3.2 Calumet Union Drainage Ditch

The Calumet Union Drainage Ditch (CUDD) subwatershed covers approximately 20 square miles and is located in the northern portion of the Little Calumet River watershed. **Table 3.2.1** lists the communities and the drainage areas contained within the CUDD subwatershed.

Table 3.2.1: Communities Draining to CUDD

Community	Tributary Area (mi^2)
Country Club Hills	3.39
East Hazel Crest	0.72
Flossmoor	1.08
Harvey	1.84
Hazel Crest	3.39
Homewood	3.48
Markham	2.96
Oak Forest	0.07
Phoenix	0.02
South Holland	2.11
Thornton	0.29
Unincorporated Cook County	1.19

Table 3.2.2 lists the land use breakdown by area within the CUDD subwatershed. **Figure 3.2.1** 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.

There are 15 tributaries, including the CUDD main tributary, encompassing a study reach length of 31 miles, nearly 8 miles of which are enclosed conduits. The tributaries all discharge to the Little Calumet River via the CUDD main tributary, except for Dixie Creek, Park Creek, Belaire Creek, and the I-57 Drainage Ditch, which are diverted to the Little Calumet River via the Robey Street diversion conduit or directly through the I-57 Drainage Ditch.

Table 3.2.2: Land Use Distribution for CUDD

Land Use	Acres	%
Commercial/Industrial	2,339	18
Forest/Open Land	2,235	17
Institutional	630	5
Residential	6,472	49
Transportation/Utility	977	7
Water/Wetland	122	1
Agricultural	374	3

- Calumet Union Drainage Ditch (CUDD) – originates near 161st Street and Central Park Avenue in Markham, flows east across I-57 through Harvey, to the confluence with the Little Calumet River just east of State Street in South Holland. The majority of the subwatershed drains to CUDD, including the CUDD Southwest Branch, Cherry Creek, and Canadian Central tributaries.

- Calumet Union Drainage Ditch Southwest Branch (CUSW) – begins east of Cicero Avenue in Country Club Hills, continues northeast through Hazel Crest, crosses the Tri-State Tollway and ends at the confluence with CUDD east of I-294 in Markham. The Edward C. Howell Reservoir is located on the CUDD Southwest Branch approximately 2,000 feet upstream of its confluence with CUDD.

- Calumet Union Drainage Ditch Southwest Branch Tributary N (CUTN) – originates at Cicero Avenue and I-80 in Country Club Hills. It travels easterly, flowing mostly in an enclosed conduit running parallel to 175th Street and Country Club Hills Community Park, to its confluence with CUDD Southwest Branch near 175th Street and Crawford Avenue. The area between 175th Street and I-80 drains directly into the enclosed conduit via a storm sewer system.

- Calumet Union Drainage Ditch Southwest Branch Tributary S (CUTS) – begins north of 186th Avenue in Country Club Hills. It flows north to its confluence with CUDD Southwest Branch near 178th Street and Chestnut Avenue. The tributary is primarily enclosed in pipe through a residential development.

- Cherry Creek (CHCR) – originates at the confluence of Cherry Creek East Branch and Cherry Creek West Branch near 175th Street in Hazel Crest. It flows northeast, through the Calumet Country Club in Homewood and under the Tri-State Tollway. At 169th Street in Hazel Crest it enters a pipe and is conveyed approximately 5,000 feet until its confluence with CUDD under Dixie Highway in Markham.

- Cherry Creek East Branch (CHEB) – originates in the Coyote Run Golf Course in the Village of Flossmoor, and flows east past Homewood-Flossmoor High School. It continues northeast, roughly following Governors Highway through the Village of Homewood. It joins with Cherry Creek West Branch at 175th Street in Hazel Crest, where it becomes Cherry Creek.

- Cherry Creek East Branch Tributary (CHET) – begins near Flossmoor Road and Governors Highway in Flossmoor. It is a small roadside ditch which flows along Governors Highway to its confluence with Cherry Creek East Branch near Homewood-Flossmoor High School.

- Cherry Creek West Branch (CHWB) – originates in the detention area south of 183rd Street in the Village of Flossmoor. Flow is conveyed northeasterly, primarily through residential neighborhoods in Flossmoor and Hazel Crest, to its confluence with Cherry Creek East Branch at 175th Street, where it becomes Cherry Creek. There is a small offline detention pond downstream of Kedzie Avenue, and three inline ponds at 183rd Street with individual inline weirs for control structures.

- Cherry Creek West Branch East Fork (CHWE) – originates near 189th Street and Pulaski Road in Flossmoor. It flows northeasterly to its confluence with Cherry Creek West Branch West Fork in the Village of Hazel Crest, where it becomes Cherry Creek West Branch.

- Robey Street Diversion Conduit (RSDC) - redirects flow from CUDD and Dixie Creek north to the Little Calumet River at Ashland Avenue and Thornton Road. The conduit includes a 5-foot diameter pipe from CUDD to Dixie Creek and a 7.5-foot diameter pipe from Dixie Creek to the Little Calumet River. The conduit runs under the original Robey Street, which is currently an open space.

- Dixie Creek (DXCR) - begins as an enclosed conduit from Robey Street and 161st Street to Dixie Highway and ends as an open channel 1,500 feet southwest of the I-57/I-294 interchange. Depending on flow conditions, west of I-294 the creek flows to the I-57 Drainage Ditch, while east of I-294 the creek flows to the Robey Street Diversion. The tributary flows through both the Markham and Harvey communities.

- I-57 Drainage Ditch (I57D) – is an open channel running along I-57 from 157th Street to the Little Calumet River. It includes runoff from the east side of I-57, Park Creek, and portions of Dixie Creek depending on flow conditions. At the confluence with Dixie Creek, the channel enters a 10-foot diameter concrete conduit that discharges to the Little Calumet River at Ashland Avenue and Thornton Road.

- Park Creek (PKCR) – begins near Birch Road, at the border between the municipalities of Midlothian and Markham. It flows easterly towards Kedzie Avenue, under I-57, to its confluence with the I-57 Drainage Ditch in Markham.

- Belaire Creek (BLCR) – begins near 155th Street east of Kedzie Avenue in Markham. It flows easterly, through the Markham Prairie and under the Tri-State Tollway, and then turns northerly and flows to its confluence with Dixie Creek near Rockwell Street, at the border between the Cities of Markham and Harvey.

- Canadian Central Drainage Ditch (CCDD) – runs alongside the Canadian Central Rail Yard and Center Avenue in Harvey, between I-80 and US Highway 6 (159th Street). The ditch was never named since no FEMA study has been conducted. For this study, the ditch has been named "Canadian Central Drainage Ditch." Canadian Central is tributary to CUDD and conveys runoff from Harvey, East Hazel Crest, and Homewood.

- Unnamed Overland Flow Path - Although not a tributary, this area receives significant overbank flow from CUDD shortly upstream of Park Avenue at US Highway 6. The area is also a combined sewer area and is bounded to the northeast by the GTW Railroad Canadian National rail line. It includes Harvey, Posen, and Dixmoor.

There are two major regional flood control facilities within the Calumet Union Drainage Ditch subwatershed.

- Calumet Union Reservoir - The Calumet Union Reservoir is located on Cherry Creek approximately 10,000 feet upstream of CUDD. It provides flood control for Homewood, Hazel Crest, Markham, and Harvey and is operated by the MWRDGC. At an elevation of 629.0 feet, it stores approximately 420 acre feet.

- Edward C. Howell Reservoir - The Edward C. Howell Reservoir is located on CUDD Southwest Branch approximately 3,500 feet upstream of CUDD. The reservoir stores approximately 590 acre feet at elevation 617.0 feet, providing flood relief for Markham and Harvey.

3.2.1 Sources of Data

3.2.1.1 Previous Studies

One study was made available which pertained to the Calumet Union Drainage Ditch subwatershed.

- 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.

During Phase A of the project, all the data, topography, precipitation, stream flow, land use and soils data needed for the development of the subwatershed model were collected.

3.2.1.2 Water Quality Data

There are no MWRDGC, IEPA or USGS water quality monitoring gages in the Calumet Union Drainage Ditch subwatershed. Per the IEPA's *2008 Integrated Water Quality Report*, which includes the Clean Water Act (CWA) 303(d) and the 305(d) lists, there are no impaired waterways within the subwatershed. No Total Maximum Daily Loads (TMDLs) have been established for CUDD or its tributaries.

NPDES point source discharges are listed in **Table 3.2.3.** In addition to the point source discharges listed in **Table 3.2.3**, municipalities discharging to CUDD 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 the 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.

Table 3.2.3: Point Source Dischargers in Calumet Union Drainage Ditch Area

Name	NPDES	Community	Receiving Waterway
Canadian NTL IL Central RR	IL0005193	Homewood	Calumet Union Drainage Ditch
Envirite of Illinois Inc.	IL0071285	Harvey	Calumet Union Drainage Ditch
Allied Tube and Conduit Corp.	IL0063649	Harvey	Calumet Union Drainage Ditch

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.

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 Little Calumet River Watershed. Wetland areas were identified using National Wetlands Inventory (NWI) mapping. NWI data includes roughly 147 acres of wetland areas in the CUDD 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.

3.2.1.4 Floodplain Mapping

FEMA's 2006 effective models were not made available by the Illinois State Water Survey (ISWS) during the development of the subwatershed hydraulic model; however, the ISWS model of CUDD and CUDD Southwest Branch were made available.

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

Table 3.2.4 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 to the District. There were 23 problem areas reported related to the CUDD subwatershed. Problems are classified in **Table 3.2.4** as regional or local. This classification is based on criteria described in **Section 2.2.1** of this report. All the listed regional problems were provided a resolution based on the alternative analysis.

Table 3.2.4: Community Response Data for Calumet Union Drainage Ditch Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
BRE1	Bremen Township	Siltation and scouring at culverts	175th Street from Oak Park to Argyle Avenue	Other (siltation)	Local	Culvert maintenance issue, local responsibility
BRE3	Bremen Township	Debris and siltation	167th Street from Kilbourn Avenue to Western Avenue	Debris at upstream end of culvert	Local	This is a local drainage issue; problem not located on a regional waterway
BRE8	Bremen Township	Debris and siltation; storm sewer flow restriction	Kedzie Avenue from 183rd Street to 135th Street	Other (debris, siltation, storm sewer restriction)	Local	This is a local storm sewer system problem; problem not located on a regional waterway
CCH1	East Hazel Crest	Pavement flooding	171st Street between Ashland Avenue and South Park Avenue	Pavement flooding that appears to have been addressed with the Cook County Highway Department's (CCHD) recent roadway and stormwater improvements	Local	Issue has been addressed by CCHD
CCH3	Chicago Heights	Pavement flooding - vegetation and dumping	Center Street/Illinois Central/Canadian National Railroad Ditch	Canadian Central tributary appears to have significant vegetation and may be prone to dumping	Local	Channel maintenance issue is local responsibility
COU1	Country Club Hills	Parking lots flooding	NE corner of Pulaski Road and 175th Street	Local drainage problems associated with the intersection. Modeling does show 175th overtops during the 100-year storm, but depths are less than 0.5 ft	Local	Local drainage issue
HAR1	Harvey	Basement and ponding	Entire village	Local drainage may be causing basement and street flooding. Modeling shows flooding due to CUDD overtopping during the 100-year event	Regional	Reservoir expansion and upsizing of conduit (Alternative CUDDG1-A8)

Table 3.2.4: Community Response Data for Calumet Union Drainage Ditch Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
HAR4	Harvey	Pavement flooding (IDOT)	US 6 between Park Avenue and Center Street	Local drainage problem at this underpass, although Highway 6 does overtop approx. 1,000 ft west	Local	Local drainage issue at underpass
HAR8	Harvey	Bank erosion and sedimentation	Lathrop Avenue and 161st Street	Siltation and vegetation in channel	Channel Maintenance	Removal of debris to be addressed by stream maintenance
HCT1	Hazel Crest	Siltation pond needs regular dredging	172nd Street and Palmer Avenue	Siltation in Pond #2 of the Cal-Union Reservoir	Facility Maintenance	Dredging of pond to be addressed by O&M
MRK1	Markham	Water in yard/ crawl space; 2-3 times per year. Significant erosion. Complaints received from residents during workshops	Arthur Terrace and Blackstone Avenue/ Lawndale Avenue	Overbank flooding from CUDD with additional basement flooding likely due to local drainage problems. Significant erosion	Regional	4-ft high floodwall with erosion protection, including culvert retrofit and channel rehabilitation (Alternative CUDDG3-A2)
MRK2	Markham	Overbank flooding	Dixie Highway and Western Avenue/ 159th Street and 156th Place (maybe 150th Place)	Local flooding due to local drainage problems, not overbank flooding from CUDD or Belaire Creek	Local	Not related to overbank flooding of regional waterway
MRK3	Markham	Overbank flooding, ponding	Dixie Highway and Park Avenue/167th and 161st Streets	Overbank flooding from CUDD with additional basement flooding likely due to local drainage problems. Construction of deep shaft has helped ease flooding	Regional	Reservoir expansion and upsizing of conduit (Alternative CUDDG1-A8)
MRK4	Markham	Overbank flooding, ponding	Lincoln Highway and Parkside Avenue/California and Lincoln Highway	Overbank flooding from Belaire Creek with additional basement flooding likely due to local drainage problems	Regional	Levee and pumped storage area (Alternative BLCRG1-A6)
MRK5	Markham	Storm sewer flow restriction	Lawndale Avenue and 167th Street	Storm sewer flow restriction	Local	Local storm sewer issue

Table 3.2.4: Community Response Data for Calumet Union Drainage Ditch Subwatershed

Problem ID	Municipality	Problems as Reported by Local Municipality	Location	Problem Description	Local/ Regional	Resolution in DWP
MRK6	Markham	Ponding	Oxford Drive and Richmond Avenue/ 2800 Circle Drive	Local storm sewer floods	Local	Local storm sewer issue
MRK7	Markham	Ponding	Magnolia Drive and Alta Road	Backyards flood approximately twice a year	Local	Local issue
MRK8	Markham	Yards flooding	155th Street and Lawndale Avenue	Ponding	Local	Not related to overbank flooding of regional waterway
MRK9	Markham	Basement flooding, ponding	West to Rockwell Avenue/162nd to 159th Streets	No problem has been observed since 2000; ponding due to overbank flow from CUDD	Regional	Construct 450 ac-ft detention basin with diversion culverts (Alternative CUDDG2-A1)
MRK10	Markham	Ponding, storm sewer flow restriction	154th to 155th Streets/Crawford Avenue to Hamlin Avenue	Yards flood 2-3 times a year	Local	Local storm sewer issue
MRK11	Markham	Pavement flooding	Route 6 at 6000 west (IDOT)	Pavement flooding	Local	Local issue
THO2	Thornton Township	Siltation and debris	171st Street from Robey Street to Halsted Street	Other (siltation, storm sewer flow restriction	Local	Maintenance issue
THO3	Thornton Township	Culvert flow restriction	Center Street from 175th Street to 159th Street	Debris at culvert opening	Local	Local maintenance issue

3.2.1.6 Near Term Planned Projects

No near-term planned major flood control projects have been identified. Two conveyance projects or stream maintenance projects have been identified: retrofit of the Country Club Lane crossing at Independence Park to reduce upstream stages, and maintenance along the Canadian Central Rail Yard.

3.2.2 Watershed Analysis

3.2.2.1 Hydrologic Model Development

3.2.2.1.1 Subbasin Delineation

The CUDD subwatershed was delineated according to the methods described in **Sections 1.3.2** and **2.3.2**. There are 63 subbasins ranging in size from 0.019 to 2.13 square miles with an average size of 0.393 square miles.

3.2.2.1.2 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**. A table summarizing the drainage area, final CN, directly connected impervious percentage and unit hydrograph parameters for each subbasin are shown in **Appendix G**.

3.2.2.2 Hydraulic Model Development

3.2.2.2.1 Field Data, Investigation, and Existing Model Data

During Phase A, any available existing models were collected and analyzed to determine if data could be used for developing the comprehensive model. Only existing models that were less than 10 years old were reviewed.

The FEMA effective hydraulic model for CUDD and the Calumet Union Drainage Ditch Southwest Branch was developed in January 2006 by the Illinois State Water Survey using HEC-2, and was made available for this study. The model met District criteria as identified in the CCSMP, and was used to support DWP development. Effective hydraulic models for the other tributaries were developed using the DWP field survey.

The HEC-2 model was reviewed to determine if any of the cross-sectional data and hydraulic structure information could be reused. If any information regarding location, date, and vertical datum was not available, the cross-sectional data was not used. For cross sections with this data available, the cross section was compared to the current channel conditions to ensure that the cross section was still representative of current conditions. The hydraulic structure dimensions were compared to 2007 field reconnaissance data and also to bridge/culvert dimension data provided by Cook County Highway Department (data provided for state/county highways only). Based on the existing model analysis, additional cross sections and hydraulic structures to be surveyed were determined. Any data used from the existing models was geo-referenced to represent true physical coordinates.

After review of existing models, field reconnaissance data, and hydraulic structure dimension data, a field survey plan 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 surveying was performed in early 2008. Cross sections were generally surveyed between 500 to 1,000 feet apart. The actual spacing and location were determined based on the variability of the channel's shape, roughness, and slope. A total of 281 cross sections and 70 hydraulic structures were surveyed to develop the hydraulic model for the CUDD subwatershed. Additional cross sections were developed by interpolating the surveyed channel data and combining with contour data.

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 0.060 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 3.2.5** lists the channel and overbank ranges of n-values that were used for the subwatershed model.

Table 3.2.5: Channel and Overbank Associated Manning's n-Values[1]

Tributary	Range of Channel n-Values	Range of Overbank n-Values
CUDD	0.013 - 0.05	0.013 - 0.12
CUSW	0.015 - 0.05	0.015 - 0.12
CUTN	0.013 - 0.055	0.013 - 0.03
CUTS	0.013 - 0.05	0.03
CHCR	0.013 - 0.045	0.013 - 0.12
CHEB	0.013 - 0.116	0.015 - 0.12
CHET	0.045	0.10
CHWB	0.015 - 0.045	0.03 - 0.12
CHWE	0.05	0.045 - 0.12
DXCR	0.013 - 0.12	0.013 - 0.12
PKCR	0.045	0.12
I57D	0.045	0.12
BLCR	0.04 - 0.06	0.03 - 0.12
CCDD	0.035 - 0.045	0.035 - 0.4
RSDC	0.013	0.013

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

3.2.2.2.2 Boundary Conditions

There are three downstream locations where boundary conditions were required to run the hydraulic model. Since CUDD upstream to Halsted Street was modeled within the Little Calumet River hydraulic model, the downstream boundary condition was not critical at the CUDD and Little Calumet River confluence. Normal depth was used as the downstream boundary condition for CUDD at the confluence with the Little Calumet River, the Robey Street Diversion Conduit at the Little Calumet River, and the I-57 Drainage Ditch at the Little Calumet River.

3.2.2.3 Calibration and Verification

A detailed calibration was not conducted on the CUDD subwatershed since historic gage records and high water marks were not available. Revisions to the hydrologic parameters were made based on the calibration results of the other subwatersheds. Five historic storms were modeled: August 2007, April 2007, April 2006, July 1996, and September 2008. An inspection of high water marks following the September

2008 storm event corresponded well to the 100-year model results along CUDD, Dixie Creek, and Belaire Creek.

For the historical 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 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.

Runoff hydrographs were developed using HEC-HMS and routed through the hydraulic model. Since a formal calibration of the subwatershed was not possible, changes made to the hydrology of the Midlothian Creek subwatershed were adopted for the CUDD subwatershed. The CN and directly connected impervious percentage were adjusted by -10% and -10%, respectively. The Clark's Unit Hydrograph storage coefficient R was increased by +25 percent.

The hydraulic model was verified by comparing the hydraulic model results with available high water marks for the September 2008 storm event. High water marks were surveyed in June 2009 using field photos taken after the event**.** **Table 3.2.6** shows the comparison of the model results to the surveyed high water marks.

Table 3.2.6: Calumet Union Drainage Ditch Subwatershed Verification Results

Storm Event	Location	Field Elevation (ft)	Model Elevation (ft)
Sep-08	Calumet Union Reach 1 RS 9663	605.25	605.49
Sep-08	Calumet Union Reach 1 RS 9768*	604.78	605.79
Sep-08	Calumet Union Reach 1 RS 9880*	604.17	605.82
Sep-08	Overbank area adjacent to Calumet Union Reach 2 RS 15702	607.56	608.01
Sep-08	Overbank area adjacent to Calumet Union Reach 2 RS 15702	607.78	608.01
Sep-08	Calumet Union Reach 3 RS 16367	608.25	608.03
Sep-08	Calumet Union Reach 3 RS 16505.7	607.98	608.10
Sep-08	Calumet Union Reach 3 RS 16552	608.66	608.10
Sep-08	Calumet Union Reach 3 RS 16676	608.20	608.13
Sep-08	Markham overbank area adjacent to Calumet Union Reach 2	607.96	607.32
Sep-08	Calumet Union SW Reach 1 RS 8321	627.07	627.59
Sep-08	Belaire Creek Reach 1 RS 5876	606.53	606.96

*Upstream high water mark is lower than downstream

Although gage data was not available, comparison to high water marks obtained during the September 2008 storm suggests the model is reasonably predicting stages along CUDD. Observed high water marks and modeled stages are within 0.51 feet. Two surveyed high water marks (see footnote) are inconsistent with the surveyed high water mark immediately downstream. If these two high water marks are discounted, modeled stages are within 0.35 feet of the surveyed high water marks.

3.2.2.4 Existing Conditions Evaluation

3.2.2.4.1 Flood Inundation Areas.

The existing conditions hydraulic model was run for the 2- through 500-year storm events. A critical duration analysis was performed for the subwatershed hydraulic model. The 100-year, 1-, 3-, 6-, 12-, 24-, and 48-hour storm events were run to determine the critical duration that produces the highest stages and flows. The 6-hour duration was found to be the representative critical duration for CUDD Southwest Branch Tributary N, CUDD Southwest Branch Tributary S, Cherry Creek East Branch Tributary, Cherry Creek West Branch East Fork, and portions of CUDD Southwest Branch, Cherry Creek East Branch, Cherry Creek West Branch, and the Canadian Central Drainage Ditch. The remainder of the reaches had a critical duration of 48 hours. **Figure 3.2.1** shows inundation area produced for the 100-year critical duration storm event.

3.2.2.4.2 Hydraulic Profiles

Hydraulic profiles for CUDD 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.

3.2.3 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 3.2.7** summarizes problem areas identified through hydraulic modeling of the CUDD 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 3.2.7: Modeled Problem Definition for the Calumet Union Drainage Ditch Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
CUDD1	CUDD-G1	Highway 6 and Park Avenue	10, 25, 50, & 100	HAR1	CUDDG1-A8
CUDD2	CUDD-G1	CUDD from Dixie Highway to Park Avenue	25, 50, & 100	MRK3	CUDDG1-A8
CUDD3	CUDD-G2	CUDD from Tri-State Tollway to Dixie Highway	10, 25, 50, & 100	MRK9	CUDDG2-A1
CUDD4	CUDD-G3	CUDD from Hamlin Avenue to Central Park	25, 50, & 100	MRK1	CUDDG3-A2

Table 3.2.7: Modeled Problem Definition for the Calumet Union Drainage Ditch Subwatershed

Problem ID	Group ID	Location	Recurrence Interval (yr) of Flooding	Associated Form B	Resolution in DWP
CUDD5	CUDD-G3	CUDD from Sunset to Central Park	10, 25, 50, & 100	MRK1	CUDDG3-A2
CUSW1	CUSW-G1	CUDD Southwest from Holmes Avenue to Tri-State Tollway	50 & 100	None	CUSWG1-A1
CUSW2	CUSW-G2	CUDD Southwest at Kedzie Avenue	25, 50, & 100	None	CUSWG2-A2
CUTS1	CUTS-G1	CUDD SW Tributary South at Baker Avenue	100	None	CUTSG1-A1
CHCR1	CUDD-G1	Cherry Creek from Tri-State Tollway and I-80 interchange to Dixie Highway	50, & 100	None	CUDDG1-A8
CHEB1	CHEB-G1	Cherry Creek East Branch at Governors Highway	25, 50, & 100	None	CHEBG1-A4
CHEB2	CHEB-G2	Cherry Creek East Branch at Chayes Court	25, 50, & 100	None	Floodproofing/ acquisition
CHEB3	CHEB-G3	Cherry Creek East Branch at Governors Highway and the Homewood-Flossmoor High School	50, & 100	None	CHEBG3-A3
BLCR1	BLCR-G1	Belaire Creek from Albany Avenue to Afton Avenue	100	MRK4	BLCRG1-A6
PKCR1	PKCR-G1	Park Creek near 153rd Street	50, & 100	None	PKCRG1-A4
PKCR2	PKCR-G1	Park Creek from Kedzie Avenue to I-57	50, & 100	None	PKCRG1-A4

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

3.2.3.1 CUDD-G1 – Calumet Union Drainage Ditch Problem Group 1

3.2.3.1.1 Problem Definition, CUDD-G1

The CUDD-G1 problem group consists of overbank flooding in Markham along CUDD from Dixie Highway to Vincennes Avenue. In this reach, 100-year flows ranging between 1,364 cfs at Dixie Highway to 1,608 cfs at Vincennes Avenue exceed the capacity of the channel. In addition, US Highway 6 upstream of Park Avenue overtops and flooding occurs north of US 6 within Harvey. The combined Markham and Harvey flooding include approximately 1,060 building structures. Flooding in

Markham was not shown on the recent DFIRM floodplain maps, since the current flood insurance study (FIS) maintains lower 100-year flow rates. The Harvey area is shown on the recent DFIRM floodplain maps; however, this is due to flooding from Dixie Creek and Dixie Highway, not CUDD. The flood protection elevation varies between 609.88 feet at Dixie Highway 601.37 feet at Vincennes Avenue.

An associated problem area consists of overbank flooding on Cherry Creek, between the Tri-State Tollway and Dixie Highway. In this reach, 100-year flows of 500 cfs generally exceed the capacity of the channel and the culvert crossings at 171st Street, Crane Avenue, 170th Street, and Head Avenue.

3.2.3.1.2 Damage Assessment, CUDD-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD 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 3.2.8** lists the estimated damages for the problem group.

Table 3.2.8: Estimated Damages for Calumet Union Drainage Ditch Subwatershed, Problem Group CUDD-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CUDD-G1	Property	$5,782,000	Structures at risk of flooding
	Transportation	$0	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.1.3 Technology Screening, CUDD-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.9** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.9: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CUDD-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible and necessary
Conveyance Improvement – Culvert/Bridge Replacement	Not adequate to address flooding
Conveyance Improvement – Channel Improvement	Not adequate to address flooding
Conveyance Improvements – Diversion	Feasible and necessary
Flood Barriers, Levees/Floodwalls	Impractical given other technologies

3.2.3.1.4 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 3.2.10** summarizes flood control alternatives developed for Problem Group CUDD-G1.

Table 3.2.10: Flood Control Alternatives for Problem Group CUDD-G1

Alternative	Location	Description
CUDDG1-A1	Edward C. Howell Reservoir	Expansion of the Edward C. Howell Reservoir
CUDDG1-A2	Calumet Union Reservoir	Expansion of the Calumet Union Reservoir
CUDDG1-A3	CUDD from Dixie Highway to Vincennes Avenue	Conveyance improvements by widening and deepening CUDD, retrofit structures through the Canadian Central Rail Yard
CUDDG1-A4	Robey Street Diversion Conduit	Replace the existing Robey Street Diversion Conduit with a higher conveyance diversion.
CUDDG1-A5	From Tri-State Tollway to Dixie Highway	Conveyance improvements to reduce flooding on Cherry Creek
CUDDG1-A6	Edward C. Howell and Calumet Union Reservoirs	Expansion of both reservoirs to their maximum capacity (combination of Alternatives CUDDG1-A1 and CUDDG1-A2). This did not reduce flows in CUDD enough to prevent overtopping. While the Calumet Union Reservoir expansion helped reduce flows significantly, expansion of the Edward C. Howell Reservoir did not. This alternative is not preferred
CUDDG1-A7	Calumet Union Reservoir and CUDD from Dixie Highway to Vincennes Avenue	Expansion of the Calumet Union Reservoir and conveyance improvements along CUDD (combination of Alternatives CUDDG1-A2 and CUDDG1-A3). Even with channel improvements, CUDD does not have enough capacity and this alternative is not preferred
CUDDG1-A8	Calumet Union Reservoir, Robey Street Diversion Conduit	Expansion of the Calumet Union Reservoir with improvements to the Robey Street Diversion Culvert (combination of Alternatives CUDDG1-A2 and CUDDG1-A4)

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

3.2.3.1.5 Alternative Evaluation and Selection

Alternatives included in **Table 3.2.10** 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 3.2.12** 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 CUDDG1-A8 from **Table 3.2.10** is the preferred alternative for this Problem Group. This improvement includes the expansion of the Calumet Union

Reservoir and the upgrading of the Robey Street Diversion Conduit. The Calumet Union Reservoir expansion project component includes the following items:

- Expansion of both Pool #4 and Pool #6 by increasing to their maximum capacities at 4:1 side slopes. This increases Pool #4 by 150 acre feet and Pool #6 by 235 acre feet.

- Construction of a new pool north of Pool #6.

- Raise the spillway on Pool #4 to 625 feet to provide more storage during the storm peak.

- If both pools are increased to their maximum depth, Pool #6 would have a lower invert than Pool #4. As a result, Pool #4 would need to be reconfigured to drain towards Pool #6, and a pump station would need to be constructed to dewater Pool #6.

- Construct a new pool to the north of Pool #6, between the Calumet Union Southwest Tributary and 171st Street at the Oak Hill Toll Park. At 13.4 acres and 55 feet deep, the pool would provide approximately 150 acre feet of storage.

- Add a diversion structure at 171st Street to divert flow from either Pool #6 or the forebay, and gravity pipes to drain the new pool into Pool #6.

The Robey Street Diversion Conduit improvement project component includes the removal of the existing 7.5-foot and 5-foot concrete pipe and construction of two (2) new 12-foot by 8-foot box culverts. The diversion would reduce flows and stages downstream by diverting flow north to the Little Calumet River.

Table 3.2.11 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CUDD-G1.

Table 3.2.11: Alternative Condition Flow & WSEL Comparison for Problem Group CUDD-G1

Location	Station	Existing Conditions		Alternative CUDDG1-A8	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
80' downstream of 171st Street	Cherry Creek 1 7644.381	622.04	909	621.05	501
Wolcott Avenue	CUDD2 15702	608.37	624	603.89	40
Upstream of Highway 1	CUDD1 8542	605.31	1,202	603.17	591

3.2.3.1.6 Data Required for Countywide Prioritization of Watershed Projects

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.12** lists the alternative analyzed in detail. The recommended alternative consists of expansion of and improvements to the Calumet Union Reservoir and upsizing the Robey Street Diversion Conduit. **Figure 3.2.2** 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 3.2.12: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CUDD-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
CUDD-G1	CUDDG1-A8	Reservoir expansion and upsizing of conduit	0.03	$5,782,000	$165,318,000	1,065 Structures	Positive	Markham, Harvey, Hazel Crest

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

3.2.3.2 CUDD-G2 – Calumet Union Drainage Ditch Problem Group 2

3.2.3.2.1 Problem Definition, CUDD-G2

The CUDD-G2 problem group consists of overbank flooding in Markham and Harvey as well as the unincorporated area between the Tri-State Tollway and Dixie Highway. In this reach, 100-year flows, ranging between 442 cfs at the Tri-State Tollway to 640 cfs at Dixie Highway, exceed the capacity of the channel. Flooding in this area impacts approximately 20 properties. This area is shown as flooding on the current FEMA DFIRMs. The flood protection elevation varies between 607.62 feet at Artesian Avenue and 607.0 feet upstream of Dixie Highway.

3.2.3.2.2 Damage Assessment, CUDD-G2

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD 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 percent of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.2.13** lists the estimated damages for the problem group.

Table 3.2.13: Estimated Damages for CUDD Subwatershed, Problem Group CUDD-G2

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CUDD-G2	Property	$3,789,000	Structures at risk of flooding
	Transportation	$668,560	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.2.3 Technology Screening, CUDD-G2

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.14** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.14: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CUDD-G2

Flood Control Option	Feasibility
Detention Facilities	Feasible and necessary
Conveyance Improvement – Culvert/Bridge Replacement	Not adequate to address flooding
Conveyance Improvement – Channel Improvement	Not adequate to address flooding
Conveyance Improvements – Diversion	Feasible and necessary to divert to storage
Flood Barriers, Levees/Floodwalls	Not feasible due to stage increases downstream

3.2.3.2.4 Alternative Development, CUDD-G2

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 3.2.15** summarizes flood control alternatives developed for Problem Group CUDD-G2.

Table 3.2.15: Flood Control Alternatives for Problem Group CUDD-G2

Alternative	Location	Description
CUDDG2-A1	Edward C. Howell Reservoir	Create new storage pool adjacent to the Edward C. Howell Reservoir. The new storage pond would be approximately 450 ac-ft with a surface area of 18.5 ac and depth of 59 ft. The reservoir was purposely separated from the existing reservoir (as opposed to expanding the existing reservoir) to provide for separate operations for CUDD versus CUDD Southwest. During a detailed design, it may be possible to combine the existing and proposed pools after a more detailed analysis of the operations Construct diversion conduit from Tri-State Tollway to the new storage pool adjacent to the Edward C. Howell Reservoir. Includes construction of two (2) 1,500 LF, 12 ft by 3 ft culverts to divert flow from the Tollway to a new pumped storage reservoir

Table 3.2.15: Flood Control Alternatives for Problem Group CUDD-G2

Alternative	Location	Description
CUDDG2-A2	Various sections, CUDD	Construct levees and/or floodwalls to prevent overbank flooding. Traditional and set-back levees were both found to increase stages downstream. To not increase stages downstream, set-back levees would require significant acquisitions that were not considered feasible
CUDDG2-A3	Robey Street Diversion Conduit	Divert flood flows to the Robey Street Diversion Conduit. This resulted in increased stages along CUDD due to the Robey Street Diversion Conduit flowing over capacity

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

3.2.3.2.5 Alternative Evaluation and Selection, CUDD-G2

Alternatives included in **Table 3.2.15** 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 3.2.17** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative. 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 CUDDG2-A1 from **Table 3.2.15** is the preferred alternative for this Problem Group. The CUDD-G2 alternative analysis focused on reducing stages at CUDD2, specifically between the Tri-State Tollway and Dixie Highway. A diversion at the Tri-State Tollway to a new pumped storage pond adjacent to the Edward C. Howell Reservoir prevents flooding in the problem area. This alternative does not necessarily corresponded to a significant reduction in flows, since lowering the stage results in flow reversals near the CUDD Southwest confluence. A significant amount of storage is required since a reduction in stage is needed over a long period.

Table 3.2.16 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CUDD-G2.

Table 3.2.16: Alternative Condition Flow & WSEL Comparison for Problem Group CUDD-G2

Location	Station	Existing Conditions		Alternative CUDDG2-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
300' u/s Artesian Ave	CUDD5 1475	608.77	342	607.62	191
u/s Dixie Hwy	CUDD4 16821	608.49	636	607.00	552

3.2.3.2.6 Data Required for Countywide Prioritization of Watershed Projects, CUDD-G2

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.17** lists the alternative analyzed in detail. The recommended alternative consists of the construction of a 450 acre-foot detention facility adjacent to the Edward C. Howell Reservoir, with a diversion conduit to divert flow from CUDD near the Tri-State Tollway. **Figure 3.2.3** 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 3.2.17: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CUDD-G2

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
CUDD-G2	CUDDG2-A1	Construct 450 ac-ft detention basin with diversion culverts	0.07	$3,377,000	$50,406,000	20 Structures	Positive	Markham, Harvey, Unincorporated Cook

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

3.2.3.3 CUDD-G3 – Calumet Union Drainage Ditch Problem Group 3

3.2.3.3.1 Problem Definition, CUDD-G3

The CUDD-G3 problem area consists of severe streambank erosion and overbank flooding in Markham between Springfield Avenue and Central Park. In this reach, 100-year flows are approximately 150 cfs. Flooding and erosion in this area impact approximately 60 properties. This area is not shown as flooding on the current FEMA DFIRMs since the FIS was only completed up to the culvert entrance at Central Park. The flood protection elevation is approximately 623 feet at Lawndale Avenue, where the majority of flooding occurs.

3.2.3.3.2 Damage Assessment, CUDD-G3

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD 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 percent of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.2.18** lists the estimated damages for the problem group.

Table 3.2.18: Estimated Damages for CUDD Subwatershed, Problem Group CUDD-G3

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CUDD-G3	Property	$972,458	Structures at risk of flooding and erosion
	Transportation	$171,610	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.3.3 Technology Screening, CUDD-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 3.2.19** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.19: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CUDD-G3

Flood Control Option	Feasibility
Detention Facilities	No space available
Conveyance Improvement – Culvert/Bridge Replacement	Would need to improve Central Park Avenue resulting in stage increases downstream
Conveyance Improvement – Channel Improvement	Not adequate to address flooding due to restriction at Central Avenue
Conveyance Improvements – Diversion	Not feasible due to downstream enclosed conduit
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.2.3.3.4 Alternative Development, CUDD-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 3.2.20** summarizes flood control alternatives developed for Problem Group CUDD-G3.

Table 3.2.20: Flood Control Alternatives for Problem Group CUDD-G3

Alternative	Location	Description
CUDDG3-A1	Vicinity of Lawndale Avenue and Central Park Avenue	Increase capacity of channel in vicinity of area where overbank flooding occurs. Channel conveyance alone was not sufficient to prevent flooding between Lawndale Avenue and Central Park Avenue, mainly due to the restriction at Central Park Avenue. Improvement of the Central Park Avenue culvert will result in stage increases downstream
CUDDG3-A2	East of Hamlin Avenue to Central Park Avenue	Construct a 4-ft high floodwall from east of Hamlin Avenue to Central Park Avenue. Ideally, the floodwall could be constructed in combination with channel restoration and erosion protection to provide an aesthetic flood reduction structure. Performed in combination with streambank stabilization alternative (see **Table 3.2.21**)
CUDDG3-A3	Between Crawford Avenue and Central Avenue	Enclose CUDD in a culvert between Crawford Avenue and Central Avenue. This alternative will increase stages downstream

Streambank Stabilization Alternatives. **Table 3.2.21** summarizes streambank stabilization control alternatives developed for Problem Group CUDD-G3.

Table 3.2.21: Streambank Stabilization Alternatives for Problem Group CUDD-G3

Alternative	Location	Description
CUDDG3-A2	East of Hamlin Avenue to Central Park Avenue	Channel rehabilitation, culvert retrofits, and permanent erosion protection measures along the channel reach. Performed in combination with flood control alternative (see **Table 3.2.20**).

3.2.3.3.5 Alternative Evaluation and Selection, CUDD-G3

Alternatives included in **Tables 3.2.20** and **3.2.21** 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 3.2.23** 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 CUDD-G3-A2 from **Table 3.2.20** and **Table 3.2.21** is the preferred alternative for this problem group. Alternative CUDD-G3-A2 focused on resolving the erosion and flooding problem between Sunset Avenue and Central Park Avenue in Markham. Significant erosion has occurred in the past few years, especially between Sunset Avenue and Hamlin Avenue. Erosion has resulted in damage to two homes' foundations, widening of the creek, and weakening of culvert headwalls. Without proper protection, erosion will continue at these locations and propagate downstream. Given that erosion protection between Sunset Avenue and Hamlin Avenue may result in accelerated erosion downstream, erosion protection has been proposed between Sunset Avenue and Central Park Avenue. Overbank flooding begins shortly downstream of Hamlin Avenue and continues to Central Park Avenue. The proposed alternative includes a 4-foot high concrete floodwall along both banks. This provides flood protection during the 100-year event. An earthen levee was considered impractical due to limited space.

Table 3.2.22 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CUDD-G3.

Table 3.2.22: Alternative Condition Flow & WSEL Comparison for Problem Group CUDD-G3

Location	Station	Existing Conditions		Alternative CUDDG3-A2	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of Springfield	CUDD5 11934	633.22	153	631.36	124
Upstream of Hamlin	CUDD5 11406	630.49	168	630.08	169
Upstream of Lawndale Ave	CUDD5 10563	625.55	191	626.19[1]	160

[1]Levee provides protection.

3.2.3.3.6 Data Required for Countywide Prioritization of Watershed Projects, CUDD-G3

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.23** lists the alternative analyzed in detail. The recommended alternative consists of construction of a concrete floodwall from Hamlin Avenue to Central Park Avenue, and erosion protection between Sunset Avenue and Central Park Avenue. **Figure 3.2.4** 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 3.2.23: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CUDD-G3

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures Protected	Water Quality Benefit	Involved Community
CUDD-G3	CUDDG3-A2	4 ft high floodwall with erosion protection, including culvert retrofit and channel rehabilitation	0.40	$1,144,000	$2,852,000	60 Structures	Positive	Markham

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

3.2.3.4 CUSW-G1 – Calumet Union Drainage Ditch Southwest Problem Group 1

3.2.3.4.1 Problem Definition, CUSW-G1

The CUSW-G1 problem area consists of roadway overtopping and overbank flooding from Holmes Avenue to the Tri-State Tollway. In this reach, 100-year flows of 1,130 cfs generally exceed the capacity of the channel and the culvert crossing on California Avenue. There is overtopping of two critical access roads and I-80. This problem area was not shown on the recent DFIRM floodplain maps. The flood protection elevation in this reach would be 629.0 feet at California Avenue. Flood protection elevations were developed based on the roadway elevation.

3.2.3.4.2 Damage Assessment, CUSW-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD 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 percent of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.2.24** lists the estimated damages for the problem group.

Table 3.2.24: Estimated Damages for CUDD Subwatershed, Problem Group CUSW-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CUSW-G1	Property	$0	
	Transportation	$15,000	California Avenue overtopped for 0.06 days during the 100-year storm; Holmes Avenue overtopped less than 0.5 ft; I-80 overtopped for 0.14 days during the 100-year storm
	Recreation	$0	

3.2.3.4.3 Technology Screening, CUSW-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 3.2.25** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.25: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CUSW-G1

Flood Control Option	Feasibility
Detention Facilities	Unnecessary given alternative
Conveyance Improvement – Culvert/Bridge Replacement	Feasible to retrofit California Avenue
Conveyance Improvement – Channel Improvement	Unnecessary given alternative
Conveyance Improvements – Diversion	Unnecessary given alternative-
Flood Barriers, Levees/Floodwalls	Unnecessary given alternative

3.2.3.4.4 Alternative Development, CUSW-G1

Flood Control Alternatives. An alternative solution to regional flooding problems was developed and evaluated consistent with the methodology described in **Section 1.4** of this report. **Table 3.2.26** summarizes the flood control alternative developed for Problem Group CUSW-G1.

Table 3.2.26: Flood Control Alternatives for Problem Group CUSW-G1

Alternative	Location	Description
CUSWG1-A1	California Avenue	Retrofit the existing culvert with five (5) 10-ft x 6-ft (or equivalent) culverts. This reduces stages to 628.31 ft at California Avenue and 631.18 ft at Holmes Avenue upstream. Since the flood protection stage is 629 ft, this suggests that fewer or smaller culverts may be possible and should be assessed during a detailed design

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

3.2.3.4.5 Alternative Evaluation and Selection, CUSW-G1

The alternative included in **Table 3.2.26** 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 3.2.28** provides a summary B/C ratio, net benefits, total project costs, number of structures protected, and other relevant alternative data for the preferred alternative.

Alternative CUSWG1-A1 from **Table 3.2.26** is the preferred alternative for this problem group. By retrofitting the existing culvert with five (5) 10-foot x 6-foot (or equivalent) culverts, stages are reduced to 628.31 feet at California Avenue and 631.18 feet at Holmes Avenue upstream. This brings the maximum water surface elevation at California Avenue below the flood protection elevation of 629.0 feet.

Table 3.2.27 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CUSW-G1.

Table 3.2.27: Alternative Condition Flow & WSEL Comparison for Problem Group CUSW-G1

Location	Station	Existing Conditions		Alternative CUSWG1-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of California Avenue	CUSW 8321	630.58	1,080	628.13	1,130
Downstream of California Avenue	CUSW 8200	628.52	1,076	627.80	1,130
Upstream of Holmes Avenue	CUSW 9652	631.91	1,085	631.18	1,101
Downstream of Holmes Avenue	CUSW 9492	630.87	1,060	629.84	1,101

3.2.3.4.6 Data Required for Countywide Prioritization of Watershed Projects, CUSW-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.28** lists the alternative analyzed in detail. The recommended alternative consists of the upgrading California Avenue crossing over CUDD Southwest Brach. **Figure 3.2.5** 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 3.2.28: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CUSW-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
CUSW-G1	CUSWG1-A1	Upgrade crossing	0.03	$15,000	$536,000	1 Roadway	No Impact	Hazel Crest

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

3.2.3.5 CUSW-G2 – Calumet Union Drainage Ditch Southwest Problem Group 2

3.2.3.5.1 Problem Definition, CUSW-G2

The CUSW-G2 problem group consists of roadway overtopping at Kedzie Avenue. The 100-year flow of 1,039 cfs exceeds the culvert capacity at Kedzie Avenue. The flood protection stage would be 636.0 feet.

3.2.3.5.2 Damage Assessment, CUSW-G2

Damages were defined following the protocol defined by the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD 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 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.2.29** lists the estimated damages for the problem group.

Table 3.2.29: Estimated Damages for CUDD Subwatershed, Problem Group CUSW-G2

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CUSW-G2	Property	$0	
	Transportation	$6,000	Kedzie Avenue overtopped 0.12 days during the 100-year event
	Recreation	$0	

3.2.3.5.3 Technology Screening, CUSW-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 3.2.30** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.30: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CUSW-G2

Flood Control Option	Feasibility
Detention Facilities	Unnecessary given alternative
Conveyance Improvement – Culvert/Bridge Replacement	Feasible but not ideal given alternatives
Conveyance Improvement – Channel Improvement	Does not address the constriction at Kedzie Avenue
Conveyance Improvements – Diversion	Feasible
Flood Barriers, Levees/Floodwalls	Not feasible

3.2.3.5.4 Alternative Development, CUSW-G2

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 3.2.31** summarizes flood control alternatives developed for Problem Group CUSW-G2.

Table 3.2.31: Flood Control Alternatives for Problem Group CUSW-G2

Alternative	Location	Description
CUSWG2-A1	Kedzie Avenue	Replace existing crossing with a crossing with a larger hydraulic opening to increase conveyance capacity
CUSWG2-A2	Kedzie Avenue	Construct a diversion culvert parallel to Kedzie Avenue, 8 ft by 6 ft and 860 LF long to increase conveyance capacity

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

3.2.3.5.5 Alternative Evaluation and Selection, CUSW-G2

Alternatives included in **Table 3.2.31** 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 3.2.33** 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 CUSWG2-A2 from **Table 3.2.31** is the preferred alternative for this problem group. This alternative focused on reducing stages upstream of Kedzie Avenue and at I-80. To do so, stages need to be reduced to 636.0 feet upstream of Kedzie Avenue. This alternative was preferred to replacing the existing culvert because it prevents the need for modifications to Kedzie Avenue.

Table 3.2.32 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CUSW-G2.

Table 3.2.32: Alternative Condition Flow & WSEL Comparison for Problem Group CUSW-G2

Location	Station	Existing Conditions		Alternative CUSWG2-A2	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Upstream of Kedzie Avenue	CUSW 11920	636.60	809	635.81	733
Downstream of Kedzie Avenue	CUSW 10993	633.31	807	633.02	733

3.2.3.5.6 Data Required for Countywide Prioritization of Watershed Projects, CUSW-G2

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.33** lists the alternative analyzed in detail. The recommended alternative consists of construction a diversion culvert parallel to Kedzie Avenue. **Figure 3.2.6** 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 3.2.33: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CUSW-G2

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
CUSW-G2	CUSWG2-A2	Additional culvert parallel to Kedzie Avenue	< 0.01	$6,000	$1,206,000	1 Roadway	No Impact	Hazel Crest

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

3.2.3.6 CUTS-G1 – CUDD Southwest Branch Tributary S Problem Group 1

3.2.3.6.1 Problem Definition, CUTS-G1

The CUTS-G1 problem group consists of overbank flooding in the area adjacent to the Calumet Union Drainage Ditch Southwest Branch Tributary S (CUTS) at the upstream end, generally corresponding to Baker Avenue from 186th Street to 185th Street. In this reach, 100-year flows of 45 cfs generally exceed the channel capacity, causing flows to back up into the low overbank area. There is flooding of approximately 10 building structures and overtopping of two roadway crossings, both of which are local roads. This problem area was shown on the recent DFIRM floodplain maps, but flooding was not as significant as suggested by the existing conditions hydraulic model developed for this study. The flood protection elevation in this reach would be 699.5 feet. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.2.3.6.2 Damage Assessment, CUTS-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD 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 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.2.34** lists the estimated damages for the problem group.

Table 3.2.34: Estimated Damages for CUDD Subwatershed, Problem Group CUTS-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CUTS-G1	Property	$53,423	Structures at risk of flooding
	Transportation	$9,428	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.6.3 Technology Screening, CUTS-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 3.2.35** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.35: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CUTS-G1

Flood Control Option	Feasibility
Detention Facilities	Not feasible since reducing stages in the creek is not feasible. The creek is only 2 ft deep at the 100-year stage
Conveyance Improvement – Culvert/Bridge Replacement	Same as above
Conveyance Improvement – Channel Improvement	Same as above
Conveyance Improvements – Diversion	Same as above
Flood Barriers, Levees/Floodwalls	Feasible given that the problem is not that stages are too high in the creek, but that a low overbank area exists

3.2.3.6.4 Alternative Development, CUTS-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 3.2.36** summarizes flood control alternatives developed for Problem Group CUTS-G1.

Table 3.2.36: Flood Control Alternatives for Problem Group CUTS-G1

Alternative	Location	Description
CUTSG1-A1	Baker Avenue	Construct a 945 LF, 4-ft high earthen levee adjacent to the flooded properties along Baker Avenue

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

3.2.3.6.5 Alternative Evaluation and Selection, CUTS-G1

The alternative included in **Table 3.2.36** 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 3.2.38** 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 CUTSG1-A1 from **Table 3.2.36** is the preferred alternative for this problem group. A levee or floodwall was the only solution considered to be feasible, given that the cause of flooding is due to the low elevations adjacent to Baker Avenue. The 100-year depth in the creek is only 2 feet, which means any reduction in stage is not feasible. A small earthen levee would protect homes while maintaining a reasonable stage in the creek. A 945 linear-foot, 4-foot high earthen levee adjacent to the flooded properties would prevent overbank flooding during the 100-year event. At 4 feet high, the levee would provide approximately 3 feet of freeboard.

Table 3.2.37 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CUTS-G1.

Table 3.2.37: Alternative Condition Flow & WSEL Comparison for Problem Group CUTS-G1

Location	Station	Existing Conditions		Alternative CUTSG1-A1	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
350' South of 185th Street	4747.33	700.0	45	700.0[1]	45

[1]Levee provides protection.

3.2.3.6.6 Data Required for Countywide Prioritization of Watershed Projects, CUTS-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.38** lists the alternative analyzed in detail. The recommended alternative consists of constructing an earthen levee adjacent to flooded properties. **Figure 3.2.7** 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 3.2.38: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CUTS-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
CUTS-G1	CUTSG1-A1	Earthen levee	0.02	$63,000	$2,917,000	10 Structures, 2 Roadway	No Impact	Country Club Hills

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

3.2.3.7 CHEB-G1 – Cherry Creek East Branch Problem Group 1

3.2.3.7.1 Problem Definition, CHEB-G1

The CHEB-G1 problem group consists of overbank and roadway flooding along Cherry Creek East Branch, from near Governors Highway to approximately 500 feet upstream. In this reach, 100-year flows of 580 cfs generally exceed the capacity of the channel, flooding homes on the right bank and overtopping Governors Highway on the left bank. Governors Highway is also overtopped further upstream near 183rd Street. Along this reach, there is flooding of approximately 16 building structures and overtopping of 2 roadway crossings. This problem area was shown on the recent DFIRM floodplain maps. The flood protection elevation in this reach would be 635.36 feet. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.2.3.7.2 Damage Assessment, CHEB-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD 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 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.2.39** lists the estimated damages for the problem group.

Table 3.2.39: Estimated Damages for CUDD Subwatershed, Problem Group CHEB-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CHEB-G1	Property	$144,614	Structures at risk of flooding
	Transportation	$25,520	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.7.3 Technology Screening, CHEB-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.40** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.40: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CHEB-G1

Flood Control Option	Feasibility
Detention Facilities	Inline storage was considered feasible as part of conveyance improvements, but a large pumped storage reservoir was considered infeasible due to size
Conveyance Improvement – Culvert/Bridge Replacement	Feasible given the need to reduce stages
Conveyance Improvement – Channel Improvement	Feasible given the need to reduce stages
Conveyance Improvements – Diversion	Infeasible given availability of other alternatives
Flood Barriers, Levees/Floodwalls	Infeasible given availability of other alternatives

3.2.3.7.4 Alternative Development, CHEB-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 3.2.41** summarizes flood control alternatives developed for Problem Group CHEB-G1.

Table 3.2.41: Flood Control Alternatives for Problem Group CHEB-G1

Alternative	Location	Description
CHEBG1-A1	Hillcrest Park	Provide overbank storage in Hillcrest Park
CHEBG1-A2	Ravisloe Country Club to 175th Street	Channel improvements, including widening and deepening
CHEBG1-A3	Governors Highway and 175th Street crossings	Replace crossings with larger hydraulic openings
CHEBG1-A4	Hillcrest Park, Ravisloe Country Club to 175th Street, Governors Highway and 175th Street crossings	Provide overbank storage, channel improvements, and replace two crossings (combination of Alternatives CHEBG1-A1, CHEBG1-A2 and CHEBG1-A3)

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

3.2.3.7.5 Alternative Evaluation and Selection, CHEB-G1

Alternatives included in **Table 3.2.41** 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 3.2.43** 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 CHEBG1-A4 from **Table 3.2.41** is the preferred alternative for this problem group. This problem group can be addressed by improving the channel conveyance between the Ravisloe Golf Course and 175th Street, including culvert improvements, channel improvements, and storage at Hillcrest Park.

Table 3.2.42 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CHEB-G1.

Table 3.2.42: Alternative Condition Flow & WSEL Comparison for Problem Group CHEB-G1

Location	Station	Existing Conditions		Alternative CHEBG1-A4	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
30' upstream of Governors Hwy	Cherry Creek East 1 1309.79	636.79	557	635.36	580

3.2.3.7.6 Data Required for Countywide Prioritization of Watershed Projects, CHEB-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.43** 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 3.2.8** 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 3.2.43: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CHEB-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
CHEB-G1	CHEBG1-A4	Channel improvements, replace two crossings, in-line storage	0.05	$170,000	$3,300,000	16 Structures, 2 Roadway	No Impact	Homewood, Hazel Crest

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

3.2.3.8 CHEB-G2 – Cherry Creek East Branch Problem Group 2

3.2.3.8.1 Problem Definition, CHEB-G2

The CHEB-G2 problem area consists of a single apartment building impacted by flooding at Chayes Court. This problem area was shown on the recent DFIRM floodplain maps. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.2.3.8.2 Damage Assessment, CHEB-G2

Damages were not calculated since the proposed alternative for CHEB-G2 is non-structural floodproofing or acquisition only.

3.2.3.8.3 Technology Screening, CHEB-G2

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.44** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.44: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CHEB-G2

Flood Control Option	Feasibility
Detention Facilities	Unnecessary given non-structural alternative
Conveyance Improvement – Culvert/Bridge Replacement	Unnecessary given non-structural alternative
Conveyance Improvement – Channel Improvement	Unnecessary given non-structural alternative
Conveyance Improvements – Diversion	Unnecessary given non-structural alternative
Flood Barriers, Levees/Floodwalls	Unnecessary given non-structural alternative

3.2.3.8.4 Alternative Development, CHEB-G2

Flood Control Alternatives. No flood control alternatives were developed for the isolated structure.

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

3.2.3.8.5 Alternative Evaluation and Selection, CHEB-G2

The preferred alternative for this problem is floodproofing or acquisition. For the single residential structure, although the flood stage is below the flood protection stage, the inundation area overlaps the structure. While floodproofing was generally not considered as primary solution for the DWP, in this case it is recommended.

3.2.3.9 CHEB-G3 – Cherry Creek East Branch Problem Group 3

3.2.3.9.1 Problem Definition, CHEB-G3

The CHEB-G3 problem area consists of roadway overtopping at Governors Highway and Braemar Road, as well as overbank flooding of homes along Braemar Road. Flood protection stages are approximately 668.2 feet at 60 feet upstream of Governor's Highway. There is flooding of approximately 9 building structures and overtopping of 2 roadway crossings, one of which is an arterial roadway. This problem area was shown on the recent DFIRM floodplain maps. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.2.3.9.2 Damage Assessment, CHEB-G3

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD 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 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.2.45** lists the estimated damages for the problem group.

Table 3.2.45: Estimated Damages for CUDD Subwatershed, Problem Group CHEB-G3

Problem Group ID	Damage Category	Estimated Damage ($)	Description
CHEB-G3	Property	$6,528,000	Structures at risk of flooding
	Transportation	$1,152,000	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.9.3 Technology Screening, CHEB-G3

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.46** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.46: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group CHEB-G3

Flood Control Option	Feasibility
Detention Facilities	Inline storage was considered infeasible due to size and land availability
Conveyance Improvement – Culvert/Bridge Replacement	Feasible
Conveyance Improvement – Channel Improvement	Feasible but would require permanent easements and one acquisition
Conveyance Improvements – Diversion	Not feasible due to hydraulics
Flood Barriers, Levees/Floodwalls	Not feasible due to space constraints and flooding of both overbanks

3.2.3.9.4 Alternative Development, CHEB-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 3.2.47** summarizes flood control alternatives developed for Problem Group CHEB-G3.

Table 3.2.47: Flood Control Alternatives for Problem Group CHEB-G3

Alternative	Location	Description
CHEBG3-A1	Braemer Road and Governors Highway	Channel conveyance improvements; Replace Governors Highway crossing with (6) 8 ft x 4 ft culverts and the Braemer Road crossing with (4) 8 ft x 4 ft culverts (or equivalent)
CHEBG3-A2	Along channel from Homewood-Flossmoor HS to intersection of Braemer Road and Governors Highway	Channel improvements to widen and deepen the channel. This alternative would require 9 permanent easements and 1 acquisition
CHEBG3-A3	Braemer Road and Governors Highway crossings and along channel from Homewood-Flossmoor HS to Braemer Road/ Governors Highway intersection	Replace culverts at Braemer Road and Governors Highway; widen and deepen channel (combination of Alternatives CHEBG3-A1 and CHEBG3-A2)

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

3.2.3.9.5 Alternative Evaluation and Selection, CHEB-G3

Alternatives included in **Table 3.2.47** 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 3.2.49** 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 CHEBG3-A3 from **Table 3.2.47** is the preferred alternative for this problem group. The alternative analysis focused on reducing stages along Governors Highway and Braemer Road. The proposed alternative is to provide channel and culvert improvements. To obtain adequate capacity, these modifications may require acquisition of one property at Braemer Road and Governors Highway.

Table 3.2.48 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for CHEB-G3.

Table 3.2.48: Alternative Condition Flow & WSEL Comparison for Problem Group CHEB-G3

Location	Station	Existing Conditions		Alternative CHEBG3-A3	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
60' upstream of Governors Hwy	Cherry Creek East 1a 10491.10	668.71	254	667.71	256

3.2.3.9.6 Data Required for Countywide Prioritization of Watershed Projects, CHEB-G3

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.49** 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 3.2.10** 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 3.2.49: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group CHEB-G3

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
CHEB-G3	CHEBG3-A3	Channel widening and culvert improvements	3.37	$7,680,000	$2,282,000	9 Structures, 2 Roadways	No Impact	Homewood

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

3.2.3.10 BLCR-G1 – Belaire Creek Problem Group 1

3.2.3.10.1 Problem Definition, BLCR-G1

The BLCR-G1 problem area consists of overbank flooding in the area adjacent to Belaire Creek from approximately Albany Avenue to Afton Avenue. In this reach, 100-year flows of 11 cfs exceed the capacity of the channel, since the channel is a small ditch with significant vegetation. There is flooding of approximately 15 building structures. This problem area was shown on the recent DFIRM floodplain maps. The flood protection elevation in this reach would be 606.32 feet. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.2.3.10.2 Damage Assessment, BLCR-G1

Damages were defined following the protocol defined in the CCSMP. A critical duration analysis was performed to determine the highest flood stages for CUDD 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 percent of the property damages, unless otherwise noted. Recreation damages were estimated based on depth and duration of flooding. **Table 3.2.50** lists the estimated damages for the problem group.

Table 3.2.50: Estimated Damages for CUDD Subwatershed, Problem Group BLCR-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
BLCR-G1	Property	$1,949,000	Structures at risk of flooding
	Transportation	$343,950	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.10.3 Technology Screening, BLCR-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.51** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.51: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group BLCR-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible and necessary to reduce stage increases from levee
Conveyance Improvement – Culvert/Bridge Replacement	Modification of the Tri-State Tollway crossing did not reduce stages significantly, and increased stages downstream
Conveyance Improvement – Channel Improvement	Not feasible due to sensitive nature of the Markham Prairie. In addition, channel improvements did not reduce stages enough to prevent flooding
Conveyance Improvements – Diversion	Feasible to reduce stages upstream of the Tollway, diverted to a pumped storage pond
Flood Barriers, Levees/Floodwalls	Feasible and necessary

3.2.3.10.4 Alternative Development, BLCR-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 3.2.52** summarizes flood control alternatives developed for Problem Group BLCR-G1.

Table 3.2.52: Flood Control Alternatives for Problem Group BLCR-G1

Alternative	Location	Description
BLCRG1-A1	Upstream end of channel to I-294	Channel improvements from the upstream end to I-294. This does not reduce stages adequately, and channel improvements would disturb the Markham Prairie area
BLCRG1-A2	I-294 culvert crossing	Upgrade I-294 culvert crossing. This does not reduce stages adequately. When completed in conjunction with Alternative 1, stages would not be adequately reduced, and stages would increase downstream
BLCRG1-A3	Cherry Creek at upstream end of I-294	Construct a 4-ft high, 42-ft wide, 1,100-ft long earthen levee along Belaire Creek from Albany Avenue to Afton Avenue

Table 3.2.52: Flood Control Alternatives for Problem Group BLCR-G1

Alternative	Location	Description
BLCRG1-A4	Cherry Creek at upstream end of I-294	Construct a 10.5 acre surface area, 15-ft deep, 125 ac-ft pumped storage area located downstream of I-294 and a 700-ft long, double 10 ft by 3 ft diversion culvert from the channel to the pond. Diversion was considered from either side of the Tollway, but found to be more effective from the upstream side
BLCRG1-A5	Upstream end of channel to I-294, I-294 culvert crossing	Channel improvements and upgrade of I-294 culvert crossing (combination of Alternatives BLCRG1-A1 and BLCRG1-A2). This alternative did not reduce stages adequately and caused stage increases downstream. In addition, any channel modifications would disturb the Markham Prairie area
BLCRG1-A6	Cherry Creek at upstream end of I-294	Construct earthen levee along Belaire Creek along with a 125 ac-ft pumped storage area (combination of Alternatives BLCRG1-A3 and BLCRG1-A4)

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

3.2.3.10.5 Alternative Evaluation and Selection, BLCR-G1

Alternatives included in **Table 3.2.52** 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 3.2.54** 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 BLCRG1-A6 from **Table 3.2.52** is the preferred alternative for this problem group. This problem area can be addressed by constructing an earthen levee to prevent flooding of the overbank areas. A levee would require compensatory storage unless flood easements could be purchased.

Table 3.2.53 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for BLCR-G1.

Table 3.2.53: Alternative Condition Flow & WSEL Comparison for Problem Group BLCR-G1

Location	Station	Existing Conditions		Alternative BLCRG1-A6	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Albany Avenue	Belaire Creek 5777	607.50	12	606.91	26

3.2.3.10.6 Data Required for Countywide Prioritization of Watershed Projects, BLCR-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.54** 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 3.2.11** 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 3.2.54: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group BLCR-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
BLCR-G1	BLCRG1-A6	Levee and pumped storage area	0.17	$2,293,000	$13,842,000	15 Structures	Positive	Markham

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

3.2.3.11 PKCR-G1 – Park Creek Problem Group 1

3.2.3.11.1 Problem Definition, PKCR-G1

The PKCR-G1 problem area consists of two areas of overbank flooding. The first is along Park Creek from Birch Road to Homan Avenue. In this reach, 100-year flows of 185 cfs generally exceed the capacity of the channel. This section has flooding of approximately 53 building structures. This problem area was shown on the recent DFIRM floodplain maps. The flood protection elevation in this reach would be 609.0 feet.

The second area is along Park Creek from Kedzie Avenue to I-57. In this reach, 100-year flows of 108 cfs generally exceed the capacity of the channel. This area has flooding of approximately 6 building structures. This problem area was shown on the recent DFIRM floodplain maps. The flood protection elevation in this reach would be 607.58 feet. Flood protection elevations were developed based on field reconnaissance of the area based on typical residential structures.

3.2.3.11.2 Damage Assessment, PKCR-G1

Damages were defined following the protocol defined in the CCSMP. Critical duration analysis was performed to determine the highest flood stages for CUDD 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 percent of the property damages, unless otherwise noted. Recreational damages were estimated based on depth and duration of flooding. **Table 3.2.55** lists the estimated damages for the problem group.

Table 3.2.55: Estimated Damages for CUDD Subwatershed, Problem Group PKCR-G1

Problem Group ID	Damage Category	Estimated Damage ($)	Description
PKCR-G1	Property	$4,510,000	Structures at risk of flooding
	Transportation	$676,560	Assumed as 15% of property damage due to flooding
	Recreation	$0	

3.2.3.11.3 Technology Screening, PKCR-G1

Several combinations of technologies were analyzed to address the flooding problems at this location. Flood control technologies from the CCSMP were considered as potential solutions for the regional flooding problems. **Table 3.2.56** summarizes the evaluation of these technologies in terms of their potential feasibility for this problem group.

Table 3.2.56: Evaluation of Flood Control Technologies for CUDD Subwatershed, Problem Group PKCR-G1

Flood Control Option	Feasibility
Detention Facilities	Feasible and necessary to prevent flooding and stage increases from proposed levee
Conveyance Improvement – Culvert/Bridge Replacement	Feasible from Kedzie to I-57, in conjunction with other alternatives
Conveyance Improvement – Channel Improvement	Feasible from Kedzie to I-57, in conjunction with other alternatives
Conveyance Improvements – Diversion	Feasible at the upstream end of Park Creek
Flood Barriers, Levees/Floodwalls	Feasible if done in conjunction with other alternatives

3.2.3.11.4 Alternative Development, PKCR-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 3.2.57** summarizes flood control alternatives developed for Problem Group PKCR-G1.

Table 3.2.57: Flood Control Alternatives for Problem Group PKCR-G1

Alternative	Location	Description
PKCRG1-A1	Upstream end of Park Creek	Construct a 200 ac-ft pumped detention facility at the upstream end of the reach to reduce stages and prevent increases from a levee
PKCRG1-A2	Park Creek from Kedzie to I-57	Implement channel and culvert improvements. Conveyance improvements alone do not reduce stages enough, but they are useful in minimizing stage increase due to a levee
PKCRG1-A3	Park Creek from Kedzie to I-57	Construct a 1,000 LF earthen levee between Kedzie Avenue and I-57 to prevent overbank flooding. With detention and conveyance improvements alone, overbank flooding still occurs. This must be done in conjunction with Alternatives 1 and 2 to prevent any stage increases along or downstream of the levee

Table 3.2.57: Flood Control Alternatives for Problem Group PKCR-G1

Alternative	Location	Description
PKCRG1-A4	Park Creek from Kedzie to I-57	Construct a 200 ac-ft pumped detention facility along with channel and culvert improvements and a 1,000 LF earthen levee (combination of Alternatives PKCRG1-A1, PKCRG1-A2 and PKCRG1-A3)

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

3.2.3.11.5 Alternative Evaluation and Selection, PKCR-G1

Alternatives included in **Table 3.2.57** 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 3.2.59** 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 PKCRG1-A4 from **Table 3.2.57** is the preferred alternative for this problem group. This project combination was the only combination deemed feasible to prevent flooding in both problem areas. While detention alone solves the upstream problem, it does not adequately address the downstream problem. A levee alone, from Kedzie Avenue to I-57, would prevent overbank flooding downstream, but cause stage increases as well. Therefore, the feasible alternative is a combination of all three technologies. An 11.5 acre surface area, 25-foot deep, 200 acre-foot pumped storage reservoir with a side channel spillway is proposed at the upstream end of Park Creek. Channel improvements between Kedzie Avenue and I-57 include channel widening and culvert improvements. A 1,000-foot-long, 3-foot-high and 34-foot-wide earthen levee is proposed parallel to the residential roadway paralleling the creek.

Table 3.2.58 provides a comparison of the modeled water surface elevation and modeled flow at the time of peak for PKCR-G1.

Table 3.2.58: Alternative Condition Flow & WSEL Comparison for Problem Group PKCR-G1

Location	Station	Existing Conditions		Alternative PKCRG1-A4	
		Max WSEL (ft)	Max Flow (cfs)	Max WSEL (ft)	Max Flow (cfs)
Roesner Drive	Park Creek 3793	610.30	196	608.84	41
Between Kedzie Avenue and I-57	Park Creek 763.5	608.76	108	608.46	79

3.2.3.11.6 Data Required for Countywide Prioritization of Watershed Projects, PKCR-G1

Appendix I presents conceptual level cost estimates for the recommended alternative. **Table 3.2.59** 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 3.2.12** 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 3.2.59: CUDD Project Alternative Matrix to Support District CIP Prioritization for Problem Group PKCR-G1

Group ID	Alternative ID	Description	B/C Ratio	Net Benefits ($)	Total Project Cost ($)	Cumulative Structures & Roadways Protected	Water Quality Benefit	Involved Community
PKCR-G1	PKCRG1-A4	Detention facility upstream with conveyance improvements and levee downstream	0.26	$5,187,000	$20,327,000	53 structures	Positive	Markham

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

3.2.4 Recommended Alternatives, Calumet Union Drainage Ditch Subwatershed

Table 3.2.60 summarizes the recommended alternatives for the CUDD subwatershed. The District will use data presented here to support prioritization of a countywide stormwater CIP.

Table 3.2.60: CUDD 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
CUDD-G1	CUDDG1-A8	Reservoir expansion and upsizing of conduit	0.03	$5,782,000	$165,318,000	1,065 Structures	Positive	Markham, Harvey, Hazel Crest
CUDD-G2	CUDDG2-A1	Construct 450 ac-ft detention basin with diversion culverts	0.07	$3,377,000	$50,406,000	20 Structures	Positive	Markham, Harvey, Unincorporated Cook
CUDD-G3	CUDDG3-A2	4-ft high floodwall with erosion protection, including culvert retrofit and channel rehabilitation	0.40	$1,144,000	$2,852,000	60 Structures	Positive	Markham
CUSW-G1	CUSWG1-A1	Upgrade 1 crossing	0.03	$15,000	$536,000	1 Roadway	No Impact	Hazel Crest

Table 3.2.60: CUDD 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
CUSW-G2	CUSWG2-A2	Additional culvert parallel to Kedzie Avenue	<0.01	$6,000	$1,206,000	1 Roadway	No Impact	Hazel Crest
CUTS-G1	CUTSG1-A1	Earthen levee	0.02	$63,000	$2,917,000	10 Structures, 2 Roadways	No Impact	Country Club Hills
CHEB-G1	CHEBG1-A4	Channel improvements, replace two crossings, in-line storage	0.05	$170,000	$3,300,000	16 Structures, 2 Roadways	No Impact	Homewood, Hazel Crest
CHEB-G3	CHEBG3-A3	Channel widening and culvert improvements	3.37	$7,680,000	$2,282,000	9 Structures, 2 Roadways	No Impact	Homewood
BLCR-G1	BLCRG1-A6	Levee and pumped storage area	0.17	$2,293,000	$13,842,000	15 Structures	Positive	Markham
PKCR-G1	PKCRG1-A4	Detention facility upstream with conveyance improvements and levee downstream	0.26	$5,187,000	$20,327,000	53 Structures	Positive	Markham

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