with local communities, and coordination with other watershed planning consultants.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.7.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were identified for the Calumet-Sag Tributary C subwatershed. The open channel of Calumet-Sag Tributary C and all crossings were surveyed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficient to the stream.

3.7.2.3 Boundary Conditions

The downstream boundary condition of the Calumet-Sag Tributary C model is the upstream end of a 42- by 84-inch elliptical pipe that carries flows from the subwatershed to the Calumet-Sag Channel. This storm sewer starts at the Midlothian Turnpike and discharges to the Calumet-Sag Channel west of Cicero Avenue. A rating curve was defined to represent the inflow capacity to this storm sewer.

3.7.2.4 Calibration and Verification

No measured or observed stages were available for Calumet-Sag Tributary C to compare model results to support making calibration modifications to the model. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8. The model results are consistent with anecdotal reports from local communities that the stormwater detention basin at 143rd Street and Linder Avenue frequently overtops.

3.7.2.5 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.7.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Calumet-Sag Tributary C system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100- and 500-year recurrence interval design storms.

3.7.3 Development and Evaluation of Alternatives

3.7.3.1 Problem Definition

Table 3.7.4 summarizes problem areas identified through hydraulic modeling of Calumet-Sag Tributary C. Though no Form Bs were submitted related to the modeled problem areas listed in Table 3.7.4, communities did confirm that Problem IDs MPA4 and MPA5 do correspond to known flooding areas.

TABLE 3.7.4
Modeled Problem Definition for Calumet-Sag Tributary C

Problem ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
MPA4	Area at 143rd Street and Linder Avenue	50, 100, 500		Sufficient land was not available in the area for potential capital projects that could address the problem. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.
MPA5	Area between tributary and Lavergne Avenue from 143rd Street to Midlothian Turnpike	2, 5, 10, 25, 50, 100, 500		Sufficient land was not available in the area for potential capital projects that could address the problem. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.

3.7.3.2 Damage Assessment

Economic damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. No erosion or recreation damages due to flooding were identified for Calumet-Sag Tributary C. Transportation damages were estimated as 15 percent of property damages. Table 3.7.5 lists the damage assessment for existing conditions.

TABLE 3.7.5
Estimated Damages for Calumet-Sag Tributary C

Damage Category	Estimated Damage ($)	Note
Property	464,500	
Erosion	0	
Transportation	69,700	Assumed as 15% of property damage due to flooding

3.7.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate for addressing the flooding problems in Calumet-Sag Tributary C. Increased conveyance or storage was identified as the principal technologies applicable for addressing stormwater problems in Calumet-Sag Tributary C.

3.7.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Table 3.7.6 summarizes flood control alternatives developed for Calumet-Sag Tributary C.

Local communities suggested several potential locations for detention facilities for flood damage reduction alternatives. These included Cook County Forest Preserve property online with Calumet-Sag Tributary C just upstream of Central Avenue, and a floodplain area with homes just north of 143rd Street at Linder Avenue. WPC participants suggested that the Central Avenue storm sewer system that discharges to Calumet-Sag Tributary C may be contributing to high flows. Therefore, the sewer was routed to the proposed pond upstream of Central Avenue in the alternatives analysis.

Alternative CSTC-1 is an in-line pond at the headwaters of the tributary providing approximately 37 ac-ft of detention. A moderate amount of excavation is needed to construct the stormwater detention facility. The storm sewer along Central Avenue from 147th Street will be diverted across Central Avenue to the proposed facility, since it has been identified as a source of flooding. Alternatives CSTC-2 and CSTC-3 are conveyance improvement alternatives that reduce hydraulic restrictions.

TABLE 3.7.6
Flood Control Alternatives for Calumet-Sag Tributary C

Alternative Number	Location	Description
CSTC-1	West of Central Avenue	Construct a 37 acre-feet detention pond on Cook County Forest Preserve property at Central Avenue between 147th Street and Midlothian. Also, the existing Central Avenue storm sewer should be diverted into a pond.
CSTC-1b	West of Central Avenue	Construct a 12 acre-feet detention pond on Cook County Forest Preserve property at Central Avenue between 147th Street and Midlothian. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
CSTC-2	Linder Avenue and 143rd Street	Increase dimensions of culverts at two road crossings to a 3.5-foot by 6-foot- elliptical pipe at Linder Avenue and two 2.5-foot by 3.75-foot elliptical pipes at 143rd Street. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
CSTC-3	Linder Avenue 143rd Street, and Midlothian Turnpike	Alternative CSTC-2, plus increase the downstream boundary culvert size (currently 42-inch by 84-inch elliptical pipe) to double current capacity. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.

3.7.3.5 Alternative Evaluation and Selection

Alternatives included in Table 3.7.6 were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damage reduction. Table 3.7.7 provides a summary of B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data. Alternatives that did not produce a significant change in inundation areas are described in this report, but benefits were negligible and conceptual level costs were not developed for these alternatives. CSTC-1 was evaluated at a size of 37 acre-feet, which required excavation incurring significant cost while only reducing damages significantly to two properties, which resulted in a low B/C ratio. CSTC-1b, a variation on CSTC-1, was also considered, in which a control structure would restrict flow from the area without significant excavation, relying on about 12 acre-feet of existing depressional area. This was modeled, and determined to have no benefit to the affected structures. Model analysis concluded that CSTC-1b, CSTC-2, and CSTC-3 were not effective in reducing flood damages.

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

3.7.3.6 Data Required for Countywide Prioritization of Watershed Projects

Table 3.7.7 lists alternatives evaluated in detail.

TABLE 3.7.7
Calumet-Sag Tributary C Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
CSTC-1	37 ac-ft detention pond	0.05	196,900	4,355,700	8		Positive	No	Crestwood, Midlothian

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.8 Castle Bowl

Castle Bowl is located in southwestern Cook County, south of the I&M Canal, in the western portion of the Calumet-Sag Channel Watershed. Table 3.8.1 lists the areas of communities that drain to Castle Bowl. The population density of the Castle Bowl subwatershed is relatively high with a mix of suburban development and little available open land. Most of the open land within the watershed is Cook County Forest Preserve property. The drainage area is 1.7-square-miles.

TABLE 3.8.1
Communities Draining to Castle Bowl

Community	Tributary Area (mi^2)
Lemont	1.5
Unincorporated/ Forest Preserve	0.2

TABLE 3.8.2
Land Use Distribution for Castle Bowl

Land Use	Area (acres)	%
Residential	638.2	59
Forest/Open Land	244	22.6
Institutional	130.9	12.1
Commercial/Industrial	37.1	3.4
Water/Wetland	13.7	1.3
Agricultural	13.1	1.2

The Castle Bowl area, shown in Figure 3.8.1 is tributary to the Hillview Ditch, which is an open-channel stream until it reaches the School Gully Culvert and then flows through a concrete channel leading to the downtown Village of Lemont storm sewer system. The storm sewer system discharges into the I&M Canal. Table 3.8.2 lists land use by area within the Castle Bowl subwatershed.

A detailed hydraulic model was not developed for Hillview Ditch as only the Village of Lemont is tributary to the open channel portion of the ditch. Thus, any potential stormwater problem on this portion of the ditch would be classified as a local problem. Areas entirely drained by storm sewers such as the downtown Lemont were generally not studied in detail as a part of the Calumet-Sag Detailed Watershed Plan development.

3.8.1 Sources of Data

3.8.1.1 Previous Studies

One study of Castle Bowl was identified for consideration as a component of DWP development—a report titled *Construction and Maintenance of Dams: Dam Safety Permit for Castle Bowl Retention Facility*, prepared for the Village of Lemont by Engineering Resource Associates, Inc. (2006). The report includes information on the proposed Castle Bowl retention facility.

3.8.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Hillview Ditch. No reaches are identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for Hillview Ditch. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Hillview Ditch. Municipalities discharging to Hillview Ditch are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.8.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes 18.1 acres of wetland area in the Castle Bowl subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.8.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated in the revised floodplains. Castle Bowl and Hillview Ditch were not mapped in detail in the DFIRM mapping update. According to the FIS, no hydrologic or hydraulic analyses have been performed.

3.8.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Table 3.8.3 lists reported problems within the Castle Bowl subwatershed.

TABLE 3.8.3
Community Response Data for Castle Bowl

Problem ID	Municipality	Problem as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
LT4	Lemont Township	Bank erosion, sedimentation	Stephen St. and North of Talcott St.	Tree branches and debris in I&M Canal block flow	Regional	Maintenance and debris removal recommended.
LE1	Lemont	Ponding	Cass Street and Lemont Street, downtown Lemont	During major storms, sewer system in downtown Lemont surcharges, flooding basements, and first floors of commercial, industrial, and residential buildings	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

3.8.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Castle Bowl subwatershed.

3.8.2 Watershed Analysis

3.8.2.1 Hydrologic Model Development

Subbasin Delineation. The Castle Bowl tributary area was delineated based upon LiDAR topographic data developed by Cook County in 2003. Eleven subbasins were delineated for the Castle Bowl area, with an average subbasin area of 107.6 acres and a total drainage area of 1.85 square miles.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.8.2.2 Hydraulic Model Development

A detailed hydraulic model was not developed for Hillview Ditch as only the Village of Lemont is tributary to the open channel portion of the ditch. Thus, any potential stormwater problem on this portion of the ditch would be classified as a local problem. Heavily sewered areas such as the downtown Lemont storm sewer system were generally not studied in detail in the Calumet-Sag Detailed Watershed Plan.

3.8.3 Development and Evaluation of Alternatives

No regional problem areas were identified in the Castle Bowl subwatershed, so no alternatives were developed. The proposed Castle Bowl detention basin was analyzed in terms of benefits that it provided to regional problems located on the I&M Canal downstream of Castle Bowl. It was determined that the implementation of the Castle Bowl detention basin produces negligible benefits to regional problems, as discussed in Section 3.11.3.4.

3.9 Crestwood Drainage Ditch

Crestwood Drainage Ditch is a manmade waterway located in southwestern Cook County, south of the Calumet-Sag Channel, in the eastern part of the Calumet-Sag Channel Watershed. The 0.9-mile-long stream drains a contributing area of 1.3 square miles. Table 3.9.1 summarizes the communities that are tributary to Crestwood Drainage Ditch. Figure 3.9.1 provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas, and flood inundation areas are also shown and are discussed in the following subsections.

The upstream part of the Crestwood Drainage Ditch subwatershed is principally Cook County Forest Preserve land, with a mixture of residential and commercial/industrial land use north and east of Central Avenue. Table 3.9.2 summarizes the land use distribution for areas draining to Crestwood Drainage Ditch.

TABLE 3.9.1
Communities Draining to Crestwood Drainage Ditch

Community	Tributary Area (mi^2)
Crestwood	0.76
Unincorporated/ Forest Preserve	0.49

TABLE 3.9.2
Land Use Distribution for Crestwood Drainage Ditch

Land Use	Area (acres)	%
Residential	386.2	47.7
Forest/Open Land	274.1	33.8
Commercial/ Industrial	79.4	9.8
Institutional	58.2	7.2
Agricultural	8.7	1.1
Water/Wetland	2.8	0.3
Transportation/ Utility	0.5	0.1

3.9.1 Sources of Data

3.9.1.1 Previous Studies

No studies of Crestwood Drainage Ditch were identified for consideration as a component of DWP development.

3.9.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Crestwood Drainage Ditch. No reaches are identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for Crestwood Drainage Ditch. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Crestwood Drainage Ditch. Municipalities discharging to Crestwood Drainage Ditch are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.9.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 9.2 acres of wetland areas in the Crestwood Drainage Ditch subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.9.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated in the revised floodplains. Crestwood Drainage Ditch is mapped in detail in the DFIRM mapping update, with Zone AE floodplain defined for the length of Crestwood Drainage Ditch. According to the FIS, the original H&H analysis was performed in 1979. The hydrologic modeling was performed using regression equations from 1975 and L-PTIII. Hydraulic routing performed was steady state and used the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.9.1.5 Stormwater Problem Data

Communities, regional agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. No problems were reported by communities related to the Crestwood Drainage Ditch.

3.9.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Crestwood Drainage Ditch subwatershed.

3.9.2 Watershed Analysis

3.9.2.1 Hydrologic Model Development

Subbasin Delineation. The Crestwood Drainage Ditch tributary area was delineated based upon LiDAR topographic data developed by Cook County in 2003. Ten subbasins were delineated for the Crestwood Drainage Ditch area, with an average subbasin area of 81 acres and a total drainage area of 1.27 square miles.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.9.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. The open channel of Crestwood Drainage Ditch and all crossings were surveyed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficient to the stream.

Boundary Conditions. Boundary condition elevations for the Calumet-Sag Channel based on output from the CWS model are included in Appendix E. The elevation produced by the CWS model for the 100-year storm at the outlet of Crestwood Drainage Ditch was 585.10 feet NAVD 88, 3 feet above the invert of Crestwood Drainage Ditch near its confluence with the Calumet-Sag Channel. This relatively shallow depth indicates that downstream stage on Crestwood Drainage Ditch is controlled, not by the receiving system, but by its own capacity to convey flows received from its tributary area. Normal depth assuming a friction slope of 0.002 was used as a downstream boundary condition for the Crestwood Drainage Ditch, which resulted in a WSEL 4.5 feet higher than the CWS model outlet elevation.

3.9.2.3 Calibration and Verification

No measured or observed stages were available for Crestwood Drainage Ditch to compare model results to observed flows or stage. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.9.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.9.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm. The existing FEMA floodplain from the adjacent Tinley Creek subwatershed extends into the Crestwood Drainage Ditch subwatershed as flow from Tinley Creek may reach this area when the subwatershed divide is overtopped. A berm now exists along Tinley Creek in this area, which hydraulic model results have shown to largely prevent floodwaters from Tinley Creek from extending into the Crestwood Drainage Ditch subwatershed.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Crestwood Drainage Ditch system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.9.3 Development and Evaluation of Alternatives

Crestwood Drainage Ditch is predicted to remain in its banks for the 100-year event, with the exception of the detention area at the north end of the stream near its confluence with the Calumet-Sag Channel. No modeled problem locations or damages are predicted for Crestwood Drainage Ditch. Therefore, no alternatives were developed for Crestwood Drainage Ditch.

3.10 Crooked Creek

Crooked Creek is located in southwestern Cook County, north of the Calumet-Sag Channel, in the northwestern part of the Calumet-Sag Channel Watershed. Table 3.10.1 summarizes areas of communities that drain to Crooked Creek. The population density of the Crooked Creek subwatershed is low with a relatively small area of suburban development in the upper tributary area, and the subwatershed has a significant amount of open land within Cook County Forest Preserve property. The drainage area is 3.5 square miles. Crooked Creek is a natural open-channel stream that begins at the Belly Deep Slough, drains through the Saganashkee Slough, and discharges into the Calumet-Sag Channel. Table 3.10.2 lists the land use breakdown by area within the Crooked Creek subwatershed. Figure 3.10.1 is an overview of the tributary area of the subwatershed. Reported stormwater problem areas and flood inundation areas are also shown on the figure, and are discussed in the following subsections.

TABLE 3.10.1
Communities Draining to Crooked Creek

Community	Tributary Area (mi^2)
Unincorporated/Forest Preserve	3.13
Palos Hills	0.32
Hickory Hills	0.07

TABLE 3.10.2
Land Use Distribution for Crooked Creek

Land Use	Acres	%
Forest/Open Land	1,979.1	88.7
Residential	126.1	5.7
Water/Wetland	107	4.8
Commercial/Industrial	19.1	0.9

3.10.1 Sources of Data

3.10.1.1 Previous Studies

No studies of Crooked Creek were identified for consideration as a component of DWP development.

3.10.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Crooked Creek. No reaches are identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. Crooked Creek is the main tributary to the Saganashkee Slough, an impaired water body per the IEPA 303(d) Report (ILH-01_RHH). The Saganashkee Slough's designated use is for fish consumption and is impaired by suspended solids, nickel, phosphorus, sedimentation, siltation, silver, and polychlorinated biphenyls (PCBs). There are no TMDLs established for Crooked Creek or Saganashkee Slough. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Crooked Creek or Saganashkee Slough. Municipalities discharging to Crooked Creek are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.10.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 225.1 acres of wetland areas in the Crooked Creek subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.10.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated in the revised floodplains. Crooked Creek is not mapped in detail in the DFIRM mapping update, with Zone AE floodplain defined for the length of Crooked Creek. The DFIRM contains only the Belly Deep Slough and Saganashkee Slough portions of the creek, and those sloughs are marked as Unnumbered Zone A.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.10.1.5 Stormwater Problem Data

Communities, regional agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Table 3.10.3 lists reported problems along Crooked Creek.

3.10.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Crooked Creek subwatershed.

3.10.2 Watershed Analysis

3.10.2.1 Hydrologic Model Development

Subbasin Delineation. The Crooked Creek tributary area was delineated based upon LiDAR topographic data developed by Cook County in 2003. Nineteen subbasins were delineated for the Crooked Creek area, with an average subbasin area of 118.2 acres and a total drainage area of 3.5 square miles.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

TABLE 3.10.3
Community Response Data for Crooked Creek

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
PHI5	Palos Hills	Overbank flooding, ponding	Kean Ave. and Los Palos Ln.	Flows in Hickory Hills have no retention, and the Los Palos Hills reservoir has insufficient capacity to capture larger storms. Overflows flood the intersection. In 100-year event.	Regional	Model results did not show property damage due to flooding in this area. Previous observations may have been the result of a condition already remedied, downstream debris or maintenance issue, or a local issue.
PT5	Palos Township	Pavement flooding	Kean Ave. at 100th St. to 111th St.	IDOT reports pavement flooding	Regional	Model results did not confirm roadway flooding due to a regional problem in this area. Previous observations may have been the result of a condition already remedied or a local issue.
PT6	Palos Township	Overbank flooding, water quality, wetland riparian	U.S. Rte 45 at Crooked Creek	Flooding overtops the banks and decrease water quality	Regional	Model results did not confirm roadway flooding due to a regional problem in this area. Previous observations may have been the result of a condition already remedied or a local issue.

3.10.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. Thirteen structures were surveyed. Since a detailed study was not required, cross-sectional geometry was obtained solely from Cook County topographic data. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficient to the stream.

Boundary Conditions. Appendix E contains boundary condition elevations for the Calumet-Sag Channel based on output from the CWS model. As Crooked Creek flows into the Saganashkee Slough before reaching the Calumet-Sag Channel, the CWS model output water surface elevation was not used to define the downstream boundary condition in this case. Downstream stage was assumed to be controlled by the capacity of Crooked Creek to convey flows received from its tributary area. A normal depth with a friction slope of 0.002 was evaluated as the downstream boundary condition for Crooked Creek and resulted in a WSEL about 3 feet higher than the normal pool level of the Saganashkee Slough.

3.10.2.3 Calibration and Verification

No measured or observed stages were available for Crooked Creek to compare model results to observed flows or stage. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.10.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.10.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Crooked Creek system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.10.3 Development and Evaluation of Alternatives

There were no problem areas identified through hydraulic modeling of Crooked Creek, so no alternatives were developed. While three reported problem areas were classified as regional problems based on the information reported, hydraulic model results did not confirm existence of these problems. Previous observations may have been the result of a condition already remedied or a local issue.

3.11 Illinois and Michigan Canal

The I&M Canal is located in southwestern Cook County in the western part of the Calumet-Sag Channel Watershed. The I&M Canal south of the Calumet-Sag Channel was modeled in detail. The I&M Canal north of the channel was modeled in limited detail. The part of the I&M Canal discussed in this subsection is that south of the Calumet-Sag Channel. Table 3.11.1 lists the areas of communities that drain to the I&M Canal. The population density of the I&M Canal subwatershed is low with a mix of suburban development and a high amount of open land. Most of the open land within the watershed is Cook County Forest Preserve Property.

TABLE 3.11.1
Communities Draining to I&M Canal

Community	Tributary Area (mi^2)
Unincorporated/Forest Preserve	3.21
Lemont	3.49

TABLE 3.11.2
Land Use Distribution for I&M Canal

Land Use	Acres	%
Commercial/Industrial	216.3	8.1
Forest/Open Land	999.2	37.5
Institutional	0.7	0
Residential	121.1	4.5
Transportation/Utility	773.8	29
Water/Wetland	555.5	20.8

The drainage area is roughly 6.7 square miles. The I&M Canal is a manmade canal that has been dammed and blocked at two locations. It receives flow from I&M Tributary A and I&M Tributary B & C (also known as Convent Creek) near Lemont, as well as from the Castle Bowl subwatershed (also known as School Gully and Hillview Ditch) in Lemont. It discharges to the CSSC through a channel on the International-Matex Tank Terminals (IMTT) industrial property. Table 3.11.2 lists the land use breakdown by area within the I&M Canal subwatershed. Figure 3.11.1 provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

3.11.1 Sources of Data

3.11.1.1 Previous Studies

Christopher B. Burke Engineering conducted a study detailed in the *Flood Mitigation Studies Final Report* prepared for the Village of Lemont (Christopher B. Burke Engineering, 1997). The study recommended increasing the culvert size on a channel on the IMTT property through which the I&M Canal discharges to the CSSC and constructing a new outlet to the CSSC at the KA Steel property in Lemont.

3.11.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on the I&M Canal. No reaches are identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for the I&M Canal. Table 3.11.3 lists point source NPDES discharge permits identified through a USEPA water permit discharge query for facilities in the I&M Canal subwatershed area. IMTT's permits list the receiving water as the Calumet-Sag Channel, but the permits are included in this list since this particular property is discussed in this section.

TABLE 3.11.3
Point Source Dischargers in I&M Canal Area

Name	NPDES	Community	Receiving Waterway
IMTT—Lemont	IL0005126	Lemont	Calumet-Sag Channel
IMTT—Lemont SW discharge only	IL0061182	Lemont	Calumet-Sag Channel
KA Steel and Chemicals, Inc.	IL0022934	Lemont	I&M Canal, CSSC
Cook Composite and Polymers	IL0002399	Lemont	I&M Canal

Note: NPDES facilities were identified from the USEPA Water Discharge Permits Query Form at http://www.epa.gov/enviro/html/pcs/pcs_query_java.html.

Municipalities discharging to the I&M Canal are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.11.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 843 acres of wetland areas in the I&M Canal subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.11.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information, but the effective models, which are used to estimate flood levels, generally were not updated. LOMRs were incorporated in the revised floodplains. I&M Canal is not mapped in detail in the DFIRM mapping update but does have Zone A floodplain defined for the length of I&M Canal. Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.11.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdiction. Table 3.11.4 shows reported problems within the I&M Canal subwatershed.

3.11.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the I&M Canal subwatershed.

TABLE 3.11.4
Community Response Data for I&M Canal

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
LT4	Lemont Township	Bank erosion, sedimentation	Stephen Street and North of Talcott St.	Tree branches and debris in I&M Canal block flow	Regional	Maintenance and debris removal recommended.
LT1	Lemont Township	Pavement flooding	Route 171 (Archer Ave.) between Castlewood and Rte 83	IDOT reported pavement flooding.	Local	Roadway flooding issue not located on a regional waterway. This is a local problem.
LE1	Lemont	Ponding	Cass St. and Lemont St., downtown Lemont	During major storms, the sewer system in downtown Lemont surcharges and overflows, flooding basements, and first floors of buildings and residences.	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
WS1	Willow Springs	Overbank flooding	I&M Canal Crossing Rte 171	Pavement flooding due to high stages in the channel, three known occurrences	Local	Problem not located on a regional waterway. This is a local problem.
WS2	Willow Springs	Overbank flooding, ponding	Willow Drive and Archer Road	Channel draining Renaissance Development along Metra tracks near I&M Canal does not drain sufficiently	Local	Problem not located on a regional waterway. This is a local problem.

3.11.2 Watershed Analysis

3.11.2.1 Hydrologic Model Development

Subbasin Delineation. The I&M Canal subwatershed was delineated based upon LiDAR topographic data developed by Cook County in 2003. Forty-three subbasins, with an average area of 106 acres, were delineated for the I&M Canal area, which has a total drainage area of 6.7 square miles.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.11.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. Because the I&M Canal is dammed and blocked on both its upstream and downstream ends, it functions as a level-pool reservoir that is appropriately modeled as such within the hydrologic model. No hydraulic models were required to analyze flooding of the KA Steel and IMTT properties located near the I&M Canal since water surface elevations were produced through hydrologic modeling.

Boundary Conditions. Boundary condition elevations for the Calumet-Sag Channel based on output from the CWS model are included in Appendix E. The elevation produced by the CWS model for the 100-year storm at the outlet of I&M Canal was 583.92 feet NAVD 88.

3.11.2.3 Calibration and Verification

No measured or observed stages were available for the I&M Canal to compare model results to observed flows or stage. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.11.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.11.1 shows inundation areas produced for the 100-year, 12-hour duration storm.

Hydraulic Profiles. Hydraulic profiles were not produced as hydraulic modeling was not performed.

3.11.3 Development and Evaluation of Alternatives

3.11.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.11.5 summarizes problem areas identified through hydrologic modeling of the I&M Canal.

TABLE 3.11.5
Modeled Problem Definition for the I&M Canal

Problem ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
MPA47	KA Steel and Chemicals, 15185 Main Street, Lemont	25, 50, 100		Project IMCA-1 addresses this flooding.
MPA48	IMTT, 13589 Main Street, Lemont	100		Project IMCA-1 addresses this flooding.

3.11.3.2 Damage Assessment

Damages were defined following the protocol established in Chapter 6.6 of the CCSMP. Water surface elevations produced by the hydrologic model for the level-pool reservoir that represented the I&M Canal were used to define damages. No erosion damages or recreation damages due to flooding were identified for the I&M Canal. Transportation damages were estimated as 15 percent of property damages. Although no Form B was submitted, WPC participants did confirm the existence of problems at the KA Steel and IMTT sites (Problem IDs MPA47 and MPA48). Estimated Damages for the I&M Canal are listed in Table 3.11.6.

TABLE 3.11.6
Estimated Damages for the I & M Canal

Damage Category	Estimated Damage ($)	Note
Property	30,400	
Erosion	0	
Transportation	4,600	Assumed as 15% of property damage due to flooding

3.11.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate for addressing the flooding problems in the I&M Canal. Increased conveyance or storage was identified as the principal technologies applicable for addressing stormwater problems in the I&M Canal.

3.11.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in Section 1.4. Table 3.11.7 summarizes flood control alternatives developed for the I&M Canal. Based on community feedback, alternatives developed for the I&M Canal were taken from two previous studies: *Flood Mitigation Studies Final Report* by Christopher B. Burke Engineering, Ltd. and *Construction and Maintenance of Dams: Dam Safety Permit for Castle Bowl Retention Facility* by Engineering Resource Associates.

TABLE 3.11.7
Flood Control Alternatives for I&M Canal

Alternative	Location	Description
IMCA-1	IMTT and KA Steel sites	Construct new outlet channel at KA Steel site, and replace two 48-inch culverts at IMTT site with three 5- by 10-foot box culverts.
IMCA-2	Castle Bowl	Construct 18 acre-foot Castle Bowl detention basin. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.

3.11.3.5 Alternative Evaluation and Selection

Alternatives included in Table 3.11.7 were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. Recommended alternative IMCA-1 results in reduced stage of the I&M Canal sufficient to address all existing conditions damages due to flooding. Table 3.11.8 provides a comparison of the modeled maximum WSEL, and modeled flow at the time of peak on the I&M Canal.

TABLE 3.11.8
I&M Canal Existing and Alternative Condition Flow and WSEL Comparison

Location	Existing Conditions		IMCA-1	
	100 Yr WSEL (ft)	Max Flow (cfs)	100 Yr WSEL (ft)	Max Flow (cfs)
I&M Canal	584.5	2203	581.6	2155

Table 3.11.9 provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data. Analysis showed that IMCA-2 did not reduce existing conditions damages, thus this alternative does not appear in Table 3.11.9.

3.11.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. Table 3.11.9 lists the alternative analyzed in detail. The recommended alternative, IMCA-1, consists of construction of a new outlet channel at the KA Steel site and replacement of the two 48-inch culverts at the IMTT site with three 5- by 10-foot box culverts. Figure 3.11.2 shows the location of recommended alternative IMCA-1 and a comparison of the inundation mapping for existing conditions and with the recommended alternative IMCA-1.

TABLE 3.11.9
I&M Canal Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Water Quality Benefit	Recommended	Involved Community
IMCA-1	Construct new outlets	0.03	34,700	1,043,800	3	No Impact	Yes	Lemont

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.12 Illinois and Michigan Canal Tributary A

The I&M Canal Tributary A is located in southwestern Cook County, south of the Calumet-Sag Channel, in the western part of the Calumet-Sag Channel Watershed. Table 3.12.1 summarizes the areas of communities that drain to I&M Tributary A. The I&M Tributary A subwatershed contains a mix of suburban development and some available open land. The drainage area is 0.95 square miles. I&M Tributary A is a natural open-channel stream that drains into the I&M Canal in Lemont. Table 3.12.2 lists the land use breakdown by area within the I&M Tributary A subwatershed. Figure 3.12.1 provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and flood inundation areas are also shown on the figure, and are discussed in the following subsections.

TABLE 3.12.1
Communities Draining to I&M Tributary A

Community	Tributary Area (mi^2)
Lemont	0.9
Unincorporated/Forest Preserve	0.05

TABLE 3.12.2
Land Use Distribution for I&M Tributary A

Land Use	Acres	%
Residential	373.4	61.1
Forest/open land	118.3	19.3
Commercial/industrial	60.3	9.9
Institutional	39.4	6.4
Agricultural	15.5	2.5
Transportation/utility	4.6	0.7

3.12.1 Sources of Data

3.12.1.1 Previous Studies

Christopher B. Burke Engineering conducted a study for the Village of Lemont (Christopher B. Burke Engineering, 1997). The study recommended increasing the Main Street, New Avenue, and railroad crossings of I&M Tributary A to 8-foot-high by 12-foot-wide culverts. Because these are the sizes of the culverts at Main Street and the railroad crossing, and the culverts appear to have been constructed recently, it is believed that the recommendations for these two culverts from this study were implemented. The New Avenue structure consists of a 6- by 10-foot box culvert and a 5- by 8-foot box culvert.

3.12.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on I&M Tributary A. No reaches are identified as impaired in the IEPA's 2008 Integrated Water Quality Report, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for I&M Tributary A. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to I&M Tributary A. Municipalities discharging to I&M Tributary A are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.12.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory

(NWI) mapping. NWI data includes roughly 1.8 acres of wetland areas in the I&M Tributary A subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.12.1.4 Floodplain Mapping

Floodplain areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information, but the effective models, which are used to estimate flood levels, generally were not updated. LOMRs were incorporated in the revised floodplains. I&M Tributary A is mapped in detail in the DFIRM mapping update, with Zone AE floodplain defined for the length of I&M Tributary A. According to the FIS, the original hydrologic and hydraulic analysis was performed in 1988. The hydrologic modeling was performed using Regression Equations 73 and 75. Hydraulic routing performed was steady state and used the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.12.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. No problems were reported along I&M Tributary A.

3.12.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the I&M Tributary A subwatershed.

3.12.2 Watershed Analysis

3.12.2.1 Hydrologic Model Development

Subbasin Delineation. The I&M Tributary A tributary area was delineated based upon LiDAR topographic data developed by Cook County in 2003. Eight subbasins were delineated for the I&M Tributary A area, with an average subbasin area of 76.5 acres and a total drainage area of 0.95 square mile.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.12.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. The open channel of I&M Tributary A and all crossings were surveyed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section data. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficient to the stream.

Boundary Conditions. Boundary condition elevations determined for tributaries to the Calumet-Sag Channel based on output from the CWS model are included in Appendix E. The elevation produced by the CWS model for the 100-year storm at the outlet of I&M Tributary A was 581.32 feet NAVD 88, roughly 2 feet above the invert of I&M Tributary A near its confluence with the Calumet-Sag Channel. This shallow depth indicates that downstream stage on I&M Tributary A is not controlled by the receiving system, but by its own capacity to convey flows received from its tributary area. Normal depth at the downstream most cross section of the I&M Tributary A hydraulic model assuming a friction slope of 0.032 was used as a downstream boundary condition for I&M Tributary A.

3.12.2.3 Calibration and Verification

No measured or observed stages were available for I&M Tributary A to compare model results to observed flows or stage. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.12.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.12.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the I&M Tributary A system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.12.3 Development and Evaluation of Alternatives

There were no regional problem areas reported or identified through hydraulic modeling of I&M Tributary A, so no alternatives were developed.

3.13 Illinois and Michigan Canal Tributary B and C

I&M Tributary B & C is located in southwestern Cook County, south of the Calumet-Sag Channel, in the western part of the Calumet-Sag Channel Watershed. The areas of communities that drain to I&M Tributary B & C are summarized in Table 3.13.1. I&M Tributary B & C is a natural open-channel stream that drains approximately a 2.5 square mile area, discharging into the I&M Canal. The population density of the I&M Tributary B & C subwatershed is low with a mix of suburban development and a high portion of open land. Most of the open land within the watershed is Cook County Forest Preserve property. Table 3.13.2 lists the land use breakdown by area within the I&M Tributary B & C subwatershed. Figure 3.13.1 provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and flood inundation areas are also shown on the figure, and are discussed in the following subsections.

TABLE 3.13.1
Communities Draining to I&M Tributary B & C

Community	Tributary Area (mi^2)
Unincorporated/Forest Preserve	1.94
Lemont	0.6

TABLE 3.13.2
Land Use Distribution for I&M Tributary B & C

Land Use	Area (acres)	%
Forest/ Open Land	759.2	46.9
Residential	442.9	27.3
Water/Wetland	195.1	12.1
Agricultural	176.4	10.9
Institutional	30	1.9
Commercial/ Industrial	15.8	1

3.13.1 Sources of Data

3.13.1.1 Previous Studies

No studies of I&M Tributary B & C were identified for consideration as a component of DWP development.

3.13.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on I&M Tributary B & C. There are no reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for I&M Tributary B & C. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to I&M Tributary B & C. Municipalities discharging to I&M Tributary B & C are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.13.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 83.5 acres of wetland areas in the I&M Tributary B & C subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.13.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated in the revised floodplains. I&M Tributary B & C is mapped in detail in the DFIRM mapping update, with Zone AE floodplain defined for the length of I&M Tributary B & C. According to the FIS, the original hydrologic and hydraulic analysis was performed in 1988. The hydrologic modeling was performed using Regression Equations 73 and 75. Hydraulic routing performed was steady state and used the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.13.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. No problems were reported along I&M Tributary B & C.

3.13.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the I&M Tributary B & C subwatershed.

3.13.2 Watershed Analysis

3.13.2.1 Hydrologic Model Development

Subbasin Delineation. The I&M Tributary B & C subwatershed was delineated based upon LiDAR topographic data developed by Cook County in 2003. Fourteen subbasins were delineated for the I&M Tributary B & C area, with an average subbasin area of 116 acres and a total drainage area of 2.5 square miles.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds.

Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.13.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. The open channel of I&M Tributary B & C and all crossings were surveyed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficient to the stream.

Boundary Conditions. Boundary condition elevations for the Calumet-Sag Channel based on output from the CWS model are included in Appendix E. The elevation produced by the CWS model for the 100-year storm at the outlet of I&M Tributary B & C was 582.32 feet NAVD 88, which is about 10 feet below the invert of I&M Tributary B & C near its confluence with the I&M Channel because there is a drop spillway at the outlet of the tributary. This negative tailwater situation indicates that downstream stage on I&M Tributary B & C is controlled not by the receiving system, but by its own capacity to convey flows received from its tributary area. Normal depth assuming a friction slope of 0.003 was thus used as a downstream boundary condition for I&M Tributary B & C.

3.13.2.3 Calibration and Verification

No measured or observed stages were available for I&M Tributary B & C to compare model results to observed flows or stage. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.13.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.13.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the I&M Tributary B & C system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.13.3 Development and Evaluation of Alternatives

3.13.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.13.3 summarizes problem areas identified through hydraulic modeling of I&M Tributary B & C.

TABLE 3.13.3
Modeled Problem Definition for I&M Tributary B & C

Problem ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
MPA6	Area along eastern bank of tributary at downstream end north of Main St.	25, 50, 100, 500		Risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as floodproofing or acquisition.

3.13.3.2 Damage Assessment

Damages were defined following the protocol established in Chapter 6.6 of the CCSMP. No erosion damages or recreation damages due to flooding were identified for I&M Tributary B & C. Transportation damages were estimated as 15 percent of property damages.

TABLE 3.13.4
Estimated Damages for I&M Tributary B & C

Damage Category	Estimated Damage ($)	Note
Property	405,900	
Erosion	0	
Transportation	60,900	Assumed as 15% of property damage due to flooding

3.13.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate for addressing the flooding problems in I&M Tributary B & C. Increased conveyance or storage were identified as the principal technologies applicable for addressing stormwater problems in I&M Tributary B & C.

3.13.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Flood control alternatives developed for I&M Tributary B & C were focused towards on-line detention facilities and channel conveyance improvements and are summarized in Table 3.13.5.

3.13.3.5 Alternative Evaluation and Selection

Alternatives included in Table 3.13.5 were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. None of the detention or levee alternatives analyzed effectively reduced flood damages.

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural

TABLE 3.13.5
Flood Control Alternatives for I&M Tributary B & C

Alternative	Location	Description
IMTBC–1	Along creek from Walker Road to Main Street	On-line detention facility constructed by excavating the right overbank to create an additional 24 acre-feet of storage
IMTBC–2	Along creek from Main Street north to railroad	On-line detention facility constructed by excavating the right overbank to create an additional 6.9 acre-feet of storage
IMTBC–3	Along creek near outfall	An on-line detention facility added to the Alternative IMTBC-2 model constructed by excavating the left overbank to create an additional 3.2 acre-feet of storage
IMTBC–4	Along right overbank from railroad to outfall of creek	Levee on the right overbank as well as the southern property line of the industrial facility located east of the outfall of the creek to protect the site from floodwater

measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

3.13.3.6 Data Required for Countywide Prioritization of Watershed Projects

None of the alternatives analyzed were effective in reducing flood damages, and therefore, benefits and costs are not presented for these alternatives. No alternatives are recommended for I&M Tributary B & C.

3.14 Illinois and Michigan Canal Tributary D

I&M Tributary D is located in southwestern Cook County, north of the Calumet-Sag Channel, in the northern part of the Calumet-Sag Channel Watershed. Table 3.14.1 summarizes the areas of communities that drain to I&M Canal Tributary D. I&M Tributary D is a natural open-channel stream draining 0.9 square miles of area before discharging into the I&M Canal. The land-use distribution within the subwatershed is a mixture of suburban development and open land, most of which is Cook County Forest Preserve property. Table 3.14.2 lists the land use breakdown by area within the I&M Canal subwatershed.

Figure 3.14.1 provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas and flood inundation areas are also shown on the figure, and are discussed in the following subsections.

TABLE 3.14.1
Communities Draining to I&M Tributary D

Community	Tributary Area (mi^2)
Unincorporated/ Forest Preserve	0.49
Hickory Hills	0.22
Willow Springs	0.19

TABLE 3.14.2
Land Use Distribution for I&M Tributary D

Land Use	Acres	%
Forest/Open Land	360	62.8
Residential	205.1	35.8
Commercial/Industrial	8.5	1.5
Institutional	0.1	0

3.14.1 Sources of Data

3.14.1.1 Previous Studies

No studies of I&M Tributary D were identified for consideration as a component of DWP development.

3.14.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on I&M Tributary D. There are no reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for I&M Tributary D. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to I&M Tributary D. Municipalities discharging to I&M Tributary D are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.14.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. NWI data includes roughly 24.8 acres of wetland areas in the I&M Tributary D subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.14.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated in the revised floodplains. I&M Tributary D is mapped in detail in the DFIRM mapping update, with Zone AE floodplain defined for the length of I&M Tributary D. According to the FIS, the original H&H analysis was performed in 1979. The hydrologic modeling was performed using Regression Equation 73. Hydraulic routing performed was steady state and used the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.14.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Table 3.14.3 shows reported problems along I&M Tributary D.

TABLE 3.14.3
Community Response Data for I&M Tributary D

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
HH5	Hickory Hills	Ponding, storm sewer capacity, maintenance	91st Pl. at Kean Ave.	The storm sewer to the forest preserve is typically full due to a restricted outfall in the forest preserve, and during rainfall events, the catch basin ponds back up to a property in the subwatershed.	Regional	Although model results did not show property damage, DWP includes recommendation that Forest Preserve regrade channel to allow positive drainage.
LYT1	Lyons township	Overbank flooding	Tributary to I&M Canal Crossing La Grange Rd.	Pavement flooding due to high stages in the channel, 8 known occurrences	Regional	Model results did not confirm roadway flooding due to a regional problem in this area. Previous observations may have been the result of a condition already remedied or a local issue.
WS1	Willow Springs	Pavement flooding	Archer Avenue at La-Grange Road	IDOT reported pavement flooding	Local	Problem not located on a regional waterway. This is a local problem.

3.14.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the I&M Tributary D subwatershed.

3.14.2 Watershed Analysis

3.14.2.1 Hydrologic Model Development

Subbasin Delineation. The I&M Tributary D area was delineated based upon LiDAR topographic data developed by Cook County in 2003. Five subbasins were delineated for the I&M Tributary D area, with an average subbasin area of 114.8 acres and a total drainage area of 0.9 square mile.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.14.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. The open channel of I&M Tributary D and all crossings were surveyed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficient to the stream.

Boundary Conditions. Appendix E contains boundary condition elevations for the Calumet-Sag Channel based on output from the CWS model. The elevation produced by the CWS model for the 100-year storm at the outlet of I&M Tributary D was 587.69 feet NAVD 88, about 3 feet above the invert of I&M Tributary D near its confluence with the I&M Canal. This shallow depth indicates that the downstream stage on I&M Tributary D is controlled not by the receiving system, but by its own capacity to convey flows received from its tributary area. Normal depth assuming a friction slope of 0.0025 was thus used as a downstream boundary condition for I&M Tributary D, resulting in a 100-year elevation of 587.69 feet at the confluence.

3.14.2.3 Calibration and Verification

No measured or observed stages were available for I&M Tributary D to compare model results to observed flows or stage. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.14.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.14.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the I&M Tributary D system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.14.3 Development and Evaluation of Alternatives

There were no damages identified through hydraulic modeling of I&M Canal Tributary D, so no alternatives were developed. Modeling did not confirm pavement flooding where reported by IDOT through the Form B. Previous observations may have been the result of a condition already remedied or a local issue. It is recommended that the problem reported by Hickory Hills regarding flooding at 95th Street and Kean Avenue be addressed through improving maintenance practices on Forest Preserve property. This recommendation is discussed further in Section 4, Maintenance.

3.15 Justice Ditch

Justice Ditch is located in southwestern Cook County, north of the Calumet-Sag Channel, in the northern part of the Calumet-Sag Channel Watershed. The drainage area of Justice Ditch is 0.42 square miles. Approximately 0.31 square mile of that area drains to the open channel part of Justice Ditch. The remaining 0.11-square-mile area to the west of Garden Lane is drained by a network of sewers and shallow, overland flow. Communities tributary to Justice Ditch are described in Table 3.15.1.

TABLE 3.15.1
Communities Draining to Justice Ditch

Community	Tributary Area (mi^2)
Justice[a]	0.31
Unincorporated Cook County	0.11

[a]All flows tributary to the modeled open channel of Justice Ditch are contributed from within Justice.

The area draining to Justice Ditch is largely residential, with part of Bethania Cemetery draining from the upstream, easternmost section of the subwatershed. Table 3.15.2 summarizes the land use distribution within the Justice Ditch subwatershed.

TABLE 3.15.2
Land Use Distribution for Justice Ditch

Land Use Category	Area (acres)	%
Residential	178.4	66.9
Commercial/Industrial	6.3	2.3
Forest/Open Land	70.8	26.6
Institutional	4.6	1.7
Transportation/Utility	4.4	1.7
Water/Wetland	2	0.7

Figure 3.15.1 is an overview of the tributary area of the subwatershed. Reported stormwater problem areas, and flood inundation areas are also shown on the figure, and are discussed below.

The modeled waterway is roughly 2,300 feet long upstream of Garden Lane, with enclosed conduits making up roughly 1,165 feet of that length. Justice Ditch discharges into a 60-inch storm sewer that conveys flows under Garden Lane and discharges to the I&M Canal west of Jocare Drive. The storm sewer is not part of the hydraulic model of the Justice Ditch.

During intense rainfall, the Justice Ditch subwatershed receives some flows from a depressional area bounded roughly by 73rd Place and 75th Street to the north and south, and Cork Avenue and 88th Avenue, to the west and east. This area was included in the 71st Street Ditch drainage area and is drained by a 24-inch sewer to the 71st Street Ditch. However, during intense rainfall events, runoff exceeds the capacity of this small sewer and reaches an elevation of about 596.5 feet, where it then overflows towards Justice Ditch, resulting in interbasin flow.

The existence of the interbasin flow, and the stormwater problem associated with it, led to the need to develop a hydraulic model for Justice Ditch to properly analyze the effects of the interbasin flow.

3.15.1 Sources of Data

3.15.1.1 Previous Studies

A 1980 IDOT study examined numerous stormwater improvements to Justice Ditch. These included channel improvements, various channel diversion alignments, and combinations of both. The 60-inch storm sewer under Garden Lane, which was designed to provide a 10-year level of service, was constructed as a result of this study (IDOT, 1980).

3.15.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Justice Ditch. There are also no reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for Justice Ditch. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Justice Ditch. Municipalities discharging to Justice Ditch are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.15.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes no wetland areas in the Justice Ditch tributary area. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.15.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated in the revised floodplains. TR-20 and HEC-2 were used for the effective hydrologic and hydraulic Justice Ditch models, respectively. According to the FIS, the original H&H analysis was performed in 1979.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.15.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Table 3.15.3 lists reported problems for Justice Ditch. JU2 is in the 71st Street Ditch Watershed, but is included below because resolution of the problem there would help both subwatersheds. The Village of Justice has indicated that, since the installation of a 36-inch lateral sewer connected to the Garden Lane sewer, overbank flooding associated with Justice Ditch has not been a problem.

3.15.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is consid-

TABLE 3.15.3
Community Response Data for Justice Ditch

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
JU2[a]	Justice	Ponding	East of Cork Ave. between 73rd Pl. and 75th St.	Depressional area has no natural outlet. Presently drains to 71st Street Ditch through an undersized storm sewer.	Local	Although this is a local problem, recommended alternative SFDT-2 provides additional discharge capacity to I&M Canal, which is a component of the IDNR plan to address local problems.

[a]Problem located in 71st Street Ditch Watershed, but affects Justice Ditch for larger storms.

ered in development of the DWP. No near-term planned projects by others have been identified for the Justice Ditch subwatershed.

3.15.2 Watershed Analysis

3.15.2.1 Hydrologic Model Development

Subbasin Delineation. The Justice Ditch tributary area was delineated based upon LiDAR topographic data developed by Cook County in 2003. The area draining to problem area JU2 was included in the original delineation of Justice Ditch. However, further review of the 1980 IDOT study and the contour data in this area suggested that this location would drain to the 71st Street Ditch for small- to medium-sized storms, with inter-basin flow to Justice Ditch occurring when water levels exceed an elevation of 596.5 feet. Further cause for inclusion of this area in the 71st Street Ditch drainage basin is the proposed solution for local drainage issues in this area, which would increase discharge to the 71st Street Ditch through an enlarged sewer.

Three subbasins were delineated for the Justice Ditch tributary area, with an average subbasin area of 89 acres. Subbasin W540 drains a mobile home park area west of Garden Lane, and was modeled exclusively hydrologically as a tributary to the CSSC.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

Inflow. Interbasin flow from the 71st Street Ditch to the Justice Ditch subwatershed begins to occur when water surface elevations in the area surrounding problem JU2 exceed an elevation of 596.5 feet, which is where overland flow to Justice Ditch occurs. The overland flows exiting the 71st Street Ditch tributary area were loaded into the Justice Ditch model.

3.15.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. The open channel of Justice Ditch and all crossings were surveyed, along with the intake structure for the Garden Lane channel diversion, to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficient to the stream.

Boundary Conditions. The Justice Ditch model was extended slightly downstream of Garden Lane. The pipe discharging into the drop structure to the Garden Lane sewer is restrictive, and results in an increased stage at the upstream face of a structure located at the Justice Ditch intersection with Garden Lane. The simulated water surface elevation upstream of Garden Lane thus functions as the boundary condition for the Justice Ditch.

3.15.2.3 Calibration and Verification

No measured or observed stages were available for Justice Ditch to compare model results to observed flows or stage. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.15.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.15.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Justice Ditch system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.15.3 Development and Evaluation of Alternatives

3.15.3.1 Problem Definition

Model results show that overbank flooding along the Justice Ditch is significant for every recurrence interval storm evaluated as a part of the Calumet-Sag Channel DWP. Stormwater conveyed to the Justice Ditch originates within the Village of Justice and problems associated with the flooding of Justice Ditch have been classified as local. WPC participants familiar with the area have noted that flooding along Justice Ditch has not been a problem since the Garden Lane sewer was installed along with the 36-inch lateral sewer beneath 76th Place connecting to the Garden Lane sewer. The existing conditions hydraulic model developed for the DWP indicates that parts of the Justice Ditch tributary area are at risk of flooding, even with these changes in place. Differences between model results and local understanding of flood problems may result from the impact of unmodeled or simplified storm sewers and culverts that may significantly affect routing of flows in the small drainage area of Justice Ditch. Table 3.15.4 provides a summary of problem areas identified through modeling of Justice Ditch.

TABLE 3.15.4
Modeled Problem Definition for Justice Ditch

Problem ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
MPA7	Along Justice Ditch, between Garden Lane and Banks Street	2, 5, 10, 25, 50, 100		Although this is a local problem, recommended alternative SFDT-2 provides additional discharge capacity to I&M Canal, which is a component of the IDNR plan to address local problems.
MPA8	Between 76th Place and 75th Street and Cork Avenue and Banks Street	2, 5, 10, 25, 50, 100		Although this is a local problem, recommended alternative SFDT-2 provides additional discharge capacity to I&M Canal, which is a component of the IDNR plan to address local problems.

Since problem areas within the Justice Ditch subwatershed are classified as local, no damages have been assigned for Justice Ditch. No alternatives have therefore been developed for the Justice Ditch subwatershed.

3.16 Ken Kay Ditch

Ken Kay Ditch is located in southwestern Cook County, north of the Calumet-Sag Channel, in the center of the Calumet-Sag Channel Watershed. Table 3.16.1 summarizes the areas of communities that drain to Ken Kay Ditch. The subwatershed consists mostly of suburban residential development with some open land.

TABLE 3.16.1
Communities Draining to Ken Kay Ditch

Community	Tributary Area (mi^2)
Worth	1.21
Unincorporated/Forest Preserve	0.03
Alsip	0.02
Palos Heights	0.01

The drainage area is 1.3 square miles. Ken Kay Ditch is an open-channel stream that serves as a lateral drainage ditch parallel to the Calumet-Sag Channel, which it discharges into at both ends of Ken Kay Ditch. Table 3.16.2 lists the land use breakdown by area within the Calumet-Sag subwatershed. Figure 3.16.1 is an overview of the tributary area of the subwatershed. Reported stormwater problem areas are also shown on the figure, and are discussed in the following subsections.

TABLE 3.16.2
Land Use Distribution for Ken Kay Ditch

Land Use	Area (acres)	%
Residential	534.5	65.8
Forest/Open Land	177.2	21.8
Commercial/Industrial	70	7.5
Transportation/Utility	23.5	2.9
Institutional	15.6	1.9
Water/Wetland	0.3	0
Agricultural	0.1	0

No hydraulic model was developed for Ken Kay Ditch. All areas tributary to Ken Kay Ditch are drained through storm sewer systems that are completely within the Village of Worth. Problems along Ken Kay Ditch are classified as local.

3.16.1 Sources of Data

3.16.1.1 Previous Studies

No studies of Ken Kay Ditch were identified for consideration as a component of DWP development.

3.16.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Ken Kay Ditch. There are no reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for Ken Kay Ditch. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Ken Kay Ditch. Municipalities discharging to Ken Kay Ditch are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.16.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 31.1 acres of wetland areas in the Ken Kay Ditch subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.16.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, generally were not updated. LOMRs were incorporated in the revised floodplains. Ken Kay Ditch is not mapped in detail in the DFIRM mapping update, and so there was no known model that meets the criteria established in Chapter 6 of the CCSMP for use in the development of DWPs.

3.16.1.5 Stormwater Problem Data

Communities, agencies (IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Table 3.16.3 shows one reported problem along Ken Kay Ditch. This problem had a readily apparent solution because the problem is related to channel maintenance. Poor grading of the channel was identified as a potential hazard to human health and safety caused by mosquito breeding in shallow stagnant waters. This problem is classified as local, however, and has not been attributed to any flood damages along the Ken Kay Ditch.

TABLE 3.16.3
Community Response Data for Ken Kay Ditch

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
WO3	Worth	Ponding, bank erosion	Ken Kay Ditch at 116th Street and Harlem Avenue	Creek is in need of sediment removal. Ponding occurs in the village and within IDOT ROW adjacent to the creek.	Local	Field assessment identified the need for maintenance and grading to aid drainage.

3.16.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Ken Kay Ditch subwatershed.

3.16.2 Watershed Analysis

3.16.2.1 Hydrologic Model Development

CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.16.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. No hydraulic model was developed for Ken Kay Ditch because there is only one community with significant amount of drainage area within the Ken Kay Ditch watershed. Any potential stormwater problem along Ken Kay Ditch would be classified as a local problem.

3.16.2.3 Calibration and Verification

No measured or observed stages were available for Ken Kay Ditch to compare model results to observed flows or stage. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.16.3 Development and Evaluation of Alternatives

There were no regional problems reported or damages identified in the Ken Kay Ditch subwatershed, so no alternatives were developed.

3.17 Long Run Creek

Long Run Creek is a regional waterway located in southwestern Cook County, in the southern part of the Calumet-Sag Channel Watershed. There are three distinct areas within Cook County that each drain to three waterways tributary to Long Run Creek. From west to east, the three subwatershed areas are an area that drains primarily to Long Run Creek Tributary B, the Tampier Slough drainage area, and the area that drains to Long Run Creek Tributary A and the main branch of Long Run Creek. From its headwaters located roughly southwest of the intersection of Wolf Road and 143rd Street in Orland Park, Long Run Creek flows roughly northwest and crosses into Will County near the intersection of Will-Cook Road and 139th Street. Long Run Creek Tributary A discharges into this stretch of Long Run Creek northwest of the intersection of Wolf Road and 143rd Street. Long Run Creek flows for approximately 4.8 miles within Will County, before crossing briefly back into Cook County near the intersection of State Street and Archer Avenue south of Lemont, where Long Run Creek Tributary B discharges into Long Run Creek. Near this location, Long Run Creek then flows back into Will County.

TABLE 3.17.1
Communities Draining to Long Run Creek

Community	Tributary Area (mi^2)
Unincorporated/ Forest Preserve	7.93
Lemont	1.70
Orland Park	3.40
Palos Park	0.92

TABLE 3.17.2
Land Use Distribution for Long Run Creek

Land Use Category	Area (acres)	%
Agricultural	1120.0	12.6
Commercial/Industrial	159.4	1.8
Forest/Open Land	2792.8	31.5
Institutional	82.1	0.9
Residential	3904.6	44.1
Transportation/Utility	90.3	1.0
Water/Wetland	708.3	8.0

The total drainage area to Long Run Creek within Cook County to the point where flow returns to Will County near Lemont is 13.8 square miles. Table 3.17.1 lists the communities within Cook County that drain to Long Run Creek.

The Long Run Creek subwatershed contains a mix of suburban development with open space and agricultural area. Table 3.17.2 summarizes the land use distribution within the Long Run Creek subwatershed.

Figures 3.17.1a and b show an overview of the tributary area of the subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown on the figure and discussed in the following subsections.

3.17.1 Sources of Data

3.17.1.1 Previous Studies

Will County recently created H&H models of existing conditions in Long Run Creek to examine floodplain areas and channel improvements for the part of Long Run Creek in Will County. The extent of the H&H model does not include the parts of Long Run Creek in Cook County, and so it did not contribute directly to the development of the Calumet-Sag Channel DWP.

3.17.1.2 Water Quality Data

Monitoring Data. The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Long Run Creek. No reaches are identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA Sections 303(d) and 305(b) lists. Tampier Slough, which is a wetland area draining to Long Run Creek from the north, is on the IEPA's 303(d) report because of total phosphorus and total suspended solids (TSS). No TMDLs have been established for Long Run Creek. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Long Run Creek. Municipalities discharging to Long Run Creek are regulated by the IDNR's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.17.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes 773.8 acres of wetland area in the Long Run Creek subwatershed area within Cook County. Tampier Slough accounts for 370 acres of this area. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.17.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization program. Floodplain boundaries were revised based upon updated Cook County topographic information, but the effective models, which are used to estimate flood levels, generally were not updated. LOMRs were incorporated into revised floodplain areas.

Long Run Creek is mapped in detail in the DFIRM mapping update, with Zone AE floodplain shown across the length of Long Run Creek. The original hydrologic and hydraulic analysis was performed in 1979. The hydrologic modeling was performed using L-PTIII and Regression Equations 73 and 75. Hydraulic routing performed was steady state and used the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.17.1.5 Stormwater Problem Data

Communities, agencies (IDOT, CCHD), and stakeholders submitted District Form B questionnaire response data to the District summarizing stormwater problems within their jurisdictions. Stormwater problems were classified as regional or local based upon the criteria described in Section 1 of the report. Table 3.17.3 summarizes the Form B data for Long Run Creek.

3.17.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Long Run Creek subwatershed.

3.17.2 Watershed Analysis

3.17.2.1 Hydrologic Model Development

Subbasin Delineation. The Long Run Creek subwatershed was delineated based upon LiDAR topographic data developed by Cook County in 2003. The subwatershed drainage area includes 9.5 square miles of area in Will County that drain into Cook County. The area within Will County was delineated using USGS maps showing 10-foot contours where LiDAR data was unavailable. Inclusion of this area was necessary to account for total flow volumes into Long Run Creek.

TABLE 3.17.3
Community Response Data for Long Run Creek

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
LT3	Lemont Township	Pavement flooding	Route 171 (Archer Avenue) at 131st Street	IDOT reported pavement flooding	Local	Problem not located on a regional waterway. This is a local problem.
OP11	Orland Park	Bank erosion, sedimentation	143rd Street and Wolf Road	Erosion/sedimentation causes flow restriction and flooding	Regional	Sedimentation not noted in field survey. May have been addressed by recent maintenance activities.
OP9	Orland Park	Overbank flooding	Long Run Creek Crossing 143rd Street (West of Wolf Road)	Pavement flooding due to high stages in the channel, 18 known occurrences	Regional	Project LRCR-5 will raise 143rd Street to address transportation damages.
OT2	Orland Township	Bank erosion, sedimentation	Will-Cook Road at Long Run Creek crossing	Silt in culvert, and severe erosion along southeast embankment	Regional	Erosion area visited and determined not to threaten any structures. Siltation not noted in field survey; may have been addressed by recent maintenance.
PP10	Palos Park	Overbank flooding, basement flooding, storm sewer capacity, bank erosion	116th Avenue and 123rd Street	Floodwaters exceed capacity, 1 time per year	Local	Problem not located on a regional waterway. This is a local problem.

Eighty subbasins were delineated for the Long Run Creek tributary area, with an average subbasin area of 180 acres, including those delineated within Will County. Excluding Will County subbasins, the average size is 127.47 acres.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

For Will County subwatershed areas tributary to Long Run Creek where LiDAR data was missing, drainage paths and lag times were approximated using USGS data and available aerial photography. This was adjusted based on the historic gage record explained in more detail in Section 3.17.2.3.

3.17.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. The open channel of Long Run Creek and all crossings were surveyed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Stream sections in Will County were not modeled hydraulically. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficient to the stream.

Boundary Conditions. Long Run Creek was modeled in two separate reaches: Long Run Creek upstream of Will-Cook Road and Long Run Creek Tributary B. Normal depth was set as the boundary condition for both reaches of Long Run Creek at each point of discharge into Will County. A slope of 0.0026 was used for Long Run Creek upstream of Will-Cook Road, and a slope of 0.0015 was used for Long Run Creek Tributary B where it discharges into Long Run Creek. These values are based on the slopes of the streams at each location.

3.17.2.3 Calibration and Verification

USGS Gage 05537500 is located on Long Run Creek at its crossing of State Road in southwestern Cook County, near Lemont. The gage records instantaneous stage and flow data for Long Run Creek. The data is available on the USGS Web site in "real-time," meaning usually within hours from the time that it was recorded. Summarized daily, monthly, and yearly data is also available. The drainage area of Long Run Creek to the gage location is 20.9 square miles, including 9.5 square miles within Will County. The gage record spans from 1951 to the present.

An event-based calibration of Long Run Creek was not performed because the Will County part of Long Run Creek, approximately 4.8 miles of Long Run Creek draining 16.8 acres, was not modeled hydraulically. At least one in-line reservoir is present on the Will County portion of Long Run Creek, based upon review of aerial photographs. The hydrologic model for the Will County tributary area of Long Run Creek was also of limited detail.

The absence of hydraulic routing in the Will County part of Long Run Creek initially resulted in an overprediction of flows by the model at the downstream reach of Long Run Creek. A hydrologic routing element was added to the model to account for the storage and flood routing attenuation in this area. Flood quartiles for modeled recurrence intervals from *Estimating Flood-Peak Discharge Magnitude and Frequencies for Rural Streams in Illinois* (USGS, 2004) were used to calibrate the hydrologic model. Table 3.17.4 compares the gaged and modeled flows for the range of recurrence intervals.

The comparison of modeled and gaged flows for the range of modeled design events are generally in close agreement, particularly for the larger magnitude events. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

TABLE 3.17.4
Modeled Peak Flow versus Gage Record Flow

Recurrence Interval	Modeled Peak Flow (cfs)	Gage Record Flow (cfs)	% Difference
2	611	602	1
5	1,039	1,090	-5
10	1,461	1,510	-3
25	2,011	2,140	-6
50	2,508	2,700	-7
100	3,033	3,340	-9
500	5,040	5,160	-2

3.17.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Flood inundation areas were developed based on HEC-RAS water surface elevations and Cook County topographic data. Figures 3.17.1a and b show inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Long Run Creek system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.17.3 Development and Evaluation of Alternatives

3.17.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.17.5 summarizes major problem areas identified through modeling of Long Run Creek.

TABLE 3.17.5
Modeled Problem Definition for Long Run Creek

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Form B	Resolution in DWP
MPA10	Area south of 139th Street and Will-Cook Road	10, 25, 50, 100	OT2	Risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.

3.17.3.2 Damage Assessment

Damages due to flooding were calculated for Long Run Creek in accordance with the methodology described in Section 1.4 and are summarized in Table 3.17.6. Transportation damages were calculated for flooding overtopping 143rd Street at the Long Run Creek crossing.

TABLE 3.17.6
Estimated Damages for Long Run Creek

Damage Category	Estimated Damage ($)	Note
Property	62,000	
Erosion	0	
Transportation	60,500	Assumed as 15% of property damage plus damages due to overtopping of 143rd Street
Recreation	0	

3.17.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate for addressing the flooding problems in Long Run Creek. Storage, levees, and increased conveyance were considered as possible alternatives.

3.17.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Table 3.17.7 summarizes flood control alternatives developed for Long Run Creek.

Erosion Control Alternatives. No erosion control alternatives were developed for Long Run Creek. Reported erosion problems were determined not to threaten any structures.

3.17.3.5 Alternative Evaluation and Selection

Five alternatives were developed for Long Run Creek to reduce damages associated with problems MPA10 and OP9. LRCR-1 consists of a levee coupled with compensatory storage in the opposite bank of the problem area near Will-Cook Road, and model results show that this alternative reduced flooding for the 25-year storm. Limited land availability in the right overbank area to provide compensatory storage prevented provision of a higher level of service, and floodwaters are predicted to circumvent the levee and cause damages for storm events larger than the 25-year storm. This alternative was not recommended because it only

TABLE 3.17.7
Flood Control Alternatives for Long Run Creek

Alternative Number	Location	Description
LRCR-1	Long Run Creek at Will-Cook Road crossing	A 300-foot levee in left overbank area with excavation in right overbank area to provide compensatory storage
LRCR-2	Long Run Creek at Will-Cook Road crossing	Increased conveyance with compensatory storage downstream of Will-Cook Road. This alternative was considered infeasible because land was not available for compensatory storage, thus benefits and costs were not developed.
LRCR-3	Long Run Creek and Long Run Creek Tributary A confluence	47 acre-foot detention basin; this alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
LRCR-4	Long Run Creek at Ruggles Court	6 acre-foot detention basin; this alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
LRCR-5	Long Run Creek at 143rd Street	Raise 143rd Street approximately four feet and construct culverts and weir structure to mimic existing hydraulic conditions up to the 100-year storm event.

protects two structures for smaller storms, resulting in a low B/C ratio with no local or ancillary benefits.

LRCR-2 involves increasing conveyance through the culvert under Will-Cook Road which discharges into Will County. This alternative was found to be effective at lowering WSELs in the vicinity of problem MPA10. However, this alternative is not considered viable because there is not enough upstream land available to provide compensatory storage to prevent flood stages from increasing downstream in Will County.

Large parcels of land were unavailable near the modeled flood problem MPA10, but were available farther upstream, such as at the area north of 131st Street between Parker Road and Bell Road. Two such locations were modeled as LRCR-3 and LRCR-4. While these storage alternatives lowered the WSEL locally, that they are located too far upstream of the problem areas to be effective in reducing flooding damages.

LRCR-1 was shown to reduce damages in the Long Run Creek subwatershed while being feasible from a regulatory perspective, although it is not recommended for the reasons provided above.

LRCR-5 consists of raising 143rd Street to prevent road overtopping. The concept for LRCR-5 includes a new culvert and weir structure designed to mimic existing hydraulic conditions up to the 100-year storm, with two orifices at the invert and of the size of the existing culverts, the weir at the elevation of the existing road, and a new culvert underneath the raised 143rd Street sized to sufficiently convey the 100-year storm event flows without increasing peak flows or WSELs upstream or downstream.

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

Table 3.17.8 below provides a summary of the depth of road flooding at 143rd Street for existing conditions and with recommended alternatives.

TABLE 3.17.8
Long Run Creek Road Overtopping Summary

Road Crossing	Road Elevation	2-yr Depth of Flooding	5-yr Depth of Flooding	10-yr Depth of Flooding
143rd Street	692.9	0.5	0.5	0.8
143rd Street (with alternative LRCR-5)	696.9			
Road Crossing	**Road Elevation**	**25-yr Depth of Flooding**	**50-yr Depth of Flooding**	**100-yr Depth of Flooding**
143rd Street	692.9	1.9	2.4	2.4
143rd Street (with alternative LRCR-5)	696.9			

Note: Blank entry indicates that road crossing does not overtop for that particular storm event.

3.17.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. Table 3.17.9 lists benefits and costs for LRCR-5. Alternatives LRCR-1 through LRCR-4 are not listed in Table 3.17.9 because they did not effectively reduce water surface elevations. LRCR-5 is recommended as raising 143rd Street will effectively address transportation damages at this location. The recommended alternative LRCR-5 is shown in Figure 3.17.2. A comparison of the existing conditions and alternative conditions inundation mapping is included in these figures.

TABLE 3.17.9
Long Run Creek Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
LRCR-5	Raise 143rd Street	0.06	51,100	862,700	0		None	Yes	Orland Park

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.18 Lucas Ditch

Lucas Ditch is a manmade tributary to Stony Creek in southwestern Cook County, north of the Calumet-Sag Channel, in the central part of the Calumet-Sag Channel Watershed. The ditch is roughly 2.0 miles long and drains an area of 2.7 square miles. Table 3.18.1 summarizes the communities draining to Lucas Ditch.

TABLE 3.18.1
Communities Draining to Lucas Ditch

Community	Tributary Area (mi^2)
Palos Hills	1.96
Hickory Hills	0.46
Unincorporated/Forest Preserve	0.28

The Lucas Ditch subwatershed contains a mix of urban development and little available open land in the upstream part of the subwatershed. Much of the area is drained by storm sewers or roadside ditches. Table 3.18.2 summarizes the land use distribution within the subwatershed.

TABLE 3.18.2
Land Use Distribution for Lucas Ditch

Land Use Category	Area (acres)	%
Residential	961.7	55.6
Forest/Open Land	484.7	28
Institutional	187.7	10.9
Commercial/Industrial	90.6	5.2
Water/Wetland	3.3	0.2
Transportation/Utility	1.9	0.1

The Lucas Ditch drainage system interacts with the Lucas Diversion Ditch drainage system to the east. No natural divide separates the manmade Lucas and Lucas Diversion Ditches, and the two drainage systems were modeled as hydraulically connected by overland flow during significant storms. Roberts Road forms the boundary between the tributary areas of Lucas Ditch and Lucas Diversion Ditch. Roughly 577 acres of the Lucas Ditch watershed drains into the Roberts Road storm sewer at its intersection with 99th Street, and ultimately to Stony Creek. An overflow outlet at 101st Street discharges to the headwaters of Lucas Ditch. Figure 3.18.1 provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

3.18.1 Sources of Data

3.18.1.1 Previous Studies

The following studies relevant to parts of the Lucas Ditch drainage system were reviewed and considered as a part of the Calumet-Sag Channel DWP development.

Drainage Investigation: Patrick Engineering (2006) / Cook County Highway Department: Study of Roberts Road Storm Sewer from Archer Avenue to 111th Street. The study of the Roberts Road storm sewer found the sewer significantly undersized through Palos Hills, which resulted in pavement flooding. Significant offsite flows are generated from the upstream parts of the Lucas Ditch watershed, contributing to the frequent surcharge of the sewer. The report recommended increasing the size of parts of the storm sewer from 84 to 96 inches. This proposed improvement has not been implemented.

Detention Study: Knight Infrastructure Cook County Highway Department and Illinois Department of Natural Resources: Study of Proposed Detention. This study examined the effect of two proposed stormwater detention basins on flooding problems in the upstream part of the Lucas Ditch watershed. It recommends a project to expand a detention pond at 96th Street east of 88th Avenue from 2.2 to 4.4 acre-feet. A detention basin is proposed on a 0.9-acre site at the intersection of 88th Avenue and 99th Street. Gabion basket check dams are proposed in the Forest Preserve to retard flows discharging to the Roberts Road Storm sewer and to reduce streambank erosion.

3.18.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on the Lucas Ditch. No reaches are identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for the Lucas Ditch. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Lucas Ditch. Municipalities discharging to the Lucas Ditch are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.18.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI includes roughly 17.6 acres within the Lucas Ditch subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.18.1.4 Floodplain Mapping

Flood inundation areas supporting the National Flood Insurance Program (NFIP) were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. Localized Letters of Map Revisions (LOMRs) were incorporated into revised floodplain areas. The original FEMA hydrologic and hydraulic modeling was performed in 1979 using HEC-1 and WSP-2.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.18.1.5 Stormwater Problem Data

Communities, agencies (IDOT, CCHD), and stakeholders submitted District Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Stormwater problems were classified as regional or local based upon the criteria described in Section 1.4 of the report. Table 3.18.3 summarizes the Form B data for Lucas Ditch.

3.18.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Lucas Ditch subwatershed.

TABLE 3.18.3
Community Response Data for Lucas Ditch

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
HH6	Hickory Hills	Overbank flooding, basement flooding, ponding, bank erosion	95th St. at 84th Ct. (Flamingo Apartments)	Runoff from forest preserves exceeds outflow drains and results in flooding two apartment buildings to the first floor. Erosion on forest preserve property.	Local	Building not identified as at imminent risk per field visit to location. Reported flooding upstream of modeled waterway. This is a local problem.
PHI2	Palos Hills	Ponding, storm sewer capacity	82nd Avenue and Eleanor Avenue	Sedimentation in Lucas Ditch upstream of 103rd St. restricts Lucas Ditch capacity.	Regional	Project LUDT-7 address sedimentation in this area. Sufficient land was not available to address all flooding in this area. Such properties are candidates for protection using nonstructural flood control measures, such as floodproofing or acquisition.
PHI3	Palos Hills	Overbank flooding, basement flooding, bank erosion	111th Street and 86th Avenue (11118 Spathis Drive)	Lucas Ditch floods adjacent buildings when Stony Creek is high, sometimes resulting in erosion as well. Former study recommended building a levee wall to isolate the floodplain.	Regional	Project LUDT-5 will protect properties from flooding
PHI6	Palos Hills	Bank erosion, sedimentation	101st Street and Roberts Road	Debris at upstream end of culvert, far upstream portion of Lucas Ditch, where it crosses Roberts Road.	Local	Although this is a local problem, it is addressed as part of dredging project LUDT-7

TABLE 3.18.3
Community Response Data for Lucas Ditch

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
PHI7	Palos Hills	Overbank flooding, ponding	88th Avenue and 99th Street	Localized flooding in sewered headwaters of Lucas Ditch. Previous studies have identified need for additional storage and increased conveyance.	Local	Not addressed in DWP. CCHD has proposed plan to address problems at this location.
PHI8	Palos Hills	Overbank flooding, storm sewer capacity, bank erosion, wetland riparian	96th Street and Arrowhead Drive	Flooding and erosion problems due to high flows. The buildings threatened by erosion are actually in Hickory Hills.	Local	Not addressed in DWP. CCHD has proposed plan to address problems at this location.

3.18.2 Watershed Analysis

3.18.2.1 Hydrologic Model Development

Subbasin Delineation. The Lucas Ditch tributary area was delineated based primarily upon LiDAR topographic data developed by Cook County in 2003. The initial delineation based on topographic data was then reviewed and modified to reflect manmade alterations to the watershed in some locations where storm sewer data was available. One specific example of these modifications includes changes made to direct flows from the Hickory Hills Country Club and upstream areas to drain into the Roberts Road storm sewer at 98th Place.

Fourteen subbasins were delineated for the Lucas Ditch tributary area, with an average subbasin area of 124 acres and a total drainage area of 2.7 square miles.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

Flow Diversions. The Roberts Road storm sewer has a hydraulic capacity of 384 cfs (Patrick Engineering, 2006), and an overflow outlet into Lucas Ditch at 101st Street. A simplified hydraulic model of the portion of the Roberts Road storm sewer south of 98th Street was constructed using information from the Patrick Engineering study, with one outlet to Stony Creek and another representing the overflow to Lucas Ditch. The 500-year flow produced in the 577-acre area within Lucas Ditch tributary to the storm sewer was input into the model, producing a diversion rating curve into Lucas Ditch when the inflow exceeds the capacity of the Roberts Road storm sewer. Although not fully representing the dynamics of the Roberts Road storm sewer, this method of developing a flow diversion curve is believed to more accurately represent the system hydraulics than more simplified methods, such as taking the ratio of the pipe cross-sectional area to divert flow. This diversion curve was used for all storms to split flow between Lucas Ditch and the Roberts Road sewer.

3.18.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. Surveys of the open channel part of Lucas Ditch and all crossings were performed to characterize the channel and near overbank channel geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficients along the modeled stream length.

Boundary Conditions. The Lucas Ditch model was run as a component of the larger Stony Creek hydraulic model, with downstream boundary conditions defined by Stony Creek WSELs. A lateral structure representing the overland flow path between Lucas Ditch and Lucas Diversion Ditch was defined using a weir height of 594 feet, based upon topography in the area. This lateral structure allows interbasin flow between Lucas Ditch and Lucas Diversion Ditch if WSELs exceeds the overland flow height and a head differential exists between the two waterways.

3.18.2.3 Calibration and Verification

No measured or observed flows or stage data was available for Lucas Ditch for comparison with modeled values. Lucas Ditch is tributary to Stony Creek, which was calibrated using high-water mark elevation data. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.18.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.18.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Lucas Ditch system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.18.3 Development and Evaluation of Alternatives

3.18.3.1 Modeled Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.18.4 summarizes problem area locations identified through modeling.

TABLE 3.18.4
Modeled Problem Definition for Lucas Ditch

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Form B	Resolution in DWP
MPA12	Between 103rd Street and 105th Street, and 83rd Avenue and 84th Street	50, 100	PHI2	Project LUDT-7 addresses flooding in this area.
MPA13	Area bounded by 103rd Street, Lucas Ditch, and Roberts Road	25, 50, 100		Project LUDT-7 addresses flooding in this area.
MPA14	Between 111th Street and West Stony Creek Confluence	50, 100	PHI3	Project LUDT-5 addresses flooding in this area.

3.18.3.2 Damage Assessment

Damages due to flooding were calculated for Lucas Ditch in accordance with the methodology described in Section 1.4 and are summarized in Table 3.18.5.

3.18.3.3 Technology Screening

TABLE 3.18.5
Estimated Damages for Lucas Ditch

Damage Category	Estimated Damage ($)	Note
Property	1,038,300	
Erosion	0	
Transportation	155,700	Assumed as 15% of property damage (excluding damaged parcels at the confluence)
Recreation	0	

Flood control technologies were screened to identify those most appropriate for addressing the flooding problems along Lucas Ditch. Stormwater detention was identified as an integral component of any damage reduction strategy, with conveyance improvements, and levees (in the downstream part of Lucas Ditch) also potentially feasible technologies for addressing flood damages along Lucas Ditch. It is noted that conveyance improvement alternatives would require storage, either within the Lucas Ditch watershed or downstream in the Stony Creek corridor to avoid negative downstream impact.

3.18.3.4 Alternative Development

Stormwater improvement alternatives were developed to address flooding problems in Lucas Ditch and adjacent Lucas Diversion Ditch, which are hydraulically connected during heavy storms. The alternatives listed in Table 3.18.6 have a primary benefit in Lucas Ditch, though may result in additional damage reductions along the Lucas Diversion Ditch. For this reason, benefits are presented for Lucas Diversion Ditch as well. Flood control alternatives are listed in Table 3.18.6. No erosion control alternatives were developed for Lucas Ditch.

TABLE 3.18.6
Flood Control Alternatives for Lucas Ditch

Alternative	Location	Description
LUDT-1	Hickory Hills Golf Course	Excavate roughly 60 acre-feet of storage to reduce discharge to Roberts Road Storm Sewer/Lucas Ditch.
LUDT-2	Hickory Hills Golf Course	Impound roughly 60 acre-feet of storage on to reduce discharge to Roberts Road Storm Sewer/Lucas Ditch.
LUDT-3	From Lucas Ditch to Stony Creek along 83rd Avenue and Palos Drive	Construct 96-inch channel diversion to increase conveyance from Lucas Ditch to Stony Creek. Construct 28 ac-ft detention basin.
LUDT-4	From Lucas Ditch to Stony Creek along 83rd Avenue and Palos Drive	Construct 96-inch channel diversion to increase conveyance from Lucas Ditch to Stony Creek. Impound roughly 60 acre-feet of storage on Hickory Hills Golf Course
LUDT-5	Lucas Ditch and West Stony Creek confluence	Construct levee to restrict floodwaters from inundating structures east of Lucas Ditch at Stony Creek confluence. Construct roughly 9.5 ac-ft of compensatory storage.
LUDT-6	Lucas Ditch upstream of 103rd Street	Dredge Lucas Ditch upstream of 103rd Street, combined with 96-inch channel diversion to Stony Creek
LUDT-7	Lucas Ditch upstream of 103rd Street and Hickory Hills Golf Course	Dredge Lucas Ditch upstream of 103rd Street and impound roughly 60 acre-feet of storage on Hickory Hills Golf Course to reduce discharge to Roberts Road Storm Sewer/Lucas Ditch

3.18.3.5 Alternative Evaluation and Selection

Both LUDT-1 and LUDT-2 propose stormwater detention volumes of roughly 60 acre-feet to relieve flooding in both the Lucas Ditch and Lucas Diversion Ditch subwatersheds and Roberts Road corridor. LUDT-1 is significantly more expensive to construct, because of the cost of excavating a significant quantity of overburden material above the proposed overflow elevation (624 feet for LUDT-1) to obtain the necessary storage volume. Roughly 2 cubic yards of land must be excavated for each cubic yard of storage obtained in the area. LUDT-2, shown in Figure 3.18.2, requires more land acquisition but uses the natural topography of the area to provide the necessary storage volume. Roughly 8 acre-feet of excavation is included in this alternative to obtain fill material to for the earthen dam used to retain floodwaters. Both alternatives assume availability of land at the Hickory Hills Country Club. It may be found that this volume of detention, required to reduce the damages indicated in Table 3.18.5, is obtainable in locations other than the Hickory Hills Country Club. Costs associated with the impoundment of flows at the Hickory Hills Country Club may not reflect all engineering costs associated with regulations of dam design and construction.

Both LUDT-1 and LUDT-2 are ideally located to intercept significant flows that contribute to flooding in Lucas Ditch, and to a lesser extent Lucas Diversion Ditch, as well as the undersized storm sewer beneath Roberts Road. Damages associated with storm sewer systems such as Roberts Road are local and are not included in regional damages.

LUDT-3 proposes a 96-inch channel diversion to divert some flows from Lucas Ditch south to Stony Creek along 83rd Court and Palos Lane. Approximately 28 ac-ft of detention is also included in this alternative, so that increased flow into Stony Creek does not adversely impact properties adjacent to Stony Creek. Although water surfaces are lowered substantially, the only property damage due to flooding predicted in this area is near MPA12, comprising a relatively small fraction of overall Lucas Ditch damages. LUDT-4 combines the channel diversion from alternative LUDT-3 with the storage associated with alternative LUDT-2, resulting in more significant damage reduction than either alternative individually. Regulatory approval from regulatory agencies such as IDNR and the USACE would be required for LUDT-3 or LUDT-4. The increased conveyance would involve a new outfall with additional flow to Stony Creek. Other alternatives recommended in the DWP within the Stony Creek subwatershed include storage and will result in lower peak flow rates on Stony Creek following implementation. All flows from individual tributaries are relatively small in comparison to total flow within the Calumet-Sag Channel.

LUDT-5 protects several parcels at the confluence of Lucas Ditch with Stony Creek that are predicted to be inundated during minor storms and to have flood depths up to 2.49 feet for the 100-year storm. Construction of a levee along the east bank of Stony Creek is recommended to protect the structures from inundation. Since inundation in the area is a result of backwater from Stony Creek, the construction of a levee does not raise upstream stages on Lucas Ditch. To compensate for loss of current floodplain storage, the conceptual cost estimate for LUDT-5 includes roughly 9.5 acre-feet of storage upstream in the Stony Creek watershed. Interior drainage behind the proposed levee was assumed to need a discharge capacity roughly equal to 10 acre-feet in a 24-hour period.

LUDT-6 includes the dredging of Lucas Ditch upstream of 103rd Street. Sedimentation has reduced culvert openings and decreased channel capacity in Lucas Ditch north of 103rd Street by 1 to 1.5 feet, according to the field survey. Initial model runs including solely a dredging component reduced water surface elevation north of 103rd Street, however increased flows and predicted water surface levels downstream. Therefore, it was necessary either to reduce upstream flows by storage, or to increase downstream conveyance also to avoid exacerbating downstream flooding. LUDT-6 includes LUDT-3 with the channel diversion proposed in LUDT-3. LUDT-7 pairs the channel dredging component of LUDT-6 with the storage on Hickory Hills golf course proposed in LUDT-2.

LUDT-5, shown in Figure 3.18.3, is recommended to address significant predicted damages at the confluence of Lucas Ditch with Stony Creek. LUDT-7 is recommended to reduce flooding damages in Lucas Ditch and Lucas Diversion Ditch, including potential local benefits in the Roberts Road corridor, and to help reduce overbank flooding in Lucas Ditch upstream of 103rd street. The land necessary for construction of detention basin on the Hickory Hills golf course may not be currently available for use as a stormwater facility, however should be considered for this purpose in the event of future development, given its ideal location to intercept flows to an area with significant damages.

TABLE 3.18.7
Lucas Ditch Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		LUDT-7	
Location	Station	100 Yr WSEL (ft)	Max Flow (cfs)	100 Yr WSEL (ft)	Max Flow (cfs)
Roughly 200-ft downstream of Roberts Road	10561.6	593.12	143.31	592.87	92.92
Roughly 300-ft downstream of 82nd Ave.	8968.99	591.94	174.39	591.13	123.16
Roughly 200-ft downstream of 103rd St.	7650.485	591.15	209.64	590.54	140.01
Just upstream of Winter Park Dr.	4719	589.90	282.31	589.41	250.02
Roughly 230-ft downstream of 107th St.	3251.408	588.71	298.07	588.41	263.77
Roughly 250-ft upstream of the confluence with West Stony Creek	343.5076	587.43	372.29	587.35	310.19

Recommended alternatives result in reduced stage and/or flow along the modeled waterway. Table 3.18.7 provides a comparison of the modeled maximum WSEL, and modeled flow at the time of peak at representative locations along the waterway. LUDT-5, although recommended, is not included in this table because it results in no impact on the water surface elevations.

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

3.18.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternatives. Table 3.18.8 lists alternatives analyzed in detail. Based on a comparison of B/C ratios, the recommended alternatives are LUDT-5 and LUDT-7, and are shown in Figures 3.18.2 and 3.18.3. A comparison of the existing conditions and alternative conditions inundation mapping is included in these figures.

TABLE 3.18.8
Lucas Ditch Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
LUDT-1	Storage on Hickory Hills golf course created by excavation	0.02	276,200	12,584,400	49		Slightly Positive	No	Hickory Hills, Palos Hills, Bridgeview
LUDT-2	Storage on Hickory Hills golf course created by impoundment	0.06	276,200	4,282,700	49		Slightly Positive	No	Hickory Hills, Palos Hills, Bridgeview
LUDT-3	96-inch channel diversion to Stony Creek	0.01	75,000	6,720,300	9		Slightly Negative	No	Palos Hills
LUDT-4	LUDT-2 and LUDT-3	0.03	259,100	8,080,900	45		No Impact	No	Palos Hills, Hickory Hills, Bridgeview
LUDT-5	Levee at confluence with Stony Creek, and compensatory storage	0.27	845,200	3,136,900	4		No Impact	Yes	Palos Hills
LUDT-6	Dredging upstream of 103rd Street combined with 96-inch channel diversion beneath Palos Lane	0.02	144,500	6,910,300	26		No Impact	No	Palos Hills, Hickory Hills, Bridgeview
LUDT-7	Dredge Lucas Ditch upstream of 103rd Street and provide roughly 60 ac-ft of detention on Hickory Hills golf course	0.08	340,200	4,472,600	54		Slightly Positive	Yes	Palos Hills, Hickory Hills, Bridgeview

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.19 Lucas Diversion Ditch

The area tributary to Lucas Diversion Ditch is generally flat and drained almost entirely by storm sewers. Interpretation of storm sewer data was used in conjunction with topographic data to define the subwatershed boundaries with 71st Street Ditch to the north, Melvina Ditch to the east, and Lucas Ditch to the west. Table 3.19.1 summarizes the communities that drain to the Lucas Diversion Ditch.

TABLE 3.19.1
Communities Draining to Lucas Diversion Ditch

Community	Tributary Area (mi^2)
Bridgeview	1.89
Hickory Hills	0.96
Palos Hills	0.38
Justice	0.1
Oak Lawn	0.05
Chicago Ridge	0.03

The 3.4 square miles tributary area to Lucas Diversion Ditch is heavily developed, with predominantly residential and commercial/industrial development. Table 3.19.2 summarizes the land use distribution within the Lucas Diversion Ditch subwatershed.

TABLE 3.19.2
Land Use Distribution for Lucas Diversion Ditch

Land Use Category	Area (acres)	%
Residential	1,043.8	47.8
Commercial/Industrial	636.7	29.2
Transportation/Utility	212	9.7
Forest/Open Land	208	9.5
Institutional	73.8	3.4
Water/Wetland	7.1	0.3

The drainage system of Lucas Diversion Ditch is interconnected with the Lucas Ditch system. No natural divide separates the manmade Lucas and Lucas Diversion Ditches, and the two drainage systems were modeled as hydraulically connected by overland flow during significant storms. Roberts Road was defined as the boundary between the tributary areas of Lucas Ditch and Lucas Diversion Ditch.

I-294 bisects the Lucas Diversion Ditch watershed, providing a barrier to stormwater runoff tributary to the Lucas Diversion Ditch. A large part of the area north of the I-294 collects stormwater runoff through storm sewers up to 72 inches in diameter that discharge into two detention ponds northeast of the intersection of 95th Street and I-294. A storm sewer discharges from the detention ponds to Lucas Diversion Ditch. Additional flows from the area north of I-294 drain south through either the Harlem Avenue storm sewer or overland flow routes into Stony Creek. Figure 3.19.1 provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

3.19.1 Sources of Data

3.19.1.1 Previous Studies

No studies of Lucas Diversion Ditch were found to exist. An ongoing study being performed by Robinson Engineering was identified in the community response data from Bridgeview, but the study report was not obtained. The IDOT study, *Strategic Planning Study for Flood Control*, Justice, (1980) and the Patrick Engineering Roberts Road Drainage Investigation study (2006) were both useful in confirming drainage patterns at boundaries of the Lucas Diversion Ditch subwatershed.

The Patrick Engineering study found the Roberts Road storm sewer to be significantly undersized through Palos Hills and to cause pavement flooding. Significant offsite flows are generated from the upstream part of the Lucas Ditch Watershed, contributing to the frequent surcharge of this sewer. The report recommended upsizing parts of the Roberts Road storm sewer from 84 to 96 inches. The proposed improvement has not yet been implemented.

3.19.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Lucas Diversion Ditch. There are also no reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for Lucas Diversion Ditch. According to a USEPA water permit discharge query, no NPDES permits were issued by IEPA for discharges to Lucas Diversion Ditch. Municipalities discharging to Lucas Diversion Ditch are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.19.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data include roughly 11.9 acres of wetland areas in the Lucas Diversion Ditch subwatershed Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.19.1.4 Floodplain Mapping

Flood inundation areas supporting the National Flood Insurance Program (NFIP) were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. Localized Letters of Map Revisions (LOMRs) were incorporated into revised floodplain areas. The original FEMA hydrologic and hydraulic analysis was performed in 1979 using HEC-1 and HEC-RAS.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.19.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Community response data from Bridgeview, Palos Hills, and Hickory Hills were used to help define stormwater problems related to Lucas Diversion Ditch. Problems were classified as local or regional based upon the criteria described in Section 1. Table 3.19.3 provides a summary of Form B data for Lucas Diversion Ditch.

3.19.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Lucas Diversion Ditch subwatershed.

3.19.2 Watershed Analysis

3.19.2.1 Hydrologic Model Development

Subbasin Delineation. The Lucas Diversion Ditch tributary area was delineated based upon LiDAR topographic data developed by Cook County in 2003. Twenty-five subwatersheds areas were defined with an average size of 87.6 acres. The topographic delineation was reviewed and modified in some locations to reflect manmade alterations to the watershed. The delineation was modified at the crossing of Harlem Avenue and I-294 to allow the upstream part of Lucas Diversion Ditch watershed to drain to Stony Creek.

TABLE 3.19.3
Community Response Data for Lucas Diversion Ditch

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
BV1	Bridgeview	Overbank flooding, pavement flooding, storm sewer capacity	Route 43 (Harlem Ave.) at 86th St.	IDOT reported flooding problems (southbound)	Local	Problem not located along a regional waterway.
BV2	Bridgeview	Basement flooding, ponding, storm sewer capacity	100th Pl. between 76th Ave. and Harlem Ave.	Excessive ponding occurs at 100th Pl. between 76th Ave. and Harlem Ave. due to drainage problems.	Local	Although this is a local problem, it may benefit from project LDDT-3.
BV5	Bridgeview, Chicago Ridge	Pavement flooding	Route 43 (Harlem Ave.) at I-94	IDOT reported pavement flooding.	Local	Problem not located along a regional waterway.
HH1	Hickory Hills	Overbank flooding, basement flooding, ponding, bank erosion, maintenance	98th St. at 7700 West	Drainage ditches have insufficient capacity to convey storm flows, resulting in ponding and basement flooding. Possible maintenance issues related to Lucas Ditch.	Regional	Project LDDT-3 will lower water elevations in downstream waterway for local sewers in this area.
HH4	Hickory Hills	Basement flooding, ponding, storm sewer capacity	Roberts Rd. between 90th and 95th Streets	Roberts Road storm sewer has insufficient capacity to convey moderate floods. Cook County will not allow additional connections to the Robert Rd. storm sewer.	Local	LUDT-7 will increase conveyance of overflow from Roberts Rd. sewer.

TABLE 3.19.3
Community Response Data for Lucas Diversion Ditch

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
PHI1	Palos Hills	Overbank flooding, basement flooding, ponding	100th Pl. and 78th Ave.	Lucas Diversion Ditch has insufficient capacity, overflowing into existing undersized detention area and nearby homes.	Regional	Project LDDT-3 provides stormwater detention to address problem. Sufficient land was not available to address all flooding in this area. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.
PHI4	Palos Hills, Bridgeview	Basement flooding, ponding, storm sewer capacity, bank erosion, maintenance	Lucas Diversion Ditch from 102nd Street to 105th St.	Debris and sediment build up restricts flow in Lucas Diversion Ditch causing basement flooding north of 103rd St. in Bridgeview/ Palos Hills.	Regional	LDDT-3 includes clearing/dredging downstream of 103rd Street.
PHI6	Palos Hills	Bank erosion, sedimentation	101st St. and Roberts Rd.	Debris at upstream end of culvert, far upstream part of Lucas Ditch, where it crosses Roberts Rd.	Local	Problem not located along a regional waterway.
PHI9	Palos Hills, Bridgeview	Basement flooding, ponding, storm sewer capacity, bank erosion, maintenance	Lucas Diversion Ditch from 103rd St. to 105th St.	Sediment and debris buildup in Lucas Diversion Ditch	Regional	Project LDDT-3 addresses accumulation of sediment and debris downstream of 103rd Street.

The northern boundary of the Lucas Diversion Ditch tributary area was set at 83rd Street, based upon information from a previous study (IDOT, 1980). The delineation was modified along a part of Roberts Road to force flows from the Hickory Hills Country Club and upstream areas to drain into the Roberts Road storm sewer at 98th Place. The areas are classified as being within the Lucas Ditch watershed, but they may drain to Lucas Diversion Ditch during heavy rainfalls.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

Flow Diversion. Stormwater from north of I-294 is understood to drain into the Lucas Diversion Ditch through a storm sewer beneath the interstate that discharges from detention ponds north of the interstate. Inflow into the Lucas Diversion hydraulic model was limited to 80 cfs, based upon the estimated capacity of the 60-inch pipe flowing southwest beneath the tollway. Review of contour data suggests that excess flow drains beneath the Tri-State Tollway along Harlem Avenue to the West Branch of Stony Creek, either within a storm sewer or overland.

3.19.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. Surveys of the open channel part of Lucas Ditch and all crossings were performed to characterize the channel and near overbank channel geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficients along the modeled stream length.

Boundary Conditions. A lateral structure representing the overland flow path between Lucas Ditch and Lucas Diversion Ditch was defined using a weir height of 594 feet, based upon topography in the area. This lateral structure allows interbasin flow between Lucas Ditch and Lucas Diversion Ditch if WSELs exceed the overland flow height and a head differential exists between the two waterways.

The Lucas Diversion Ditch model was run as a component of the larger Stony Creek hydraulic model, with downstream water surface defined by the Stony Creek water surface elevation.

3.19.2.3 Calibration and Verification

No measured or observed stages were available for Lucas Diversion Ditch to compare model results to observed flows or stage. Lucas Diversion Ditch is tributary to Stony Creek, which was calibrated using high-water mark elevation data. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.19.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.19.1 shows inundation areas along Lucas Diversion Ditch produced by the hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profile. Appendix H contains hydraulic profiles of existing conditions in the Lucas Diversion Ditch system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.19.3 Development and Evaluation of Alternatives

3.19.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.19.4 summarizes problem area locations determined through modeling.

TABLE 3.19.4
Modeled Problem Definition for Lucas Diversion Ditch

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Form B	Resolution in DWP
MPA9	Roberts Road to Lucas Diversion Ditch, north of 103rd Street	10, 25, 50, 100	PHI1	Project LDDT-3 addresses flooding in this area. Sufficient land was not available to address all flooding in this area. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.

3.19.3.2 Damage Assessment

Damages due to flooding were calculated for Lucas Diversion Ditch in accordance with the methodology described in Section 1.4, as summarized in Table 3.19.5.

TABLE 3.19.5
Estimated Damages for Lucas Diversion Ditch

Damage Category	Estimated Damage ($)	Note
Property	1,279,100	
Erosion	0	
Transportation	191,900	Assumed as 15% of property damage (excluding damaged parcels at the confluence)
Recreation	0	

3.19.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate for addressing the flooding problems in the Lucas Diversion Ditch. Stormwater detention and conveyance improvements were also identified as potential technologies for addressing flood damages in Lucas Ditch. It is noted that conveyance improvements would require storage, either within the Lucas Diversion Ditch watershed or upstream of Lucas Diversion Ditch's confluence with Stony Creek, to avoid translating flood problems downstream.

TABLE 3.19.6
Flood Control Alternatives for Lucas Diversion Ditch

Alternative	Location	Description
LDDT-1	ComEd ROW	Excavate 17 acre-feet of detention at existing baseball diamond.
LDDT-2	ComEd ROW and along 76th Avenue north of 103rd Street	Construct three detention basins of 17, 10, and 36 acre-feet.
LDDT-3	ComEd ROW, along 76th Avenue north of 103rd Street, and LDDT south of 103rd Street	Construct detention per LDDT-2 along with channel clearing/dredging downstream of 103rd Street.
LDDT-4	ComEd ROW and along 76th Avenue north of 103rd Street	Construction of four detention basins of 17, 10, and 36 acre-feet, and 32 acre-feet. Construct berm around wetland area in lower Bridgeview area.
LDDT-5	Along 76th Avenue north of 100th Place	Construct 36 acre-ft detention basin

3.19.3.4 Alternative Development

Flood control alternatives for Lucas Diversion Ditch are listed in Table 3.19.6. No erosion control alternatives were developed for Lucas Diversion Ditch.

3.19.3.5 Alternative Evaluation and Selection

LDDT-1 consists of increasing the detention from the ComEd right-of-way, and converting a baseball field north of the property to detention. The alternative was designed to reduce damages from smaller storms causing flood damage (10- to-25-year recurrence interval) and provides limited benefits for higher magnitude events.

LDDT-2 and LDDT-3 provide significantly more stormwater detention in the Lucas Diversion Ditch subwatershed. Increasing the available conveyance capacity downstream of 103rd Street, in combination with increased detention, results in more benefits and a higher benefit-cost ratio than detention alone. Although LDDT-4 has the highest benefits of the modeled alternatives, the benefit-cost ratio is less than that of LDDT-3. Two other noneconomic considerations prevent the recommendation of LDDT-4:

- Proposed additional detention on Concord homes property is near a low-lying area where Bridgeview experiences flooding problems. The Village has expressed concern with collecting additional stormwater runoff into an already problematic location.
- Proposed additional detention on Concord homes property is currently designated as wetland area, and regulation may prohibit significant modification for stormwater detention purposes. Palos Hills has noted that the area may be a designated habitat for a species of snake.

Finally, LDDT-5 includes just the 36 ac-ft detention basin proposed on private property near the upstream extent of Lucas Diversion Ditch. Land availability and/or overall cost may cause this alternative to be more feasible than the set of detention basins comprising LDDT-3.

The predicted benefits for the Lucas Diversion Ditch alternatives occur predominantly upstream of 103rd Street. However, the modeled alternatives also result in reduced downstream flows, and also have a benefit on Stony Creek.

Recommended alternative LDDT-3 results in reduced stage and flow along the modeled waterway. Table 3.19.7 provides a comparison of the modeled maximum WSEL, and modeled flow at the time of peak at representative locations along the waterway.

TABLE 3.19.7
Lucas Diversion Ditch Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		LDDT-3	
Location	Station	100 Yr WSEL (ft)	Max Flow (cfs)	100 Yr WSEL (ft)	Max Flow (cfs)
500-ft downstream of 76th Ave.	6045	594.60	641.85	594.15	450.05
400-ft upstream of 103rd St.	4153	594.06	647.37	593.50	458.38
Intersection of 104th Pl. and Vicky Ln.	2804	592.27	317.89	591.77	370.69
Just upstream of 107th St.	1042	591.95	290.51	591.03	379.08

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

3.19.3.6 Data Required for Countywide Prioritization of Watershed Projects

Based upon consideration of the B/C ratio and noneconomic criteria, LDDT-3, shown in Figures 3.19.2 is recommended to address damages due to flooding along the Lucas Diversion Ditch. The project also has benefits outside the Lucas Diversion Ditch watershed due to reduced flow to Stony Creek. Appendix I presents conceptual level cost estimates for alternatives discussed in Section 3.19.3.5. Table 3.19.8 lists the total estimated cost, benefits, and B/C ratio for each alternative. A comparison of the existing conditions and alternative conditions inundation mapping is included in Figure 3.19.2.

TABLE 3.19.8
Lucas Diversion Ditch Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
LDDT-1	One detention basin with 17 ac-ft of storage	0.09	160,900	1,883,400	8		Slightly Positive	No	Bridgeview, Palos Hills
LDDT-2	Three detention basins with 63 ac-ft of storage	0.13	848,300	6,325,500	59		Slightly Positive	No	Bridgeview, Hickory Hills, Palos Hills
LDDT-3	Three detention basins with 63 ac-ft of storage and channel clearing south of 103rd St.	0.13	885,200	6,765,000	56		Slightly Positive	Yes	Bridgeview, Hickory Hills, Palos Hills
LDDT-4	Four detention basins with 95 ac-ft of storage	0.1	1,109,000	11,648,400	65		Slightly Positive	No	Bridgeview, Hickory Hills, Palos Hills
LDDT-5	36 ac-ft detention basin	0.13	523,300	3,959,300	34		Slightly Positive	No	Bridgeview, Hickory Hills, Palos Hills

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.20 Marley Creek

Marley Creek is a regional waterway located in southwestern Cook County, in the southern portion of the Calumet-Sag Channel Watershed. The 9.91-square-mile drainage area includes 0.58 square miles of drainage area from Will County. Table 3.20.1 provides a summary of the communities within Cook County that drain to Marley Creek. Figure 3.20.1 provides an overview of the tributary area of the subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

TABLE 3.20.1
Communities Draining to Marley Creek

Community	Tributary Area (mi^2)
Orland Park	6.1
Unincorporated/Forest Preserve	3.2
Orland Hills	0.03
Will County	0.58

The Marley Creek subwatershed contains a mix of suburban development, open space, and agricultural area. Table 3.20.2 summarizes the land use distribution within the Marley Creek subwatershed.

TABLE 3.20.2
Land Use Distribution for Marley Creek

Land Use Category	Area (acres)	%
Forest/Open Land	1,875	30.0
Residential	1,835	29.4
Agricultural	1,500	24.0
Commercial/Industrial	603	9.6
Water/Wetland	316	5.1
Institutional	105	1.7
Transportation/Utility	15	0.2

3.20.1 Sources of Data

3.20.1.1 Previous Studies

Will County recently created H&H models of existing conditions in Marley Creek to examine floodplain areas and channel improvements for the part of Marley Creek in Will County. The extent of the H&H model did not contain the part of Marley Creek in Cook County, and so it did not contribute directly to the development of the Calumet-Sag Channel DWP.

3.20.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Marley Creek. No reaches are identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. Lake Sedgewick, which is a reservoir draining to the upstream end of Marley Creek from the North, is on the IEPA's 303(d) list due to total mercury and TSS. No TMDLs have been established for Marley Creek. According to a USEPA water permit discharge query, there is an NPDES permit issued by IEPA to the Andrew Corporation, located in Orland Park, for discharges to Marley Creek. Municipalities discharging to Marley Creek are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.20.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 297 acres of wetland area in the Marley Creek tributary area. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.20.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated into revised floodplain areas.

Marley Creek is mapped in detail in the DFIRM mapping update, with Zone AE floodplain shown across the length of Marley Creek. The original hydrologic and hydraulic analysis developed to produce floodplain mapping was completed in 1976. The hydrologic modeling was performed using Regression Equations 73 and 75. Steady state hydraulic routing was was performed using the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.20.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Stormwater problems were classified as regional or local based upon the criteria described in Section 1 of the report. Table 3.20.3 summarizes the Form B data for Marley Creek.

3.20.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Marley Creek subwatershed.

3.20.2 Watershed Analysis

3.20.2.1 Hydrologic Model Development

Subbasin Delineation. The Marley Creek subwatershed was delineated based upon LiDAR topographic data developed by Cook County in 2003. The subwatershed drainage area includes 0.56 square mile in Will County that drains into Cook County. The area within Will County was delineated using USGS maps showing 10-foot contours. Forty-six subbasins

TABLE 3.20.3
Community Response Data for Marley Creek

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
FP1	Forest Preserve District	Overbank flooding, ponding, water quality, wetland riparian	LaGrange and 167th Street	High runoff and salt from roads has degraded habitat and water quality.	Local	Problem not located on a modeled, regional waterway
OP12	Orland Park	Bank erosion, sedimentation	108th Avenue at Marley Creek crossing	Silt in three 10- by 8-foot box culverts where Marley Creek crosses 108th Avenue.	Regional	Maintenance recommended to address problem, not associated with property damages. Sediment was observed in the box culverts.
OP3	Orland Park	Overbank flooding, bank erosion, sedimentation, maintenance, wetland riparian	Marley Creek at Cameron Parkway and Norfolk Southern R.R.	Flooding on Wolf Road due to restricted conveyance in Marley Creek, seems to be caused primarily by debris and sedimentation causing blockages in conveyance.	Regional	Stream maintenance and debris removal recommended to address problem. Sediment was not observed in Marley Creek in this area during field visit. Adjacent property damage due to flooding addressed by project MACR-1.
OP6	Orland Park	Maintenance, sedimentation, bank erosion	Marley Creek at Anthony Drive to Meade Street	Flooding on 104th Avenue due to restricted conveyance in Marley Creek, seems to be caused primarily by debris and sedimentation causing blockages in conveyance.	Regional	Stream maintenance and debris removal recommended to address problem. Debris was observed in Marley Creek in this area. No property damage due to flooding.

were delineated for the Marley Creek Tributary area, with an average subbasin area of 138 acres.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

For Will County subbasins tributary to Marley Creek, drainage paths and lag times were approximated using available USGS data and available aerial photography.

3.20.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. Surveys of the open channel part of Marley Creek and all crossings were performed to characterize the channel and near overbank channel geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Stream sections in Will County were not modeled hydraulically. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficient to the stream.

Boundary Conditions. Normal depth with a friction slope of 0.002 was used as the boundary condition for Marley Creek at the point of discharge into Will County.

3.20.2.3 Calibration and Verification

No measured or observed stages were available for Marley Creek to compare model results. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.20.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Flood Inundation areas were developed based on HEC-RAS water surface elevations and Cook County topographic data. Figure 3.20.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Marley Creek system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.20.3 Development and Evaluation of Alternatives

3.20.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.20.4 summarizes major problem areas identified through modeling of Marley Creek.

3.20.3.2 Damage Assessment

Economic damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. No erosion or recreation damages due to flooding were identified for Marley

Creek. Transportation damages were estimated as 15 percent of property damages. Table 3.20.5 lists the damage assessment for existing conditions.

TABLE 3.20.4
Modeled Problem Definition for Marley Creek

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Form B	Resolution in DWP
MPA15	Area near West Dr. and Centennial Dr. intersection	100, 500		Model results show roadway flooding, but no property damage. Due to the availability of alternative routes, a resolution to transportation damages has been deemed unnecessary.
MPA16	Area north of 173rd St. and Wolf Rd.	25, 50, 100, 500		Project MACR-1 addresses flooding in this area
MPA17	Area north of 175th St. and 110th Ct.	5, 10, 25, 50, 100, 500		Project MACR-1 addresses flooding in this area
MPA18	Homes on Marley Brook Ct.	100, 500	OP3	Project MACR-1 addresses flooding in this area

3.20.3.3 Technology Screening

Flood control technologies were screened to identify appropriate technologies for addressing the flooding problems in Marley Creek. Storage was the primary potential technology considered for addressing flooding problems along Marley Creek. Levees were not considered as the properties with flood damages were located far apart and the existing inundation area is rather large with deep flood elevations.

TABLE 3.20.5
Estimated Damages for Marley Creek

Damage Category	Estimated Damage ($)	Note
Property	472,500	
Erosion	0	
Transportation	70,900	Assumed as 15% of property damage
Recreation	0	

3.20.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding were developed and evaluated consistent with the methodology described in Section 1.3.8 of this report. Table 3.20.6 summarizes flood control alternatives developed for Marley Creek.

TABLE 3.20.6
Flood Control Alternatives for Marley Creek

Alternative Number	Location	Description
MACR-1	Marley Creek at Wolf Road crossing	117 acre-feet detention upstream of flooding problems with overflow pipe and overflow weir
MACR-2	Long Run Creek at Will-Cook Road crossing	Three detention basins, 117 acre-feet, 21acre-feet, 8 acre-feet, each with low flow pipe and overflow weirs. This alternative did not effectively reduce water surface elevations beyond reduction caused by MACR-1 in the flooding problem area, thus benefits and costs were not developed.

Stormwater detention alternatives were modeled for Marley Creek to relieve the flooding in the areas around Wolf Road (listed in Table 3.20.4 as modeled flooding problem areas MACR2 and MACR3). Alternative MACR-1, a detention basin on large, vacant parcels just upstream of 171st Street and Wolf Road was effective in lowering flooding damages. One major parcel of open land considered for stormwater detention is owned by the Archdiocese, near the intersection of Marley Creek and Wolf Road.

Erosion Control Alternatives. No erosion control alternatives were developed for Marley Creek.

3.20.3.5 Alternative Evaluation and Selection

The alternatives listed in Table 3.20.6 were evaluated to determine their effectiveness and to produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. MACR-2 did not result in additional WSEL reduction as compared to MACR-1. A summary of B/C ratios, net benefits, total project costs, number of structures protected, and other relevant alternative data is provided in Section 3.20.3.6. Alternatives that did not produce a significant reduction in water surface are not listed in this table.

Recommended alternatives result in reduced stage and/or flow along the modeled waterway. Table 3.20.7 provides a comparison of the modeled maximum WSEL, and modeled flow at the time of peak at representative locations along the waterway.

TABLE 3.20.7
Marley Creek Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		MACR-1	
Location	Station	Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
104th Ave and 159th St.	20877	686.07	159.38	686.07	159.87
100-ft upstream of 108th Ave.	16990	685.19	560.94	685.17	561.69
Downstream of Wolf Rd.	11480	679.64	672.33	679.18	609.32
NE of 175th St. and Wolf Rd.	7271	677.18	903.94	676.69	775.04

TABLE 3.20.7
Marley Creek Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		MACR-1	
Location	**Station**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**
104th Ave and 159th St.	20877	686.07	159.38	686.07	159.87
500-ft downstream of Marley Creek Tributary B confluence	5177	677.02	1442.96	676.34	1215.68
400-ft downstream of 179th St.	2690	673.06	1560.01	672.68	1304.69
Cook-Will County line	266	670.50	1708.14	670.08	1440.32

It is recognized that alternative MACR-1 is a large capital project that results in benefits to a few structures, and a low B/C ratio. When isolated structures require such a large capital project to address flood damages, flood-proofing may be a more cost-effective alternative. A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

Although not contributing to modeled damages, channel maintenance downstream of 108th Avenue is recommended to address debris and sedimentation in this portion of the creek.

3.20.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternatives. Table 3.20.8 lists alternatives analyzed in detail. The recommended alternative MACR-1 is shown in Figure 3.20.2. A comparison of the existing conditions and alternative conditions inundation mapping is included in this figure.

TABLE 3.20.8
Marley Creek Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
MACR-1	Construct 117 ac-ft detention basin	0.01	160,100	15,985,700	3		Slightly Positive	Yes	Orland Park

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.21 Melvina Ditch

Melvina Ditch is tributary to Stony Creek in southwestern Cook County, north of the Calumet-Sag Channel, in the northern portion of the Calumet-Sag Channel Watershed. The open channel portion of Melvina Ditch is just less than one mile long; however, it drains a heavily sewered tributary area of 8.5 square miles. Seven communities are tributary to Melvina Ditch (Table 3.21.1), with principal sources of flow from Bedford Park, Burbank, and Oak Lawn.

TABLE 3.21.1
Communities Draining to Melvina Ditch

Community/Tributary	Tributary Area (mi^2)
Burbank	3.76
Bedford Park	2.57
Oak Lawn	1.51
Bridgeview	0.21
Chicago Ridge	0.18
Unincorporated/Forest Preserve	0.13
Chicago	0.09

The Melvina Ditch tributary area is almost entirely developed, with large amounts of impervious area associated with residential and commercial development. The distribution of land use within Melvina Ditch tributary area is summarized in Table 3.21.2.

TABLE 3.21.2
Land Use Distribution for Melvina Ditch

Land Use Category	Area (acres)	%
Residential	2,883.1	53.3
Commercial/ Industrial	1,353	25
Transportation/Utility	525.8	9.7
Forest/Open Land	404.6	7.5
Institutional	240.5	4.4
Water/Wetland	7.1	0.1

Two reservoirs within the Melvina Ditch tributary area provide significant storage for the watershed. At the upstream part of the tributary area, the 300 acre-feet Bedford Park reservoir detains flows from Bedford Park. The outlet from this reservoir is controlled by a sluice gate that is closed during rainfall events to protect downstream areas. The Melvina Ditch Reservoir, located in Burbank, provides 165 acre-feet of stormwater detention. During a storm, the reservoir can be pumped up to a rate of 200 cfs discharging to Melvina Ditch. A significant part of the watershed downstream of Melvina Ditch Reservoir has no significant stormwater detention. Figure 3.21.1 is an overview of the tributary area of the subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown on the figure, and are discussed in the following subsections.

3.21.1 Sources of Data

3.21.1.1 Previous Studies

No recent studies of Melvina Ditch are known to exist. The report *Preliminary Report on Melvina Ditch* (Consoer, Townsend & Associates/District, 1968) was reviewed to obtain information relevant to the Calumet-Sag Channel DWP development. It examines the capacity of Melvina Ditch to accept flows discharged from the Melvina Ditch Reservoir. No data from the report was used to support modeling or the development and evaluation of alternatives for the Calumet-Sag Channel DWP.

3.21.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Melvina Ditch. No reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report* (which includes the CWA 303(d) and 305(b) lists). No TMDLs have been established for Melvina Ditch. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Melvina Ditch. Municipalities discharging to Melvina Ditch are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.21.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes 87.2 acres of wetland areas in the Melvina Ditch subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.21.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated in the revised floodplains.

Melvina Ditch is mapped in detail in DFIRM mapping update, with Zone AE floodplain defined for the length of the ditch. The original hydrologic and hydraulic analysis was performed in 1979. Hydrologic modeling was performed by using TR-20 in combination with regression equations from 1974. Steady state hydraulic routing was performed using the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.21.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Stormwater problems were classified as regional or local based upon the criteria described in Section 1 of the report. Table 3.21.3 summarizes the Form B data.

3.21.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Melvina Ditch subwatershed.

TABLE 3.21.3
Community Response Data for Melvina Ditch

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
BU1	Burbank	Overbank flooding, storm sewer capacity	87th St. and Natchez Ave.	Overbank flooding and ponding has historically occurred surrounding the Melvina Ditch Reservoir. The District made improvements to the reservoir and coordinated with Bedford Park, with no problems at the reservoir reported since.	Local	Problem not located on a regional waterway.
BU2	Burbank	Pavement flooding	Route 50 (Cicero Ave.) at Keller Dr. (77th Street Viaduct)	IDOT reported pavement flooding	Local	Problem not located on a regional waterway
CR1	Chicago Ridge	Maintenance, ponding	Melvina Ditch at West Stony Creek	Previously reported maintenance request (Nov 2006) at confluence with Stony Creek	Regional	Removal of debris to be addressed by stream maintenance
CR2	Chicago Ridge, Oak Lawn	Bank erosion, sedimentation	Melvina Ditch along Chicago Ridge Mall (between 95th St. and West Stony Creek)	Sediment and erosion problems, lack of maintenance	Regional	Project MEDT-1 addresses erosion problems between 95th and 99th Street
CR3	Chicago Ridge	Overbank flooding	Confluence of Melvina Ditch with Stony Creek	The adverse confluence angle of Melvina Ditch with Stony Creek is perceived to contribute to higher flood stages along West Stony Creek	Regional	Impact of Melvina Ditch junction angle was considered, and analysis concluded that the adverse angle has no significant impact on flooding.

3.21.2 Watershed Analysis

3.21.2.1 Hydrologic Model Development

Subbasin Delineation. The Melvina Ditch tributary area was delineated based upon LiDAR topographic data developed by Cook County in 2003. Forty subbasins were defined with an average size of 146.4 acres. The Melvina Ditch tributary area is flat and generally drained by storm sewer systems. Significant modifications to the initial topographic delineation were required to accurately characterize drainage patterns into the Bedford Park and Melvina Ditch Reservoirs based upon available storm sewer data.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

Reservoirs. The Bedford Park and Melvina Ditch reservoirs each were represented as reservoirs in the Melvina Ditch subwatershed hydrologic model. The depth-volume relationship of the 165 acre-foot Melvina Ditch reservoir and the 277 acre-foot Bedford Park reservoir were obtained from Cook County topographic data. The Bedford Park reservoir drains by gravity through a 4-foot sluice gate. District M&O personnel reported that the gate is closed during storms to maximize storage in the reservoir and to reduce downstream flow to the Melvina Ditch Reservoir. The Melvina Ditch Reservoir is drained by three stormwater pumps, each with a capacity of 66 cfs (District *M&O Facilities Handbook,* 2006). The maximum pumped discharge rate from Melvina Ditch Reservoir is 200 cfs.

Flow Restrictions. Most of the tributary area represented in the Melvina Ditch hydrologic model is sewered. The storm sewer network and the hydraulic capacity generally are not represented in the hydrologic model. Where surface topography is very flat, indicating limited overland flow, it was necessary to limit the flow conveyed within the hydrologic model to the estimated conveyance capacity of the sewer. The 120-inch pipe influent to the Melvina Ditch Reservoir was limited to 600 cfs capacity. In addition, an 84-inch storm sewer in Oak Lawn flows east into the discharge pipe from Melvina Ditch Reservoir at the intersection of 93rd Street and Nashville Avenue. The conveyance capacity of this pipe was limited to roughly 200 cfs. Approximately 1.5 square miles of Oak Lawn discharges to Melvina Ditch through a number of storm sewers downstream of the Melvina Ditch Reservoir, including 42-inch and 84-inch storm sewers along 93rd Street (upstream of the open channel portion of Melvina Ditch). Peak flows from this heavily developed area of Oak Lawn are estimated as approximately 540 cfs, which is more than twice the peak discharge from the Melvina Ditch Reservoir.

Combined Sewer. Roughly 320 acres of the Melvina Ditch tributary area in Bedford Park is served by combined sewers. The combined sewers convey an estimated 0.25 cfs/acre of runoff out of the Melvina Ditch subwatershed through the District interceptor. Runoff in excess of 0.25 cfs/acre was routed through the Melvina Ditch hydrologic model.

3.21.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. Surveys of the open channel part of Melvina Ditch and all crossings were performed to characterize the channel and near overbank channel geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficients along the modeled stream length.

Boundary Conditions. The Melvina Ditch model is a component of the larger Stony Creek hydraulic model, with downstream water surface defined by the Stony Creek water surface elevation.

3.21.2.3 Calibration and Verification

Observed Data. The wet well elevation of Melvina Ditch Reservoir is recorded continuously on paper charts, which were obtained and compared with model results for the storm events of September 13, 2008 and August 23, 2007. Reservoir elevations were extracted from the chart at hourly intervals, and typical values and patterns preceding and following the storm were noted. An elevation of 3.5 feet was observed to be the average wet well elevation when the reservoir is dry. Therefore, 3.5 feet was subtracted from charted wet-well elevations for comparison with the hydrologic model results. For the August 23, 2007 event, a dry weather flow value of 7.5 ft was subtracted from the recorded level to represent a baseflow observed on the paper charts.

Verification Results. The hydrologic and hydraulic models were evaluated using the revised curve numbers reduced by 10 percent from the originally calculated values, as described in Section 1.3.8. This adjustment was based upon calibration evaluations in other subwatersheds that had gage data available. Figures 3.21.2 and 3.21.3 show model results for the reservoir depth compared with the monitoring data. Peak depths are summarized in Table 3.21.4.

TABLE 3.21.4
Peak Depths

Rainfall Event	Recorded Reservoir Depth (ft)	Modeled Wet-Well Depth (ft)	Difference (ft)
08/23/2007	10.5	10.87	0.33
09/13/2008	19	19.7	0.7

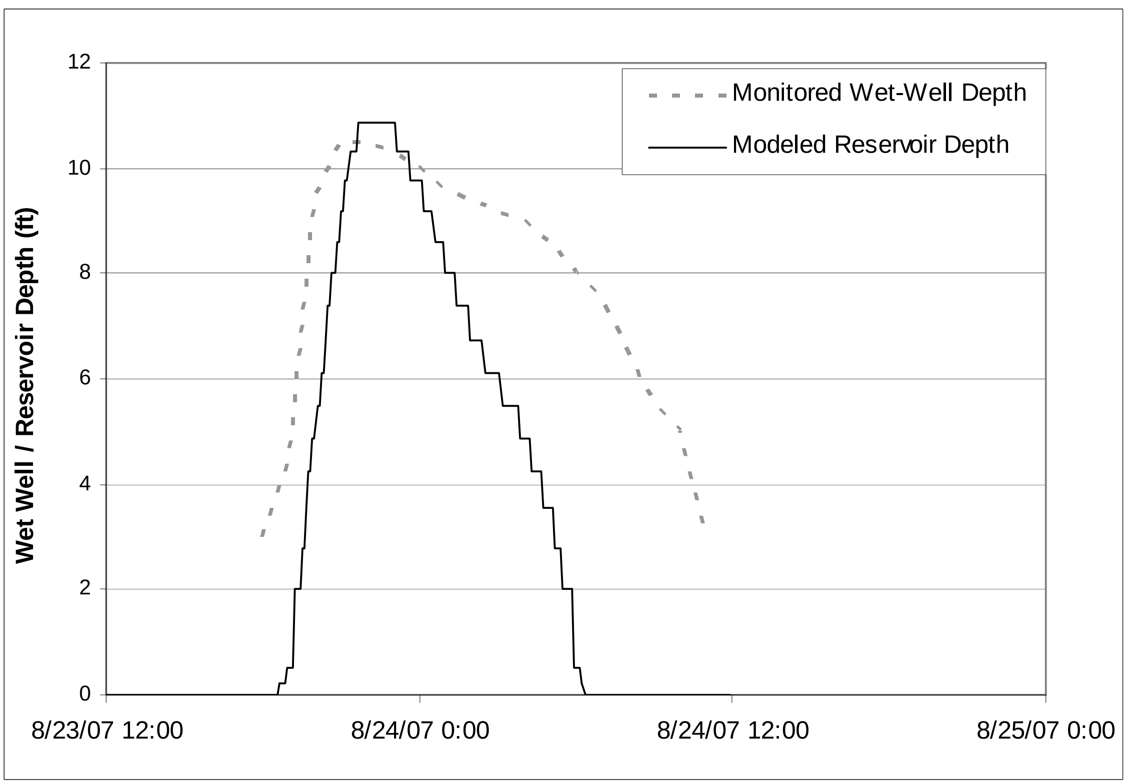
As Figures 3.21.2 and 3.21.3 demonstrate, the Melvina Ditch hydrologic model is generally accurate in predicting reservoir depths for the historic rainfall events considered. It is likely that operational decisions of the pumps discharging from Melvina Ditch Reservoir, or operation of the sluice gate regulating discharge from the Bedford Park Reservoir, contribute to some of the observed discrepancy. Some of the variables potentially impacting the ability to simulate Melvina Ditch Reservoir inflows and outflows include the following:

- **Reservoir Operation—**Actual operation of the Melvina Ditch Reservoir, or the upstream Bedford Park Reservoir, may deviate from generalized understanding of typical operating procedures. The Bedford Park sluice gate is kept closed in the hydrologic model, although in reality, the gate is opened following the storm to allow discharge to the Melvina Ditch Reservoir.
- **Monitoring Accuracy—**Recorded wet well elevation data include some atypical patterns that may not be accurate.

- **Rainfall Variability—**A single rain gage (ISWS Gage 12) was used to represent rainfall in the 8.47-square-mile tributary area of Melvina Ditch for modeled events. Variability in timing and intensity of actual rainfall within the tributary area is likely. Likely variability of rainfall data is evident during the 9/14 storm event when recorded stage data in the Melvina Ditch Reservoir showed an increase that did not correspond to the recorded rainfall data at ISWS Gage 12. District rain gage data was also reviewed and determined to be consistent with ISWS gage data.
- **Hydraulics of Tributary System—**The hydrologic model delivering flows to Melvina Ditch Reservoir has a limited ability to model hydraulic restrictions in storm sewers within the area tributary to the reservoir. Inflow into the Melvina Ditch Reservoir was limited to 600 cfs based upon hydraulic limitations of the primary pipe discharging into the reservoir. However, the hydrologic model does not generally reflect hydraulic restrictions in within the local Burbank and Bedford Park storm sewer systems.

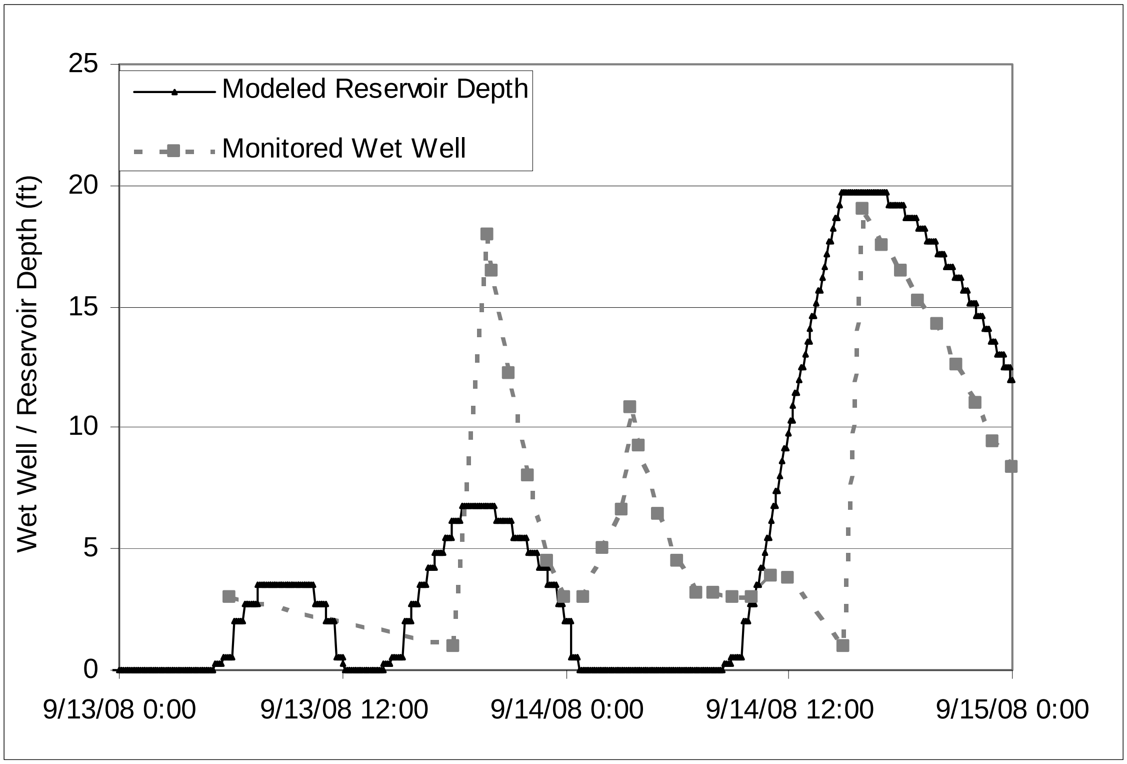
Modifications to Model Input. Curve numbers in the Melvina Ditch subwatershed were reduced by 10 percent from the originally calculated values based upon the calibration effort described in Section 1.3.8.

FIGURE 3.21.2
Modeled vs. Monitored Melvina Ditch Reservoir Depth during August 23, 2007 Storm



* Average recorded dry weather flow wet-well depth of 7.5 feet subtracted from monitored wet well depth

FIGURE 3.21.3
Modeled vs. Monitored Melvina Ditch Reservoir Depth during September 13, 2008 Storm



* Average recorded dry weather flow wet-well depth of 3.5 feet subtracted from monitored wet well depth

3.21.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.21.1 shows inundation areas along Melvina Ditch produced by the hydraulic model for the 100-year, 12-hour duration design storm. Flooding at the downstream end of Melvina Ditch is due to backwater from Stony Creek.

Hydraulic Profiles. Appendix H contains hydraulic profiles of the existing conditions in the Melvina Ditch system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.21.3 Development and Evaluation of Alternatives

3.21.3.1 Modeled Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.21.5 summarizes problem areas identified through hydraulic modeling of Melvina Ditch.

TABLE 3.21.5
Modeled Problem Definition for Melvina Ditch

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Form B	Resolution in DWP
MPA19	Between 99th Street and 98th Street, between Melvina Ditch and the railroad tracks	25, 50, 100		Projects STCR-3 and STCR-8 will reduce flooding in this area

3.21.3.2 Damage Assessment

Economic damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Erosion damages were determined based on the values of structures located within 30-feet of areas of active erosion. Other damages also included in erosion damages for Melvina Ditch include damage to the Nashville Avenue roadway and utilities and the temporary relocation of households for which Nashville Avenue is the only means of access. No recreation damages due to flooding were identified for Melvina Ditch. Transportation damages were estimated as 15 percent of property damage due to flooding. Table 3.21.6 lists the damage assessment for existing conditions.

TABLE 3.21.6
Estimated Damages for Melvina Ditch

Damage Category	Estimated Damage ($)	Note
Property	170,600	
Erosion	340,300	6615 West 95th Street in Oak Lawn at imminent risk of damage due to erosion
Transportation	25,600	Assumed as 15% of property damage due to flooding
Other – Road/Utility Repair/Replacement	1,220,600	Damage to road along Nashville Avenue
Other – Temporary Relocation of Residents	105,000	Temporary relocation of seven households with only Nashville Avenue as means of access to home

3.21.3.3 Technology Screening

Erosion control measures were considered for Melvina Ditch to protect buildings and adjacent infrastructure from damage due to erosion. Due to the steep banks of Melvina Ditch, hard armoring and structural stabilization were considered the most feasible erosion protection measures.

3.21.3.4 Alternative Development

Flood Control Alternatives. No flood control alternatives were developed for Melvina Ditch.

Table 3.21.7 summarizes the two erosion control alternatives developed for Melvina Ditch. The cost estimate for MEDT-1 includes hard armoring of the west bank of Melvina Ditch between 95th and 99th Streets, as well as biostabilization of half of the east bank of the channel, which may be conservative since some locations might not need lining. Some parts of the ditch do not show signs of active erosion and may not require stabilization. The extent of stabilization required to address damages should be confirmed through a detailed evaluation of site conditions conducted during a design study.

TABLE 3.21.7
Erosion Control Alternatives for Melvina Ditch

Alternative	Location	Description
MEDT-1	Between 95th and 99th Street	Hard armoring of west channel banks for both channel banks between 95th and 99th Streets. Reinforced concrete walls were used in cost estimates, however, in some locations, softer channel protection measures may be appropriate and will be determined during the project design phase. Some excavation is required to avoid reduction of channel conveyance capacity. Some excavated material may be replaced within the channel to provide a low flow channel with variable habitat.
MEDT-2	Between 95th and 99th Streets	Enclose Melvina Ditch in two 102-inch pipes (the dimensions of 99th Street crossing). Fill in above pipes and provide vegetative cover for area

3.21.3.5 Alternative Evaluation and Selection

Both MEDT-1 and MEDT-2 propose channel modifications that address all damages associated with erosion problems between 95th Street and 99th Street. The benefits for MEDT-2 include roughly $200,000 in benefits (over a 50-year time horizon) for property damage due to flooding and associated transportation damages. These benefits occur in a location where Oak Lawn has not indicated historic flooding problems. MEDT-1, shown in Figure 3.21.5, is more cost-effective for addressing the erosion problems actively threatening a structure in Chicago Ridge, a 2,200-foot stretch of Nashville Avenue, and associated utilities north of 99th Street. Four additional noneconomic considerations favor MEDT-1 as the recommended alternative to address damages between 95th and 99th streets:

- **USACE Section 14 Funding—**The USACE provides financial support for channel-lining projects that protect public infrastructure from damage due to erosion.
- **Downstream Impacts—**Increased velocity within the enclosed conduit proposed in MEDT-2 would require dissipation downstream to avoid creating erosion damages further downstream. Installation of such a structure could reduce channel conveyance.
- **Aquatic Habitat—**Enclosure of Melvina Ditch reduces aquatic habitat within the Calumet-Sag Channel Watershed. The 2,800-foot stretch of Melvina Ditch upstream of 99th Street is part of the only open channel aquatic environment within the 8.47 square mile watershed.
- **Regulatory Feasibility—**Enclosure of Melvina Ditch may present a greater permitting obstacle than lining of the channel, because of the potential downstream impact combined with loss of aquatic habitat.

MEDT-1 is recommended as a lower cost, feasible improvement to address erosion damages that will continue to worsen without corrective action.

MEDT-1 does not address shallow flooding predicted by the existing conditions in Melvina Ditch subwatershed. A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

3.21.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternatives. Table 3.21.8 lists the total estimated cost, benefits, and B/C ratio for each alternative. The recommended alternative MEDT-1 is shown in Figure 3.21.4. A comparison of the existing conditions and alternative conditions inundation mapping is included in this figure.

TABLE 3.21.8
Melvina Ditch Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
MEDT-1	Hard-armoring of eroding streambank	0.58	1,665,900	2,854,500	8	USACE	Slightly Positive	Yes	Chicago Ridge, Oak Lawn
MEDT-2	Enclosure of channel upstream of 99th Street	0.24	1,862,100	7,743,300	8	USACE	Slightly Negative	No	Chicago Ridge, Oak Lawn

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.22 Merrionette Park Ditch

Merrionette Park Ditch is located in southwestern Cook County, north of the Calumet-Sag Channel, in the northern part of the Calumet-Sag Channel Watershed. The areas of communities that drain to Merrionette Park Ditch are summarized in Table 3.22.1. The population density of the Merrionette Park Ditch subwatershed is relatively high with a mix of urban development and little available open land. Figure 3.22.1 is an overview of the tributary area of the subwatershed. Reported stormwater problem areas and flood inundation areas are shown and are discussed in the following subsections.

TABLE 3.22.1
Communities Draining to Merrionette Park Ditch

Community	Tributary Area (mi^2)
Chicago	3.07
Unincorporated/ Forest Preserve	0.54
Merrionette Park	0.38
Blue Island	0.14
Alsip	0.08
Evergreen Park	0.01

The 4.2-square-mile drainage area is heavily sewered and relatively flat, and discharges to East Stony Creek. Merrionette Park Ditch consists of a manmade channel located in line with Central Park Avenue along the Alsip municipal boundary. The ditch alignment is located directly above a District sanitary sewer interceptor. Table 3.22.2 provides a summary of land use distribution within the Merrionette Park Ditch subwatershed.

TABLE 3.22.2
Land Use Distribution for Merrionette Park Ditch

Land Use Category	Area (acres)	%
Residential	1742.5	64.6
Forest/Open Land	673.4	25
Commercial/Industrial	197.82	7.3
Institutional	77.8	2.9
Water/Wetland	6.4	0.2

3.22.1 Sources of Data

3.22.1.1 Previous Studies

No existing studies of Merrionette Park Ditch were identified for consideration as a component of DWP development.

3.22.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Merrionette Park Ditch. There are no reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for Merrionette Park Ditch. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Merrionette Park Ditch. Municipalities discharging to Merrionette Park Ditch are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.22.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 13.8 acres of wetland areas within the Merrionette Park Ditch subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.22.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as part of the FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated in the revised floodplains.

Merrionette Park Ditch is mapped in detail in DFIRM mapping update, with Zone AE floodplain defined for the length of Merrionette Park Ditch. According to the FIS, the original hydrologic and hydraulic analysis was performed in 1978. The hydrologic modeling was performed by using Regression Equation 73. Steady state hydraulic modeling was performed using the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.22.1.5 Stormwater Problem Data

Table 3.22.3 summarizes reported problem areas reviewed as a part of the DWP development. This reported problem area data was primarily obtained from Form B questionnaire response data provided by watershed communities, agencies, and stakeholders to the District. Problems are classified in Table 3.22.3 as regional or local. This classification is based on a process described in Section 1 of this report.

TABLE 3.22.3
Community Response Data for Merrionette Park Ditch

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
ME1	Merrionette Park, Chicago	Pavement flooding	Kedzie Avenue between 119th St. and 126th St.	IDOT reported pavement flooding	Local	Problem not located on a regional waterway. This is a local problem.

3.22.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Merrionette Park Ditch subwatershed.

3.22.2 Watershed Analysis

3.22.2.1 Hydrologic Model Development

Subbasin Delineation. The Merrionette Park Ditch tributary area was delineated based upon LiDAR topographic data developed by Cook County in 2003. Twenty-five subbasins were delineated for the Merrionette Park Ditch area, with an average subbasin area of 108 acres and a total drainage area of 4.2 square miles.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.22.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. The open channel of Merrionette Park Ditch and all crossings were surveyed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's n roughness coefficients to the stream.

Boundary Conditions. The Merrionette Park Ditch model was combined with the Stony Creek model, with Merrionette Park Ditch directly tributary to East Stony Creek. The downstream boundary condition of Merrionette Park Ditch was defined by East Stony Creek WSEL.

3.22.2.3 Calibration and Verification

No measured or observed stages were available for Merrionette Park Ditch to compare model results to observed flows or stages. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.22.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.22.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Merrionette Park Ditch system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.22.3 Development and Evaluation of Alternatives

3.22.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.22.4 summarizes problem areas identified through hydraulic modeling of Merrionette Park Ditch.

TABLE 3.22.4
Modeled Problem Definition for Merrionette Park Ditch

Problem ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
MPA24	Area around 121st and Lawndale, flooding expands south for larger storms	50, 100, 500		Risk of flooding cannot be feasibly mitigated by structural measures. Affected properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.

3.22.3.2 Damage Assessment

Economic damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. No erosion or recreation damages due to flooding were identified for Merrionette Park Ditch. Transportation damages were estimated as 15 percent of property damages. Table 3.22.5 shows the damage assessment for existing conditions.

3.22.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate for addressing the flooding problems in Merrionette Park Ditch. Increased conveyance or storage was identified as the principal technologies applicable for addressing stormwater problems in Merrionette Park Ditch.

TABLE 3.22.5
Estimated Damages for Merrionette Park Ditch

Damage Category	Estimated Damage ($)	Note
Property	393,200	
Erosion	0	
Transportation	59,000	Assumed as 15% of property damage due to flooding

3.22.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding and streambank erosion problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Table 3.22.6 summarizes flood and erosion control alternatives developed for Merrionette Park Ditch. No feedback from watershed communities was received related to stormwater detention alternatives developed for Merrionette Park Ditch.

Erosion Control Alternatives. No erosion control alternatives were developed for Merrionette Park Ditch.

TABLE 3.22.6
Flood Control Alternatives for Merrionette Park Ditch

Alternative Number	Location	Description
MPDT-1	Oak Hill Cemetery	Construct 37 acre-feet of stormwater detention on Oak Hill Cemetery property at the southeast corner of Central Park Avenue and 119th Street. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
MPDT-2	Merrionette Park Ditch at 123rd Street	Increase size of 123rd Street culvert to 5- by 18-foot box culvert. Adequate land for compensatory storage for this alternative was not available, thus benefits and costs were not developed.

3.22.3.5 Alternative Evaluation and Selection

Alternatives included in Table 3.22.6 were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were evaluated through H&H modeling to evaluate their impact on water elevations and flood damages. There was not sufficient available space for a detention basin larger than the 37 acre-feet in volume at the Oak Hill Cemetery property location, evaluated as MPDT-1. The 37 acre-foot volume was not large enough to reduce flood damages downstream. Alternative MPDT-2 reduced flood damages in the area of Merrionette Park Ditch, but increased flow downstream to Stony Creek, as compensatory storage locations were not available. Because MPDT-1 was not effective and MPDT-2 lacked potential compensatory storage locations, benefits and costs were not developed for these alternatives.

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

3.22.3.6 Data Required for Countywide Prioritization of Watershed Projects

No alternatives are recommended for Merrionette Park Ditch.

3.23 Mill Creek

Mill Creek is a regional waterway located in southwestern Cook County, in the southern portion of the Calumet-Sag Channel Watershed. The 10.6-square-mile drainage area for Mill Creek includes 3.1 square miles of the tributary area from Mill Creek West Branch, which drains to Mill Creek near where Mill Creek crosses 123rd Street. Table 3.23.1 provides a summary of the land area of communities within the Mill Creek subwatershed. Figure 3.23.1 is an overview of the tributary area of the subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown on the figure and are discussed in the following subsections.

TABLE 3.23.1
Communities Draining to Mill Creek

Community	Tributary Area (mi^2)
Unincorporated/ Forest Preserve	5.7
Orland Park	3.4
Palos Park	1.5

The Mill Creek subwatershed contains a mix of suburban development with large areas of open land and forest preserve. Table 3.23.2 summarizes the land use distribution within the subwatershed.

TABLE 3.23.2
Land Use Distribution for Mill Creek

Land Use Category	Area (acres)	%
Residential	2,801	41.1
Forest/Open Land	2,708	39.7
Water/Wetland	485	7.1
Agricultural	299	4.4
Commercial/Industrial	256	3.8
Institutional	179	2.6
Transportation/Utility	86	1.3

3.23.1 Sources of Data

3.23.1.1 Previous Studies

Mill Creek Model (IDNR). The HEC-1 and HEC-2 models developed by the IDNR simulated a small tributary of the Mill Creek subwatershed (0.05 square mile). The segment of the creek modeled is about 1,000 feet long from 135th Street to Pine Street in the Village of Orland Park. The purpose of the modeling was to size pumps for an existing levee. The size of the area modeled and extent of data documented prevented use of the model as a part of Calumet-Sag Channel DWP development.

Mill Creek Model (IDOT). A study was completed by Mackie Consultants for IDOT on an upstream tributary to Mill Creek that runs along Southwest Highway (Mackie Consultants, 2008). This study was performed to address flooding issues along Southwest Highway. The modeling extent of this study did not meet the District's requirements for use as a part of the Mill Creek model; however, the results of this model and suggested alternatives were reviewed and considered as a part of the Calumet-Sag Channel DWP development.

3.23.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Mill Creek. No reaches are identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for Mill Creek. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Mill Creek. Municipalities discharging to Mill

Creek are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.23.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using NWI mapping. NWI data includes 760 acres of wetland area in the Mill Creek subwatershed in Cook County. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.23.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information, but the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated into revised floodplain areas.

Mill Creek is mapped in detail in the DFIRM mapping update, with Zone A and Zone AE floodplain shown across portions of Mill Creek. The original H&H analysis was performed in 1979. The hydrologic modeling was performed using TR-20, L-PTIII, and Regression Equations 73, 75, and 77. Hydraulic routing performed was steady state and used the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.23.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Stormwater problems were classified as regional or local based upon the criteria described in Section 1 of the report. Table 3.23.3 summarizes the Form B data for Mill Creek.

3.23.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. The Village of Orland Park is in the design phase of improvements to existing stormwater detention basins located upstream of Mill Creek near 135th Street and 86th Avenue. Models were not available at the time of DWP development, so the improvements were not included in baseline conditions in the H&H models. The improvements are intended to address reported problem OP7, and this is noted in the DWP.

3.23.2 Watershed Analysis

3.23.2.1 Hydrologic Model Development

Subbasin Delineation. The Mill Creek tributary area was delineated based upon LiDAR topographic data developed by Cook County in 2003. The original delineation of Mill Creek was reviewed against the Cook County topographic data and aerials. No modification to the subwatershed boundary was necessary. Forty-five subbasins were delineated for the Mill Creek tributary area, with an average subbasin area of 152 acres.

TABLE 3.23.3
Community Response Data for Mill Creek

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
OP1	Orland Park	Pavement flooding	Southwest Highway and 135th St.	Flooding several times per year	Regional	Project MICR-4 addresses this problem.
OP13	Orland Park	Pavement flooding	Rte 7 (Southwest Hwy) at Rte 45 (La Grange Rd.)	IDOT reported pavement flooding	Regional	Project MICR-4 addresses this problem.
OP14	Orland Park	Pavement flooding	Route 7 at 145th St. to 148th St.	IDOT reported pavement flooding	Local	Problem not located on a regional waterway. This is a local problem.
OP7	Orland Park	Ponding	Strawberry Ln. (Parkview Estates)	Flooding due to off-site flows from outside village	Regional	Village has contracted with CBBEL to develop a project to address this problem.
PP5	Palos Park	Overbank flooding, basement flooding, water quality, storm sewer capacity, bank erosion, wetland riparian, maintenance	123rd St. between Hobart Avenue and Elm Street	Floodwater exceeds conveyance capacity, and erosion is also affecting northern Groundhog Slough	Regional	Model results show roadway flooding, but no property damage. Due to the availability of alternative routes, a resolution to transportation damages has been deemed unnecessary.
PP6	Palos Park	Overbank flooding, basement flooding, ponding, storm sewer capacity, bank erosion	Southwest Hwy between 131st St. and 135th St.	Flooding due to insufficient capacity reduces or prevents access to businesses in this area	Regional	Project MICR-4 addresses this problem.

TABLE 3.23.3
Community Response Data for Mill Creek

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
PP8	Palos Park	Overbank flooding, basement flooding, storm sewer capacity, bank erosion	Kinvarra Drive and Wild Cherry Lane (9845 Wild Cherry Lane)	Excessive floodwaters result in flooding of a number of houses at least 3 times in the last 10 years. Stream maintenance is required downstream to address sedimentation and debris.	Regional	Project MICR-2 addresses this problem.
PT2	Palos Township	Ponding	Halfway between 104th Ave. and Indian Trail Dr. on Lakeland Dr.	Ponding	Local	Problem not located on a regional waterway. This is a local problem.
PT3	Palos Township	Ponding	West end of Bernice Dr. near 104th Ave. and 131st St.	Ponding	Local	Problem not located on a regional waterway. This is a local problem.
PT4	Palos Township	Ponding	Intersection of Stephen Dr. and Walter Dr.	Ponding	Local	Problem not located on a regional waterway. This is a local problem.
PT8	Palos Township	Maintenance	North and East of intersection of 111th Street (Route 83) and 104th Avenue	CCHD reported flooding due to debris blockages within a poorly maintained ditch on Forest Preserve property	Local	Problem not located on a regional waterway. This is a local problem.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.23.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. Surveys of the open channel part of Mill Creek and all crossings were performed to characterize the channel and near overbank channel geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficients along the modeled stream length.

Boundary Conditions. Boundary condition elevations determined for the Calumet-Sag Channel based on output from the CWS model are included in Appendix E. The elevation produced by the CWS model for the 100-year storm at the outlet of Mill Creek was 584.64 feet NAVD 88, and was used as the downstream boundary condition for the Mill Creek model.

Inflow. The drainage system of Calumet-Sag Tributary B interacts with the Mill Creek drainage system. A railway ditch crosses what was previously a natural drainage divide between the Mill Creek and Calumet-Sag Tributary B subwatersheds. When water surface elevations in Mill Creek reach an elevation of 667 feet NAVD 1988, Mill Creek overflows into the railroad ditch, which flows to Calumet-Sag Tributary B. The overflow hydrograph generated in the Mill Creek hydraulic model was used as input to Calumet-Sag Tributary B hydrologic model to properly represent existing conditions. This overflow results in flow of floodwaters across the subwatershed divide and is reflected in an inundation area that crosses the subwatershed divide in this location.

3.23.2.3 Calibration and Verification

In the hours following the August 20, 2007 storm, evidence of high water elevation marks was observed at four locations on Mill Creek West Branch. The rainfall data from ISWS gage 16, which is the rainfall gage closest to the observed high water elevation, was obtained for this time period. Gage 16 recorded 1.2 inches of rainfall over a 7-hour period. High water marks during the September 13th – 14th, 2008 storm event were not recorded on the Mill Creek watershed.

Table 3.23.4 lists the locations and elevations of the field-observed water surface elevations. The model results are listed for both initial (pre-calibration) model results and calibrated model results (with the 10 percent reduction of the curve number values applied). The difference between the observed and calibrated model water surface elevations are generally considered to be acceptable due to the margin of error associated with high water mark elevation data. High water elevations are taken at a point in time when it is not certain that the peak water elevation occurred. The comparison of observed and model result water surface elevations for the August 20, 2007 storm for the Mill Creek subwatershed serves as a verification of the curve number reduction made watershed-wide based on the calibration to the September 13th – 14th, 2008 storm event.

TABLE 3.23.4
Comparison of Observed and Model Result Water Surface Elevations for August 20, 2007 Storm

Location	Observed High Water Surface Elevation (ft)	Initial Model Results Water Surface Elevation (ft)	Calibrated Model Results Water Surface Elevation (ft)
Mill Creek West Branch at Creek Road	678.1	680.37	679.79
Mill Creek West Branch at Wild Cherry Lane	675.6	677.21	676.47
Mill Creek West Branch at Windsor Drive	674.2	675.43	675.07
Mill Creek West Branch at Hobart Drive	658.2	660.48	659.24

3.23.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Flood inundation areas were developed based on HEC-RAS water surface elevations and Cook County topographic data. Figure 3.23.1, the tributary overview figure, shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Mill Creek system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.23.3 Development and Evaluation of Alternatives

3.23.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.23.5 summarizes major problem areas identified through modeling of Mill Creek.

TABLE 3.23.5
Modeled Problem Definition for Mill Creek

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Form B	Resolution in DWP
MPA20	Area along the Southwest Hwy between LaGrange Road and 135th Street	25, 50, 100, 500	PP6, OP1	Project MICR-4 will reduce flooding in this area.
MPA21	Area around 87th Avenue and 127th Street	50, 100, 500		Project MICR-4 will reduce flooding in this area.
MPA22	Area around 96th Avenue and Wild Cherry Lane	25, 50, 100, 500	PP8	Project MICR-2 will reduce flooding in this area.
MPA23	Area around Wild Cherry Lane and Windsor Drive	25, 50, 100, 500	PP8	Sufficient land was not available in the area for potential capital projects that could address the problem. Such properties are candidates for protection using nonstructural flood control measures, such as floodproofing or acquisition.

3.23.3.2 Damage Assessment

Damages due to flooding were calculated for Mill Creek in accordance with the methodology described in Section 1.4 and are summarized in Table 3.23.6.

TABLE 3.23.6
Estimated Damages for Mill Creek

Damage Category	Estimated Damage ($)	Note
Property	2,390,000	
Erosion	0	
Transportation	849,300	Includes 15% applied to property damage and transportation damages calculated for flooding of Southwest Highway
Recreation	0	

3.23.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate to address the flooding problems in Mill Creek. Stormwater detention and conveyance improvements, along with levees, were identified as potential technologies for addressing flood damages in the Mill Creek watershed. No damages were associated with the reach of Mill Creek downstream of where Mill Creek West Branch discharges to the main branch of Mill Creek.

3.23.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Table 3.23.7 summarizes flood control alternatives developed for Mill Creek.

TABLE 3.23.7
Flood Control Alternatives for Mill Creek

Alternative Number	Location	Description
MICR-1	Flooding along Southwest Highway	53 acre-feet detention basin at LaGrange Road and Southwest Highway, 32 acre-feet detention basin at 131st Street and Southwest Highway, and increased conveyance capacity through replacing 7 existing undersized culverts with 5-foot by 10-foot box culverts between the two detention ponds
MICR-2	Flooding along right overbank of WBMC	Levee off houses along right overbank to prevent flooding on Mill Creek West Branch, provide compensatory storage on open land adjacent to left overbank
MICR-3	Flooding along MICR just upstream of confluence with WBMC	46 acre-feet detention along Mill Creek near 127th Street and 87th Avenue. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
MICR-4	Flooding along Southwest Highway	32 acre-feet detention basin at 131st Street and Southwest Highway, and increased conveyance capacity through replacing 7 existing undersized culverts with 5-foot by 10-foot box culverts between the two detention ponds

Stormwater detention alternatives were modeled to address flooding problems along Mill Creek and Mill Creek West Branch. Alternative MICR-1 consists of two detention basins: one located at the northeast corner of Southwest Highway and LaGrange Road and one located at the southeast corner of 131st Street and Southwest Highway. A tributary to Mill Creek flows along Southwest Highway between these two areas. This tributary flows through seven culverts, all of which are frequently overtopped during storm events. Alternative MICR-1 replaces all seven culverts with 5-foot by 10-foot box culverts to increase conveyance capacity. Alternative MICR-1 addresses the flooding described as problem area MPA20 in Table 3.23.5. This alternative was effective at reducing flood damages in the area and significantly reducing the frequency of overtopping of Southwest Highway. This alternative is similar to the solution proposed in an IDOT report, but includes more storage in order to address the 100-year storm event (Mackie Consultants, 2008).

Alternative MICR-2 consists of a levee in the right overbank to prevent flooding in problem area MPA22. The levee would require compensatory storage, which is proposed in an area in the left overbank opposite the levee. Model results showed that the alternative was effective in protecting flooded structures in the right overbank area while preventing any increase in upstream or downstream water elevations.

Alternative MICR-3 consists of 46 acre-feet of detention along Mill Creek near 127th Street and 87th Avenue. Model results showed that this alternative and other similar storage alternatives analyzed in nearby available areas were not effective in significantly lowering WSELs along Mill Creek. Also, the existing nearby diversion of flows from Mill Creek to Calumet-Sag Tributary B limits the effectiveness of alternatives in this area as lowering the WSEL of Mill Creek just upstream of the diversion causes less diverted flow to Calumet-Sag Tributary B, and does not lower Mill Creek WSELs downstream of the diversion. Downstream of Southwest Highway, Mill Creek enters Cook County Forest Preserve property. Hydraulic model results determined that the 90th Avenue culvert in this area creates a backwater which contributes to the MPA21 flooding problem area. The culvert size could not be increased without increasing downstream WSELs or providing a significant amount of detention in the area. The area was not considered for detention alternatives as it was on Cook County Forest Preserve property.

Alternative MICR-4 was analyzed as an alternative to MICR-1. This alternative consists of the same seven culvert replacements along Southwest Highway and the same 32-acre-feet detention basin located at the corner of 131st Street and Southwest Highway without the 53-acre-feet detention basin at Southwest Highway and LaGrange Road that was proposed as a part of MICR-1. This alternative was nearly as effective at reducing flood damages in the area and reducing the frequency of overtopping of Southwest Highway as MICR-1 at a much lower cost.

Erosion Control Alternatives. No erosion control alternatives were developed for Mill Creek.

3.23.3.5 Alternative Evaluation and Selection

Modeling analysis concluded that MICR-3 could not provide effective stormwater detention resulting in flood damage reduction partly because of the diversion to Calumet-Sag Tributary B. Both the MICR-2 and MICR-4, shown in Figures 3.23.2 and 3.23.3 respectively, alternatives did lower WSEL and are recommended.

Recommended alternatives result in reduced stage and/or flow along the modeled waterway. Table 3.23.8 provides a comparison of the modeled maximum WSEL, and modeled flow at the time of peak at representative locations along the waterway.

TABLE 3.23.8
Mill Creek Existing and Alternative Condition Flow and WSEL Comparison

	Existing Conditions		MICR-2		MICR-4	
Location	**100-yr WSEL (ft)**	**100-yr Flow (cfs)**	**100-yr WSEL (ft)**	**100-yr Flow (cfs)**	**100-yr WSEL (ft)**	**100-yr Flow (cfs)**
Mill Creek West Branch just upstream of Wild Cherry Ln.	679.97	509.83	679.97	509.83	679.97	509.82
Mill Creek West Branch upstream of Powell Rd. and 96th Ave.	678.33	569.83	678.33	569.83	678.33	569.69
Mill Creek 100-ft upstream of 135th St.	673.91	347.97	673.91	347.97	673.46	312
Mill Creek 100-ft upstream of Southwest Hwy	669.2	470.77	669.2	470.77	669.04	463.99
Mill Creek 60-ft upstream of 123rd St.	652.11	524.58	652.11	524.58	652.06	510.99
Mill Creek 50-ft upstream of 119th St.	628.29	1386.42	628.29	1386.42	628.16	1352.78

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

The alternatives listed in Table 3.23.7 were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. A summary of B/C ratios, net benefits, total project costs, number of structures protected, and other relevant alternative data is provided in Table 3.23.9. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, and thus costs were not calculated for these alternatives.

3.23.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternatives. Table 3.23.9 lists alternatives analyzed in detail. The recommended alternatives are MICR-2 and MICR-4, and are shown in Figures 3.23.2, and 3.23.3. A comparison of the existing conditions and alternative conditions inundation mapping is included in these figures.

TABLE 3.23.9
Mill Creek Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
MICR-1	Increased convey-ance and storage	0.04	601,900	14,541,200	3	IDOT	Slightly Positive	No	Orland Park
MICR-2	Levee and storage	0.2	409,600	2,003,400	6		Slightly Positive	Yes	Palos Park
MICR-4	Increased convey-ance and storage	0.1	459,000	5,918,100	3	IDOT	Slightly Positive	Yes	Orland Park

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.24 Mosquito Creek

Mosquito Creek is located in southwestern Cook County, north of the Calumet-Sag Channel, in the eastern part of the Calumet-Sag Channel Watershed. Table 3.24.1 summarizes the areas of communities that drain to Mosquito Creek, which is also known as the Alsip Drainage Ditch. The Mosquito Creek subwatershed contains a mix of suburban development and a moderate amount of available open land. Most of the open land within the watershed is cemetery. The drainage area is 0.9-square-miles. Figure 3.24.1 provides an overview of the tributary area of the subwatershed.

Mosquito Creek is a mixture of open channel and long sections of closed-conduit, and a considerable portion of the original tributary area has been diverted through sewer pipes to the Calumet-Sag Channel. Table 3.24.2 lists the land use breakdown by area within the Mosquito Creek subwatershed.

TABLE 3.24.1
Communities Draining to Mosquito Creek

Community	Tributary Area (mi^2)
Alsip	0.91

TABLE 3.24.2
Land Use Distribution for Mosquito Creek

Land Use	Area (acres)	%
Commercial/Industrial	185.9	32
Forest/Open Land	171.7	29.6
Residential	141.2	24.3
Transportation/Utility	81	13.9
Institutional	1.2	0.2
Water/Wetland	0.1	0

3.24.1 Sources of Data

3.24.1.1 Previous Studies

No existing studies of Mosquito Creek were identified.

3.24.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Mosquito Creek. There are no reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the 303(d) and 305(b) lists. No TMDLs have been established for Mosquito Creek. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Mosquito Creek. Municipalities discharging to Mosquito Creek are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.24.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes 6.2 acres of wetland areas in the Mosquito Creek subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.24.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated in the revised floodplains. Mosquito Creek is not mapped in detail in the DFIRM mapping update; it is currently mapped as an unnumbered Zone A labeled as the Alsip Drainage Ditch. Therefore, there was no known model that meets the criteria established in Chapter 6 of the CCSMP for use in the development of DWPs.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.24.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. There were no reported problems along Mosquito Creek.

3.24.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Mosquito Creek subwatershed.

3.24.2 Watershed Analysis

3.24.2.1 Hydrologic Model Development

Because of the drainage pattern of Mosquito Creek, with a series of local drainageways intermittent with sewers, but no continuous defined open channel, the subwatershed was modeled with hydrologic modeling only. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.24.3 Development and Evaluation of Alternatives

There were no regional problem areas reported or identified through modeling of Mosquito Creek, so no alternatives were developed.

3.25 Navajo Creek

Navajo Creek is located in southwestern Cook County, south of the Calumet-Sag Channel, in the central part of the Calumet-Sag Channel Watershed. Table 3.25.1 lists the areas of communities that drain to Navajo Creek. Figure 3.25.1 is an overview of the tributary area of the subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown, and are discussed in the following subsections.

The population density of the Navajo Creek subwatershed is relatively high with a mix of suburban development and little available open land. The drainage area is roughly 2.9 square miles and heavily sewered. Navajo Creek is a natural open-channel stream, except in areas located between 76th Avenue and Harlem Avenue where it passes through a City of Palos Heights storm sewer system. Navajo Creek discharges into the Calumet-Sag Channel. Table 3.25.2 lists the land use breakdown by area within the Navajo Creek subwatershed.

TABLE 3.25.1
Communities Draining to Navajo Creek

Community	Tributary Area (mi^2)
Palos Heights	2.21
Unincorporated/Forest Preserve	0.56
Orland Park	0.08
Palos Park	0.02

TABLE 3.25.2
Land Use Distribution for Navajo Creek

Land Use Category	Area (acres)	%
Residential	1,175.8	64.1
Forest/Open Land	462.8	25.2
Institutional	104.5	5.7
Commercial/Industrial	48.7	2.7
Transportation/Utility	29.2	1.6
Water/Wetland	12.7	0.7

3.25.1 Sources of Data

3.25.1.1 Previous Studies

No studies of Navajo Creek were identified for consideration as a component of DWP development.

3.25.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Navajo Creek. There are no reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the 303(d) and 305(b) lists. No TMDLs have been established for Navajo Creek. Lake Arrowhead is located within the Navajo Creek Watershed. It is an upstream lake that is tributary to Navajo Creek. Lake Arrowhead is listed as impaired for mercury in the IEPA's 2008 *Integrated Water Quality Report*. Its identification number is IL_RHZE and its designated use is fish consumption. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Navajo Creek. Municipalities discharging to Navajo Creek are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.25.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 52.3 acres of wetland areas in the Navajo Creek subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.25.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information, but the effective models used to estimate flood levels generally were not updated. LOMRs were incorporated in the revised floodplains.

Navajo Creek is mapped in detail in the DFIRM mapping update, with Zone AE floodplain defined for the length of Navajo Creek. According to the FIS, the original hydrologic and hydraulic analysis was performed in 1978. The hydrologic modeling was performed by using Regression Equations 73 and L-PTIII. Hydraulic routing performed was steady state and used the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.25.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Table 3.25.3 lists reported problems along Navajo Creek. In several cases, separate Form B entries submitted by Palos Heights were combined into a single problem area. This was typically done with individual properties located in the same vicinity that were listed in multiple locations on Form B questionnaires.

3.25.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Navajo Creek subwatershed.

3.25.2 Watershed Analysis

3.25.2.1 Hydrologic Model Development

Subbasin Delineation. The Navajo Creek tributary area was delineated based upon LiDAR topographic data developed by Cook County in 2003. Thirteen subbasins were delineated for the Navajo Creek area, with an average subbasin area of 143 acres and a total drainage area of 2.9 square miles. Storage provided by Lake Arrowhead was included in the hydrologic model.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

TABLE 3.25.3
Community Response Data for Navajo Creek

Problem ID	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
PH2	Ponding	12605 Melvina Ave.	Ponding in ROW about 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local problem.
PH3	Ponding	Palos Meadows Subdivision near 131st Street and 71st Avenue (includes 13013 Oak Park Avenue).	Flooding throughout neighborhood 2 to 5 times a year	Regional	Project NVCR-3 addresses this problem.
PH4	Ponding	12500 McCarthy Rd. and on Carmichael Dr. west of 76th Ave.	Storm sewer restriction at McCarthy Rd. and ponding at nearby school detention pond	Local	Problem not located on a regional waterway. This is a local problem.
PH5	Ponding	21 Country Squire Ct. near 76th Ave. and College Dr.	Ponding in ROW and front yard, 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local problem.
PH6	Ponding	12601 Harold Ave., 12542 74th Ave., and 12542 75th Ave.	Ponding in ROW 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local problem.
PH7	Ponding	124th Avenue and 69th Court; and 12217 68th Court	Ponding in ROW 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local problem.
PH8	Basement flooding, ponding	12002 Harold Ave.	Basement and backyard flooding due narrow conveyance of overflow from 76th Avenue	Local	Problem not located on a regional waterway. This is a local problem.

TABLE 3.25.3
Community Response Data for Navajo Creek

Problem ID	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
PH9	Ponding	12102,12232, 12303, and 12312 71st Avenue	Ponding in ROW 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local problem.
PH10	Ponding	12333 69th Ave. near Navajo Creek and Oak Park Ave. and College Dr.	Flooding in street ROW in front of residence, about 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local problem.
PH12	Ponding	12911 71st Court	Sewer backup caused by high Navajo Creek Elevation 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local problem.
PH13	Ponding	13032 71st Ave.	Flooding in backyard 2 to 5 times a year	Regional	Project NVCR-3 addresses this problem.
PH14	Ponding	6843 Evergreen Ave.	Ponding in ROW 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local storm sewer problem.
PH15	Ponding	Approximately 150 ft west of 76th Avenue on north side of McIntosh Drive	Flooding 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local storm sewer problem.
PH16	Flooding	11938 68th Ct.	Flooding in ROW 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local storm sewer problem.
PH17	Overbank flooding, basement flooding	Nashville Ave. and 125th St.	Flooding in ROW 2 to 5 times a year	Regional	Project NVCR-5 will reduce flooding in this area.
PH18	Flooding	127th Street and 70th Avenue	Navajo Creek elevation affects this area	Regional	Project NVCR-5 will reduce flooding in this area.
PH19	Basement flooding, ponding, storm sewer capacity	Approximately 150 ft north of 131st Street on west side of Cypress Lane	Flooding 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local storm sewer problem.
PH20	Ponding, pavement flooding	12001 73rd Ct., 12151 73rd Ave., and 12412 73rd Ave.	Flooding in ROW 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local storm sewer problem.

TABLE 3.25.3
Community Response Data for Navajo Creek

Problem ID	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
PH21	Storm sewer capacity	7350 Choctaw Rd.	Flooding in backyard 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local storm sewer problem.
PH22	Ponding	12224 Cheyenne Dr.	Ponding in ROW 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local storm sewer problem.
PH23	Ponding	12250 76th Ave. and 12223 Richard Ave.	Ponding in ROW 2 to 5 times a year	Local	Problem not located on a regional waterway. This is a local storm sewer problem.

3.25.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. The open channel of Navajo Creek and all crossings were surveyed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficient to the stream. Field survey information is available in Appendix D.

Boundary Conditions. Appendix E contains boundary condition elevations determined for the Calumet-Sag Channel based on output from the Chicago Waterway model. The elevation produced by the CWS model for the 100-year storm at the outlet of Navajo Creek was 585.02 feet NAVD 88, roughly 4 feet above the invert of Navajo Creek near its confluence with the Calumet-Sag Channel. This relatively shallow depth indicates that the downstream stage on Navajo Creek is controlled not by the receiving system, but by its own capacity to convey flows received from its tributary area. Normal depth assuming a friction slope of 0.005 was used as a downstream boundary condition for Navajo Creek.

3.25.2.3 Calibration and Verification

In the hours following the August 20, 2007 storm, evidence of a high water elevation was observed at the downstream end of Navajo Creek, 240 feet downstream of College Drive. The rainfall data from ISWS gage 16, which is the rainfall gage closest to the observed high water elevation, was obtained for this time period. Gage 16 recorded 1.2 inches of rainfall over a 7-hour period. High water marks during the September 13th – 14th, 2008 storm event were not recorded on the Navajo Creek watershed.

Table 3.25.4 lists the location and elevation of the field-observed water surface elevation and the peak modeled water surface elevation. The model results are listed for both initial (pre-calibration) model results and calibrated model results (with the 10 percent reduction of curve number values applied). The difference between the observed and calibrated model water surface elevations are generally considered to be acceptable due to the margin of error associated with high water mark elevation data. High water elevations are taken at a point in time when it is not certain that the peak water elevation occurred. The comparison of observed and model result water surface elevations for the August 20th, 2007 storm for the Navajo Creek subwatershed serves as a verification of the curve number reduction made watershed-wide based on the calibration to the September 13th – 14th, 2008 storm event.

TABLE 3.25.4
Comparison of Observed and Model Result Water Surface Elevations for August 20, 2007 Storm Event

Location	Observed High Water Surface Elevation (ft)	Initial Model Results Water Surface Elevation (ft)	Calibrated Model Results Water Surface Elevation (ft)
240 feet downstream of College Drive	585.0	586.01	585.69

3.25.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.25.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Navajo Creek system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.25.3 Development and Evaluation of Alternatives

3.25.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.25.5 summarizes problem areas identified through hydraulic modeling of Navajo Creek.

TABLE 3.25.5
Modeled Problem Definition for Navajo Creek

Problem ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
MPA25	Area east of Harlem Avenue, around 127th Street	5, 10, 25, 50, 100, 500	PH18	Project NVCR-5 will reduce flooding in this area.
MPA26	Area around S. Oak Park Avenue north of W. 125th Street	25, 50, 100, 500	PH17	Project NVCR-5 will reduce flooding in this area.

TABLE 3.25.5
Modeled Problem Definition for Navajo Creek

Problem ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
MPA27	Northeast side of Trinity Christian College	500		Project NVCR-5 will reduce flooding in this area.

3.25.3.2 Damage Assessment

Economic damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. No erosion or recreation damages due to flooding were identified for Navajo Creek. Transportation damages were estimated as 15 percent of property damages. Table 3.25.6 lists the damage assessment for existing conditions.

TABLE 3.25.6
Estimated Damages for Navajo Creek

Damage Category	Estimated Damage ($)	Note
Property	2,817,200	
Erosion	0	
Transportation	497,100	Assumed as 15% of property damage due to flooding

3.25.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate for addressing the flooding problems in Navajo Creek. Increased conveyance or storage was identified as the principal technologies applicable for addressing stormwater problems in Navajo Creek.

3.25.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding and streambank erosion problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Table 3.25.7 provides a summary of flood and erosion control alternatives developed for Navajo Creek.

Based on community feedback, flood damage reduction alternatives developed for Navajo Creek were focused on detention facilities and channel diversions. The City of Palos Heights suggested several potential locations for detention facilities. These included a Lake Arrowhead expansion by raising an existing forest preserve pathway by one additional foot, a steep ravine area near Misty Meadow Drive and Kirkcaldy Court, and along a downstream portion of Navajo Creek on Trinity Christian College property. The City of Palos Heights also suggested Harlem Avenue, 70th Avenue, and Oak Park Avenue as potential channel diversion alignment locations.

Alternatives are described in Table 3.25.7. Figure 3.25.2 shows the locations and a summary of the alternatives described in Table 3.25.7. Alternatives NVCR-1, NVCR-2, and NVCR-4 involve large amounts of excavation to construct stormwater detention facilities. Alternative NVCR-3 does not involve significant excavation, but rather is a minor modification to an existing pond to provide a small amount of additional detention volume. Alternatives NVCR-5, NVCR-6, NVCR-7, and NVCR-8 require significant conveyance infrastructure to deliver flows from Navajo Creek to the Calumet-Sag Channel. Regulatory approval from regulatory agencies such as IDNR and the USACE would be required. The increased conveyance would involve new outfalls with additional flow to the Calumet-Sag Channel. Other alternatives recommended in the DWP include storage and will result in lower peak discharge rates at points where tributaries discharge to the Calumet-Sag Channel. All flows from individual tributaries are relatively small in comparison to total flow within the Calumet-Sag Channel.

Erosion Control Alternatives. There were no erosion control alternatives analyzed for Navajo Creek.

3.25.3.5 Alternative Evaluation and Selection

Alternatives included in Table 3.25.7 were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. Table 3.25.10 provides a summary of B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data.

Alternatives that did not produce a significant change in inundation areas (NVCR-1, NVCR-2, NVCR-4, NVCR-6, and NVCR-9) are not listed as benefits were negligible, and thus costs were not calculated for these alternatives. NVCR-3 consists of expanding Lake Arrowhead by raising an existing forest preserve pathway by a height of one additional foot. Hydrologic model results demonstrated that this alternative effectively prevents the 100-year storm event from overtopping, thus preventing flooding problems related to Lake Arrowhead overtopping immediately downstream of Lake Arrowhead.

Although alternative NVCR-8 has a higher B/C ratio, alternative NVCR-5 is recommended because there is the potential of cost-sharing with the City of Palos Heights, which indicated through community feedback that an alignment along Harlem Avenue may provide a potential opportunity for the City to address its local problems. NVCR-7 is not recommended because it addresses the same problem area as NVCR-5, which has a better B/C ratio. NVCR-11, which is the combination of NVCR-5 and NVCR-8, was analyzed separately in order to determine the benefits realized by the construction of both diversions. NVCR-11 resulted in a lower B/C ratio than NVCR-5, so NVCR-5 alone was recommended.

TABLE 3.25.7
Flood Control Alternatives for Navajo Creek

Alternative Number	Location	Description
NVCR-1	Harlem Avenue and Navajo Creek	Proposed 23 acre-foot detention pond at Harlem Avenue near Navajo Creek outfall from City of Palos Heights storm sewer in a current area of open space. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
NVCR-2	Trinity Christian College (between Menomonee Parkway and 122nd Street)	Two online ponds totaling 180 acre-feet of detention on Trinity Christian College property. Considered concurrently with Alternative NVCR-1. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
NVCR-3	Lake Arrowhead Expansion on Cook County Forest Preserve property southeast of 131st Street and Harlem Avenue	Expansion of Lake Arrowhead by raising existing forest preserve pathway by 1 foot, creating 16 acre-feet of additional detention.
NVCR-4	Area northeast of Misty Meadow Drive and Kirkcaldy Court	Proposed 22 acre-feet pond located upstream of Navajo Creek and cut into a steep ravine in a residential area. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
NVCR-5	Harlem Avenue	Channel diversion at intersection of creek and Harlem Avenue. The pipe diameter was maximized to fit along entire route to Navajo Creek, while maintaining a minimum 2 feet of cover.
NVCR-6	76th Avenue	Channel diversion at intersection of creek and 76th Avenue. The pipe diameter was maximized to fit along entire route to Navajo Creek, while maintaining a minimum 2 feet of cover. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
NVCR-7	70th Avenue	Channel diversion at intersection of creek and 70th Avenue. The pipe diameter was maximized to fit along entire route to Navajo Creek, while maintaining a minimum 2 feet of cover.
NVCR-8	Oak Park Avenue	Channel diversion at intersection of creek and Oak Park Avenue. The pipe diameter was maximized to fit along entire route to Navajo Creek, while maintaining a minimum 2 feet of cover
NVCR-9	Between Harlem Ave and Menominee Parkway	Increase various combinations of culvert sizes within the problem area in attempt to reduce flooding. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
NVCR-11	Between Harlem Ave and Menominee Parkway	Channel diversions along Harlem Ave and Channel diversion along Oak Park Ave

Recommended alternatives result in reduced stage and/or flow along the modeled waterway. Table 3.25.8 provides a comparison of the modeled maximum WSEL, and modeled flow at the time of peak at representative locations along the waterway.

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

TABLE 3.25.8
Navajo Creek Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		NVCR-3		NVCR-5	
Location	**Station**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**
Lake Arrowhead	N/A	630.2	228.9	630.6*	18.3	630.2	228.9
Upstream of 76th Ave.	14417	634.17	326.23	634.17	326.23	634.17	326.29
Upstream of 70th Ave.	8914	617.87	859.99	617.87	859.99	617.52	650.54
230-ft downstream of Oak Park Ave.	6218	612.33	1027.11	612.33	1027.11	611.83	801.22
230-ft upstream of College Dr.	974	596.19	1139.85	596.19	1139.85	595.78	891.08
Confluence with Calumet-Sag Channel	272	585.99	1149.00	585.99	1149.00	585.37	896.16

* Alternative NVCR-3 consists of raising the berm elevation at Lake Arrowhead from 630 ft to 631 ft to contain the 100-year storm event within Lake Arrowhead.

Hydraulic modeling results identified two roadway crossings (state route, US highway, or four-lane road or greater) where Navajo Creek overtops for storm events of 100-year recurrence interval and below. Table 3.25.9 below lists the two locations and provides a summary of the depth of road flooding for existing conditions and with recommended alternatives. Limited available land and topography prevented the reduction of flooding of College Drive to less than 0.5 feet of depth under alternative conditions.

TABLE 3.25.9
Navajo Creek Road Overtopping Summary

Road Crossing	Road Elevation	50-yr Depth of flooding	100-yr Depth of flooding
127th Street	618.9	0.5	0.8
127th Street (with alternative NVCR-5)	618.9	0.1	0.4
College Drive	594.6	0.2	1.0
College Drive (with alternative NVCR-5)	594.6		0.6

Note: Blank entry indicates that road crossing does not overtop for that particular storm event. Although College Drive experiences overtopping greater than 0.5 feet under alternative conditions, alternate routes are available.

3.25.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternatives. Table 3.25.10 lists alternatives analyzed in detail. The recommended alternatives are NVCR-3, raising of the berm downstream of Lake Arrowhead and NVCR-5, construction of a channel diversion from Navajo Creek to the Calumet-Sag Channel beneath Harlem Avenue. The location of NVCR-3 is shown in Figure 3.25.2 and the location of NVCR-5 is shown in Figure 3.25.3. A comparison of the existing conditions and alternative conditions inundation mapping is included in these figures.

TABLE 3.25.10
Navajo Creek Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
NVCR-3	Raise Lake Arrowhead berm three feet to provide one-foot of additional storage and two feet of freeboard	0.69	98,700	143,900	15		No Impact	Yes	Palos Heights
NVCR-5	Harlem Avenue channel diversion	0.15	1,148,300	7,903,100	29		No Impact	Yes	Palos Heights
NVCR-7	70th Avenue channel diversion	0.12	693,500	5,721,300	19		No Impact	No	Palos Heights
NVCR-8	Oak Park Avenue channel diversion	0.21	873,600	4,085,000	19		No Impact	No	Palos Heights
NVCR-11	Channel diversion along Harlem Ave and Channel diversion along Oak Park Ave	0.14	1,678,000	11,988,100	33		No Impact	No	Palos Heights

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.26 Oak Lawn Creek

Oak Lawn Creek is located in southwestern Cook County, north of the Calumet-Sag Channel, in the northern part of the Calumet-Sag Channel Watershed. Table 3.26.1 lists the area of each community tributary to Oak Lawn Creek. The population density of the Oak Lawn Creek subwatershed is relatively high with a mix of urban development and little available open land. Figure 3.26.1 is an overview of the tributary area of the subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown in the figure and discussed in the following subsections.

The drainage area is 3.7 square miles. A stormwater detention pond, known as Lake Oak Lawn, is located at the upstream end of the open-channel part of Oak Lawn Creek, which consists primarily of a manmade channel parallel to the Norfolk and Western Railroad. Oak Lawn Creek discharges into West Stony Creek. Table 3.26.2 lists the land use breakdown by area within the Oak Lawn Creek subwatershed.

TABLE 3.26.1
Communities Draining to Oak Lawn Creek

Community	Tributary Area (mi^2)
Oak Lawn	3.08
Burbank	0.36
Chicago Ridge	0.18
Hometown	0.05

TABLE 3.26.2
Land Use Distribution for Oak Lawn Creek

Land Use Category	Area (acres)	%
Residential	1,582	67.5
Commercial/Industrial	499	21.3
Institutional	144.5	6.2
Forest/Open Land	94.8	4.0
Transportation/Utility	21.5	0.9
Water/Wetland	1.9	0.1

3.26.1 Sources of Data

3.26.1.1 Previous Studies

No studies of Oak Lawn Creek were identified for consideration as a component of DWP development.

3.26.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Oak Lawn Creek. There are no reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists. No TMDLs have been established for Oak Lawn Creek. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Oak Lawn Creek. Municipalities discharging to Oak Lawn Creek are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.26.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes 3.4 acres of wetland areas in the Oak Lawn Creek subwatershed. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.26.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information, but the effective models used to estimate flood levels generally were not updated. LOMRs were incorporated in the revised floodplains.

Oak Lawn Creek is mapped in detail in the DFIRM mapping update, with Zone AE floodplain defined for the length of Oak Lawn Creek. According to the FIS, the original hydrologic and hydraulic analysis was performed in 1979. The hydrologic modeling was performed by using Regression Equations 73 and 74, and L-PTIII. Hydraulic routing performed was steady state and used the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.26.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Table 3.26.3 lists reported problems along Oak Lawn Creek, which include flooding and erosion problems. Problem OL7 includes bank erosion that threatens residential structures. There are about 12 homes in the area within 30 feet of the eroding stream bank and another 3 homes where the bank is actively eroding but still farther than 30 feet from structures. The channel bank has a slope of approximately 2:1 and a 16-foot depth, creating significant shear stresses during flooding conditions when the creek overtops the banks. Several residents have relocated fences a distance of at least 5 feet numerous times due to loss of land.

TABLE 3.26.3
Community Response Data for Oak Lawn Creek

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
OL7	Oak Lawn	Severe bank erosion, sedimentation, maintenance, water quality, overbank flooding	Oak Lawn Creek between Mayfield and Central avenues (near 99th Street and Menard Avenue)	Severe bank erosion such that residential structures are threatened along Oak Lawn Creek.	Regional	Project OLCR-3 will address this erosion problem on a regional waterway that threatens structures by stabilizing stream banks.

TABLE 3.26.3
Community Response Data for Oak Lawn Creek

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
OL8	Oak Lawn	Storm sewer capacity, bank erosion, sedimentation, water quality, overbank flooding	Lake Oak Lawn along East and West Shore Drive	Severe bank erosion such that shorelines, adjacent walks, and structures risk failing. Poorer water quality and loss of wildlife habitat due to increased sedimentation from bank erosion.	Regional	Project OLCR-1 expansion of Lake Oak Lawn will include addressing existing erosion and sedimentation problems within Lake Oak Lawn, and reduce flooding.

3.26.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Oak Lawn Creek subwatersheds.

3.26.2 Watershed Analysis

3.26.2.1 Hydrologic Model Development

Subbasin Delineation. The Oak Lawn Creek tributary area was delineated based upon LiDAR topographic data developed by Cook County in 2003. Twenty-one subbasins were delineated for the Oak Lawn Creek area, with an average subbasin area of 112 acres and a total drainage area of 3.7 square miles.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.26.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. The open channel of Oak Lawn Creek and all crossings were surveyed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficient to the stream. Storage provided by Lake Oak Lawn was included in the hydraulic modeling.

Boundary Conditions. The Oak Lawn Creek model was combined with the Stony Creek model, with Oak Lawn Creek directly tributary to West Stony Creek.

3.26.2.3 Calibration and Verification

No measured or observed stages were available for Oak Lawn Creek to support model calibration. Calibration and verification of the Stony Creek model is discussed in Section 3.28.2.3. Results of the hydraulic model did show overbank flooding of areas consistent with past observed flooding in the Village of Oak Lawn. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.26.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.26.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Oak Lawn Creek system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.26.3 Development and Evaluation of Alternatives

3.26.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.26.4 summarizes problem areas identified through hydraulic modeling of Oak Lawn Creek.

TABLE 3.26.4
Modeled Problem Definition for Oak Lawn Creek

Problem ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
MPA28	Area surrounding Lake Oak Lawn (bounded by Central Avenue, 95th Street, 54th Avenue, and Edison Avenue)	100	OL8	Project OLCR-1 will include addressing existing erosion and sedimentation problems within Lake Oak Lawn, and reduce flooding. Sufficient land was not available to address all flooding in this area. Such properties are candidates for protection using non-structural flood control measures, such as flood-proofing or acquisition.
MPA29	Area between Mayfield Avenue and 54th Avenue, south of Oak Lawn Creek, and north of 101st Street	25, 50, 100		Sufficient land was not available to reduce flooding in this area. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.
MPA30	Area between Ridgeland Avenue and Central Avenue, north of Oak Lawn Creek, and south of 97th Street	25, 50, 100		Projects STCR-2 and STCR-3 will reduce flooding in this area.

3.26.3.2 Damage Assessment

Economic damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. No recreation damages due to flooding were identified for Oak Lawn Creek. Erosion damages were determined based on the values of structures located within 30-feet of areas of active erosion. Transportation damages were estimated as 15 percent of property damages. Table 3.26.5 lists the damage assessment for existing conditions.

TABLE 3.26.5
Estimated Damages for Oak Lawn Creek

Damage Category	Estimated Damage ($)	Note
Property	6,268,400	
Erosion	3,081,000	
Transportation	940,300	Assumed as 15% of property damage due to flooding

3.26.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate for addressing the flooding problems in Oak Lawn Creek. Increased conveyance or storage was identified as the principal technologies applicable for addressing stormwater problems in Oak Lawn Creek.

TABLE 3.26.6
Flood Control and Erosion Control Alternatives for Oak Lawn Creek

Alternative	Problem Addressed	Location	Description
OLCR-1	Flooding	Lake Oak Lawn	Construct 30 acre-feet of additional stormwater detention by expanding Lake Oak Lawn further north to 95th Street through existing park land and one commercial property on 95th Street.
OLCR-2	Flooding	Lake Oak Lawn	Construct 80 acre-feet of additional stormwater detention by expanding Lake Oak Lawn further north to 95th Street through existing park land and one commercial property on 95th Street. This alternative also assumes property acquisition of 24 neighboring homes. This alternative was deemed infeasible based on community feedback, thus benefits and costs were not developed.
OLCR-3	Erosion	Oak Lawn Creek between Mayfield Avenue and Central Avenue	Stabilize banks of Oak Lawn Creek at its confluence with Stony Creek to prevent structural failure of channel banks.

3.26.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding and streambank erosion problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Table 3.26.6 summarizes flood and erosion control alternatives developed for Oak Lawn Creek.

Based on community feedback, stormwater detention alternatives developed for Oak Lawn Creek were focused on the area surrounding Lake Oak Lawn and also within a park at 99th Street and Meade Avenue. Modeling showed that detention at the 99th Street and Meade Avenue location did not significantly lower WSELs in Oak Lawn Creek. Modeling showed that alternative OLCR-1, which consists of a 30 acre-feet expansion of Lake Oak Lawn, did reduce WSELs and flood damages.

In conjunction with the expansion of Lake Oak Lawn, the existing erosion problems in the area will also be addressed through proper stabilization of the expanded lake. The 30 acre-feet expansion assumes that the lake can be widened by taking a portion of both West Shore Drive and East Shore Drive and making the streets narrower for one-way traffic only. It is also possible to expand the lake an additional 30 acre-feet without taking a portion of the streets, but this would involve taking all park land to the north. Alternative OLCR-2 was modeled, but was not considered further due to community feedback regarding the requirement of land currently occupied by 24 existing residences.

Erosion Control Alternative. The alternative proposed to address the erosion problems along Oak Lawn Creek will provide hard armoring of the bank where erosion is occurring. Roughly 2,200 feet of armoring is required to address the problem area. This armoring is conceptually developed to include costs consistent with traditional approaches to armoring such as concrete walls. As an alternative to using concrete, there are other hard-armoring erosion protection techniques available to stabilize Oak Lawn Creek that will give a more natural appearance than concrete. Given its urban setting with limited space available, the straight alignment of Oak Lawn Creek will likely have to remain. However, through the use of rock and geotextile fabric, a hard-armoring protection technique can be designed to protect the slope in a more aesthetically pleasing way. This type of bank treatment will be keyed-in for toe-of-slope protection and there will be transitions to the natural slope at the downstream end of the problem area near the Stony Creek Golf Course. The treatment will be scaled to the gradient of the slope and the shear stresses to which the slope is exposed.

3.26.3.5 Alternative Evaluation and Selection

Alternatives included in Table 3.26.6 were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were evaluated through H&H modeling to evaluate their effect on water elevations and flood damages. Erosion control alternatives were evaluated through field investigations to recommend appropriate stream bank stabilization alternatives. Table 3.26.9 provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, and thus costs were not calculated for these alternatives.

Recommended alternatives result in reduced stage and/or flow along the modeled waterway. Table 3.26.7 provides a comparison of the modeled maximum WSEL, and modeled flow at the time of peak at representative locations along the waterway.

TABLE 3.26.7
Oak Lawn Creek Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		OLCR-1	
Location	Station	Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Southeast corner of 95th St. and 54th St.	5771	605.65	919.28	605.35	901.56
Parkside Ave and Edison Ave	4856	598.26	875.52	598.17	857.05
99th St and Mayfield Ave.	2823	595.74	623.85	595.73	618.45
Confluence with Stony Creek	155	595.22	526.02	595.20	531.18

Hydraulic modeling results identified one roadway crossing (state route, US highway, or four-lane road or greater) where Oak Lawn Creek overtops for storm events of 100-year recurrence interval and below by a depth of 0.5 feet or greater. Table 3.26.8 below provides a summary of the depth of road flooding for existing conditions and with recommended alternatives. Following implementation of alternative OLCR-1, the model results show that there will be a minimal decrease in the depth of flooding for each storm event. Lack of available space and the topography of the area prevented the development of alternatives that could further reduce the flooding.

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

TABLE 3.26.8
Oak Lawn Creek Road Overtopping Summary

Road Crossing	Road Elevation	5-yr Depth of flooding	10-yr Depth of flooding	25-yr Depth of flooding	50-yr Depth of flooding	100-yr Depth of flooding
Central Avenue	594.6	0.5	1.5	2.8	3.6	4.4
Central Avenue (with alternative)	594.6	0.3	1.4	2.7	3.5	4.3

Note: Although Central Avenue experiences overtopping, alternate routes are available.

3.26.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternatives. Table 3.26.9 lists recommended alternatives analyzed in detail. The recommended alternatives are OLCR-1 and OLCR-3, shown in Figures 3.26.2 and 3.26.3 respectively. A comparison of the existing conditions and alternative conditions inundation mapping is included in these figures.

TABLE 3.26.9
Oak Lawn Creek Project Alternative Matrix to Support District CIP Prioritization

Alternative	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
OLCR-1	Lake Oak Lawn Expansion (30 additional ac-ft)	0.07	450,000	6,306,100	35		Slightly Positive	Yes	Oak Lawn
OLCR-3	Stabilize Oak Lawn Creek between Mayfield Ave and Central Ave	0.42	3,081,000	7,299,200	15		Slightly Positive	Yes	Oak Lawn

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.27 Spring Creek

Spring Creek is a regional waterway located in southwestern Cook County, in the southern part of the Calumet-Sag Channel Watershed. The total drainage area of the Spring Creek subwatershed is 2.6 square miles, which includes some drainage area from Will County. Table 3.27.1 summarizes the communities within Cook County that drain to Spring Creek. Figure 3.27.1 is an overview of the tributary area of the subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown and discussed in the following subsections.

TABLE 3.27.1
Communities Draining to Spring Creek

Community	Tributary Area (mi^2)
Orland Park	1.75
Unincorporated/Forest Preserve	0.85

The Spring Creek subwatershed contains a mix of suburban development with some open space. Table 3.27.2 summarizes the land use distribution within the Spring Creek subwatershed.

TABLE 3.27.2
Land Use Distribution for Spring Creek

Land Use Category	Area (acres)	%
Agricultural	651	32.6
Commercial/Industrial	90	4.5
Forest/Open Land	453	22.7
Institutional	44	2.2
Residential	612	30.6
Water/Wetland	147	7.4

3.27.1 Sources of Data

3.27.1.1 Previous Studies

Will County recently created H&H models of existing conditions in Spring Creek to examine floodplain areas and channel improvements for part of Spring Creek in Will County. The model extent does not contain the part of Spring Creek in Cook County and does not begin at the county line, and therefore, did not contribute directly to the development of the Calumet-Sag Channel DWP.

3.27.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Spring Creek. Spring Creek is identified as impaired in the IEPA's 2008 *Integrated Water Quality Report*, which includes the 303(d) and 305(b) lists. Spring Creek is on the IEPA's 303(d) list due to total manganese, total phosphorous, sedimentation and siltation. No TMDLs have been established for Spring Creek. According to a USEPA water permit discharge query, there is one NPDES permit issued by IEPA to the Andrew Corporation in Orland Park for discharges to Spring Creek. Municipalities discharging to Spring Creek are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.27.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data for 2001 identify 181.6 acres of wetland areas in the Spring Creek Tributary area. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.27.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information, but the effective models used to estimate flood levels generally were not updated. LOMRs were incorporated into revised floodplain areas.

Spring Creek is mapped in detail in the DFIRM mapping update, with Zone AE floodplain shown across the length of Spring Creek. The original hydrologic and hydraulic analyses were performed in 1976. The hydrologic modeling used Regression Equations 73 and 75. The hydraulic routing was steady state and used the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.27.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Stormwater problems were classified as regional or local based upon the criteria described in Section 1 of the report. Table 3.27.3 summarizes the Form B data for Spring Creek.

TABLE 3.27.3
Community Response Data for Spring Creek

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
OT1	Orland Township	Overbank flooding, ponding	114th Court and 157th Street	Heavy rains cause overflow of Spring Creek into adjacent subdivision	Regional	Project SPCR-1 will raise 157th Street to reduce frequency of transportation damage
OP10	Orland Park	Maintenance, overbank flooding	Deluga Woods subdivision between 155th and 159th Streets	Lack of maintenance in unincorporated area results in overbank flooding	Regional	Model results did not show property damage due to flooding from a regional waterway in this area. Stream maintenance is recommended.
OP4	Orland Park	Pavement flooding	Southwest Highway at 151st Street	IDOT reported pavement flooding	Local	Problem not located along a regional waterway. This is a local problem

3.27.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Spring Creek subwatershed.

3.27.2 Watershed Analysis

3.27.2.1 Hydrologic Model Development

Subbasin Delineation. The Spring Creek subwatershed was delineated based upon LiDAR topographic data developed by Cook County in 2003. The subwatershed drainage area includes 0.07 square mile of area in Will County that drain into Cook County. This area had available LiDAR topographic data and was delineated in the same manner as the drainage area within Cook County.

Fifteen subbasins were delineated for the Spring Creek Tributary area, with an average area of 111 acres and a total drainage area of 2.6 square miles.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.27.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met District criteria, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. The open channel of Spring Creek and all crossings were surveyed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficient to the stream. Appendix D contains field survey information in digital form.

Boundary Conditions. The downstream extent of the Spring Creek model is the point at which Spring Creek drains into Will County. The slope of the main channel there is 0.00083. Normal depth based on this slope was set as the boundary condition for Spring Creek at the point of discharge into Will County.

3.27.2.3 Calibration and Verification

No measured or observed stages were available for Spring Creek to compare model results. Curve numbers were reduced by 10 percent for existing and alternative conditions analysis based upon the calibration of streams with monitoring data as described in Section 1.3.8.

3.27.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Flood inundation areas were developed based on HEC-RAS water surface elevations and Cook County topographic data. Figure 3.27.1 shows inundation areas for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Spring Creek system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.27.3 Development and Evaluation of Alternatives

3.27.3.1 Model Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. No property damage due to flooding was identified in the Spring Creek subwatershed. Overtopping of 157th Street, which provides the only means of access to a subdivision west of Spring Creek, was identified as a modeled problem area, as shown in Table 3.27.4. The overtopping of this local road was considered a regional problem because as the only means of access to a subdivision, overtopping of this road by flooding would cut off emergency access to the entire subdivision.

TABLE 3.27.4
Modeled Problem Definition for Spring Creek

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Form B	Resolution in DWP
MPA33	157th Street crossing of Spring Creek	10, 25, 50, 100	OT1	Project SPCR-1 will raise 157th Street to reduce frequency of transportation damage

3.27.3.2 Damage Assessment

Economic damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. No property damage due to flooding is predicted based upon existing conditions H&H modeling analysis. No erosion or recreation damages were identified for Spring Creek. Transportation damages were explicitly calculated for Spring Creek as the crossing of 157th Street was identified by modeling and WPC members as a frequent flooding issue preventing the only means of access to a subdivision west of Spring Creek. Transportation damages were calculated using the method outlined in “What is a Benefit?” was used (FEMA 2001), using the same period of analysis and discount rate used for property damage due to flooding calculations. Table 3.27.5 lists the existing conditions damages for Spring Creek.

3.27.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate to address the flooding problems in the Spring Creek subwatershed. Conveyance improvements, increased storage, and levees were considered to address the MPA33 problem at the 157th Street crossing.

TABLE 3.27.5
Estimated Damages for Spring Creek

Damage Category	Estimated Damage ($)	Note
Property	0	
Erosion	0	
Transportation	24,100	Specific transportation damages calculated for emergency access restrictions at 157th Street.
Recreation	0	

3.27.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding were developed and evaluated to address the damages estimated in Table 3.27.5 consistent with the methodology described in Section 1.4 of this report. Table 3.27.6 summarizes the flood control alternatives developed for Spring Creek.

TABLE 3.27.6
Flood Control Alternatives for Spring Creek

Alternative	Location	Description
SPCR-1	Spring Creek at 157th Street	Raise 157th Street to prevent overtopping, replace culvert with larger culvert, and construct upstream restrictor and weir with same hydraulics as existing conditions.
SPCR-2	Spring Creek from 157th Street to 159th Street	Dredge Spring Creek to increase conveyance. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
SPCR-3	Spring Creek at 157th Street	Raise Road and provide in-line storage to lower downstream WSEL and prevent 157th Street from flooding. This alternative caused an increase in upstream water surface elevations, thus benefits and costs were not developed.

Erosion Control Alternatives. No erosion control alternatives were developed for Spring Creek.

3.27.3.5 Alternative Evaluation and Selection

Alternative SPCR-1 addresses transportation damages associated with the overtopping of 157th Street by raising the road. The hydraulic structure at the crossing would be designed to maintain existing hydraulic conditions upstream and downstream of 157th Street. The culvert would be replaced with two large box culverts with capacity to convey the 100-year design storm. Upstream of the road, a weir is proposed to be built to the existing elevation of the road, with a low flow pipe equal in size to the existing culvert. Noneconomic criteria is a significant factor in development and consideration of this alternative for recommendation as community feedback from Orland Township indicated that frequent flooding of 157th Street cuts off emergency access to an Orland Township neighborhood.

SPCR-2 involves dredging parts of Spring Creek, as suggested by WPC members. This alternative had little impact on modeled WSELs because downstream restrictions limited conveyance capacity. Damages and a cost estimate were not defined for this alternative.

Model results determined that SPCR-3 increased upstream stage, and therefore cannot be recommended in the DWP.

Alternatives included in Table 3.27.6 were evaluated to determine their effectiveness and produce data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. Table 3.27.8 provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data. Alternatives that did not produce a significant change in inundation areas are not listed, as benefits were negligible, and so costs were not calculated for these alternatives.

Table 3.27.7 below provides a summary of the depth of road flooding for the 157th Street crossing for existing conditions and with recommended alternatives.

TABLE 3.27.7
Spring Creek Road Overtopping Summary

Road Crossing	Road Elevation	25-yr Depth of Flooding	50-yr Depth of Flooding	100-yr Depth of Flooding
157th Street	690.1	0.6	1.2	1.6
157th Street (with alternative SPCR-1)	693.1			

Note: Blank entry indicates that road crossing does not overtop for that particular storm event.

3.27.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternatives. Table 3.27.8 lists alternatives analyzed in detail. Alternative SPCR-1 is recommended to address transportation damages. Figure 3.27.2 shows the location of recommended alternative SPCR-1 and a comparison of the inundation mapping for existing conditions and with the recommended alternative.

TABLE 3.27.8
Spring Creek Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
SPCR-1	Raise 157th street	0.02	24,100	1,053,800	0	Orland Township	No Impact	Yes	Orland Township

Note: Net Benefits values do not include local benefits or non-economic benefits.

3.28 Stony Creek

Stony Creek, which consists of an East and West Branch, is located in southwestern Cook County, north of the Calumet-Sag Channel and in the northern part of the Calumet-Sag Channel Watershed. East Stony Creek and West Stony Creek are connected at their upstream extent through the Cicero Avenue storm sewer. The area is near 111th Street and Cicero Avenue in Alsip. Five major tributaries discharge into Stony Creek, making up a 40.5 square mile area. Oak Lawn Creek, Melvina Ditch, Lucas Diversion Ditch, and Lucas Ditch flow into West Stony Creek. Merrionette Park Ditch flows into East Stony Creek. Each tributary waterway was analyzed in detail and is discussed separately in this report. Mosquito Creek also flows into East Stony Creek, but it was not analyzed in detail since most of that area is drained by storm sewer systems.

Figures 3.28.1a, 3.28.1b, and 3.28.1c show the areas directly tributary to Stony Creek (but do not include major tributary subwatersheds, which are addressed in separate sections of this report). Table 3.28.1 lists the communities located in areas directly tributary to the Stony Creek subwatershed. Areas directly tributary to Stony Creek in general are heavily drained by storm sewer systems. Figures 3.28.1a, 3.28.1b, and 3.28.1c show an overview of the tributary area of the subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown and discussed in the following subsections. Table 3.28.2 lists the land use breakdown by area within the Stony Creek subwatershed.

TABLE 3.28.1
Communities Draining to Stony Creek

Community	Tributary Area (mi^2)
Oak Lawn	8.52
Burbank	4.12
Palos Hills	3.96
Evergreen Park	3.10
Bedford Park	2.57
Chicago Ridge	2.2
Bridgeview	2.14
Hickory Hills	1.46
Chicago	5.03
Worth	0.82
Unincorporated/Forest Preserve	1.89
Justice	0.12
Hometown	0.05
Alsip	3.22
Blue Island	1.14
Merrionette Park	0.39

Note: This list includes community areas tributary to the entire Stony Creek system. It includes upstream major tributaries, such as Melvina Ditch, which are also discussed separately in this report.

TABLE 3.28.2
Land Use Distribution for Stony Creek

Land Use Category	Area (acres)	%
Residential	14,916	57.5
Commercial/Industrial	4,506.8	17.4
Forest/Open Land	3,971	15.3
Institutional	1,404	5.4
Transportation/Utility	889.2	3.4
Water/Wetland	180	0.7
Agricultural	69	0.3

3.28.1 Sources of Data

3.28.1.1 Previous Studies

The USACE produced an extensive study of Stony Creek in 2001. The study included the development of a hydrologic (HEC-1) and hydraulic (UNET) model of Stony Creek. The USACE's hydrologic model was referred to during the development of an updated hydrologic model for the Calumet-Sag Channel DWP. The USACE's hydraulic model was obtained and converted to HEC-RAS and used to support the DWP development.

The USACE study analyzed several project alternatives to address flooding in the Stony Creek basin, but none is known to be implemented. The alternatives analyzed by the USACE as a part of its study were reviewed, and the information was used in conceptualizing alternatives for the DWP. In some cases, alternatives described in this report include features consistent with those developed and evaluated by the USACE.

3.28.1.2 Water Quality Data

The IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Stony Creek. There are also no reaches identified as impaired in the IEPA's 2008 *Integrated Water Quality Report* (which includes the CWA 303[d] and 305[b] lists). No TMDLs have been established for Stony Creek. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Stony Creek. Municipalities discharging to Stony Creek are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.28.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 295.5 acres of wetland areas in the Stony Creek subwatershed (including Stony Creek tributaries described with additional detail in this report such as the Melvina Ditch tributary). Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.28.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information; however, the effective models, which are used to estimate flood levels, were generally not updated. LOMRs were incorporated into revised floodplain areas. Stony Creek is mapped in detail in the DFIRM mapping update, with Zone AE floodplain shown across the length of Stony Creek. The original H&H analysis was performed between 1978 and 1980. The hydrologic modeling was performed by using Regression Equations 73 and 74, L-PTIII, and TR-20. Hydraulic routing performed was steady state and used the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

TABLE 3.28.3
Community Response Data for Stony Creek

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
CP1	Calumet Park	Pavement flooding	I-57 at 127th St. (Burr Oak Ave.)	IDOT reported pavement flooding	Local	Problem not located on a regional waterway. This is a local problem.
CP2	Calumet Park, Chicago	Pavement flooding	I-57 at 119th St.	IDOT reported pavement flooding	Local	Problem not located on a regional waterway. This is a local problem.
OL1	Oak Lawn	Maintenance	Central Avenue, 1/4 mile south of 103rd Street	Siltation observed in south culvert barrel	Regional	Siltation may be addressed through maintenance activities
OL2	Oak Lawn	Bank Erosion	Stony Creek between 103rd Street and Central Avenue	Resident reports erosion, District field staff observed several exposed outfalls	Regional	Erosion problem does not threaten structures or conveyance of Stony Creek. Not addressed by DWP.
OL3	Oak Lawn, Chicago	Pavement Flooding	Pulaski Road and 102nd Street	IDOT reported pavement flooding	Local	Problem not located on a regional waterway. This is a local problem.
OL5	Oak Lawn	Overbank Flooding, Basement Flooding, Ponding, Water Quality, Storm Sewer Capacity	99th Street to 103rd Street between Cicero Avenue and Central Avenue	High water stages on West Stony Creek may limit drainage capacity of Oak Lawn sewers	Local	Problem not located on a regional waterway. This is a local problem.
OL6	Oak Lawn	Sedimentation, Bank Erosion, Maintenance	102nd Street and Merrimac Avenue (near Metra tracks)	Severe bank erosion, bank collapse, and sedimentation at confluence of Oak Lawn Creek and Stony Creek	Regional	Project STCR-10 will address erosion problem that threatens conveyance capacity of Stony Creek by stabilizing banks, removing sediment, and repairing culvert.
OL9	Oak Lawn	Overbank Flooding, Storm Sewer Capacity, Bank Erosion, Sedimentation, Water Quality	Wolfe Wildlife Refuge (from Cicero Avenue and 111th Street to Central Avenue and 105th Street)	Bank erosion along Stony Creek West in wildlife preserve causes additional sedimentation, reducing storm sewer capacity and contributing to overbank flooding in the area	Regional	Project STCR-3 (expansion of Wolfe Wildlife Refuge detention) will reduce flooding in this area.

TABLE 3.28.3
Community Response Data for Stony Creek

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
WO1	Worth	Pavement flooding	Ridgeland Avenue at 111th Street	IDOT reported pavement flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
WO2	Worth	Bank Erosion	Stony Creek between Oak Lawn and 76th Avenue	Stream bank is in need of stabilization and debris removal to restore the natural conveyance of Stony Creek	Regional	Removal of debris to be addressed by stream maintenance. Field assessment did not find erosion problem.
WO4	Worth	Ponding, pavement flooding	75th Avenue at 109th Street	Pavement flooding and property flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
AL1	Alsip	Bank Erosion, Sedimentation	115th Street and Stony Creek culvert, just west of Cicero Avenue	Severe erosion at northeast embankment, wing wall partially restricting opening of east barrel of culvert	Regional	This is a maintenance issue. No structural damages associated with bank erosion.
AL2	Alsip	Pavement Flooding	Route 50 (Cicero Ave) at 119th Street	IDOT reported pavement flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.
AL3	Alsip	Storm Sewer Flow Restriction, Bank Erosion, Sedimentation	113th Street and Lamon Avenue	Siltation of East Stony Creek from 115th Street North to 11200 Street interferes with drainage of a dry detention pond contributing to a mosquito breeding problem	Regional	Field assessment identified no structural damages associated with bank erosion. Alternatives STCR-4 and STCR-7 will reduce stage in ditch, reducing extent of problem.
OL4	Oak Lawn, Chicago	Pavement Flooding	Pulaski Road and 104th Street	IDOT reported pavement flooding	Local	Problem not located on a regional waterway. This is a local storm sewer system problem.

3.28.1.5 Stormwater Problem Data

Communities, agencies (e.g., IDOT, CCHD), and stakeholders submitted Form B questionnaire response data to the District summarizing known stormwater problems within their jurisdictions. Table 3.28.3 summarizes reported problem areas reviewed as a part of the DWP development. Problems are classified in Table 3.28.3 as regional or local. This classification is based on a process described in Section 1 of this report.

3.28.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. No near-term planned projects by others have been identified for the Stony Creek subwatershed.

3.28.2 Watershed Analysis

3.28.2.1 Hydrologic Model Development

Subbasin Delineation. The Stony Creek tributary area was delineated based primarily upon 2003 Cook County LiDAR generated topographic data. Delineated basins were spot checked against available storm sewer mapping to confirm drainage patterns. Table 3.28.4 summarizes the total drainage area, number of subbasins, and average subbasin size for East and West Stony Creek and subwatersheds that drain to them.

TABLE 3.28.4
Stony Creek System Subbasin Summary

Subbasin	Drainage Area (mi^2)	Number of Modeled Subbasins	Average Modeled Subbasin Size (acres)
East Stony Creek[a]	6.9	34	130
West Stony Creek[a]	11.2	55	130
Total	**18.1**	**89**	
Major Tributaries to Stony Creek (in addition to directly tributary areas)			
Merrionette Park Ditch	4.2	25	108
Melvina Ditch	8.4	37	146
Oak Lawn Creek	3.7	21	112
Lucas Ditch	2.7	14	124
Lucas Diversion Ditch	3.4	25	87
Total	**22.4**	**122**	

[a]Areas directly tributary to East and West Stony Creek. They do not include areas drained by other tributary areas summarized in report.

Significant parts of the Merrionette Park Ditch, Melvina Ditch, and East Stony Creek subwatersheds are drained by combined sewer systems. These areas were included in the hydrologic model with diversions created to simulate the approximate interceptor capacity of sewers. Where available, interceptor capacities were assumed based on information obtained from hydraulic models of the City of Chicago's combined sewer system developed in 2008 as a part of the city's citywide H&H Modeling Program. These areas appear to have been excluded from hydrologic models developed to support the production of FEMA regulatory floodplain mapping.

There are two significant reservoirs in the Melvina Ditch subwatershed: Melvina Ditch reservoir and Bedford Park reservoir. Both reservoirs were included in the hydrologic model. Storage provided by Lake Oak Lawn and two ponds within the St. Casimir Cemetery property were included in the hydraulic modeling.

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin.

The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.28.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. The existing USACE hydraulic model of Stony Creek met District criteria, as identified in Section 6.3.3.2 of the CCSMP, and was therefore used to support DWP development. Three cross sections were surveyed on Stony Creek and compared with cross-sectional data included in the USACE's model. The surveyed cross sections were located near Lucas Ditch and Lucas Diversion Ditch confluences in Palos Hills. It was determined that there was a good correlation between recently surveyed cross-sectional data and cross-sectional data included in the USACE model. Field visits were performed to assess channel and overbank roughness characteristics at several locations along Stony Creek. These were then compared with information on photographs and aerial photography to review and accept modeled Manning's *n* roughness coefficients included in the USACE model.

Boundary Conditions. The Stony Creek hydraulic model has two downstream boundary conditions defined at the downstream ends of East and West Stony Creek, where they discharge into the Calumet-Sag Channel. Fixed water surface elevations for each of the various design storms modeled were established as downstream boundary conditions. The water surface elevations were based on model output from the District's CWS model. Appendix E contains a summary of the boundary conditions analysis performed to support DWP model development.

Calibration and Verification. Stony Creek model results are compared in Table 3.28.5 below with stream crest gage results provided by the IDNR Office of Water Resources (OWR) from the storm that occurred on September 13th-14th, 2008. Curve numbers were reduced by 10 percent for existing and alternative conditions based upon the calibration of streams with monitoring data as described in Section 1.3.8. The model results are listed for both initial (pre-calibration) model results and calibrated model results (with the 10 percent reduction of curve number values applied). The difference between the observed and calibrated model water surface elevations are generally considered to be within an acceptable margin of error.

High water elevations are taken at a point in time when it is not certain that the peak water elevation occurred.

TABLE 3.28.5
Comparison of Observed and Predicted Stage for Stony Creek, 9/13/2008 Storm Event

Location Description	HEC-RAS River Station	HWM or Gage Peak WSE (ft)	Unmodified Simulated Peak WSE (ft)	Difference between observed and unmodified WSE (ft)	Simulated peak WSE (ft) with CNs modified to 0.9 * CNs	Difference between observed and modified WSE (ft)	Source of HWM
West Stony Creek 80' downstream of railroad bridge near confluence with Oak Lawn Creek	3.842	591.55	592.69	1.14	592.16	0.61	IDNR Gage 5
West Stony Creek at Virginia Road	3.166	590.60	591.34	0.74	590.82	0.22	IDNR Gage 3
West Stony Creek at Roberts Road	1.412	587.75	588.38	0.63	587.93	0.18	IDNR Gage 1
East Stony Creek at 115th Street	3.617	588.78	588.51	-0.27	588.19	-0.59	IDNR Gage 8
East Stony Creek at Kostner Avenue	2.688	587.47	588.14	0.67	587.75	0.28	IDNR Gage 9
Oak Lawn Creek, at Lake Oak Lawn	5771	598.88	599.72	0.84	599.34	0.46	Village of Oak Lawn observation

Note: Stony Creek river stations are in miles, and Oak Lawn Creek river stations are in feet

As a further verification step, DWP Stony Creek hydraulic model results were also compared with USACE Stony Creek hydraulic model results. Table 3.28.6 summarizes the water surface elevations identified by both the DWP and USACE Stony Creek hydraulic models. The elevations identified in DWP modeling are generally consistent with the USACE model results for the 100-year design storm, with higher elevations in some areas and lower elevations in other areas.

3.28.2.3 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.28.1 shows inundation areas produced by the DWP's hydraulic model for the 100-year, 12-hour duration design storm. The FEMA DFIRM modeling had a total drainage area to Stony Creek of 31.3 square miles as compared to the DWP drainage area which was 40.5 square miles. The difference in drainage area likely contributes greatly to the difference between DWP inundation areas and the FEMA DFIRM floodplain areas.

TABLE 3.28.6
Comparison of DWP and USACE Model Results for 100-Year Design Storm

Location	Model River Station	DWP HEC-RAS Model Results WSEL (ft)	Army Corps UNET Model Results WSEL (ft)
80th Avenue (Roberts Road)	1.376	590.5	590.5
Harlem Avenue	2.507	592.1	592.9*
Virginia Avenue	3.166	593.4	594.2
About 420 feet downstream of Ridgeland Avenue	Approx. 3.561	593.6	594.4
About 940 feet upstream of Ridgeland Avenue	Approx. 3.832	595.1	595.2*
Central Avenue	4.769	595.4	595.6
Wolfe Wildlife Refuge	5.331	595.4	595.7
115th Street	3.67	592.2	591.9
Kostner Avenue	2.688	592.1	591.1

*Interpolated from nearby cross-sectional values.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Stony Creek system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.28.3 Development and Evaluation of Alternatives

3.28.3.1 Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.28.7 summarizes major problem areas identified through hydraulic modeling of Stony Creek.

TABLE 3.28.7
Modeled Problem Definition for Stony Creek

Problem ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
MPA34	Area bounded by Kedzie Avenue Burr Oak Avenue, California Avenue and Vermont Street	25, 50, 100, 500		Project STCR-7 will reduce flooding in this area.
MPA35	Area along East Stony Creek between Kedzie Avenue and Merrionette Park Ditch	25, 50, 100, 500		Project STCR-7 will reduce flooding in this area.
MPA36	Area along East Stony Creek between Kostner Avenue and Crawford Avenue, north of 123rd Street	100, 500		Project STCR-7 will reduce flooding in this area.

TABLE 3.28.7
Modeled Problem Definition for Stony Creek

Problem ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
MPA37	Area near 111th and Cicero Avenue at East and West Stony confluence	25, 50, 100, 500	AL1	Project STCR-2 will reduce flooding in this area. Sufficient land was not available to address all flooding in this area. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.
MPA38	Area bounded by 107th Street, Laramie Avenue, 101st Street, and Marshall Avenue	25, 50, 100, 500	OL1, OL2, OL9	Projects STCR-2, STCR-3, and STCR-4 will reduce flooding in this area. Sufficient land was not available to address all flooding in this area. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.
MPA39	Area south of 99th Street between Oak Lawn Creek and Melvina Ditch	25, 50, 100, 500	CR1, CR3, OL6	Projects STCR-3 and STCR-8 will reduce flooding in this area. Sufficient land was not available to address all flooding in this area. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.
MPA40	Area between Melvina Ditch and Tri-State Tollway	50, 100, 500		Projects STCR-3 and STCR-8 will reduce flooding in this area. Sufficient land was not available to address all flooding in this area. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.
MPA41	Area between Tri-State Tollway and Lucas Diversion Ditch	5, 10, 25, 50, 100, 500	WO2	Project STCR-8 will reduce flooding in this area. Sufficient land was not available to address all flooding in this area. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.

TABLE 3.28.7
Modeled Problem Definition for Stony Creek

Problem ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
MPA14	Area between Lucas Ditch confluence and West Stony Creek confluence with Calumet-Sag Channel	5, 10, 25, 50, 100, 500	PHI3	Project LUDT-5 will protect properties from flooding. Sufficient land was not available to address all flooding in this area. Such properties are candidates for protection using non-structural flood control measures, such as flood-proofing or acquisition.

3.28.3.2 Damage Assessment

Economic damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. No erosion or recreation damages due to flooding were identified for Stony Creek. Transportation damages were estimated as 15 percent of property damages. Table 3.28.8 lists the damage assessment for existing conditions.

TABLE 3.28.8
Estimated Damages for Stony Creek

Damage Category	Estimated Damage ($)	Note
Property	24,046,400	
Erosion	0	
Transportation	3,607,000	Assumed as 15% of property damage due to flooding

3.28.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate for addressing the flooding problems in the Stony Creek subwatershed. Increased conveyance or storage was identified as the principal technologies applicable for addressing stormwater problems in Stony Creek.

3.28.3.4 Alternative Development

Flood Control Alternatives. Alternative solutions to regional flooding and streambank erosion problems were developed and evaluated consistent with the methodology described in Section 1.4 of this report. Table 3.28.9 summarizes flood and erosion control alternatives developed for Stony Creek. Based on the feedback from watershed communities, a review of previous studies, and a consideration of large open tracts of land, stormwater detention alternatives developed for Stony Creek were focused on areas surrounding the intersection of 111th Street and Cicero Avenue. The area contains parts of St. Casimir Cemetery, a retail development that includes a K-Mart store, and the Wolfe Wildlife Refuge.

TABLE 3.28.9
Flood Control and Erosion Control Alternatives for Stony Creek

Alternative Number	Problem Addressed	Location	Description
STCR-1	Flooding	St. Casimir Cemetery	Construct 850 acre-feet of stormwater detention and conveyance facilities required to collect West and East Stony Creek flows. Construct detention area 12 feet deep to allow gravity dewatering. This alternative requires significant conveyance facilities to collect flows into the stormwater detention basin. The Kilpatrick and Cicero Avenue existing sewers would be rerouted to the stormwater detention basin as a part of this alternative. This alternative was considered to be beyond the limits of feasible constructability, thus benefits and costs were not developed.
STCR-2	Flooding	St. Casimir Cemetery	Construct 400 acre-feet of stormwater detention and conveyance facilities required to collect West and East Stony Creek flows. Construct detention area 12 feet deep to allow gravity dewatering. This alternative requires significant conveyance facilities to collect flows into the stormwater detention basin. The Kilpatrick and Cicero Avenue existing sewers would be rerouted to the stormwater detention basin as a part of this alternative.
STCR-3	Flooding	Wolfe Wildlife Refuge	Expand Wolfe Wildlife Refuge Lake by 87 acre-feet. This includes excavation in two locations along West Stony Creek between Central Avenue and Cicero Avenue in Oak Lawn. Construct levees along Stony Creek (at elevation 597 feet, from Lawler Avenue west to Long Avenue, and at elevation 595 feet from Long Avenue to Central Avenue, and possibly low level levee along the south side of Stony Creek).
STCR-4	Flooding	K-Mart Parking Lot near 111th Street and Cicero Avenue	Incorporate stormwater detention facility into redevelopment of K-Mart parking lot area near intersection of 111th Street and Cicero Avenue. Construct 39 acre-feet of stormwater detention at this site.
STCR-5	Flooding	Melvina Ditch and West Stony Creek confluence	Construct closed conduit diversion that conveys part of the flows from Melvina Ditch to Stony Creek and relieves flooding along Stony Creek through a more hydraulically efficient alignment. This alternative is consistent with one developed and evaluated by the USACE. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
STCR-6	Flooding	Melvina Ditch and West Stony Creek confluence	Construct open channel diversion that conveys part of the flows from Melvina Ditch to Stony Creek and relieves flooding along Stony Creek through a more hydraulically efficient alignment. This was modeled with proposed detention basins adjacent to the re-aligned stream to mitigate for increased peak flows to Stony Creek from increased conveyance capacity.
STCR-7	Flooding	California Avenue Culvert	Enlarge an existing conduit that crosses underneath California Avenue to convey part of the flows from Stony Creek to the Calumet-Sag Channel.
STCR-8	Flooding	Harlem Avenue and Stony Creek	Construct closed conduit diversion that conveys part of the flows from Stony Creek to the Calumet-Sag Channel.
STCR-9	Flooding	ComED ROW and Stony Creek	Construct closed conduit diversion that conveys part of the flows from Stony Creek to the Calumet-Sag Channel.
STCR-10	Erosion	Confluence of Oak Lawn Creek and Stony Creek	Stabilize banks of Oak Lawn Creek at its confluence with Stony Creek to prevent structural failure of channel banks and flooding damages and excavate sediment where bank has fallen into Stony Creek creating a blockage of flow.
STCR-11	Flooding	Confluence of Lucas Ditch and Stony Creek	Construct levee along north side of Stony Creek downstream of Lucas Ditch to protect against area flooding.

Alternatives STCR-1 through STCR-4, summarized in Table 3.28.9, were evaluated individually and together to determine their effectiveness in reducing flooding along Stony Creek and the downstream end of other major tributaries. They were considered as critical parts of conveyance improvement alternatives developed for the East Stony Creek, West Stony Creek, Lucas Ditch, and Lucas Diversion Ditch subwatersheds.

The alternatives described in Table 3.28.9 require significant conveyance infrastructure to deliver flows to the alternative stormwater detention facilities and make several assumptions on feasibility of construction. Alternatives 1 through 4 require significant conveyance infrastructure to deliver flows to proposed stormwater detention facilities. Alternatives STCR-5 through STCR-9 are conveyance improvement alternatives that divert flows to the Calumet-Sag Channel. Regulatory approval from regulatory agencies such as IDNR and the USACE would be required. Other alternatives recommended in the DWP include storage and will result in lower peak discharge rates at points where tributaries discharge to the Calumet-Sag Channel. All flows from individual tributaries are relatively small in comparison to the total flow within the Calumet-Sag Channel.

Erosion Control Alternative. The alternative proposed to address the erosion problems near the confluence of Oak Lawn Creek and Stony Creek will provide hard armoring of the bank where erosion is occurring. Roughly 1,000 feet of armoring is required to address the problem area. The armoring is conceptually developed to include costs consistent with traditional approaches to armoring, such as concrete walls. As an alternative to using concrete, there are other hard-armoring erosion protection techniques available to stabilize Stony Creek that will give a more natural appearance than concrete. Given the limited space available, the existing alignment of Stony Creek will likely have to remain. However, through the use of rock and geotextile fabric, a hard-armoring protection technique can be designed to protect the slope in a more aesthetically pleasing way. This type of bank treatment will be keyed-in for toe-of-slope protection and there will be transitions to the natural slope at the downstream end of the problem area near the confluence with Oak Lawn Creek. The treatment will be scaled to the gradient of the slope and the shear stresses to which the slope is exposed. This alternative also includes costs for the removal of sediment buildup at the problem area caused by eroding stream banks.

3.28.3.5 Alternative Evaluation and Selection

Alternatives listed in Table 3.28.9 were evaluated to determine their effectiveness and to produce data for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water surface elevations and flood damages. Erosion control alternatives were evaluated through field investigations to recommend appropriate streambank stabilization alternatives. Table 3.28.12 provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data.

Hydraulic modeling results identified four roadway crossings (state route, US highway, or four-lane road or greater) where Stony Creek overtops for storm events of 100-year recurrence interval and below by a depth of greater than 0.5 feet. Table 3.28.10 lists the four locations and provides a summary of the depth of road flooding for existing conditions and with recommended alternatives. Following implementation of alternatives STCR-4, STCR-7, and STCR-8, model results show that two roadway crossings will have a 100-year depth of flooding of less than 0.5 feet of depth. The remaining two roadway crossings will have reduced depths of flooding, but limited available space and topography in the area prevented alternatives from further reducing the depth of flooding.

TABLE 3.28.10
Stony Creek Road Overtopping Summary

Road Crossing	Road Elevation	25-yr Depth of Flooding	50-yr Depth of Flooding	100-yr Depth of Flooding
Crawford Avenue	590.2		0.1	1.7
Crawford Avenue (with alternatives)	590.2			
111th Street	594.0		0.5	1.4
111th Street (with alternatives)	594.0			0.4
Central Avenue	592.1	1.2	2.3	3.2
Central Avenue (with alternatives)	592.1		0.9	2.3
Ridgeland Avenue	592.2	0.5	1.6	2.6
Ridgeland Avenue (with alternatives)	592.2		0.4	1.8

Note: Blank entry indicates that road crossing does not overtop for that particular storm event.
Note: Although Ridgeland Avenue and Central Avenue experience overtopping with alternatives, alternative routes are available.

Modeling analysis concluded that STCR-1, STCR-2, STCR-3, STCR-4, STCR-7, STCR-8, and STCR-9 were effective at reducing flood damages. STCR-1 was not considered further because the 850 acre-foot size is at the limits of feasibility. A more detailed analysis to determine the optimal size of a detention basin at the St. Casimir Cemetery site should be carried out during the design process should STCR-2 be selected for implementation. If STCR-2, STCR-3, and STCR-4 are selected for implementation and will be constructed at the same time, it is recommended that they are planned, engineered, and constructed as one combined project. This will save on mobilization costs and ensure that each project is properly coordinated given their adjacent locations and that the projects may involve construction of new pipes leading to and from the proposed ponds. The combined alternative is listed in Table 3.28.12 as STCR-2b.

Recommended alternatives result in reduced stage and/or flow along the modeled waterway. Table 3.28.11 provides a comparison of the modeled maximum WSEL, and modeled flow at the time of peak at representative locations along the waterway.

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

3.28.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternatives. Table 3.28.12 lists alternatives analyzed in detail as part of DWP development.

The recommended alternatives for Stony Creek are alternatives STCR-2, STCR-3, STCR-4, STCR-7, STCR-8, and STCR-10. STCR-8 is recommended over STCR-9 because of better construction feasibility. As the B/C ratios of both STCR-8 and STCR-9 are similar, it is recommended that the route of a diversion for this area of West Stony Creek be determined during a more detailed design study. This set of alternatives includes more than 500 acre-feet of stormwater detention, two major conveyance projects, and one streambank stabilization project. STCR-6 is not recommended because the benefits associated with straightening Melvina Ditch were found to be minimal.

Figures 3.28.2 through 3.28.7 show the locations and a summary of the recommended alternatives described in Table 3.28.12. Figures 3.28.2 through 3.28.7 also show comparisons of the existing condition and alternative condition inundation areas. Additional alternatives were analyzed within the major tributaries to East Stony Creek and West Stony Creek, such as Oak Lawn Creek and Lucas Ditch. Those alternatives are discussed in each individual tributary section. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, and thus costs were not calculated for these alternatives.

TABLE 3.28.11
Stony Creek Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		STCR-2		STCR-3		STCR-4		STCR-7		STCR-8	
Location	**Station**	Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream end of Stony Creek West	5.68	595.39	329.65	594.67	91.59	595.37	29.04	595.35	45.90	595.38	319.74	595.37	329.57
400-ft upstream of Central Ave.	4.88	595.36	709.14	594.66	478.25	595.33	718.60	595.32	698.91	595.35	704.13	595.33	737.79
Major Ave. and Edge Lake Dr.	4.65	595.34	746.45	594.63	525.80	595.31	755.21	595.30	742.58	595.33	743.31	595.31	775.20
Downstream of Oaklawn Creek confluence	3.84	595.08	1273.05	594.44	1122.64	595.05	1264.62	595.04	1263.48	595.07	1271.24	595.03	1312.72
Downstream of Melvina Ditch confluence	3.58	593.55	1795.76	593.12	1640.54	593.53	1790.47	593.52	1787.03	593.55	1793.12	593.42	1692.53
300-ft downstream of Southwest Hwy	2.96	593.16	1702.53	592.77	1574.89	593.12	1689.39	593.13	1685.79	593.16	1700.07	593.04	1738.85
Downstream of Lucas Diversion Ditch confluence	1.64	591.00	2458.27	590.75	2315.10	590.96	2431.15	590.97	2440.00	591.00	2456.31	590.50	2185.84
300-ft downstream of Roberts Rd.	1.34	590.41	2481.43	590.17	2339.45	590.37	2456.67	590.38	2465.00	590.41	2480.10	589.95	2211.51
Downstream of Lucas Ditch confluence	0.41	587.40	2960.64	587.24	2829.51	587.37	2936.08	587.38	2944.97	587.40	2959.60	587.09	2706.45
150-ft upstream of 115th St.	3.72	592.21	95.98	592.05	64.93	592.18	95.86	592.19	98.33	591.35	160.54	592.21	97.72
1000-ft downstream of Kostner Ave.	2.54	592.12	310.27	591.97	383.67	592.09	307.96	592.10	307.28	591.15	411.00	592.12	309.92
Downstream of Merrionette Park Ditch confluence	1.54	591.75	840.82	591.54	846.04	591.72	837.11	591.73	837.93	590.22	1053.87	591.75	840.65
Southeast of Kedzie Ave. and 127th St.	0.95	591.18	919.14	590.96	912.79	591.16	914.00	591.17	915.86	589.00	1183.08	591.18	918.80
Downstream end of Stony Creek East	0.30	590.92	1051.46	590.70	1029.15	590.90	1043.67	590.91	1047.02	588.17	1478.52	590.92	1051.30

TABLE 3.28.12
Stony Creek Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
STCR-2	400 ac-ft reservoir at St. Casimir Cemetery	0.25	12,203,700	48,496,800	666	USACE	Positive	Yes	Alsip, Oak Lawn, Chicago
STCR-2b	STCR-2, STCR-3, and STCR-4 combined	0.22	13,364,900	60,515,100	804	USACE, Village of Oak Lawn	Positive	No	Alsip, Oak Lawn, Chicago
STCR-3	87 ac-ft detention pond at Wolfe Wildlife Refuge	0.1	735,100	7,691,000	55	USACE	Positive	Yes	Alsip, Oak Lawn, Chicago
STCR-4	39 ac-ft detention pond at K-Mart site	0.05	206,600	4,327,300	20	USACE, Village of Oak Lawn	Slightly Positive	Yes	Alsip, Oak Lawn, Chicago
STCR-6	Realign Melvina Ditch confluence with Stony Creek	0.01	86,100	10,983,600	21	USACE	No Impact	No	Chicago Ridge, Oak Lawn
STCR-7	Enlarge California Avenue culvert	0.11	364,200	3,428,900	86	USACE	No Impact	Yes	Palos Hills
STCR-8	Construct closed-conduit diversion along ComEd ROW	0.18	1,146,600	6,286,400	44	USACE	No Impact	Yes	Palos Hills
STCR-9	Construct Harlem Ave channel diversion	0.2	2,654,800	13,597,300	160	USACE	No Impact	No	Palos Hills
STCR-10	Stabilization of erosion problem area near Stony Creek and Oak Lawn Creek confluence	*	*	2,754,800	0		Positive	Yes	Oak Lawn
STCR-11	Levee downstream of Lucas Ditch – West Stony Creek confluence	0.02	63,800	3,219,600	3	USACE	No Impact	No	Palos Hills

Notes: Net Benefits values do not include local benefits or non-economic benefits.
Alternative STCR-10 is recommended because it is an erosion problem that if left to continue threatens to significantly constrict Stony Creek flow.

3.29 Tinley Creek

Tinley Creek is located in southwestern Cook County, south of the Calumet-Sag Channel, in the southeastern part of the Calumet-Sag Channel Watershed. The drainage area of the Tinley Creek is 12.91 square miles, with 2.3 square miles in Boca Rio Ditch and 0.25 square mile in Arroyo Ditch. Table 3.29.1 summarizes the land area of communities within the Tinley Creek subwatershed. The middle of Tinley Creek, including the confluence with Boca Rio Ditch, is within Cook County Forest Preserve. The upstream part, as well as its tributaries Boca Rio Ditch and Arroyo Ditch, is largely residential. Table 3.29.2 summarizes the land use distribution within Tinley Creek.

TABLE 3.29.1
Communities Draining to Tinley Creek

Community/Tributary	Tributary Area (mi^2)
Unincorporated/Forest Preserve	5.62
Orland Park	4.2
Oak Forest	1.18
Orland Hills	0.86
Tinley Park	0.6
Matteson	0.17
Crestwood	0.14
Palos Heights	0.13
Alsip	0.01

Note: Includes areas tributary to Boca Rio Ditch and Arroyo Ditch

Figures 3.29.1a and 3.29.1b are an overview of the tributary area of the Tinley Creek subwatershed. Reported stormwater problem areas, flood inundation areas, and proposed alternative projects are also shown and discussed in the following subsections.

TABLE 3.29.2
Land Use Distribution for Tinley Creek

Land Use Category	Area (acres)	%
Forest/Open Land	4,002.9	48.5
Residential	3,352.9	40.6
Commercial/Industrial	487.8	5.9
Water/Wetland	135.1	1.6
Agricultural	126.3	1.5
Institutional	95	1.2
Transportation/Utility	58.7	0.7

Note: Area includes Boca Rio Ditch and Arroyo Ditch

3.29.1 Sources of Data

3.29.1.1 Previous Studies

An HSPF model of the Tinley Creek watershed is under development by the USGS to predict runoff volumes and use in a water-quality analysis of the Tinley Creek subwatershed. The model was not available during the DWP development.

3.29.1.2 Water Quality Data

IEPA does not have any sites in the Ambient Water Quality Monitoring Network on Tinley Creek. The IEPA's 2008 *Integrated Water Quality Report*, which includes the CWA 303(d) and 305(b) lists Tinley Creek as impaired for its designated use supporting aquatic life, with the cause of impairment listed as unknown. No TMDLs have been established for Tinley Creek. According to a USEPA water permit discharge query, there are no NPDES permits issued by IEPA for discharges to Tinley Creek. Municipalities discharging to Tinley Creek are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the water quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement the six minimum control measures for limiting runoff pollution to receiving systems.

3.29.1.3 Wetland and Riparian Areas

Figures 2.3.6 and 2.3.7 contain mapping of wetland and riparian areas in the Calumet-Sag Channel Watershed. NWI data includes 517 acres of wetland areas in the Tinley Creek Tributary area. Riparian areas are defined as vegetated areas between aquatic and upland ecosystems adjacent to a waterway or body of water that provides flood management, habitat, and water quality enhancement. Identified riparian environments offer potential opportunities for restoration.

3.29.1.4 Floodplain Mapping

Flood inundation areas supporting the NFIP were revised in 2008 as a part of FEMA's Map Modernization Program. Floodplain boundaries were revised based upon updated Cook County topographic information, but the effective models used to estimate flood levels generally were not updated. LOMRs were incorporated in the revised floodplains. The original H&H analysis was performed in 1976. The hydrologic modeling was performed by using L-PTIII and Regression Equation 77. Hydraulic routing was performed using the WSP-2 modeling application.

Appendix A includes a comparison of FEMA's effective floodplain mapping from updated DFIRM panels with inundation areas developed for the DWP.

3.29.1.5 Stormwater Problem Data

Table 3.29.3 summarizes reported problem areas reviewed as a part of the DWP development. The problem area data was obtained primarily from Form B questionnaire response data provided by watershed communities, agencies, and stakeholders to the District. Problems are classified in Table 3.29.3 as regional or local. This classification is based on a process described in Section 1 of this report.

3.29.1.6 Near-Term Planned Projects

Watershed communities, agencies, and stakeholders were asked about near-term planned projects so that the implementation of near-term flood control projects by others is considered in development of the DWP. The Village of Orland Park noted that engineering services had been contracted for replacement of culverts and sediment removal in the Fernway area, which is just downstream of 88th Avenue. The Village reiterated at the June 4, 2008, WPC coordination meeting that several culverts will be replaced in kind. In fall 2007, sediment was observed at some culverts during a field survey in this extent of Tinley Creek. This sediment was not included in the baseline model.

3.29.2 Watershed Analysis

3.29.2.1 Hydrologic Model Development

Subbasin Delineation. The Tinley Creek tributary area was delineated based primarily upon LiDAR topographic data developed by Cook County in 2003. Part of the Tinley Creek basin is adjacent to the Little Calumet watershed. Initial boundaries of the Calumet-Sag boundary and Little Calumet boundary were compared, and discrepancies identified. Discrepancies generally were minor and resolved by manual review of topographic data and consultation with local communities and other watershed planning consultants.

TABLE 3.29.3
Community Response Data for Tinley Creek

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
BR1	Bremen Township	Maintenance	Ridgeland Ave. from 135th St. to 147th St.	Debris and siltation of box culvert due to alignment of Tinley Creek (CCHD)	Regional	Siltation not noted in field survey. May have been addressed through maintenance activities.
BR2	Bremen Township	Maintenance	143rd St. from 82nd Ave. to Harlem Ave.	Overbank flooding due to lack of maintenance in Forest Preserve	Local	Problem not located on a regional waterway.
CW2	Crestwood	Maintenance	Central Ave. from 127th St. to 135th St.	Embankments need repair and debris in embankment and waterway	Regional	Project TICR-3 recommends the construction of a levee upstream of Central Avenue.
CW3	Alsip, Crestwood, Worth Township	Overbank flooding, basement flooding	Between 129th St. and Calumet-Sag Channel, west of Central Ave.	Overbank flooding during heavy rain, attributed in part to double bend in Tinley Creek just downstream of Central Avenue	Regional	TICR-3 protects downstream structures from damages due to flooding. Modification of channel alignment would increase downstream flooding, and cause erosion risk due to increased velocity.
OH1	Orland Hills, Orland Park	Overbank flooding, ponding, water quality, bank erosion, wetland riparian	Tinley Creek at 88th Ave.	Culvert and channel downstream of 88th Avenue have sediment and vegetation which reduces conveyance	Regional	TICR-5 addresses sedimentation upstream of 188th Street
OH2	Orland Hills	Overbank flooding, ponding, water quality, bank erosion, wetland riparian	Lake Lorin and along 167th Street between 91st Ave. and Haven Ave.	Lake Lorin vegetation, sedimentation, and outlet condition reduces Tinley Creek conveyance in this area	Regional	Maintenance of Lake Lorin recommended to preserve storage capacity. Sufficient land was not available in the area for potential capital projects that could address problem. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.

TABLE 3.29.3
Community Response Data for Tinley Creek

Problem ID	Municipality	Problems as Reported by Local Agency	Location	Problem Description	Local/ Regional	Resolution in DWP
OP15	Orland Park	Sedimentation, Overbank flooding	167th St. and 88th Ave. (Fernway area)	Sedimentation and culvert restrictions result in frequent overbank flooding of the Fernway area. Village has contracted engineering for culvert replacement and sediment removal	Regional	Orland Park has planned solution to replace culverts and remove sediment in this region. Included in baseline model conditions.
OP2	Orland Park	Pavement flooding	Route 43 (Harlem Ave.) between 151st St. and 153rd St.	IDOT reported pavement flooding	Local	Problem not located on a regional waterway. This is a local problem
OP5	Orland Park	Bank erosion, sedimentation	151st St. and Orland Brook Dr.	Significant erosion and sedimentation results in flow restriction	Regional	TICR-7 will stabilize banks to address this erosion problem on a regional waterway that threatens structures.
OP8	Orland Park	Overbank flooding	Tinley Creek at 82nd Ave.	Overbank flooding due to undersized culvert along Tinley Creek and lack of maintenance downstream	Regional	Model results did not confirm that roadway flooding in this area is associated with regional waterways. Previous observations of flooding in this area may be the result of a condition already addressed or associated with local drainage problems.
PH1	Palos Heights	Overbank flooding	135th St. from Harlem Ave. to Ridgeland Ave.	Pavement flooding due to high stages in the channel, 28 known occurrence	Local	Problem not located on a regional waterway. This is a local problem
PH11	Bremen Township, Palos Heights	Pavement flooding	Route 43 (Harlem Ave.) at 135th St.	IDOT reported pavement flooding	Local	Problem not located on a regional waterway. This is a local problem

Table 3.29.4 summarizes the total drainage area, number of modeled subbasins, and average subbasin size for Tinley Creek and its tributaries.

TABLE 3.29.4
Tinley Creek System Subbasin Summary

Subbasin	Drainage Area (mi^2)	Number of Modeled Subbasins	Average Modeled Subbasin Size (acres)
Tinley Creek	10.37	55	120.35
Major Tributaries to Tinley Creek			
Boca Rio Ditch	2.29	15	99.11
Arroyo Ditch	0.25	1	156.87
Total	12.91	71	116.37

Hydrologic Parameter Calculations. CNs were estimated for each subbasin based upon NRCS soil data and 2001 CMAP land use data. This method is further described in Section 1.3.2, with lookup values for specific combinations of land use and soil data presented in Appendix C. An area-weighted average of the CN was generated for each subbasin. The lag time, used to convert excess precipitation into a runoff hydrograph, was assumed to be 0.6 times the time of concentration for all subbasins. The time of concentration, or time of travel from the hydrologically most distant part of the subbasin, was estimated by using standard procedures assuming a length of sheet flow, shallow concentrated flow, and channel flow. In some instances, modification to parameter estimates was necessary to more accurately characterize very flat or heavily sewered subwatersheds. Appendix G provides a summary of the hydrologic parameters used for subbasins in each subwatershed.

3.29.2.2 Hydraulic Model Development

Field Data, Investigation, and Existing Model Data. No hydraulic models that met the District criteria for use in the DWP, as identified in Section 6.3.3.2 of the CCSMP, were available for DWP development. Surveys of the open channel part of Tinley Creek and all crossings were performed to characterize the channel and near overbank geometry. Cross-sectional geometry in the non-surveyed overbank area was obtained from Cook County topographic data and combined with the surveyed channel cross section. Field visits were performed to assess channel and overbank roughness characteristics, which were combined with information from photographs and aerial photography to assign modeled Manning's *n* roughness coefficients along the modeled stream length.

Boundary Conditions. Tinley Creek is tributary to the Calumet-Sag Channel. Appendix E summarizes the modeled elevation of the Calumet-Sag Channel for the modeled recurrence interval storms. The estimated elevation for the 100-year storm at the outlet of Tinley Creek was 585.18 feet NAVD 88, roughly 4 feet above the invert of Tinley Creek near its confluence with the Calumet-Sag channel. This relatively shallow depth indicates that downstream stage on Tinley Creek is controlled not by the receiving system but by its own capacity to convey flows received from its tributary area. Normal depth assuming a friction slope of 0.001 was thus used as a downstream boundary condition for Tinley Creek.

3.29.2.3 Calibration and Verification

Observed Data. USGS Stream Gage 5536500 is located on Tinley Creek at its 135th Street crossing. Approximately 11.2 square miles of the Tinley Creek system is tributary to this gage location. The gage record spans from September 26, 1951 to the present. The record was reviewed to identify recent storms of significant intensity for comparison with model results. Based upon a review of recorded flows, several generally discrete rainfall events that resulted in significant flows were identified for use in model calibration. Only events within the last 10 years were considered to minimize differences due to watershed development. Table 3.29.5 summarizes selected flow events.

TABLE 3.29.5
Flow Events

Date	Peak Monitored Flow (cfs)	Note
6/10/2006	385	No rainfall in the month preceding the event
9/13/2006	1,210	Four significant rainfall events in preceding 15 days.
8/23/2007	584	Larger, second event of August 2007.
9/13/2008	906	Four significant rainfall events in preceding 15 days.

Four ISWS rain gages are located in the Tinley Creek subwatershed area. Thiessen polygons were used to assign rain gages to each subwatershed. Figure 2.3.1 shows the Tinley Creek subwatersheds and their assigned ISWS rainfall gage. Table 3.29.6 summarizes the 12-hour rainfall accumulation and associated recurrence interval storm approximation for each gage and modeled storm.

TABLE 3.29.6
Summary of 12-Hour Rainfall Accumulation and Associated Recurrence Interval Storm Approximations

		6/10/2006		9/13/2006		8/23/2007		9/13/2008	
Gage	Area	Depth (in)	Recurrence	Depth (in)	Recurrence	Depth (in)	Recurrence	Depth (in)	Recurrence
16	2.28	2.65	2 yr	1.59	4 month	1.48	4 month	3.21	5-yr
17	2.56	2.11	< 1 yr	1.9	< 9 month	1.25	2 month	3.59	5-10 yr
20	4.45	2.29	1 yr	2.64	2 yr	1.41	3-month	n/a	n/a
21	3.63	2.52	2yr	1.23	2 month	1.48	4 month	3.08	2-5 yr

The four events listed in Table 3.29.6 were reviewed to determine each event's suitability for use in calibration. The review determined that the 9/13/2006 and 8/23/2007 events were not suitable for use in calibration because of extreme rainfall variability, high antecedent moisture conditions evident in the comparison of stream flow with runoff volume (80 percent of rainfall was measured as streamflow), and multiple peak events are difficult to simulate accurately using SCS hydrology. The 6/10/2006 and the 9/13/2008 events had less rainfall variability, span a range of storm magnitudes, and were single-peaked events well- suited to simulation with SCS hydrology. These events were considered for calibration and are summarized below.

Calibration Results. The September 13, 2008 storm was evaluated using the existing conditions model. The event lasted for approximately two days, and consisted of three periods of more intense rainfall.

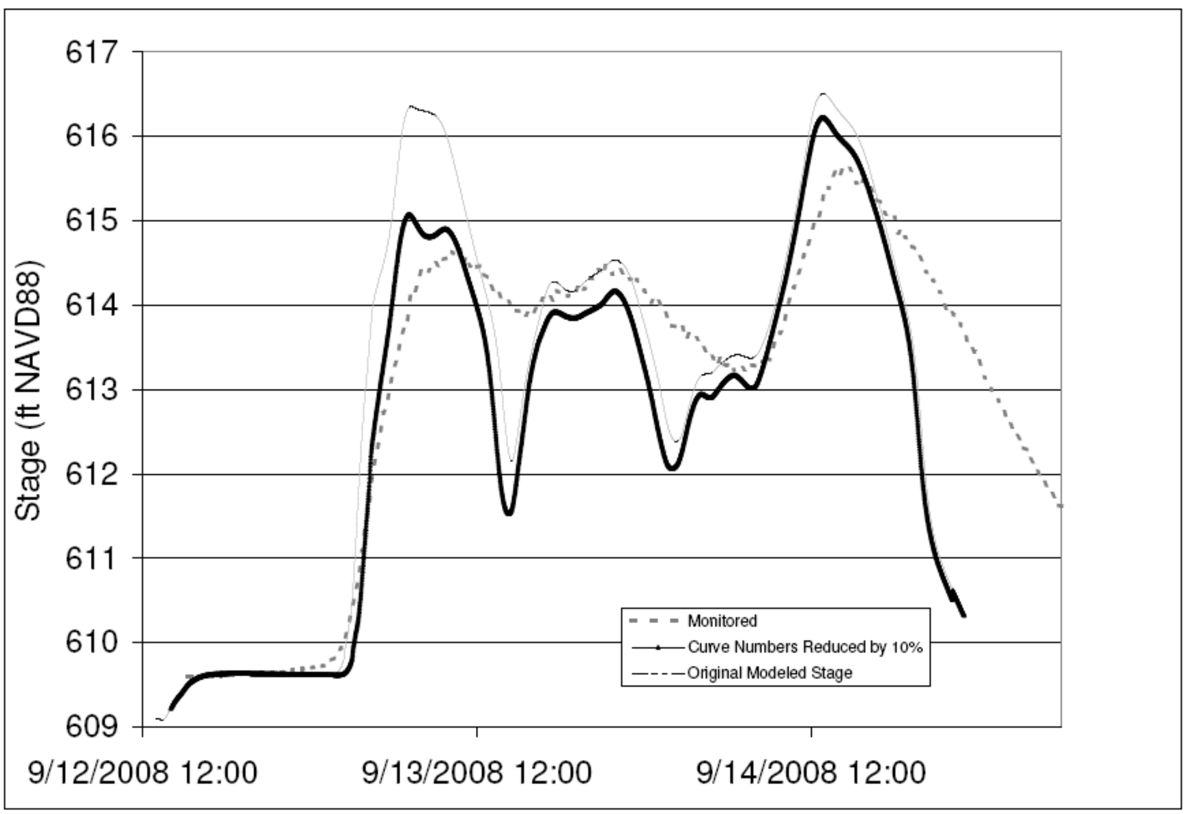
TABLE 3.29.7
9/13/2008 Monitored and Modeled Flow and Stage for Tinley Creek

Model Run	Peak Stage (ft)	Runoff Volume (ac-ft)	Difference in Peak Stage (ft)	Difference in Runoff Volume (ac-ft)
Monitored	615.6	1995.4	N/A	N/A
Original Model	616.5	2780.5	-0.9	39.3%
Revised Model	616.1	2277.2	-0.5	14.1%

The highest stage was reported, coinciding with the third peak.

A comparison of modeled and recorded stage and flow indicated that the model was over predicting these parameters. Modification of hydrologic and hydraulic variables that affect stage and flow were considered as described in Section 1.3.8. As described, the model curve numbers were reduced by 10 percent from the originally calculated values. This resulted in an improved correlation between the modeled and monitored runoff volume and stage. Table 3.29.7 provides a comparison of monitored and modeled stage and runoff volume, including both the original and revised hydrologic model results. Figure 3.29.2 provides a comparison of modeled and monitored stage for the same event.

FIGURE 3.29.2
Tinley Creek Calibration for September 13, 2008 Storm



The calibrated model results show a better correlation of stage, particularly for the two most intense portions of the events. For the first peak, the original model over predicts stage by approximately 1.5 ft, and this difference is reduced to less than half a foot with the revised model. In the periods of less rainfall, the modeled stage decreases more rapidly than the monitored stage. This behavior may be due in part to the shape of the standard SCS unit hydrograph. Hydraulic routing attenuates the unit hydrograph shape, but not to the extent that the model hydrograph at the gage location matches the receding limb.

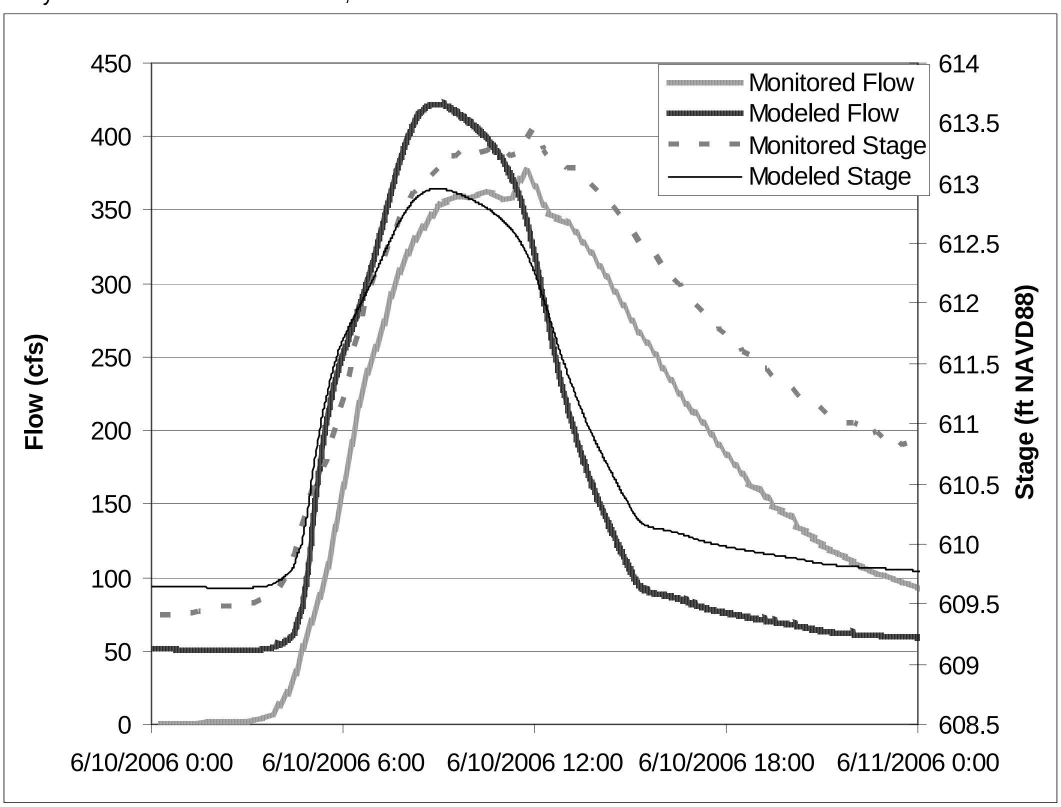
The June 10, 2006 storm was utilized for model calibration because it was a relatively isolated, single peaked event causing significant flow in Tinley Creek. The recurrence interval of the rainfall data recorded ranges from 2 months to 2 years for the gages utilized for the Tinley Creek hydrologic model. Based upon the 9/13/2008 calibration event, the model was evaluated using the model with curve numbers reduced by 10 percent from the originally calculated values, as described below.

TABLE 3.29.8
6/10/2006 Monitored and Modeled Flow and Stage for Tinley Creek

Model Run	Peak Stage (ft)	Runoff Volume (ac-ft)	Difference in Peak Stage (ft)	Difference in Runoff Volume (ac-ft)
Monitored	613.47	434.5	N/A	N/A
Revised Model	612.95	384.3	-0.52	-11.6%

Figure 3.29.3 shows the monitored and revised model flows and stage for the June 10, 2006 storm. Table 3.29.8 summarizes the difference between monitored and modeled flow and stage for the June 10, 2006 storm.

FIGURE 3.29.3
Tinley Creek Calibration for June 10, 2006 Storm



Modeled stage is under-predicted by roughly 0.5 ft, with flow slightly under-predicted as well. The period preceding the June 10, 2006 was very dry, and initial abstractions based resulting from dry soil may contribute to the slight under-prediction. The small difference between modeled and monitored stage suggests that the Tinley Creek model generally provides accurate stage and flow estimates for smaller events like the June 10, 2006 storm.

Modifications to Model Input. As shown in Tables 3.29.7 and 3.29.8 and in Figures 3.29.2 and 3.29.3, a revised model with curve number values reduced by 10 percent from the original values was found to best represent stage and overall runoff volume for the storms considered. Although this resulted in a slight under-prediction of flow and stage for the 6/10/2006 event, relatively dry antecedent conditions may have resulted in slightly less runoff than would be generally expected. The revised model was used for design event simulation and alternative evaluation.

3.29.2.4 Existing Conditions Evaluation

Flood Inundation Areas. Figure 3.29.1 shows inundation areas produced by the hydraulic model for the 100-year, 12-hour duration design storm.

Hydraulic Profiles. Appendix H contains hydraulic profiles of existing conditions in the Tinley Creek system. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year recurrence interval design storms.

3.29.3 Development and Evaluation of Alternatives

3.29.3.1 Modeled Problem Definition

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. Table 3.29.9 summarizes problem areas identified through hydraulic modeling of Tinley Creek.

TABLE 3.29.9
Modeled Problem Definition for Tinley Creek

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Form B	Resolution in DWP
MPA42	Between 127th Street and 129th Street, west of Central Ave.	50,100	CW2, CW3	Project TICR-3 addresses the flooding in this area.
MPA43	Several hundred feet upstream and downstream of Tee Brook Drive crossing	100		Risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.
MPA44	Along Tinley Creek between 88th Ave. and Laurel Drive	10, 25, 50, 100	OH1, OP15	Project TICR-5 addresses sedimentation problem in this area.

TABLE 3.29.9
Modeled Problem Definition for Tinley Creek

Problem ID	Location	Recurrence Interval of Flooding (yr)	Associated Form B	Resolution in DWP
MPA45	Upstream of 167th and downstream of Hobart Ave.	25, 50, 100	OH2	Maintenance of Lake Lorin recommended to preserve storage capacity. Sufficient land was not available in the area for potential capital projects that could address problem. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.
MPA46	Along Tinley Creek between Hobart Avenue and 94th Ave.	25, 50, 100		Maintenance of Lake Lorin recommended to preserve storage capacity. Sufficient land was not available in the area for potential capital projects that could address problem. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition.

Problem MPA42 at Tinley Creek's crossing of Central Avenue is located just upstream of where Tinley Creek makes two significant bends. The HEC-RAS modeling software used for existing conditions and alternatives analysis is a one-dimensional model, which does not consider energy or momentum losses due to rapid change in transverse channel geometry or flow direction. The 1D model may not fully account for these losses.

3.29.3.2 Damage Assessment

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. No recreation damages due to flooding were identified for Tinley Creek. Transportation damages were estimated as 15 percent of property damages. Erosion damages were determined for erosion problems that threaten structures along Tinley Creek between 160th Street and 151st Street in Orland Park. Five homes and one structure within an apartment complex were determined to be threatened by erosion because these structures were located within thirty feet of an active erosion zone.

TABLE 3.29.10
Estimated Damages for Tinley Creek

Damage Category	Estimated Damage ($)	Note
Property	2,438,200	
Erosion - structures	8,457,800	Structures at risk due to erosion
Erosion – roadway and utilities: Orlan Brook Drive	249,700	Cost to replace Orlan Brook Drive and utilities between 160th Street and 159th Street threatened by erosion of Tinley Creek
Transportation	365,700	Assumed as 15% of property damage due to flooding
Recreation	0	

3.29.3.3 Technology Screening

Flood control technologies were screened to identify those most appropriate to address the flooding problems in the Tinley Creek subwatershed. Increased conveyance or storage was identified as the principal technologies applicable for addressing stormwater problems in Tinley Creek. Levees were also identified as a potential technology for protecting properties.

3.29.3.4 Alternative Development

Stormwater improvement alternatives were developed to address regional stormwater problems identified in Tables 3.29.11 and 3.29.13, with the aim of reducing damages due to stormwater.

Flood Control Alternatives. Alternative solutions to regional flooding and streambank erosion were developed and evaluated consistent with the methodlogy described in Section 1.4 of this report. Table 3.29.11 summarizes flood and erosion control alternatives for Tinley Creek.

TABLE 3.29.11
Flood Control and Erosion Control Alternatives for Tinley Creek

Alternative	Location	Description
TICR-1	12900 South Central Avenue	Construct 96-inch channel diversion under Central Avenue to Calumet-Sag Channel
TICR-2	Forest Preserve near intersection of Justamere Road and 143rd Street	Create weir/impoundment to reduce downstream flows.
TICR-3	12900 South Central Avenue	Construct 4.5-foot levee 1,200 feet long on northwest channel bank and construct 4.5-foot levee 2,000 feet long on southeast channel bank of Tinley Creek approaching Central Avenue. Obtain flood easement on Cook County Forest Preserve property.
TICR-3B	12900 South Central Avenue	Construct 4.5-foot levee 1,200 feet long on northwest channel bank of Tinley Creek approaching Central Avenue. Obtain easement and construct a 45 acre-feet detention pond on Cook County Forest Preserve property to offset lost floodplain area
TICR-4	12900 South Central Avenue	Repair, as necessary, 1,400-foot embankment along east side of Tinley Creek downstream of Central Avenue. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
TICR-5	88th Avenue Upstream of Lake Lorin	Dredge sediment in channel between 88th Avenue and Lake Lorin.
TICR-6	Lake Lorin	Increase storage potential of Lake Lorin. This alternative did not effectively reduce water surface elevations in the flooding problem area, thus benefits and costs were not developed.
TICR-7	Tinley Creek between Oriole Court and 151st Street	Stabilize using hard-armoring or other acceptable technology to prevent erosion problems that threaten structures between Oriole Court and 151st Street.
TICR-8	Tinley Creek between 160th Street and 86th Avenue	Stabilize using hard-armoring or other acceptable technology to prevent erosion problems that threaten structures between 160th Street and 86th Avenue.

Erosion Control Alternatives. Two erosion control alternatives, TICR-7 and TICR-8, were developed for Tinley Creek to address the erosion problems that threaten structures along Tinley Creek between 160th Street and 151st Street in Orland Park. The alternatives proposed to address the erosion problems along Tinley Creek will provide hard armoring of the bank where erosion is occurring. For TICR-7, the project includes 700 feet of armoring upstream of Tee Brooke Drive on both sides of Tinley Creek, and 300 feet of armoring on one side of Tinley Creek within the Quail Hollow Drive apartment complex just south of 151st Street in Orland Park. For TICR-8, the project includes 450 feet of armoring on one side of Tinley Creek along Orlan Brook Drive between 160th Street and 159th Street, and 1,550 feet of armoring on both sides of Tinley Creek downstream of 159th Street to 86th Avenue. For both alternatives, the armoring is conceptually developed to include costs consistent with traditional approaches to armoring such as concrete walls. As an alternative to using concrete, there are other hard-armoring erosion protection techniques available to stabilize Tinley Creek that will give a more natural appearance than concrete. Given its suburban setting with limited space available, and structures located nearby, the current alignment of Tinley Creek will likely have to largely remain. However, through the use of rock and geotextile fabric, a hard-armoring protection technique can be designed to protect the slope in a more aesthetically pleasing way. This type of bank treatment will be keyed-in for toe-of-slope protection and there will be transitions to the natural slope at the upstream and downstream ends of each project area. The treatment will be scaled to the gradient of the slope and the shear stresses to which the slope is exposed.

3.29.3.5 Alternative Evaluation and Selection

TICR-1 considered construction of a channel diversion beneath Central Avenue to divert flow and lower flood stages in and around problem MPA42. Some agencies familiar with the area had noted the possibility of an existing 48-inch diversion pipe in this location. Field reconnaissance and communication with the Village of Crestwood determined that no such diversion exists. Modeling analysis showed that while the construction of a channel diversion would reduce flood stages, the embankment on the north side of Tinley Creek approaching Central Avenue would still overtop during a 100-year design storm. As this alternative would only partially address damages, other alternatives were considered and this alternative is not recommended.

TICR-2 considered the impact of impounding Tinley Creek to an elevation of 645 feet within the Forest Preserve. The effectiveness of an impoundment is predicted to be greater than TICR-1. A much smaller volume of floodwater is estimated to overtop the embankment north of Tinley Creek approaching Central Avenue during a 100-year design storm. This project is not recommended because TICR-3 addresses the same problem area and provides complete protection, addressing all damages.

TICR-3 includes a levee roughly 4.5 feet high on the north side of Tinley Creek approaching Central Avenue. In addition, a second 4.5-foot high levee is proposed on the south side of Tinley Creek to protect structures at risk of flooding. Both proposed levees provide three feet of freeboard above the modeled 100-yr WSEL, protecting the residential area north of Tinley Creek and problem area MPA42 from damages. A small pumping station is also recommended to dewater the area behind the levee to the south of Tinley Creek. In the absence of compensatory measures, the water surface upstream of the levee would rise slightly, but the upstream land includes one school, protected by the proposed levee, and areas within the Cook County Forest Preserve. The rise in WSEL in this area may be contained within a floodplain easement as allowed under IDNR regulation 3708.70.d.12. TICR-3 is recommended in favor of TICR-3B, described below, because it provides increased benefits, while minimizing impact on upstream Cook County Forest Preserve lands. Coordination with the Forest Preserve may result in cooperation to achieve both regional flood control and Forest Preserve priorities in the area.

The volume of lost floodplain storage was estimated to be 45 acre-feet, based on a rough estimate of 1.5 feet of flooding over a 30-acre downstream area. TICR-3b includes the cost of the levee and the cost to construct a 45 acre-feet detention facility to provide compensatory storage. Since the Tinley Creek subwatershed boundaries are very narrow at the proposed levee location, and land use transitions to the Forest Preserve 2,000 feet upstream, this storage location is proposed within the Forest Preserve. The site was chosen because the low slope in the area reduces the excavation volume required, and the space is relatively more open than nearby more densely forested areas. Alternative locations providing sufficient compensatory storage could not be identified outside of Cook County Forest Preserve. The proposed storage location is not online of Tinley Creek, but in the overbank area, and unlike TICR-2 does not impound Tinley Creek itself, or raise the WSEL of Tinley Creek within the Cook County Forest Preserve. TICR-3b is not a recommended alternative in this area because of the impact to the forest preserve caused by the compensatory storage is required.

TICR-4 involves the repair of the embankment along the east bank of Tinley Creek on the downstream side of Central Avenue. No damages were estimated in the overbank region in this area, due in part to the modeled impact of the existing embankment in this area, and so TICR-4 was not considered in detail. If this embankment were allowed to degrade, floodwaters could escape the right overbank region of Tinley Creek and cause roadway flooding.

TICR-5 considered the removal of accumulated sediment from a 1,500-foot reach of Tinley Creek between the outlet of Lake Lorin and 88th Avenue. Survey data obtained 350 feet downstream of the Lake Lorin outlet indicate a channel invert of 697.61 feet, roughly 1 ft above the lower of the surveyed invert of 696.61 feet on the discharge pipe from Lake Lorin. Reported problems OH1 and OP15 refer to sedimentation in 88th avenue and downstream, which were not included in the modeled baseline conditions because of the Village of Orland Park has plans to address this issue, which was consequently not included in baseline conditions. Dredging between 88th Avenue and Lake Lorin results in the most significant WSEL reductions along the dredged reach, although property damage due to flooding has not been reported adjacent to the dredged reach. Minor reductions in peak WSEL (approximately 0.1 ft) are predicted in this and adjacent reaches. One structure is estimated to be removed from the 100-year inundation area due to TICR-5, with other damages associated with minor peak WSEL reductions for the modeled storms.

TICR-6 includes several scenarios considering expansion of the storage volume of Lake Lorin. The most aggressive alternative would involve clearing some of the vegetation restricting flow along with the addition of roughly 16 acre-feet of storage on the baseball field northwest of the lake. Preliminary evaluation of these alternatives indicated very minor impacts on calculated damages. Damages upstream of 167th Street are located along a stretch of Tinley Creek with significant gradient, and the stream rises quickly above the level defined at the 167th Street crossing controlled by Lake Lorin. Downstream damages are not significantly reduced either, as Lake Lorin is still predicted to overtop for high magnitude rainfall events. The relative ineffectiveness of additional storage is most likely because it is online with Tinley Creek. The 12-hour duration storm used for analysis within the Calumet-Sag Channel Watershed results in significant storage being used within Lake Lorin before the peak of the storm. It is possible that additional storage in Lake Lorin would provide more significant benefits for high magnitude events of shorter duration.

TICR-7 is recommended to address erosion damages associated with erosion problems that threaten structures between Oriole Court and 151st Street in Orland Park. TICR-8 is recommended to address erosion damages associated with erosion problems that threaten structures between 160th Street and 86th Avenue in Orland Park.

WPC member feedback suggested the idea of pumping Lake Lorin to provide additional storage. The grade of Tinley Creek downstream of Lake Lorin does not permit lowering the outlet pipe to provide additional storage, but the lake could be pumped in advance of storms to make additional storage capacity available for flood attenuation. Although technically feasible, this alternative is complicated logistically, as operators would be required to identify pumping thresholds based on weather forecasts to provide the additional storage. The high maintenance cost for this suggestion, combined with logistical difficulty, excluded it from further consideration.

Recommended alternatives result in reduced stage and/or flow along the modeled waterway. Table 3.29.12 provides a comparison of the modeled maximum WSEL, and modeled flow at the time of peak at representative locations along the waterway.

A number of properties are at risk of shallow flooding during the 100-year flood event under existing conditions or recommended alternative conditions. In addition, due to their locations, other properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using nonstructural flood control measures, such as flood-proofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Calumet-Sag Channel DWP.

3.29.3.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternatives. Table 3.29.13 lists alternatives analyzed in detail. TICR-3, levves with a flood easement, and TICR-5, the dredging of a 1,500 ft length of Tinley Creek are recommended, and shown in Figures 3.29.4 and 3.29.5, respectively. These figures also show a comparison of the existing conditions to the alternative conditions inundation mapping with the implementation of TICR-3 and TICR-5. Figures 3.29.6 and 3.29.7, respectively, show the recommended erosion control alternatives TICR-7 and TICR-8.

TABLE 3.29.12
Tinley Creek Existing and Alternative Condition Flow and WSEL Comparison

		Existing Conditions		TICR-3		TICR-5	
Location	**Station**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**	**Max WSEL (ft)**	**Max Flow (cfs)**
Tinley Creek 100-ft downstream of 167th St.	58572	702.53	174.20	702.53	174.21	702.38	202.83
Tinley Creek crossing at 163rd St.	52956	697.76	184.77	697.76	184.81	697.67	178.76
Tinley Creek 170-ft downstream of 86th Ave.	48131	683.56	667.97	683.56	667.97	683.54	662.28
Tinley Creek 50-ft upstream of 151st St.	43469	672.34	920.21	672.34	920.19	672.32	913.56
Tinley Creek 50-ft downstream of 82nd Ave.	37894	661.70	1578.47	661.70	1578.50	661.68	1571.85
Tinley Creek 130-ft upstream of Ridgeland Ave.	18787	628.95	1908.13	629.34	2130.52	628.95	1906.67
Tinley Creek 100-ft upstream of Central Ave.	3565	604.87	2712.00	604.78	2660.19	604.86	2704.08
Tinley Creek 70-ft downstream of Calumet-Sag Rd. and 127th St.	462	592.88	2946.70	592.82	2918.71	592.86	2936.66

TABLE 3.29.13
Tinley Creek Project Alternative Matrix to Support District CIP Prioritization

Project	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Funding Possibilities	Water Quality Benefit	Recommended	Communities Involved
TICR-1	Channel Diversion	0.05	244,300	4,957,900	5	USACE	No Impact	No	Crestwood, Alsip, Unincorporated Cook County
TICR-2	Forest preserve impoundment	0.54	1,682,900	3,104,200	28	USACE	Mixed	No	Crestwood, Alsip, Unincorporated Cook County
TICR-3	Levee	0.72	1,982,000	2,764,400	42	USACE	No Impact	Yes	Crestwood, Alsip, Unincorporated Cook County
TICR-3B	Levee and compensatory storage	0.32	1,933,700	6,032,300	40	USACE	Slightly Positive	No	Crestwood, Alsip, Unincorporated Cook County
TICR-5	Dredge sediment in channel between 88th Avenue and Lake Lorin	1.26	142,600	112,800	4	USACE	No Impact	Yes	Orland Hills, Orland Park
TICR-7	Stabilize erosion of Tinley Creek between Oriole Court and 151st Street	1.03	1,524,700	1,479,700	6		Slightly Positive	Yes	Orland Park
TICR-8	Stabilize erosion of Tinley Creek between 160th Street and 86th Avenue	1.55	7,164,900	4,627,200	8	USACE	Slightly Positive	Yes	Orland Park

Note: Net Benefits values do not include local benefits or non-economic benefits.

4. Watershed Action Plan

This section summarizes the DWP recommendations. The recommendations and supporting information will be considered by the District's Board of Commissioners in their prioritization of a countywide Stormwater Capital Improvement Program (CIP). The recommendations within the DWP consist of maintenance activities (Section 4.1) and recommended capital improvements (Section 4.2).

4.1 Watershed Maintenance Activities

Review of reported stormwater problem data indicated that certain types of maintenance activities would be helpful in preventing these stormwater problems. The District, through its maintenance activities, has been actively removing blockages such as tree limbs and woody debris from channels throughout the Cook County. Local communities have reported benefits from these maintenance activities. It is recommended that the District maintenance activities be continued to address ongoing future maintenance needs.

Modeling analysis performed as part of the DWP generally revealed that dredging accumulated sediment was not effective in significantly reducing damages due to regional overbank flooding problems. In a few cases where dredging was found to have a regional benefit, it was recommended as a part of the DWP's CIP. Significant regulatory challenges exist with dredging projects. Sedimentation is a dynamic process that is affected by soil protective measures taken in upland tributary areas as well as dynamic streambank conditions. The District's Watershed Management Ordinance will define standard practices for erosion protection on construction sites. Best management practices in upland areas should be paired with stream maintenance measures to reduce sediment delivered to waterways to reduce the need for extensive dredging programs.

Stormwater improvement projects recommended in the Calumet-Sag Channel DWP including detention basins, channel diversions, or erosion control armoring, will require ongoing maintenance after construction. Costs associated with maintenance over a 50-year life-cycle period were included in cost estimates. It is recommended that the District develop maintenance plans for capital improvements, and where applicable, execute agreements with local governments, delegating certain maintenance responsibilities. Maintenance agreements will follow current District practice, where the District is responsible for operation and maintenance of structural, electrical, and mechanical facilities and grounds are the responsibility of partnering organizations.

Table 4.1.1 lists all problem area locations where standard stream maintenance activities are recommended including debris and blockage removal, removal of silt from culverts, and removal of sediment from stream channels. There is one location that has been identified within the watershed where a stream within the Cook County Forest Preserve has not been properly maintained, causing conveyance restrictions that could indirectly contribute to flooding of residences. It is recommended that the District work with the Forest Preserve to ensure that a proper grade is maintained on these channels to avoid potential problems in the future. This will require debris removal, and may require some dredging. The location is listed below in

Table 4.1.1 along with the approximate gradient to be maintained. If dredging is performed, permits may be required from regulatory agencies such as USACE and IDNR and downstream impact must be considered.

TABLE 4.1.1
Summary of Problem Areas where Debris Removal or Other Maintenance is Recommended

Problem Area ID	Tributary	Location	Type of Maintenance Activity Required
OF3	Boca Rio Ditch	Boca Rio Ditch at 151st Street in Oak Forest	Remove debris and clear channel Private property owner refuses access
LT4	I&M Canal	Stephen Street and north of Talcott Street in Lemont Township	Remove debris and clear channel
HH5	I&M Tributary D	I&M Tributary D between Kean Avenue and 87th Street	Regrade channel to a slope of 0.35% on Cook County Forest Preserve Property
OP11	Long Run Creek	143rd Street and Wolf Road in Orland Park	Remove debris and clear channel of sedimentation
OP12	Marley Creek	Marley Creek at 108th Avenue in Orland Park	Remove debris and silt from box culverts and surrounding area
OP3	Marley Creek	Marley Creek near Cameron Parkway in Orland Park	Remove debris and clear channel
OP6	Marley Creek	Marley Creek from Anthony Drive to Meade Street in Orland Park	Remove debris and clear channel
CR1	Melvina Ditch	Melvina Ditch and West Stony Creek confluence in Chicago Ridge	Remove debris and clear channel
OP8	Tinley Creek	Tinley Creek at 82nd Ave	Remove debris downstream
OP10	Spring Creek	Spring Creek just upstream of 155th Street and between 155th Street and 159th Street in Orland Township	Remove debris and clear channel
OL1	Stony Creek	Stony Creek near Central Avenue, ¼ mile south of 103rd Street in Oak Lawn	Remove debris and clear channel, including silt in and around culverts
WO2	Stony Creek	Stony Creek between Oak Lawn and 76th Avenue in Worth	Remove debris and clear channel
AL1	Stony Creek	Stony Creek at 115th Street	Remove debris and clear channel; and repair streambank

4.2 Recommended Capital Improvements

Table 4.2.1 lists all recommended improvements for the Calumet-Sag Channel DWP. The District will use data presented here to support prioritization of a countywide stormwater CIP.

4.3 Implementation Plan

Alternatives listed in Table 4.2.1 can be constructed independently. However, in some cases, benefits associated with construction of several alternatives within a subwatershed will exceed the sum of the benefits of individual alternatives. The data presented in Table 4.2.1, along with noneconomic factors, will allow the District to prioritize its CIP and to implement projects. A number of alternatives in Table 4.2.1 require the acquisition of land that currently may be unavailable. It is recommended that upon selecting an alternative for implementation, the District identify land acquisition needs and procedures.

TABLE 4.2.1
Calumet-Sag Channel Watershed Prioritization Matrix

Project	B/C Ratio	Total Benefits ($)	Total Project Cost ($)	Probable Construction Cost ($)	Relative Damage Averted 25% 50% 75%	Acreage Removed from Inundation Area	Wetland or Riparian Areas Impacted (ac)	Cumulative Structures Protected	Implementation Time (months)	Water Quality Benefit	Communities Involved
SFDT-1	0.07a	0.4 M	5.45 M	3.64 M		14	-	12	18	Positive	Justice, Bridgeview, Hickory Hills, Bedford Park
SFDT-2	0.04	0.03 M	0.72 M	0.43 M		18	-	14	12	No Impact	Justice, Bridgeview, Hickory Hills, Bedford Park
CSTB-3	0.31	0.67 M	2.13 M	0.79 M		2	-	6	6	Slightly Positive	Palos Park
IMCA-1	0.03	0.03 M	1.04 M	0.71 M		N/A	-	3	6	No Impact	Lemont
LRCR-5	0.06	0.05 M	0.86 M	0.59 M		N/A	-	0	6	No Impact	Orland Park
LDDT-3	0.13	0.89 M	6.77 M	4.5 M		33	-	56	6	Slightly Positive	Bridgeview, Palos Hills
LUDT-5	0.23	0.85 M	3.65 M	2.39 M		4	-	4	6	No Impact	Palos Hills
LUDT-7	0.08	0.34 M	4.47 M	0.81 M		28	-	54	12	Slightly Positive	Palos Hills, Hickory Hills, Bridgeview
MACR-1	0.01	0.16 M	15.99 M	8.99 M		19	-	3	15	Slightly Positive	Orland Park
MEDT-1	0.58	1.67 M	2.85 M	1.56 M		N/A	-	8	18	No Impact	Chicago Ridge, Oak Lawn
MICR-2	0.20	0.41 M	2 M	1.4 M		21	3	6	6	Slightly Positive	Palos Park
MICR-4	0.10	0.46 M	5.92 M	4.21 M		64	-	2	6	Slightly Positive	Orland Park
NVCR-3	0.69	0.1 M	0.14 M	0.1 M		34	-	15	6	No Impact	Palos Heights
NVCR-5	0.15	1.15 M	7.9 M	4.58 M		7	-	29	8	No Impact	Palos Heights
OLCR-1	0.07	0.45 M	6.31 M	4.97 M		1	-	35	7	Slightly Positive	Oak Lawn
OLCR-3	0.42	3.08 M	7.3 M	4.31 M		N/A	-	15	17	Slightly Positive	Oak Lawn
SPCR-1	0.02	0.02 M	1.05 M	0.74 M		N/A	-	0	6	No Impact	Orland Township
STCR-2	0.25	12.2 M	48.5 M	30.27 M		87	6	666	18	Positive	Alsip, Oak Lawn, Chicago
STCR-3	0.10	0.74 M	7.69 M	6.54 M		1	7	55	18	Positive	Alsip, Oak Lawn, Chicago
STCR-4	0.05	0.21 M	4.33 M	3.18 M		1	-	20	6	Positive	Alsip, Oak Lawn, Chicago
STCR-7	0.11	0.36 M	3.43 M	2.01 M		67	-	86	6	No Impact	Palos Hills
STCR-8	0.18	1.15 M	6.29 M	3.41 M		6	-	44	6	No Impact	Palos Hills
STCR-10	b	b	2.75 M	1.66 M		N/A	-	0	8	Positive	Oak Lawn
TICR-3	0.72	1.98 M	2.76 M	1.54 M		36	-	42	8	No Impact	Crestwood, Alsip, Unincorporated Cook County
TICR-5	1.26	0.14 M	0.11 M	0.09 M		2	-	4	6	No Impact	Orland Hills, Orland Park
TICR-7	1.03	1.52 M	1.48 M	0.87 M		N/A	-	6	18	Slightly Positive	Orland Park
TICR-8	1.55	7.16 M	4.63 M	2.73 M		N/A	-	8	18	Slightly Positive	Orland Park

Property Damage   Erosion   Transportation   Recreation

a- Benefits include 6 acres of wetland restoration
b- Project does not include existing regional financial benefits, but is recommended as a preventative measure because further bank failure risks a severe channel flow restriction within Stony Creek.

5. Summary and Conclusions

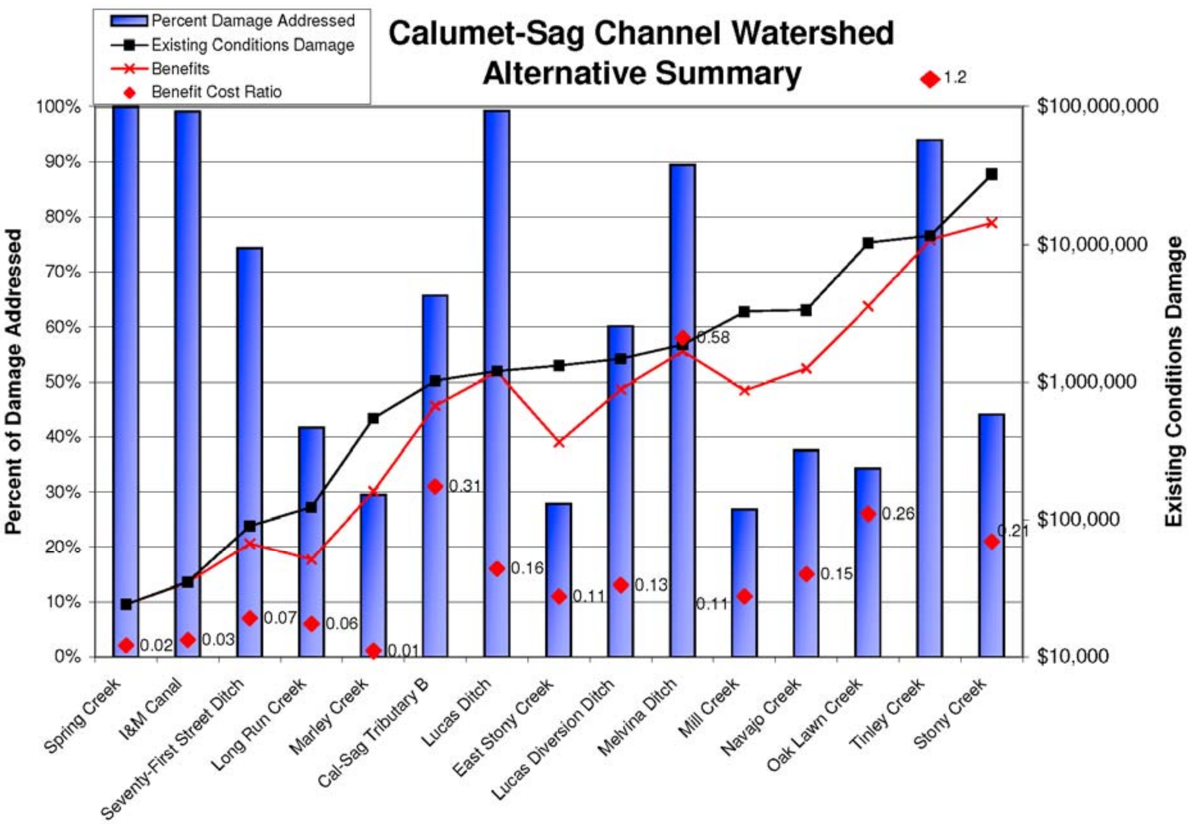
The Calumet-Sag Channel DWP was developed in coordination with the Calumet-Sag Channel WPC. The coordination focused on integrating community knowledge of stormwater problems and ideas for feasible solutions into the District's regional stormwater plan. All stormwater problem data received from stakeholders was recorded in a spatial database, and classified as local or regional according to the criteria defined in Section 1. Hydrologic and hydraulic models were developed to estimate flow and stage along regional waterways and assess the frequency and depth of flooding problems for a range of modeled recurrence intervals. Inundation mapping was developed for the 2-, 5-, 10, 25, 50, 100-year, and 500-year modeled storm events, identifying areas estimated to be at risk of flooding. Modeled water depths and inundation mapping were used to help estimate damages due to flooding within each tributary.

Stormwater improvements were developed to address regional problems throughout the Calumet-Sag Channel Watershed. Appropriate tributary-specific technologies were screened considering their applicability for addressing problem areas, constructability in the area required, and regulatory feasibility. The potential impact of future development conditions on recommended alternatives was considered. Damage estimates for proposed alternatives were performed to evaluate the alternative's effectiveness at reducing regional stormwater damages. The difference in damages between existing and alternative conditions was quantified as the alternative's benefit. In addition to numeric benefits, several other criteria were noted for each alternative, such as the number of structures protected, water-quality benefit, and wetland and riparian areas affected. Conceptual level cost estimates were developed to estimate the construction and maintenance cost of proposed alternatives over a 50-year period. The estimated benefits were divided by the conceptual cost to develop a B/C ratio for each alternative.

Figure 5.1 illustrates the potential of alternatives within the DWP to address regional damages throughout the watershed, ordered by increasing existing conditions damages. A logarithmic scale is used so that the wide range of estimated damages, ranging from $24,100 for Spring Creek to $32,400,500 for Stony Creek, can be displayed on a single graph. The columns indicate the extent to which recommended alternatives address estimated damages, while the red B/C symbols indicate the B/C ratio. As an example, the recommended Stony Creek alternatives address 45 percent of estimated damages (indicated by the column), which corresponds to a benefit of $14,498,600. In contrast, 66 percent of the damages along Calumet-Sag Tributary B are addressed, but this results in $669,700 of benefit, or 4.6 percent of benefits of recommended Stony Creek alternatives.

Recommended alternatives are estimated to reduce regional damages by $36,220,000 over a 50-year period, at an estimated cost of $159,018,400. Estimated damage reductions result from proposed stormwater improvements that increase storage in the watershed, thereby reducing peak flows and stage, increasing conveyance to receiving systems (only if increased flows do not cause downstream damages), or channel protection measures to reduce erosion damages. Floodproofing alternatives, though feasible for addressing isolated shallow flooding issues, are not included in the summary statistics below due to the individualized way in which such measures would be implemented. Benefits from proposed projects are not distributed evenly throughout the watershed, but generally concentrated in subwatersheds with greater existing conditions damages where capital improvement projects are able to address greater existing conditions damages. Differences in the amount of available land for storage alternatives also contribute to differences in benefits between subwatersheds. Recommended solutions do not generally address all damages from the 100-year inundation areas, as sufficient land is not always present in locations that can reduce floodwaters to eliminate inundation of structures along regional waterways.

FIGURE 5.1
Calumet-Sag Channel Watershed Alternative Summary



Stormwater problems, whether identified by stakeholders or identified by modeling of intercommunity waterways, indicate a need for regional stormwater management solutions throughout the Calumet-Sag Channel Watershed. Although problems are concentrated in the more intensively developed, flatter northern section of the watershed, significant stormwater problems exist throughout the watershed. If constructed, the recommended alternatives in Table 4.2.1 are expected significantly to reduce stormwater damages, although damages are expected to persist within the watershed even following construction of those projects. However, implementation of the recommended projects should reduce the number of homes and businesses adversely affected by flooding, and also the severity of damages. Communities can continue to work toward reducing stormwater damage by ensuring that development is responsibly managed with consideration given to potential stormwater impacts and the existing stormwater problems within the watershed.

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