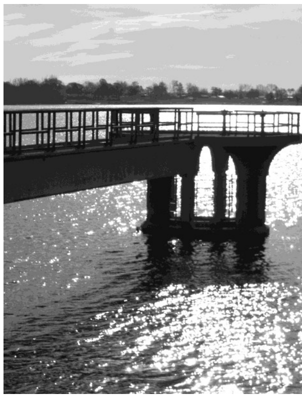

BIG CICERO CREEK WATERSHED FLOOD AND EROSION RISK MANAGEMENT PLAN

BIG CICERO CREEK JOINT DRAINAGE BOARD
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November 2014

BIG CICERO CREEK WATERSHED

FLOOD AND EROSION

RISK MANAGEMENT PLAN

Prepared for

Big Cicero Creek Joint Drainage Board
101 East Jefferson Street
Tipton, Indiana 46072

November 2014

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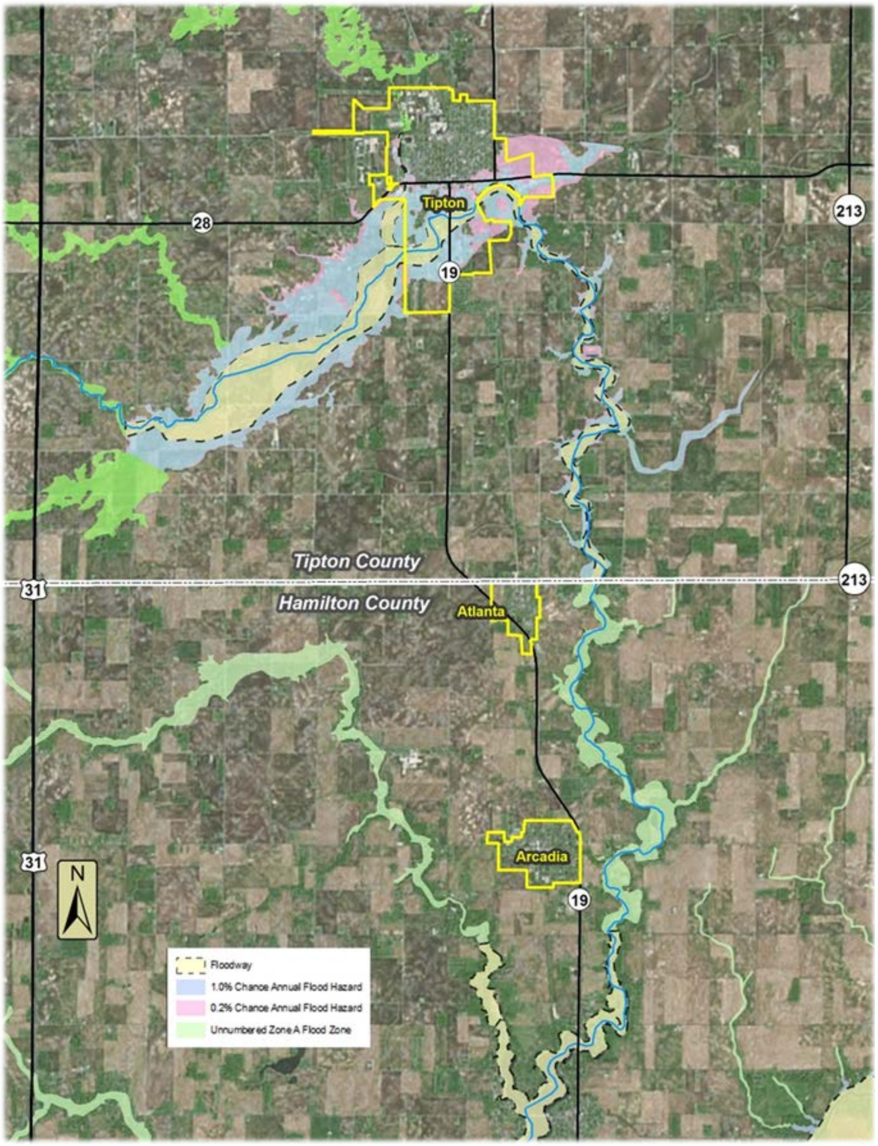
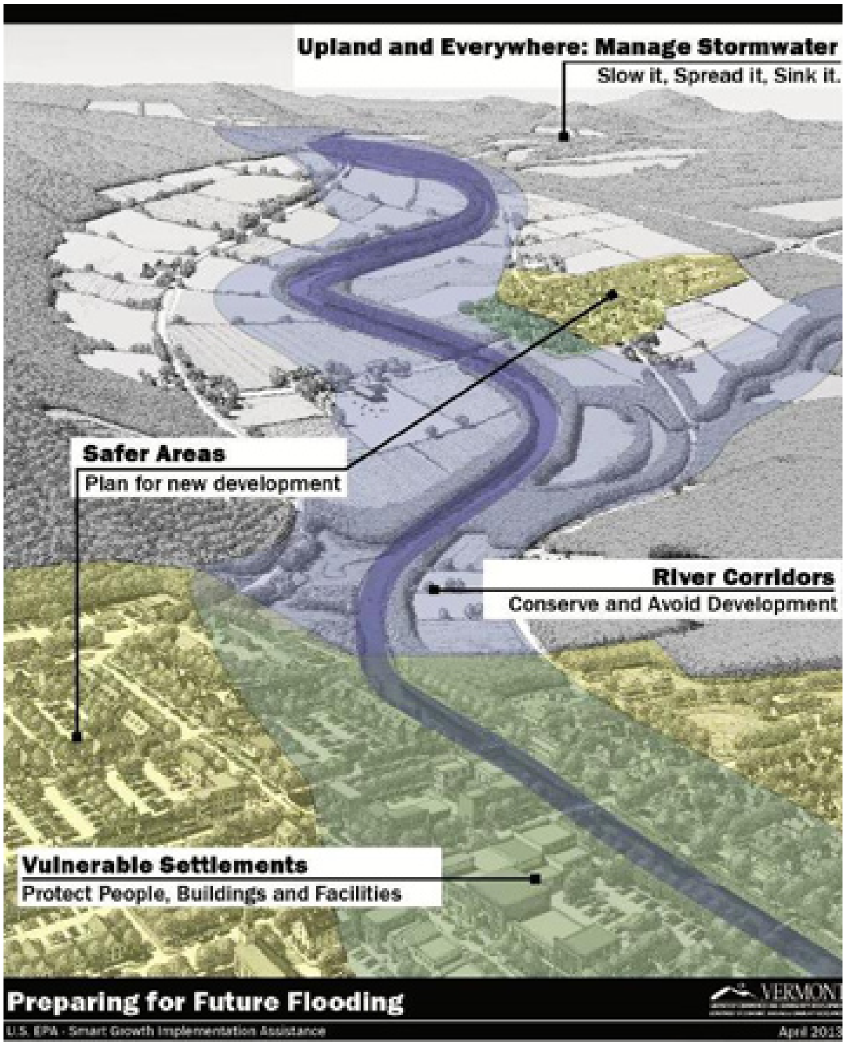
EXECUTIVE SUMMARY

Big Cicero Creek has a long history of flooding. The Flood Insurance Study (FIS) maps for Tipton and Hamilton counties show over 4000 acres of potential flood hazard in the 19-mile section of Big Cicero Creek that flows between CR 400 West in Tipton County and Morse Reservoir. Most of that impact is in the City of Tipton and the agricultural areas immediately southwest (upstream) of the city. A number of studies have been conducted to investigate potential projects to alleviate flooding in Tipton and the surrounding area. While projects have been identified, they are all very expensive, such as the proposed $30 million bypass channel. In addition, they all have negative impacts such as increased flood elevations downstream that would also require compensation.



A large concern is that the flooding could get worse. Seven of the top ten historical crests for Big Cicero Creek at Tipton have occurred since 2000. The largest impact may be from the increase in heavy rainfall. The 2014 National Climate Assessment shows that in the Midwest areas the heaviest 1% of all daily rainfalls has increased by 37% from 1958 to 2012, and that trend is predicted to continue. The effects of that increase in heavy rainfall can also be seen in changing farm practices such as converting tiles to open ditches, and the continued draining of depressional areas. These drainage modifications may also contribute to increased stream flow and flooding, but not to the degree that increased rainfall will. While elimination of flooding may not be a near term possibility, there are ways to at least prevent it from becoming worse.

Increasingly flooding and channel bank erosion in Indiana is being managed by a set of practices. Some factors that can increase flooding and erosion can be moderated by properly enforced regulations. These include: no net loss in floodplain storage (in agricultural or urban areas), no increase in flood elevations due to construction in the floodway, detention requirements for development so that post development runoff is not increased, and standards for Low Impact Design and green infrastructure. Fortunately, the Big Cicero Creek Drainage Board has already adopted some of these strategies, and has been investigating others. The image of a flood resilient watershed (left) shows how multiple approaches to managing flooding can work together.



There are also options for moderating the effect of increased rainfall, and the farm practices that potentially speed runoff and increase channel bank erosion. These include: construction of a 2-stage ditch (creating "benches" on either side of the stream, and a low flow channel to increase channel capacity), increasing soil health in the agricultural areas of the watershed through cover crops and other related practices, and developing a plan to make the area more resilient to the flooding that does occur.

The recommended 2-stage ditch, if constructed along Buck Creek and Big Cicero Creek in the Tipton area, will lower flood elevations in Tipton as well as reduce channel bank erosion. It also reduces the time out of banks in Tipton as well as upstream and downstream reaches. While it also slightly increases flood elevations downstream, the use of cover crops on even 50% of the watershed can offset those increases. Rainfall increases are likely to still be higher than what these options can offset. Therefore, the development of a plan to make Tipton more resilient to flooding is recommended.

The recommended plan components described above along with some additional components that support these major components are:

1) Initiate an update to existing stormwater ordinances and technical standards to ensure preservation of upstream floodplain storage (in both urban and agricultural areas), institute requirements for channel protection volume, and promote LID and green infrastructure in urban areas.

2) Promote and incentivize use of cover crops or other soil health practices by farmers to provide additional flood storage within the watershed.

3) Construct a 2-stage ditch/channel improvement along the lower reach of Buck Creek and the reach of Big Cicero Creek through Tipton to stabilize erosion and sedimentation and also to partially compensate for the impacts of climate change and/or agricultural practices.

4) Develop a Flood Resilience Plan and implement flood resiliency measures in Tipton. Recommended measures include buyout and floodproofing of at-risk homes, individual perimeter protection of major critical facilities, establishment of flood-safe routes, and preparation of a Flood response Plan.

5) Maintain and upgrade existing USGS stream gages to have the capability of continuous sediment and water quality monitoring

6) Conduct additional flood risk determination studies along Prairie Ditch and Tobin Ditch.

7) Establish and adhere to best maintenance practices along open channels to minimize and manage stream bank erosion issues, looking at each situation individually in order to take measures that address the real reason for the erosion at that location.

CHAPTER 1 BACKGROUND

Flooding is a long standing problem in the Big Cicero Creek watershed as the following 1913 photograph of a house at the corner of Adam and Independence Streets in Tipton indicates (**Figure 1-1**). Notice the man and horses standing near the house in the right hand portion of the photo. Based on this photograph, and images taken during the April 2013 flood, the 1913 flood appears to be the flood of record in the Tipton area.

HIGH WATER, 1913—ADAMS AND INDEPENDENCE STREETS, TIPTON.

Figure 1-1: 1913 Flood Photograph
Source: Pershing, M.W. (1914) History of Tipton County, Indiana. B.F. Bowen & Co., Inc., Indianapolis, Ind.

This isn't a surprise. 1913 is the flood of record in many communities in the Midwest. It was a result of a storm system that affected 15 States in the Ohio and Mississippi basins. In Indiana 7-9 inches of rain fell during March on ground that was still frozen or saturated. The 1913 flood is described in many resources, but an early summary by then Acting Section Director C. E. Norquest, provides a concise summary:

> "The flood of March, 1913, is without parallel in the history of Indiana. Water stages reached were from 2 to 8 feet higher than those recorded in any previous flood; the loss of life and property was unprecedented; thousands were driven from their homes, fleeing for their lives; transportation lines were helpless through loss of track and

> bridges; telephone and telegraph lines were crippled; communities were cut off from communication with the outside world for from 24 to 48 hours; cities were deprived of light and power by the flooding of power plants; isolated towns were threatened with famine; and for a period of 3 days or more the great commercial enterprises of the State were at a standstill".

The flood history of Big Cicero Creek has to be developed from a number of sources. The best data for characterizing floods come from a long-term USGS stream gage. In the Big Cicero Creek watershed, the gage at Arcadia was installed in 2004, and the gage at Tipton in 2007. Prior to those dates we depend on observations and details of high water marks. We do know that forty four years after the 1913 flood there was a flood in 1957 which was severe enough that it prompted the dredging of Big Cicero Creek near Tipton in hopes of reducing flood levels. Peak flood stages at the USGS gage site near SR 19 have been estimated (for years when no gage existed) and compiled by the National Weather Service (NWS) and are shown in **Table 1-1**.

Table 1-1: NWS Ranking of Historic Flood Levels at Tipton

Rank	Stage	Date
1	17.09	04/19/2013
2	16.50	06/28/1957
3	14.50	12/30/1990 (P)
4	13.70	06/23/2010 (P)
5	13.33	06/21/2011 (P)
6	13.30	01/26/1962
7	12.71	01/13/2013 (P)
8	12.38	02/12/2009 (P)
9	12.19	02/28/2011 (P)
10	11.47	02/06/2008 (P)

(P) Provisional

The 1913 Flood is not included in the current list of 10 historic crests in Tipton. The NWS has not yet determined a level for that event. Based on photographs from the 1913 flood the 1913 event is likely the peak of record. In addition, the July 2003 flood level has not been added. Based on high water marks by the Department of Natural Resources, the stage was about 15.0 feet and would be the 4th highest if the 1913 is included in the list.

After the 2003 flood, Tipton residents living west of SR 19 and south of SR 28 voiced concerns about how much water is frequently on their property and the problems caused when it gets up in the crawl spaces of their homes. Water gets into heating ducts. Mold is a common problem. One home near Second Street and Adams Street was condemned because flood waters moved it off its foundation. Residents also noted that hydrostatic pressure sometimes forces water to back up into their basements. When flood waters finally recede, yards and park property are typically damaged and covered with corn stalks and other debris from upstream. Residents also expressed concern that low areas that currently hold water in the field north of the cemetery would be filled and worsen the flooding on their properties.

The National Weather Service has also compiled a list of observed flood impacts that correlate with the historic crests at SR 19. These are included in **Table 1-2**.

Table 1-2: NWS Description of Flood Impacts Correlated to USGS Gage Stages at Tipton

USGS Gage Stage	Flood Impacts
17.01	In April 2013 more than 250 homes in Tipton County affected by flood waters. More than 50 homes suffered major damage while nearly 100 had minor damage. Flooding impacted much of the City of Tipton south of SR 28.
17.0	Massive flooding of Tipton and nearby area in April 2013. Flood waters higher than in June 1957...possibly exceeding March 1913. SR roads 28 and 19 both closed by at least one foot of water. Nearby mobile home park severely flooded. Homes and businesses on South Street in Tipton flooded. Portions of the Tipton Hospital parking lot may have flooded.
16.5	Near record flooding of Cicero Creek on the south side of Tipton. Residential areas in Tipton mainly south of SR 28 are threatened and/or flooded. Water may be over SR 19. Water possibly 2 or more feet deep on portions of South Street in Tipton...CR 300 S and SR 19 a block or two south of Cicero Creek.
15	Flooding from Cicero Creek becoming serious at this level. Areas of Tipton south of SR 28 may begin to flood. Level is about 2 feet below the April 2013 flood.
13.7	During June 2010...Tipton Golf Course rated this flood an 8.5 out of 10 for severity. Tipton Golf Course closed. CR 200 was among a few roads that were flooded. Portions of Tipton Park extensively flooded by 5 or more feet of water.
12.4	During February 2009 Cicero Creek extensively flooded Tipton Park and Golf Course. Almost all of the foot bridges in the park were completely underwater. South Street in Tipton, CR 300 S and SR 19 a block or two south of Cicero Creek all flooded.
12	Unusual flooding in progress. Tipton Park is likely closed. Extensive flooding of Golf Course.
10.5	Tipton Park flooded at this level on June 10, 2013. Locally heavy rainfall of 3 to nearly 5 inches fell in Tipton County.
10	Some flooding of the low areas of Tipton Park. Water within one foot of a foot bridge in park. Portions of the back nine of the golf course are flooded. Golf Course is closed. Flooding at this level is common and rates a 3 out of 10 for severity by the golf course.
8	Bankfull level for Cicero Creek in the Tipton Area. Flooding begins at local golf course.
7	High levels along the Cicero Creek in the Tipton area.

In part in response to the repeated flooding, the Big Cicero Creek Joint Drainage Board (Board) was established in 1991 to facilitate maintenance and, if needed, reconstruction along Big Cicero Creek in Tipton and Hamilton Counties. The Drainage Board consists of representatives from Boone, Clinton, Hamilton, and Tipton Counties since the watershed extends into each of these counties as shown in **Figure 1-2**. However, the actual legal drain of Big Cicero Creek is in Hamilton and Tipton Counties. The formation of a joint county drainage board to manage a watershed is an example of best management practices for watersheds and serves as a model to other watersheds of how to coordinate efforts to manage both water quality and quantity problems.

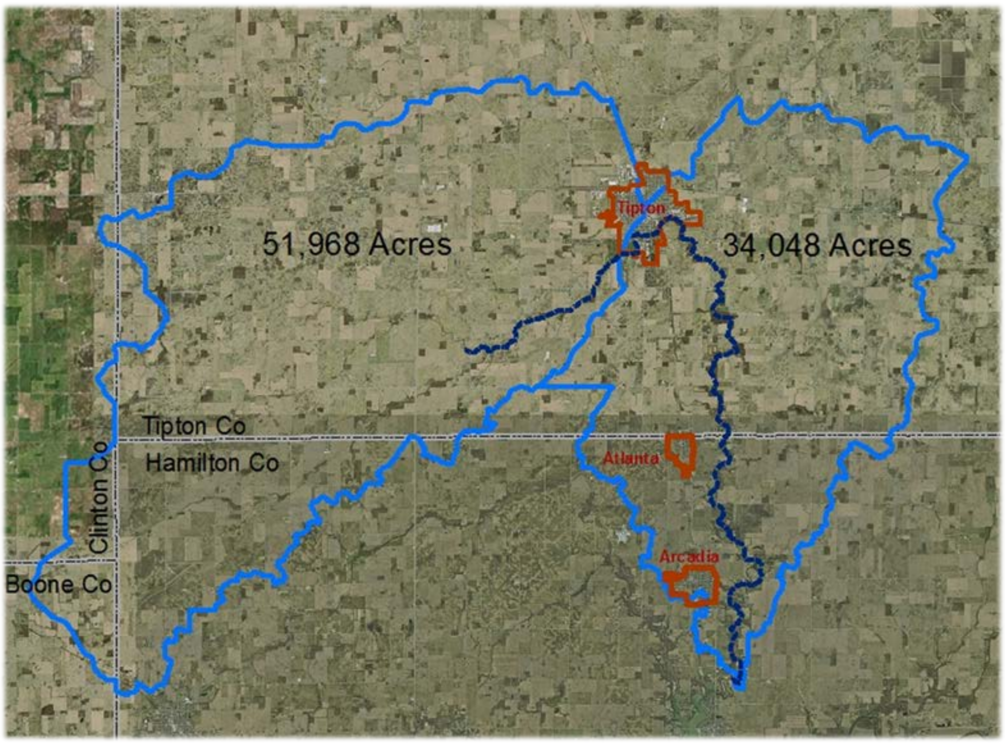


Figure 1-2: Big Cicero Creek Watershed above Morse Reservoir

Since its establishment, the Board has undertaken logjam removal, ditch bank vegetation control, and other ditch maintenance/ reconstruction activities to provide an adequate drainage outlet for agricultural fields within the watershed. In addition, the County Drainage Boards have done similar activities to maintain tributary ditches.

In late 2005, the Board commissioned a study to evaluate flood protection alternatives to mitigate known flooding problems along Big Cicero Creek from County Road 500 West downstream through the City of Tipton. The study focused on analyzing the amount of flow in Big Cicero Creek, identifying the existing flooding problems, and using the analysis to recommend ways to eliminate flooding in the town of city of Tipton and reduce flood duration of agricultural lands. The results of the study were published in a November 2006 report titled: "Big Cicero Creek Flood Control Study".

The major recommendations of the study included extending the hydraulic modeling and mapping downstream through Hamilton County to better define the flood risk areas and also be able to evaluate the impacts of upstream flood control projects on downstream reaches; a channel improvement project along a reach of Cicero Creek to somewhat reduce the extent and duration of flooding at an estimated cost of $3 million (although this project did not meet the technical criteria set for the project, the Board agreed it was the only cost-effective solution with a reasonable chance of getting funded); amending existing floodplain and stormwater ordinances to include "no net loss floodplain storage" and updated on-site detention requirements to prevent increase in potential flooding caused by new development; and additional funding towards existing and proposed USGS stream gages.

The Board's adoption of a "no net loss" floodplain storage amendment is significant. It recognized that flooding will occur naturally and that floodplains are the storage areas for floodwaters. It also recognized that there is remarkably little storage in the Big Cicero watershed. As shown in Figure 1-2, the Big Cicero watershed above Morse Reservoir can be characterized as two "lobes". The City of Tipton is situated where the two lobes connect. Of the 51,968 acres in the west lobe, only 512 acres are alluvial, or floodplain soils. The east lobe has a slightly higher percentage, with 1280 acres of floodplain soils out of 34,048 acres.

The reason for the very low percentage of floodplain goes back to the natural characteristics of the basin. The soils in the basin are predominantly poor to very poorly drained. To drain the landscape, the few natural channels were increased in length and new channels were added. By early accounts (1883), over 190 miles of channel were constructed in Tipton County alone. (Source: Hurst, L.A. and Grimes, E.J. (1914) Soil Survey of Tipton County, Indiana. U. S. Department of Agriculture, Bureau of Soils. Washington D.C.) These "new" channels were built straight and deep (with no floodplains) in order to quickly move the water off of the landscape.

Figure 1-3: Looking North from CR 300 South across Field towards Big Cicero Creek during 2003 Flooding

The primary large natural storage in the west lobe of Big Cicero Creek was a low lying depression near the confluence of Prairie and Cicero Creeks that was called "Devils Den" by the early settlers. (*S*ource: Overdorf-Thornton, J. (1996) The Overdorfs of the Devil's Den: Tipton County, Indiana, Circa 1875-1995. Hendershot & Associates)

After a heavy rain the basin would have looked like a lake. It still does as **Figure 1-3** shows. Other than the "Devil's Den" area, the only natural storage in the basin were the numerous small depressions that dotted the landscape.

Tilling has removed some of the small depressions so that current storage along the creek consists of the remaining depressions, the small amount of natural floodplains and the old Devils' Den depression. The Devils' Den depression is now farmed, and the natural outlet of the depression is located at the southwest corner of Tipton. Any additional loss of floodplain storage will only increase flooding, so the Board's move to preserve what there is should be commended.

Subsequent to the 2006 study findings, the Board initiated implementation of those study recommendations. Hydraulic modeling and mapping were extended down to Morse Reservoir and provided to IDNR for use in updating the Flood Insurance Study to more accurately represent risks, an updated stormwater management ordinance along with technical stormwater standards were developed and adopted by the Board, the Board began to fund and has continued to fund a USGS stream gage at Tipton, and design plans were prepared for the channel improvement projects. However, the Board was unable to secure additional funding for construction of the channel improvement project, mainly due to City residents who objected to aspects of the assessment strategy and maintained that the degree of flood relief did not adequately address the flooding concerns within the City.

In April 2013 a major storm delivered an average of 4.5 inches of rainfall across the Big Cicero Creek watershed. Major flooding and some erosion along Big Cicero Creek in Tipton and surrounding agricultural areas resulted. An aerial view of the flooding is shown in **Figure 1-4**.

Figure 1-4: Aerial View of Tipton during April 2013 Flood

Tipton reported \$2.5 Million in damages, primarily in the low lying residential areas in the south west corner of the city between 1st and 4th Streets. Seeking to address the observed flooding in the City with a major flood control project, assuming that additional funding could be obtained from outside interests, the Mayor of Tipton requested that the Drainage Board initiate a study to evaluate the impacts and refined cost estimates associated with a proposed plan to bypass high flows around Tipton. This alternative had been considered as part of the 2006 study and found to have technical effectiveness. However, it had not been recommended at the time due to the high cost associated with the plan. This study was undertaken and the results provided to the Board in November 2013. The study concluded that the proposed project could provide flood relief in Tipton but at a cost of about $30 million plus the cost of offsetting negative impacts requiring mitigation in the stream reach downstream of the bypass channel reconnection to Big Cicero Creek.

The Board has also recently initiated efforts to address bank erosion and instability along Big Cicero Creek in the City of Tipton as well as near Whistler Road and Forkner Drain and Mount Pleasant Road and 256th Street in Hamilton County. Concerns have also been raised regarding the significant amount of sediment that is reaching the Morse Reservoir, a major source of water supply for the City of Indianapolis.

Since large scale projects to essentially eliminate flooding in Tipton have been found to be extremely expensive and create negative downstream impacts, the Board requested investigation of a number of smaller scale practices that could at least reduce the risk of increased flooding and erosion issues through development of an integrated watershed flood and erosion risk management plan (this plan). The goal of this plan is to address flooding and erosion risks in such a way that:

- economic viability of the City and agriculture is maintained or enhanced
- the community sustainability and resiliency to flood-related risks is increased
- flood threats to critical facilities and major transportation system components are reduced
- guidance is provided to the Board for management of and reduction of the Big Cicero Board expenses associated with sedimentation/ dredging and streambank erosion problems, and,
- long-term sedimentation in Morse Reservoir is reduced

This Plan summarizes alternatives from previous studies as well as new approaches in order to provide an integrated approach to manage the flood and erosion risks to achieve these goals. The additional information now available from the USGS stream gage at Tipton was used to further calibrate computer modeling and provided critical information for use in this Plan. This type of integrated water resource planning, or management, is becoming the preferred approach to address the number of related issues that frequently drive flood and erosion risks.

CHAPTER 2 EXISTING CONDITIONS

The Big Cicero Creek watershed can be divided into two sections, or lobes that reflect different natural drainage characteristics. The west lobe has a drainage area of approximately 80 square miles. This area was historically very poorly drained and has been extensively modified to enhance drainage for agricultural use. Early accounts of the settling of Tipton County describe the ditching that took place to drain the land. The west lobe and the east lobe meet right in the City of Tipton as shown in **Figure 2-1** where Big Cicero Creek abruptly changes course and begins to flow straight south. The east lobe adds another 55 square miles of drainage area to the watershed by the time the creek reaches Morse Reservoir. The land use in the upper watershed in the west lobe is almost exclusively agricultural, and is primarily row crop. The east lobe is also primarily agricultural, but it has more residential areas, including the small towns of Atlanta and Arcadia. Atlanta and Arcadia are outside of the Big Cicero Creek floodplain. While flood damages occur throughout the watershed, recent losses have been concentrated in and around Tipton.

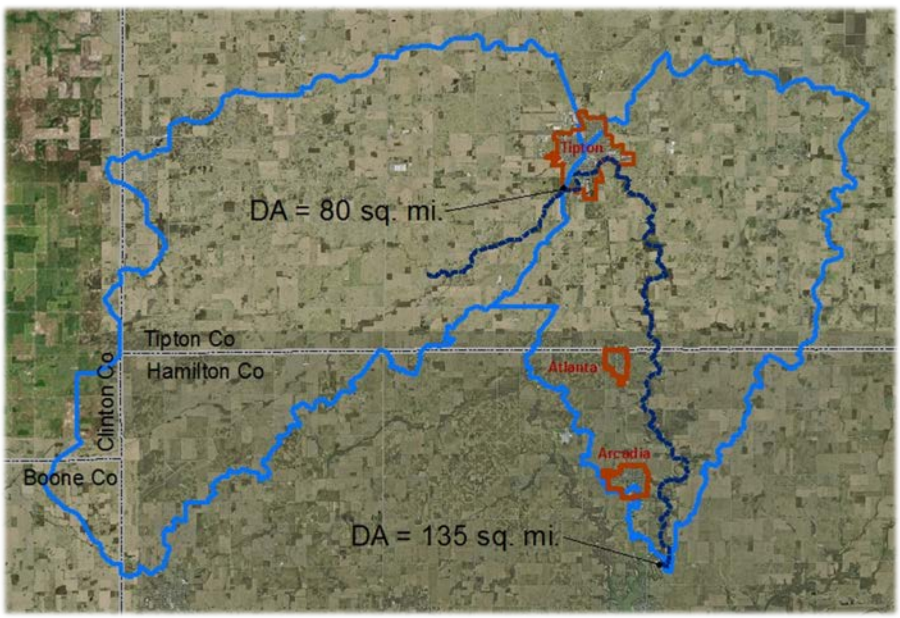


Figure 2-1: Big Cicero Creek Watershed above Morse Reservoir

The Flood Insurance Studies (FIS) for Tipton and Hamilton Counties show the Big Cicero Creek regulatory floodplain between Morse Reservoir at the downstream end and County Road 400 West at the upstream end. This is shown in **Figure 2-2**. As can be seen, the identified floodplain is much larger in and west of Tipton than south and includes large areas in Tipton as well as many acres of farm ground. South of Tipton, the floodplain is more confined and includes more wooded areas.

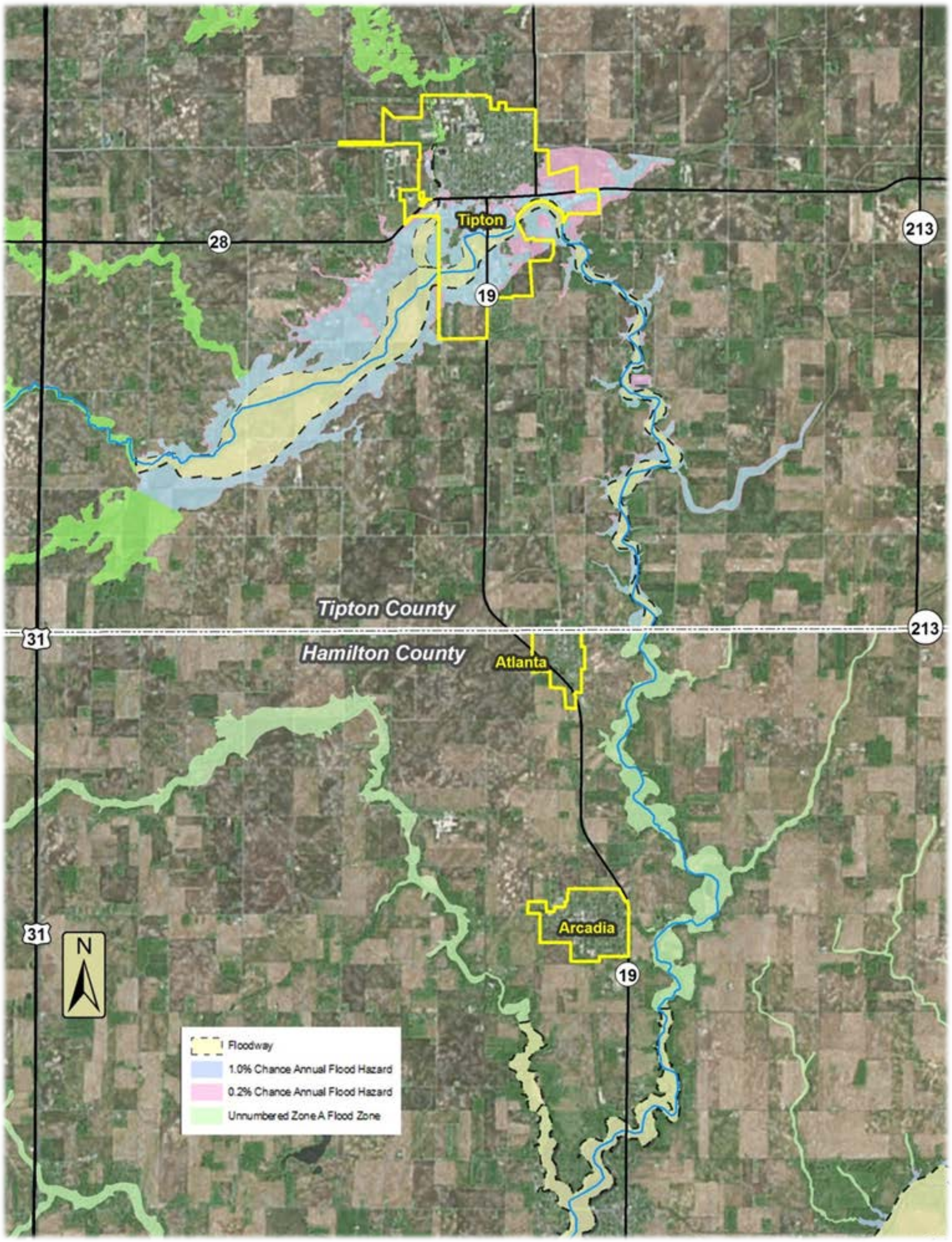


Figure 2-2: FIS Flood Hazard Areas

For the 19 mile reach of Big Cicero Creek studied, approximately 4000 acres were flooded in the April 2013 event (which was just a little lower than the FIS regulatory flood). Of those 4000 acres, only 1300 acres are downstream of Tipton and spread out over 12 miles of stream (an average of 108 acres flooded per stream mile) compared to the 2700 acres in Tipton and upstream that spread out over about 7 miles of stream (an average of 385 acres per stream mile).

2.1 FLOOD RISKS

2.1.1 Agricultural

Flooded farm land, unlike urban areas, may not be damaged, especially if no crop is in the field. Even if a crop is in the field, it can endure low velocity flooding for varying lengths of time depending on temperatures. Therefore, flood depths are not as much of a problem as flood duration. Flooding that lasts 3 days or more will likely destroy the crop. Flooding less than 2 days will likely not significantly damage the crop.

As seen above in Figure 2-2, the regulatory floodplain in and west of Tipton is large. The regulatory floodplain is typically associated with a flood that has 1% annual chance of occurrence (sometimes called a "100-year" flood). Much more common are floods that have a 50% annual chance of occurrence (sometimes called a "2-year" flood). The 50% annual chance flood discharge is considerably smaller than the 1% annual chance regulatory flood discharges so would typically be expected to be confined within channel banks or at most create a much smaller floodplain. However, the 50% annual chance floodplain in the agricultural area west of Tipton is not much smaller than the 1% annual chance floodplain as seen in **Figure 2-3**. It encompasses on the order of 2000 acres. These farm fields provide valuable storage that controls peak flood elevations downstream. These more frequent floods and their associated duration of inundation are the floods with the larger impact to farmers.

Figure 2-3: Big Cicero Creek 50% Annual Chance Floodplain West of Tipton

Big Cicero Creek downstream of Tipton has a smaller regulatory floodplain and is comprised of more wooded areas that have not been farmed. Potential crop damage due to flooding in those reaches is therefore much less extensive.

A flooding of sorts may also occur in all farm fields from too much water in the root zone for the crop. To address this ponding of water on and in the soil, farmers have added drain tiles and ditches to get the excess water off the fields in a timely manner. This drainage is an important part of the farm economy as drainage increases yields significantly and provides more flexibility in timing of field operations. An image of the soils in the Upper White River watershed of which Tipton County is on the northern edge, shown in **Figure 2-4**, indicates just how naturally poorly drained Tipton County is. According to the Natural Resource Conservation Service (NRCS), these poorly drained and very poorly drained soils in Tipton County and the rest of the drainage area have drainage tile if farmed.

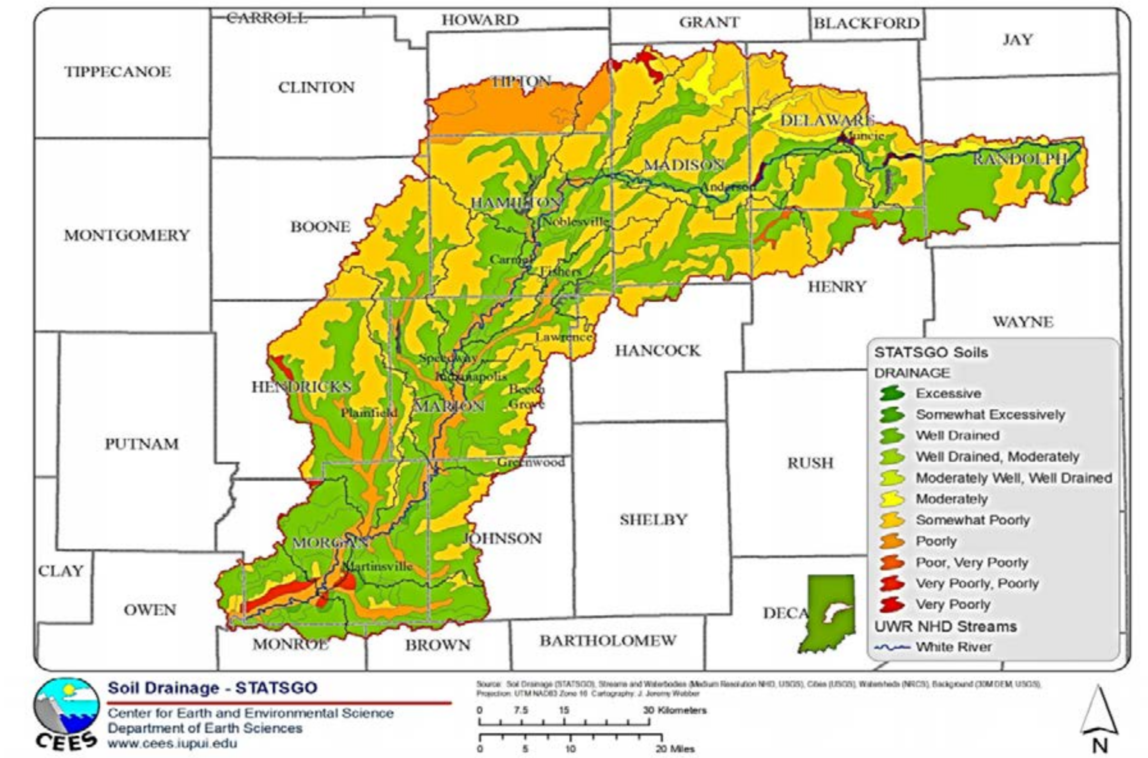


Figure 2-4: Soil Drainage Characteristics in the Upper White River Basin

NRCS soil scientists believe that current drainage systems in the Big Cicero Creek watershed include tile lines buried at 50 to 120-foot intervals in a field and connected to a main lateral pipe. Farmers may add additional lines creating down to 25 foot spacing of tiles but in this area, even these systems release water to ditches very slowly per NRCS. The tile lines feed to a lateral pipe which then outlets to a bigger pipe carrying flow from another field or to a swale. These swales or ditches feed into a system of other ditches from other fields until they reach Big Cicero Creek. Such drainage practices have provided great benefit for the farmers but have also long been blamed for increased flooding of downstream areas.

These systems are maintained through reconstruction of degraded ditches and tiles and by spraying vegetation to reduce resistance to flow in the ditches. As regulated ditches or tiles degrade, various drainage boards operating within the watershed reconstruct them to their original dimensions, thus reestablishing the capacity they once had. Spraying prevents woody vegetation from getting established and creating additional resistance which would reduce ditch flow capacities.

2.1.2 Urban

The April 2013 flood highlighted the reality of the flood risk in Tipton and showed that flooding has the potential to cause severe economic and population decline in the south sections of the city or to cause relocation of some institutional and recreational facilities in the years ahead. **Figure 2-5** shows an aerial view of the April 2013 flooding in town. In the background, the large ponding area in the fields upstream of town can be seen. In town, water is in many of the streets and surrounds or is in many buildings.

Figure 2-5: Aerial View of Tipton during April 2013 Flood

Institutional properties (schools, hospital and other health care facilities, parks, golf facilities, trails, cemetery, wastewater facility, and the county owned 4-H grounds) were all affected adversely by the April 2013 flood. The school, health care and hospital buildings were not directly flooded but were inaccessible or very close to being flooded. These facilities are the core of Tipton and its community and economic development efforts. The location of these and other critical facilities as well as residential and business buildings in relation to the Tipton portion of the FIS regulatory floodplain is shown in **Figure 2-6**. This information, along with the Big Cicero Creek floodplain for Tipton and Hamilton Counties is also provided on **Exhibit 1**. This is the area of largest impact in terms of number of people affected.

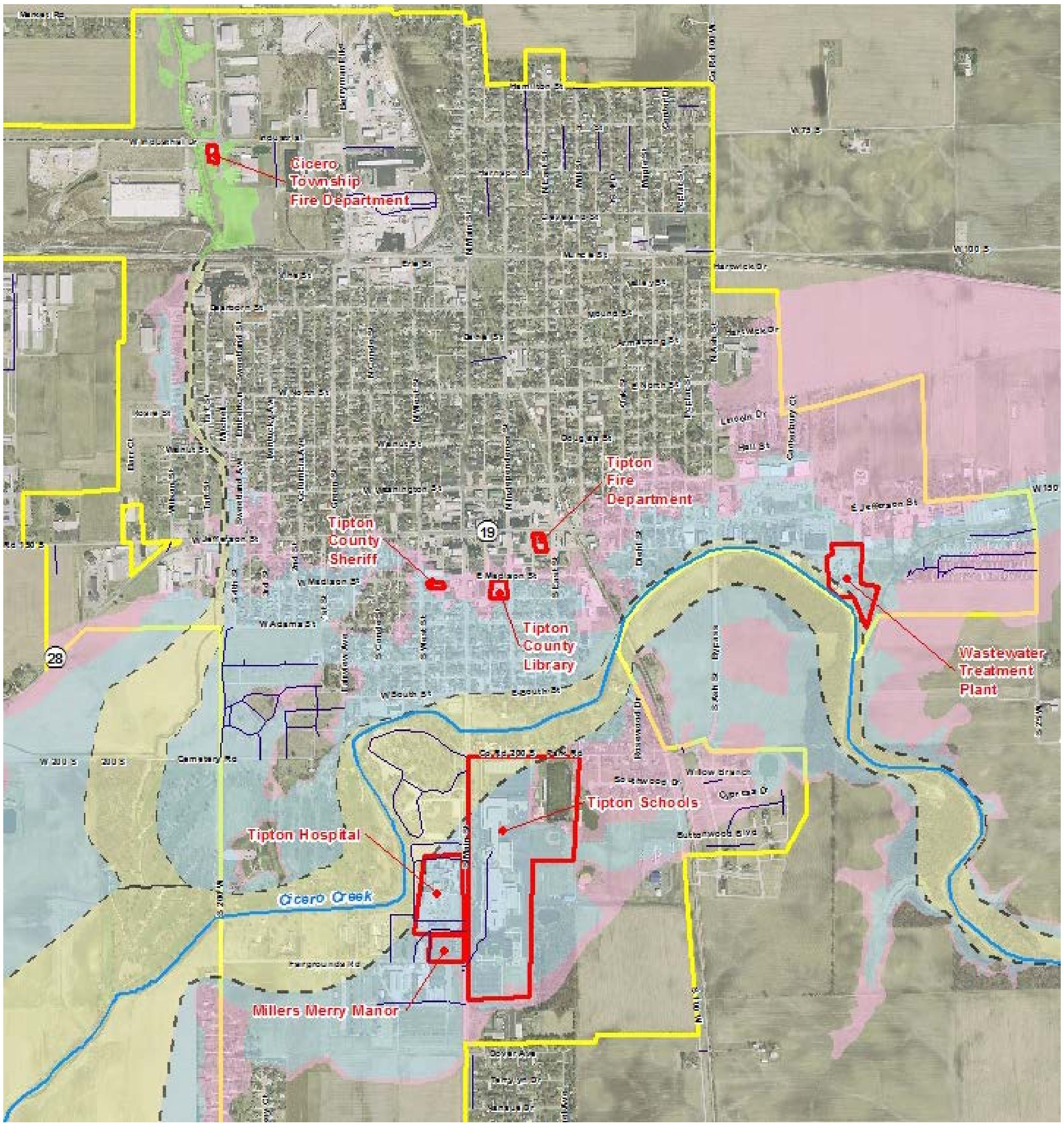


Figure 2-6: Critical Facilities (based on Google Maps) in Tipton in Relation to FIS Floodplains (High Flood Risk – blue and yellow shaded areas, Moderate Flood Risk – pink shaded area)

Unlike the agricultural areas, the length of flooding in urban areas has little impact on flood damages. If a building is flooded, it sustains damage and people are potentially displaced. According to the Tipton Mayor, Don Havens, some 50 residential, business and institutional properties were affected by the April 2013 flooding of Cicero Creek. An estimated 30 of these residential properties will eventually be mitigated by demolition with limited infill (or rebuilding) possibilities.

Integrated flood hazard management will require the consideration of more than just the physical factors involved in flood risk. According to Mayor Havens, another floodplain related concern for the City is the consequence of expensive flood insurance on lower valued properties. A lack of personal funds to pay the increased flood insurance premiums that are becoming part of the National Flood Insurance Program may cause large scale abandonment of properties in identified flood prone areas.

Approximately 575 structures were identified in the FIS high flood risk area. Structures shown in the high risk floodplain have a 1 in 4 chance of being flooded over the next 30 years. That's 27 times more likely than a fire during that 30-year period. An additional 200 structures were identified in the moderate flood chance area and have a 1 in 17 chance of being flooded during the next 30 years.

Local leaders expect a failure to mitigate flooding from Big Cicero Creek within the city boundaries may change the urban area and its future in a very negative way. The City of Tipton (the county seat) and Cicero Township, with the promise of location (17-21 miles north of Noblesville and Westfield), the promise of jobs (Chrysler), and the promise of the image of progressive agricultural practices, are viewed as potentially limited by the threat and experience of flooding.

2.1.3 Transportation

When floods occur, there is not only damage to property but roads are flooded and access to certain areas can be limited. Unfortunately, many people bypass road barriers and drive on flooded roads, not realizing that the road or bridge may be washed out or that their car can float in less than 2 feet of water.

Figure 2-7: A truck is submerged after attempting to drive through a flooded Road in Montgomery, Vt.
Source: (Vermont State Police) (weather.com "Flooding Swamps Vermont, Maine, Upstate New York, Michigan, and Eastern Canada" by Jon Erdman published April 19, 2014 7:19AM

In the Big Cicero Creek corridor, many bridge structures are significantly higher than the road approaches so people don't realize how deep the flooding is on the road leading to the bridge. Such was the case for the truck shown in **Figure 2-7**. The covered bridge behind him is shown above flood waters but the road was well below flood level.

Based on national figures, more people drown in their car than elsewhere. Drowning is the number-one cause of flood deaths. Water currents can be deceptive; six inches of moving water can knock an adult off their feet.

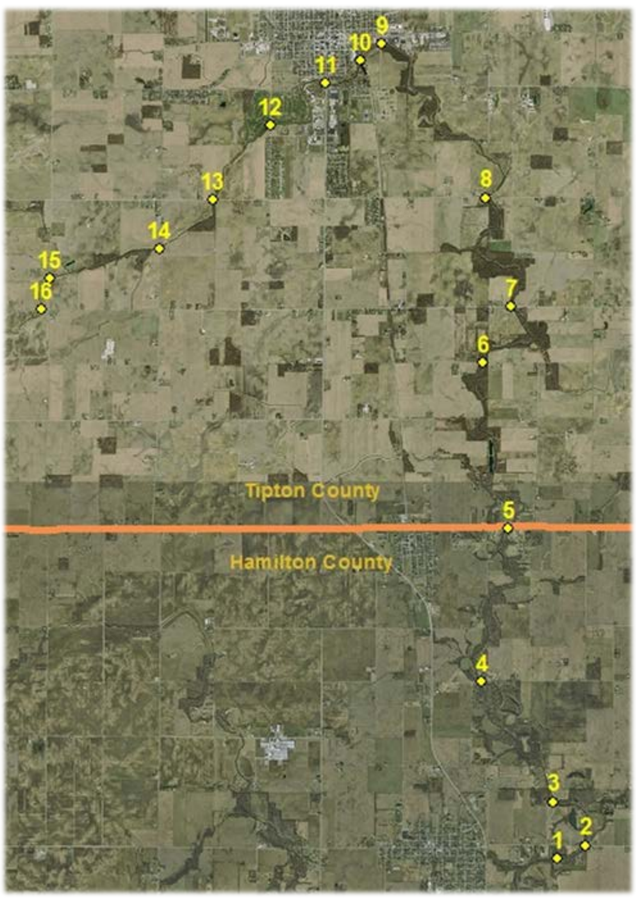


Figure 2-8: Big Cicero Creek Bridge Crossings

Figure 2-8 shows the roads within the detailed hydraulic model reach along Big Cicero Creek. **Table 2-1** lists these roads as identified in **Figure 2-8** and notes the approximate average watershed 24-hour rainfall that will cause each road to overtop. This list only includes roads crossing Big Cicero Creek so does not include those that may be flooded by tributaries.

Table 2-1: Road Overtopping Information

Road (downstream to upstream order)	ID Number From Figure 2-8	Average 24- Hour Rainfall at Which Road Flooding Begins, inches	Corresponding Approximate % Annual Chance Storm*
Mt Pleasant Road	1	2.7	50%
266th St	2	>6.0	<1%
Crooked Ck/Whistler Ave	3	>6.0	<1%
281st St	4	>6.0	<1%
296th St	5	>6.0	<1%
CR 450 S	6	< 2.7	>50%
CR 400 S	7	3.9	4%
CR 300 S	8	> 3.9	<4%
Ash St	9	>4.6	>2%
RR	10	~5.8	1%
Main St (SR 19)	11	<3.9	>4%
4th St	12	~3.9	4%
CR 300 S	13	<2.7	>50%
CR 300 W	14	<2.7	>50%
CR 400 W	15	<2.7	>50%
CR 400 S	16	<2.7	>50%

*based on updated calibrated modeling done since the FIS

2.2 STREAM STABILITY/EROSION AND SEDIMENT SUPPLY CONDITIONS

Like the flooding problems around and in the Big Cicero Creek watershed, erosion is not a new problem. The image in Figure 2-9 shows Big Cicero Creek in 1914. Note the steep banks and toppling trees. This degree of erosion is unusual today. Most of the streams are in much better condition than this image from 1914. Most of the managed waterways in the watershed are well buffered and vegetated as is seen in the **Figure 2-10** photo of Weasel Creek.

Figure 2-9: Erosion along Big Cicero Creek in 1914
Source: Pershing, M.W. (1914) History of Tipton County, Indiana. B.F. Bowen & Co., Inc., Indianapolis, Ind.

Figure 2-10: Vegetated Channel along Weasel Creek in 2014

Figure 2-11: Big Cicero Creek near Mt Pleasant Road Showing Channel (center) and Floodplain (right) Connectivity

Most of the work of stream erosion is done by frequent flows of moderate magnitude. In more natural systems these flows usually correspond with a recurrence interval of 1 to 2 years. That recurrence interval correlates with a stream stage termed "bankfull". The bankfull stage occurs when flow in the channel rises to the point that it begins flowing out onto the floodplain, if one is present. In more natural channels the bankfull stage can be physically identified in the field by using one or more indicators; the presence of a flat surface adjacent to the channel, vegetation change, or the deposition of sand. An example of this connected floodplain along Big Cicero Creek near Mount Pleasant Road is shown in **Figure 2-11**.

In highly modified urban or agricultural watersheds, runoff often increases and the bankfull stage occurs more frequently. With a more frequent occurrence of the bankfull stage the stream can do more "work", which results in more erosion. In the Big Cicero Creek watershed the bankfull stage is reached on average 12 times a year as shown by the graph in **Figure 2-12**, indicative of a highly modified system. Additionally, when a stream has downcut, or has been dredged, and the stream no longer can flow out onto a floodplain at the bankfull stage, energy is concentrated inside the active channel and erosion potential is increased.

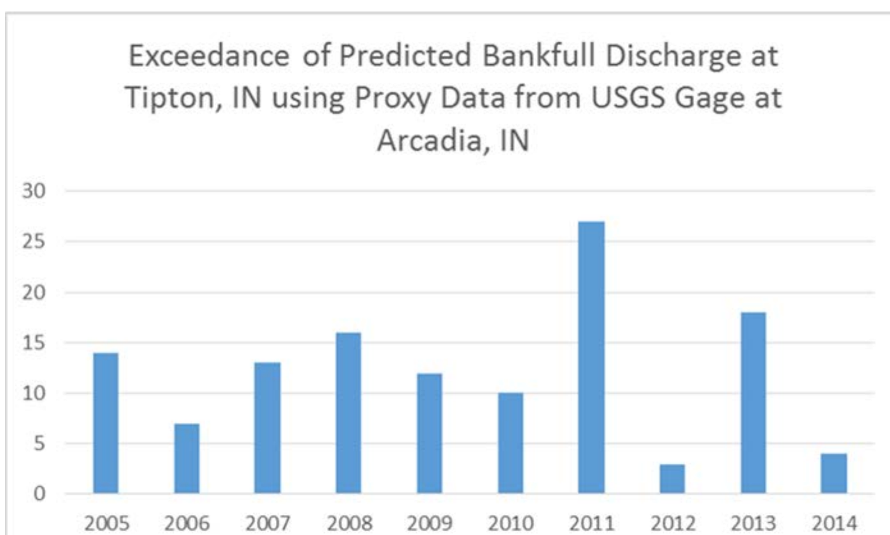


Figure 2-12: Number of Times Bankfull Discharge Exceeded by Year

To assess stream stability and potential sediment supply in the Big Cicero Creek watershed, over 90 miles of stream were surveyed in the subwatersheds as shown in **Figure 2-13**.

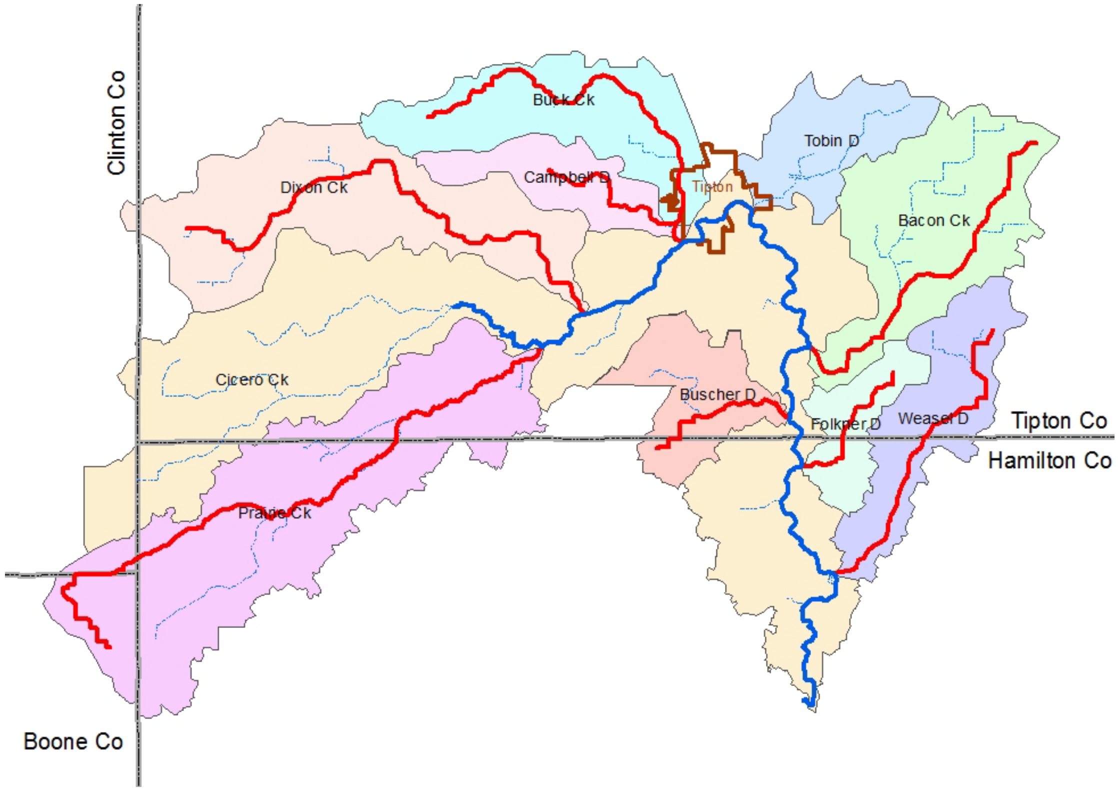


Figure 2-13: Erosion Assessment Reaches

The results were striking. Significant erosion is concentrated over the noted length in 3 subwatersheds:

• Big Cicero Creek	15,240 feet
• Buck Creek	11,150 feet
• Bacon Prairie Ditch	2,740 feet

Most of the erosion, over 22, 150 feet, or approximately 4 miles, is located in and around Tipton on Buck and Big Cicero Creeks. The area along Bacon Prairie Ditch is confined to only one reach. The increased bank instability is related to localized channel incision from historic dredging, the steep bank angle, and lack of vegetation.

Erosion hazard potential was predicted using the standard metrics associated with the bank erosion hazard index (BEHI), including bank height above the bankfull stage, rooting depth, bank angle, and surface protection. **Exhibits 2 through 4** show the results of the stream assessment along Big Cicero Creek, Buck Creek, and Bacon Creek, respectively, conducted as part of this Plan. Maps for the other streams assessed will be provided to the appropriate County Surveyor(s) only since they show minimal bank erosion locations.

2.3 SUMMARY OF EXISTING CONDITION FLOOD AND EROSION IMPACTS

For the modeled reach of Big Cicero Creek (CR400 West downstream to Morse Reservoir) approximately 4000 Acres were flooded during the April 2013 flood which was approximately equal to the FIS 1% annual chance flood area. The regulatory floodplain for the study reach includes an approximate additional 700 acres of moderate risk flood area.

The April 2013 flood highlighted the reality of the high flood risk for the area indicated in the FIS by causing damages in Tipton where it affected the schools, hospital, wastewater treatment facility, and several stream crossings, not to mention damaging about 50 residences. If the flood had occurred when crops were in the fields, thousands of acres of crops could have been damaged or destroyed, mostly in Tipton County. The Big Cicero Creek floodplain downstream of Tipton is much narrower and is largely woods instead of crop land so would not have experienced as much crop damage. Approximately 10 of the road crossings in the study reach were likely flooded in the April 2013 event, preventing normal access to some parts of Tipton and Hamilton Counties. Two deaths also occurred due to road overtopping at Mount Pleasant Road and 266th Street according to the Hamilton County Surveyor.

A stream stability assessment identified significant erosion in three watersheds. The affected reaches along Big Cicero Creek and Buck Creek are shown in **Figure 2-14**. The section along Bacon Prairie Ditch is not shown as it is confined to one area where farm animals have access to the stream.

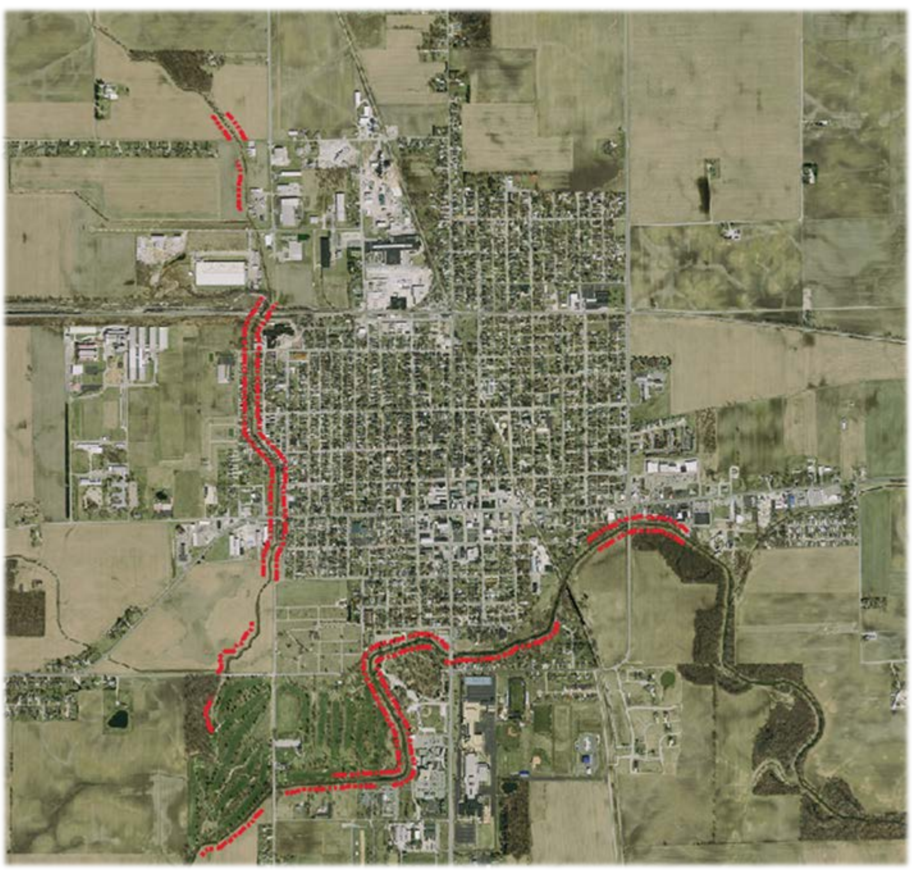


Figure 2-14: Significant Erosion Locations (shown in red)

CHAPTER 3 FUTURE CONDITIONS

Prudent planning takes not only current conditions but also potential future conditions into account. In the Big Cicero Creek watershed, several factors could impact the future flooding and erosion risks. These factors are described along with an evaluation of their potential impacts. The modeling for the FIS floodplain described in Chapter 2 was updated by calibration to the April 2013 flood high water marks and USGS stream gage rating curves. This updated modeling was used as the basis for evaluation of potential impacts described below.

3.1 FACTORS INFLUENCING FUTURE FLOOD RISKS

Changes in rainfall, runoff, and flow path capacity in a watershed have the potential to make flooding worse since they can translate into changes in flood levels and the frequency of their occurrence. The likelihood of changes in these factors and the resulting implications for flood risks in the Big Cicero Creek corridor are described in this section.

For the purpose of this report, the impacts of these factors were evaluated for two general flood severities: a 50% annual chance flood and the April 2013 flood. The 50% annual chance flood (expected to occur from a 2.7-inch rainfall over the entire watershed within a 24-hour period) was chosen to represent low-level or nuisance flooding. A 50% annual chance storm is also thought to be very close to the bankfull discharge of most streams in Indiana. The bankfull discharge is typically a major factor affecting streambank erosion and sedimentation. The April 2013 flood, which had an estimated peak discharge close to a 1% annual chance flood based on a frequency analysis of data from the USGS gage near Arcadia, was chosen to represent a major flood capable of causing serious damage.

3.1.1 Rainfall

Recent studies by the National Oceanic and Atmospheric Administration (NOAA) show an upward trend in heavy rainfall amounts. A 2009 study by NOAA showed that this increased rainfall would make the rainfall amounts that used to happen on an average of once every 20 years (5% annual chance) happen on an average of every 5 years (20% annual chance). Rainfalls over 2 inches would be expected to occur more frequently. Among other things, this means the rainfall that most often controls erosion amounts would occur more frequently, potentially increasing the frequency and extent of channel bank failures.

Documentation also suggests there will be more periods of little to no rainfall. Periods of low rainfall cause the ground to become dry and hard which tends to make any subsequent flooding worse since less water is absorbed.

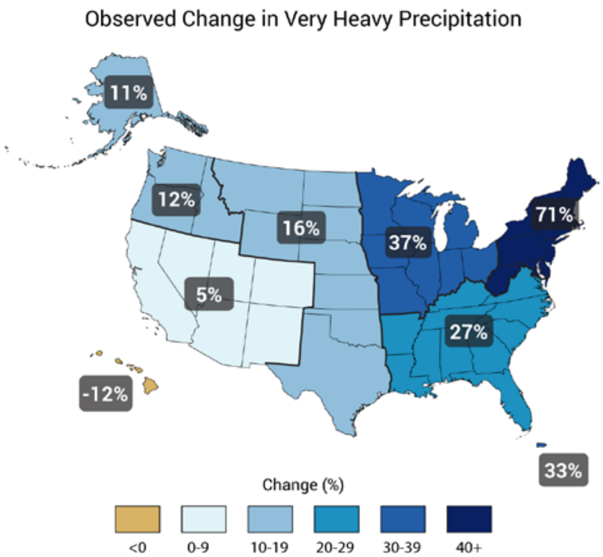


Figure 3-1: From 2014 National Climate Assessment

On August 21 and 22, 2014, just 40 miles away in Blackford County, a rainfall of over 8" covered a 170 square mile area. This is an area larger than the Big Cicero Creek watershed above Morse Reservoir. This is quite alarming given that the extent of Big Cicero Creek flooding observed in April 2013 was from just about half as much rainfall as this recent event in a relatively nearby watershed. That event may be a sign of things to come as the 2014 National Climate Assessment Report suggests a 37% increase in the highest 1% of daily rainfall amounts as shown in **Figure 3-1**.

Clear documentation of the amount of the expected increase in rainfall amounts for rare floods, such as the 1% annual chance event, was not found. However, for purposes of this plan, an increase of only 10% was assumed as an estimate of near future condition rainfall for each rainfall frequency event. Based on modeling, a 10% increase in the average April 2013 rainfall (4.6" over the watershed increased to 5.0" in a 24 hour period) would create about a half to one foot higher flood elevations, with the one foot increases happening in the City of Tipton.

An increase of 10% in rainfall depth associated with the 50% annual chance flood would increase flood elevations by about 0.7 feet. Another way to look at this finding is that the current 50% annual chance rainfall would become about a 65% annual chance rainfall so the number of bankfull events per year would increase.

3.1.2 Runoff

Land use, a major factor in runoff amounts, in the Big Cicero Creek watershed is not expected to change significantly. However, the amount of rainfall that reaches the ground and runs off to Big Cicero Creek varies based on many factors within the land use types: ground cover, soil permeability, amount of rainfall intercepted by plants, land slopes, size of depressional areas, and evaporation rates. Less ground cover, low soil permeability, steep slopes, loss of depressional storage areas, intensive agricultural field drainage, and low evaporation rates all increase runoff. The degree to which these increase runoff can vary.

Modeling along Buck Creek was used to test the impacts on one of these variables - spraying ditch banks to prevent growth of excess vegetation that would restrict flow. To reflect this practice, the channel roughness value used in the model was reduced to that for a straight channel with short grass on the banks and no obstructions instead of a straight channel with longer, thicker, taller grasses and some small bushes along the channel slopes. The results indicate that flood velocities (in the reach not impacted by Big Cicero Creek backwater) were increased by about 10% for the 10% annual chance flood (selected as an average between the 50% annual chance flood and the April 2013 flood). Extrapolation of this change in travel times in the subareas for all ditches in the Big Cicero Creek watershed would translate to less than an inch for the 50% annual chance or April 2013 floods. This is based on a comparison of the impact of travel times caused by the addition of ditches and swales to upsize outlets described below.

Research into whether or not more intensified upper watershed tile drainage increases stream flow has reached various conclusions. Some findings show increases while others show decreases. Tiling in permeable loamy soils tends to increase runoff whereas tiling of clay soils tends to decrease runoff. These findings are not true across the board however and additional research is ongoing.

While research is inconclusive as to whether or not the presence of drainage tile increases stream flow, the addition of ditches and swales to upsize outlets for the tiles has potential to increase downstream peak discharges and elevations by reducing flow time to downstream points. In addition, tiles that had originally been placed to gather subsurface drainage are being replaced by open ditches to create more capacity in the farm drainage system. In order to quantify the impacts these practices may have, the overall runoff travel time for each subbasin in the computer modeling was decreased by 1/8 to roughly equate to halving the travel time for ¼ of each subbasin's flow path (assuming ¾ of each subbasin's longest travel path is not where this practice would be applied).

Based on this modeling, it appears that addition of ditches and swales over the <u>entire</u> Big Cicero Creek watershed may increase the April 2013 flood elevations along Big Cicero Creek up to 0.5 feet near Tipton with an average of 0.3 feet in other reaches. The 50% annual chance flood elevations were increased 0.2 feet in Tipton with less than 0.1 foot increases in other reaches.

Another agricultural practice that is occurring in the watershed is the construction of swales for the purpose of draining depressional areas. An example of this is shown in **Figure 3-2**. Fence row removal may also have had the effect of draining small depressional areas. In an attempt to quantify the impact of these practices, modeling was revised to reflect the elimination of ponding to a maximum depth of 3" over ½ acre for every acre of the Buck Creek watershed.

Figure 3-2: Swale Constructed in Tiled Area along Big Cicero Creek

Based on the above assumed dimensions, the volume stored in each of these areas was 0.04 acre-feet (1750 cubic feet) per acre of watershed. For a 50% annual chance storm event on Buck Creek, if a change in equivalent total flood storage of 330 acre-feet (0.04 acre-feet per acre of Buck Creek watershed) was made, the peak flood discharge in Buck Creek changed by 5%, resulting in a change in the Buck Creek 50% annual chance flood elevations of 0.1 – 0.2 feet (~1 inch). If the change in storage was extrapolated to the entire Big Cicero Creek watershed based on similar Buck Creek discharge changes in other model comparisons, the 50% annual chance peak elevation on Big Cicero Creek may change by a couple inches in Tipton and downstream and may result in increased streambank erosion potential.

No impact to the peak April 2013 flood levels is expected due to this practice as these storage areas are small enough that they fill up before the peak runoff and can therefore not provide any attenuation of that peak. However, loss of larger depressional storage areas is expected to have a more significant impact on flooding. Therefore consideration should be given to preserving or compensating for loss of storage in larger depressional areas due to farm practices as well as due to development.

Like agricultural areas, urban areas have adopted practices that increase runoff. Urban areas do tend to have more grass than farm fields which typically allows for more infiltration of rainfall, especially since the grass is present all year long. However, urban areas also have more impervious area per acre (rooftops and streets) that prevent infiltration. In addition, storm sewers in urban areas don’t reintroduce absorbed rainfall to the runoff with a delay as agricultural tiles do but instead provide a quick, direct path to the stream for some of the surface runoff. Because the urban portion of the Big Cicero Creek basin is so small (and only because it is so small), these practices have had a very small impact on Big Cicero Creek flooding. However, potential exists for urban practices to increase peak discharges and cause streambank erosion to worsen if adequate safeguards are not put in place.

In an attempt to prevent increases in runoff due to development (not including agricultural activities) in the City of Tipton and Tipton County, the subdivision ordinance requires post development 100-year runoff to be limited to the pre development 10-year runoff. Depending on how the runoff is controlled, it may still allow increases for smaller rainfall events that could have a negative impact on downstream streambank erosion. Boone and Hamilton Counties also have the same requirement plus require that the 10-year post development runoff be limited to the 2-Year pre development runoff in an attempt to address this. Neither county has yet adopted the requirement of a channel protection volume to address control of the 2-Year / 50% annual chance and smaller flood discharges that have a larger impact on erosion. However, both Boone and Hamilton Counties are currently working on adding such a provision.

3.1.3 Flow Path Capacity

Once rainfall becomes runoff and starts to gather in streams, flood elevations are largely controlled by changes in the available channel and floodplain area for the water to flow and store and the roughness condition of the flow path. Encroachments in the area the water wants to use cause flood elevations to rise. Examples of these encroachments are buildings, fill, road crossings, levees or other embankments, landscaping, fences, and other man-made obstructions as well as naturally occurring log jams, or heavy, bushy vegetation along the creek banks. Depending on the footprint, location, and orientation within the area the water wants to flow, these encroachments can cause significant increases in flood elevations, especially when there are multiple encroachments creating cumulative impacts.

No significant floodplain flow area along the Big Cicero Creek tributaries or upstream of the Big Cicero Creek/ Prairie Creek confluence exists. The only remaining natural stream floodplain in the watershed upstream of Tipton is the area on Big Cicero Creek immediately upstream of Tipton. A loss of any of this remaining floodplain storage may have a very significant negative impact on Tipton and downstream areas.

In order to prevent the loss of important floodplain storage, the Stormwater ordinance adopted by the Big Cicero Drainage Board (as well as Tipton, Boone, and Hamilton Counties) does already have language requiring compensatory floodplain storage when new development occurs. These requirements need to be strictly enforced (in both urban and agricultural areas) to prevent the negative impacts resulting from such potential activity. For instance, if near the fairgrounds a 270 acre portion of the April 2013 floodplain that is outside of the floodway (State regulations would limit impacts of the development in the floodway) were allowed to be filled without compensatory storage, and the April 2013 rainfall and ground conditions occurred, peak flood elevations in Tipton would be increased up to 0.2 feet (~2 inches) with 0.1 foot increases continuing downstream. This 270 acre area is only a small portion of the existing floodplain storage upstream of Tipton that needs to be protected to prevent even larger flood increases downstream. The loss of storage would also have negative impacts in smaller events, such as the 50% annual chance event, because it increases the

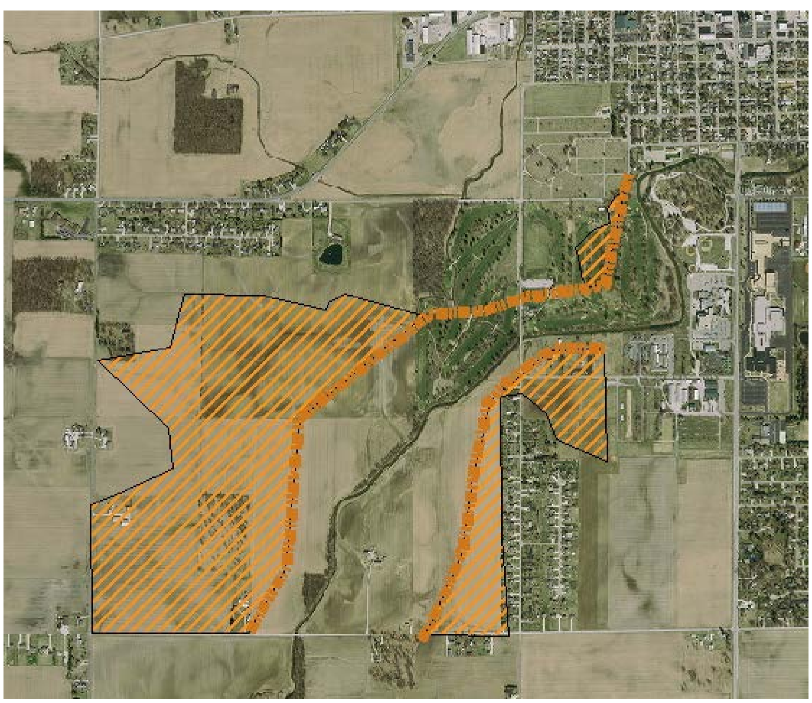


Figure 3-3: Test Fill Area West of Tipton

frequency of channel forming flows, which will lead to increased streambank erosion. Lost floodplain storage does translate to increased flood elevations and streambank erosion.

The Indiana Department of Natural Resources (IDNR) Construction in a Floodway Permit is the State's process to prevent excessive increases in flooding due to development in the floodway portion of the floodplain. Ignoring this requirement often results in increased damages from a flood. Permitted projects along Big Cicero Creek are allowed to cause up to 0.14 foot (almost 2 inches) increases in the 1% annual chance flood elevations. Experience has shown that because the 1% annual chance flood is the regulatory flood and larger or smaller events are not normally considered by the IDNR as part of their evaluation, many encroachments that are approvable by the State because they have no impact on the 1% annual chance flood can still potentially create large impacts on lower, more frequent floods or, sometimes, on larger, less frequent floods. IDNR evaluations also fail to consider the impact of floodplain storage loss on peak discharges. Therefore, enforcement of only the State regulations can still leave room for negative impacts. More stringent local regulations are therefore needed to pursue a "no adverse impact" strategy.

3.1.4 Cumulative Expected Future Condition Flood Risks

Some of the factors noted in previous subsections, such as those discussed in Section 3.1.3, may be able to be relatively easily controlled through enactment and strict enforcement of updated requirements in stormwater ordinances by the jurisdictions that have regulatory authority over activities within river corridors. However, many other factors such as those discussed in Sections 3.1.1 and 3.1.2 cannot be easily controlled in the short run. Therefore, some increase in frequency and magnitude of peak flow discharges (resulting in increased flood elevations and streambank erosion, if not addressed), seems inevitable despite the presence of existing and near future regulatory safeguards.

In order to estimate the order of magnitude of such likely increases in peak flow discharge, the cumulative impacts of a 10% increase in rainfall and ongoing agricultural practices (changing tiles to open ditches and loss of small depressional storage areas as described in Sections 3.1.1 and 3.1.2) were simulated through modeling. Based on the results of the analysis, peak flood elevations are expected to increase an average of approximately 0.8 feet along the study reach under both 50% annual chance and April 2013 conditions with over 1 foot increases in Tipton for the April 2013 flood.

Figure 3-4 (and **Exhibit 5**) shows the inundation area for this scenario under April 2013 flood conditions compared to the original April 2013 flood conditions (existing condition). Only the portion where differences in the floodplain extent can be seen is included in the figure.

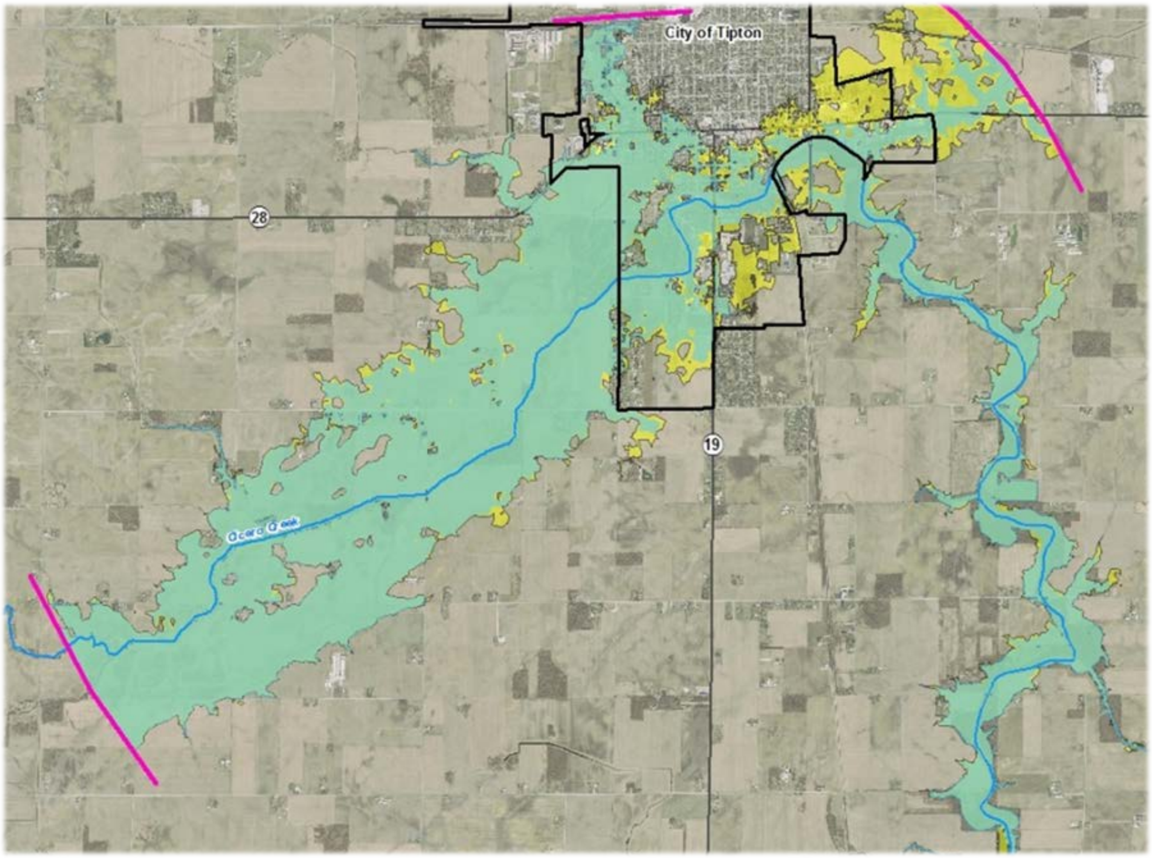


Figure 3-4: Future Condition April 2013 Floodplain (yellow) Compared to April 2013 Floodplain (blue green)

As can be seen from the figure, several more structures in Tipton, more acres of farm ground, and more transportation corridors are expected to suffer unless the increase in the factors discussed can be compensated through new flood risk mitigation efforts. In addition, buildings in the flooded area that may have been above existing condition flood levels may be inundated by future condition flood levels and add to the increases in flood damage.

3.2 POTENTIAL FUTURE STREAM STABILITY CONCERNS

Figure 3-5: Big Cicero Creek near Mt Pleasant Road

The predicted 10-20% increase in median runoff from 2041-2060, coming on top of a 37% increase in very heavy precipitation (= heaviest 1% of all daily events) from 1958 - 2012, indicates that the trend of increased runoff and decreased infiltration is likely to continue. Fortunately, evidence suggests that stable stream channels like the one shown in **Figure 3-5** that are connected to well-vegetated floodplains can sustain flood flows without impairment. Erosion is most pronounced in disturbed stream reaches – as seen in the increased erosion in and around Tipton. The challenge will be to allow stream channels to stabilize to today's runoff characteristics in the preparation for additional changes to come. The consensus of climate models is that we are entering a period of increased variability in weather patterns. While little increase in overall annual precipitation is expected, the seasonality and distribution of precipitation is expected to continue to change.

Adaptation to the heavier rains may lead to more risers placed in fields and larger surface swales. These risers are generally not buffered and offer a direct connection between the field and the waterway, increasing transport of silt and clay into tile drains and then into the waterway.

3.3 SUMMARY OF FUTURE CONDITIONS

Future flooding and erosion of the Big Cicero Creek corridor has the potential to become worse due to factors that can't be controlled – like changing weather patterns; as well as some that can be controlled, like increased drainage modification. Regulations can potentially help reduce increases due to lost floodplain storage, lost depressional storage due to development, and increased runoff impacts to the streams in the watershed. More frequent heavy rainfall and ongoing intensification of agricultural drainage and farming practices will continue to present challenges. Mitigation efforts may be able to offset these increased risks, but the key will be planning. Across the country, communities are exploring ways to become more resilient – better able to withstand environmental challenges like flooding. The Big Cicero Creek watershed has an advantage in that integrated planning began with the formation of a joint drainage board. More discussion of Mitigation measures/management options is provided in Chapter 4.

CHAPTER 4 MANAGEMENT OPTIONS

Chapter 2 discussed the current Big Cicero Creek flood levels based on existing rainfall, runoff, and flow path capacity conditions. Chapter 3 discussed future changes to these factors and the associated likely increases in flood levels. Just as activities affecting these factors can increase flood levels, actions can be taken in each area to reduce flood levels and/or damages. Therefore, management options are discussed in terms of reduced flood levels by actions affecting runoff and flow path capacity followed by options to prepare for the flooding that will still occur either from increase in frequency or depth of severe storm rainfalls that are out of human control or flooding until or after runoff and flow capacity related options have been implemented. The options that are normally available in a watershed are summarized in the graphic below. All are not necessarily feasible in the Big Cicero Creek watershed.

The November 2006 Big Cicero Creek Flood Control Study looked at over 30 options for agricultural and urban flood relief in Tipton County and the City of Tipton. Large scale projects from that study are summarized under the appropriate categories. The November 2013 more detailed study of a bypass channel is also noted. Discussion of additional options that were outside the scope of these previous studies is then added. The computer modeling calibrated to the April 2013 event and used in Chapter 3 was also used to evaluate these additional options.

4.1 RUNOFF - KEEP RAIN WHERE IT FALLS

Flooding can be reduced by keeping rain where it falls. Unless the ground is completely saturated as it is after several days of constant rain, the first inch or more of rain is largely absorbed by the ground and produces little runoff. Increasing the ability of the ground to absorb more water or creating more small depressional areas to hold water back from immediately flowing to the stream reduces the total volume of runoff. This does not necessarily translate to reduced peak discharge. Infiltration of just the first inch or so of larger rainfalls is not adequate by itself to reduce flood peaks because rainfall has usually stopped soaking in to the ground by the time the peak flow is being generated. Because the Big Cicero watershed is so large, methods of keeping rain where it falls have to be widespread and hold sufficient quantity to make an impact. The more rainfall that's held where it falls, the less there is to add to downstream flood peaks. Several methods to accomplish this are available.

4.1.1 Urban - Low Impact Development Practices

One such method for urban areas is known as Low Impact Development (LID). It can be an effective stormwater management tool that can reduce impervious cover as well as the drainage problems and pollution associated with stormwater runoff. A key concept of LID is to manage rainfall at the source using a large number of small, watershed wide techniques that infiltrate, filter, store, evaporate, and detain runoff close to its source. In the Big Cicero Creek watershed, LID practices could include:

1. Preserve open space and existing vegetated buffers along streams,
2. Planting more trees and shrubs (outside of regulated drainage easements) to intercept rainfall
3. Use land more efficiently so development anywhere in the watershed requires a smaller footprint,
4. Encourage Green Infrastructure within development /redevelopment projects
   - Establish parking requirements and strategies that reduce needed parking lot footprints,
   - increase park/open space amenities,
   - use porous pavement for parking and other less intense use areas requiring paving,
   - add bioinfiltration options such as rain gardens, etc. to other required features such as parking islands

These practices could be implemented by adding Channel Protection Volume and LID Option requirements to existing ordinance requirements in the City of Tipton, and Towns of Atlanta and Arcadia, as well as in Tipton and Hamilton Counties. Water quality benefits would also result from these kinds of projects. Because these urban areas are such a small part of the watershed, these activities would make a small impact on Big Cicero Creek flood levels. However, such measures can still make a large positive impact on local drainage issues and nuisance flooding.

4.1.2 Agricultural - Soil Health

Figure 4-1: Cover Crop Growing in Harvested Corn Field

In agricultural areas, the health of the soil has been found to have a noticeable impact on runoff amounts. More organic material in the soil equates to an increase in soil moisture potential, or the ability of the soil to store water. Essentially, organic material in the soil is the agricultural equivalent of bioinfiltration/rain gardens in the urban setting. There are also substantial benefits for agriculture in terms of decreased energy overhead and increased drought tolerance. The set of practices that the NRCS terms “soil health” appear to be the future of sustained agriculture and have the potential to change water management in agricultural regions of the United States.

Current farming practices focus on tillage and clearing the land for “the crop”. Soil health practices instead focus on continuing the crop and continuing to improve the soil. An example of a cover crop for improving soil health is shown in **Figure 4-1**. Soil health is a work in progress, with experiments across the country attempting to document the benefits of a soil health system. Farmers in Indiana are reporting increased drought tolerance and an increase of as much as 27,000 gallons of water per acre with a 1% increase in soil organic matter. That number will certainly vary with soil texture, antecedent conditions, and a number of other factors but the significance is that soil moisture storage can be increased – significantly. In a watershed like Big Cicero Creek with limited natural storage, the largest potential reservoir is in the soil and has, up to now, been ignored. The opportunity is enormous.

Because conclusions from studies on how much water organic matter in the soil holds vary, 16,000 gallons per acre, one of the lower estimates from these studies, was selected as a reasonable estimate for the Big Cicero Creek watershed. Modeling was adjusted to account for that decrease in runoff assuming that it applied to 25-30% of the watershed and then to 50%. With the 25-30% estimate, the April 2013 flood peak stage was reduced by as much as 0.2 feet or 2 inches in Tipton and slightly less in other reaches. For the 50% annual chance flood conditions, this coverage reduced elevations by 0.3-0.4 feet or 3-5 inches.

4.2 RUNOFF - GATHER RUNOFF IN UPSTREAM AREAS AND METER OUTFLOW

In addition to keeping rain where it falls, letting runoff over a given area accumulate and outlet through a flow restriction provides additional possibilities for reducing downstream flooding. This section discusses the options available for this method of managing flood levels.

4.2.1 Upland Storage

Modeling showed that upland depressional storage areas with less than 0.04 acre-feet (1750 cubic feet) of volume per acre of watershed had minimal impact on stream levels that caused flooding of structures in the City of Tipton. However, ongoing loss of such storage does impact the frequency of Big Cicero Creek bankfull flow occurrence, which exacerbates streambank erosion and sedimentation concerns. If a significant number of storage/depressional areas larger than this exist in the watershed, their loss will impact flood elevations. Compensation /re-creation of these larger depressional storage areas if lost would offset the impacts.

4.2.2 Agricultural – Drainage Water Management

Drainage Water Management is the practice of managing the timing and the amount of water that discharges from agricultural drainage systems. It works best on flat topography where the tile system is more intensive. A structure for water control is installed in the tile line which allows for management of the tile outlet elevation. The goal is to release only the amount of water necessary to ensure trafficable conditions for field operations and to provide an aerated crop root zone. Any drainage in excess of this likely carries away nitrate and water that no longer is available for crop uptake and may contribute to downstream flooding. A NRCS sheet describing this practice can be found on the web at http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1166626.pdf.

In essence, tile outlets are closed during the non-growing season when there are no crops to be impacted by excess water in the fields. This makes the tiles and the soil around them act as small reservoirs to hold water. The water stored behind the closed outlets does not contribute to the downstream runoff. This only catches the portion of the rainfall that flows to tiles that are closed. Various technologies exist for monitoring and controlling the opening and closing of these structures.

This practice could, during the non-growing season, offset any increases caused by tiling fields. It could also not only reduce some flooding but it could provide a source of water for crops during dry times.

4.2.3 Previously Identified Structural Project Options

The November 2006 study showed that about 6400 Ac-ft of storage upstream of the City of Tipton would be required in order to reduce the FIS 1% annual chance flood elevation in the City of Tipton enough to prevent flooding of all but a couple structures. If a location could be found that would accommodate a storage depth of 14 feet, 456 acres would be required to provide the necessary volume. An example area this size is shown in **Figure 4-2**. Lesser available storage depths would require even a larger footprint to provide the required volume. Estimates for the construction of this option were over $66 million.

Figure 4-2: Relative size of Alternative 3 Option A Detention Basin

The study also investigated the impact of a smaller detention area or several smaller areas scattered throughout the watershed upstream of the City of Tipton. Providing such storage (simulated through assumed elimination of the 1% annual chance flood runoff from half of the watershed) did reduce discharges by half but those values still exceeded bankfull capacity of Big Cicero Creek. This option did not therefore provide complete flood relief even with the large price tag. Additional details can be found in the November 2006 report.

4.2.4 Farmed Off-line Detention Ponds

A variation on the pond described in Section 4.2.3 was investigated for this Plan. The idea is that off-line detention area would be created in the agricultural area upstream of the City of Tipton. The area would not be flooded until a little before the peak of a large flood event, thus allowing the area to be farmed on all but rare occasions. During an extreme event, flood waters would be routed to the off-line detention basin once a predetermined elevation was reached. Most of the water above the predetermined elevation would then be held in the detention area until the flood peak passed and it could be released without causing additional flooding. This would in essence provide a flood level cap for the City of Tipton and downstream areas for a range of the more extreme flood events.

Based on the computer modeling, the minimum required volume to hold flow over the April 2013 (4.6 inch rainfall) flood flow up to that from a 5.9 inch rain was determined. That volume is over 2800 Ac-ft. If a site could be found that would allow a storage area to fill and empty with a depth for storage of 10 feet, 280 acres would be required to provide the needed storage. No natural area for creating this storage appears to exist without significant excavation. As was found in the 2006 study, the necessary excavation to create this much storage is not practical over such a large area.

4.2.5 Detention Requirement Enforcement

This regulatory approach is aimed at making sure that future development/redevelopment does not make flooding worse or undo measures that are put in place to reduce flood levels. This does not currently apply to farming practices that may increase runoff however.

For development in the City of Tipton and Tipton County, the subdivision ordinance requires post development 100-year (1% annual chance flood) runoff to be limited to the pre development 10-year (10% annual chance flood) runoff. This prevents increased 100-year (1% annual chance flood) runoff due to development. Depending on how the runoff is controlled, it may still allow increases for other smaller rainfall events that could have a negative impact on downstream streambank erosion. Addition of a Channel Protection Volume requirement to retain the 1-year, 24-hour rainfall on site would help reduce such streambank erosion impacts in the City of Tipton.

4.3 FLOW PATH – CONSERVE AND INCREASE CAPACITY

In addition to keeping rain at or near where it falls, or storing runoff and metering its release, increasing flow path capacity is another method of reducing flood elevations. This section discusses options for this.

4.3.1 Previously Identified Structural Projects

In the November 2006 Flood Control Study, several structural projects were considered. Each type of project (such as channel improvements) considered several versions (such as reach length, location, and size). A summary of each project type is provided in **Table 4-1**. Refer to the November 2006 report for additional background information or details on versions of the project type if needed. Locations of selected options from the 2006 study are shown in **Figure 4-3**, **Figure 4-4**, and **Figure 4-5**.

Table 4-1: Summary of November 2006 Study Findings

Project	Description	Cost*	Benefit	Negative Impacts
Channel Improvements**	Various channel bottom widths up to 200 feet or overbank "shelf" along various reaches of Big Cicero Creek upstream, through, and downstream of Tipton	$2-8M for the options that provided reasonable benefit to town or to ag interests	Could reduce flooding through town but not in ag areas or vice versa, other versions provided very little benefit for the cost	increase in flood stages downstream
Channel Realignment	Cut off the stream bend through the golf course to shorten the stream length		Negligible reduction in flood stages	Increased downstream stages in town
Bypass/Auxiliary Channel	Various bypass channel locations to convey some of the flood waters through an additional channel	The bypass channel that was evaluated in more detail for the Board in November 2013 was estimated at $30 Million plus mitigation costs	Several options provided little benefit for the cost. A bypass channel south of town was investigated in more depth & found to reduce 1% annual chance flood depths by 2 feet but downstream elevations increased by almost 2'	Increases in flood stages downstream
Improve RR bridge capacity	Replace the RR bridge with a more effective opening and remove the old interurban piers		Minimal impact	
Improve CR 300 W bridge	Improve the capacity of the bridge to allow upstream water to drain more quickly		Only a localized reduction in elevations and time out of banks. Not significant enough for the cost. Recommended when roads are replaced/ rehabilitated for other reasons	
Combinations of channel improvements and detention or bypass		Extremely expensive or provided little additional benefit beyond component alternative alone	Increased protection	Increased flood stages downstream

* Subsequent, more detailed estimates of costs for the bypass alternative revealed that several construction components were not included in the 2006 study so noted costs were under estimated.

** Additional, updated information is provided in Section 4.5.2

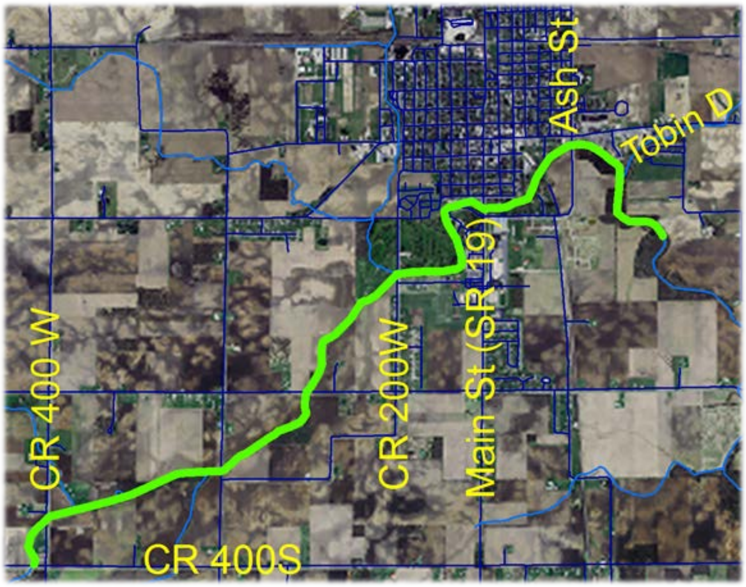


Figure 4-3: Alternative 1 Option N Channel Improvement from November 2006 Study

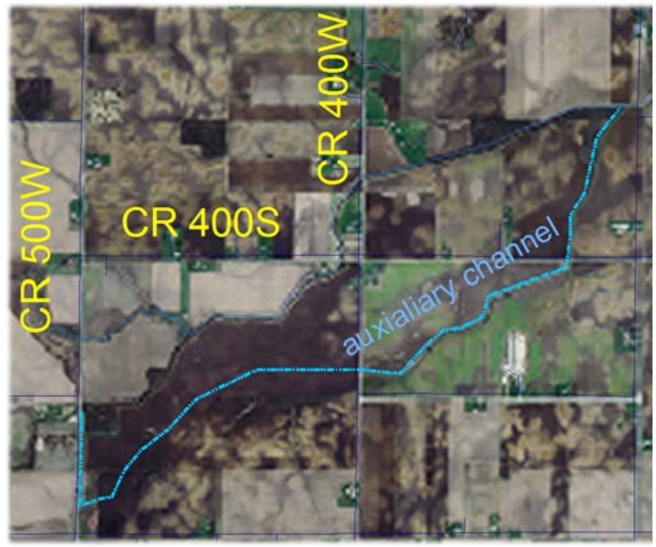


Figure 4-4: Alternative 4 Option C Auxiliary Channel from November 2006 Study

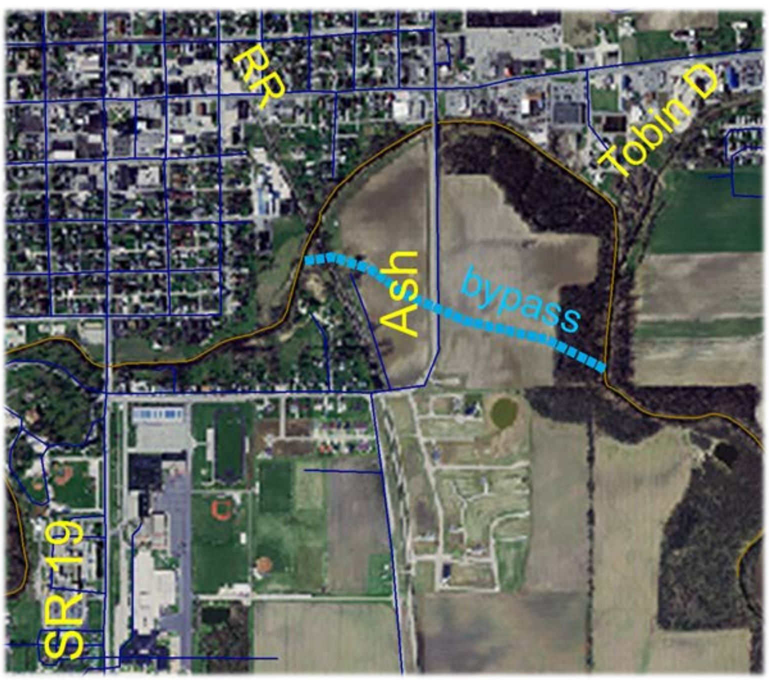


Figure 4-5: Alternative 4 Option E Auxiliary Channel from November 2006 Study

Based on the November 2006 study, the Drainage Board selected construction of a 30 foot “shelf” between Tobin Ditch and CR 400 W but did not receive enough local support to pursue construction. This option reduced the time out of banks to help agricultural interests and lowered FIS 1% annual chance flood elevations in the City of Tipton by about a half foot. However, downstream water surface elevations would have been increased by a half foot due to the more efficient channel.

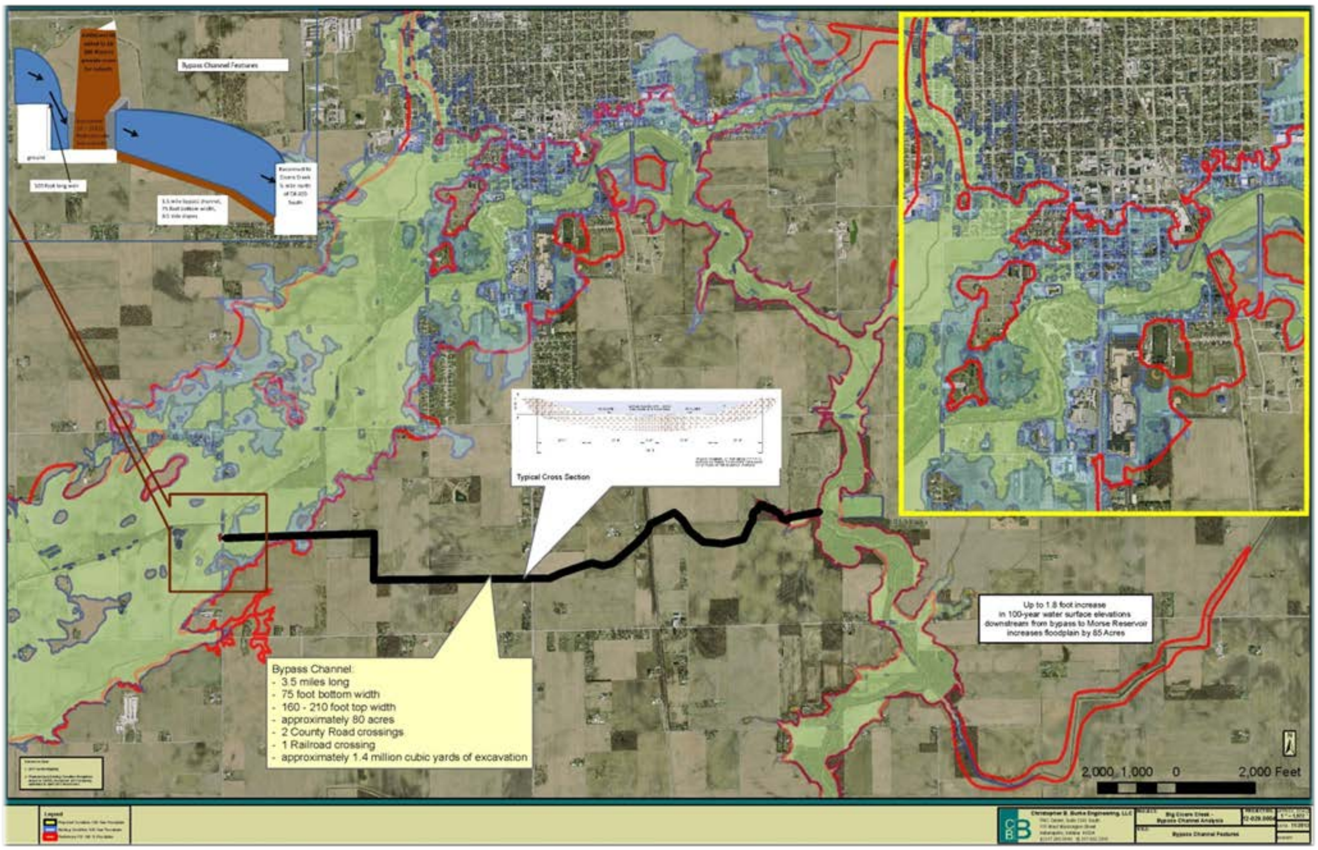


Figure 4-6: Components of Bypass Alternative Presented to Board November 2013
(red - FIS Regulatory Floodplain, blue - Existing Condition 1% Annual Chance Floodplain, yellow - With-Project condition 1% Annual Chance Floodplain)

In November 2013, a more comprehensive study of the November 2006 study bypass alternative was conducted. This option was found to cost over $30 Million so was not pursued further at the time. **Figure 4-6** shows the elements of this alternative.

4.3.2 Regulatory Approach

Regulations are designed to protect each resident as well as their neighbors. By keeping the drainage system clear and getting the proper permits before building, residents can help prevent flooding and other drainage problems from getting worse. Before building on, filling, altering, or regrading a property, the appropriate City or County planning or building department should be contacted regarding permit requirements. A permit is needed to ensure that projects do not cause problems on other properties.

Because the purpose of regulations is to prevent future development activities from causing increased flood damages or undoing the reduction in flood levels achieved by any projects that are completed, a ”no adverse impact” philosophy towards regulations is needed. This means that any proposed development in the watershed has to protect itself and be constructed such that it will not create flood elevation increases on other properties. If this cannot reasonably be done, then provisions to offset increases caused by additional impervious areas, decreased runoff travel times, loss of watershed or floodplain storage, or encroachment on the flow path need to be considered.

Current regulations regarding post development runoff limits, compensatory floodplain storage (1:1 in Tipton County and 3:1 in Hamilton County), and construction in a floodway permits should be strictly enforced. In addition, consideration should be given to allowing no increase in flood elevations from development in the floodway except as required for transportation purposes. Allowance for or encouragement of LID practices would also be helpful along with channel protection volume requirements.

In order to know the locations in which regulations should be applied, the floodplain and floodway for Tobin Ditch still need to be identified so development and surrounding areas are protected appropriately. In addition, the modeling of Big Cicero Creek should be extended about a mile upstream on Prairie Ditch to County Road 500 South in order to complete the identification of the large floodplain storage areas that should be protected.

4.4 FLOW PATH – PROTECT PEOPLE, BUILDINGS, AND FACILITIES IN VULNERABLE AREAS

This option does not attempt to reduce flood levels but employs methods to prevent or reduce damages from existing or future condition flood levels. For these options (except levee options), streets and surrounding property can still flood so accessibility issues are not eliminated. The provided information regarding relocation and floodproofing options was condensed from a Guide to Floodproofing, created by the Illinois Association for Floodplain and Stormwater Managers in 2014. The document can be found on the web at http://www.dnr.illinois.gov/ waterresources/pages/guidetofloodproofing.aspx

4.4.1 Previously Identified Structural Projects -Extensive Levees

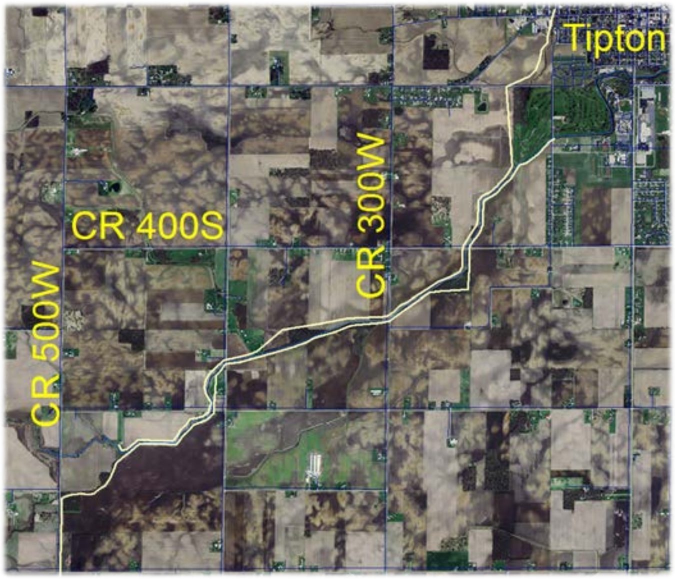


Figure 4-7: Alternative 2 Option B Levee Alignment from November 2006 Study

Various lengths of levees along Big Cicero Creek to protect most of the floodprone structures in the City of Tipton were investigated in the 2006 Flood Control Study but none were selected due to the limited space for such levees through town as well as limited room for raising SR 19 at the levee. Additional costs would be incurred in order to mitigate increased flood stages downstream and across the stream from the levees as well as for internal drainage facilities and associated maintenance after levee construction. Two of the options considered in the 2006 study are shown in **Figure 4-7** and **Figure 4-8**.

Figure 4-8: Approximate Alternative 2 Option A Levee Location from November 2006 Study (shown in red)

4.4.2 Relocation

Relocation removes individual floodprone structures from harm's way by moving the structure or demolishing and rebuilding in a very low risk flood area. Not only does this greatly reduce the flood risk to the building and its contents but it opens up more area for storage or conveyance of flood waters. When several strategically chosen structures in an area are relocated, this option can reduce localized flood elevations.

Smaller houses on crawlspaces are the easiest to move. The cost goes up with larger buildings, buildings on slabs or with fireplaces, and masonry walls. For expert guidance, use caution and check house and building moving and raising in the Yellow Pages or on the internet.

Structures that are in the floodway and are expected to experience 1% annual chance flood depths of around 3 feet or more are recommended as the first priority for relocation because of lack of options for flood proofing these structures, their location in the areas of faster flowing water, and the potential for increasing stream flow capacity with their removal. Flood depths for the buildings in the City of Tipton are based on the updated 1% annual chance flood elevations. These elevations are about 2 feet higher than the existing FIS elevations. Based on these depths, buildings in the City of Tipton were divided into 6 groups and prioritized based on the criteria shown below in **Table 4-2**. The approximate number of structures in each group is also provided. Priorities 1-3 are structures in the floodway with priority 1 structures having higher flood levels and priority 3 structures having lower flood depths. Priorities 4-6 are structures that are not in the floodway but are in the floodplain. Priority 4 structures have the higher flood depths and priority 6 structures have the lower flood depths. Structures in priority 1 are highest priority while structures in priority 6 become good candidates for floodproofing instead of relocation (unless they are surrounded by buyout candidates). Floodproofing is described in section 4.4.3. **Figure 4-9** shows the flood depth for each structure and thus the associated priority group into which it falls.

Table 4-2: Categorization of Buyout/Relocation Priorities

Priority for Buyout/Relocation	In the Floodway	In the Flood Fringe	1% Annual Chance Flood Depth			Number of Structures in Category
			> 2.5	1 – 2.5	0-1	
1	√		√			32
2	√			√		16
3	√				√	3
4		√	√			200
5		√		√		383
6		√			√	259

The numbers shown in Table 4-2 may seem disproportionate to the number of flooded structures reported in the April 2013 flood. This is due in part to the recalibration of the modeling since the FIS. That calibration raised the 1% annual chance flood elevation about 2 feet from the 1% annual chance flood elevation in the FIS, thus indicating that the April 2013 flood was much smaller than a 1% annual chance flood event. In addition, some structures shown in the floodplain may be elevated above the ground so the flood depth above ground that was used for the structure flood depth determination over exaggerates the flood depth at which structure damage actually begins. Before a final decision is made regarding flood protection for each structure, an Elevation Certificate by a licensed surveyor should be obtained in order to identify the true structure elevation for risk assessment on each building. The Elevation Certificate can also be used in determining flood insurance rates that have been impacted by recent federal legislation. Until this more detailed data exists on structure elevations, the numbers in each category in Table 4-2 serve only as initial estimates.

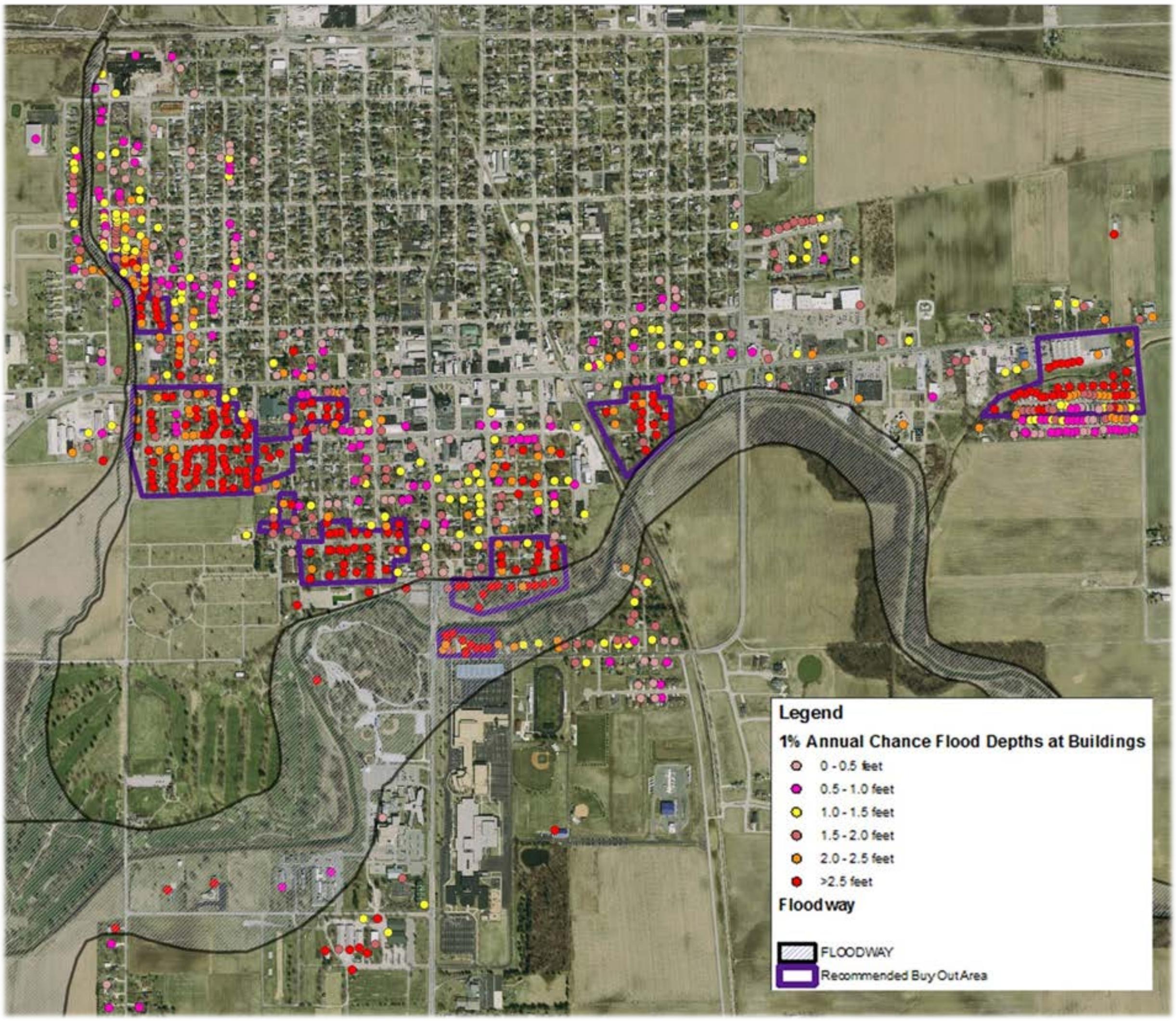


Figure 4-9: Building Flood Depths Based on 1% Annual Chance Flood Elevations and DEM Ground Elevations

Fifteen parcels with 13 of the identified structures in the floodplain are already in the process of being bought out using a $900,000 grant from FEMA through Indiana Department of Homeland Security (IDHS) and $225,000 in local cost share. These structures are in the area bounded by Adams, Madison, 2nd St and Conde Street west of SR 19 and between South Street and Big Cicero Creek east of SR 19.

Flooding depths for structures north of Walnut Street (about 160 structures) are based on Buck Creek flood elevations, not Big Cicero Creek. Of these 160, approximately 25 appear to be low enough to also be flooded by Big Cicero Creek in the 1% annual chance event.

4.4.3 Floodproofing

Floodproofing can be accomplished by individual homeowners or a City program could be developed to assist homeowners with floodproofing activities. Floodproofing costs can range from less than $100 to thousands of dollars depending on the site considerations and the method selected.

Based on the difference between the 1% annual chance flood elevation and the ground elevation garnered from available topographic information for the City of Tipton, about 110 structures in the City would be expected to have less than ½ foot of flooding in the 1% annual chance flood event. About 120 would be expected to have ½ -1 foot, and 210 to have 1-2½ foot depths. Approximately 35 of these structures are also located in the floodway and are therefore included in the recommendation for buyout or relocation instead of flood proofing.

The first step to planning for floodproofing is to understand the flood risk and then to determine an acceptable level of protection. Because of the additional model calibration to the April 2013 flood, the 1% annual chance flood is expected to be higher than the regulatory elevations in the FIS. For that reason, flood protection to the FIS Base Flood Elevation (BFE) plus 2 feet is recommended in order to provide protection from the potentially higher flooding. A 3-foot freeboard may be prudent given the National Climate Assessment conclusion that the higher 1% of daily rainfalls could be increasing by 37%. Structures with expected flood depths suitable for floodproofing based on the BFE plus 2 feet are those shown in Figure 4-9 with flood depths less than 3 feet and outside the floodway.

Floodproofing is more applicable for buildings with less than 3 feet of flood depth and can be accomplished by several different methods. These include raising the building, construction of on-site floodwalls or levees, dry floodproofing (sealing a building to prevent floodwaters from entering) or wet floodproofing (letting water enter the structure but protecting/ elevating/removing everything that could be damaged by flood waters). Each method is better suited to different building construction and site conditions.

The Illinois Association for Floodplain and Stormwater Management has developed a "Guide to Floodproofing". A copy can be found at www.dnr.illinois.gov/waterresources/pages/guidetofloodproofing .aspx. In addition to the information summarized in this section, this document provides suggestions for reducing basement flooding problems and for choosing a contractor for floodproofing work. FEMA P-259, Engineering Principles and Practices of Retrofitting Floodprone Residential Structures, provides more in depth information along with a matrix for assisting in the selection of an appropriate floodproofing options. It can be obtained online at http://www.fema.gov/media-library/assets/documents/3001. Louisiana State University has also developed helpful information which can be accessed at http://www.lsuagcenter.com/en/family_home/home/design_construction/Design/Remodeling+Renovation/Preventing+Flood+Damage/

Different flood protection techniques are appropriate for different types of buildings. **Table 4-3** shows the options most likely to apply to each type of construction. Following the table is a brief description of each method. This information is taken from the Illinois Association for Floodplain and Stormwater Management "Guide to Floodproofing" and is designed to give the reader an overview of things that can be done to protect a property from damage from the type of surface water flooding and sewer backup that faces many locations in Illinois (and Indiana). The information provided is based on careful research and input from experienced professionals. The reader must assume responsibility for adapting this information to fit his or her conditions. This guidance is not intended to replace the advice and guidance of an experienced professional who is able to examine a building and assess the needs of the particular situation.

Table 4-3: Floodproofing Options Based on Foundation Type

House Type*	Options					
	Elevation	Barriers (special conditions apply if soils are permeable)	Wet Floodproofing	Dry Floodproofing (not applicable if soils are permeable)	Other floor below ground level & basement protection	Relocation
Crawlspace	√	√	√			√
Slab Foundation		√		√		√
Basement		√	√		√	√
Split Level		√	√		√	√

- Assumes the building is in good condition
- **Note:** These protection measures are for existing buildings. There are different requirements for new buildings. Most of these measures will not relieve property owners from the need to buy flood insurance.

Owners should always check with the proper building department before building on, filling, altering, or regrading property. A permit is needed to ensure that such projects do not cause problems for other properties.

4.4.3.1 Elevation

Short of removing it from the floodplain, the best way to protect a house from surface flooding is to raise it above the flood level. The area below the flood level is either filled in or left with openings to allow floodwaters to flow under the building in a manner that causes little or no damage. Elevation is required by law whenever a new house is constructed in a floodplain. The appearance of the elevated house is similar to that of a house on a two- or three-foot crawlspace. If the house is raised two feet, the front door would be three steps higher than before. Adequate crawlspace openings are required, but may be camouflaged with landscaping.

4.4.3.2 Barriers

Barriers keep surface floodwaters from reaching a building. A barrier can be built of dirt or soil (berm) or concrete or steel (floodwall). The standard design for earthen berms is three horizontal feet for each vertical foot (3:1 slope). As a result, a minimum width of six feet for each foot in height is needed for construction of the berm. Depending on how porous the ground is, if floodwaters will stay up for more than an hour or two, the barrier will need to handle leaks, seepage of water underneath, and rainwater that falls inside the perimeter. A sump and/or drain will be needed to collect the internal groundwater and surface water. A pump and pipe is also needed to pump the internal drainage over the barrier.

A berm or floodwall should be as far from the building as possible to reduce the threat of seepage and hydrostatic pressure. However, it must not interfere with drainage along the property line. Where the house is close to the property line, backfill may be needed to make a berm next to the wall. A local permit may be needed for filling or regrading a yard. There may also be restrictions on bringing fill onto a particular site if it blocks the flow of flooding or displaces floodwater storage areas.

It should be noted that barriers can only be built so high. They can be overtopped by a flood higher than expected. Earthen berms are susceptible to erosion from rain and floodwaters if they are not properly sloped and covered with grass and maintained. Trees or shrubs should not be planted on a berm as their roots can cause leaks. Barriers can settle over time, lowering their protection levels.

Some barriers have openings for driveways and sidewalks. Closing these openings is dependent on someone being available and strong enough to put the closure in place. Protection should also be provided against water in the sewer lines backing up under the barrier and flooding inside the house.

4.4.3.3 Dry Floodproofing

This term covers several techniques for sealing up a building to ensure that floodwaters cannot get inside it. All areas below the flood protection level are made watertight. Walls are coated with waterproofing compounds or plastic sheeting. Openings (doors, windows, and vents) are closed, either permanently, with removable shields, or with sandbags. Many dry floodproofed buildings do not look any different from those that have not been modified.

Dry floodproofing is only appropriate for buildings on concrete slab floors (without basements) and with no cracks. To ensure that the slab is watertight and sound, an engineering analysis is recommended. The maximum flood protection level for dry floodproofing is two feet above the slab. Deeper water will put pressure on walls and slab flooring that they are not built to withstand. It is smarter to let deeper water into a structure than to risk loosing the walls or floor. It is very tempting for the owner of a dry floodproofed building to try to keep the flood out if floodwaters get deeper than two or three feet. This can result in collapsed walls, buckled floors, and danger to the occupants.

4.4.3.4 Wet Floodproofing

Wet floodproofing means letting the water in and removing everything that could be damaged by a flood. There are several ways to modify a building so that floodwaters are allowed inside, but minimal damage is done to the building and its contents. These techniques range from moving a few valuable items to rebuilding the floodprone area. In the latter case, structural components below the flood level are replaced with materials that are not subject to water damage. For example, concrete block walls are used instead of wooden studs and gypsum wallboard. The furnace, water heater, and laundry facilities are permanently relocated to a higher floor. Another approach is to raise these items on blocks or platforms where the flooding is not deep.

Wet floodproofing is not feasible for one-story houses because the flooded areas are the living areas. However, many people wet floodproof their basements, garages, and accessory buildings simply by relocating all hard-to-move valuables, such as heavy furniture and electrical outlets. Light or moveable items, like lawn furniture and bicycles, can be moved if there is enough warning. Moving contents is dependent on adequate warning and the presence of someone who knows what to do. Flooding a basement or garage where there is electricity, paint, gasoline, pesticides, or other hazardous materials creates a safety hazard. Fuse and electric breaker boxes should be located so the power can be safely turned off to the circuits serving floodprone areas. There will still be a need for cleanup, with its accompanying health problems.

Another approach is to wet floodproof a crawlspace. If the crawlspace has a furnace in it or is used for storage, these items could be moved to the first or second floor. Vents should be placed on the foundation walls to ensure that floodwaters can get into the crawlspace to equalize water pressure.

Wet floodproofing has one advantage over the other approaches: no matter how little is done, damages are reduced. Thousands of dollars in damage can be prevented by simply moving furniture and electrical appliances out of a basement.

In addition to home floodproofing recommendations discussed above, The City of Tipton hospital, high school, and the Wastewater treatment plant should also be individually flood-proofed through perimeter protection measures, such as those implemented for the hospital and other major facilities in Columbus, Indiana following major flooding there in 2008.

4.4.4 Insurance

Flood insurance is highly recommended for any structure in or near the 0.2% annual chance floodplain. Structures outside the 1% annual chance floodplain on the Flood Insurance Maps may purchase flood insurance at substantially lower premiums than those within the 1% annual chance floodplain. Following are some facts about flood insurance.

- Most homeowner insurance policies do not cover property for flood damage.
- Local insurance agents can sell a flood insurance policy under rules and rates set by the Federal government. Any agent can sell a policy and all agents must charge the same rates.
- Any house can be covered by a flood insurance policy.
- Detached garages and accessory buildings are covered under the policy for the lot’s main building.
- Separate coverage can be obtained for the building’s structure and for its contents (except for money, valuable papers, and the like). The structure generally includes everything that stays with a house when it is sold, including the furnace, cabinets, built-in appliances, and wall-to-wall carpeting.
- There is no coverage for things outside the house, like the driveway and landscaping.
- Renters can buy contents coverage, even if the owner does not buy structural coverage on the building.
- Mandatory insurance purchased as a requirement by the bank for a mortgage or home improvement loan may just cover the building’s structure and not the contents. During the kind of flooding that happens in most of Indiana, there is usually more damage to the furniture and contents than there is to the structure.
- Many insurance policies will only pay to repair the damage incurred. If damage is severe, the homeowner may have additional costs to bring the building up to current codes. Flood insurance now covers these costs (up to $15,000) when there is a flood. Policies should be checked to see if it has this coverage for fire, wind or other hazard.
- Flood insurance does not cover contents in a basement or the finished structural parts of a basement, such as paneling or wall to wall carpeting.

- Flood insurance only covers damage when there is a general condition of surface flooding in the area.
- Several insurance companies have sump pump failure or sewer backup coverage that can be added to a homeowner's insurance policy. Each company has different amounts of coverage, exclusions, deductibles, and arrangements. Most are riders that cost extra and exclude damage from surface flooding that would be covered by a National Flood Insurance policy. Cost varies from nothing up to about $75 for a rider on your homeowner's insurance premium.

4.4.5 Transportation Infrastructure Improvements

Several roads along the Big Cicero Creek corridor are frequently flooded. **Table 4-4** shows the approximate rainfall over the entire watershed that on the average begins to flood the roads. The frequency of flooding of each road is shown by the Priority Class. Those roads in Class 1 flood more often while those in class 3 or are undesignated flood less often. Reconstruction of these roads and bridges could possibly be done in such a way that the road and bridge would be flood free. Ash Street, the railroad in the City of Tipton, SR 19, and 4th Street were found to increase flood elevations for a short distance upstream so some localized reduction in flood elevations could also be obtained by replacing those structures with more flow capacity as well as raising the roads to allow flood free access.

Table 4-4: Bridge Improvement Priorities

Road	Average 24- Hour Rainfall at Which Road Flooding Begins, inches	Corresponding Approximate % Annual Chance Storm*	Priority Class
Mt Pleasant Road	2.7	50%	1
266th St	>6.0	<1%	
Crooked Creek/ Whistler Avenue	>6.0	<1%	
281st St	>6.0	<1%	
296th St	>6.0	<1%	
CR 450 S	< 2.7	>50%	1
CR 400 S	3.9	4%	2
CR 300 S	> 3.9	<4%	2
Ash St	>4.6	>2%	3
RR	~5.8	1%	3
Main St (SR 19)	<3.9	>4%	2
4th St	~3.9	4%	2
CR 300 S	<2.7	>50%	1
CR 300 W	<2.7	>50%	1
CR 400 W	<2.7	>50%	1
Cr 400 S	<2.7	>50%	1

*based on updated calibrated modeling done since the FIS

Reconstruction of bridge could provide reductions in flood elevations for short distance upstream

It is recommended that as plans for major maintenance or rehabilitation on any of these roads/bridges are made, an investigation also be made into the feasibility of increasing the capacity of the opening so that the bridge deck and approach roads could be raised. This information along with the importance of the road for access to buildings and transportation during a flood should be considered when prioritizing bridges and roads for upgrades to reduce flooding. As such upgrades are made over time, access to more locations would be available during a flood.

4.5 ADDRESSING EROSION CONCERNS

Erosion can be caused or accelerated by a number of factors. Section 2 discussed the overall stable nature of the maintained drains, and the increased erosion in the few remaining natural stream channels. The tendency of natural channels to erode near the confluence of a managed drain is well documented. While the managed drain is frequently designed for one purpose, the natural channel is a much more complex system that is transporting both water and sediment, providing flood storage and protection, and providing habitat functions. One of the goals of integrated water resource management is to support systems that support a range of functions. The way to achieve that goal is planning – a familiar theme in this document.

4.5.1 Spoil Bank Removal

Spoil banks provide a perfect introduction to planning. While it would seem that clearing a drain might have little impact on erosion, the reality is that continuous levees or spoil banks that are often created with the sediment cleared from the drain can have negative impacts. A spoil bank or levee can restrict the channel's ability to access the floodplain. The area behind the levee or spoil bank is prevented from storing and conveying flow during runoff events minor enough to not cause overtopping. The reduction in floodplain storage volume and flow conveyance area causes the flooding elevations to be increased adjacent to and upstream of the levee/spoil bank. Where continuous levees or spoil banks are particularly high and/ or on both sides of the channel, the increase in upstream flooding elevations can be significant. Flow velocities are also increased, contributing to erosion potential. In addition, these spoil banks, even very small ones, can prevent water from draining off the fields after a flood has passed.

Placing spoil material along the top of the bank during sediment removal and channel side-slope amendment activities can inadvertently create continuous or non-continuous levee segments along the channel. That material then forms what is essentially a high bank of loosely consolidated material that can slough into the channel as the stream moves against the bank. Rather than piling the material up next to the channel, it should be spread as level as possible on nearby fields.

4.5.2 2-Stage Ditch

Recent research on 2-stage ditches is showing a variety of benefits. Depending on the size of the increased ditch capacity in relation to the area of the floodplain, flood elevations can also be reduced. The benches tend to help filter out chemicals in the water thus improving water quality. In addition, the benched increased flow area allows the water to slow down thus reducing the stresses at the steeper channel bank and reducing or eliminating erosion of the channel banks.

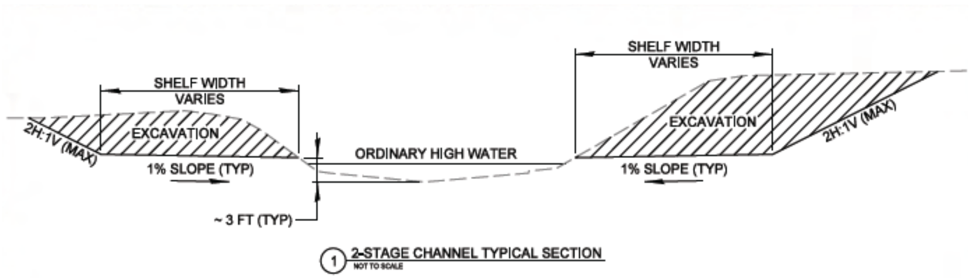


Figure 4-10: Typical 2-Stage Ditch Cross Section

2-stage ditches are constructed by leaving the low flow channel intact and creating a bench on each side at an appropriate height above that low flow invert. The bench extends back from the stream some distance before sloping up to meet existing ground. A typical cross section is shown in **Figure 4-10**. Ideally, the bench varies in width and is as wide as the natural floodplain wants to be in the area. Its height is set by the elevation of the scour line as shown in **Figure 4-11** by the yellow arrow.

Figure 4-11: Scour Line along Big Cicero Creek Used to Determine 2-Stage Ditch Bench Elevation

Based on the field assessment of the Big Cicero Creek watershed streams/ditches, areas were identified that experience high erosion rates and could benefit by the creation of the 2-stage ditch. The areas identified are along Buck Creek from about 1500 feet upstream of the mouth to the Railroad (1.1 miles) and along Big Cicero Creek from upstream of 4th Street to downstream of Tobin Ditch confluence (2.5 miles).

Based on observed channel properties, the proposed shelf along Buck Creek is proposed to be set at 2 feet above the invert and varies in width from 20 to 70 feet. The proposed shelf along Big Cicero Creek is proposed to be set at 3 ½ feet above the invert and varies from 20 to 50 feet in width). The shelf width was sized so that it would be the maximum possible while allowing a 2H:1V slope up to existing ground and leaving a 25' maintenance path in the existing 75' drainage easement. The shelf is proposed to be placed on both sides of the streams unless significant development would prevent the necessary excavation. Where a shelf could not be placed due to existing overbank uses, coir logs are proposed in order to stabilize the toe of the slope and create a small bench, thus improving the success of bank revegetation.

In addition to its main purpose of erosion and sediment control benefits, the 2-stage ditch does provide some flood control benefits through the City of Tipton. Elevations between the RR and CR 300 W would be expected to be reduced a half to one foot for the April 2013 event level. This brings the April 2013 event profile for this reach very close to the 10% annual chance flood elevations. In addition, inundation times are also expected to be reduced by a few hours both upstream and downstream of the 2-stage ditch.

Figure 4-12 shows the proposed conceptual limits and placement of the noted channel improvements along Buck Creek and Big Cicero Creek. **Exhibits 6-1 through 6-5** provide further details on the proposed improvements. Based on this conceptual analysis, the estimated cost for the proposed 2-stage ditch project (including combination of shelf on one side and coir logs on the other side, as appropriate) is $6.8 Million along Big Cicero Creek and $3.9 Million along Buck Creek. These estimates do not include any potential land acquisition costs.

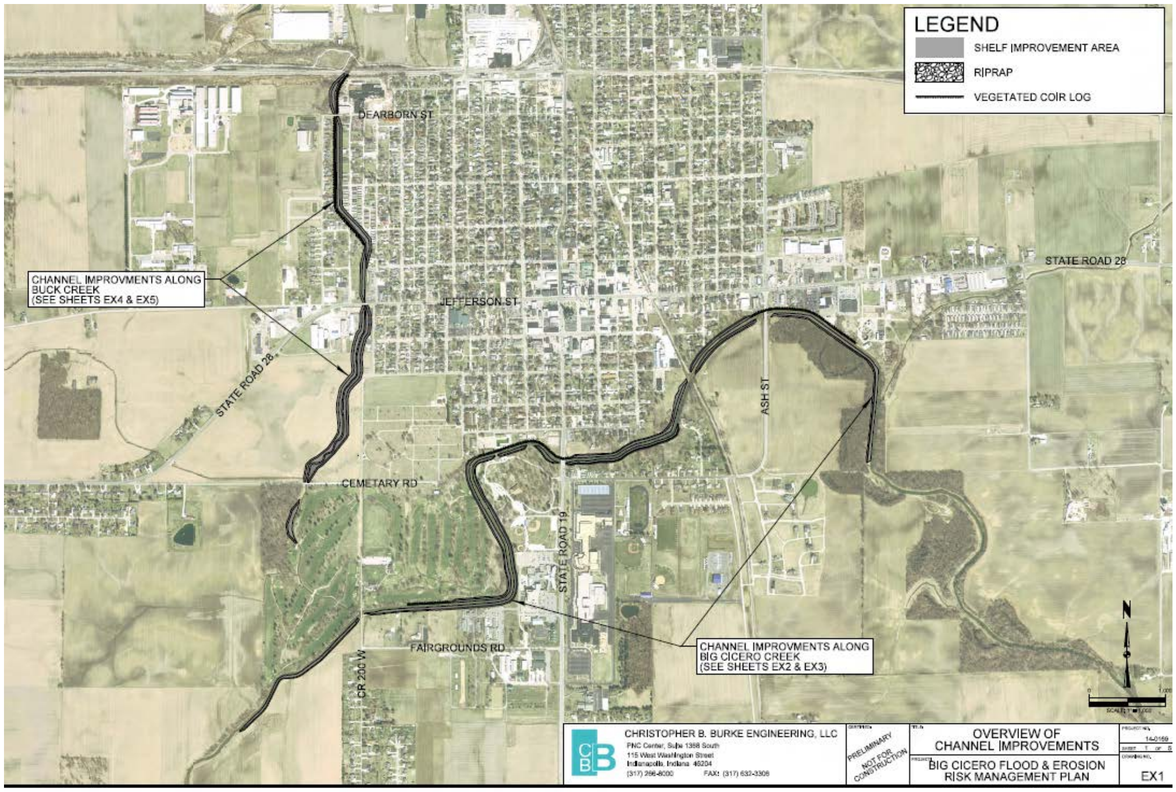


Figure 4-12: Proposed 2-Stage Ditch Locations

Modeling of the proposed channel improvements also showed an increase in channel velocities for the April 2013 flood conditions in certain reaches of the modeled length. However, these increases appear to be in the center of the channel and not at the edges where they would increase erosion of currently stable banks.

Modeling of the shelf also showed an increase in flood stage of approximately 0.4 feet for the 50% annual chance and April 2013 flood conditions downstream of the proposed improvement due to the increased capacity of the channel. However, this increase in flood stages does not appear to cause a major increase in regulatory floodplain limits and is expected to be offset by the proposed increase in cover crop coverage as will be discussed further in this report. Modeling showed that attempts to mitigate the above increase in downstream flood elevations through adding offline storage in other areas is cost prohibitive.

4.5.3 Maintenance Methods

With the exception of the portion through the City of Tipton, erosion and bank stabilization issues along Big Cicero Creek appear to be due to localized conditions. In order to maintain these reaches and any other reaches where erosion would become a problem, each site should be analyzed to determine the causes and then design solutions accordingly. This will help minimize efforts that do not take care of the problem or that just transfer the problem to another location.

4.5.4 Buffer Strips

The Big Cicero Creek watershed illustrates the importance of adequate stream buffers for improving stream stability and for reducing erosion. In assessing over 126 miles of stream channel in the Big Cicero Creek watershed, only 5.6 miles (20,130 feet) of the stream corridor were found to have significant erosion. Five and a half miles of eroding channel bank is significant in that it equates to tons of sediment per year, but, only 4% of the channel banks being ranked as unstable in a significantly agriculturally modified watershed is a testament to good stewardship. The stream reaches experiencing significant erosion share a common characteristic - they are not buffered adequately, either because of land use decisions or natural disturbance.

It is beyond the scope of this document to discuss what the best buffer is. That is most often a very site specific determination. There are minimum buffer widths for various NRCS programs and recommended buffer widths for achieving water quality goals. Those standards provide excellent guidance, but, in a watershed like Big Cicero Creek, most of the reaches that were easily buffered are in excellent condition. The problems are occurring in sections that have proved hard to buffer. Now that the areas have been identified, it is recommended that they be further assessed to determine the site specific cause(s) of the instability so the problem(s) can be corrected. Refer to section 2.2 for additional information on channel stability in the watershed.

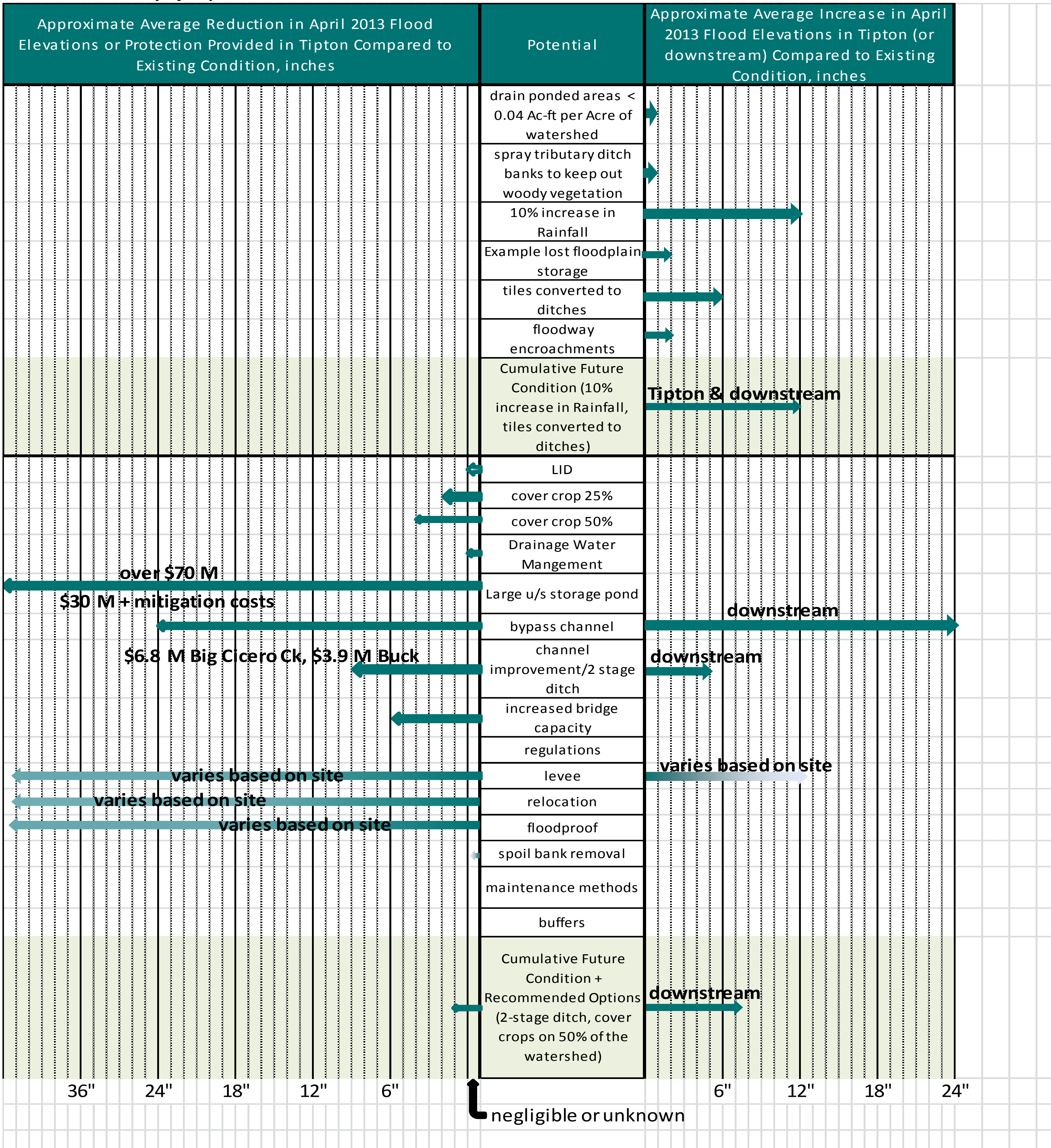
4.6 SUMMARY OF MANAGEMENT OPTIONS

This chapter has discussed management options that could offset the current and future flood and erosion risks discussed in Chapters 2 and 3. Those having to do with flooding are summarized in **Table 4-5** by the associated expected increase or decrease in April 2013 flood levels. The increases and decreases shown in the figure were selected as representative of most of the reach. Changes in flood elevations do however vary in each of the reaches.

Increases associated with each future condition scenario are shown as well as the increase associated with the expected cumulative future condition assuming regulatory options are implemented. Below this information, the impact on flood elevations of each of the management options discussed is then shown individually as well as for the cumulative recommended plan which is discussed in more detail in Chapter 5. Some scenarios are beneficial for the City of Tipton area but cause increased flooding downstream. These downstream increases are noted to provide a fuller picture of the implications of the noted options. Costs of select options are also noted.

Erosion issues can have such a wide variety of causes that each location should be analyzed to determine solutions that are specific to its causes. A 2-stage ditch is proposed in Tipton along Big Cicero Creek and Buck Creek to address bank stabilization issues in Tipton. This 2-stage ditch also provides some flood level reductions.

Table 4-5: Summary of Impacts



CHAPTER 5 INTEGRATED MANAGEMENT RECOMMENDATIONS

5.1 SUMMARY OF MAJOR RECOMMENDATIONS

The goal of this plan is to address flooding and erosion risks in such a way that:

- economic viability of the City and agriculture is maintained or enhanced
- the community sustainability and resiliency to flood-related risks is increased
- flood threats to critical facilities and major transportation system components are reduced
- guidance is provided to the Big Cicero Creek Drainage Board for management of and reduction of the Board expenses associated with sedimentation/ dredging and streambank erosion problems, and,
- long-term sedimentation in Morse Reservoir is reduced

To achieve the above noted goal, several management options were explored and presented in Chapter 4. Based on the evaluation of feasibility, effectiveness, and likelihood of implementation, the following are the major recommendations of this plan:

1. Initiate an update to existing stormwater ordinances and technical standards to ensure preservation of upstream floodplain storage (in both urban and agricultural areas), institute requirements for providing channel protection volume, and promote LID and green infrastructure.

2. Promote and incentivize use of cover crops by farmers to provide additional flood storage within the watershed. Such cover crop use is also necessary to compensate for the impact of some ongoing farm practices (such as surface draining of depressional areas and upsizing main collector drains/pipes). The use of cover crops would also help reduce the frequency of the stream flows that determine the channel size, thus reducing increases in streambank erosion and sedimentation caused by climate change and/or farm drainage practices.

3. Construct 2-stage ditch/channel improvement along the lower reach of Buck Creek and the reach of Big Cicero Creek through the City of Tipton to stabilize erosion and sedimentation and also try to reverse the impacts of climate change and/or agricultural drainage practices.

4. Develop a Flood Resilience Plan and implement flood resiliency measures in the City of Tipton. Recommended measures include buyout and floodproofing of at-risk homes, individual perimeter

protection of major critical facilities, establishment of flood-safe routes, and preparation of a Flood Response Plan. The Plan should be developed with consideration of the National Climate Assessment statements of potential increases of over 35% in heavy rainfall amounts for this area.

5. Maintain and upgrade existing USGS stream gages into “super gages” that have the capability of continuous sediment and water quality monitoring.

6. Conduct additional flood risk determination studies along Tobin Ditch and along Prairie Ditch upstream of its confluence with Big Cicero Creek.

7. Establish and adhere to best maintenance practices along open channels to minimize and manage streambank erosion issues.

5.2 EXPECTED IMPACTS OF MAJOR RECOMMENDED ACTIONS

To test the impact of combinations of existing and future conditions plus various management options, several combinations were evaluated using the computer modeling described in other sections of this Plan. These combinations and their impacts over an estimated time line are summarized below in **Table 5-1**.

Table 5-1: Timeline of Impacts of Recommended Actions

Approximate Years into the Future	Description	Change in Water Surface Elevation Compared to the Existing Condition April 2013 Model, inches		
		Downstream of Tipton	City of Tipton	Upstream of Tipton
5	1) Main tiles have been converted to ditches over entire watershed & 2) Cover crops have been established on 25% of the watershed	-1	negligible	negligible
6	2-stage ditch is completed	+2 to +3	-7 to -10	negligible
10	Cover crop use expands to 50% of the watershed	+<1	-12	-0 to -12
15	Frequency of the April 2013 rainfall is now a 10% higher rainfall amount	+6 to +9 (+7 to 10 if cover crop use has only reached 25%) (+12 if only 10% rainfall increase)	-1 to -3 (+3 if cover crop use has only reached 25%) (+12 if only 10% rainfall increase)	+1 to +3 (+4 if cover crop use has only reached 25%) (+5 if only 10% rainfall increase)
0-15	If not prevented, loss of larger upland storage/depression areas, floodplain storage, or floodplain conveyance area will increase the above noted differences, potentially by feet in some locations			

For general comparison purposes, the future condition modeling discussed in Section 3.1.4 was modified further to include both the proposed 2-stage ditches and establishment of cover crops on at least 50% of the watershed farms. Based on the results of the analysis, the 50% annual chance flood peak flood elevations increased by about 0.8 feet along the study reach due to a 10% increase in rainfall and ditching/tiling practices (assuming no management/mitigation measures). These increases in the City of Tipton were offset and lowered 1.2 feet below existing conditions by the practice of using cover crops on 50% of the watershed and construction of the 2-stage ditches proposed along Buck Creek and Big Cicero Creek. Upstream, these management options brought the future condition back to the existing condition while downstream they only offset 0.4 feet of future condition increases leaving 0.4 feet of increase over existing conditions but still showing a decrease compared to future condition flood elevations.

For April 2013 conditions, the 1.0 foot increase in flood elevations in Tipton due to future conditions was offset by the recommended mitigation actions enough to bring the future condition elevations back to close to the existing conditions. Downstream, the recommended options reduced elevations by about 4 of the unmitigated future condition 12-inch increase. Upstream, the future condition elevations were brought back down about 2 of the 4 inch increase to be within about 2 inches of the existing condition elevations.

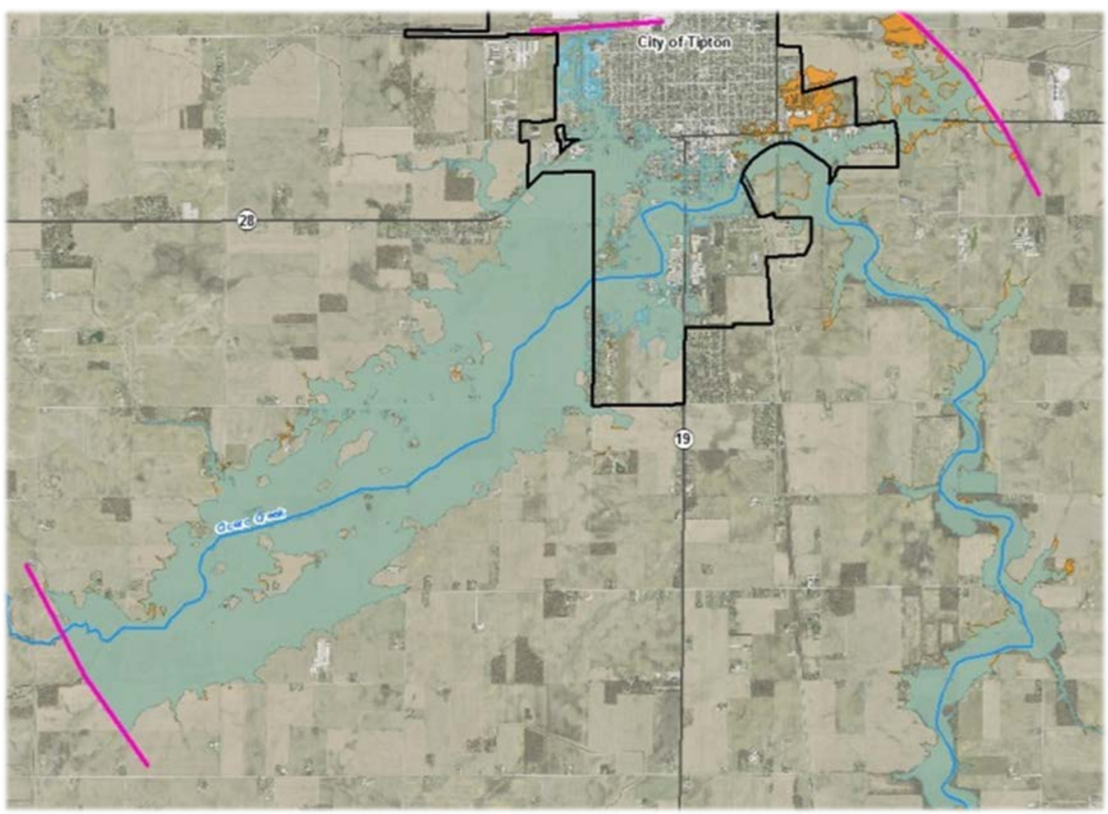


Figure 5-1: April 2013 Future Condition Floodplain with Recommended Options (orange) Compared to April 2013 Floodplain (blue)

Figure 5-1 (and **Exhibit 7**) shows the inundation area for such likely future condition with mitigation scenario for the same frequency of flood as the April 2013 flood. The original (existing conditions) modeled April 2013 flood inundation limits are also shown for comparison. The floodplain comparison is not shown for Hamilton County as no difference is visible at the map scale.

As can be seen from the Figure 5-1 (and Exhibit 7), mitigation projects, while able to reverse some of the expected future condition increases in flood risks, the proposed mitigation projects are not able to totally eliminate flood risk. Even with the management options outlined in this Plan, the City of Tipton will remain the most vulnerable area within the watershed in terms of the number of people impacted by flooding. Because of this and the fact it cannot control all of the flood inputs, it is suggested that the information in this Plan, along with other available information and input from key City stakeholders, be used to develop a Flood Resiliency Plan. Such a plan would provide detailed actions Tipton can take to create a community that is resilient to the flooding that will occur.

5.3 POTENTIAL PARTNERS AND FUNDING OPTIONS

For Board projects, the watershed assessments would be the main source for funding. For City or County options or for those practices that individual farmers may do, potential funding sources are listed below. This list is not exhaustive and funding availability may change as agency priorities change.

Federal:

FEMA Flood Mitigation Assistance (FMA) Grant Program – provide funding to communities with approved Flood Mitigation Plans to implement measures to reduce flood losses. This program requires a 25% non-Federal cost share.

FEMA Hazard Mitigation Grant Program (HMGP) – provides grants to States and local governments to implement long-term hazard mitigation measures after a major disaster declaration. Funds may be used to protect either public or private property or to purchase property that has been subjected to, or is in danger of, repetitive damage. This program requires a 25% non-Federal cost share.

FEMA Pre-Disaster Mitigation Program (PDMP) – provides funds for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. This program requires a 25% non-Federal cost share.

FEMA Repetitive Flood Claims (RFC) – these funds can be used to reduce flood damages to insured properties that have had one or more claims to the National Flood Insurance Program (NFIP). This program requires a 25% non-Federal cost share.

FEMA Severe Repetitive Loss Program (SRL) – provides funding to reduce or eliminate the long-term risk of flood damage to sever repetitive loss structures insured under the NFIP. This program requires a 25% non-Federal cost share.

FEMA Risk Map Funding – These funds that are administered through the IDNR Division of Water may cover the costs for preparing a flood resiliency plan for the City of Tipton or funds for additional flood risk determination studies.

HUD Sustainable Communities Regional Planning (SCRP) Grants – supports metropolitan and multi-jurisdictional planning efforts to integrate housing, land use, economic and workforce development, transportation and infrastructure investment to meet the challenges of economic competitiveness and revitalization, social equity and access to opportunity, energy use and climate change, and public health and environmental impact.

NRCS programs – Financial assistance is available for soil health projects as well as for other aspects. The local NRCS office should be consulted for program requirements and assistance availability.

State:

Community Development Block Grant (CDBG) – funds provided from the US Department of Housing and Urban Development (HUD) to States for a wide range of unique community development activities including but not limited to property acquisition, public services, planning activities, and development projects. These projects may include flood-related projects such as stream studies, floodplain management, infrastructure, and ordinance development. Federal funds are administered through the Indiana Office of Community and Rural Affairs (OCRA) and Indiana Housing and Community Development Authority (HCDA).

IDNR Division of Water: Water Resource Development Funds – these funds can be accessed if specifically included in the IDNR biennial budget and approved by the Indiana Legislature

Indiana Heritage Trust (IHT) – The purpose of the IHT is to acquire state interests in real property that are examples of outstanding natural resources and habitats or provide areas for conservation, recreation, protection or restoration of native biological diversity within the state of Indiana. IHT could serve as a cash or in-kind match for areas slated for acquisition that also provide a benefit to the goals of the IHT.

Legislative appropriation – the Indiana legislature can appropriate money for specific projects deemed important for the citizens of the State. Such an appropriation would be pursued through the respective State Senator or Representative for the area in need.

Local:

County Commissioners/City Council – can provide local cost-share match (in-kind and/or cash) required by many State and Federal grant programs. General operating funds would provide the resources necessary to sustain the day-to-day activities and pay for all administrative and operating expenses.

County Emergency Management Agency – can provide local cost-share match (in-kind and/or cash) required by many State and Federal grant programs

Local Watershed Groups – can provide local cost-share match (in-kind and/or cash) required by many State and Federal grant programs

Soil and Water Conservation Districts (SWCDs) – can provide local cost-share match (in-kind and/or cash) required by many State and Federal grant programs

Stormwater Utility – A stormwater utility can be formed and user fees established to provide funds for drainage maintenance, capital improvements, and implementation of stormwater management permit programs.

Private:

Citizens Energy Group (CEG) – Due to concern for sedimentation of Morse Reservoir, CEG may be interested in providing funding assistance or cost-share towards some of the recommendations, such as mitigation measures or upgrading and maintaining a USGS “super gage” at Arcadia.

5.4 RECOMMENDED ACTIONS AND IMPLEMENTATION STEPS

Based on the summary of existing and future flood and erosion risks and the impacts and costs of various management options described in Chapter 4, the following actions are recommended. Each recommendation is described and the party most likely responsible for its implementation is identified. Tasks are grouped by type.

DATA	PLANNING	PROJECTS - STRUCTURES	PROJECTS - ROADWAYS	REGULATORY	FARM PRACTICES	

PRIORITY	RECOMMENDATION and IMPLEMENTATION STEPS	RESPONSIBLE PARTY
	USGS Gages	
1	Maintain funding of current USGS stream gages	Tipton gage - Board, Arcadia gage - CEG
2	Investigate additional local resources for the funding of USGS stream gages	City
3	Upgrade the Tipton and Arcadia gages on Big Cicero Creek to include water quality and sediment load monitoring in order to track the impacts of implementation of this Plan	Tipton gage - Board, Arcadia gage - CEG
	Update or Expand Available Hydraulic/Hydrologic Modeling	
1	Pursue creation of modeling to determine flood elevations and floodway along Tobin Ditch for appropriate application of floodplain regulations and protection of future development	City
	• Add new or revised flood elevation data to the regulatory processes used for planning and building permits	City/ Tipton County
2	Pursue modeling of Prairie Ditch upstream from its confluence with Big Cicero Creek to about CR 500 S (1 ½ mile) in order to identify the extent of floodplain storage in the reach that should be protected	Board
	• Add new or revised flood elevation data to the regulatory processes regarding preservation of floodplain storage in agricultural areas	Tipton County
	Rainfall Gages	
1	Solicit at least 7 volunteers scattered throughout the watershed to participate in the CoCoRaHs network of rainfall data collection. This would provide better data on rainfall for use in future modeling and understanding of the impact of implementation of this plan as well as benefitting the National Weather Service in their forecasting efforts	Board

DATA	PLANNING	PROJECTS - STRUCTURES	PROJECTS - ROADWAYS	REGULATORY	FARM PRACTICES	

PRIORITY	RECOMMENDATION and IMPLEMENTATION ITEMS	RESPONSIBLE PARTY
1	Develop a City resiliency plan that: a) protects the City and provides flood protection protocols and b) prioritizes and plans for buyouts, floodproofing, flood free access routes, and other actions to protect citizens from flooding and reduce damages (Note that flood protection elevation decisions should be based on the BFE + at least 2 feet due to possible underestimation of the FIS elevations. BFE + 3 feet should be considered in light of rainfall trends.)	City
2	Encourage residents in and near the floodplain to purchase flood insurance	City/Board
3	Investigate CRS program as option for reducing flood insurance premiums for citizens	City/ Tipton County
4	Secure mitigation funding from FEMA to acquire and/or floodproof buildings as determined in the resiliency plan	City
5	Identify other funding sources to acquire and/or floodproof prioritized buildings	City
6	Update City and County Comprehensive Plans to include findings from this Plan	City/Hamilton County, Tipton County

DATA	PLANNING	PROJECTS - STRUCTURES	PROJECTS - ROADWAYS	REGULATORY	FARM PRACTICES	

PRIORITY	RECOMMENDATION and IMPLEMENTATION ITEMS	RESPONSIBLE PARTY
	Projects - 2-Stage Ditch	
1	Construct a 2-stage ditch in the drainage easement of Big Cicero Creek from upstream of Buck Creek to downstream of Tobin Creek	Board
	• establish priorities and break the project into phases, if necessary	
	• coordinate project with other City projects if possible such as buyouts/relocation and creation of additional park space	
	• complete preliminary engineering report	
	• secure funding for project	
	• complete design and construction documents	
	• construct the 2-stage ditch	
2	Construct a 2-stage ditch in the drainage easement of Buck Creek from upstream of Big Cicero Creek to the RR	Board
	• establish priorities and break the project into phases, if necessary	
	• coordinate project with other City projects if possible such as buyouts/relocation and creation of additional park space	
	• complete preliminary engineering report	
	• secure funding for project	
	• complete design & construction documents	
	• construct the 2-stage ditch	

DATA	PLANNING	PROJECTS - STRUCTURES	PROJECTS - ROADWAYS	REGULATORY	FARM PRACTICES	

PRIORITY	RECOMMENDATION and IMPLEMENTATION ITEMS	RESPONSIBLE PARTY
1	Add a factor of safety of 2.0 foot to the FIS 1% annual chance flood elevation as the basis for design of bridge/road replacement design to account for increase in flood elevation due to findings of the additional model calibration of the April 2013 event	City/ Tipton & Hamilton County
2	Coordinate with State Highway, County Highway, and city street decision makers so that whenever a road/bridge project is considered, the opportunity to create flood-free access and a reduction in flood elevations using the priorities listed in this Plan is maximized	City/ Tipton & Hamilton County

DATA	PLANNING	PROJECTS - STRUCTURES	PROJECTS - ROADWAYS	REGULATORY	FARM PRACTICES	

PRIORITY	RECOMMENDATION and IMPLEMENTATION ITEMS	RESPONSIBLE PARTY
1	Update ordinances of all entities in the watershed to set BFE along Big Cicero Creek at 2 feet above the current FIS BFE for the 1% annual chance flood elevations to account for potential underestimated flood elevations identified by calibration to the April 2013 flood subsequent to the FIS modeling	City/Tipton & Hamilton County
2	Do not exclude agricultural areas from the requirement of floodplain storage compensation since this has such a huge impact for flood elevations in the City and downstream	All 4 Counties
3	Revise the Tipton ordinance to require flood protection grades of critical facilities to be at least 3 feet above the current FIS BFE instead of at it	City
4	Consider revising ordinances for each entity along Big Cicero Creek to limit floodway construction to 0.01 foot maximum increases instead of the state allowed 0.14 foot	City /Tipton & Hamilton County
5	Revise stormwater ordinance and technical standards requirements to include channel protection volume requirements	City/Tipton & Hamilton County
6	Update stormwater ordinances and technical standards to include standards for Low Impact Design and green infrastructures	City/Tipton & Hamilton County

DATA	PLANNING	PROJECTS - STRUCTURES	PROJECTS - ROADWAYS	REGULATORY	FARM PRACTICES	

PRIORITY	RECOMMENDATION and IMPLEMENTATION ITEMS	RESPONSIBLE PARTY
1	Protect the existing floodplain storage along Big Cicero Creek from being reduced or made inaccessible to floodwaters	City/ Tipton & Hamilton County
2	Encourage the Soil Health practices, especially cover crops throughout the watershed to help offset increased stream flows due to drainage practices	Board/ all 4 Counties
3	Encourage compensation of or not draining depressional areas in the watershed that provide a significant (more than 1750 cubic feet per acre) volume of storage for runoff	Board/ all 4 Counties
4	Apply Best Maintenance Practices of open channels outlined in this Plan	Board

Figure 5-2 below provides a general summary of the actions that the recommendations of this plan are attempting to encourage. The goal of these actions is the maximization of reasonable efforts throughout the watershed to create flood resilient stream corridors. No one action will solve all flood problems. The cumulative impact of a variety of actions can greatly increase flood resiliency.

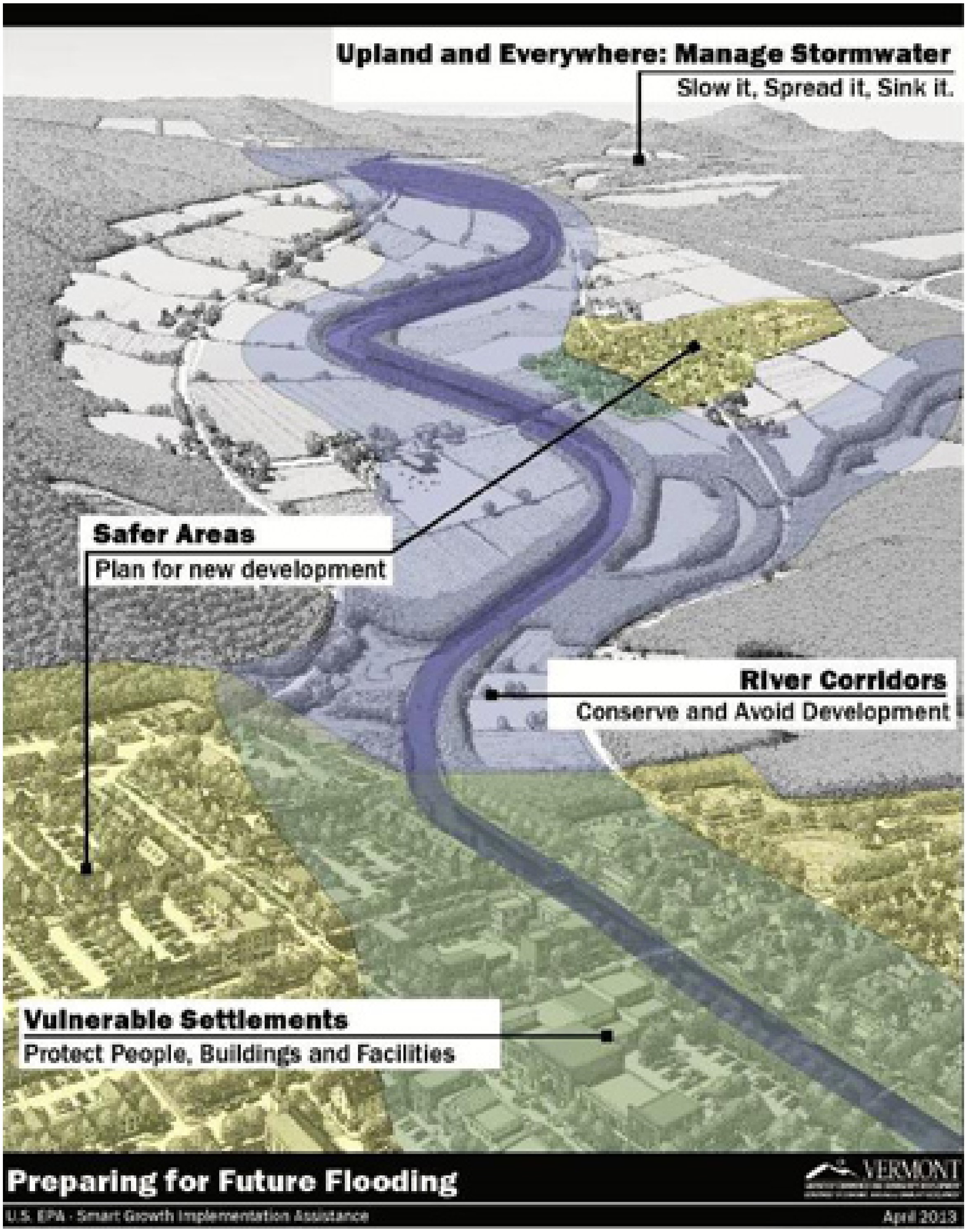
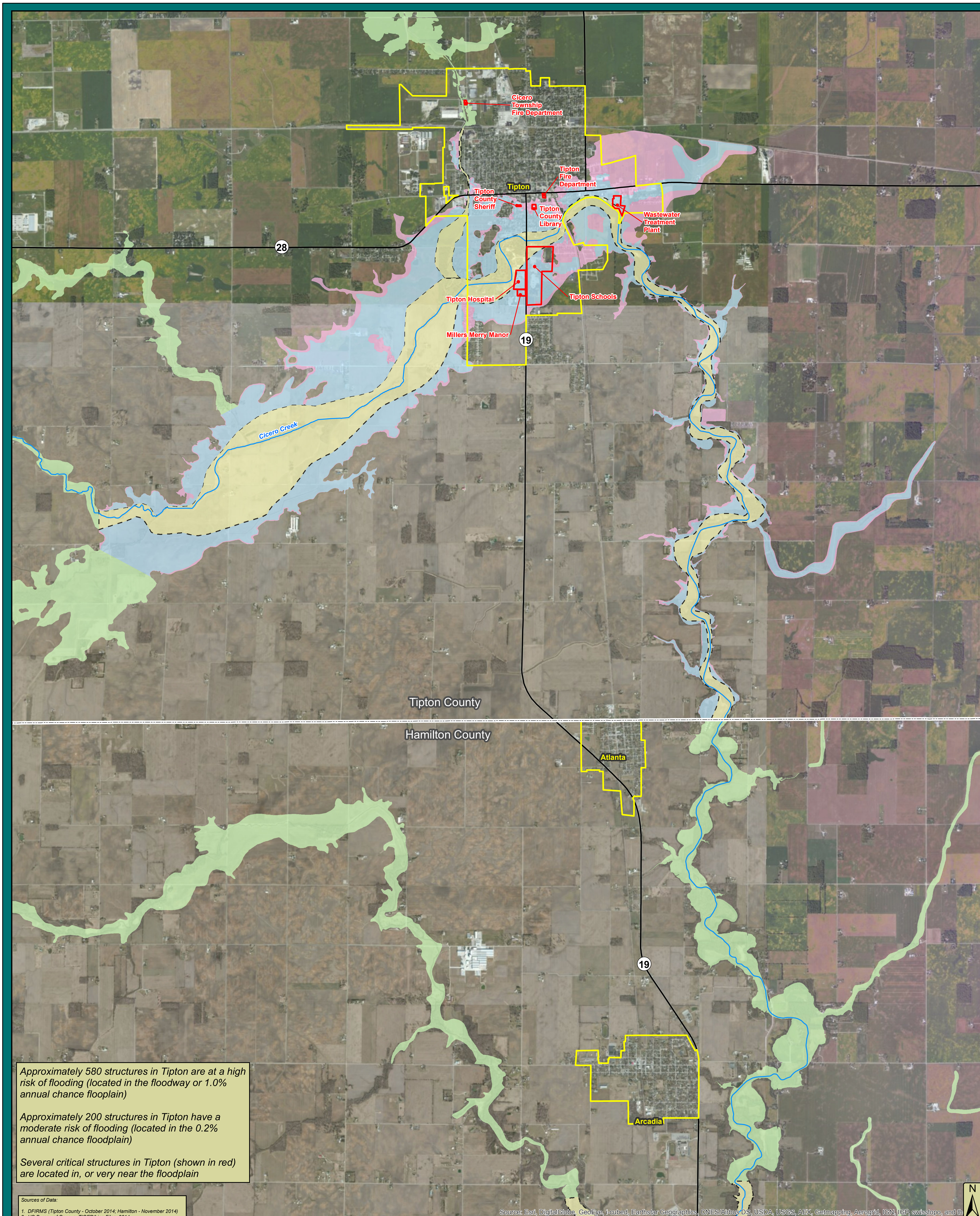


Figure 5-2: Integration of Actions for Flood Resiliency



0 0.5 1

Scale in Miles

Locations of Critical Facilities

County Boundaries

Municipal Boundaries

Floodway Boundary

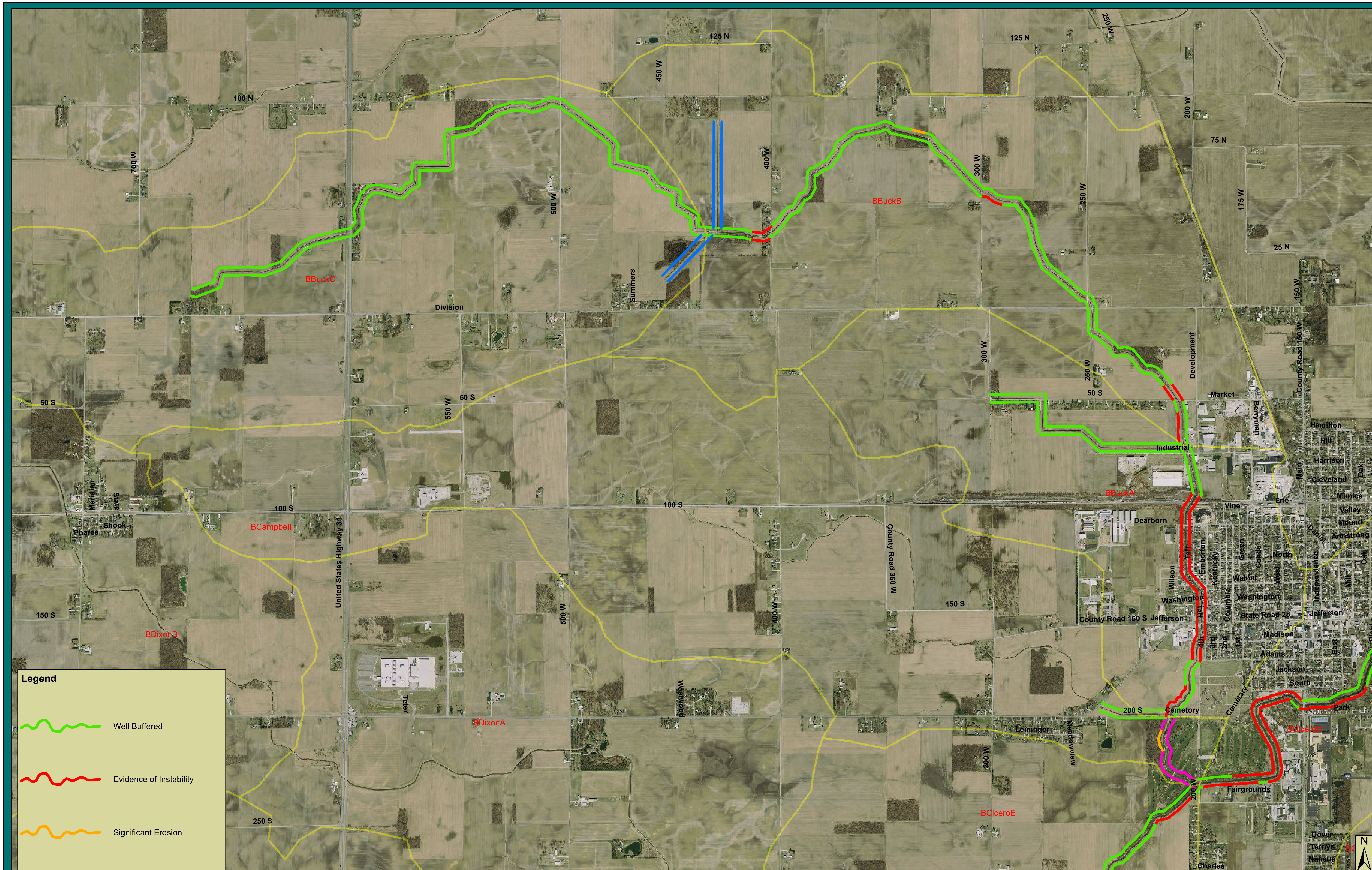
1.0% Annual Chance Floodplain Boundary

0.2% Annual Chance Floodplain Boundary

Unnumbered Zone A Boundary

Christopher B. Burke Engineering, LLC PNC Center, Suite 1368 South 115 West Washington Street Indianapolis, Indiana 46204 (t) 317.266.8000 (f) 317.632.3306	PROJECT: **Big Cicero Creek Watershed Flood and Erosion Risk Management Plan**	PROJECT NO. **14-0169**	APPROX. SCALE **1 "=0.5 miles**
	TITLE: **Existing Identified Flood Risk**		DATE: **11/2014** EXHIBIT **1**

Christopher B. Burke Engineering, LLC PNC Center, Suite 1368 South 115 West Washington Street Indianapolis, Indiana 46204 (t) 317.266.8000 (f) 317.632.3306	PROJECT: Big Cicero Creek Management Plan	PROJECT NO. 14-0169	APPROX. SCALE 1 " = 2,000 '
	TITLE: Big Cicero Creek Erosion Assessment		DATE: 09/2014
			EXHIBIT 2



Legend

Well Buffered

Evidence of Instability

Significant Erosion

Needs Checking

Tributary

Big Cicero Creek Watersheds

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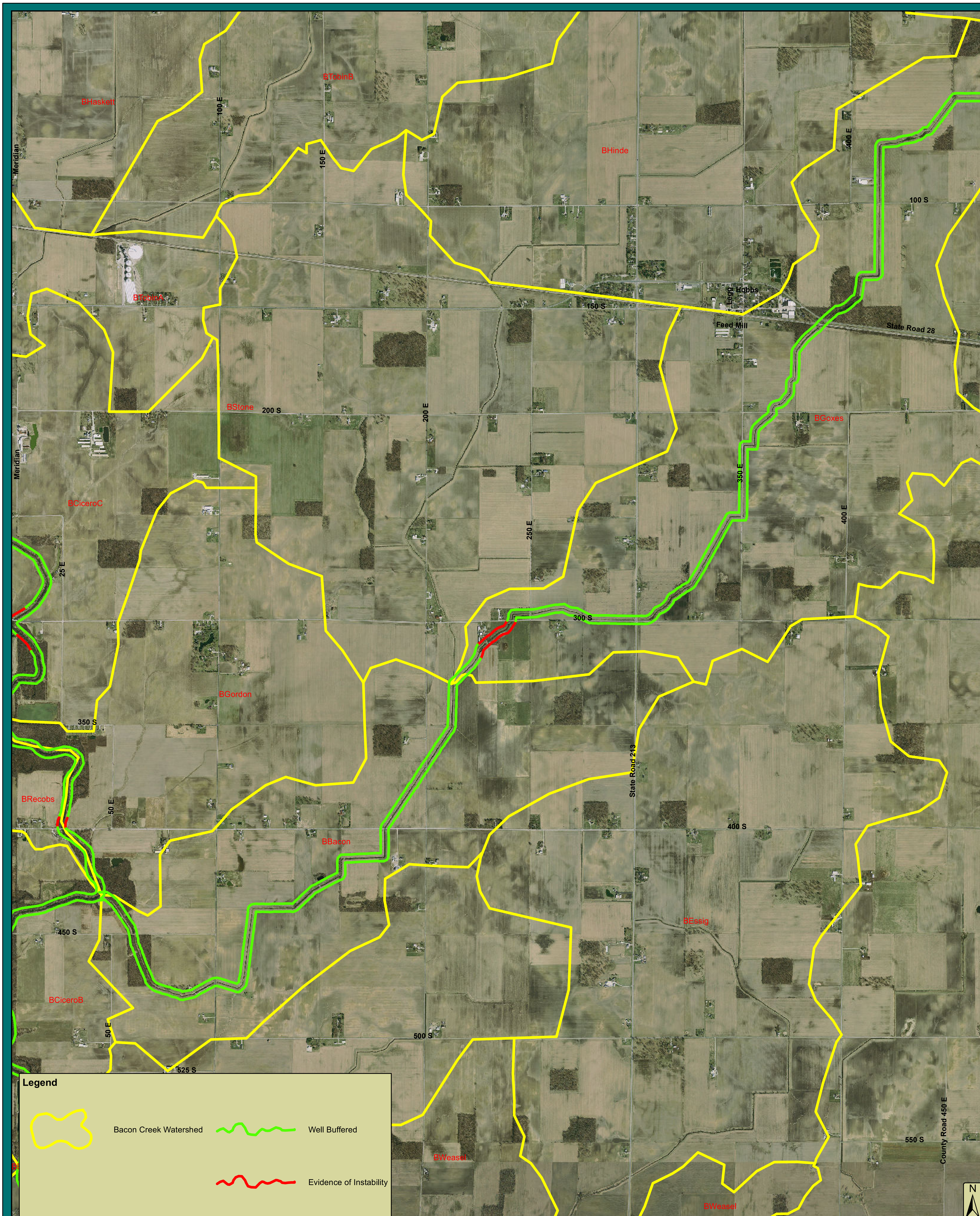
(t) 317.266.8000 (f) 317.632.3306

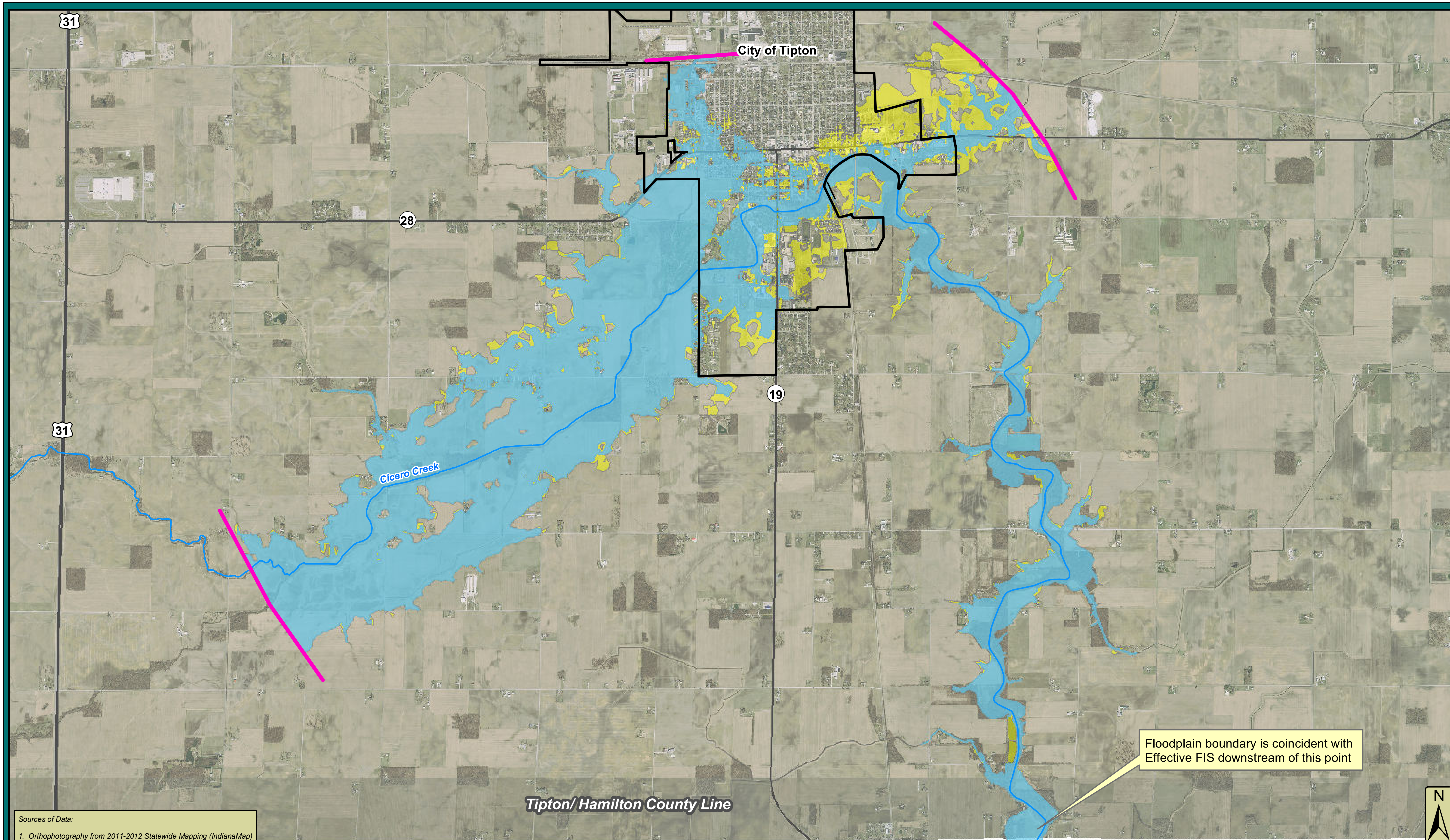
PROJECT:	PROJECT NO.	APPROX. SCALE
Big Cicero Creek Management Plan	14-0169	1 " = 1,500 '
TITLE: Buck Creek Erosion Assessment		DATE: 09/2014
		EXHIBIT 3



Legend

- Bacon Creek Watershed
- Well Buffered
- Evidence of Instability
- Significant Erosion
- Needs Checking
- Tributary

Christopher B. Burke Engineering, LLC PNC Center, Suite 1368 South 115 West Washington Street Indianapolis, Indiana 46204 (t) 317.266.8000 (f) 317.632.3306	PROJECT: **Big Cicero Creek Management Plan**	PROJECT NO. **14-0169**	APPROX. SCALE 1 " = 1,500 '
	TITLE: **Bacon Creek Erosion Assessment**		DATE: 09/2014 EXHIBIT 4



Sources of Data:

1. Orthophotography from 2011-2012 Statewide Mapping (IndianaMap)

Existing Condition

Future Conditions

Limits of Study

Christopher B. Burke Engineering, LLC
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(t) 317.266.8000 (f) 317.632.3306

PROJECT:	PROJECT NO.	APPROX. SCALE
Big Cicero Creek Watershed Flood and Erosion Risk Management Plan	14-0169	1 " = 3,000 '
TITLE: Comparison of April 2013 Floodplains under Existing and Future Conditions		DATE: 11/2014
		EXHIBIT 5

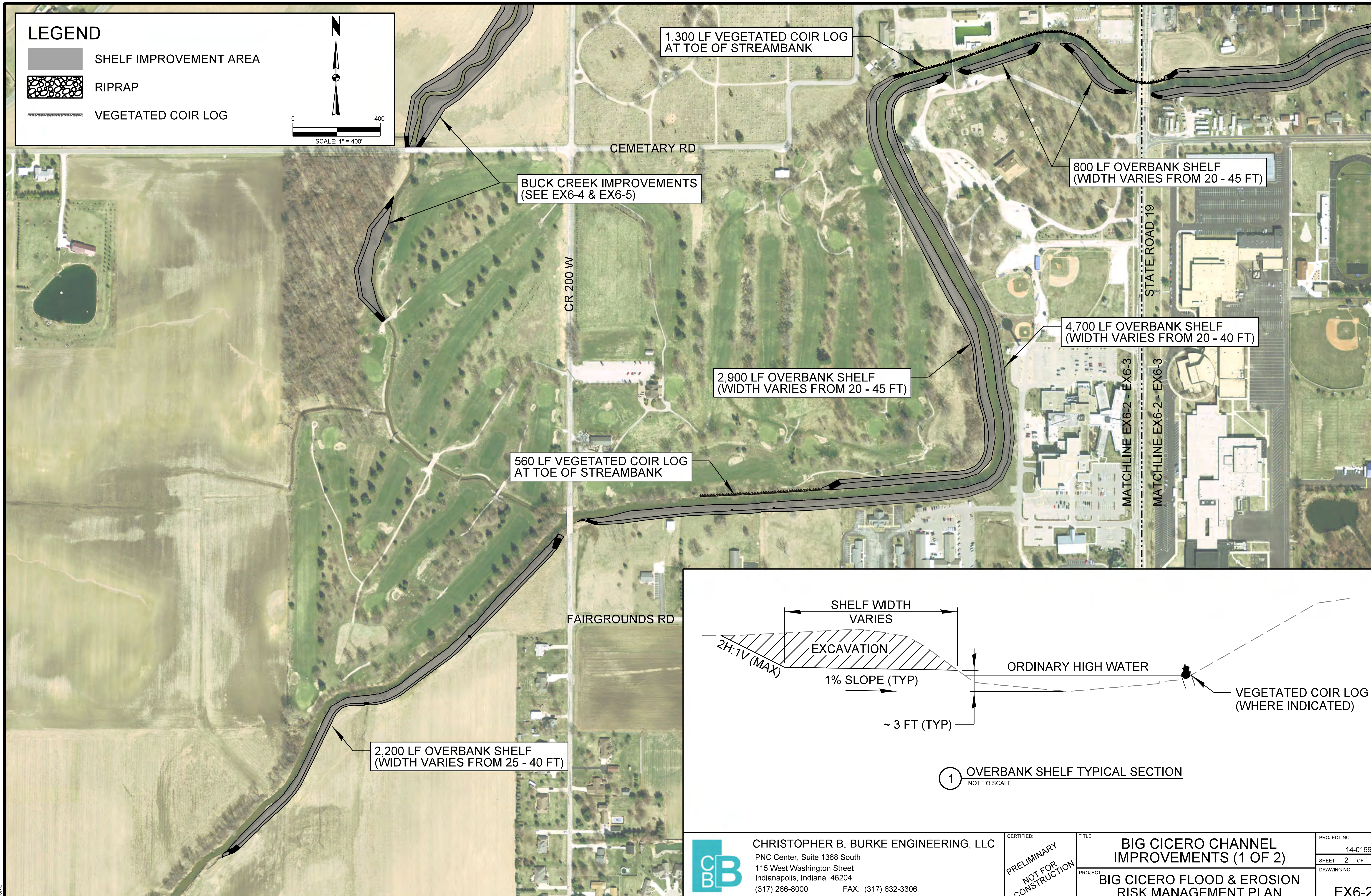
CHRISTOPHER B. BURKE ENGINEERING, LLC
PNC Center, Suite 1368 South
115 West Washington Street
Indianapolis, Indiana 46204
(317) 266-8000 FAX: (317) 632-3306

CERTIFIED:
PRELIMINARY
NOT FOR CONSTRUCTION

TITLE:
OVERVIEW OF
CHANNEL IMPROVEMENTS

PROJECT:
BIG CICERO FLOOD & EROSION
RISK MANAGEMENT PLAN

PROJECT NO. 14-0169
SHEET 1 OF 5
DRAWING NO. EX6-1



1 OVERBANK SHELF TYPICAL SECTION
NOT TO SCALE

CHRISTOPHER B. BURKE ENGINEERING, LLC
PNC Center, Suite 1368 South
115 West Washington Street
Indianapolis, Indiana 46204
(317) 266-8000 FAX: (317) 632-3306

CERTIFIED: PRELIMINARY NOT FOR CONSTRUCTION

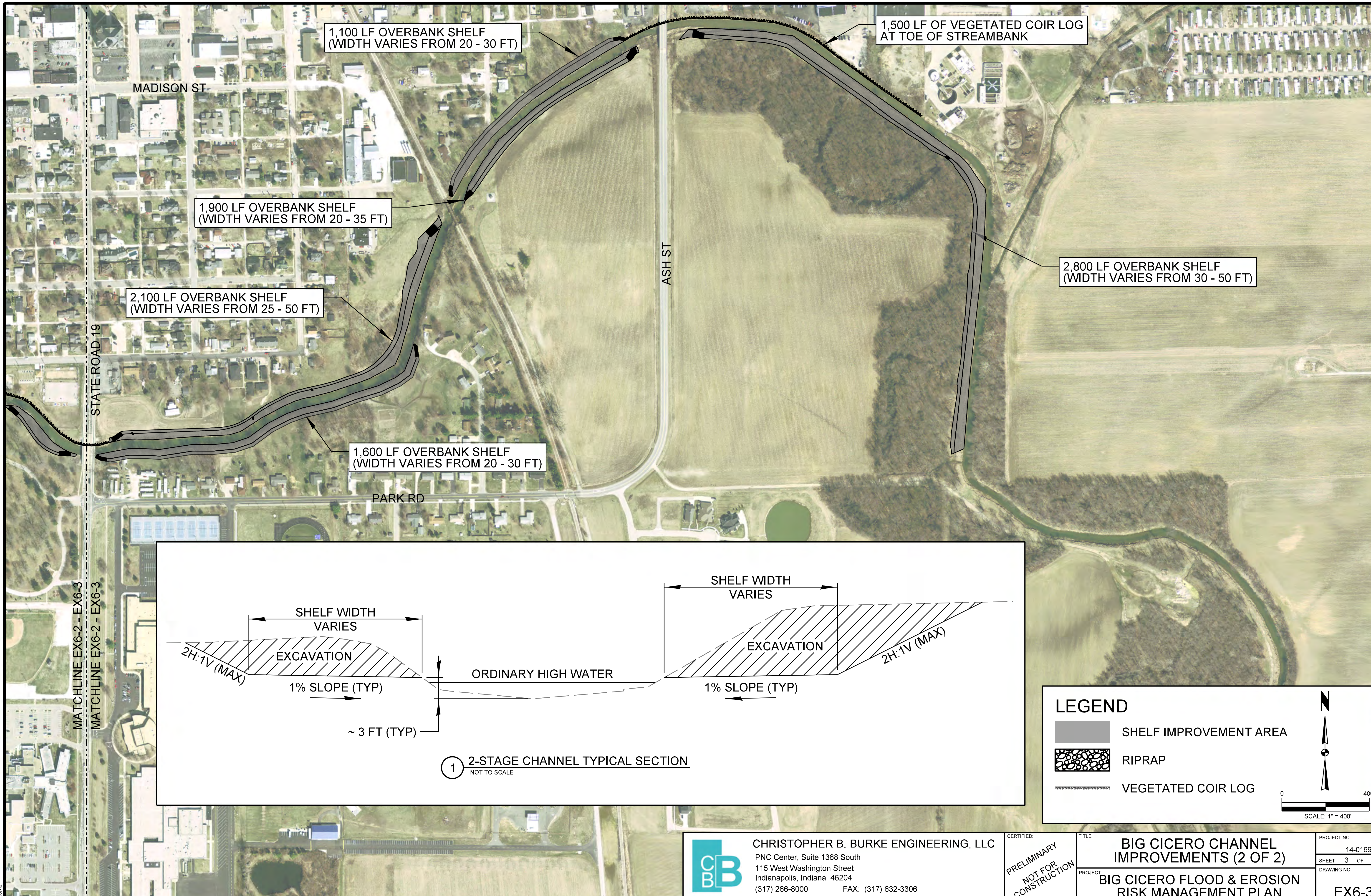
TITLE: BIG CICERO CHANNEL IMPROVEMENTS (1 OF 2)

PROJECT: BIG CICERO FLOOD & EROSION RISK MANAGEMENT PLAN

PROJECT NO. 14-0169

SHEET 2 OF 5

DRAWING NO. EX6-2



1 2-STAGE CHANNEL TYPICAL SECTION
NOT TO SCALE

LEGEND

- SHELF IMPROVEMENT AREA
- RIPRAP
- VEGETATED COIR LOG

0 400
SCALE: 1" = 400'

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Indianapolis, Indiana 46204
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CERTIFIED: PRELIMINARY NOT FOR CONSTRUCTION

TITLE: BIG CICERO CHANNEL IMPROVEMENTS (2 OF 2)

PROJECT: BIG CICERO FLOOD & EROSION RISK MANAGEMENT PLAN

PROJECT NO. 14-0169

SHEET 3 OF 5

DRAWING NO. EX6-3

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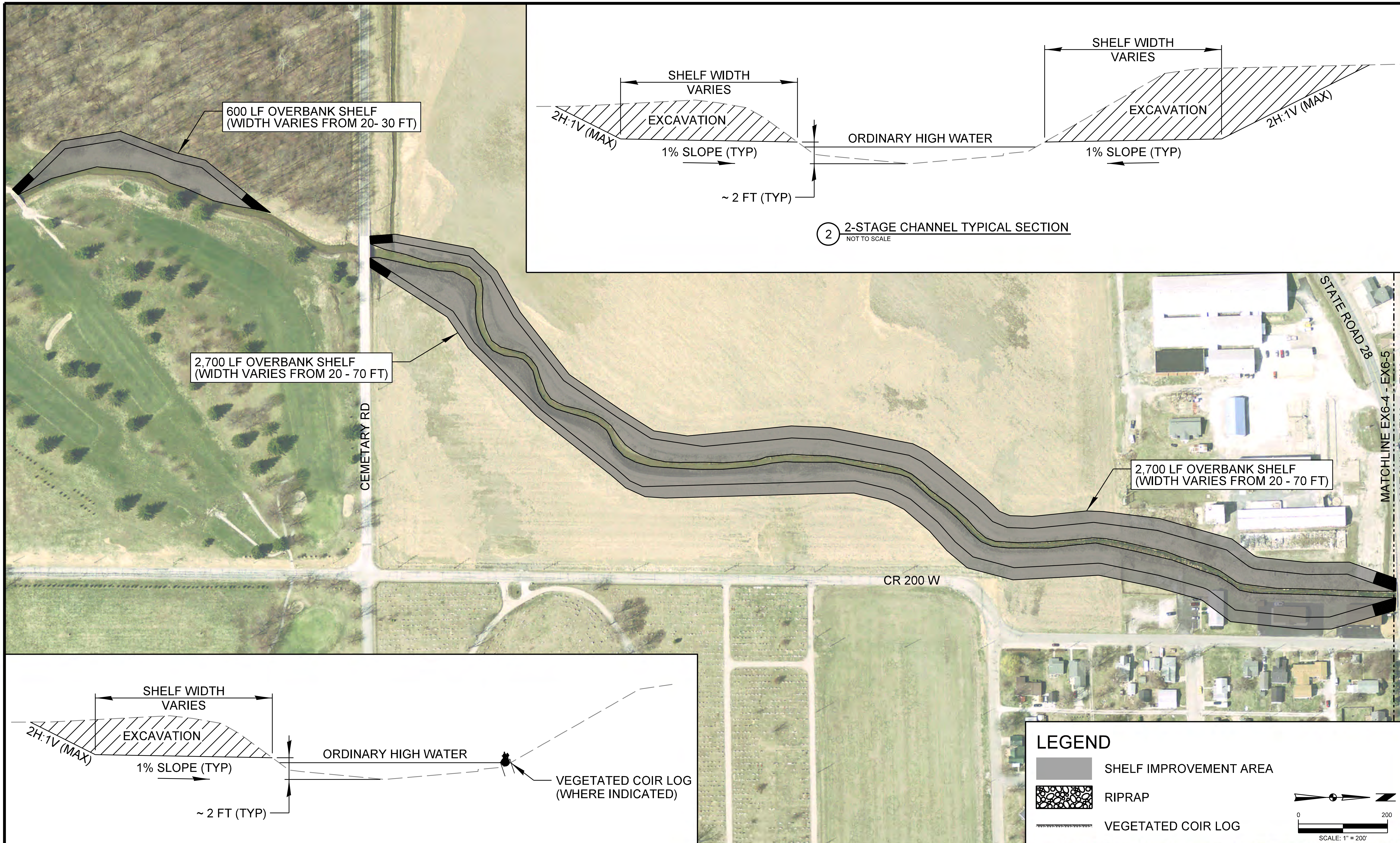
11/6/2014



1 OVERBANK SHELF TYPICAL SECTION
NOT TO SCALE

CHRISTOPHER B. BURKE ENGINEERING, LLC
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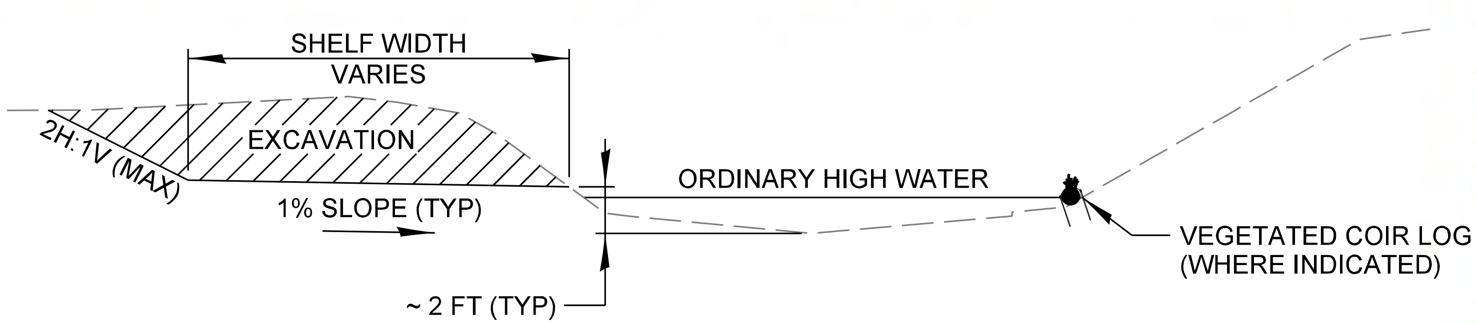
115 West Washington Street
Indianapolis, Indiana 46204
(317) 266-8000 FAX: (317) 632-3306

CERTIFIED:
PRELIMINARY
NOT FOR CONSTRUCTION

TITLE:
BUCK CREEK CHANNEL IMPROVEMENTS (1 OF 2)

PROJECT:
BIG CICERO FLOOD & EROSION RISK MANAGEMENT PLAN

PROJECT NO. 14-0169
SHEET 4 OF 5
DRAWING NO.
EX6-4



1 OVERBANK SHELF TYPICAL SECTION
NOT TO SCALE

LEGEND

- SHELF IMPROVEMENT AREA
- RIPRAP
- VEGETATED COIR LOG

0 200
SCALE: 1" = 200'

CHRISTOPHER B. BURKE ENGINEERING, LLC
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Indianapolis, Indiana 46204
(317) 266-8000 FAX: (317) 632-3306

CERTIFIED: PRELIMINARY NOT FOR CONSTRUCTION

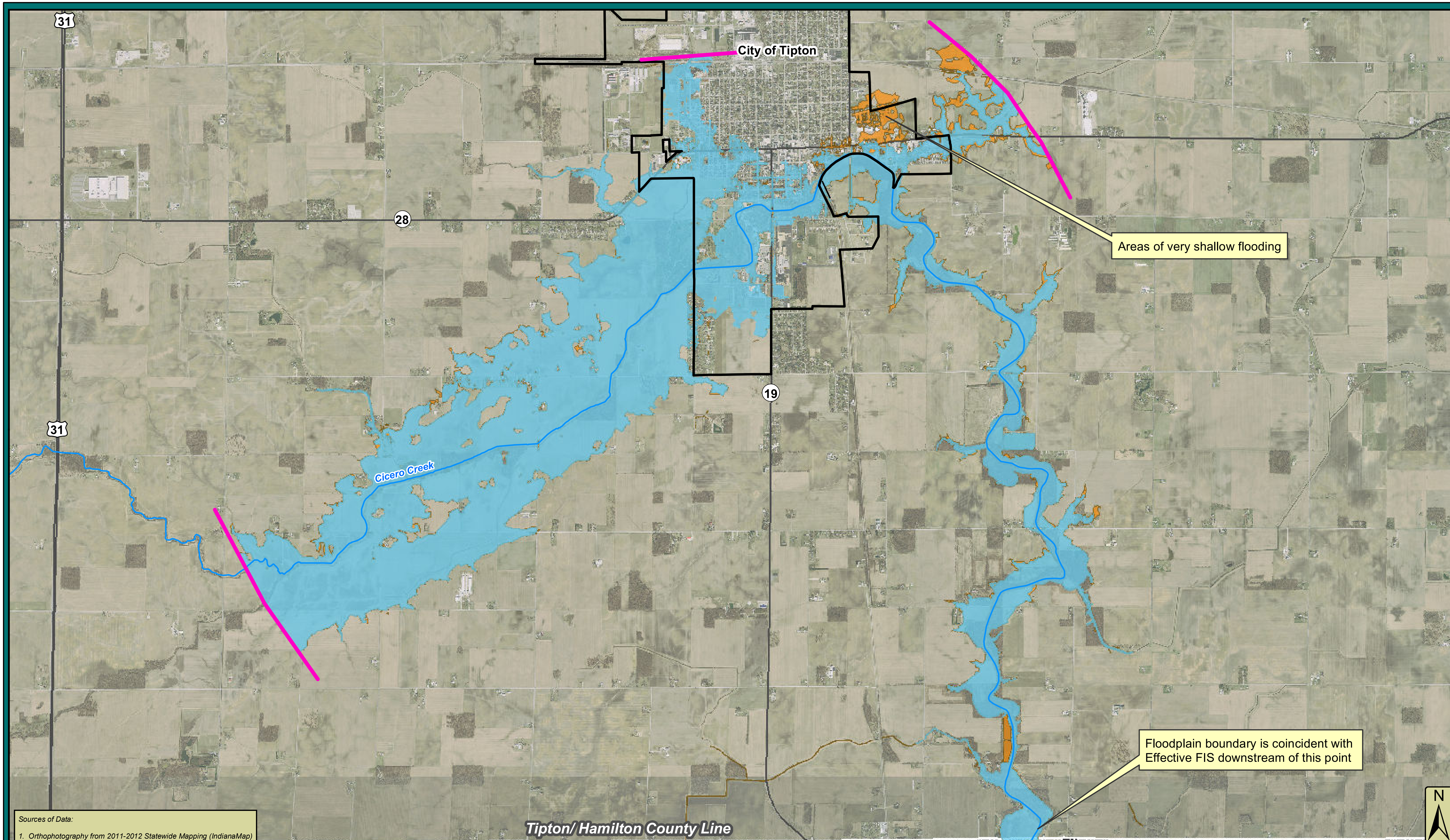
TITLE: BUCK CREEK CHANNEL IMPROVEMENTS (2 OF 2)

PROJECT: BIG CICERO FLOOD & EROSION RISK MANAGEMENT PLAN

PROJECT NO. 14-0169

SHEET 5 OF 5

DRAWING NO. EX6-5



Existing Condition
Future Condition with Recommendations
Limits of Study

Christopher B. Burke Engineering, LLC
PNC Center, Suite 1368 South
115 West Washington Street
Indianapolis, Indiana 46204
(t) 317.266.8000 (f) 317.632.3306

PROJECT: Big Cicero Creek Watershed Flood and Erosion Risk Management Plan	PROJECT NO. 14-0169	APPROX. SCALE 1 " = 3,000 '
TITLE: Comparison of April 2013 Floodplains under Existing and Future Conditions with Recommendations		DATE: 11/2014
		EXHIBIT 7