City of Greenwood

Stormwater Master Plan

October 2012

ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS

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1 EXECUTIVE SUMMARY

This master plan provides documentation, review, analysis, and recommendations for the City of Greenwood's Stormwater Utility. This master plan was developed as a guide to assist the City in creating a comprehensive plan to fund water quality control, operation and maintenance activities, and capital project and flood control projects that affect the City's current stormwater infrastructure.

The City of Greenwood is located within Johnson County with city limits of East County Line Road to the north; Interstate 65 to the east; East County Road 700 North to the south; and State Route 135 to the west. The city limits do extend slightly beyond Interstate 65 to the east and East County Road 700 North to the south, as detailed in **Figure 1-1** to the right. The City of Greenwood consists of a mix of residential, commercial, industrial, and agricultural properties.

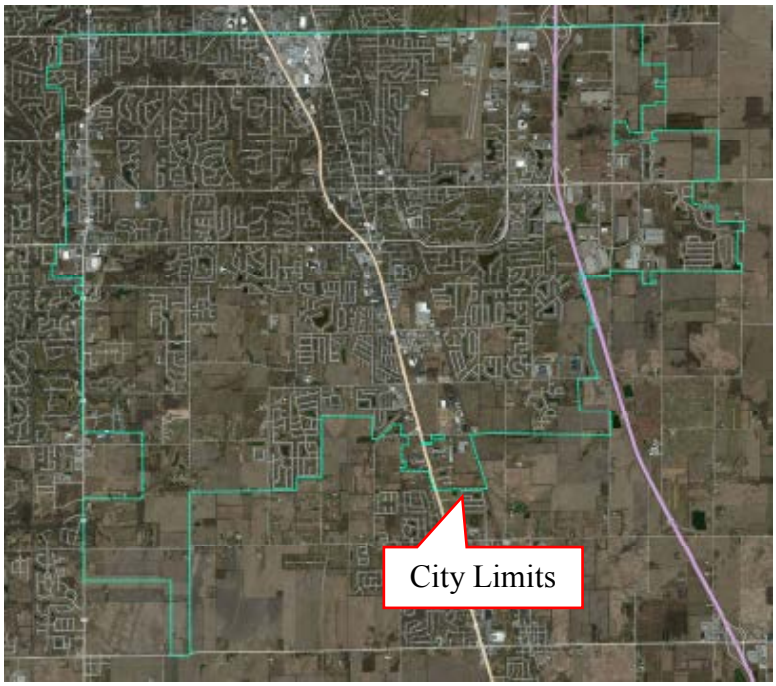
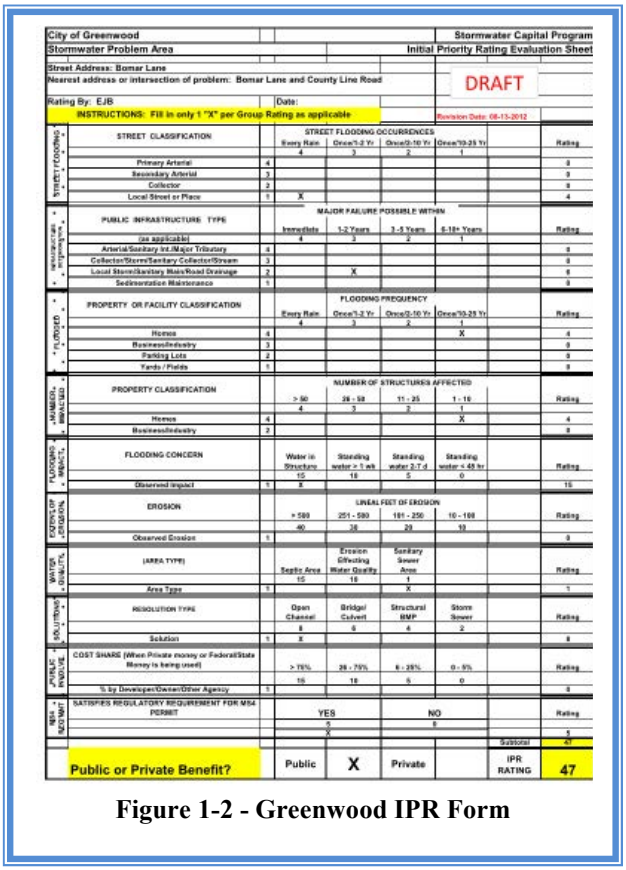


Figure 1-1 - City of Greenwood City Limits

The City staff has identified several areas based upon customer complaint data and knowledge of drainage problems throughout the City. Much of the drainage complaints consist of minor standing water issues, and some rear yard swale issues that could be alleviated with routine maintenance. **Appendix A** provides both a graphical and tabular presentation of the customer complaints. These complaints were evaluated and used as part of the master planning process to determine capital and maintenance needs. One of the main goals of this master plan is to identify projects that are potential capital projects and identify smaller problematic areas that can be completed through yearly operation and maintenance (O&M) practices.

In order to assist with a determination of prioritizing the capital projects that were identified as part of this plan an initial priority rating (IPR) was developed to assist the City in ranking the capital and maintenance projects recommended within this master plan. Priorities were based upon factors including, but not limited to, severity of issues, type of structures affected, and

solution to the drainage problems. These IPRs were developed through a standard form, which is seen below in **Figure 1-2** and in **Appendix B**.



City of Greenwood — Stormwater Capital Program
Stormwater Problem Area — Initial Priority Rating Evaluation Sheet
Street Address: Bomar Lane
Nearest address or intersection of problem: Bomar Lane and County Line Road
DRAFT
Rating By: EJB | Date:
INSTRUCTIONS: Fill in only 1 "X" per Group Rating as applicable
Revision Date: 08-13-2012

STREET FLOODING — STREET CLASSIFICATION — STREET FLOODING OCCURRENCES

STREET CLASSIFICATION		Every Rain 4	Once/1-2 Yr 3	Once/2-10 Yr 2	Once/10-25 Yr 1	Rating
Primary Arterial	4					0
Secondary Arterial	3					0
Collector	2					0
Local Street or Place	1	X				4

INFRASTRUCTURE — PUBLIC INFRASTRUCTURE TYPE — MAJOR FAILURE POSSIBLE WITHIN

PUBLIC INFRASTRUCTURE TYPE (as applicable)		Immediate 4	1-2 Years 3	3 - 5 Years 2	6-10+ Years 1	Rating
Arterial/Sanitary Int./Major Tributary	4					0
Collector/Storm/Sanitary Collector/Stream	3					0
Local Storm/Sanitary Main/Road Drainage	2		X			0
Sedimentation Maintenance	1					0

FLOODED — PROPERTY OR FACILITY CLASSIFICATION — FLOODING FREQUENCY

PROPERTY OR FACILITY CLASSIFICATION		Every Rain 4	Once/1-2 Yr 3	Once/2-10 Yr 2	Once/10-25 Yr 1	Rating
Homes	4				X	4
Business/Industry	3					0
Parking Lots	2					0
Yards / Fields	1					0

HOMES/BUSINESS IMPACTED — PROPERTY CLASSIFICATION — NUMBER OF STRUCTURES AFFECTED

PROPERTY CLASSIFICATION		> 50 4	26 - 50 3	11 - 25 2	1 - 10 1	Rating
Homes	4				X	4
Business/Industry	2					0

FLOODING IMPACT — FLOODING CONCERN

FLOODING CONCERN		Water in Structure 15	Standing water > 1 wk 10	Standing water 2-7 d 5	Standing water < 48 hr 0	Rating
Observed Impact	1	0				15

EXISTING EROSION — EROSION — LINEAL FEET OF EROSION

EROSION		> 500 40	251 - 500 30	101 - 250 20	10 - 100 10	Rating
Observed Erosion	1					0

WATER QUALITY — (AREA TYPE)

(AREA TYPE)		Septic Area 15	Erosion Affecting Water Quality 10	Sanitary Sewer Area 1		Rating
Area Type	1			X		1

RESOLUTION — RESOLUTION TYPE

RESOLUTION TYPE		Open Channel 8	Bridge/ Culvert 6	Structural BMP 4	Storm Sewer 2	Rating
Solution	1	X				8

FEASIBILITY — COST SHARE (When Private money or Federal/State Money is being used)

COST SHARE (When Private money or Federal/State Money is being used)		> 75% 10	26 - 75% 10	6 - 25% 5	0 - 5% 0	Rating
% by Developer/Owner/Other Agency	1					0

NPDES REQUIRMENT — SATISFIES REGULATORY REQUIREMENT FOR MS4 PERMIT

SATISFIES REGULATORY REQUIREMENT FOR MS4 PERMIT	YES 5	NO 0	Rating
	X		5
		Subtotal	40

Public or Private Benefit?	Public	X	Private	IPR RATING	47

Figure 1-2 - Greenwood IPR Form

It is important to note that the IPR is not the overall deciding factor; it is only one element that will allow the City to quickly identify an individual project's rank within the Stormwater Capital Improvement Program.

IPR's were determined for fifteen (15) areas within the city limits. These areas are shown below in **Table 1-1**, in order of priority ranking. It should be noted that some of the projects have a higher priority ranking than other projects with a higher IPR score. This is due to the fact that some of the projects will offer a greater cost benefit ratio, while other projects had a more significant economic impact. The IPR scores also tend to rank road issues, or those issues affecting multiple residential properties higher, than those affecting a large, single, off-street property. Opinions of probable costs for each project are listed in 2012 dollars. These areas are depicted visually in **Appendix D,** and photos for each project area are shown in **Appendix E.**

Table 1-1 - Summary of Capital and Maintenance Projects

Priority	IPR	Drainage Area Description	Opinion of Probable Total Project Costs (2012 Dollars)
1	93	Pleasant Creek (ACOE Project)	$7,750,000
2	79	John Bonner (Fry Road and Loews Boulevard)	$890,000
3	28	Southern Bowl	$360,000
4	73	Green Valley Neighborhood	$1,570,000
5	62	Tracy Ditch	$1,100,000
6	62	Old City Park	$875,000
7	60	Valle Vista*	$50,000
8	51	Endress Place Development	$140,000
9	59	Northern Park*	$30,000
10	55	Lakeview Additions*	$18,000
11	49	Pleasant Run (Greenwood Mall)	$1,000,000

Priority	IPR	Drainage Area Description	Opinion of Probable Total Project Costs (2012 Dollars)
12	47	Bomar Lane**	$-
13	46	Southern Green	$300,000
14	35	Eden Estates	$190,000
15	26	Country Aire Subdivision*	$300,000
		Misc. City Wide Projects***	$2,500,000
		Parks Educational Project Number 1****	$225,000
		Parks Educational Project Number 2****	$225,000
Total			$17,523,000

*Denotes potential Maintenance Projects
**Project costs will be determined by impact of the selected alternative from the ACOE Project.
***Project costs will be evenly distributed over the entire 10-year period.
****See **Section 8** for potential Parks projects.
Note: Refer to the Stormwater Master Plan for detailed project costs.

Implementation of this master plan will not only help in alleviating flooding occurrences and drainage issues, it will provide a basis for future integration of other city projects, and will also work toward improving the quality of life for the residents of Greenwood.

The remainder of the report is divided up into eleven sections as detailed below:

- Section 2: Background Information
  - Provides the history of the area in regards to the storm sewer system, the waterways and the physical characteristics of the area (i.e. soil types, wetlands, etc.).
- Section 3: Public Input
  - Indentifies the public input process including questionnaires, public official interviews, and public meetings.
- Section 4: Potential Project Areas
  - Details the problems with specific project areas throughout Greenwood, and breaks down the scope of solutions into Capital or Maintenance costs.
- Section 5: Hydrologic/Hydraulic Modeling
  - Describes the modeling process and the parameters used to develop the model. The section will also describe the physical attributes that were included of the City's storm sewer system.
- Section 6: Capital Improvement Alternatives
  - Provides a summary of the capital improvement alternatives being proposed based on the technical, environmental, and financial feasibility.
- Section 7: Maintenance Alternatives

  - Provides a summary of the maintenance alternatives being proposed based on the technical, environmental, and financial feasibility.
- Section 8: Dual Purpose Facilities
  - Provides a summary of the areas that could potentially serve additional purposes beyond providing stormwater detention/retention.
- Section 9: Implementation
  - Provides a summary of the recommended schedule to implement the proposed improvements.
- Section 10: Future Needs and Goals
  - Provides a summary of items that should be addressed in the future.
- Section 11: References
  - Provides a list of references used to help develop this Master Plan Document.

2 BACKGROUND INFORMATION

The City of Greenwood has limits generally to East County Line Road to the north, Interstate 65 to the east, East County Road 700 North to the south, and State Route 135 to the west. The city limits do extend slightly beyond Interstate 65 to the east and East County Road 700 North to the south, as detailed in **Figure 2-1** below. This map, and all the maps presented in this section, can be viewed in **Appendix C**.

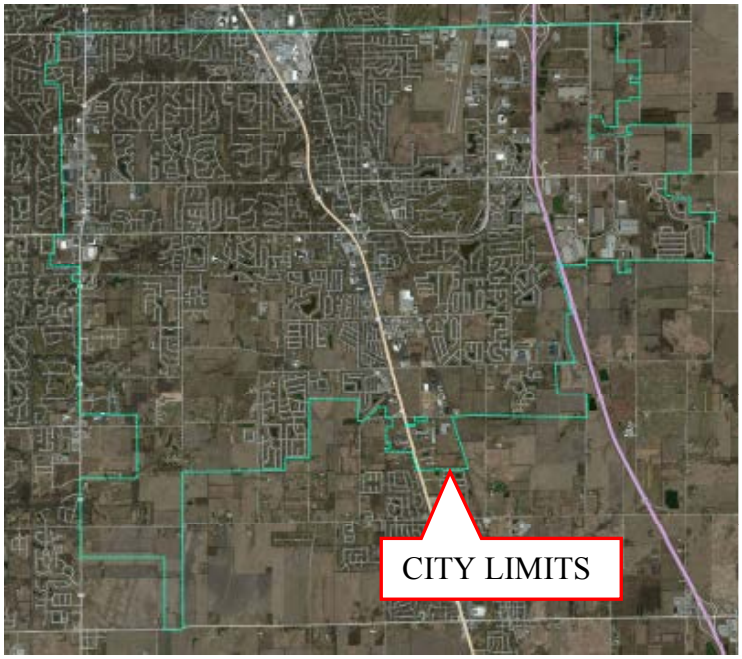


Figure 2-1 - City of Greenwood City Limits

According to the 2010 census there are approximately 19,615 households within Greenwood, and the majority of them are single family residential homes. In addition to the single family residential units, there are several apartment and condominium complexes, schools, and multiple locations for shopping, and commercial/industrial activities located within the City of Greenwood.

2.1 General Condition of Stormwater Infrastructure

The system is comprised of a mix of conventional storm sewers, open ditches, detention basins, and natural features. Much of the system has been expanded since the original construction, and has also seen various forms of repair. These repairs range from complete reconstruction to minor site repairs. During the repairs it was noted that several areas were deteriorating, and in some cases the pipe had either deteriorated or had severe root intrusion. Much of these problems lead to sinkholes forming within the residential yards, or lack of capacity in the pipe. The emergence of sinkholes indicate that the pipe has been infiltrated in some way, and the soil surrounding the pipe is being washed away resulting in a void.

In addition to the deterioration of the system, several areas do not appear to have sufficient capacity to convey frequent storm events. Based upon the feedback received during the initial

field visit with City staff, it was indicated that there were several areas with poor drainage. These areas mainly consisted of residential neighborhoods that were constructed prior to the adoption of the original stormwater ordinance. These areas received minimal storm infrastructure, and where not designed to the more stringent storm sewer standards currently in place. These systems with poor capacity could lead to flooding and standing water on roads, which causes to the infrastructure failing prior to its intended service life. This could potentially lead to additional costs to the City, because of the decreased time between repairing or replacing road infrastructure.

2.2 Watersheds and Storm Sewer Sub-basins

The City of Greenwood is located within multiple watersheds. The northern portion of the City is located within the Pleasant Run Creek Watershed (HUC 051202011206), half of the southern portion of the City is located within the Turkey Pen Creek-Honey Creek Watershed (HUC 051202011401), with the other half the south located within the Grassy Creek-Youngs Creek (HUC 051202040601). Then there are two smaller portions of the City located within the Hurricane Creek Watershed (HUC 051202040602), and the Little Sugar Creek Watershed (HUC 051202040702). These watersheds are identified in **Figure 2-2**.

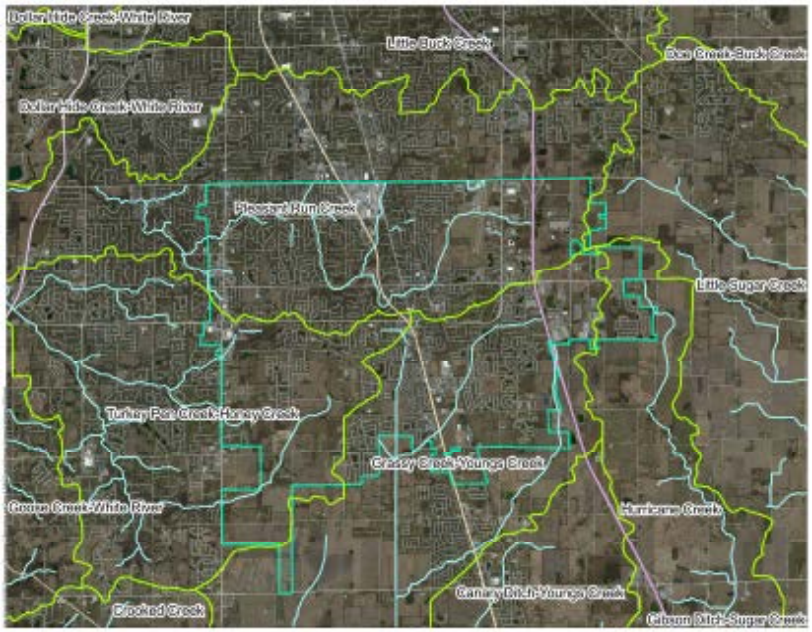


Figure 2-2 - Greenwood Watersheds

The Pleasant Run Creek Watershed is drained via Pleasant Run Creek within the city limits, this watershed ultimately discharges into the White River. The Turkey Pen Creek-Honey Creek Watershed is drained via the Turkey Pen Creek by way of the Honey Creek within the city limits, which ultimately discharges into the White River. The Grassy Creek-Youngs Creek Watershed is drained via the Tracy Ditch by way of the Grassy Creek in the city limits, which ultimately discharges into the Big Blue River. The Hurricane Creek Watershed is drained via Hurricane Creek in the city limits, and ultimately discharges into the Big Blue River. The Little Sugar

Creek Watershed is drained by the Grubbs Ditch within the city limits, which ultimately discharges into the Big Blue River.

2.3 Soil Data

There are numerous soils located throughout the city limits, but there are three that make up over seventy percent (70%) of the soils. These three soils are Brookston silty clay loam (Br), Crosby silt loam (CrA), and Miami silt loam (MnB2). Brookston and Crosby loams are poorly drained, and are not very suitable for infiltrative practices. The Miami loam is more suitable for infiltrative practices, but still not optimal. Soil amendments can be made to increase the capacity of infiltration, but will still be limited by the underlying soil. Soil information for the north and south sides of the City are shown in **Figure 2-10** and **Figure 2-11** respectively. The soils are summarized in **Table 2-1**. The figures and table may be seen at the end of this section.

2.4 Wetlands

Figure 2-12, shown at the end of this section, depicts wetlands based upon the USFWS GIS mapping data. It is not anticipated that any wetlands will be present within any of the project locations; however, this should be verified by the engineer at the time of detailed design.

2.5 Floodplains

There are several projects that lie within the 100-year flood boundary. **Figure 2-13** through **Figure 2-16** show the floodplains located in the Northwest through the Southwest quadrants of the city limits. The following FEMA Firm maps were also referenced throughout this report; 18081C0019D, 18081C0038D, 18081C0039D, 18081C0043D, 18081C0107D, 18081C0126D, 18081C0127D, 18081C0135D, 18081C0128D, 18081C0129D.

2.6 County Regulated Drains

The Johnson County Drainage Board currently has jurisdiction over all regulated drains within the City of Greenwood. According to the Johnson County Surveyor Office the regulated drains within the City limits are; Tracy Ditch, Lee Park, East Grassy, Julia Johnson Tile, Sam Gregg, Sheek, Bagby Tile, Robert Crawford Tile, Scott Tile, Scott-Pruner Tile, Villa Heights, Jennings Tile, Peggs Tile, PR Griffith, and Scott-High bridge.

Currently, property owners residing within a regulated drain watershed are required to pay an assessment to maintain the legal drain. These assessments are set by The Johnson County Drainage Board and are based on the recommendation of the Johnson County Survey Office.

Using these assessments the surveyor is to provide for periodic maintenance and repair for each regulated drain.

According to the Indiana Code IC-36-9-27-20, the Drainage Board has the ability to relinquish its jurisdiction over ditches and drains located within the City or sanitary district. For instance, the City currently has an interlocal agreement with the Johnson County Drainage board to construct the Southeast Interceptor Project. This project consists of the construction of interceptor sewers within the public legal drain, Tracy Ditch. The agreement between the Drainage Board, the Johnson County Surveyor and the City of Greenwood, which is made available in **Appendix J**, allows the City to receive assessment fees collected by the County. In turn, the City has jurisdiction over the Tracy Ditch and its maintenance. Similar agreements may be needed to improve additional regulated drains and construct additional stormwater improvements within the City of Greenwood. Such an agreement may be a practical alternative for other regulated drain improvements in the City.

2.7 Other Applicable Regulations

The United States Army Corps of Engineers (USACOE), Indiana Department of Environmental Management (IDEM), and Indiana Department of Natural Resources (IDNR) have regulating authority over the ditches and creeks, as they may be considered waters of the United States. They generally carry with them Ordinary High Water Marks (OHWMs), which needs to be delineated by a local agency and confirmed by the USACOE. Any activities involving cleaning, dredging, culvert replacement or obstruction removal within the ditches and creeks will require permits.

2.8 Historical Flooding

There have been several flooding events in the history of Greenwood; however, the most recent event occurred in the late spring of 2008. This flooding was a result of several factors throughout the state. Preceding the flooding the central and southern portions of the State were hit fairly hard with precipitation, and as a result the Ohio River and its tributaries were at or near capacity. Then during 4th and 7th of June, the area was hit extremely hard by precipitation, with some areas receiving over 10 inches of rainfall over several hours on the 7th. According to National Oceanic and Atmospheric Administration's (NOAA) historical data, this period created the highest known flood crest elevation for several stream gauges. Unfortunately there are no stream gauges within the City of Greenwood, or within close proximity, to accurately depict the actual flood elevations; however, there are two within Johnson & Marion Counties that provide the best available information on how severe the flooding actually was in Greenwood. The stream gauge in Youngs Creek (Gauge Number AMTI3), which is located on the south side of Franklin, Indiana, recorded a flood crest of 15.67 feet above creek bottom. This flood level is the highest

Figure 2-3 - Old City Park Flooding

on record, which dates back to 1952. This flood level was over 2 feet higher than the previous record. The stream gauge in Little Buck Creek (Gauge Number LBCI3), which is located just north of the intersection between SR 37 and Southport Road, recorded a flood crest of 13.21 feet above creek bottom. This flood level is the highest on record, which dates to 1990.

This flooding downstream from Greenwood, as well as the high amount of precipitation lead to the eventual flooding within the city limits. Severe flooding occurred within the Old City Park area, which required Machledt Drive to be closed down. This area also suffered property damage to several tennis courts and several buildings located in the "bowl" area of the park. **Figure 2-3** shows a comparison shot between a pedestrian bridge during the flooding, and a photograph that was taken during the field visit. This bridge was completely destroyed as it was dislodged from its foundation, and carried downstream. Several other parks were flooded during this event as well. Northwest Park and Westside Park were both under significant amount of flood water during the June 2008 event. **Figure 2-4** and **Figure 2-5** show the levels during the flood for Northwest Park and Westside Park respectively.

Figure 2-4 - Westside Park Flooding

Figure 2-5 - Northwest Park Flooding

The Sweetgrass Subdivision, which is located just north of the intersection between South Emerson Avenue and CR E 750 N, received significant flooding as well; however, this flooding did not result in the flooding of any homes. This did make vehicular travel difficult, where the water depths could possible disable vehicles. **Figure 2-6** show some of the flooding throughout the Sweetgrass Neighborhood. Greenwood Pines and Olive Branch Manor, as well as several other neighborhoods, received various amounts of flooding during the June event.

Figure 2-6 – Intersection of Shenandoah Way & Bentgrass Drive

Figure 2-7 – Intersection of Stop 18 & US 31

Some major intersections were required to be shut down as well. The intersection between Stop 18 Road and US 31 was shut due to flooding, which is shown in **Figure 2-7**. Based upon the image, it appears as though some sections of the road were under as much as eighteen (18) inches of water. Another intersection that was severely flooded and was required to be closed was that of Madison Avenue and Greenwood Park Drive E, which is one of the main entrances to the Greenwood Mall. This area saw the flood waters enter into several business on the east side of Madison Avenue, which is shown in **Figure 2-8**. These businesses received damage during the flooding, and several of the businesses had to shut down due to the flooding.

In additional to several major intersections, several road segments were shut down, or were made to be extremely dangerous with the rising flood waters. Peterman Road, which carries traffic north and south from Olive Branch Road to W Stop 11, was shut down north of Fairview Road. **Figure 2-9** shows this road closure, and gives an indication of how deep the flood waters got along this road.

Figure 2-8 – Madison Avenue Business Flooding

Figure 2-9 – Peterman Road Flooding

The areas presented within this section are only a small portion of the total area affected by the June 2008 flooding, and do not depict the entirety of the flooding the City of Greenwood received. The areas that were presented within this section only help to present a small portion of the total damage to the City of Greenwood during the June 2008 flooding event.

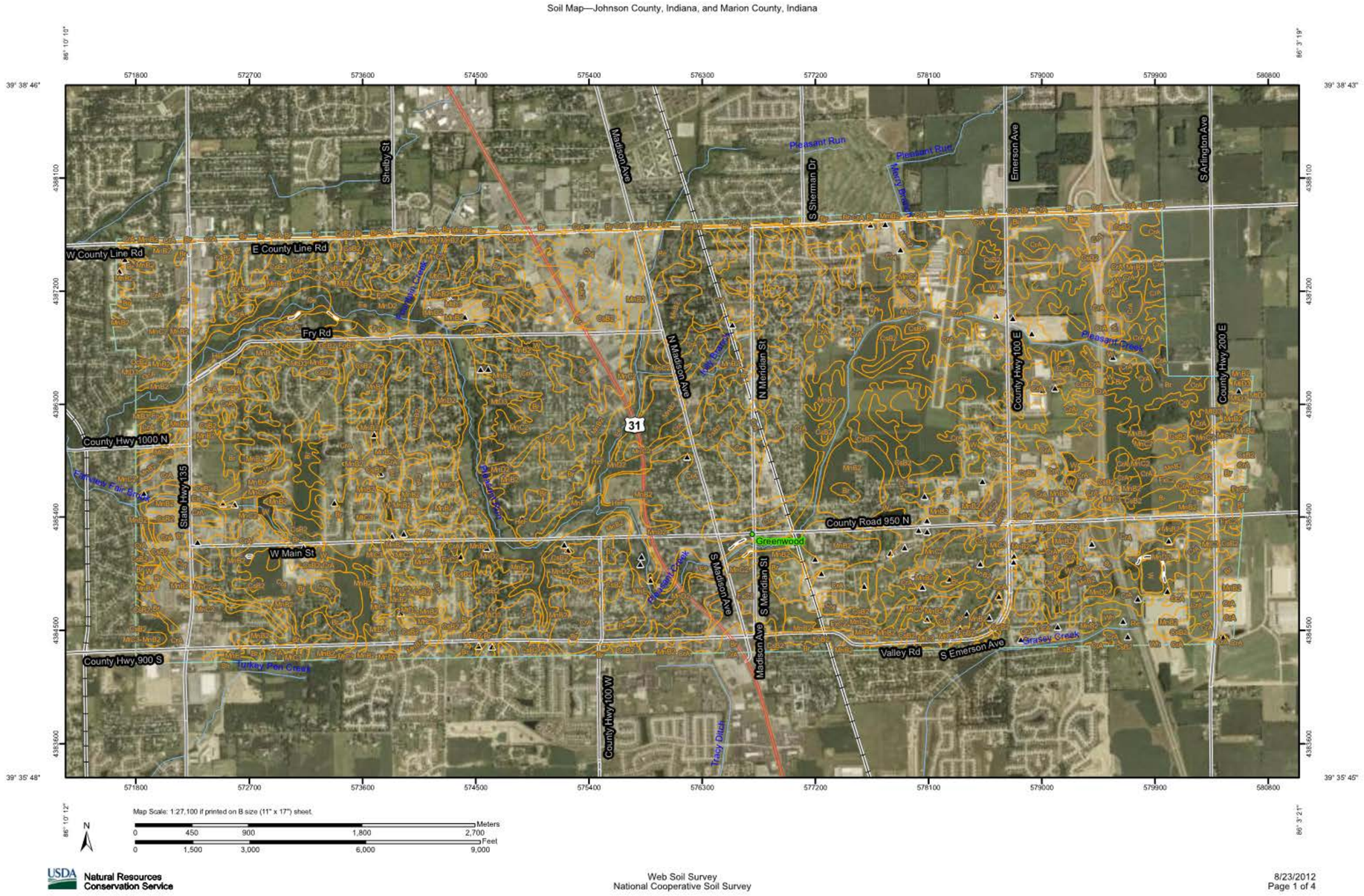


Figure 2-10 - City of Greenwood Soils Map-North

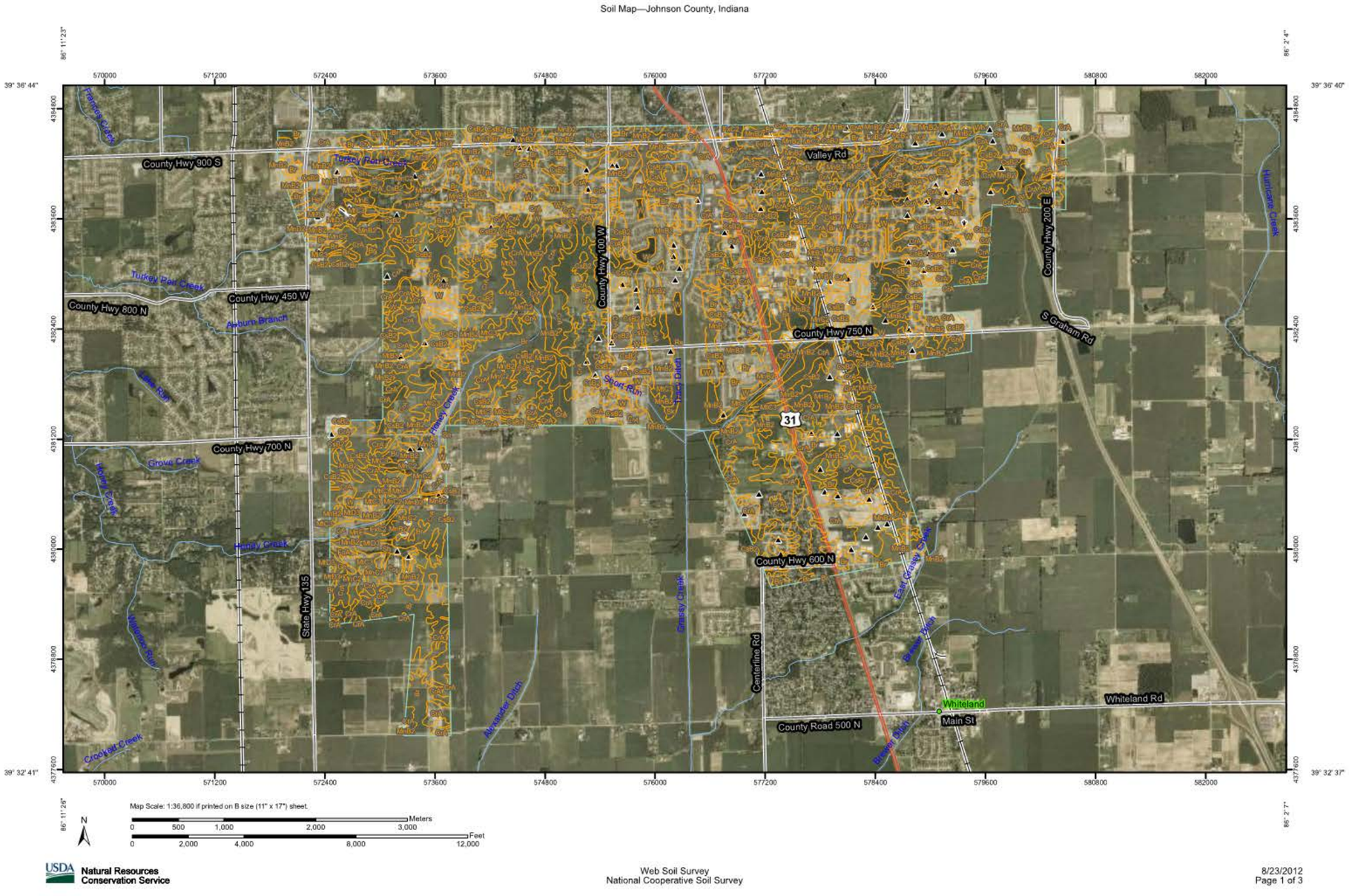


Figure 2-11 - City of Greenwood Soils Map-South

Table 2-1 - Greenwood Soils Descriptions

		North		South		Combined	
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI	Acres in AOI	Percent of AOI	Acres in AOI	Percent of AOI
Br	Brookston silty clay loam	1805.5	24.6%	2373.6	33.0%	4179.1	28.8%
CrA	Crosby silt loam, 0 to 2 percent slopes	2711.3	37.0%	2735.7	38.1%	5447.0	37.5%
CsB2	Crosby-Miami silt loams, 2 to 4 percent slopes	331.5	4.5%	462.2	6.4%	793.7	5.5%
Ee	Eel silt loam	169	2.3%	36.1	0.5%	205.1	1.4%
FoA	Fox loam, 0 to 2 percent slopes	17	0.2%	4.8	0.1%	21.8	0.2%
FoB2	Fox loam, 2 ro 4 percent slopes	25.6	0.3%	20.7	0.3%	46.3	0.3%
FxC2	Fox complex, 6 to 12 percent slopes, eroded	70.5	1.0%	18.9	0.3%	89.4	0.6%
Ge	Genesee loam	229.1	3.1%	40.1	0.6%	269.2	1.9%
HeF	Hennepin loam, 25 to 50 percent slopes	45.1	0.6%	11.5	0.2%	56.6	0.4%
MnB2	Miami silt loam, 2 to 6 percent slopes, eroded	1145.4	15.6%	543.2	7.6%	1688.6	11.6%
MnC2	Miami silt loam, 6 to 12 percent slopes, eroded	158.2	2.2%	75.5	1.1%	233.7	1.6%
MnD2	Miami silt loam, 12 to 18 percent slopes, eroded	109.1	1.5%	45.8	0.6%	154.9	1.1%
MnE	Miami silt loam, 18 to 25 percent slopes	20.7	0.3%	20.1	0.3%	40.8	0.3%
MtB3	Miami clay loam, 2 to 6 percent slopes, severly eroded	9.4	0.1%	15.9	0.2%	25.3	0.2%
MtC3	Miami clay loam, 6 to 12 percent slopes, severly eroded	140.1	1.9%	167.1	2.3%	307.2	2.1%
MtD3	Miami clay loam, 12 to 18 percent slopes, severly eroded	47.1	0.6%	35.2	0.5%	82.3	0.6%
OcA	Ockley loam, 0 to 2 percent slopes	66.7	0.9%	6.7	0.1%	73.4	0.5%
OcB2	Ockley loam, 2 to 6 percent slopes, eroded	14.2	0.2%	2.2	0.0%	16.4	0.1%
Re	Rensselaer silty clay loam	135	1.8%	407.5	5.7%	542.5	3.7%
Sh	Shoals silt loam	0.5	0.0%	35.5	0.5%	36.0	0.2%
Sn	Sleeth loam			4.3	0.1%	4.3	0.0%
Sk	Sloan clay loam			27.9	0.4%	27.9	0.2%
Ua	Udorthents, cut and filled	1.7	0.0%		0.0%	1.7	0.0%
W	Water	67.1	0.9%	89.1	1.2%	156.2	1.1%
Wh	Whitaker silt laom	9.4	0.1%	4.7	0.1%	14.1	0.1%
	Total	7329.2	100.0%	7184.3	100.0%	14513.5	1

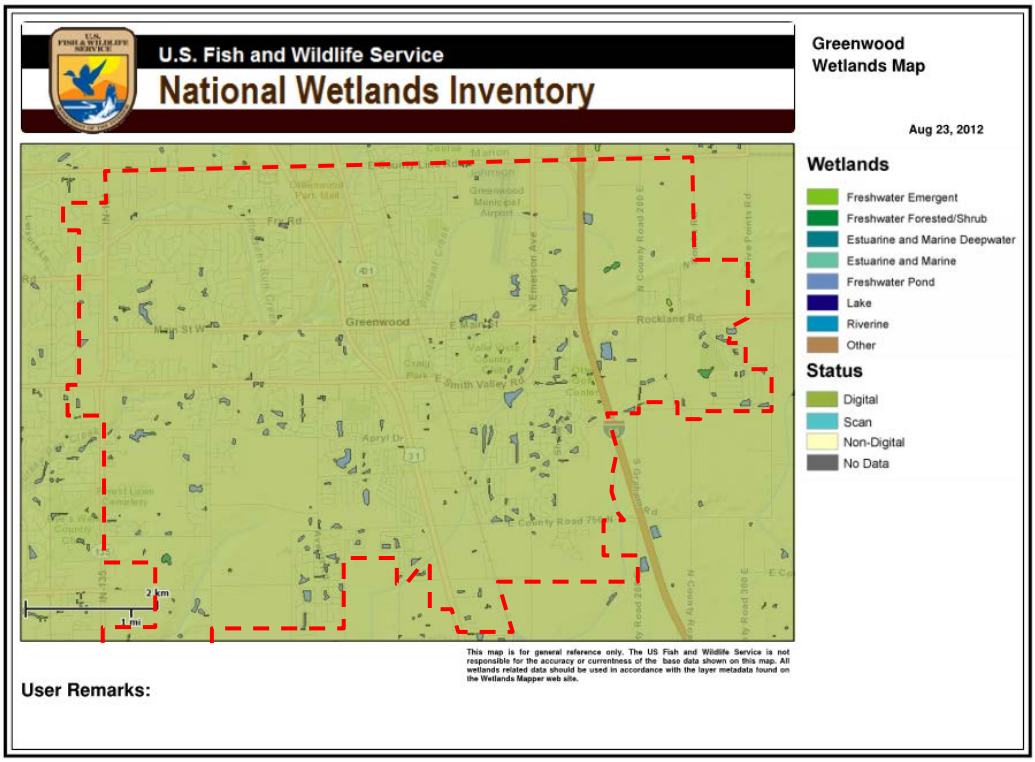


Figure 2-12 - National Wetland Inventory Map

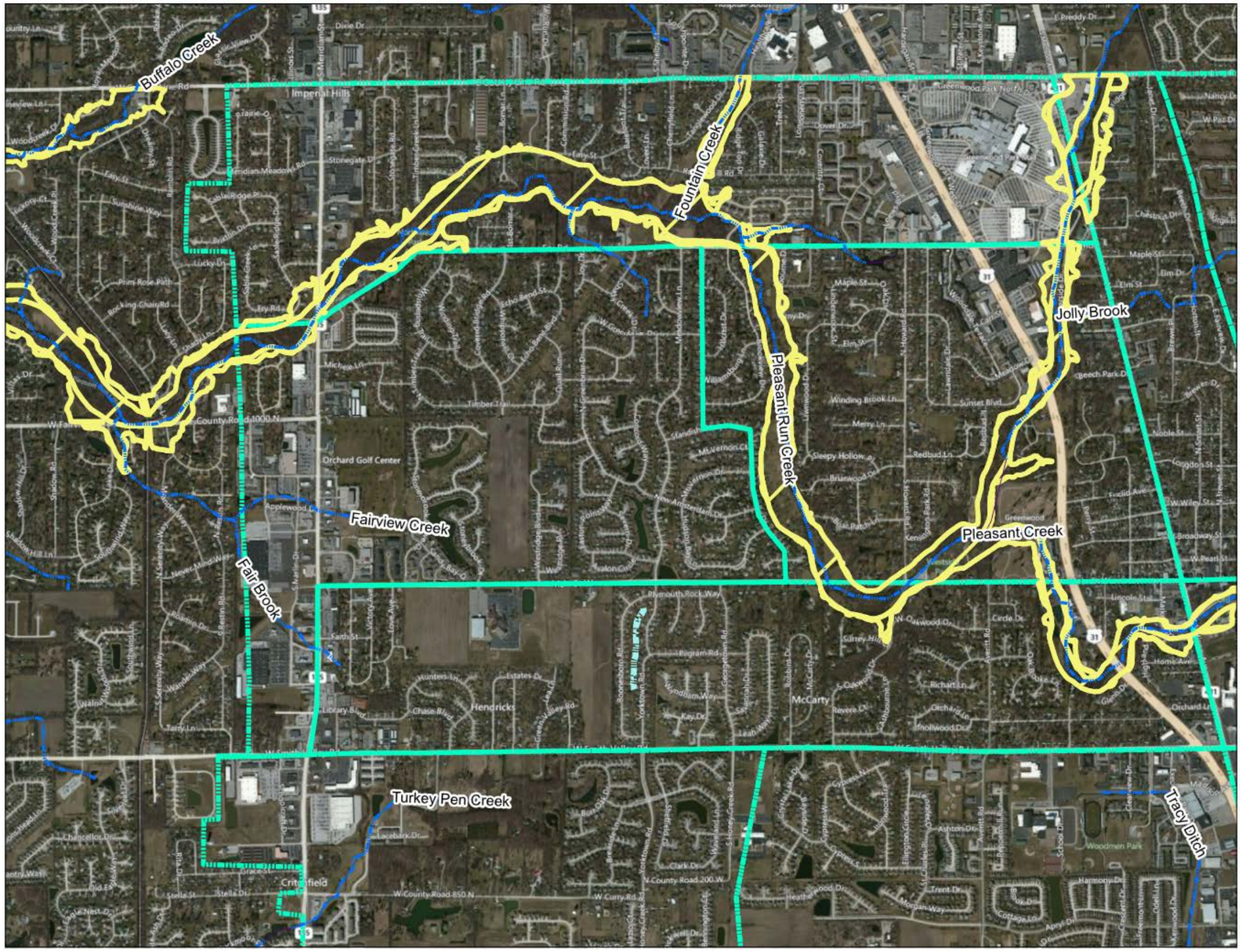


Figure 2-13 - Northwest Greenwood Flood Zones

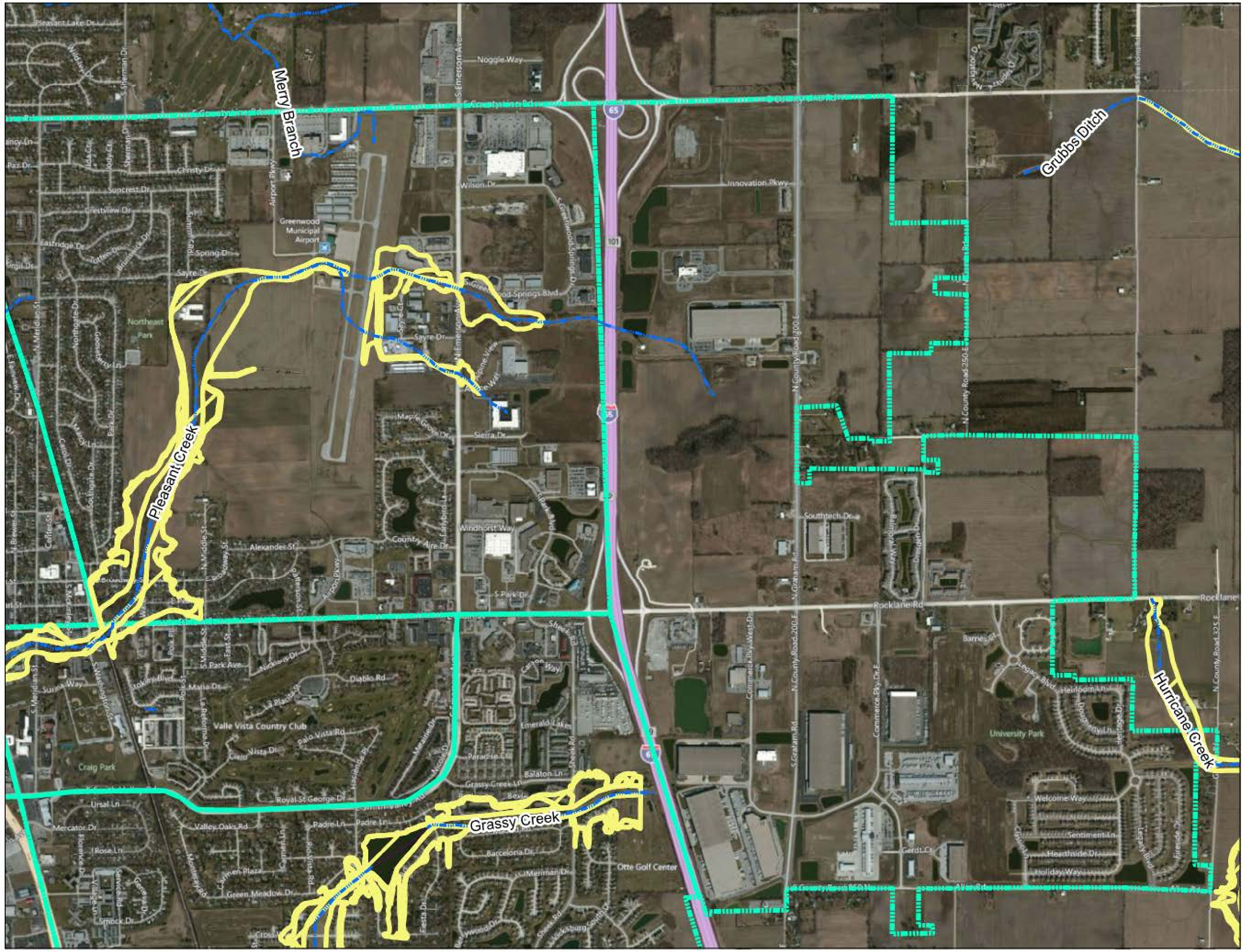


Figure 2-14 - Northeast Greenwood Flood Zones

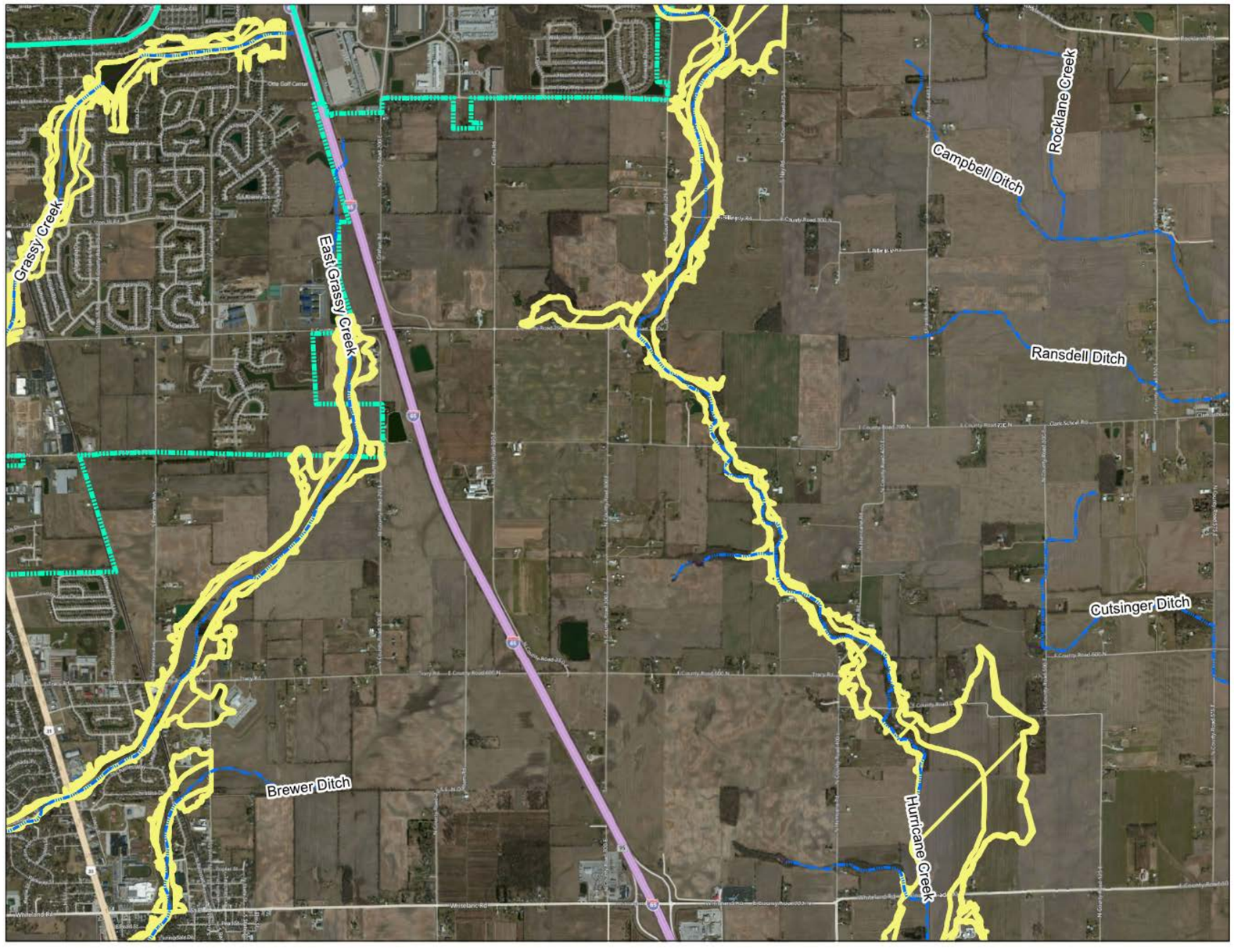


Figure 2-15 - Southeast Greenwood Flood Zones

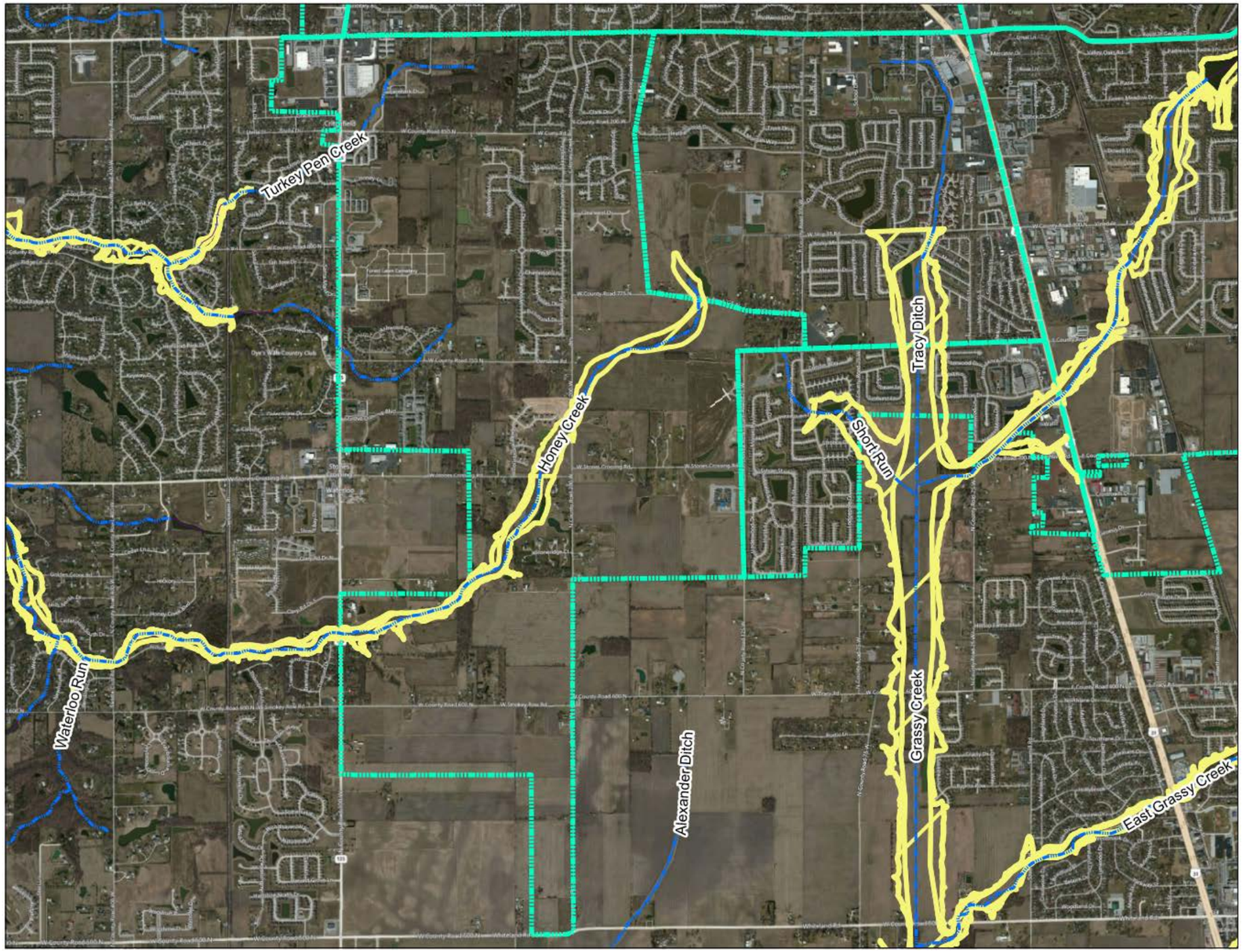


Figure 2-16 - Southwest Greenwood Flood Zones

3 PUBLIC INPUT

Several components of public input were obtained and included in the development of this report. This mainly consisted of public meetings held on behalf of the City of Greenwood. The first meeting was of the Stormwater Board, which was held on July 5, 2012. This meeting was an informal presentation to discuss the establishment of the Stormwater Department, and the establishment of the User Fees.

The next meeting held was for the Stormwater Advisory Committee (SWAC), which was held on August 16, 2012. This meeting was to inform local residents and business owners of what exactly the SWAC was, and what their responsibilities are. The SWAC's responsibilities are to provide feedback on stormwater issues from findings and decisions the Stormwater Department has made, and to represent the stormwater program service area, which consists of residents and business owners. They will also be responsible for the community education and outreach initiatives of the stormwater program. The meeting also discussed the Stormwater Program, and the projected Stormwater User Fee implementation.

The next meeting of the SWAC was held on September 20, 2012, and this meeting discussed the stormwater credit program. This program will establish various credits for non-residential property owners, which will reduce their User Fees by a set amount. This program will also help establish the appeals process, for what the property owners believe are incorrect service charges. Additional SWAC meetings will be held throughout the year, which will help to better inform the public of the Stormwater Program activities, and the findings of this Stormwater Master Plan document.

Public outreach will also be held in Town Hall Meeting formats. These meetings will be held on October 20th, October 25th, and November 3rd. These meetings will reach out to the public and inform them of the proposed implementation of the Stormwater User Fees, and the establishment of the Stormwater Department.

4 DRAINAGE IMPROVEMENT PROJECT AREAS

Staff from the City of Greenwood Engineering and Stormwater departments sent DLZ a list of 20 project areas. These project areas were based upon consistent customer complaints, and known drainage problems. DLZ and several City personnel then visited these sites to discuss the current drainage problems facing the areas, and the possible solutions to these problems. Two of the areas were removed from consideration in the Master Plan, because completed or current projects have solved the drainage problems. The following sections generally describe the drainage problems as they were observed during the site visits, and from input from the City staff. **Table 4-1** is a list of the projects that are to be discussed in the following sections, and also provides the priority ranking that was developed from the IPRs and feedback from City Staff. **Figure 4-1** provides a graphical description of where all the projects are located at. **Figure 4-2** is a general legend for all images presented here. This figure should provide some clarity to what the figures are depicting. Full 11x17 figures are attached in **Appendix D**, and photos from the field visit can be seen in **Appendix E**.

Table 4-1 - Greenwood Projects

City of Greenwood Project Areas	
Project Name	**Priority Ranking**
Bomar Lane	12
Cottonwood (Tracy Ditch)	5
Country Aire	15
Endress Place Development	8
Eden Estates	14
Green Valley Neighborhood	4
John Bonner (Fry Road & Loews Boulevard)	2
Lakeview Additions	10
Northern Park	9
Old City Park	6
Pleasant Creek Field (ACOE Project)	1
Pleasant Run (Greenwood Mall)	11
Southern Bowl	3
Southern Green	13
Valle Vista	7

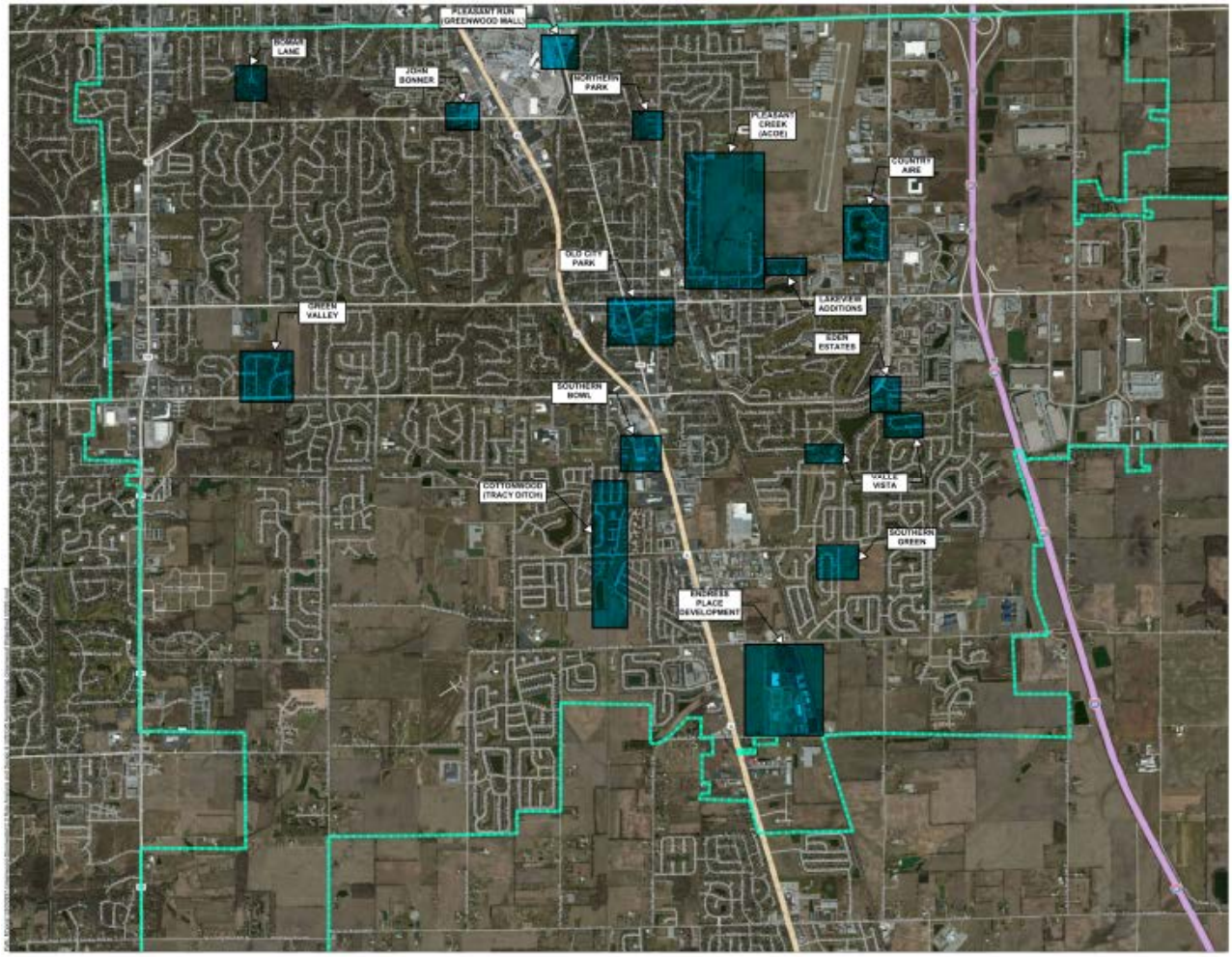


Figure 4-1- Overall Project Locations

Figure 4-2 - General Figure Legend

4.1 Bomar Lane

The Bomar Lane project is located south of Fry Road along Bomar Lane, in the northwest corner of the city limits. The need for this project resulted from the flooding that occurred during 2008, which inundated several homes. In fact, according to FEMA flood maps, there are approximately 14 homes within the floodway. **Figure 4-3** shows the approximate limits floodway along with the existing sanitary sewer and storm sewer.

Figure 4-3 - Bomar Lane Project

Though there are numerous homes within the floodway, there are four homes of concern. Three of these homes received significant damage during the flooding in 2008, and nearly all the home owners within the floodway required extraction during said flooding. Damage to secondary structures also occurs, as debris is washed through the low lying areas and destroys fences and storage sheds. The only drainage structure within the Bomar Lane project area is a concrete culvert, which drains the grassy cul-de-sac at the end of Bomar Lane (Note: This pipe was not included in the GIS information, and its location was approximated based on the field visit).

Based upon the potential level of flooding and the complexity of design required to mitigate flooding, this project will be part of the Capital Improvements Projects. See **Section 6.9** for the alternative discussions for this project.

4.2 Cottonwood (Tracy Ditch)

The Cottonwood project is located just west of US 31 along Stop 18 Road. This project was the result of flooding upstream from the Tracy Ditch, which is depicted below in **Figure 4-4** as the blue line. This flooding is mainly a result from the detention basins, which are shown below in blue, when they cannot discharge into the Tracy Ditch. This causes the storm sewers to backup, and cause street flooding. There have been several instances where sections of Stop 18 were closed, or travel was restricted due to the flooding.

The likely reason for the backup is the vegetation within Tracy Ditch, which cause the velocity within the channel to slow down. This reduced velocity causes the hydraulic capacity to be reduced, which causes further problems when the majority of the ponds share a common discharge (highlighted in orange). This will cause simultaneous backups at five (5) ponds, all of which are north of Stop 18. Another part of the flooding issue is due to the fact that part of Stop 18 is within the flood zone, which is shown as the light blue hatch area above.

Figure 4-4 - Cottonwood Project

Based upon the nature of the problem, and the limited scope required to fix the problem, it is recommended that this project be part of the Capital Improvement Projects. See **Section 6.5** for further discussion of the required solutions and estimated costs.

4.3 Country Aire

The Country Aire project is located on the east side of Greenwood, between Intersection 65 and Greenwood Municipal Airport. The project is located within the Country Aire subdivision, which is served by both sanitary sewer and storm sewer. **Figure 4-5** below shows the project area with the existing sanitary sewer and storm sewer. It should be noted that the storm sewer has not be completely mapped within the current GIS system, and the location was approximated based upon field visits.

Figure 4-5 - Country Aire Project

The pipe that is currently highlighted is the main drainage pipe for the large detention pond, which is currently a large diameter corrugated metal pipe. Unfortunately the metal pipe has begun deteriorating to the point of causing sinkholes within the yards. A section of pipe was recently replaced between the detention pond and the road. During the initial field visit additional sinkholes were found in the yard between the road and the farm field, which indicates that the pipe has further deteriorated.

There have also been complaints by the local farmer

who owns the farm field, who says that the Country Aire development has been flooding out some of his farm field. The large retention pond within Country Aire should sufficiently detain the surface runoff, and release it slowly overtime. The City has also installed a storm sewer system that runs along the fence line separating the farm field and the Country Aire Subdivision, which picks up any additional surface runoff that did not run to the retention pond.

Based upon the nature of the problem, and the limited scope required to fix the problem, it is recommended that this project be part of the Maintenance Projects. See **Section 7.4** for further discussion of the required solutions and estimated costs.

4.4 Endress Place Development

The Endress Place Development project is located on the south side of the City of Greenwood, and just east of US 31. This area is currently zoned as an industrial park, but requires some improvements to the drainage structures and ditches for future development to occur. **Figure 4-6** below shows the project area with the existing sanitary sewer and storm sewer. The area is still being further developed, and as such the storm sewer shown is only a portion of what could potentially be present within the area.

Figure 4-6 - Endress Place Development

The area is currently served by standard side ditches and standard storm sewers. Highlighted in yellow, there are several culvert pipes that are either completely crushed or partially silted in. This causes the ditch, highlighted in orange, to backup, and floods out behind the businesses located on the east side of the project area. There is also some concern with the hydraulic capacity of the existing ditch as the area continues to develop. Many of the facilities within the area are installing their own detention/retention facilities, but the ditch's hydraulic capacity could still be questionable given the amount of drainage area it serves. This area includes the business directly adjacent to Endress Place, and a large farm field to the east of the railroad. The ditch also requires additional maintenance to insure that it is as hydraulically efficient as possible.

Based upon the problems affecting the area, it is recommended that this project be part of the Capital Improvements Projects. See **Section 6.7** for further discussion of the required solutions and estimated costs.

4.5 Eden Estates

The Eden Estates project is located on the east side of the City, just west of Interstate 65. The major intersection within the project is between Emerson Avenue and Grassy Creek Lane, and the area is served by both sanitary sewer and storm sewers. It should be noted that the storm sewer has not been completely mapped within the current GIS system, and the location was approximated based upon field visits. There is also a substantial road side ditch along Grassy Creek Lane and Emerson Avenue, which eventually drains into several large detention ponds. **Figure 4-7** shows the existing sanitary sewer and storm sewer; however, the GIS system did not have some of the storm sewer, so the locations were approximated.

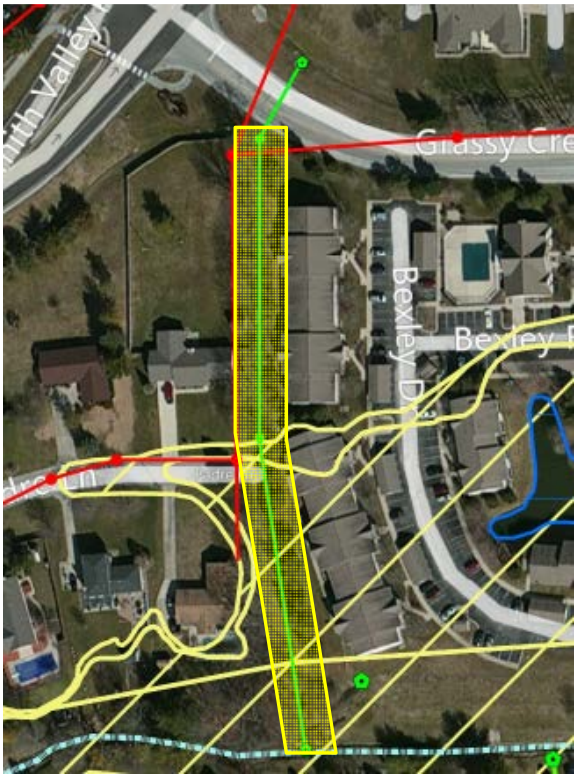


Figure 4-7 - Eden Estates Project

The highlighted section of pipe in **Figure 4-7** is the problem that initiated the project to be considered. This section of pipe runs along the property line between the apartment complex and a residential subdivision, which also has several mature trees that provide a visual break between the two areas. These trees have also penetrated the section of pipe, causing the upstream system to backup and creating on street flooding. The road side ditch also has some issues with erosion, which might be caused by improper grading or design. The erosion is not significant, but should it be allowed to continue the ditch bank would eventually collapse.

Based upon the nature of the problem, it is recommended that this project be part of the Capital Improvements Projects. See **Section 6.11** for further discussion of the required solutions and estimated costs.

4.6 Green Valley

The Green Valley project is located on the west side of Greenwood, just east of SR 135. The project area, which is located in the Green Valley subdivision, is served by a sanitary sewer, and a ditch and culvert storm system. **Figure 4-8** below shows the existing sanitary sewer and storm sewer; however, the GIS system did not have some of the storm sewer, so the locations were approximated based upon the initial field visit. The limited pipes that were installed seem to be original with the subdivision, and are reaching their effective service life.

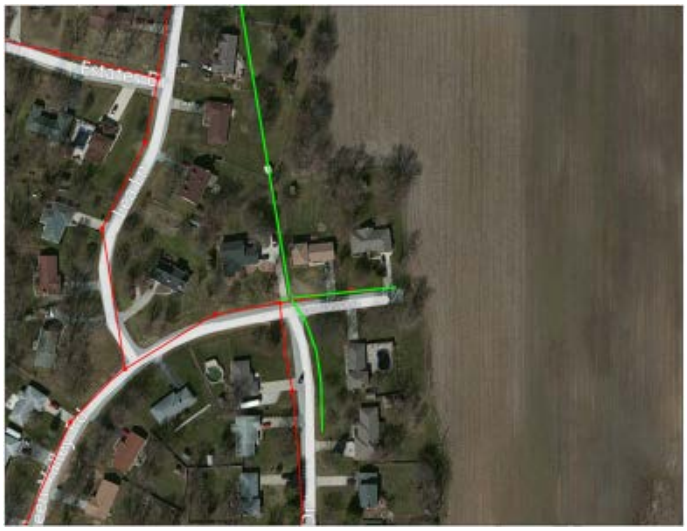


Figure 4-8 - Green Valley Project

This lack of standard storm sewer would not normally be a problem; however, the farm field drains toward the subdivision. This additional surface runoff inundates the storm sewer system, and causes flooding throughout the subdivision. There are some large road side ditches throughout the project area; however, these are still relying on the storm sewer that is not sized to handle the additional runoff from the farm field.

Based upon the nature of the problem, it is recommended that this project be part of the Capital Improvements Projects. See **Section 6.4** for further discussion of the required solutions and estimated costs.

4.7 John Bonner

The John Bonner project is located in the north of Greenwood, just southwest of the Greenwood Mall. **Figure 4-9** shows that the area is served by both sanitary sewer and storm sewers. The storm sewers consist mainly of two small diameter corrugated metal pipes, and a large roadside ditch on the north side of Fry Road. It should be noted that the storm sewer has not be completely mapped within the current GIS system, and the location was approximated based upon field visits.

The two pipes highlighted in **Figure 4-9**, along with the structure within roadside ditch, are of particular concern to the City. The bottom of the north pipe has completely eroded away, and is

at risk of completely failing. City personnel informed DLZ that the pipe was in such poor shape, that they entered the pipe to grout and seal the joints, in hope that this repair would prolong the life of the pipe.

The headwall/inlet structure is also a concern, because of the whirlpool affect that it causes. This is of some concern, especially when the proximity to the roadway and private parking is taken into account. Should swirling waters erode the banks of the side ditch sufficiently, there is a possibility for catastrophic failure. Most likely this scenario would be far in the future, but the possibility still exists.

Figure 4-9 - John Bonner Project

Based upon the nature of the problem, it is recommended that this project be part of the Capital Improvements Projects. See **Section 6.3** for further discussion of the required solutions and estimated costs.

4.8 Lakeview Additions

The Lakeview Additions project is centrally located between US 31 and Interstate 65, just off of Main Street. **Figure 4-10** shows that area is served by both sanitary sewer and storm sewers. The drainage in the area is handled by both conventional storm sewers and rear yard ditches, which eventually drain into the large detention basin. The main problem within this area are the rear yard ditches, which are often encroached by residential fences and overgrown vegetation. There is also some erosion within the project area, which is caused by the ditch not having proper inlet and outlet protection.


Figure 4-10 - Lakeview Additions Project Area

The remainder of the system appears to be in good working order, and has not caused residents within the area to complain.

Based upon the nature of the problems affecting the area, and the minimal resources required to fix the problem, it is recommended that this project area be part of the Maintenance Projects. See **Section 7.3** for further discussion of the required solutions and estimated costs.

4.9 Northern Park

The Northern Park project area in the northern city limits, located between US 31 and Interstate 65. **Figure 4-11** below shows that the area is served by both sanitary sewer and storm sewer. The storm sewer drains to the Jolly Brook, which is depicted as the dashed light blue line. Jolly Brook has begun to erode the bank just west of Meridian Street, which prompted the area to be investigated.

Figure 4-11 - Northern Park Project

There is some bank stabilization at the outlets for the culvert pipes; however, it doesn't extend far enough downstream, or is insufficient. Based upon the initial field visit it appeared as though the outlet for the culverts is an artificial low point. This most likely causes the water to swirl and become turbulent, causing the erosion of the bank and channel. Limits of erosion are highlighted in **Figure 4-11**.

Based upon the nature of the problem, it is recommended that this project be part of the Maintenance Projects. See **Section 7.2** for further discussion of the required solutions and estimated costs.

4.10 Old City Park

The Old City project is located within the downtown, located just east of US 31. **Figure 4-12** shows that this project area is served by both sanitary sewer and storm sewer system. The storm sewers within the project area drain into Pleasant Creek, which is the main cause for concern in this area.

Figure 4-12 - Old City Project

Pleasant Creek serves as the ultimate outfall for a large portion of the storm sewer systems with the City of Greenwood, and north of the Old City project is no exception. There are approximately 1,700 acres that drain into Pleasant Creek, which includes the Greenwood Municipal Airport and a significant amount of farm fields. This area causes a large amount of flow to enter the Old City project area, and has caused significant bank erosion and flooding. During the 2008 flooding event within the project area, a significant portion of property was inundated for several days. This flooding caused significant damage to the park property, and required significant repurposing of the area highlighted in yellow in **Figure 4-12**.

Figure 4-13 - Retaining wall in Old City

The area highlighted in orange shows the second cause for concern within the project area, which is associated with a failing retaining wall. This is of particular concern, because of the safety hazard it potentially presents. The retaining wall, as seen in **Figure 4-13** to the right, is in various states of disrepair. Should the retaining wall fail, it is possible that a significant portion of the parking lot could fall into Pleasant Creek. This would cause a loss of hydraulic capacity within the channel, and cause flooding upstream of the retaining wall.

Based upon the nature of the problem, and the complexity of solving flooding issues, it is recommended that this project be part of the Capital Improvements Projects. See **Section 6.6** for further discussion of the required solutions and estimated costs.

4.11 Pleasant Creek Field

This project is located in the center of Greenwood, just north of CR 950 N. **Figure 4-14** shows that the area is served by both sanitary sewer and storm sewers. It should be noted that the storm sewer has not be completely mapped within the current GIS system, and the site was not completely surveyed. This area is mainly drained by the Pleasant Creek, which is depicted as the

Figure 4-14 - Pleasant Creek Field Project

dashed light blue line in **Figure 4-14**.

This area was considered for consideration within this Master Plan, because a portion of the field drains into the neighboring residential yards. This area was also considered because it is part of a study performed by the Army Corps of Engineers (ACOE), which considered this area for regional water quality detention basins.

Based upon the nature of the problem, and the additional study by the ACOE, it is recommended that this project be part of the Capital Improvements Projects. See **Section 6.2** for further discussion of the required solutions and estimated costs.

4.12 Pleasant Run (Greenwood Mall)

The Pleasant Run project is located just to the east of the Greenwood Mall, which is just south of County Line Road. **Figure 4-15** shows that the area is served by both sanitary sewers and storm sewers. It should be noted that the storm sewer has not be completely mapped within the current GIS system, and the site was not completely surveyed.

Figure 4-15 - Pleasant Run Project

The entire area is also within the 100-year floodplain, which is what brought about this project for consideration in this Master Plan. During the 2008 flooding event there were several businesses, highlighted in yellow, that incurred significant flooding damage, and the intersection between Madison Avenue and Greenwood Park Drive was impassable. One business suffered significant damage, and was forced to close down, mainly due to health code issues from conditions directly associated with the flood.

Based upon the complexity dealing with floodplain remediation, it is recommended that this project be part of the Capital Improvements Projects. See **Section 6.8** for further discussion of the required solutions and estimated costs.

4.13 Southern Bowl

The Southern Bowl project is located just north of the Coopers project, which was previously discussed in **Section 6.12**. **Figure 4-16** shows that this area is served by both sanitary sewer and storm sewer. It should be noted that the storm sewer has not be completely mapped within the current GIS system, and the location was approximated based upon field visits.

The main cause for concern within this project area is the main drainage pipe, which runs across the middle of the Southern Bowl parking lot. This pipe is quite large, and according to City personnel is around 60-inches. This pipe drains some of the US 31 corridor, the frontage road leading up to the Southern Bowl, and much of the parking lot. This pipe is the main cause for this area to be considered within the Master Plan. During heavy rain events the pipe is likely to backup and cause flooding within the Southern Bowl parking lot, which, at one point, was severe enough to cause vehicles within the parking lot to become buoyant.

The pipe eventually drains into the Tracy Ditch, which appears to have sufficient capacity at the outlet point. The main concern is the pipe itself, which has undergone several repairs. One such repair was to add several tons of concrete to encase the pipe, which had failed within the Southern Bowl parking lot. The City also has an agreement with the private property owners along the pipe alignment to perform maintenance of this drainage pipe, and they were also granted an easement for this work.[4]

Figure 4-16 - Southern Bowl Project

Based upon the problems affecting this project area, and the potential for the project to quickly expand in scope, it is recommended that this project be part of the Capital Improvements Projects. See **Section 6.12** for further discussion of the required solutions and estimated costs.

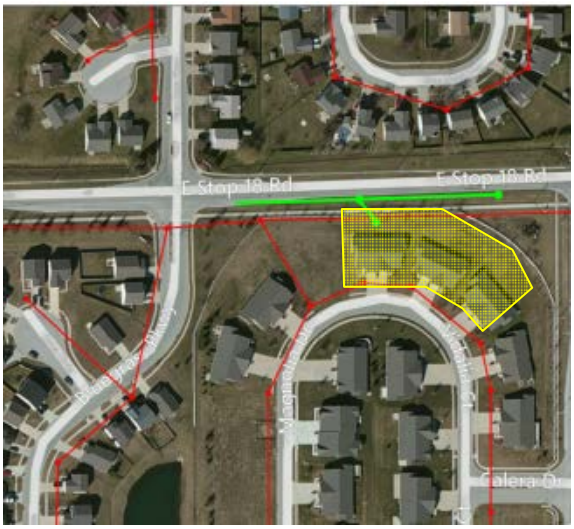


Figure 4-17 - Southern Green Project

4.14 Southern Green

The Southern Green project is located on the south side of Greenwood, at the intersection of East Stop 18 Road and South Emerson Avenue. **Figure 4-17** shows that this area is served by both sanitary sewer and storm sewer. It should be noted that the storm sewer has not be completely mapped within the current GIS

system, and the location was approximated based upon field visits.

There are several storm sewers throughout this area, which serve to drain the rear yards of the homes, and the road side ditch. It is the storm sewer that serves the homes, that is of particular concern. During heavy rain events, the storm sewer cannot keep up, and causes the yards to flood. The homes that are highlighted in **Figure 4-17** have had surface runoff come close to entering the structures. Based upon conversations with City staff, it is possible that the existing finished floor elevations are below what was designed.

Based upon the fix required to solve the flooding issues, it is recommended that this project be part of the Capital Improvements Projects. See **Section 6.10** for further discussion of the required solutions and estimated costs.

4.15 Valle Vista

The Valle Vista project area is centrally located between US 31 and Interstate 65, within the Valle Vista subdivision. This project area has two problems within close proximity, and the first is illustrated in **Figure 4-18** and the second is illustrated in **Figure 4-19**.

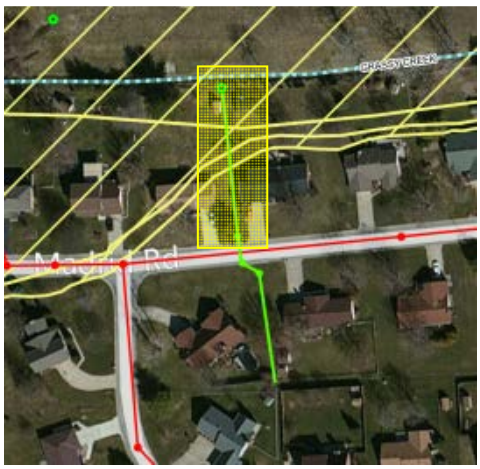


Figure 4-18 - Valle Vista Pipe Project

The first problem is due to the highlighted section of pipe in **Figure 4-18**. Due to some site activities between the residential properties, a section of pipe was crushed, which has caused a severe flow restriction. This section of pipe is the ultimate outfall for a significant amount of surface runoff, and has required routine maintenance to insure that the pipe is not clogged. City staff regularly clears out the line to insure that it has as much hydraulic capacity as possible. However, during heavy rain events the pipe simply does not have enough capacity in its current state, and will cause the system to back up. This will cause street level flooding along Madrid Road and Barcelona Drive, as well as some flooding in the back yards where the two manholes/inlets are located.

The second problem area is due to the ditch that is highlighted in **Figure 4-19**, which has become overgrown with vegetation. This will cause the storm sewer system to backup, and force surface runoff to find an alternative route to Grassy Creek or the detention basin. This ditch also holds water after rain events, and has optimal breeding conditions for mosquitoes. This is of

particular concern with the recent rise in West Nile virus, and the proximity to a number of homes.

The storm sewer that discharges into the ditch is not of concern, but need to be replaced with the next 10 years. This is mainly due to the pipe being corrugated metal, which has a tendency to fail prior to the projected service life.

Based upon the solutions to both the problem areas it is recommended that these projects be included in Maintenance Projects. See **Section 7.1** for further discussion of the solutions and estimated costs.

Figure 4-19 - Valle Vista Ditch Project

5 HYDROLOGIC/HYDRAULIC MODELING

This section will discuss the investigation of the hydrologic and hydraulic within the Capital Project Areas identified by City Staff. Calculations were completed to determine existing pipe capacities, preliminary sizing of proposed pipes and availability of downstream capacity for proposed connections to outlets.

Preliminary calculations were also completed on the basin within West Side Park to determine approximate storage capacity for flood mitigation.

The Army Corps of Engineer's Pleasant Run Flood Mitigation report was reviewed, but no verification of their hydrologic and hydraulic models were completed. Please refer to this report for more information and detailed calculations. Below please find a summary table of the calculations performed as part of the stormwater master plan investigation.

Please refer to **Appendix I** for more detailed calculations.

6 CAPITAL IMPROVEMENT PROJECTS

The following section provides a summary of the capital improvement alternatives recommended for further action. The main goal of these alternatives is to increase conveyance capacity, alleviate localized drainage problem areas and reduce the risk of flooding. Capital improvement projects (CIP) are presented in order based upon the priority ratings, which were developed during the initial field visit and subsequently revised based upon City input. **Appendix F** provides a full sized detail of each project, with each individual section provides smaller "snapshots". Probable costs are located within each individual section, with **Appendix H** providing a detailed cost estimates. It should be noted that no land costs were developed for the majority of these alternatives, because it was assumed that the City possessed easements within the project areas. Land costs are typically $2,500 per residential parcel.

6.1 Green Infrastructure Considerations

Several projects presented in the following sections will make considerations that involve various green infrastructure items. One such item is the hybrid ditch system, which acts similar to a French drain. These hybrid ditch systems have been used throughout the City of Indianapolis, with good results. Hybrid ditches look like a typical open ditch on the surface with topsoil and grass, however underneath there is perforated pipe surrounded by pervious stone and sand that operates like a French drain. This section of clean stone and sand creates storage for stormwater while simultaneously filtering the runoff as it seeps into the ditch and flows toward an outlet. See **Figure 6-1** for an example of a hybrid ditch section. This system could potentially eliminate the required water quality structure, which is also known as a best management practice (BMP). Because the City is within an MS4 district, certain water quality criteria must be met when constructing storm sewers. This criterion mainly deals with the reduction of sedimentation and water volume control. The hybrid ditch system meets all these criteria, and is very successful at controlling the amount of volume that discharges from the system.

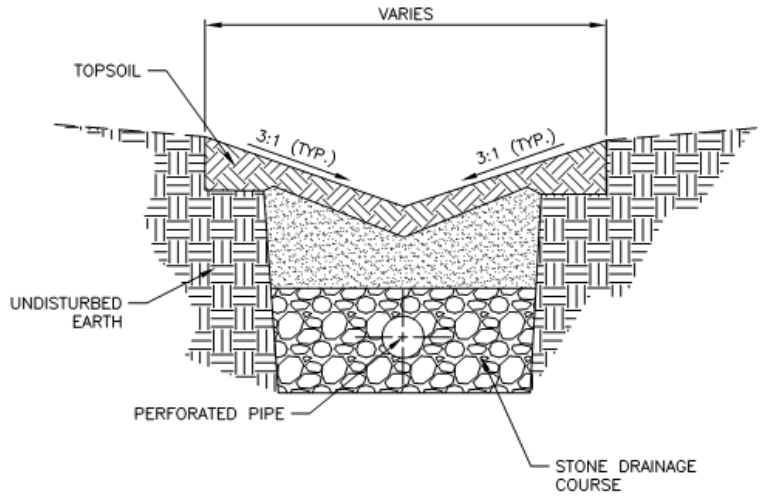


Figure 6-1 - Typical Hybrid Ditch Cross-Section

Another green infrastructure option considered for some of these projects was the use of a vegetated dry detention basin. Vegetated basins work similar to the hybrid ditches, but do not typically have an underdrain system. This design can be easily modified to include underdrains to further increase the effectiveness of the basins and add underground storage, but it is typically not needed. **Figure 6-2** below provides a typical section of a vegetated basin, with the dimensions varying depending on the location of the basin.

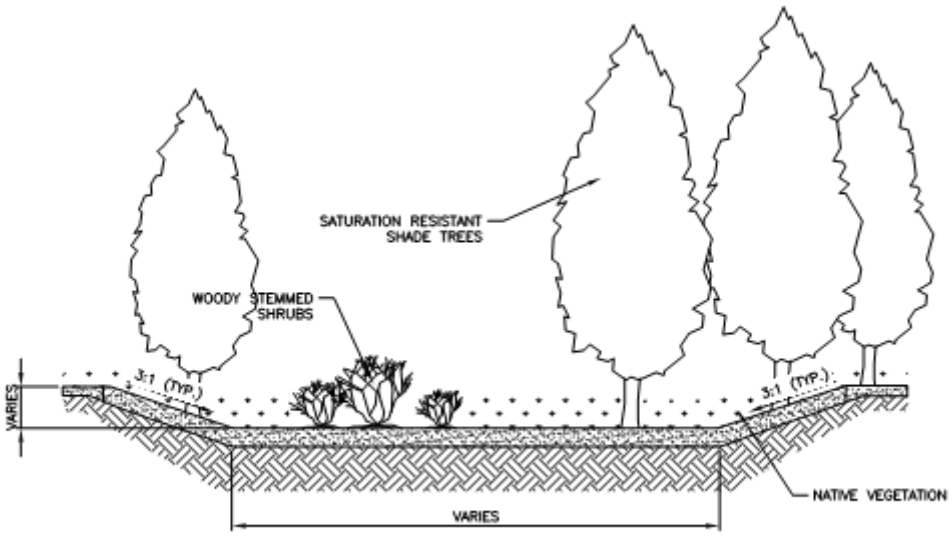


Figure 6-2 - Typical Vegetated Basin

6.2 Pleasant Creek (ACOE Project)[1]

This project, which was previously discussed in **Section 4.11**, will deal with the construction of a large detention basin to help relieve flooding throughout Greenwood. This project was part of an Army Corps of Engineers study of the Pleasant Creek basin authorized under Section 205 of the 1948 Flood Control Act. The study, which was started in the late 90's, was eventually completed in 2006. The study looked at possible flood damage to 159 structures within the Floodzone along Pleasant Creek, of which 133 structures were residential, 23 were commercial, and the remaining 3 structures were public facilities. A 1% flood event, which is a 100-year flood, is estimated to affect 129 structures and cause over $5.5 million in total damages; approximately 40% of this cost coming from damage to commercial facilities, and the remaining 60% to residential. The 0.2% flood event, which is a 500-year flood, is estimated to affect 144 structures and cause over $5.9 million in total damages.

Figure 6-3 - Pleasant Creek Basin

Numerous options were studied at a feasibility level, but many of them became impractical when looking at the cost to benefit ratios. Ultimately the study settled on an in-line detention basin along Pleasant Creek, as shown in **Figure 6-3**. The detention basin will be a dry bottom reservoir that would detain excessive runoff during periods of high rain fall, and would then drain back into Pleasant Creek. This basin would reduce the chance of flooding by as much to 70% within the Pleasant Creek Flood Area, and could possibly have an effect on flooding along Pleasant Run. The study did not cover these possible benefits down Pleasant Run, so any possible benefits to flooding relief are simply conjuncture. The basin will also have a positive effect on the water quality, as water naturally infiltrates out the bottom of the basin prior to draining back into Pleasant Creek.

6.2.1 Opinion of Probable Costs

Costs were developed for the Pleasant Creek project. These costs include design, construction, and inspection costs. These numbers are for budgetary purposes only, and should not be considered final.

Regional In-Line Detention Basin - $7,750,000*

*Costs are based upon the City taking responsibility for the entire project costs, and yearly operation and maintenance (O&M) expenses of $7,500.

6.3 John Bonner (Fry Road & Loews Boulevard)

This project, which was previously discussed in **Section 4.7**, is designed to stabilize the erosion within the roadside ditch along Fry Road. This erosion is primarily caused by the way the headwall structure is designed. With the pipes in a sump, the water tends to create whirlpools as it drains from the ditch. This alternative, as shown in **Figure 6-4**, will involve completely enclosing the ditch. This will remove the possibility that the ditch slopes could possibly fail, and the unsafe right turn from Fry Road onto Loews Boulevard.

The two existing 24-inch pipes will be replaced with a single 36-inch pipe, which will have approximately five-and-a-half times the capacity of the two existing pipes. The new pipe will be installed at the same slope, as long as grade and cover allow, and will have a more efficient flow channel. Corrugated metal pipes, like those to be replaced, have a fairly inefficient flow channel, which is compounded by the various states of corrosion the pipes are in. **Appendix I** has the initial calculations that were done to determine the preliminary sizing of the new pipe.

This option will also allow the Parks Department to implement a portion of their 2007 – 2012 Master Plan[2], which calls for a new trail to be installed along Fry Road. This could be completed along with the design of the pipe replacement, which would be an opportunity for the Stormwater Utility to partner with the Park Department, thus creating a benefit from cost sharing.

Figure 6-4 - John Bonner Improvements

It is important to note that existing utilities are not shown in **Figure 6-4**, but that there are several within the vicinity of the proposed pipe. It is unlikely that the utilities will conflict with the proposed alignment, as it corresponds to the existing pipe alignment. The detailed design of this project should determine the locations of underground utilities, and any possible relocation that might need to occur.

6.3.1 Alternatives

Should the City decide to not pursue the full ditch enclosure, there are a couple of options that should be considered for this project. The first alternative would be to replace the failing pipes, and slightly regrade the ditch section to remove the sump condition. This regrading should also remove the near vertical drop off from Loews Boulevard, to create a safer right-turn movement from Fry Road.

The second option would be to replace the two pipes, but also install hybrid ditches along the entire ditch length. This option could potentially remove, or at the very least reduce, the requirement for the end line water quality unit. This would also allow for a reduction in the proposed pipe size, which would translate into a slight cost savings.

6.3.2 Opinion of Probable Costs

Costs were developed for all three possibilities for the John Bonner project. These costs include design, construction, and inspection costs. These numbers are for budgetary purposes only, and should not be considered final.

Completely Enclose Ditch - $890,000*
Install New Pipe & Regrade Ditch - $462,000
Install New Pipe with Hybrid Ditches - $620,000

*Only storm infrastructure costs are presented here. Additional costs should be included for the installation of the trail and all associated items.

6.4 Green Valley

This project, which was previously discussed in **Section 4.6**, is designed to upgrade the existing storm sewer system by adding hybrid ditches and conventional storm sewer throughout the Green Valley subdivision. This upgraded system, as shown in **Figure 6-5**, will be designed to handle the additional runoff from the undeveloped farm field, which currently floods out the existing system.

The existing storm sewer system within the neighborhood will be replaced by the hybrid ditches, which mainly consist of roadside ditches and drive culverts. The majority of the area appears to have sufficient room to construct these hybrid ditches, which would be mainly constructed within the green space between the edge of pavement and property lines. The current discharge for this system appears to head north, following a utility easement within the farm field. It was assumed for this project that this easement would be used for the discharge line of the hybrid ditch system which would be a 12-inch pipe. The system would eventually discharge into a roadside ditch along Main Street, which would eventually empty into Fairview Creek.

Figure 6-5 - Green Valley Hybrid Ditches

The final design of this project would require the designer to determine the impact of additional drainage on the existing roadside ditch along Main Street, as well as the detention basin that potentially receives this additional flow. The hybrid ditch system, as mentioned previously in **Section 6.1**, provides some volumetric control via the French drain design, which will limit the impact on this detention basin.

As an alternative, the system could potentially drain to the south to Turkey Pen Creek; however, this alternative would require the acquisition of several residential parcels. This would add some costs to the project, and most likely delay the construction as the City attempts to acquire easements from the homeowners.

6.4.1 Opinion of Probable Costs

Costs were developed for two possibilities for the Green Valley project. These costs include design, construction, and inspection costs. These numbers presented are for budgetary purposes only, and should not be considered final.

Hybrid Ditches (Half the Neighborhood) - $1,570,000
Hybrid Ditches (Full Neighborhood) - $2,600,000

6.5 Tracy Ditch

This project, which was discussed previously in Section 4.2, is designed to provide a multi-year maintenance plan for the Tracy Ditch. This maintenance plan will allow the ditch to operate better hydraulically, and will also help to relieve the street flooding caused by the detention pond outlet pipes backing up. This plan will also include the inspection and cleaning of the outlet pipes from the detention ponds that connect into the Tracy Ditch. This will allow the City to evaluate the replacement or repair needs of those particular storm sewers, and should help prevent the system from backing up.

Figure 6-6 - Tracy Ditch Maintenance

Figure 6-6 shows the limits of recommended maintenance, and pipe inspection. Highlighted in yellow are the limits of the ditch regrading and clearing within the project area, which will extend to the north and south from what is shown in Figure 6-6. This maintenance is mainly clearing the ditch of vegetation within the flow channel (i.e. cattails, invasive weeds, etc.), which significantly slows down the flow within the ditch. The nuisance vegetation will be replaced with native plantings, which when properly maintained, allow for the channel to flow properly and prevent erosion.

This will also include the estimated costs for yearly maintenance activities, which will help to keep the ditch near optimum hydraulic capacity. The maintenance activities should include removal of nuisance vegetation, and the mowing and care taking of the native plantings. Depending on the development that might take place south of Stop 18 Road; the ditch may need to be dredged to remove additional sediments.

Design of this project would mainly revolve around the development of an optimal hydraulic profile, and the proper maintenance schedule. The design would also look at the existing outfalls, and determine if they would require any additional measures (i.e. rip-rap or flap gates).

6.5.1 Opinion of Probable Costs

Costs were developed for the initial maintenance and design of the project, and then additional costs were estimated for the routine maintenance items. The initial design

and maintenance costs include design, construction, and inspection costs. These numbers presented are for budgetary purposes only, and should not be considered final.

Initial Maintenance and Design - $1,100,000
Routine Maintenance Costs - $37,000

6.6 Old City Park

This project, which was previously discussed in **Section 4.10**, will look at regrading and erosion mitigation of Pleasant Creek, and will also look at replacing the retaining wall for a business parking lot. The first portion of the project, which is shown in **Figure 6-7**, will regrade portions of the ditch that have become severely eroded. The ditch will also be reseeded with native plantings to help with bank stabilization. These native plantings will establish a strong root system, and provide for greater bank stability. The plantings will help to keep the channel looking natural. With the project taking place in such a public area, it should be a focus to make the project as visually appealing as possible. Some riprap might still be required in areas where Pleasant Creek turns sharply, or where a storm sewer discharge point occurs. The native plantings in appropriate areas will help give the park area along the creek a more natural and ecological feel.

Figure 6-7 - Old City Park Pleasant Creek Regrading

The remaining portion of this project will deal with the retaining wall, which appears to be failing. The wall has suffered greatly from differential settlement, which has caused portions of the parking lot to settle more drastically than others (See **Figure 4-13**). This differential settlement is of particular concern with the stability of the wall, as now some sections of the wall could potentially be holding back more bearing pressure than others. (Please note the wall has not been inspected by a structural engineer, and it is recommended that the City hire a structural engineer to perform an analysis on the condition of the wall). One viable solution to fix this issue is to replace the retaining wall, which will include removing the existing retaining wall; temporary shoring within the parking lot; and temporary relocation of the overhead power lines. There is a possibility for the City to have cost sharing with the private businesses that rely on the retaining wall to keep their parking lot from failing and falling into Pleasant Creek.

The scope originally talked about the possibility of some flood mitigation as well; however, should the City decide to proceed with the previously discussed ACOE project it could potentially alleviate flooding issues for this area.

6.6.1 Opinion of Probable Costs

Costs were developed for the multiple areas of the Old City Park project. As discussed in the main section, the costs for the ACOE project can be found in **Section 6.2**. These costs include design, construction, and inspection costs. These numbers presented are for budgetary purposes only, and should not be considered final.

Pleasant Creek Erosion Mitigation - $145,000
Retaining Wall Replacement - $730,000
Total Project Costs - $875,000

6.7 Endress Place Development

This project, which was previously discussed in **Section 4.4**, could potentially be completed in multiple phases. The different phases for this project will produce multiple levels of flood protection, and will allow the City to spread the costs of this project out over several years.

Figure 6-8 - Endress Place Development Ditch Regrading & Pipe Replacement

The first phase will consist of a maintenance fix, which will replace the existing pipes under Endress Place, and several maintenance activities on the existing ditch. The existing pipes are in various states of failure, and will be replaced with a single structure. Due to the shallow bury depth of the existing pipes, it is recommended that the three pipes be replaced with a single, concrete box structure. This will remove the possibility for multiple pipes to fail, and should also prevent the structure from becoming damaged from the semi traffic. The ditch will be regraded east of Endress Place, and be completely reconstructed to the west of the Endress Place. The ditch is poorly defined to the west of Endress Place, and appears to contribute to much of the capacity problems facing this area. Based upon the initial field visit, it was assumed that the ditch loses over half of its capacity after it crosses Endress Place. The ditch

should be increased to a section greater or equal to what currently exists on the east side of Endress Place. The approximate limits of pipe replacement and ditch regrading are shown above in **Figure 6-8**.

Figure 6-9 - Endress Place Development Study Limits

The next phase will involve the study of the drainage characteristics of the upstream and downstream areas of the Endress Place Development. As outlined in **Figure 6-9**, there are several detention basins within the industrial park. The largest basin, which is highlighted in yellow, is currently in construction as Endress+Hauser prepares to begin operation of their new building sometime within 2013 or 2014. This detention basin should be sized to properly store a 100-year event of all the contributing area upstream, and properly release this volume at a rate equal to the pre-developed 10-year storm event[3]. The study will cover the impacts of this basin on the upstream and downstream discharge rates, as well as what should be done within the project vicinity to eliminate flooding. This study will be far more comprehensive than what is being presented within this Master Plan, and will go into greater detail of the proposed design. This study should roll directly into the third phase, which is the funding and construction of the recommended projects.

6.7.1 Opinion of Probable Costs

Costs were developed for the maintenance project and the hydraulic study, which was based upon an inflated rate of design costs for the maintenance activities. Costs will be developed for possible flood remediation after the hydraulic study is finalized, and the exact conditions for the flood remediation have been determined. Multiple smaller projects could come as a result from this study, or a single large project could be the result. This plan has briefly looked at some projects that could become from the study, but specifics were not developed.

Maintenance Work & Hydraulic Study - $140,000
Final Flood Remediation - $TBD

6.8 Pleasant Run (Greenwood Mall)

This project, which was discussed previously in **Section 4.12**, is a proposed building demolition and construction of detention basin and storm sewer. Options were considered to remediate the flooding problem within the Greenwood Park Mall parking lot; however, this would most likely require more capital input than the Mall would be willing to contribute. However, with the City establishing a credit program that would allow non-residential properties to reduce their yearly stormwater utility fee, it is possible that the Mall would perform some sort of runoff reduction.

Figure 6-10 - Pleasant Run Greenwood Mall Modification

The ACOE project, which was discussed in **Section 6.2**, could potentially provide some relief to the flooding, but it is unlikely to completely remove the buildings from the floodzone. This floodzone extends into the mall parking lot, and limits the amount of work that can be done. This is why the preferred alternative is to perform work within the mall parking lot, which is illustrated in **Figure 6-10**. This alternative involves the construction of buffer strips at the end of parking stalls, and the installation of either underground detention or permeable pavement. These additions within the parking lot should help alleviate some flooding, and will allow the mall to receive a credit from their stormwater utility fee. This alternative will also include the installation of several new inlets within the intersection of Madison Avenue and Greenwood Park Drive E.

An additional alternative would be to demolish the existing buildings damaged during the 2008 flood event, and create a detention basin within this area. This basin would have approximately 5.50 Acre-ft of storage, which was initially sized to handle a portion of the mall parking lot. Several assumptions were made to perform this initial sizing, and a more detailed analysis should be performed to determine the exact sizing needed. It is also uncertain about how much influence the floodzone will have on the basin operation.

Additional alternatives were considered for this project area; however, the cost to benefit ratio did not make the projects feasible. It is possible that the do nothing alternative will be the selected alternative for this project area as the 100-year floodzone is a severely limiting factor.

6.8.1 Opinion of Probable Costs

Costs were developed for the multiple alternatives developed for this project area. These costs include design, construction, and inspection costs. These numbers presented are for budgetary purposes only, and should not be considered final.

Permeable Pavement & Buffer Strips - $2,500,000
Underground Storage & Buffer Strips - $1,300,000
Building Demolition & Basin Construction - $1,000,000

6.9 Bomar Lane

This magnitude of this project, which was previously discussed in **Section 4.1**, will be determined based upon the flood remediation done by the ACOE project, which was discussed previously in **Section 6.2**. The final extents to the floodzone reduction can only be determined after the project has been constructed, and an additional flood study has been completed. Once everything is finalized a plan can be determined for the Bomar Lane area, which might be expanded to consider performing a study on Pleasant Run.

6.9.1 Opinion of Probable Costs

Refer to **Section 6.2.1** for costs of the ACOE project. Costs for this project are to be determined after the exact flood remediation from the ACOE project has been determined. It should be noted that several grants and loans are available for communities to provide flood remediation and relief.

6.10 Southern Green

This project, which was previously discussed in **Section 4.14**, is a project that will deal with flood remediation for some residential homes. The fix for this issue will be to intercept surface runoff, which is shown in **Figure 6-11**. This detention basin will also intercept the roadside ditch along Stop 18 Road, which partially contributes to the overall flooding of the project area. This basin should have an approximate volume to handle the acreage from the farm field, and some additional

Figure 6-11 – Southern Green Detention Basin

flow from the surrounding subdivisions. With limited information and the contours from the GIS system, it was preliminarily determined that this basin should have an approximately surface area between 8,000 square feet and 12,000 square feet. The sizing was performed by using the rational method to determine the peak flow rates of the 100-year and the 10-year return periods, and then determining the required detention volume from these two flow rates. These calculations are shown in **Appendix I.** This assumed that approximately half the farm field would eventually drain into the roadside ditch along Stop 18 Road, and various portions of subdivisions. This design also assumed that the farm field would remain undeveloped, and did not consider any reduction in flow gained by crops planted.

This basin could potentially become a vegetated basin with a minor increase in cost. The vegetated basin, which was previously discussed in **Section 6.1**, can occupy the same foot print as the regular dry detention basin. This basin should satisfy the requirements for water quality, as well as volumetric control. The vegetated basin will provide a little less detention than the traditional detention basin, but will allow a greater volume of water to be infiltrated through the bottom of the basin. The vegetated basin could potentially turn into a partnership with the Parks Department, which would involve adding some trails through the basin and extending pedestrian access along Stop 18 Road creating the potential for a small park.

6.10.1 Opinion of Probable Costs

Costs were developed for the Southern Green project. These costs include design, construction, and inspection costs. These numbers presented are for budgetary purposes only, and should not be considered final. Both of the costs presented were increased by $20,000 to include land acquisition.

Detention Basin - $290,000
Vegetated Basin - $300,000

6.11 Eden Estates

This project, which was previously discussed in **Section 4.5**, will be a pipe replacement and erosion mitigation project. The main problem within this project area is the condition of the pipe, which is the orange line in the middle of **Figure 6-12**. This pipe has deteriorated to the point where tree roots have begun to infiltrate the pipe, and has caused significant loss in hydraulic capacity of the pipe. Several scenarios were run to determine the possible effects of various pipe restrictions, and various roughness coefficients. These calculations are shown in **Appendix I**.

There are a couple viable solutions for this problem, and the selection of the final solution will be determined by the conditions of the existing pipe. The first viable solution will be to perform pipe lining. Depending on the size of the root intrusion, it is possible to remove the roots with specialty water jets. The pipe will then be inspected to ensure that all of the roots have been removed, and then the pipe will be line. There are several types of pipe liners that could be considered, but for the purposes of this report a CIPP liner will be considered. This type of liner system will insert a resin impregnated felt liner through the damage pipe, and will cure within the existing pipe. This will slightly reduce the diameter of the pipe; however, it will increase the efficiency of the pipe. This is accomplished by smoothing out the flow channel, and removing the flow restrictions (i.e. roots).

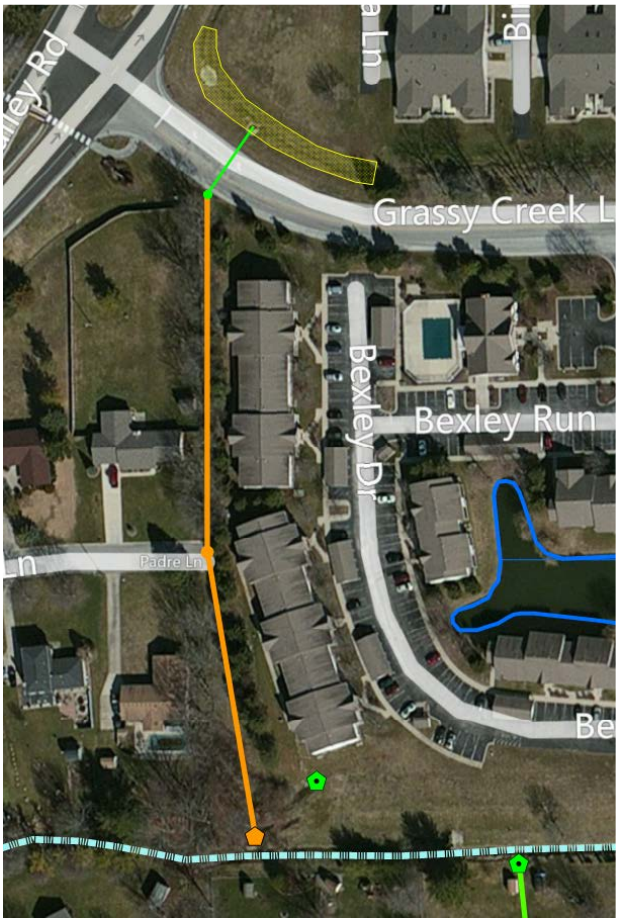


Figure 6-12 - Pipe Lining/Replacement

The second viable solution for this project is to completely replace the pipe and remove/relocate the trees that have caused this problem. Depending on the size of the trees, and the availability of excess land, it could be possible to temporary remove the trees from the project area, and then replant them after the project was complete. This would add some additional costs for the care of the trees while they are kept offsite during construction. The existing 24-inch CMP should be replaced with either a RCP or a CPP, which will have a greater resistance to root intrusion and corrosion. These materials also have a smoother flow channel when compared to CMP, which will help increase the hydraulic efficiency of the new pipe.

Another solution that was considered was to reroute the storm sewer system; however, that would have required regrading a significant portion of the roadside ditch along North Emerson Avenue and Grassy Creek Lane. However, these additional costs made this project unfeasible.

The second portion of this project will be to re-armor the large road side ditch along Grassy Creek Lane and North Emerson Avenue, which the limits are highlight in orange in **Figure 6-12**. This ditch currently has some significant erosion along the flow line where a significant amount of rip rap was laid, see **Figure 6-13**. There are multiple options when considering re-armoring a ditch, with the most traditional being that of rip-rap. There has been a movement that last decade to move toward a more green approach, which would include native plantings and natural gabions. Should the natural ditch armoring be the selected method by the City, rip rap will still have to be utilized around the road culvert that flows into the storm sewer system.

Figure 6-13 - Ditch Erosion in Eden Estates

6.11.1 Opinion of Probable Construction Costs

Costs were developed for two possibilities for the Eden Estates project. These costs include design, construction, and inspection costs. These numbers presented are for budgetary purposes only, and should not be considered final.

Pipe Lining with Natural Armoring - $190,000
Pipe Replacement with Natural Armoring - $232,000

6.12 Southern Bowl

This project, which was previously discussed in **Section 4.13**, will deal with replacing a large diameter pipe within the Southern Bowl parking lot. As also previously discussed, the City currently has an agreement with several of the private property owners that they will maintain this pipe.

This pipe is currently deteriorating faster than anticipated, and has required

Figure 6-14 - Southern Bowl Pipe Replacement

numerous repairs. The existing pipe CMP shall be replaced with a reinforced concrete pipe (RCP), which should be replaced as highlighted in **Figure 6-14**. The pipe was replaced from US 31 to the approximate location shown to the right, the exact location will likely change once the project is designed and surveyed. Several structures will be added as part of this project; which will ensure that the inlets no longer directly connect into the main storm trunk line. This will allow the City staff to more easily perform routine maintenance and replace smaller sections of pipe should a failure occur.

6.12.1 Opinion of Probable Costs

Total costs were developed for the replacing of the large diameter pipe within the parking lot. This cost includes design, construction, and inspection costs. These numbers presented are for budgetary purposes only, and should not be considered final.

Replacing Pipe Only - $360,000

7 POTENTIAL MAINTENANCE PROJECTS

These projects presented within the following sections are small, maintenance projects that can be remediated easily. The projects mainly arise from customer complaints, but also can come from known utility information from City staff. These types of projects also come about every year, and are generally added to a master list as they are encountered. These projects are only a small portion of what could potentially be a much larger list once the final rates have been implemented.

7.1 Valle Vista

This project, as discussed previously in **Section 4.15**, will deal with two projects within the Valle Vista Subdivision. The first project is to replace a pipe that was previously damaged, which is detailed in **Figure 7-1**. This pipe is currently a 24-inch corrugated metal pipe, which should be completely replaced. The pipe will be replaced with a new reinforced concrete pipe, which has significantly stronger resistance to crushing and corrosion than the existing corrugated metal pipe. This project will also include some ditch regrading at the point of discharge, as well as some clearing of some nuisance vegetation.

Figure 7-1 - Valle Vista Pipe Replacement

The second project will help with maintenance issues of a ditch, which is highlighted in **Figure 7-2**. This ditch has some vegetation problems, which causes the ditch to lose hydraulic capacity. This loss in capacity is also due to buildup of sedimentation, which is caused by normal erosion. The ditch has been recommended to be dredged and regraded, and the banks to be stabilized with native plantings. These minor fixes will ease the amount of erosion that occurs along the ditch, and should also cut down on the prevalence of nuisance plants. The project will also include removing some of the trees and shrubs that have encroached on the drainage

Figure 7-2 - Valle Vista Ditch Paving

easement.

7.1.1 Opinion of Probable Costs

Costs were developed for both projects within the Valle Vista area. These costs include construction and construction engineering. These numbers presented are for budgetary purposes only, and should not be considered final.

Pipe Replacement - $22,000
Ditch Paving - $28,000
Total - $50,000

7.2 Northern Park

This project, as previously discussed in **Section 4.9**, will help to eliminate the erosion and backup issues that are caused by the Jolly Brook, which is shown in **Figure 7-3** as the dashed light blue line. The ditch regrading will help better define the bottom of the ditch, and will insure that there are no intermediate low spots. These low spots are creating the erosion and back up issues. The ditch will be reseeded with native plantings, which will help to stabilize the side slopes, and will also help with the aesthetics of the Jolly Brook. This project should also include pipe cleaning of the storm sewer that discharges into the Jolly Brook. This cleaning will remove debris that could potentially be contributing to the backups within this area.

Figure 7-3 - Northern Park Ditch Restoration

7.2.1 Opinion of Probable Costs

Costs were developed for the project within the Northern Park area. These costs include construction and construction engineering. These numbers presented are for budgetary purposes only, and should not be considered final.

Ditch Restoration - $30,000

7.3 Lakeview Additions

This project, as previously discussed in **Section 4.8**, will involve ditch restoration and native plantings to protect the ditch from erosion and silting in. There is a possibility for this project to become more involved than a simple ditch restoration project. This would involve turning the standard ditch into a hybrid ditch, which is discussed in **Section 6.1**. Similar to The Coopers project area, this project does not have an easy ingress/egress for either of the proposed solutions. Contractors will have to move materials further than normal; however, with such a short project length this shouldn't affect the overall project costs.

Figure 7-4 - Lakeview Additions Ditch Restoration

7.3.1 Opinion of Probable Costs

Costs were developed for the project within the Lakeview Additions area. These costs include construction and construction engineering. These numbers presented are for budgetary purposes only, and should not be considered final.

Ditch Restoration - $18,000
Hybrid Ditch Option - $68,000

7.4 Country Aire Subdivision

This project, which was previously discussed in **Section 4.3**, will include video inspection on all the pipes located within the County Aire Subdivision. This video inspection will allow the City to properly perform an inventory of the condition of the pipes, and outline a plan to replace or rehabilitate the pipes that are damaged or deteriorated. There is one section of pipe that needs to be replaced or rehabilitated, which is highlighted in **Figure 7-5**. This pipe serves as one of several drainage pipes for the large detention basin in the center of the subdivision, and has caused several sink holes to develop within residential yards. Any pipes set for

Figure 7-5 - Country Aire Pipe Replacement

replacement should be replaced with RCP.

Pipe replacement will be much more expensive than the lining of pipes; however, lining pipes causes the inside diameter of the pipes to be decreased by one size (i.e. A pipe with a 24-inch inside diameter will now have an inside diameter of 21-inches). Lining also can only overcome certain pipe failures, and often times cannot fix pipes with a severe joint offset. The amount of rehabilitation will completely depend on the findings of the video inspection.

7.4.1 Opinion of Probable Costs

Costs were developed for the potential projects within the Country Aire Subdivision area. These costs include construction and construction engineering. These numbers presented are for budgetary purposes only, and should not be considered final.

Single Pipe Replacement as highlighted - $36,000
Pipe Inspection & Lining - $296,000*
Pipe Inspection & Replacement - $386,000*

*Costs for these projects include the pipe replacement for the one pipe highlighted in **Figure 7-5**. These costs also assume approximately 30% of the pipes inspected will need to be either replaced or rehabilitated.

8 DUAL PURPOSE FACILITIES

As part of the stormwater master plan sites for potential dual purpose facilities were investigated within the City of Greenwood. These dual purpose facilities will assist with creating regional and/or localized areas that will provide potential water quality benefits as well as stormwater quantity management, while simultaneously providing recreational, educational, and aesthetic value. The City of Greenwood Recreation Infrastructure Improvement and Park and Recreation Master Plan 2007-2012[2] were reviewed to determine what deficiencies had been identified in park and recreational facilities. When looking at regional facilities and determining overall planning of stormwater facilities these areas were taken into account when trying to find the most holistic and beneficial projects that could be completed. Currently there is a lack of trails, open space area and park area. These dual purpose facilities will assist in meeting the demand for parks and recreational areas while providing water quality and quantity control benefits as well as potentially promoting future growth and development within the community.

8.1 Institutional Parcels

As discussed in the Park and Recreation Master Plan the City of Greenwood and the School System have previously worked jointly to create new parks. This intergovernmental cooperation can potentially be used to develop an institutional space for stormwater facilities. For instance, an area located directly west of the intersection at County Road 300 E and Rocklane Road, which is shown in **Figure 8-1**. This location and other institutional locations can help alleviate the current lack of park area, provide water quality benefits and assist in meeting future park needs. For example, a wetland area can be constructed within this area before the construction of the institution. This will assist in treating stormwater runoff, serve as additional flood storage and also provide students with an educational experience in the future. With the City and the School District working collectively, it has the potential to also reduce the overall expenditure of the park system and the impact fee required to pay for the system.

Figure 8-1 - Institutional Parcel

8.1.1 Westside Park

Westside Park is a 24.5 acre park which is located approximately 0.4 miles west of the intersection at US 31 and West Main Street. At the location between Westside Park and the Greenwood Cemetery, a levee/dam with the length of approximately 450 feet is proposed (See **Figure 8-2**). Using GIS data, topography at Westside Park and properties surrounding Pleasant Run Creek and its tributary were then measured. Using elevations and lengths, the valley surrounding Pleasant Run Creek and its tributary was then calculated. It was found that approximately 48 acre-feet of current open space can be used as flood storage after the installation of this levee. Easements may need to be obtained from the Westside Park and surrounding properties. Even so, the construction of this levee will provide storage during future flooding while providing recreational value to the park. This will allow the community to enjoy paddle boating and canoeing while enjoying the scenic water feature. Because of the complexity of this type of facility and the required permitting it is recommended that a preliminary drainage study be completed to determine the extent of flood mitigation and total amount of land acquisition that would be required for this project. The study should also compare the viability of a dry detention basin and a wet detention basin.

Figure 8-2 – Westside Park

8.1.2 Trails Park

Trails Park is a 2.5 acre park located South of Fry road just west of Northwest Park. This park is of linear form and can be found surrounded by residential neighborhoods (See **Figure 8-3**). At the northeast portion of this park there is currently an area of open space above a drainage swale, which runs through the center of the park. At this northeast location, a wetland area can be constructed and serve as a dual purpose

Figure 8-3 - Trails Park

facility. Constructing a wetland at this location will be visually appealing to the neighborhood and the citizens who drive down Fry Road. During flooding, water will also wash down into the wetland and provide additional water storage while filtering water from roads and yards. Almost any of the parks would be able to utilize a wetland or dry basin within their boundaries.

8.1.3 Old City Park

The City of Greenwood is currently evaluating the revitalization of Old City Park located southeast of the intersection at Main Street and Madison Avenue. The City is looking into improving the park site including the area surrounding Pleasant Creek. This area will be lined with wetland plants, boulders, weir and stone seating, and other natural features. The boulders serve as an internal dam system and the middle of the park also serves as a detention basin. As a result, this dual purpose facility is not only visually appealing but also includes both water quality and quantity benefits.

8.2 Future Growth and Development Areas

Within the Greenwood Comprehensive Plan, Future Growth and Redevelopment Areas have been identified. One of these areas is specifically categorized as a Regional Entertainment Area and is located south east of the intersection at East County Line and North County Road 200E (See **Figure 8-4**). This area contains an undeveloped parcel which can be developed into a dual purpose facility. Purchasing this parcel and constructing a detention pond would benefit the City of Greenwood. The detention pond will be able to store runoff from surrounding areas due to its low elevation and potentially influence businesses to develop within the surrounding area.

Figure 8-4 – Regional Entertainment Area

Overall, incorporating these dual purpose facilities will provide holistic solutions to the City of Greenwood's infrastructure. These facilities will help to overcome current park deficiencies and help meet future park needs. An additional example of a dual purpose facility is mentioned in **Section 6.3**, referencing the alternative of constructing a trail along Fry Road. Implementing this alternative will aid in lowering the trail deficiency and will also provide several recreational

opportunities within the community. The current 10-year capital budget for the construction of these dual purpose facilities is $250,000 each and assuming that two of these types of facilities will be constructed. This does not include the West Side Park flood control facility, or the Old City Park project which would be budgeted under the current capital plan. Using this budgeted money to construct these sites should overall improve the quality of stormwater and assist in the prevention of future flooding.

9 IMPLEMENTATION

Proper implementation of the selected alternatives from this plan requires the coordination of design, permitting, land acquisition, financial, accessibility, stakeholder, and scheduling aspects of each project.

9.1 Design Considerations

Each of the projects requires some level of design to ensure proper sizing of facilities, proper coordination between utilities, and proper coordination between the various agencies involved in these projects. Some of the projects, specifically much of the capital improvement projects, will require a significant amount of design. These projects will require the detailing of rim elevations, invert elevations, pipe sizing, utility locations, and numerous other design activities.

9.2 Permitting Considerations

Permitting will be required for all the capital projects and for some of the maintenance projects as well. These permits will vary from project to project, but most will deal with permits relating to water quality through Indiana Department of Environmental Management's (IDEM) Rule 5 program. Local permits will also be required on the projects that may interrupt local traffic patterns, and require partial or full street closures. There will be some permits required from the Department of Natural Resources, especially the projects that will be dealing with modifying flow patterns and flood mitigation.

9.3 Financial Considerations

Implementing the projects will greatly depend in the availability of funds, and the means with which to raise the funds. Each project will have a unique set of circumstances surrounding the project, and which funds can be used to design and construct it. The detailed opinions of probable costs were generated to help establish a base line, which will allow the City to obtain funding. No costs for easements or land acquisition were included, but generally residential parcels cost around $2,500 per parcel. The assumptions for all projects also did not include any unusual/unexpected poor soil conditions, environmental issues (i.e. soil contamination), or unusually high water tables requiring dewatering. These detailed opinions of probable costs are provided in **Appendix H**.

9.4 Stakeholders

There will be numerous stakeholders involved with this project. The majority will be home/private property where the projects are taking place, and if any easements are required for

construction. Depending on the amount of repair or replacement for the Southern Bowl Project, an easement might be required from the Indiana Department of Transportation (INDOT).

9.5 Scheduling

Scheduling of projects is an important factor in developing any implementation plan. Scheduling projects before or after certain projects could be the result of several different considerations. Some of the considerations are as follows:

- The development of downstream conveyance (i.e. storm sewers, channels) alternatives generally precedes that of upstream conveyance alternatives;
- Development of detention & retention alternatives generally precedes that of conveyance alternatives;
- One particular project may address more critical and eminent problems within the system;
- Project development may depend on easement acquisitions, permitting, and other factors.

9.6 Recommended Implementation Plan

Table 9-1 summarizes the recommended implementation schedule for the various master plan projects.

Table 9-1 - Implementation Schedule

Project Name	Capital Project Cost	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Pleasant Creek (ACOE Project)	$ 7,750,000				$ 250,000	$ 250,000	$ 2,650,000	$ 4,250,000	$ 350,000			
John Bonner (Fry Road & Loews Boulevard)	$ 890,000	$ 340,000	$ 540,000									
Southern Bowl	$ 360,000		$ 360,000									
Green Valley Neighborhood	$ 1,570,000				$ 500,000	$ 1,070,000						
Tracy Ditch	$ 1,100,000										$ 1,100,000	
Old City Park	$ 875,000		$ 175,000	$ 700,000								
Valle Vista	$ 50,000	$ 50,000										
Endress Place Development	$ 140,000					$ 140,000						
Northern Park	$ 30,000	$ 30,000										
Lakeview Additions	$ 18,000	$ 18,000										
Pleasant Run	$ 999,975								$ 999,975			
Bomar Lane	$ -											
Southern Green	$ 300,000							$ 300,000				
Eden Estates	$ 190,000									$ 190,000		
Country Aire Subdivision	$ 296,000										$ 296,000	
Yearly - Misc. City Wide Projects	$ 2,500,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000
SW Spending on Transportation Projects												
Parks/Educational Project Number 1	$ 225,000	$ 225,000										
Parks/Educational Project Number 2	$ 225,000									$ 225,000		

NOTE: THIS SCHEDULE IS SUBJECT TO CHANGE BASED UPON CLIENT INPUT, AND SHOULD NOT BE CONSIDERED FINAL.

10 FUTURE NEEDS AND GOALS

The alternatives presented earlier in this report provide relief from the current surface flooding. Additionally, the proposed maintenance alternatives will help to preserve the system elements that are not replaced by any of the capital improvements. These improvements both capital and maintenance will be a great start to resolving stormwater related issues within the City limits. However, these improvements should not be considered the end of improvements to the community.

10.1 Stormwater Asset Inventory & Management

As the City of Greenwood begins to move forward with the Master Plan, and receive additional monies, the City should begin to build a system that would keep an inventory of their current stormwater assets. This inventory should keep a detailed account of pipe material, size, and condition; any detention basins currently operated and maintained by the City; and any regulated drains currently operated and maintained by the City. This inventory will be another tool that the City can use to develop and maintain their current stormwater infrastructure, and will allow City staff to more accurately project infrastructure needs.

10.2 Conclusions

The work and cooperative effort that went into this Master Plan has indentified significant problems within the Greenwood Storm Sewer System. Additionally the improvement alternatives, both the capital and maintenance, presented provide a guideline on how to prepare the system to last for many more decades. The problems affecting the City of Greenwood's existing infrastructure are from several decades of age and use, and will take many years to rectify. The solutions will take several years to complete, and will take a cooperative effort and commitment. It should be noted that the issues in this plan are not static, and new issues may come up and will need to be incorporated into the program.

11 REFERENCES

[1] US Army Corps of Engineers, Louisville District. (October 2006). Flood Damage Reduction Study. *Draft Detailed Project Report Pleasant Creek: Greenwood, Indiana*

[2] HNTB Corporation. (November 2007). Five Year Park and Recreation Master Plan 2007 – 2012.

[3]City of Greenwood Board of Public Works and Safety. (May 1991). Interlocal Cooperation Agreement for the Maintenace of the Tracy Ditch. *A Public Legal Drain, Inside Greenwood.* Greenwood, IN.

[4]City of Greenwood Board of Works. (April 1976). Storm Sewer Agreement. Greenwood, IN.