Section 3
Tributary Characteristics and Analysis

3.1 Butterfield Creek

The Butterfield Creek subwatershed encompasses approximately 26 square miles (24.35 in Cook County and 1.50 in Will County) within the Little Calumet River watershed. There are ten tributaries within the subwatershed, including Butterfield Creek, totaling over 24 stream miles. **Table 3.1.1** lists the communities that lie within the subwatershed and the associated drainage area for each community contained within the subwatershed.

Table 3.1.1: Communities Draining to Butterfield Creek Subwatershed Within Cook County

Community	Tributary Area (mi^2)
Chicago Heights	0.91
Country Club Hills	0.28
Flossmoor	2.27
Frankfort Square	<0.01
Glenwood	0.57
Homewood	1.61
Matteson	6.08
Olympia Fields	2.80
Park Forest	0.46
Richton Park	2.31
University Park	0.11
Unincorporated/Forest Preserve	6.96

Table 3.1.2 lists the land use breakdown by area within the Butterfield Creek subwatershed. **Figure 3.1.1** 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 3.1.2: Land Use Distribution for Butterfield Creek Subwatershed Within Cook County

Land Use	Acres	%
Commercial/Industrial	1,026	6.5
Forest/Open Land	3,568	22.8
Institutional	642	4.1
Residential	7,010	44.9
Transportation/Utility	488	3.1
Water/Wetland	596	3.8
Agricultural	2,253	14.4

Within the Butterfield Creek subwatershed, a total of 24.4 stream miles were studied among the ten tributaries: Butterfield Creek Main Tributary, Butterfield Creek East Branch, Butterfield Creek East Branch Tributary, Butterfield Creek East Branch Tributary A, Butterfield Creek Tributary 1, Butterfield Creek Tributary 3, Butterfield Creek Tributary 4, Unnamed Tributary to Butterfield Creek East, Unnamed Tributary to Butterfield Creek West, Unnamed Tributary to Butterfield Creek East Branch, and Unnamed Tributary to Butterfield Creek East Branch South.

- Butterfield Creek Main Tributary (BTCR) – headwaters start near the intersection of Ridgeland Avenue and Lincoln Highway in Unincorporated Cook County and extend to the confluence with Thorn Creek, located near the Chicago Heights Glenwood Road and 187th Street intersection in the Village of Glenwood.

- Butterfield Creek East Branch (BCEB) – extends from the Cook/Will County line near the intersection of Kostner Avenue and Steger Road in the Village of University Park to the confluence with Butterfield Creek Main Tributary, located east of the intersection of Governors Highway and Crawford Avenue in the Village of Olympia Fields.

- Butterfield Creek East Branch Tributary (BEBT) – extends from the Cook/Will County line near the intersection of Lakeshore Drive and Steger Road in the Village of Richton Park to the confluence with Butterfield Creek East Branch at Lake George in the Village of Matteson.

- Butterfield Creek East Branch Tributary A (BETA) – headwaters start near the intersection of Imperial Drive and Lorraine Court in the Village of Richton Park and extend to the confluence with Butterfield Creek East Branch Tributary at Lake George in the Village of Richton Park.

- Butterfield Creek Tributary 1 (BCT1) – headwaters start southeast of the intersection of Western Avenue and Vollmer Road in the Village of Olympia Fields and extend to the confluence with Butterfield Creek Main Tributary in the Village of Flossmoor.

- Butterfield Creek Tributary 3 (BCT3) – headwaters start south of the intersection of Kedzie Avenue and Governors Highway and extend to the confluence with Butterfield Creek Main Tributary in the Village of Flossmoor.

- Butterfield Creek Tributary 4 (BCT4) – extends from the intersection of Vollmer Road and Metra Railway Tracks to the confluence with Butterfield Creek Tributary 3 in the Village of Flossmoor.

- Unnamed Tributary to Butterfield Creek East (UBCE) – headwaters start near the intersection of 187th Street and Halsted Street and extend to the confluence with Butterfield Creek main stem in the Village of Glenwood.

- Unnamed Tributary to Butterfield Creek West (UBCW) – extends from northeast of the intersection of Lincoln Highway and Central Avenue to the confluence with Butterfield Creek main tributary located in the Village of Matteson.

- Unnamed Tributary to Butterfield Creek East Branch (UBEN) – headwaters start near the intersection of Quinn Avenue and 214th Street and extend to the confluence with Butterfield Creek East Branch located in the Village of Matteson.

- Unnamed Tributary to Butterfield Creek East Branch South (UBES) – headwaters start west of the intersection of Imperial Drive and Lorraine Court

and extend to the confluence with Butterfield Creek East Branch in the Village of Richton Park.

- All of the above tributaries drain to the Butterfield Creek Main Tributary and then to Thorn Creek. There are no major regional flood control facilities within the Butterfield Creek subwatershed.

3.1.1 Sources of Data

3.1.1.1 Previous Studies

Several studies have been performed related to the Butterfield Creek subwatershed to assess stormwater flooding problems and evaluate solutions. Below is a list of studies that have been performed since the mid 1970's:

- *Interim Review Report of Little Calumet River*, U.S. Army Corps of Engineers, December 1973

- *Little Calumet River Watershed Engineering Design Report (Revised)*, U.S. Department of Agriculture, Metropolitan Sanitary District of Greater Chicago and the Illinois Department of Conservation, January 1977

- *Floodplain Management Study Butterfield Creek and Tributaries, Cook-Will Counties, Illinois*, Prepared by United States Department of Agriculture, Soil Conservation Service, Illinois Department of Transportation and Division of Water Resources, November 1987

- Study of the Flossmoor Tributary to Butterfield Creek, Lindley and Sons, Inc., 1990

- Revised Computer Analysis of the Flossmoor Tributary to Butterfield Creek, Lindley and Sons, Inc., July 1997

- Stormwater Analysis and Recommendation Study for Village of Flossmoor, Prepared by Christopher B. Burke Engineering, LTD., August 1998

The studies listed above were consulted during development of the DWP.

3.1.1.2 Water Quality Data

Water quality for the Butterfield Creek subwatershed is monitored by two agencies, Illinois Environmental Protection Agency (IEPA) and the United States Geological Survey (USGS). IEPA monitors water quality at four locations in the Butterfield Creek subwatershed as part of the Ambient Water Quality Monitoring Network (AWQMN), shown in **Table 3.1.3**.

Table 3.1.3: IEPA Water Quality Monitoring Stations in Butterfield Creek Subwatershed

Station ID	Waterbody	Road Crossing, Municipality
HBDB-01	Butterfield Creek	Glenwood Road, Village of Glenwood
HBDB-02	Butterfield Creek	Crawford Avenue, Village of Olympia Fields
HBDB-03	Butterfield Creek	Chicago Road, Village of Homewood
HBDB-04	Butterfield Creek	Lincoln Highway, Village of Matteson

USGS also monitors water quality at USGS Gage 5536255 located downstream of Riegel Road crossing in Village of Flossmoor, Illinois.

IEPA's 2008 Integrated Water Quality Report, which includes the Clean Water Act (CWA) 303(d) and the 305(d) lists, identifies reach IL_HBDB-03 (Butterfield Creek Main Tributary) as impaired for Aquatic Life designated uses, with potential causes being DDT, Nitrogen (Total), Dissolved Oxygen, Phosphorous (Total) and Total Dissolved Solids. Additionally, a Stage 1 Total Maximum Daily Load (TMDL) analysis has been developed for Butterfield Creek reach IL_HBDB-01 (Butterfield Creek Main Tributary) for dissolved oxygen.

There are two National Pollutant Discharge Elimination System (NPDES) permits issued by IEPA for discharges into Butterfield Creek: permit IDs IL0072362 and IL0029211. No further details about the discharges were readily available. In addition to the point source discharges listed, municipalities discharging to Butterfield 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 get a construction permit.

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 Little Calumet River watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 645 acres of wetland areas in the Butterfield 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.

3.1.1.4 Floodplain Mapping

The floodplain boundaries for Butterfield Creek subwatershed were revised in 2008 as part of the FEMA's Map Modernization program. The Butterfield Creek subwatershed floodplain boundaries were revised based upon updated Cook County topographic data, and the boundary condition at the Thorn Creek confluence was adjusted to account for the Thornton Transitional Reservoir. The effective model developed in the mid 1980s by the National Resources Conservation Services was

used to create the floodplain boundaries. The 2008 Flood Insurance Rate Maps (FIRMs) show a detailed study was performed for all the Butterfield Creek tributaries and hence was mapped as Zone AE.

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

3.1.1.5 Stormwater Problem Data

There were a total of 44 stormwater problems reported for the Butterfield Creek subwatershed. The problem area data was obtained primarily from questionnaire response data (FORM B) provided by the watershed's communities to the District. **Table 3.1.4** lists the details of these stormwater problems. All the problems were classified as a regional or local stormwater problem based on the criteria established in **Section 2.1.1**. All the listed regional problems were addressed based on the alternative analysis, as discussed in the following sections.

Table 3.1.4: Community Response Data for Butterfield Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
CHT4	Chicago Heights	Pavement flooding	US 30 at Orchard Street	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
COU2	Country Club Hills	Pavement flooding	IL 50 at 189th Street.	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
FLO1	Flossmoor	Road overtopping and first floor flooding	Kathleen Lane/ Alexander Crescent Intersection to Kedzie Avenue	Storm sewer flow restriction	Local	Not located on a regional waterway. This is a local drainage issue.
FLO2	Flossmoor	Overbank flooding	Dartmouth Road (south sag) to Flossmoor Road	Overbank flooding	Regional	Construct floodwall and channel improvements (Alternative BTCRG3-A4).
FLO3	Flossmoor	Overflows from Flossmoor Country Club	Dartmouth Road (Butterfield sag) to Flossmoor Road	Overbank flooding	Regional	Construct floodwall and channel improvements (Alternative BTCRG3-A4).
FLO4	Flossmoor	Overflows from Flossmoor Country Club	Brockwood Road/ Butterfield Road	Overbank flooding	Regional	Sufficient land was not available to address all flooding in this area. Properties at risk of flooding in this area are candidates for protection using non-structural measures, such as floodproofing or acquisition.

Table 3.1.4: Community Response Data for Butterfield Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
FLO5	Flossmoor	Pavement flooding	Dixie Highway at Flossmoor Road	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
FLO6	Flossmoor	Pavement flooding	Dixie Highway at Holbrook Road to Vollmer Road	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
FLO7	Flossmoor	Pavement flooding	Western Avenue between Vollmer Road and Flossmoor Road	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
FLO8	Flossmoor	Pavement flooding	Vollmer Road at Butterfield Creek	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
HWD1	Homewood	Pavement flooding	IL 1 at 183rd to 195th Street	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
MAT1	Matteson	Channel blockages	US 30 and Governors Highway	Storm sewer flow restriction	Local	Not located on a regional waterway. This is a local drainage issue.
MAT2	Matteson	Channel blockages	Cicero to Vollmer	Storm sewer flow restriction	Channel maintenance	Removal of debris to be addressed by stream maintenance.
MAT3	Matteson	Channel blockages	US 30/Ridgeland	Storm sewer flow restriction	Channel maintenance	Removal of debris to be addressed by stream maintenance.
MAT4	Matteson	Channel blockages	Lindenwood to Rose Lane	Storm sewer flow restriction	Channel maintenance	Removal of debris to be addressed by stream maintenance.
MAT5	Matteson	Channel blockages	1/4 to 1/2 mile south of US 30/ Kostner	Storm sewer flow restriction	Channel maintenance	Removal of debris to be addressed by stream maintenance.
MAT6	Matteson	Pavement flooding	Crawford Avenue at 216th to 219th	Pavement flooding	Regional	Construct detention facility, culvert improvements, channel improvements and earthen levee (Alternative BCEBG1-A5).
MAT7	Matteson	Pavement flooding	Crawford Avenue at 221st (N/O Sauk Trail Road)	Pavement flooding	Regional	Construct detention facility, culvert improvements, channel improvements and earthen levee (Alternative BCEBG1-A5).

Table 3.1.4: Community Response Data for Butterfield Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
MAT8	Matteson	Pavement flooding	Governors Highway at EJ&E Viaduct (N/O 219th Street)	Pavement flooding	Regional	Construct detention facility, culvert improvements, channel improvements and earthen levee (Alternative BCEBG1-A5).
MAT9	Matteson	Pavement flooding	Governors Highway from US 30 to 216th Street	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
MAT10	Matteson	Pavement flooding	US 30 at Central Avenue to Ridgeland Road	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
MAT11	Matteson	Pavement flooding	US 30 at IL 50 (Cicero Avenue)	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
MAT12	Matteson	Overbank flooding in rains	Vincennes and south of Flossmoor Road	Pavement flooding	Local	Not located on a regional waterway. This is a local drainage issue.
OLY1	Olympia Fields	Basement flooding, ponding, storm sewer flow restriction	Suburban Woods Subdivision (near 207th and Olympian Way)	Flooding of basements and public areas	Local	Not located on a regional waterway. This is a local drainage issue.
OLY2	Olympia Fields	Basement flooding, ponding, storm sewer flow restriction	Fairway Estates/ Olympia Woods Subdivision (near Promethean Way and Chariot Lane)	Flooding of basements and public areas	Local	Not located on a regional waterway. This is a local drainage issue.
OLY3	Olympia Fields	Basement flooding, ponding, storm sewer flow restriction	Graymoor Subdivision (near Western Avenue and Vollmer Road)	Flooding of basements and public areas	Local	Not located on a regional waterway. This is a local drainage issue.
OLY4	Olympia Fields	Storm sewer flow restriction and ponding	Vollmer Road and Crawford Avenue	Ponding at intersection	Local	Not located on a regional waterway. This is a local drainage issue.
OLY5	Olympia Fields	Storm sewer flow restriction and ponding	Vollmer Road Metra Viaduct (near Kedzie Avenue)	Inadequate viaduct capacity	Local	Not located on a regional waterway. This is a local drainage issue.
OLY7	Olympia Fields	Storm sewer flow restriction and ponding	Orchard Drive and US 30	Insufficient inlet capacity on roadway	Local	Not located on a regional waterway. This is a local drainage issue.
OLY8	Olympia Fields	Storm sewer flow restriction and ponding	203rd Street east of Crawford Avenue in front of St. James	Insufficient inlet capacity on roadway	Local	Not located on a regional waterway. This is a local drainage issue.

Table 3.1.4: Community Response Data for Butterfield Creek Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
OLY9	Olympia Fields	Storm sewer flow restriction and ponding	Sparta Court off of Brockwood Drive	Flooding of basements and public areas	Local	Not located on a regional waterway. This is a local drainage issue.
OLY10	Olympia Fields	Pavement flooding	Governors Highway. at Pulaski	Pavement flooding	Local	Problem not located on a regional waterway. This is a local problem.
OLY12	Olympia Fields	Pavement flooding	US 30 at railroad bridge (viaduct) w/o Olympian Way	Pavement flooding	Local	Problem not located on a regional waterway. This is a local problem.
RIC1	Richton Park	Overbank and street flooding	Maple Avenue west of Governors Highway, along Butterfield Creek	Overbank flooding	Regional	Construct detention facility, culvert improvements, channel improvements and earthen levee (Alternative BCEBG1-A5).
RIC2	Richton Park	Overbank flooding	North of Poplar Avenue, along Butterfield Creek Tributary	Flooding due to beaver dams	Channel maintenance	Removal of debris to be addressed by stream maintenance.
RIC3	Richton Park	Overbank flooding	North of Steger Road, west of Lakeshore Drive	Flooding on tributary upstream of Lake George	Local	Problem not located on a regional waterway. This is a local problem.
RIC6	Richton Park	Pavement flooding	Governors Highway S/O Sauk Trail	Overbank flooding	Regional	Construct detention facility, culvert improvements, channel improvements and earthen levee (Alternative BCEBG1-A5).
RIT2	Rich Township	Siltation and vegetation	Sauk Trail from Harlem Avenue to Western Avenue	Siltation and vegetation	Channel maintenance	Removal of debris to be addressed by stream maintenance.
RIT3	Rich Township	Debris in channel	Vollmer Road from Harlem Avenue to Western Avenue	Debris in channel	Channel maintenance	Removal of debris to be addressed by stream maintenance.
RIT4	Rich Township	Siltation	Flossmoor Road from Ridgeland Avenue to Governors Highway	Siltation	Channel maintenance	Removal of debris to be addressed by stream maintenance.
RIT6	Rich Township	Siltation and debris	Ridgeland Avenue from Steger Road to 183rd Street	Siltation and debris	Channel maintenance	Removal of debris to be addressed by stream maintenance.

3.1.1.6 Near Term Planned Projects

No near-term planned major flood control projects to be constructed by others were identified for the Butterfield Creek subwatershed.

3.1.2 Watershed Analysis

3.1.2.1 Hydrologic Model Development

3.1.2.1.1 Subbasin Delineation

The Butterfield Creek subwatershed was delineated based upon LiDAR topographic data developed by Cook County in 2003. There are 58 subbasins ranging in size from 0.015 to 2.20 square miles with an average size of 0.446 square miles.

3.1.2.1.2 Hydrologic Parameter Calculations

Curve numbers (CN) 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.

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 subbasins in each subwatershed.

3.1.2.2 Hydraulic Model Development

*3.1.2.2.1 Field Data, Investigation, and Existing Model Data*The FEMA effective hydraulic model was developed by NRCS in the mid 1980s using WSP-2. The model data was over 20 years old and was not used in the DWP development.

A field reconnaissance was conducted in June 2007. Information was compiled on stream crossings, land use, and channel conditions. The collected hydraulic structure dimensions were compared to bridge/culvert dimensions data provided by Cook County Highway Department (provided data for only state/county highways). Based on the field reconnaissance data and hydraulic structures dimensions data, a field survey plan for Butterfield 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 and 1,000 feet apart. The actual spacing and location was determined based on the variability of the channel shape, roughness, and slope. To develop the model, 99 hydraulic structures throughout the subwatershed, including immediate upstream and downstream cross sections, were surveyed, as well as 98 additional cross sections along all the tributaries.

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 into the HEC-RAS hydraulic model. 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 0.06 for areas with few buildings to 0.15 for fully developed areas. If significant blockage was caused by buildings in the flood fringe, the developed areas were modeled as ineffective flow. **Table 3.1.5** lists the channel and overbank ranges of n-values that were used for the subwatershed model.

Table 3.1.5: Channel and Overbank Associated Manning's n-Values[1]

Tributary	Range of Channel n-Values	Range of Overbank n-Values
BTCR	0.045 – 0.06	0.05 – 0.12
BCEB	0.045 – 0.06	0.05 – 0.12
BEBT	0.045 – 0.06	0.05 – 0.12
BETA	0.045 – 0.06	0.05 – 0.10
BCT1	0.045 – 0.06	0.05 – 0.08
BCT3	0.045 – 0.06	0.05 – 0.07
BCT4	0.045 – 0.06	0.05 – 0.08
UBCE	0.045 – 0.06	0.05 – 0.10
UBCW	0.045 – 0.06	0.05 – 0.10
UBEN	0.045 – 0.06	0.05 – 0.10

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

*3.1.2.2.2 **Boundary Conditions***A downstream boundary condition was required within the Butterfield Creek hydraulic model at its confluence with Thorn Creek. The boundary condition was determined by extracting the flow output hydrograph from the HEC-RAS model and inputting it as an upstream flow for the Thorn Creek model. Once the Thorn Creek HEC-RAS model was run, the stage hydrograph at the confluence generated by the Thorn Creek model was used as the downstream boundary condition in the Butterfield Creek model. This allowed the modeling of any backwater effects that may be present due to the confluence of the two creeks.

3.1.2.3 Calibration and Verification A detailed calibration was performed for the Butterfield Creek subwatershed using historic gage records under the guidelines of Chapter 6 of the Cook County Stormwater Management Plan (CCSMP). Three historical storms (July 1996, April 2006 and September 2008) were found appropriate for calibration and verification. These historical storms were qualified and selected based on available stream gage data, precipitation amounts and records of flooding in the Butterfield Creek subwatershed.

For the above mentioned calibration storms, ISWS Cook County precipitation gages, NWS recording and non-recording gages, and CoCoRAHS precipitation amounts 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. USGS 05536255 Butterfield Creek

at Village of Flossmoor is the only stream gage in the Butterfield Creek subwatershed and was used for the calibration efforts. This gage is located at latitude 41°32'24" longitude 87°38'57" (NAD27), downstream of the Riegel Road crossing. The datum of the gage is 620.41 NGVD29 (620.12 NAVD88). Instantaneous flow data is available at this gage from August 18, 1989 through September 30, 2008.

Runoff hydrographs were developed using HEC-HMS and routed through the Butterfield Creek hydraulic model. The stages and flows produced for each calibration storm were compared to the observed stream gage data. During calibration of the Butterfield Creek subwatershed, the curve number, directly connected impervious area percentage, and lag time were adjusted so that the peak flow rate, hydrograph shape and timing, and total volume matched the observed hydrographs within the criteria specified in the CCSMP.

During calibration, the curve number and directly connected impervious percentage were reduced by 5% and 10%, respectively. The Clark's storage coefficient R was increased by +25%.

After the final adjustments to the HEC-HMS and HEC-RAS models, the flow and stage comparisons to the observed data were within the CCSMP's criteria. **Table 3.1.6** shows the comparison of the flows and stages for the three calibration storms. **Figures 3.1.2**, **3.1.3** and **3.1.4** show the calibration results for July 1996, April 2006 and September 2008, respectively.

Table 3.1.6: Butterfield Creek Subwatershed Calibration Results

	Observed		Modeled		CCSMP's Criteria[1]	
Storm Event	**Flow (cfs)**	**Stage (ft)**	**Flow (cfs)**	**Stage (ft)**	**Percentage Difference in Peak Flow**	**Difference in Stage (ft)**
July 1996	2,220	629.10	2,228	628.81	0%	-0.29
April 2006	2,640	629.59	1,711	627.9	-54%[2]	-1.69[2]
September 2008	2,020	628.57	2,064	628.56	2%	-0.01

[1]Flow within 30% and stage within 6 inches.
[2]April 2006 event did not meet the CCSMP criteria. The stream gauge was malfunctioning during this event and it appears that this rainfall event was not uniform across the Butterfield Creek watershed.

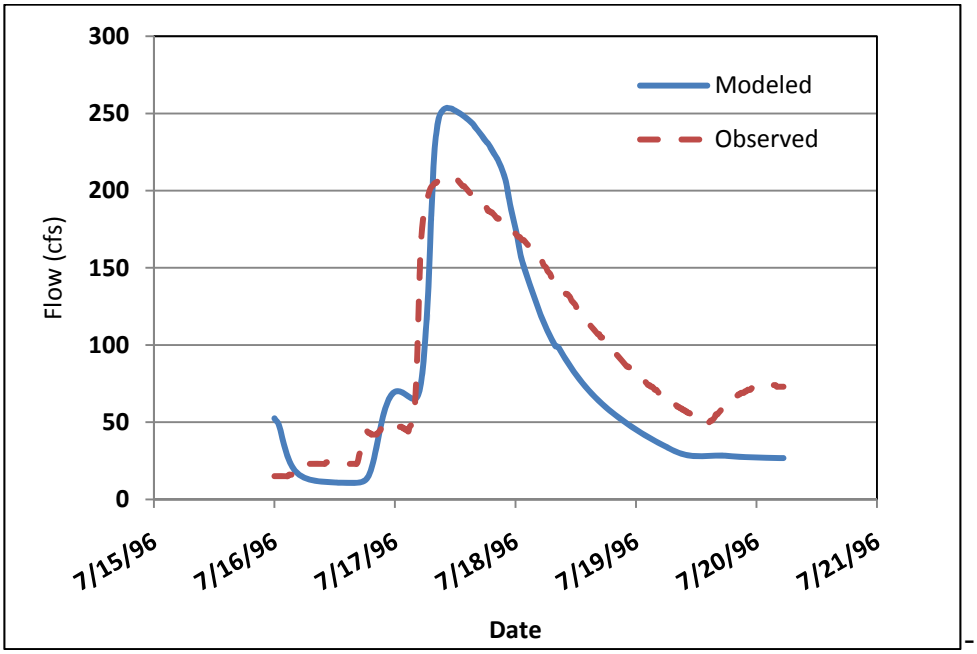

Figure 3.1.2: Butterfield Creek Subwatershed Calibration Results, July 1996 Storm Event

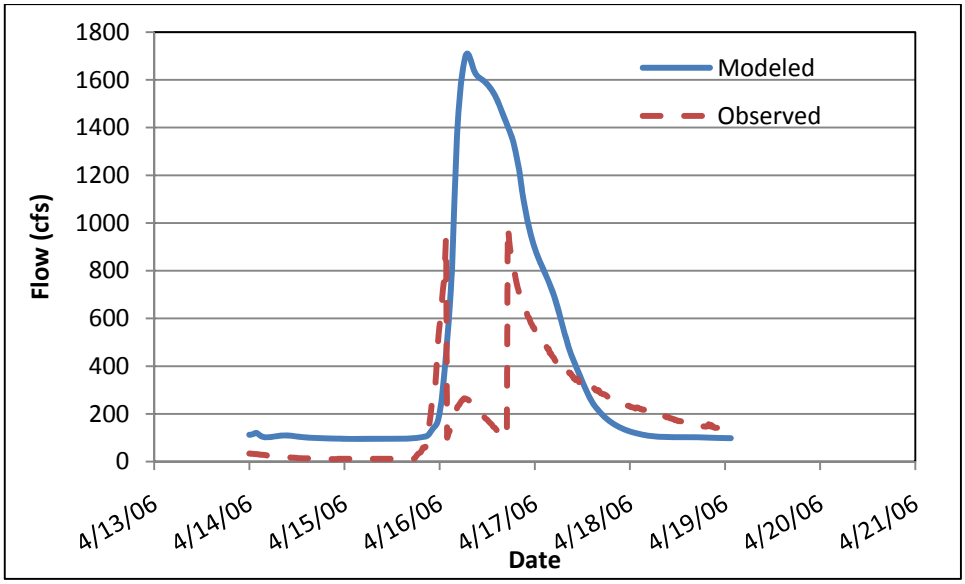

Figure 3.1.3: Butterfield Creek Subwatershed Calibration Results, April 2006 Storm Event

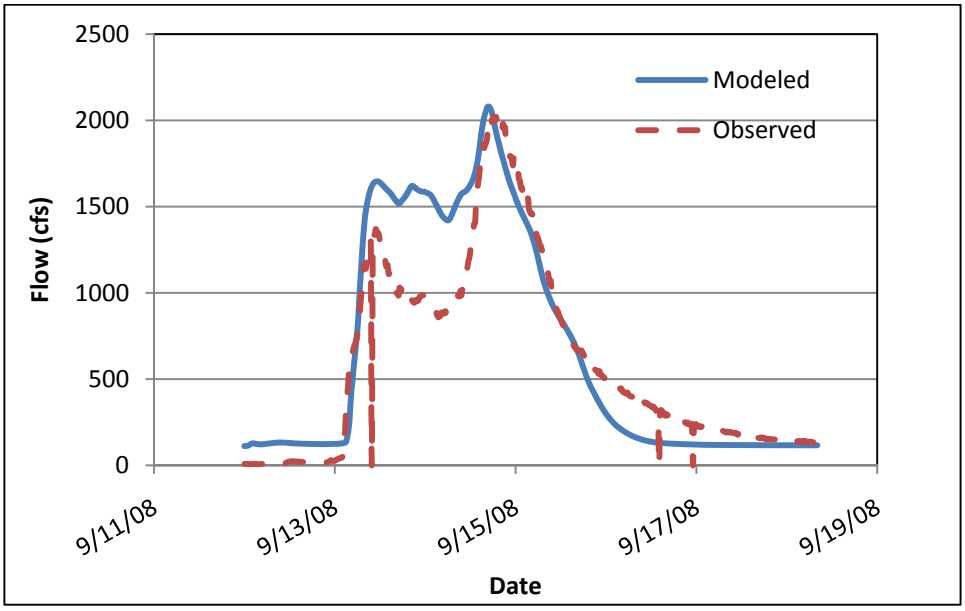

Figure 3.1.4: Butterfield Creek Subwatershed Calibration Results, September 2008 Storm Event

3.1.2.4 Existing Conditions Evaluation

3.1.2.4.1 ***Flood Inundation Areas***A critical duration analysis was run for the Butterfield Creek subwatershed hydraulic model. The 100-year, 1-, 3-, 6-, 12-, 24-, and 48-hour storm events were run to determine the critical duration. The 48-hour storm event was found to be representative of the critical duration for BTCR, BCT1, UBCW, UBCE, and downstream parts of BCEB and BEBT. The 12-hour duration was found to be representative of the critical duration storm event for UBEN, UBES, BCT3, BCT4, BETA, and upstream parts of BCEB and BEBT.

Figure 3.1.1 shows inundation area produced for the 100-year critical duration storm event.

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

3.1.3 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 3.1.7** summarizes problem areas identified through hydraulic modeling of the Butterfield Creek subwatershed.

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

Table 3.1.7: Modeled Problem Definition for the Butterfield Creek Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
BTCR1	BTCR-G1	Butterfield Creek Main Tributary, 203rd thru 206th Street, Unincorporated Cook County	50, 100	N/A	BTCRG1-A3
BTCR2	BTCR-G2	Butterfield Creek Main Tributary, Greenwood Drive and 207th Street, Olympia Fields	50, 100	N/A	BTCRG2-A1
BTCR3	BTCR-G3	Butterfield Creek Main Tributary, near Dartmouth Road and Dixie Highway, Flossmoor	50, 100	FLO2, FLO3	BTCRG3-A4
BTCR4	BTCR-G4	Isolated structures throughout Butterfield Creek subwatershed	50, 100	N/A	Floodproofing/ Acquisition
BCEB1	BCEB-G1	Butterfield Creek East Branch, Sauk Trail and Governors Highway, Matteson	10, 25, 50, 100	MAT6, MAT7, MAT8, RIC1, RIC6	BCEBG1-A5

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

3.1.3.1 BTCR-G1 – Butterfield Creek Main Tributary Problem Group 1

3.1.3.1.1 Problem Definition

The BTCR-G1 problem area consists of overbank flooding between 203rd and 206th Streets. The extent of flooding is approximately 2,300 feet between 203rd Street and Keystone Avenue to 206th Street and Keeler Avenue. The overbank flooding is due to flow restriction within the 12-foot circular culvert at 206th Street. The flow backs up and inundates structures along the banks between 203rd Street thru 206th Street. Approximately 18 building structures are impacted by flooding, including the overtopping of two local roadway crossings. This area is shown as inundated on the FEMA DFIRM map.

In this problem area, 100-year flows of 850 cfs generally exceed the capacity of the channel and the culvert crossings on 204th and 205th Streets, and the 100-year flood elevation reaches 691.6 feet compared to a lowest damage elevation of 690.8 feet at 203rd Street.

3.1.3.1.2 Damage Assessment, BTCR-G1

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Butterfield Creek and its tributaries. 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% of the property damages, unless otherwise noted. Recreation

damages were estimated based on depth and duration of flooding. **Table 3.1.8** lists the estimated damages for the problem group.

Table 3.1.8: Estimated Damages for Butterfield Creek Subwatershed, Problem Group BTCR-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
BTCR-G1	Property	$1,300,000	Structures at risk of flooding
	Transportation	$195,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.1.3.1.3 Technology Screening, BTCR-G1

Several combinations of technologies were analyzed to address the flooding problems associated with BTCR-G1. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.1.9** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.1.9: Evaluation of Flood Control Technologies for Butterfield Creek Subwatershed, Problem Group BTCR-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible. Potential site for detention near west of 203rd Street and Keeler Avenue
Conveyance Improvement – Culvert/Bridge Replacement	Feasible. Increase opening at 206th Street
Conveyance Improvement – Channel Improvement	Not feasible. Limited right of way available
Conveyance Improvements – Diversion	Not feasible. No available outfall downstream
Flood Barriers, Levees/Floodwalls	Not feasible. Limited right of way available

3.1.3.1.4 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 the DWP. **Table 3.1.10** summarizes flood control alternatives developed for Problem Group BTCR-G1.

Table 3.1.10: Flood Control Alternatives for Problem Group BTCR-G1

Alternative	Location	Description
BTCRG1-A1	206th Street	Upgrade existing crossing from 12-ft circular culvert to (2) 12-ft circular culverts. Due to the larger opening there will be higher stage increases downstream of 206th Street. This alternative cannot be implemented without compensatory storage.
BTCRG1-A2	West of 203rd Street and Keeler Avenue	Construct detention facility to detain the stage increases from the 206th Street culvert improvements.
BTCRG1-A3	206th Street, west of 203rd Street and Keeler Avenue, structures between 203rd Street and 206th Street	Upgrade existing crossing at 206th Street and construct detention facility west of 203rd Street and Keeler Avenue (combination of Alternatives BTCRG1-A1 and BTCRG1-A2). Additionally, non-structural solutions, such as floodproofing or acquisition, are recommended for three building structures where there will still be residual damages.

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

3.1.3.1.5 Alternative Evaluation and Selection

Alternatives included in **Table 3.1.10** 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. **Table 3.1.12** 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 BTCR-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.

Alternative BTCRG1-A3 from **Table 3.1.10** provides the preferred alternative for Problem Group BTCR-G1. By increasing the opening area of the crossing with a twin, 12-foot circular culvert and the construction of the 65 acre-foot detention facility, the 100-year water surface elevation (WSEL) will be reduced to 690.4 feet at 203rd Street, which is 1.2 feet below the existing 100-year elevation.

Three properties are at risk of flooding under existing and recommended alternative conditions. Due to their locations, these properties' risk of flooding cannot be feasibly mitigated by structural measures. Such properties are candidates for protection using non-structural flood control measures, such as floodproofing or acquisition. These measures may be considered to address damages that are not fully addressed by capital projects recommended in the Little Calumet River DWP.

Table 3.1.11 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for BTCR-G1.

Table 3.1.11: Alternative Condition Flow & WSEL Comparison for Problem Group BTCR-G1

Location	Station	Existing Conditions		Alternative BTCRG1-A3	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of 204th Street	4819	691.46	808	690.09	739
Upstream of 205th Street	4076	691.33	828	689.41	766
Upstream of 206th Street	3350	691.17	850	688.64	793

3.1.3.1.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.1.12** lists the alternative analyzed in detail. The recommended alternative consists of replacement of the existing circular culvert crossing at 206th Street with a twin, 12-foot circular culvert and 65 acre-foot detention facility near 203rd and Keystone Avenue. **Figure 3.1.5** 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 3.1.12: Butterfield Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group BTCR-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
BTCR-G1	BTCRG1-A3	Replace 206th Street crossing and construct detention facility	0.18	$1,495,000	$8,494,000	18 Structures	Positive	Unincorporated Cook County

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

3.1.3.2 BTCR-G2 – Butterfield Creek Problem Group 2

3.1.3.2.1 Problem Definition, BTCR-G2

The BTCR-G2 problem group consists of overbank flooding near Greenwood Drive and 207th Street in Olympia Fields. Near this problem area, the 100-year stage of 680.6 feet inundates approximately four building structures. This problem area was shown on the recent DFIRM floodplain maps. The flood protection elevation in this reach is 677.7 feet. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.1.3.2.2 Damage Assessment, BTCR-G2

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Butterfield Creek and its tributaries. These stages were used to calculate the depth of flooding and then 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% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.1.13** lists the estimated damages for the problem group.

Table 3.1.13: Estimated Damages for Butterfield Creek Subwatershed, Problem Group BTCR-G2

Problem Group ID	Damage Category	Estimated Damage ($)	Description
BTCR-G2	Property	$11,000	Structures at risk of flooding
	Transportation	$2,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.1.3.2.3 Technology Screening, BTCR-G2

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.1.14** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.1.14: Evaluation of Flood Control Technologies for the Butterfield Creek Subwatershed, Problem Group BTCR-G2

Flood Control Option	Feasibility
Detention Facilities	Feasible but not preferred given alternative
Conveyance Improvement – Culvert/Bridge Replacement	Feasible but not preferred given alternative
Conveyance Improvement – Channel Improvement	Feasible but not preferred given alternative
Conveyance Improvements – Diversion	Feasible but not preferred given alternative
Flood Barriers, Levees/Floodwalls	Feasible given that the problem is not due to high stages in the creek, but that a low overbank area exists

3.1.3.2.4 Alternative Development, BTCR-G2

Flood Control Alternatives. Alternative solutions to regional flooding problems were developed and evaluated consistent with the methodology described in **Section 1.4** of the DWP. **Table 3.1.15** summarizes flood control alternatives developed for Problem Group BTCR-G2.

Table 3.1.15: Flood Control Alternatives for Problem Group BTCR-G2

Alternative	Location	Description
BTCRG2-A1	Greenwood Drive	Construct a 700 LF, 8-ft high earthen levee adjacent to the flooded properties along Greenwood Drive

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the BTCR-G2 Problem Group.

3.1.3.2.5 Alternative Evaluation and Selection, BTCR-G2

The alternative included in **Table 3.1.15** was evaluated to determine its effectiveness and produce data required for the countywide prioritization of watershed projects. The flood control alternative was modeled to evaluate its impact on water elevations and flood damages. **Table 3.1.17** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative.

Alternative BTCRG2-A1 from **Table 3.1.15** is the preferred alternative for this Problem Group. An earthen levee was the only solution considered to be feasible, given that the cause of flooding is due to the low bank elevations adjacent to Greenwood Drive. A small earthen levee would protect homes while maintaining existing stages in the creek. A 700 linear-foot, average 8-foot high earthen levee adjacent to the flooded properties would prevent overbank flooding during the 100-year event. At an average height of 8-feet, the levee would provide approximately 3 feet of freeboard.

Table 3.1.16 provides a comparison of the modeled WSEL and modeled flow at the time of peak for BTCR-G2.

Table 3.1.16: Alternative Condition Flow & WSEL Comparison for Problem Group BTCR-G2

Location	Station	Existing Conditions		Alternative BTCRG2-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of Olympian Way	42602	680.55	1,985	680.48[1]	1,973

[1]Levee provides protection.

3.1.3.2.6 Data Required for Countywide Prioritization of Watershed Projects, BTCR-G2

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.1.17** lists the alternative analyzed in detail. The recommended alternative consists of constructing an earthen levee adjacent to flooded properties. **Figure 3.1.6** 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 3.1.17: Butterfield Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group BTCR-G2

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
BTCR-G2	BTCRG2-A1	Earthen levee	<0.01	$13,000	$9,556,000	4 Structures	No Impact	Olympia Fields

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

3.1.3.3 BTCR-G3 – Butterfield Creek Main Tributary Problem Group 3

3.1.3.3.1 Problem Definition, BTCR-G3

The BTCR-G3 problem area consists of overbank flooding in the area adjacent to Butterfield Creek Main Tributary from approximately Laurel Avenue to Dixie Avenue. In this reach, 100-year flows of 2,665 cfs exceed the capacity of the channel, and the critical water surface elevation is 638.6 feet at Laurel Avenue. There is flooding of approximately 12 building structures. This problem area was shown on the recent DFIRM floodplain maps. The flood protection elevation near the problem area is 637 feet at Laurel Avenue. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.1.3.3.2 Damage Assessment, BTCR-G3

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Butterfield Creek and its tributaries. These stages were used to calculate the depth of flooding and then 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% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.1.18** lists the estimated damages for the problem group.

Table 3.1.18: Estimated Damages for Butterfield Creek Subwatershed, Problem Group BTCR-G3

Problem Group ID	Damage Category	Estimated Damage ($)	Description
BTCR-G3	Property	$964,000	Structures at risk of flooding
	Transportation	$145,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.1.3.3.3 Technology Screening, BTCR-G3

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.1.19** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.1.19: Evaluation of Flood Control Technologies for Butterfield Creek Subwatershed, Problem Group BTCR-G3

Flood Control Option	Feasibility
Detention Facilities	Feasible and necessary to reduce stage increases from levee
Conveyance Improvement – Culvert/Bridge Replacement	Not feasible. Improvements to Dixie Highway will not reduce stages
Conveyance Improvement – Channel Improvement	Feasible and necessary to reduce stage increases from levee
Conveyance Improvements – Diversion	Feasible but not ideal given recommended alternative
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.1.3.3.4 Alternative Development, BTCR-G3

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 3.1.20** summarizes flood control alternatives developed for Problem Group BTCR-G3.

Table 3.1.20: Flood Control Alternatives for Problem Group BTCR-G3

Alternative	Location	Description
BTCRG3-A1	Laurel Avenue	Channel improvements for approximately 1,300 feet from downstream of Laurel Avenue crossing
BTCRG3-A2	Dixie Highway	Increasing the hydraulic capacity of the Dixie Highway will not reduce stages upstream, but included due to the proposed IDOT improvements to the Dixie Highway
BTCRG3-A3	Between Cambridge Avenue and Dixie Highway	Construct a 7-ft high, 3,100-ft long floodwall along left bank of BTCR from Cambridge Avenue to Dixie Avenue
BTCRG3-A4	Laurel Avenue, and between Cambridge Avenue and Dixie Highway	Channel improvements downstream of Laurel Avenue crossing, floodwall along creek from Cambridge Ave. to Dixie Highway (Combination of Alternatives BTCRG3-A1 and BTCRG3-A3)

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the BTCR-G3 Problem Group.

3.1.3.3.5 Alternative Evaluation and Selection, BTCR-G3

Alternatives included in **Table 3.1.20** 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 3.1.22** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. 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.

Alternative BCRG3-A4 from **Table 3.1.20** is the preferred alternative for this problem group. This problem area can be addressed by constructing a floodwall to prevent

flooding of the overbank areas. Stages would remain the same, or decrease slightly, due to the 1,300-foot channel improvement.

Table 3.1.21 provides a comparison of the modeled WSEL and modeled flow at the time of peak for BTCR-G3.

Table 3.1.21: Alternative Condition Flow & WSEL Comparison for Problem Group BTCR-G3

Location	Station	Existing Conditions		Alternative BTCRG3-A4	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Downstream of Laurel Avenue	18608	641.45	2,610	641.03	2,645
Upstream of Chicago and Vincennes Road	15884	637.09	2,665	636.31[1]	2,693

[1]Levee provides protection.

3.1.3.3.6 Data Required for Countywide Prioritization of Watershed Projects, BTCR-G3

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.1.22** lists the alternative analyzed in detail. The recommended alternative consists of conveyance improvements including channel widening and deepening, replacing two roadway crossings, and providing overbank storage. **Figure 3.1.7** 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 3.1.22: Butterfield Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group BTCR-G3

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
BTCR-G3	BTCRG3-A4	Levee and channel Improvements	0.04	$1,109,000	$29,876,000	12 Structures and 2 Roadways	No Impact	Flossmoor

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

3.1.3.4 BTCR-G4 – Butterfield Creek Problem Group 4

3.1.3.4.1 Problem Definition, BTCR-G4

The BTCR-G4 problem group consists of overbank flooding of isolated structures throughout the Butterfield Creek subwatershed. There are a total of five problem areas, each having fewer than four structures inundated. One isolated structure is inundated in BCEB near the intersection of Davis Avenue and Governors Highway. There are four building structures inundated in BTCR near the intersection of Crawford Avenue and Governors Highway in Matteson, two isolated structures inundated near Western Avenue and Brookwood Drive in Flossmoor, four building

structures inundated near Kuechler Avenue and Flossmoor Road in Flossmoor, and one isolated structure near Riegel Road in Flossmoor.

3.1.3.4.2 Damage Assessment, BTCR-G4

Damages were not calculated since the proposed alternative for BTCR-G4 is a non-structural measure such as floodproofing or acquisition only.

3.1.3.4.3 Technology Screening, BTCR-G4

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.1.23** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.1.23: Evaluation of Flood Control Technologies for Butterfield Creek Subwatershed, Problem Group BTCR-G4

Flood Control Option	Feasibility
Detention Facilities	Not feasible for the isolated structures
Conveyance Improvement – Culvert/Bridge Replacement	Not feasible for the isolated structures
Conveyance Improvement – Channel Improvement	Not feasible for the isolated structures
Conveyance Improvements – Diversion	Not feasible for the isolated structures
Flood Barriers, Levees/Floodwalls	Not feasible for the isolated structures

3.1.3.4.4 Alternative Development, BTCR-G4

Flood Control Alternatives. No flood control alternatives were developed for isolated structures in the BTCR-G4 Problem Group.

Streambank Stabilization Alternatives. No streambank stabilization alternatives were developed for the BTCR-G4 Problem Group.

3.1.3.4.5 Alternative Evaluation and Selection, BTCR-G4

Since the building structures are isolated, located throughout the watershed, are relatively small in number, and their risk of flooding cannot be feasibly mitigated by structural measures, such structures are candidates for protection using non-structural flood control measures such as floodproofing or acquisition. The decision to acquire vs. floodproof should be taken on a case-by-case basis and be based on actual surveyed first floor elevations.

3.1.3.4.6 Data Required for Countywide Prioritization of Watershed Projects, BTCR-G4

None of the structural alternatives considered were effective in reducing flood damages for the 12 isolated residential structures; therefore, benefits and costs are not presented for these alternatives. No structural measures are recommended for Problem Group BTCR-G4.

3.1.3.5 BCEB-G1 – Butterfield Creek East Branch Problem Group 1

3.1.3.5.1 Problem Definition, BCEB-G1

The BCEB-G1 problem group consists of roadway overtopping at the intersection of Sauk Trail Road and Governors Highway and overbank flooding of approximately 3,200 feet along Governors Highway from Sauk Trail Road to the Metra railroad tracks in Matteson. The 100-year flow of 450 cfs exceeds the culvert capacity at Sauk Trail Road and the 100-year flow of 650 cfs exceeds the channel capacity of Butterfield Creek East Branch from downstream of Sauk Trail Road to the Metra railroad tracks.

There are a total of six building structures inundated, including the overtopping of two major roadways.

3.1.3.5.2 Damage Assessment, BCEB-G1

Damages were defined following the protocol defined in Chapter 6.6 of the CCSMP. Critical duration analysis was performed to determine the highest flood stages for Butterfield Creek and its tributaries. These stages were used to calculate the depth of flooding and then 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% of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.1.24** lists the estimated damages for the problem group.

Table 3.1.24: Estimated Damages for Butterfield Creek Subwatershed, Problem Group BCEB-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
BCEB-G1	Property	$315,000	Structures at risk of flooding
	Transportation	$200,000	Overtopping of Governors Highway and Sauk Trail Road
	Recreation	$0	

3.1.3.5.3 Technology Screening, BCEB-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from Chapter 6 of the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.1.25** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.1.25: Evaluation of Flood Control Technologies for Butterfield Creek Subwatershed, Problem Group BCEB-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible. Provide detention for peak flows
Conveyance Improvement – Culvert/Bridge Replacement	Feasible. Increase capacity of Sauk Trail crossing
Conveyance Improvement – Channel Improvement	Feasible. Regrade profile and widen BCEB channel
Conveyance Improvements – Diversion	Not feasible. No outlet downstream
Flood Barriers, Levees/Floodwalls	Feasible, if done in conjunction with other flood control options

3.1.3.5.4 Alternative Development, BCEB-G1

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 3.1.26** summarizes flood control alternatives developed for Problem Group BCEB-G1.

Table 3.1.26: Flood Control Alternatives for Problem Group BCEB-G1

Alternative	Location	Description
BCEBG1-A1	1,000 feet south of Sauk Trail Road and Governors Highway	Construct a 130 ac-ft pumped detention facility at the upstream end of the reach to reduce stages and prevent increases from Sauk Trail Road crossing improvements. This will not solve the problems located downstream of Sauk Trail Road.
BCEBG1-A2	Sauk Trail Road and Governors Highway	Implement culvert improvements. Conveyance improvements alone do not reduce stages enough, but will aid in increasing the hydraulic capacity of the crossing.
BCEBG1-A3	Between Sauk Trail and Metra Railroad tracks	Regrade the BCEB channel to establish positive slope from Sauk Trail Road to the Metra railroad tracks. By increasing the conveyance capacity of BCEB, more water will be diverted from Sauk Trail Road, which will result in an increase of flows along the reach and have no positive impact on reducing flooding along the tributary.
BCEBG1-A4	Maple Avenue to Metra Railroad tracks	Construct a 1,700 LF earthen levee between Maple Avenue and the Metra railroad tracks to prevent overbank flooding. With detention and conveyance improvements alone, overbank flooding still occurs due to the restriction from the Metra railroad tracks. This must be done in conjunction with Alternatives 1, 2, and 3 to prevent any stage increases along or downstream of the levee.
BCEBG1-A5	Vicinity of Sauk Trail Road and Governors Highway; Maple Avenue to the Railroad tracks	Construct a detention facility at the upstream end of the creek, culvert improvements at Sauk Trail Road and Governors Highway, regrading of creek, and construction of an earthen levee (combination of Alternatives BCEBG1-A1, BCEBG1-A2, BCEBG1-A3 and BCEBG1-A4).

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

3.1.3.5.5 Alternative Evaluation and Selection, BCEB-G1

Alternatives included in **Table 3.1.26** 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 3.1.28** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. 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.

Alternative BCEBG1-A5 from **Table 3.1.26** is the preferred alternative for this problem group. This combination was the only combination deemed feasible to address flooding in both problem areas. While detention alone alleviates the upstream problem, it does not adequately address the downstream problem. A levee alone, from Sauk Trail Road to the Metra railroad tracks will prevent overbank flooding downstream but will cause stage increases. Therefore, the feasible alternative is a combination of all four technologies. A 130 acre-foot storage reservoir (20 acre-foot surface area, 6.5 feet deep with a side channel spillway) is proposed at the upstream end of Sauk Trail Road. Sauk Trail Road culvert replacement from an existing 9.5-foot x 5.5-foot elliptical culvert to a 15-foot x 6-foot box culvert. Channel improvements between Sauk Trail Road and the Metra railroad tracks include channel widening and culvert improvements. An earthen levee that is 1,700 feet long, an average of 7 feet high and 25 feet wide is proposed parallel to Governors Highway from Maple Avenue to the Metra railroad tracks parallel to the creek.

Table 3.1.27 provides a comparison of the modeled WSEL and modeled flow at the time of peak for BCEB-G1.

Table 3.1.27: Alternative Condition Flow & WSEL Comparison for Problem Group BCEB-G1

Location	Station	Existing Conditions		Alternative BCEBG1-A5	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of Sauk Trail Road	15271	708.05	450	706.67	308
Upstream of Poplar Avenue	13559	706.19	585	705.03	440
Upstream of Maple Avenue	12984	706.17	646	704.96	446
Upstream of Railroad Tracks	11243	706.15	225	704.92	206

3.1.3.5.6 Data Required for Countywide Prioritization of Watershed Projects, BCEB-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.1.28** lists the alternative analyzed in detail. The recommended alternative consists of construction a detention facility, Sauk Trail Road culvert improvements, channel and culvert improvements between Sauk Trail Road and the Metra railroad tracks and an earthen levee between Maple Avenue and the Metra railroad tracks along Governors Highway. **Figure 3.1.8** 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 3.1.28: Butterfield Creek Project Alternative Matrix to Support District CIP Prioritization for Problem Group BCEB-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
BCEB-G1	BCEBG1-A5	Detention facility, culvert improvements, channel improvements, earthen levee	0.02	$515,000	$28,079,000	6 Structures and 2 Roadways	Positive	Matteson

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

3.1.4 Recommended Alternatives, Butterfield Creek Subwatershed

Table 3.1.29 summarizes the recommended alternatives for the Butterfield Creek subwatershed. The District will use data presented here to support prioritization of a countywide stormwater CIP.

Table 3.1.29: Butterfield Creek Project Alternative Matrix to Support District CIP Prioritization, All Problem Groups

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Structures & Roadways Protected	Water Quality Benefit	Involved Community
BTCR-G1	BTCRG1-A3	Replace 206th Street crossing and construct detention facility	0.18	$1,495,000	$8,494,000	18 Structures	Positive	Unincorporated. Cook County
BTCR-G2	BTCRG2-A1	Earthen levee	<0.01	$13,000	$9,556,000	4 Structures	No Impact	Olympia Fields
BTCR-G3	BTCRG3-A4	Levee and channel Improvements	0.04	$1,109,000	$29,876,000	12 Structures and 2 Roadways	No Impact	Flossmoor
BCEB-G1	BCEBG1-A5	Detention facility, culvert improvements, channel improvements, earthen levee	0.02	$515,000	$28,079,000	6 Structures and 2 Roadways	Positive	Matteson

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