3.6 Plum Creek

The Plum Creek subwatershed encompasses approximately 54 square miles (1.07 in Cook County, 33.03 in Will County and 19.82 in Lake County, Indiana) within the southeastern portion of the Little Calumet River watershed. There are two tributaries within the subwatershed, including Plum Creek, totaling over 23 stream miles. **Table 3.6.1** lists the communities that lie within the subwatershed and the associated drainage area for each community contained within the subwatershed.

Table 3.6.1: Communities Draining to Plum Creek Subwatershed Within Cook County

Community	Tributary Area (mi^2)
Sauk Village	0.08
Unincorporated Cook County	0.99

Table 3.6.2 lists the land use breakdown by area within the Plum Creek subwatershed. **Figure 3.6.1** 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.

Table 3.6.2: Land Use Distribution for Plum Creek Subwatershed within Cook County

Land Use	Acres	%
Forest/Open Land	581	86.58
Institutional	1	0.14
Residential	54	8.04
Water/Wetland	35	5.21

The majority of the Plum Creek subwatershed lies within Will County, Illinois and Lake County, Indiana, with only 3 river miles within the Cook County limits.

- Plum Creek (PLCR) – Plum Creek, named Hart Ditch in Indiana, originates south of Church Road and east of Western Avenue in Unincorporated Will County. The creek flows northeasterly and crosses into Unincorporated Cook County at Steger Road (231st Street) east of Burnham Avenue. The creek continues approximately 3 miles northeast through the Plum Creek Forest Preserve, and crosses into Indiana near Forest Park Drive in Dyer, Indiana. The creek continues as Hart Ditch for approximately 6 miles to its confluence with the Little Calumet River, approximately 0.5 miles southwest of Interstate 80 and US Route 41 in Munster, Indiana.

- Cady Marsh Ditch (CADY) – Cady Marsh Ditch is contained entirely in the State of Indiana. It originates north of 45th Avenue and east of Cleveland Street in Gary, Indiana. It flows westerly to its confluence with Plum Creek, west of US Route 41 and south of Ridge Road in Munster, Indiana. There is a flow diversion culvert along Cady Marsh Ditch located at Arborgast Avenue near Lawndale Drive in Griffith, Indiana. This culvert diverts flow from Cady Marsh Ditch north through a 6-foot diameter culvert under Arborgast Avenue to the Little Calumet River approximately 1.5 miles north of Cady Marsh Ditch.

No major flood control facilities are located within the Plum Creek subwatershed.

3.6.1 Sources of Data

3.6.1.1 Previous Studies

Previous studies were made available pertaining to the Plum Creek subwatershed for use in assessing stormwater flooding problems and designing structural solutions.

- *WSP-2 Study,* Illinois Department of Transportation (IDOT), 1980.
- *Hart Ditch Hydraulic Study*, Indiana Department of Natural Resources (DNR), 2002.

No information from IDOT was applicable to the development of the DWP. The Indiana DNR study was used during the development of the hydraulic model for Plum Creek.

3.6.1.2 Water Quality Data

Water quality for the Plum Creek subwatershed within Illinois is monitored by the Illinois Environmental Protection Agency (IEPA). IEPA monitors water quality at one location in the Plum Creek subwatershed as part of the Ambient Water Quality Monitoring Network (AWQMN). This water quality monitoring station (HBE-01) is at the Steger Road crossing, five miles east of Steger at the Will County/Cook County boundary.

IEPA's *2008 Integrated Water Quality Report*, which includes the Clean Water Act (CWA) 303(d) and the 305(d) lists, does not identify Plum Creek tributaries as impaired. No Total Maximum Daily Loads (TMDLs) have been established for Plum Creek tributaries.

No National Pollutant Discharge Elimination System (NPDES) permits have been issued by IEPA for discharges into Plum Creek. Government entities discharging to Plum Creek or its tributaries are regulated by IEPA's NPDES Phase II Stormwater Permit Program, which was created to improve the quality of stormwater runoff from urban areas, and requires that municipalities obtain permits for discharging stormwater and implement six minimum control measures for limiting runoff pollution to receiving systems. Also as part of the Phase II Stormwater Permit Program, construction sites disturbing greater than 1 acre of land are required to obtain a construction permit.

3.6.1.3 Wetland and Riparian Areas

Figures 2.3.6 and **2.3.7** contain wetland and riparian area mapping in the Little Calumet River Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 35 acres of wetland areas in the Illinois portion of the Plum 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.

3.6.1.4 Floodplain Mapping

The floodplain boundaries for the Plum Creek subwatershed were revised in 2008 as part of FEMA's Map Modernization program. Floodplain boundaries were revised solely based on recent Cook County topographic data. The entire length of Plum Creek in Cook County is mapped as Zone AE.

FEMA's 2006 effective model for Plum Creek was not made available during the development of the Plum Creek subwatershed hydraulic model. A UNET model for Cady Marsh Ditch was available for use from the USCOE. **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

Table 3.6.3 summarizes reported problem areas reviewed as a part of DWP development. The problem area data was obtained primarily from questionnaire response data (Form B) provided by watershed communities to the District. Only problem areas located within Cook County were included. Problems are classified in **Table 3.6.3** as regional or local. This classification is based on criteria described in **Section 2.2.1** of this report.

Table 3.6.3: Community Response Data for Plum Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
CCH2	Cook County Highway Department	Overbank flooding	Steger Road between Burnham Avenue and Indiana border	Overbank flooding of Plum Creek at Steger Road	Local	Local drainage issue, roadway flooding less than 0.5 ft
LYN4	Lynwood	Bank erosion and sedimentation	Lincoln Highway and Sauk Trail	Heavy sedimentation	Channel maintenance	Removal of debris to be addressed by stream maintenance

3.6.1.6 Near Term Planned Projects

There are no near-term planned projects within the Illinois portion of the Plum Creek watershed.

3.6.2 Watershed Analysis

3.6.2.1 Hydrologic Model Development

3.6.2.1.1 Subbasin Delineation

The Plum Creek subwatershed was delineated according to the methods described in **Sections 1.3.2** and **2.3.2**. There are 23 subbasins ranging in size from 0.021 to 10.3 square miles with an average size of 3.07 square miles.

3.6.2.1.2 Hydrologic Parameter Calculations

Curve numbers (CN) and directly connected impervious percentages were estimated for each subbasin as described in **Section 1.3.2**. An area-weighted average of the CN was generated for each subbasin. Clark's unit hydrograph parameters were estimated using the method described in **Section 1.3.2**. **Appendix G** provides a summary of the hydrologic parameters used for the subbasins in each subwatershed.

3.6.2.2 Hydraulic Model Development

3.6.2.2.1 Field Data, Investigation, and Existing Model Data

The FEMA effective hydraulic model for Plum Creek was not available for use in developing the hydraulic model. A WSP-2 model from 1980, which includes the portion of Plum Creek in Illinois was provided by IDOT, but was not considered usable since it was developed over ten years ago.

A HEC-RAS model from 2002 covering the Indiana portion of Plum Creek was provided by the Indiana DNR. The model was reviewed to determine which portions met the CCSMP's criteria and could be used. The portion of the model covering Plum Creek downstream of 213th Street in Dyer, Indiana was found to be within District standards and was used in the hydraulic model development for the subwatershed.

The UNET model provided by the USCOE for Cady Marsh Ditch was used in its entirety to develop the HEC-RAS model for Cady Marsh Ditch. Since Cady Marsh Ditch falls entirely within Indiana and the tributary was modeled only to represent the boundary condition at Plum Creek (Hart Ditch), no additional cross sections or structures were surveyed.

After a review of existing models, field reconnaissance data and hydraulic structures dimensions data, a field survey plan for Plum Creek was developed. Field survey was performed under the protocol of FEMA's *Guidelines and Specifications for Flood Hazard Mapping partners, Appendix A: Guidance for Aerial Mapping and Surveying*. Field survey was performed in early 2008. Cross sections were generally surveyed between 500 to 1,000 feet apart. The actual spacing and location was determined based on the variability of the channel's shape, roughness, and slope. A total of 4 cross sections and 8 hydraulic structures were surveyed to develop the hydraulic model for the Plum Creek subwatershed.

The Manning's n-values at each cross section were estimated using a combination of aerial photography and photographs from field survey and field reconnaissance. The horizontal extent of each type of land cover and the associated n-value for each cross section were manually entered in to the HEC-RAS hydraulic model. The initial n-values were used as a model starting point and were adjusted within the provided ranges during calibration. All the n-values were manually adjusted using the HEC-RAS cross-sectional data editor.

The n-values were increased where buildings are located within the floodplain to account for conveyance loss. The n-values in these areas may range from 0.060 for areas with few buildings to 0.15 for fully developed areas. If significant blockage is

caused by buildings in the flood fringe, the developed areas were modeled as ineffective flow. **Table 3.6.4** lists channel and overbank ranges of n-values that were used for the Plum Creek subwatershed model.

Table 3.6.4: Channel and Overbank Associated Manning's n-Values[1]

Tributary	Range of Channel n-Values	Range of Overbank n-Values
PLCR	0.03 - 0.15	0.06 - 0.15
CADY	0.045	0.09 - 0.10

[1]**Source**: Open Channel Hydraulics, Chow 1959

Boundary Conditions. The Plum Creek hydraulic model required one boundary condition at the downstream confluence with the Little Calumet River. Since the downstream end of Plum Creek is relatively steep and is reasonably free of backwater effects, normal depth was used as the downstream boundary condition.

3.6.2.3 Calibration and Verification

A detailed calibration was performed for the Plum Creek subwatershed using historic gage records under the guidelines of the Cook County Stormwater Management Plan (CCSMP). Three historical storms, April 2006, April 2007 and September 2008, were evaluated based on the stream gage flows, precipitation totals and records of flooding in the Plum Creek subwatershed and were found to be applicable for calibration and verification.

For the calibration storms, Illinois State Water Survey (ISWS) Cook County precipitation gages, National Weather Service (NWS) recording and non-recording gages, and Community Collaborative Rain, Hail & Snow Network (CoCoRAHS) precipitation depths were used. Theissen polygons were developed for each storm based on the rain gages available for that storm. The gage weightings for the recording and non-recording gages were computed in ArcGIS for each subbasin.

There are two USGS gages located in the Plum Creek subwatershed. USGS Gage 05536179, located on Plum Creek (Hart Ditch) at 213th Street in Dyer, Indiana, was used for calibration. This gage is at latitude 41°30'28" longitude 87°30'36" (NAD27). The datum of the gage is 607.38 feet NGVD29. Stage data is available at this gage from 9/19/1989 through present.

The second USGS gage, USGS Gage 05536190, is located on Plum Creek (Hart Ditch) at Hawthorne Drive in Munster, Indiana. The gage is located approximately 0.5 miles from the confluence with the Little Calumet River. Because of the proximity of the gage to the downstream boundary condition, it was not used for calibration for the Plum Creek subwatershed; however, it was used for calibration in the Little Calumet subwatershed (see **Section 3.8**).

Runoff hydrographs were developed using HEC-HMS and routed through the Plum Creek hydraulic model. The stages and flows produced for each calibration storm were compared to the observed stream gage data. During calibration of the Plum Creek subwatershed model, the curve number, directly connected impervious area

percentage, and lag times were adjusted so that the peak flow rate, hydrograph shape and timing, and total volume matched the observed hydrographs within the CCSMP's criteria. During calibration, the Clark's storage coefficient R was increased by 25 percent.

After the final adjustments to the HEC-HMS and HEC-RAS models, the flow and stage from the model were compared to the observed data and the CCSMP's criteria. **Table 3.6.5** shows the comparison of the flows and stages for all calibration storms. **Figures 3.6.2**, **3.6.3** and **3.6.4** show the calibration results for the April 2006, April 2007 and September 2008 storms, respectively. The April 2006 event is not within the CCSMP's criteria. Upon further research, it appears that this event's rainfall was not uniform within the Plum Creek subwatershed.

Table 3.6.5: Plum Creek Subwatershed Calibration Results

Storm Event	Observed		Modeled		CCSMP's Criteria[1]	
	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	Percentage Difference in Peak Flow	Difference in Stage (ft)
April-2006	1,430	617.57	730	617.76	-49%	0.19
April-2007[2]	712	unknown	565	614.59	-21%	unknown
Sept-2008	3,110	623.56	3,088	623.32	-1%	-0.24

[1]Flow within 30% and stage within 6 inches.
[2]Stage data not available for April 2007 storm event.

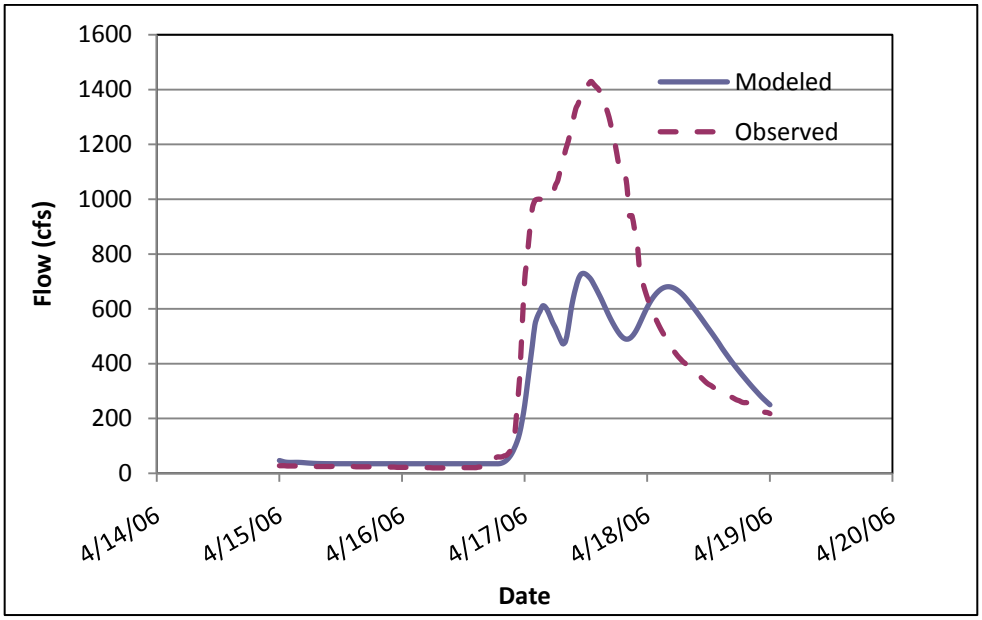

Figure 3.6.2: Plum Creek Subwatershed Calibration Results, April 2006 Storm Event

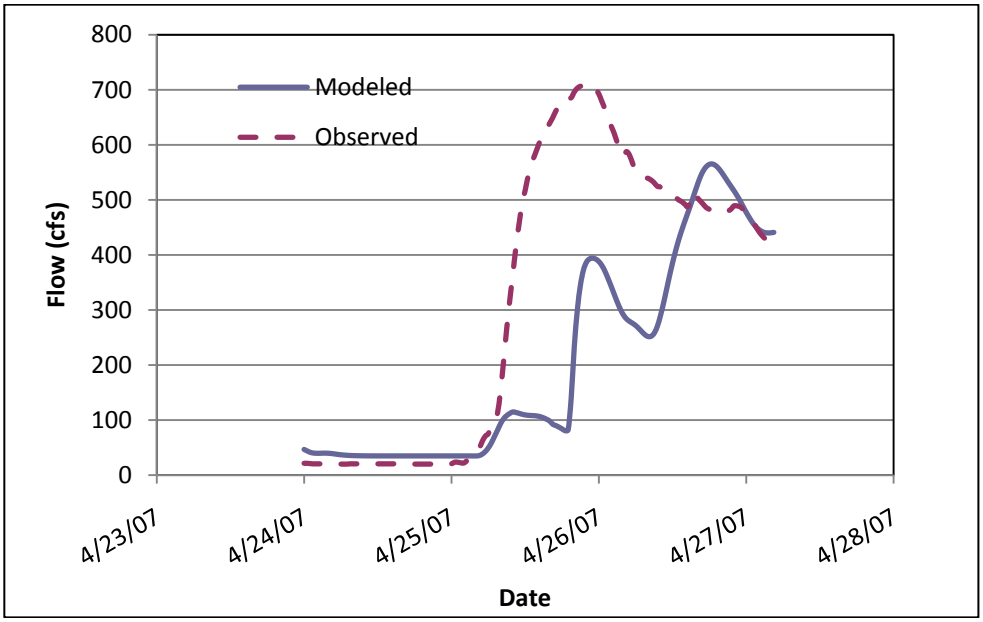

Figure 3.6.3: Plum Creek Subwatershed Calibration Results, April 2007 Storm Event

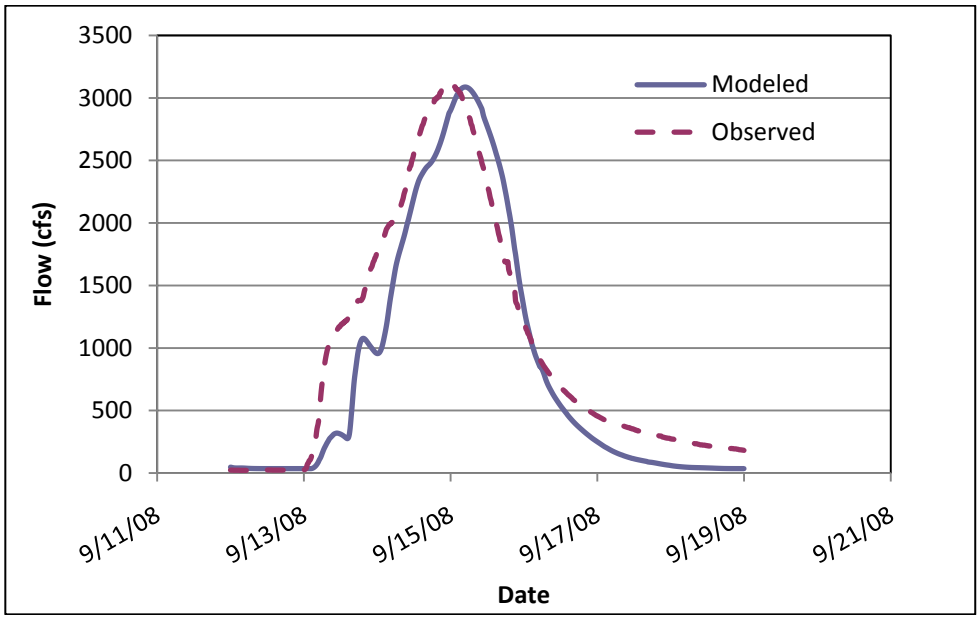

Figure 3.6.4: Plum Creek Subwatershed Calibration Results, September 2008 Storm Event

3.6.2.4 Existing Conditions Evaluation

3.6.2.4.1 Flood Inundation Areas

A critical duration analysis was performed for the Plum Creek subwatershed hydraulic model. The 100-year, 1-, 3-, 6-, 12-, 24-, 48- and 72-hour storm events were run to determine the critical duration. The 48-hour storm event was found to be the critical duration for the Plum Creek subwatershed.

Figure 3.6.1 shows the inundation area produced for the 100-year critical duration storm event.

3.6.2.4.2 Hydraulic Profiles

Hydraulic profiles for Plum Creek and its tributary are shown in **Appendix H**. Profiles are shown for the 2-, 5-, 10-, 25-, 50-, 100- and 500-year recurrence interval design storm events.

3.6.3 Development and Evaluation of Alternatives

Hydraulic model results were reviewed with inundation mapping to identify locations where property damage due to flooding is predicted. **Table 3.6.6** summarizes problem areas identified through hydraulic modeling of the Plum Creek subwatershed.

Problem areas that were hydraulically interdependent or otherwise related were grouped for alternatives analysis. Each project group is addressed in terms of combined damages and alternatives/solutions.

Table 3.6.6: Modeled Problem Definition for the Plum Creek Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (year) of Flooding	Associated Form B	Resolution in DWP
PLCR1	PLCR-G1	St. Margaret Mercy Hospital, Illinois/Indiana state line	25, 50 & 100	N/A	PLCRG1-A1

Damage assessment, technology screening, alternative development and alternative selection were performed by problem grouping, since each group is independent of the other. Each problem grouping is evaluated in the following sections by Group ID.

3.6.3.1 PLCR-G1 – Plum Creek Problem Group 1

3.6.3.1.1 Problem Definition

The PLCR-G1 problem area consists of overbank flooding along Plum Creek near the Steger Illinois-Indiana border, near St. Margaret Mercy Hospital. The hospital is a regional hospital serving Northwest Indiana and the Southeast Chicago metropolitan area. Flood damages to the hospital from the August 24, 2007 storm event caused flooding of the hospital and evacuation of over 60 patients. Approximately $20 million in damages occurred, with extensive clean-up causing portions of the hospital to remain closed for over two months. There was a floodwall constructed around the area after the storm event, and while this floodwall does provide some benefit, it was not constructed to FEMA standards.

3.6.3.1.2 Damage Assessment, PLCR-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Plum Creek and its tributary. These stages were used to calculate the depth of flooding and

to estimate damages at each flooding problem area. The District's Stormwater Planning Database Tool was used to estimate the damages. Property damages for each building structure were calculated and transportation damages were estimated at 15 percent of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.6.7** lists the estimated damages for the problem group.

Table 3.6.7: Estimated Damages for Plum Creek Subwatershed, Problem Group PLCR-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
PLCR-G1	Property	$2,418,000	Structures at risk of flooding
	Transportation	$363,000	Assumed as 15 percent of property damage due to flooding
	Recreation	$0	

3.6.3.1.3 Technology Screening, PLCR-G1

Several combinations of technologies were analyzed to address the flooding problems associated with PLCR-G1. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problem. **Table 3.6.8** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.6.8: Evaluation of Flood Control Technologies for Plum Creek Subwatershed, Problem Group PLCR-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible upstream of Steger Road
Conveyance Improvement – Culvert/Bridge Replacement	Feasible in reach, but with limited benefit
Conveyance Improvement – Channel Improvement	Feasible in reach, but with limited benefit
Conveyance Improvements – Diversion	Not feasible, since no available outfall
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.6.3.1.4 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 3.6.9** summarizes flood control alternatives developed for Problem Group PLCR-G1.

Table 3.6.9: Flood Control Alternatives for Problem Grouping PLCR-G1

Alternative	Location	Description
PLCRG1-A1	St. Margaret Mercy Hospital	Construct floodwall around the property with compensatory storage
PLCRG1-A2	Upstream of Steger Road	Construct a 1,250 ac-ft reservoir with weir inlet and gravity outlet on Longwood Golf Course property in Will County. Solution would provide benefits to Dyer, Indiana as well as the Hospital
PLCRG1-A3	Plum Creek within Cook County	Channel improvements to increase capacity of channel. This does not provided benefits to the Hospital, located at the downstream end of the Cook County portion of the creek. It may be beneficial to increase channel capacity of the creek downstream of the Hospital, but this section of the creek lies in Indiana and is outside Cook County
PLCRG1-A4	Structures downstream of Hospital	Increase channel capacity by increasing hydraulic opening of structures along Plum Creek downstream of the hospital. This alternative may provide benefits, but this section of the creek lies in Indiana and is outside Cook County

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the PLCR-G1 Problem Group.

3.6.3.1.5 Alternative Evaluation and Selection

Alternatives included in **Table 3.6.9** were evaluated to determine their effectiveness and produce the data required for the countywide prioritization of watershed projects. Flood control alternatives were modeled to evaluate their impact on water elevations and flood damages. It should be noted that when calculating benefits for the alternatives in the Plum Creek subwatershed, only benefits within the Illinois portion of the watershed and benefits to Illinois population that relies on St. Margaret Mercy Hospital were included in the analysis of flood control alternatives. There are benefits with the identified flood control alternatives in Indiana, but these benefits were not included in the calculation of the B/C ratio.

Table 3.6.11 provides the B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative for Problem Group PLCR-G1. Alternatives that did not produce a significant change in inundation areas are not listed as benefits were negligible, thus costs were not calculated for these alternatives.

PLCRG1-A1 from **Table 3.6.9** is the preferred alternative for Problem Group PLCR-G1. The preferred alternative includes the construction of a floodwall along the north bank of Plum Creek around St. Margaret Mercy Hospital at an elevation of 640.0 feet and built to FEMA standards. The compensatory storage for the floodwall would be provided just upstream of the floodwall and within the property limits of the Hospital. This alternative will take the Hospital out of the 100-year floodplain.

Table 3.6.10 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for PLCR-G1.

Table 3.6.10: Alternative Condition Flow & WSEL Comparison for Problem Group PLCR-G1

Location	Station	Existing Conditions		Alternative PLCRG1-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Southwest corner of Hart Street and Lincoln Highway	32200	635.08	3558	635.08	3558[1]

[1] Levee provides protection

3.6.3.1.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.6.11** lists the alternative analyzed in detail. The recommended alternative consists of the construction of floodwall along the left bank of Plum Creek and corresponding compensatory storage. **Figure 3.6.5** shows the location of the recommended alternative and a comparison of the inundation area for existing conditions with the reduced inundation area resulting from the recommended alternative.

Table 3.6.11: Plum Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group PLCR-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
PLCR-G1	PLCRG1-A1	Floodwall with Comp Storage	0.73	$2,781,000	$3,803,000	1 Structure	No Impact	Will County, Dyer, Indiana

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

3.6.4 Recommended Alternatives, Plum Creek Subwatershed

Table 3.6.12 summarizes the recommended alternatives for the Plum Creek subwatershed. The District will use data presented here to support prioritization of a countywide stormwater CIP.

Table 3.6.12: Plum Creek Project Alternative Matrix to Support District CIP Prioritization, All Problem Groups

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
PLCR-G1	PLCRG1-A1	Floodwall with Comp Storage	0.73	$2,781,000	$3,803,000	1 Structure	No Impact	Will County, Dyer, Indiana

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