LITTLE RIVER ENGINEERING FEASIBILITY STUDY

Huntington, IN | November 2022

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LITTLE RIVER
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Prepared for:

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EXECUTIVE SUMMARY

This report documents the results and methodology used by Christopher B. Burke Engineering, LLC (Burke) to identify problem areas along Little River in Huntington County, Indiana and to develop conceptual mitigation solutions. Robert Barr, a fluvial geomorphologist, assisted Burke in this effort.

The study reach was approximately 15.8 miles in length and extended from the confluence with the Wabash River to the Huntington-Allen County Line, approximately 3 miles upstream from the Town of Roanoke. Little River has a drainage area of approximately 290 square miles at the Wabash River confluence, approximately 80 square miles of which are contained in Huntington County.

A functional assessment and engineering feasibility study of Little River was completed by Burke and Robert Barr to identify sites of current or potential future erosion, risk to human life, or other stream health impediments, to locate problem areas that are in the greatest need of intervention, and to aid in the development of conceptual mitigation solutions. The assessment included review of previous studies and analysis of available data for the stream and its contributing watershed. The assessment determined the following:

1. **The reach from the Wabash River confluence to Co. Rd. 200 E is generally stable:** Little River both downstream and upstream of Huntington has a generally robust wooded riparian corridor. Tree roots provide stabilization to the streambanks and the riparian corridor provides flood storage and energy dissipation. Through the City of Huntington, the riparian corridor is less consistent, but a wider channel and accessible floodplain serve to relieve stress from the banks in most locations.
2. **The reach in Huntington Co. upstream from Co. Rd. 200 E is generally unstable:** Upstream of County Road 200 E, large stretches of the wooded riparian corridor have been removed. This has led to systemic instability throughout the reach. Steep, silty banks have eroded and collapsed, contributing large amounts of sediment to the stream.
3. **There is evidence of stream straightening, deepening, and/or widening for much of the stream's length in Huntington County:** Other than the apparent widening of the channel in Huntington, most of the remaining study reach has channel bottom widths that closely match predicted values. However, historical channel dredging for agricultural drainage has left the banks 3-5 times as high as predicted in many locations. The channel has also been straightened significantly. Many of the forested "pockets" that remain along the channel are remnants of old meander bends.
4. **Increased flow rates and more frequent bankfull discharges are indicated:** Analysis of historical flowrates at the USGS stream gage indicates an increasing trend in average and peak streamflow. Higher peak flow rates and more frequent bankfull discharges have resulted in more frequent saturation of the soils, which can lead to instability in steep, silty banks.
5. **Nearly all of the stream's historically wetland floodplain area has been converted to agriculture:** Over 90% of the historical wetland land cover within the Little River watershed has been lost. The historic "Great Marsh" that occupied much of the Little River Valley was drained for agriculture nearly 150 years ago and the region is still dominated by agriculture today.

The engineering feasibility study identified three problem areas for which conceptual solutions were developed. Two recommended sites are located in the City of Huntington. The recommended mitigation improvements include channel modifications to increase bank stability, reduce sediment load, and increase public access to the stream for recreation. A list of the projects and associated costs is provided in the table below.

Project	Location	Construction Cost	Cost of Engineering	Total Cost
Streambank Stabilization	CR 200 E to Allen Co. Line	$167,400*	$37,000*	$204,400*
Power Line Foundation Removal	Downstream of Broadway St	$162,100	$27,000	$189,100
Stream Access	Downstream of Broadway St	$28,400	$27,000	$55,400

*Per 100 feet of bank stabilization

1.0 PROJECT OVERVIEW

1.1 INTRODUCTION AND PROJECT PURPOSE

This report documents the results and methodology used by Christopher B. Burke Engineering, LLC (Burke) to complete a functional assessment and engineering feasibility analysis of Little River in Huntington County, Indiana. Robert Barr, a fluvial geomorphologist, assisted Burke in this effort. The assessment was commissioned by the Upper Wabash River Basin Commission (UWRBC) through the Indiana Department of Natural Resources (IDNR) Lake and River Enhancement (LARE) grant program to identify the stressors leading to channel instability, to identify the fluvial erosion hazards along the study reach, and to determine the feasibility of stream corridor improvements.

1.2 STUDY AREA

The study reach was approximately 15.8 miles in length and extended from the confluence with the Wabash River to the Huntington-Allen County Line, approximately 3 miles upstream from the Town of Roanoke. Little River has a drainage area of approximately 290 square miles at the Wabash River confluence, approximately 80 of which are contained in Huntington County. The study area is located within the 0512010109 to 0512010111 ten-digit hydrologic unit codes (HUCs) in the U.S. Geological Survey (USGS) watershed nomenclature. A map of the study area is shown in **Exhibit 1**.

Figure 1: Little River Upstream of Meridian Road

2.0 BACKGROUND

Existing data and previous studies were used as supporting information for the assessment. Additional data and observations were collected to provide a more comprehensive understanding of the physical processes at work near the sites and within the river system. The following sections detail the origin and use of existing datasets and applicable previous studies, as well as the type and extent of additional information gathered.

2.1 DATA SOURCES

Aerial Photography
Aerial photography of the Little River Watershed was obtained from multiple sources. The primary source of aerial photography information was the 2017 IndianaMap Orthophotography. Historical aerial imagery was collected from Google Earth.

Land Use Information
Information concerning the types and extent of land use practices in the area were necessary for a portion of the analysis. Land use information was gathered from historical and recent National Land Cover Datasets (NLCD). Aerial photography from the 2017 IndianaMap Framework Dataset was inspected to generally confirm the land uses shown in the NLCD data. A map of land use change is provided in **Exhibit 2**.

Topographic Data
The analysis of the Little River corridor through the study area required detailed topographic information for various calculations. The 2017 IndianaMap Digital Elevation Model (DEM) was used as the source of topographic data for floodplain connectivity considerations. The IndianaMap DEM data cover the entire Little River Watershed and has a 2.5-foot cell resolution.

Streamflow Data
Streamflow information was obtained from the United States Geological Survey's (USGS) online portal to provide a record of the hydrology for Little River. USGS gage 03324000 is located approximately 3.5 miles upstream of Huntington, IN. The streamflow information was used to determine long-term trends in flow rates and the frequency of significant storm events.

Surficial Geology and Soils Information
Geologic composition and deposition information was obtained from the Quaternary Map of Indiana (Gray, 1989). A map showing the distributions of the various glacial deposits in the Little River watershed is shown in **Exhibit 3**.

Soils information was obtained from the United States Department of Agriculture (USDA) Soil Survey Geographic Database (SSURGO) to provide the properties of the soils along the Little River corridor. The characterization of channel bed and bank material at the project sites were completed using visual observations.

2.2 PREVIOUS STUDIES AND ANALYSES

The review of previous studies in the Little River watershed was limited to hydrologic and hydraulic analyses, as well as a small number of other reports of significance to fluvial stability and flooding considerations.

Previous Studies

Applicable references included the following reports published by the United States Geologic Survey, the Federal Emergency Management Agency (FEMA), Burke, and others.

Recent (circa 1998 to 2011) Channel Migration Rates of Selected Streams in Indiana (USGS, 2013a)

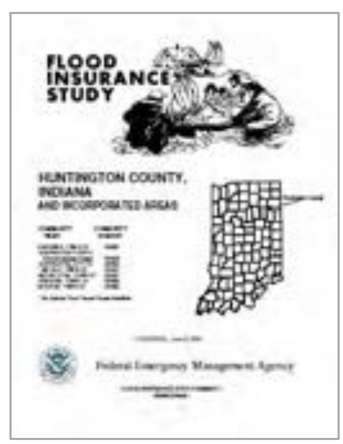
A total of 42 streams in Indiana were measured to determine observed lateral migration rates of the streams, or how much a channel's banks shift relative to the surrounding land features. Lateral migration rates can be used as a surrogate for overall stream stability. The analysis completed by the USGS revealed that of most streams in northeast Indiana migrate less than 1 foot per year, on average. Though bank instability exists along Little River, it is unlikely that the channel will deviate significantly from its current alignment.

Regional Bankfull Channel Dimensions of Non-Urban Wadeable Streams in Indiana (USGS, 2013b)

Regionally-based relationships for channel dimensions were developed by analyzing data from streams throughout Indiana. The data was obtained from 81 streams that are non-urban, wadeable, and pristine or naturalized. The regional equations can be used to determine a channels departure from the expected dimensions as well as to aid in channel restoration design processes.

Flood Insurance Study: Huntington County, Indiana and Incorporated Areas (2015)

The most recent FIS report for Huntington County provides flood elevations along Little River for the 10-, 50-, 100-, and 500-year return period events. Flood profiles of the water surface elevations can be found within the report. An interactive map of the 100- and 500-year floodplains can be accessed online through the Indiana Department of Natural Resources' (IDNR) updated Flood Information Portal (INFIP 2.0). Flood elevations were reviewed at key locations to characterize floodplain connectivity results and assess potential flooding and erosion risks.



Little River Initial Assessment and Alternative Analysis Study (Burke, 2010)

The previous Burke study focused on the reach from Aboite Creek to Meridian Road, paying special attention to the flooding experienced in Roanoke due to Little River, Cow Creek, and McPherren Ditch. The study used detailed hydrologic and hydraulic modeling to evaluate more than 10 alternative solutions, including floodproofing, raising bridges, and constructing reservoirs. Burke recommended educating landowners regarding runoff redutcion, adopting updated stormwater ordinances, managing logjams, and implementing voluntary buyouts and floodproofing practices.

Upper Wabash River Watershed Mangement Plan, Phase III (ECI, 2021)


Upper Wabash River
Watershed Management Plan
Phase III

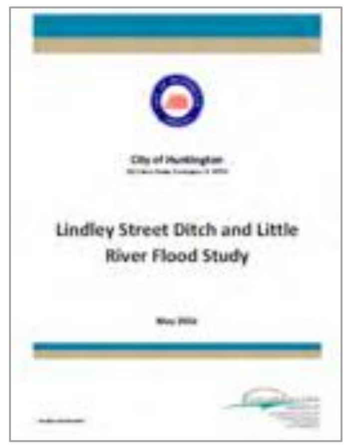
This study, funded by a 205(j) grant from IDEM was largely focused on water quality. Stated goals of the project were to develop a plan to reduce pollutant loads in the Wabash River to meet total maximum daily load (TMDL) requirements, water quality monitoring, and education and outreach. The report recommended a variety of practices to reduce pollutant inputs and improve water quality in the Wabash River, including cover crops, riparian forested buffers, 2-stage ditches, and wetland creation, enhancement, and restoration.

Geology of the Little River Valley (Fleming, 2014)

This report by Tony Fleming, hosted on the Little River Wetland Project's website, summarizes the geologic history and current state of the Little River Valley. As described in the report, post-glacial melting and settling unleashed the "Maumee Torrent" through what is now the Little River Valley approximately 14,000 years ago. Since that time, the valley, which is approximately a mile wide, has filled in 20-30 feet with sand, silt, and, in places, muck. As recently as the mid-1800s, "virtually the entire floor" of the valley, was covered by the 25,000-acre "Great Marsh." Drainage of the valley began in the late 1800s and was largely complete by the late 1880s, paving the way for the dominance of agricultural land uses that are present in the valley today.

Little River Watershed Diagnostic Study (Commonwealth Biomonitoring & Empower Results, 2009)
This LARE study was completed for the four counties in the Little River watershed. The primary goals were to identify water quality problems in the watershed and propose potential solutions. Of the 19 water sampling locations, most showed elevated nutrient levels but were within acceptable ranges for other water quality attributes. Channelization and removal of streambank vegetation were associated with decreased habitat value. Solutions included reducing or strategically scheduling channel modifications, using vegetated buffers to reduce sedimentation, and improving manure application processes.

Lindley Street Ditch and Little River Flood Study (Lochmueller, 2016)
This study found that structures near the confluence of Lindley Street Ditch and Little River (just downstream of the Broadway Street bridge in Huntington) experience frequent flooding and that improvements to Lindley Ditch are unlikely to improve conditions during larger storm events. Suggested improvements included increasing storage utilization in Clare Lake, offline detention storage, and property buyouts. After the publication of this report, several of the suggested parcels were purchased by the City.



Available Models
Extensive modeling was performed for the 2010 Burke study, but those models were not utilized for this study beyond using the results to contextualize the findings herein. The FIS model for Little River in Huntington County is nearly 40 years old and it is difficult to extract useful information beyond the flood elevations, which are provided in the FIS report and in shapefiles provided by FEMA. A more recent permit model for the Huntington County reach of Little River was completed in 2004, but many geometry attributes were missing from the available copy, and thus it was not used for this work.

3.0 FUNCTIONAL CHANNEL ASSESSMENT

3.1 INITIAL BACKGROUND ANALYSIS

An initial background analysis was completed to develop a baseline understanding of the river system prior to completing site visits and visual observation of the river corridor. The initial background analysis included evaluation of the physical basin characteristics, surficial geology and soils, the extent and composition of the riparian corridor, and the hydrologic characteristics of the contributing watershed.

3.1.1 Basin Description

Little River has a drainage area of approximately 290 mi^2 at the confluence with Wabash River near Huntington, IN. Little River flows from northeast to southwest through Allen and Huntington counties (Exhibit 1). The stream runs through the cities of Roanoke and Huntington, and its watershed includes Ossian, Zanesville, and portions of Ft. Wayne. Eightmile Creek, the largest tributary to Little River, contributes nearly 30% of the total drainage area. The predominant land use in the watershed is agricultural.

3.1.2 Surficial Geology and Soils

Surficial geology is important when considering the potential for erosion and stream stability issues. Little River is in the Bluffton Till Plain and its banks are composed primarily of silt loam soils, shifting to loam near the City of Huntington. The surficial geology deposition type in the greater watershed is primarily silty clay loam and clay loam till. Geology within the Little River Valley is dominated by lacustrine silt and clay, remnants of the historic lake overflows from Fort Wayne. Near Huntington, the valley is characterized by limestone and dolomite bedrock.

The capacity of a soil to resist erosion is primarily dependent on three factors. The first two factors, soil grain size and cohesion, often determine the importance of vegetation, the third factor. Fine-grained, low cohesion or cohesionless soils such as sands and silts have a low tolerance for erosive forces and require vegetation to remain stable over long periods of time. Clayey soils are cohesive and are much more resistant to erosion than sands and silts. Higher percentages of clay in a soil type can dramatically increase the resistance to erosion. The soils along Little River are largely classified as silt loams. Silt loams are composed of sand, silt, and a smaller amount of clay, plus organic material. They are generally friable, poorly consolidated, and easily eroded.

3.1.3 Wooded Riparian Buffer Assessment

The existence of vegetation is often the most critical factor for the capacity of a soil to resist erosion. Vegetation reinforces the soil structure and serves as a buffer to reduce stress on the soil surface. This factor is particularly important for the stability of Little River, given the highly erodible silty soils that comprise the stream's banks. Most of the study reach was bordered by a forested corridor, though the width of the buffer is quite narrow in places. The presence of a buffer can allow for small, natural adjustments of the stream necessary to maintain stability without impairing adjacent land uses.

Much of Little River has inconsistent or absent wooded riparian buffers. The reach from the Wabash River confluence to approximately Lafontaine Street in Huntington (2 miles) has a generally good riparian buffer on both sides, though the buffer is thin in some places. Through Huntington, from Lafontaine Street to Broadway (1.5 miles), the buffer is very patchy and often only present on one side of the stream. The stream is very wide through the city, with relatively low bank height, minimizing the detrimental effects of the insubstantial riparian buffer. Between Broadway and CR 200 E (3.5 miles) the riparian buffer is very strong. The nearly 9-mile reach from CR 200 E to the Allen County line has a generally poor or entirely absent riparian corridor (**Figure 2**). Remaining wooded buffers are generally only present on one side of the stream at a time and are often associated with remnants of wet woods in old meanders that were cut off during past channel straightening projects. The recent removal of woody vegetation from the streambanks in this reach has led to systemic streambank instability. The silty soils are unable to hold the high, steep banks without support from extensive root systems. A relative "bright spot" in this upstream reach is the portion of Little River from State Street in Mahon to Vine Street in Roanoke (2 miles) that has a higher prevalence of two-sided wooded buffers, though the buffer is sometimes only one or two trees wide on one side.

The effects of woody vegetation on bank stability can be quantified using a method known as the Bank Erosion Hazard Index (BEHI). The BEHI analysis combines factors such as bank height, bank angle, and vegetative rooting to estimate the risk of erosion. As shown in **Appendix 1**, woody vegetation is the primary reason that erosion risks are lesser downstream of CR 200 E than they are upstream of the road. The roots of the woody vegetation are longer than the roots of the grassy vegetation. Additionally, root density and surface protection are higher due to the nature of the vegetation and lack of recent bank failures at the downstream site.

Figure 2: Wooded Riparian Buffer Quality

3.1.4 Hydrology

The response of the watershed to rainfall is a key factor in the amount of fluvial instability and flooding risk potential posed by a stream. The amount of runoff generated, and the time required for the flow to accumulate and reach the stream affect the erosive potential of the channel and determine how much flow must pass through the most restrictive sections of the channel which may or may not result in significant flooding. Increased drainage efficiency in agricultural areas and other intensive land uses frequently increase runoff and decrease infiltration. These changes often result in higher and more frequent peak flows, as well as a larger volume of runoff.

The Little River watershed is primarily agricultural in nature (roughly 75%), with most of the remaining land area devoted to comparable amounts of urban (13%) and forested (9%) land cover. Notably, wetlands now comprise less than 1% of the watershed, whereas the "Great Marsh" alone used to occupy 10-15% of the basin. The land use characteristics of the watershed have remained largely unchanged over the past 20 years, according to NLCD datasets. Land use change within the Little River Watershed is represented in **Figure 3**. A map showing the spatial distribution of the land use changes is shown in Exhibit 2**.**

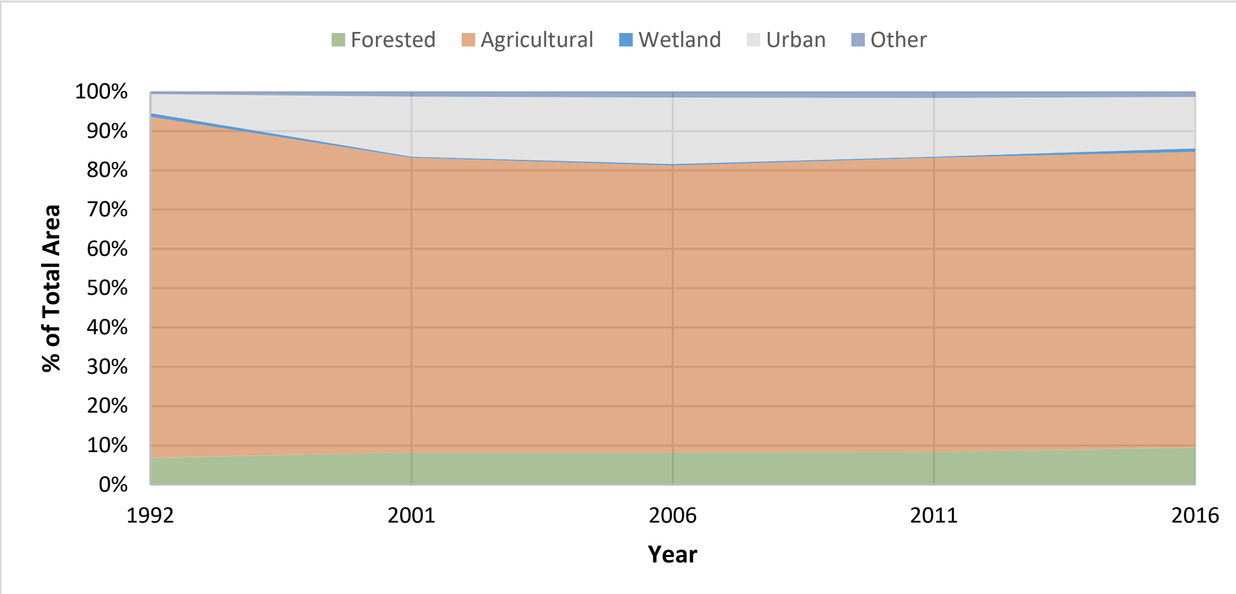


Figure 3: Land Use Characteristics in the Little River Watershed

Total land use change from 1992-2016 for each subbasin in the Little River watershed is summarized in **Table 1**. The northernmost subbasins, Aboite Creek and McCulloch Ditch, have experienced the largest percentages of land use "intensification" over the past 20 years. Over 20% of the Aboite Creek watershed has been urbanized since 1992, and that percentage is even higher for McCulloch Ditch, with over 35% urbanization. It is notable that nearly 10% of the entire Little River basin has been converted from agricultural to urban land uses since 1992, with the Little River and Robinson Creek watersheds showing significant development, in addition to Aboite Creek and McCulloch Ditch. As discussed in Section 3.4, the Little River basin was historically dominated by wetland habitat, however most of the conversion away from wetland land use occurred in the 1800s and is not captured by the NLCD data. It can be seen in Exhibit 2 that the majority of the land use change in the basin has occurred outside of Huntington County. While in some sense this may mean that the development and associated increase in flows is not the "fault" of Huntington County, that does not reduce the impact of the development or preclude Huntington County and other parties interested in the health of Little River from taking action to reduce the potential harmful impacts.

Table 1: Land Use Change by Subbasin

Subbasin Name	Basin Area (mi^2)	Land Use Change (%)					
		Forested to Urban	Forested to Ag.	Ag. to Urban	Wetland to Urban	Other	Total
Eightmile Creek	80.8	0.2	3.4	2.1	0.0	0.6	6.3
Aboite Creek	52.8	3.3	3.1	17	0.4	1.4	25.2
Bull Creek	14.5	0.3	5.1	0.4	0.0	0.3	6.1
Calf Creek	10.6	0.8	6.4	1.9	0.0	0.6	9.7
Flat Creek	26.3	0.1	2.3	0.8	0.0	0.7	3.9
Little River	64.5	1.9	4.1	9.7	0.1	0.7	16.5
McCulloch Ditch	22.1	9.8	2.2	26	0.8	1.9	40.7
Robinson Creek	16.5	0.7	4.2	8.6	0.1	0.8	14.4
TOTAL	**288**	**2.0**	**3.6**	**8.5**	**0.2**	**0.6**	**15.1**

3.2 STREAM GAGE AND PRECIPITATION ANALYSIS

An analysis of available hydrologic data was completed to determine the characteristics and trends in the watershed's response to rainfall. USGS gage 03324000 on Little River is at the CR 200 E bridge upstream of Huntington. The average peak annual flow has increased by approximately 25% over the past 80 years. The 10-year moving average transitions from 4,000 cfs to 5,000 cfs around the year 1980 (**Figure 4**). The increase in peak annual flow shows that large events that can cause significant channel erosion and adjustment are occurring more often.

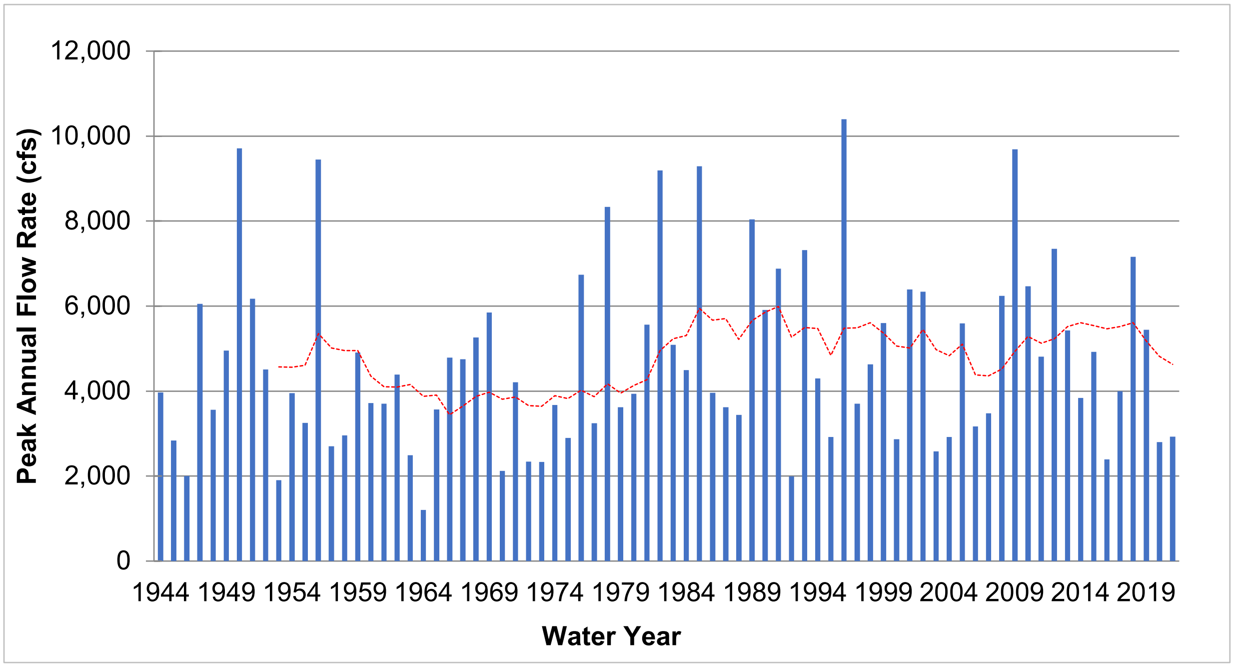


Figure 4: Peak Annual Flow Rate at USGS Gage in Bluffton, IN

It is important to remember that erosion occurs in streams at all flow rates, it is simply a matter of how much erosion occurs. High flow rates obviously lead to high erosion rates; however, it is typically the bankfull flow rate that statistically moves the most sediment over time. This fact highlights the true nature of erosion in streams: a relatively slow and grinding process that is constantly reshaping the channel. For a healthy stream, the bankfull flow rate will occur for a few hours, roughly every 18 months. A statistical analysis of the USGS gage data suggests that the bankfull flow rate is approximately 3,200 cfs. The average number of days at bankfull discharge has doubled over the period of record, with bankfull discharges now occurring 2-3 times per year (**Figure 5**). This is 3-4 times the expected frequency.

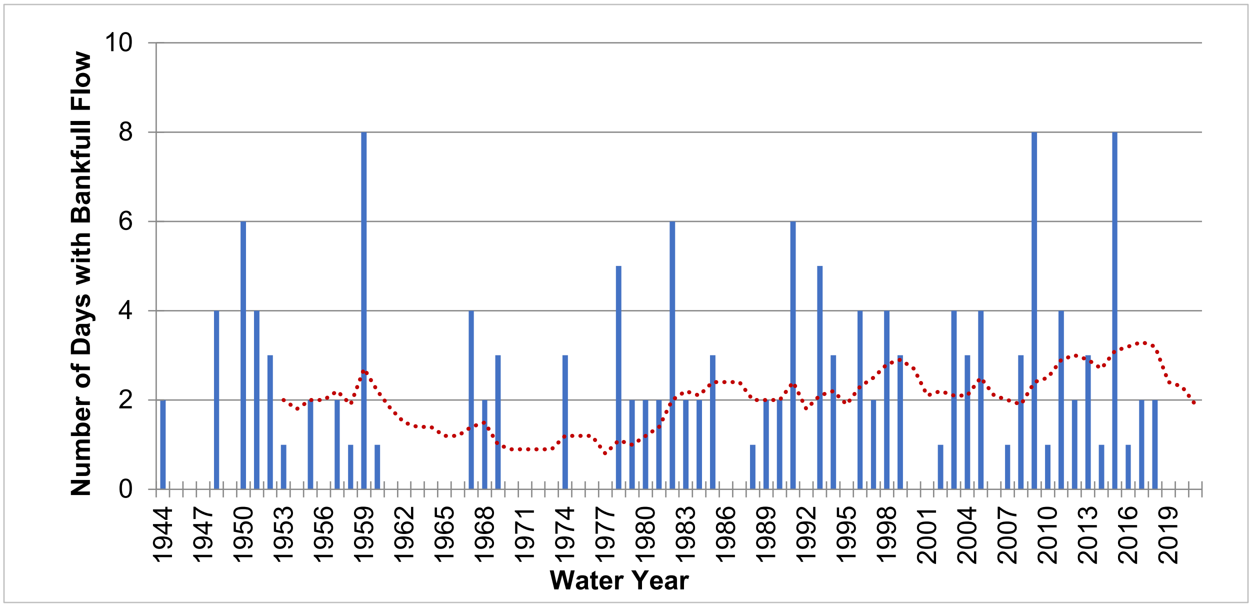


Figure 5: Frequency of Bankfull Discharge at USGS Gage in Linn Grove, IN

The average annual precipitation in northeast Indiana is approximately 36 inches. The annual precipitation has a slightly increasing trend over the last 120 years (Climate at a Glance, NOAA). A more pronounced trend in has been observed since 1960, with the 10-year moving average increasing from 34 to nearly 40 inches per year, as shown in **Figure 6**.

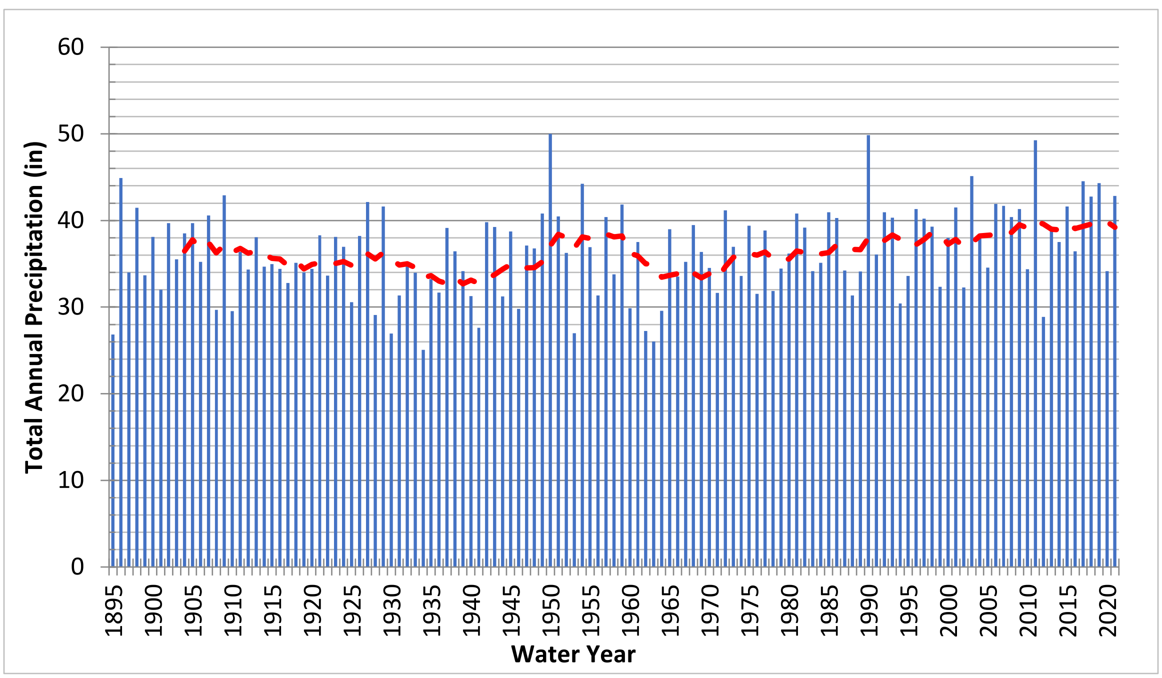


Figure 6: Annual Rainfall Depth, Northeast Indiana
(Climate at a Glance, NOAA)

More relevant with regards to flooding and erosion potential than annual average precipitation is the frequency of heavy rainfall events. Previous studies of National Weather Service data from 1958 to 2016 have shown that Indiana as a whole has seen the days of extreme precipitation events increasing from 1 to 3 days since 1900 (IN CCIA, 2018), as shown in **Figure 7**. This is particularly relevant to the stability of Little River given the recent loss of wooded riparian corridor along significant reaches of the stream.

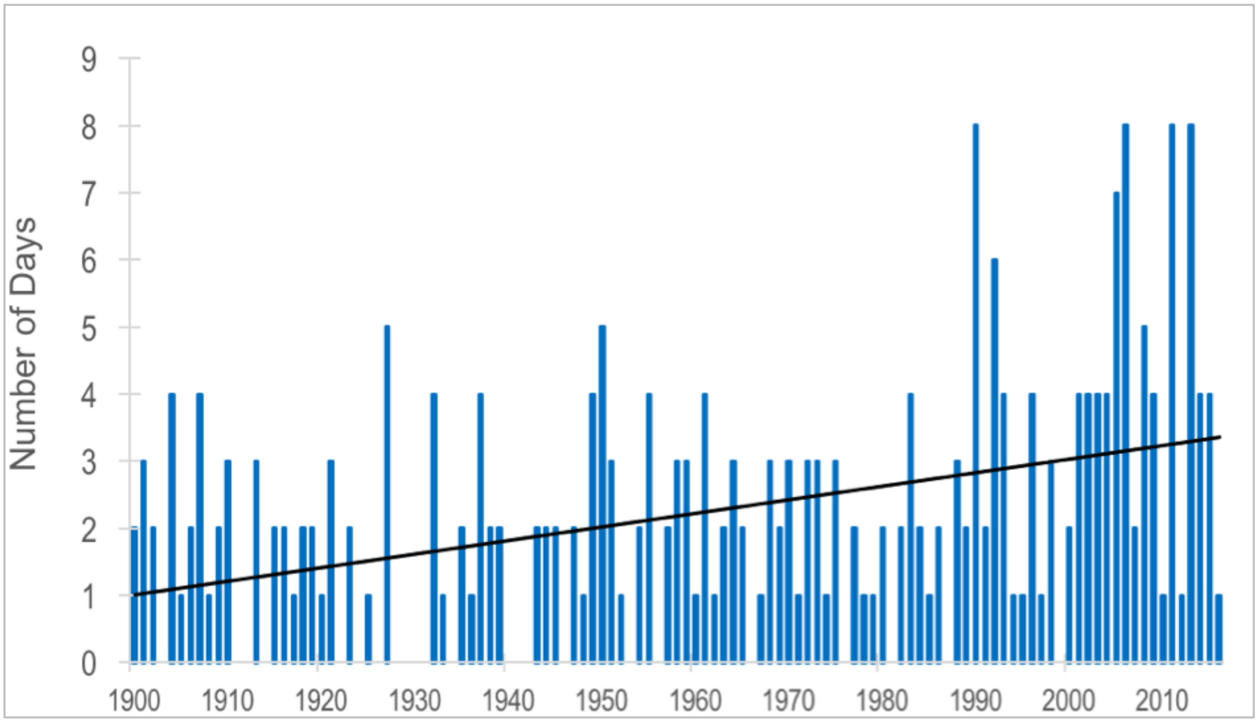


Figure 7: Change in Very Heavy Precipitation
(IN CCIA, 2018)

3.3 CURRENT GEOMORPHIC CHANNEL CHARACTERISTICS

The study reach was divided into several sections based on channel morphology, influence of tributaries, and history of channel modifications. **Figure 8** and **Figure 9** provide information about these reaches. **Appendix 2** contains field photos and descriptions of channel dimensions. The reach from the confluence with the Wabash to Huntington did not require extensive investigation due to the health of the riparian corridor and lack of reported problems. The reach through Huntington was observed at several locations to assess the character of the stream. In general, the channel appears to be in good shape. The channel is very wide, and typically has a lower bank that allows the stream to access its floodplain. Instability was not a major concern in this reach.

The reach from Huntington to Mahon is generally consistent in channel dimensions, but there is a distinct dichotomy in the stability of the stream. The channel is generally quite deep (bank heights on the order of 15 feet) and steep (2:1 Horizontal:Vertical (H:V) slope or steeper). The reach from Huntington to CR 200 E has a strong wooded riparian corridor and is relatively stable given the height and steepness of the banks. Upstream of CR 200 E, instabilities are pervasive due to the removal of trees from the banks of the stream. The primary determining factor in the level of instability in this reach is the height of the bank. Bank height remains similar up through Huntington County, though the stream is narrower upstream of the confluence with Eightmile Creek, which doubles the stream's drainage area.

Upstream of the Huntington-Allen county line, the stream becomes noticeably smaller and straighter, having the character of a manmade ditch. Although steep banks are still present, the reduced bank height and lesser contributing drainage area reduce the risk of bank failures and the channel is more stable.

Figure 8: Cross Section Locations

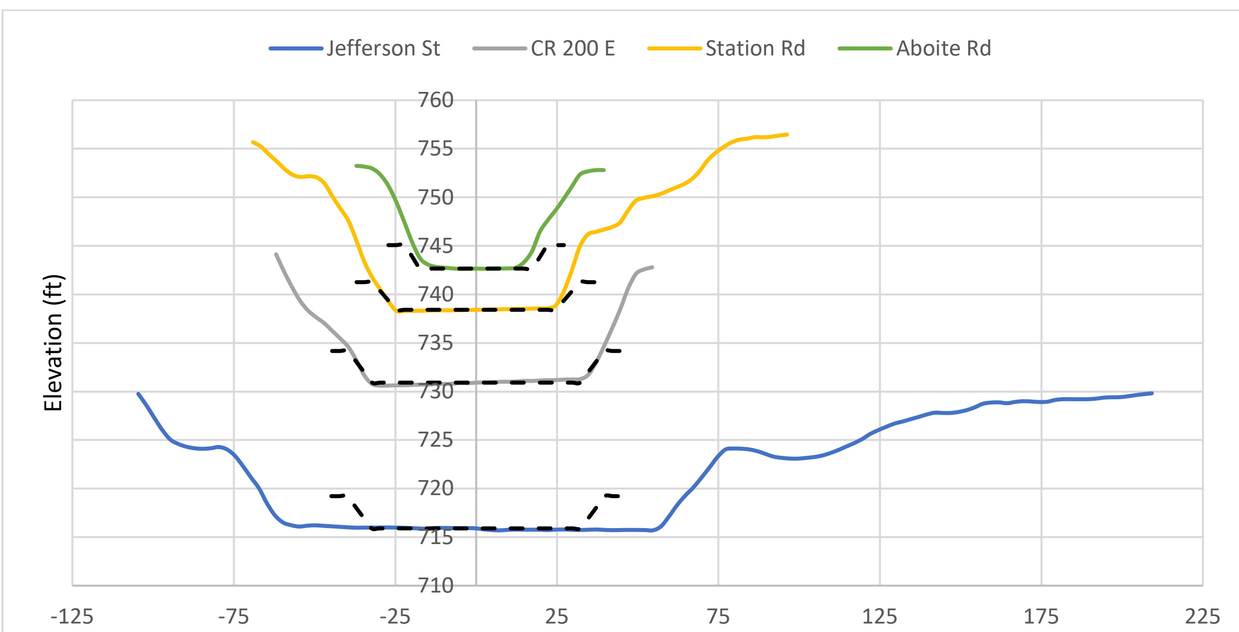


Figure 9: Stream Cross Sections

(Dashed lines represent bankfull dimensions predicted by USGS regional curves.)

Regression equations developed for Indiana streams by the USGS (USGS, 2013) provide useful comparison points for the observed channel dimensions. The "regional curves" predict bankfull channel dimensions based on drainage area, with predictions tailored based on the stream's location within the state. Little River lies within the Central Till Plain Region of Indiana. However, Little River is located very near the border of the Northern Moraine and Lake Region, and the extremely flat channel slope and predominance of hydric soils within the river valley give the stream more northerly characteristics. As shown in Figure 9, the bottom width of the channel upstream of the City of Huntington very closely matches the predictions based on regional curves. However, the channel has been dramatically deepened to increase drainage and channel capacity. This exposes the banks to much higher flow volumes and velocities than would naturally occur, which, combined with removal of woody vegetation from the banks, has led to the observed instabilities In the City of Huntington, the channel shows signs of having been widened. While the banks are approximately twice as high as predicted, the "extra" width of the channel has likely kept flood velocities and shear stresses low enough to prevent systemic bank issues from developing, even in reaches where the wooded riparian corridor is less robust.

3.4 CHANNEL SLOPE

In addition to the cross-sectional shape of the channel, channel slope can also play a role in channel stability. Steeper channels typically have higher velocities than flatter channels and thus are more at risk for bank and bed erosion. A longitudinal profile of Little River shows that the channel is incredibly flat. As described by Fleming (2014), the Little River Valley was historically a tabletop-flat wetland. This legacy is still represented in the modern day channel, even after a century and a half of modification. As seen in **Figure 10**, the break in slope at station 20,000 is located just upstream of the City of Huntington. This location also generally corresponds to the stream's transition to a bedrock channel as it nears the city (Exhibit 3). A more detailed plot is included as **Exhibit 4**, but even from this smaller image, it is clear that the slope of the channel between the City of Huntington and the Allen County line (station 21,000 – 83,000) is on the order of 1 ft/mile. This suggests that, while rainfall and flowrates are trending upward, channel velocities are likely not excessively high. Thus, channel instabilities are likely mostly attributable to over-steepened banks and vegetation removal. Were the banks of the stream to be flattened and/or revegetated, the channel would be expected to maintain relative stability even as flowrates continue to increase.

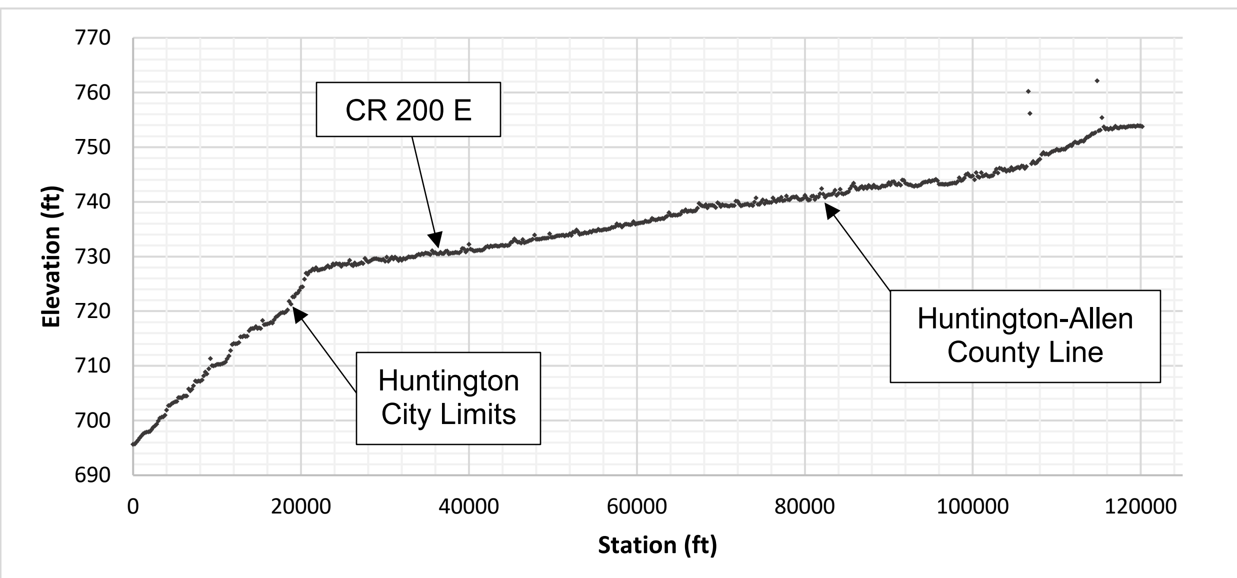


Figure 10: Longitudinal Profile of Little River

3.5 FLOODPLAIN CONNECTIVITY ANALYSIS

An analysis was performed to estimate the floodplain connectivity of the river, or how much access the river has to its floodplain during flooding events of different magnitudes. A new tool was developed to compare the width of the floodplains at one- and two times bankfull depth above the channel bottom. Bankfull depths were estimated using the USGS regional curves. The floodplain width at one bankfull depth is, by definition, the width of the channel at the top of its banks just before flow would spill out in a flood event. Streams are typically assumed to experience bankfull flow during the 1.5-year return period flood, or once every year-and-a-half on average. The floodplain width at two times bankfull depth is sometimes referred to as the "floodprone width" and typically corresponds to a flood event of intermediate magnitude, perhaps on the order of a 25- to 50-year return period event depending on the stream.

By comparing the extents of the floodplains at elevations of one and two times bankfull depth, it is possible to visualize the degree to which a stream is connected to its floodplain (**Figure 11**). Highly entrenched or incised streams will show very little difference between the bankfull and floodprone widths, indicating that the channel might only access its floodplain during extreme events or that, even if the floodplain is accessed, it provides little relief to the stream. Once a stream loses access to its floodplain, a positive feedback loop often contributes to further channel incision as higher magnitude, higher-energy events are contained within the channel and worsen bank and bed erosion. Conversely, streams that have floodprone widths that are wide relative to their bankfull widths are generally more stable because flow is more able to leave the channel and dissipate energy in the overbanks rather than in the channel.

Figure 11: Bankfull (blue), Floodprone (yellow), and Regulatory Floodplain (red) Widths in the City of Huntington.

The results of applying this analysis to the Little River, shown in **Exhibit 5**, indicate that the river is generally not highly entrenched, though there is considerable variation in the degree of connectivity throughout the study reach. By observing the floodplain widths at one bankfull depth (shown in light blue) and two bankfull depths (shown in yellow), patterns in channel management become clear. From the Wabash River Confluence to Meridian Rd, the river is generally well connected to its floodplain. From Meridian Rd to Mahon Rd, there is little-to-no connectivity to the broader floodplain. Even absent the non-levee embankments along the channel (pink lines), the channel is too deep for the calculated floodprone elevation to escape the channel. Upstream of Mahon, the channel bank heights decrease and much more connectivity is shown.

Note that the calculations used to generate the maps are based on natural channels in Indiana, which tend toward common depth-to-flow-area ratios. In heavily modified channels, such as Little River upstream of Huntington, the assumptions built into the equations do not hold. The "standard" comparison of floodprone width to the 25- to 50-year event floodplain is inaccurate in this case because the channel is now significantly deeper than it would have been in its natural state. Even at twice the predicted bankfull depth, flow is still contained within the channel. However, because the relationship between flow depth and flow area has been dramatically altered from the natural state, significant flooding may be experienced in "real life" even if it is not represented in the mapping. In the City of Huntington, where the river appears to have been widened, the mapped connectivity may overestimate the extents of the bankfull and floodprone floodplains. Thus, the application of these methods to Little River is not a good representation of actual flooding frequency but does provide useful information on the stresses acting upon the channel.

In addition to visually comparing the extent of the floodplains at 1x and 2x bankfull width, the tabulation of the width ratios can facilitate comparisons to published classifications of entrenchment. In the literature, dividing the floodprone width by the bankfull width yields what it referred to as the "entrenchment ratio" (Rosgen, 1996). Thus, somewhat counterintuitively, streams with a higher entrenchment ratio are actually less entrenched. The entrenchment ratio was calculated at 51 locations at regular intervals along Little River. The measurement locations and their classifications are indicated by the regularly spaced, color-coded dots in **Exhibit 6**. Applying generally accepted entrenchment thresholds (Rosgen, 1996) leads to approximately 50% of the river being classified as heavily or moderately entrenched, with the remaining 50% classified as slightly entrenched. Results are summarized in **Table 2** and presented more fully in Exhibit 6.

Table 2: Entrenchment Ratio Summary for Little River

Classification	Entrenchment Ratio	Count	Percent of Total
Heavily Entrenched	1.0 - 1.4	12	24%
Moderately Entrenched	1.4 - 2.2	14	27%
Slightly Entrenched	2.2+	25	49%

3.6 WETLANDS

Wetlands provide vital ecological and economic benefits. In addition to providing habitat for large numbers of native species, they also retain and infiltrate surface water following precipitation events. This stormwater retention reduces peak channel flows, which in turn reduces stream maintenance costs and other economic and social costs associated with downstream flooding. As detailed in the Little River Valley geology report (Fleming, 2014), virtually the entire Little River Valley was historically wetland. This "Great Marsh" covered approximately 25,000 acres and was a mile wide. The soils that developed under those wetland conditions are still present and, absent drainage enhancements provided by Little River and agricultural ditches, much of the area would likely return to a wetland ecosystem. Today, there are over 43,000 acres of hydric soils in the Little River Watershed (excluding the Eightmile Creek watershed, which is largely in Wells County and not formally a part of this study). For the purposes of this study, hydric refers to soil types that are associated with hydric conditions at least 75% of the time. In contrast, only 3,000 acres of wetland are currently identified by the U.S. Fish & Wildlife Service in their National Wetland Inventory (NWI). This amounts to a 93% loss of wetlands in the watershed. **Exhibit 7** compares the current distribution of wetlands with the distribution of hydric soils in the Little River Valley.

Despite the overwhelming percentage of historic wetlands that have been lost, considerable effort is currently being made to preserve remaining wetlands or even increase the amount of wetlands in the Little River Watershed. The USDA NRCS has approximately 1,400 acres of easements within the watershed. The Indiana Department of Natural Resources manages approximately 1,700 acres of land in the watershed. Not all of this area is necessarily wetland, but it does represent an effort to maintain natural environments. The most prominent local group in this arena is the Little River Wetlands Project (LRWP). They have protected over 1,300 acres of wetlands in the watershed, some of which is now managed by IDNR or other partners, and are actively seeking new conservation opportunities.

Figure 12: Conservation Plantings Upstream of Aboite Road.

Most of the conservation lands described above are located in Allen County. A map of wetland conservation opportunities for Huntington County is included as **Exhibit 8**. Identified opportunities were limited to existing wetlands identified in the NWI. As described above, much of the Little River Valley could be reverted to wetland with proper management, but the scope of this project was limited to existing wetlands. The other primary criterion was adjacency to Little River. This factor maximizes the benefit to Little River by maintaining flood storage and woody riparian vegetation next to the streambank. This also minimizes the impact to existing agricultural operations. The areas identified are not currenly in agricultural production and formal conservation would not inhibit continuing cultivation of current cropland. Nearly 300 acres of conservable land meeting these criteria are present along Little River in Huntington County.

3.7 PROBLEM AREA IDENTIFICATION

3.7.1 INITIAL PROBLEM AREA IDENTIFICATION AND VERIFICATION

Problem areas were identified through a combination of UWRBC input, field visits by the Burke Team, and coordination with the City of Huntington. The primary area of concern discussed with Huntington County representatives on the UWRBC prior to the commencement of fieldwork was the power line foundation in the middle of Little River just downstream of Broadway Street in the City of Huntington. This area was noted as being a location of frequent buildups of large woody debris in the channel.

The noted area of concern was evaluated during field reconnaissance along the entirety of Little River by the Burke Team in March, 2022. Observations were made at road crossings and by walking on foot along the River and its tributaries. The initial field observations identified a second problem area in the form of an extended reach of bank instability upstream of Huntington CR 200 E.

Following the initial field investigation, interim updates to the UWRBC, and communications with officials from the City of Huntington, an additional potential project was identified. The City expressed a desire to improve at least one potential access location for canoeing and kayaking on the river through the city. The

City identified one potential location near Broadway Street and one location upstream of Jefferson Street. A second field visit was conducted by the Burke Team in May, 2022 to gather stream measurements at the unstable reach near CR 200 E and to review the potential access locations in the City of Huntington.

The evaluation, identification, and confirmation of identified problem areas discussed above were completed using the full spectrum of available data. Because all identified problem areas are not the same "type" of problem, there is no single index that can be used to rank them objectively. Rather, a combination of factors including current or potential future erosion risk, risk to human life, or other stream health impediments were considered to rank these problem areas.

3.7.2 RANKING OF PROBLEM AREAS

The three identified project locations are shown in **Exhibit 9**. Two sites are adjacent to each other just inside the Huntington city limits. The third is an extended reach of instability located largely in unincorporated Huntington County. The problem areas are listed by priority ranking in **Table 3**.

Table 3: List of Problem Areas

Problem Area	Rank	Basis for Assigned Rank
Little River Streambanks, CR 200 E to Allen County Line	1	High potential for sediment contribution to Little River and Wabash River
Duke Energy Power Line Foundation	2	Obstruction of channel; likelihood of logjams and ice jams; improvement of stream access location
Stream Access Location	3	Low impact on stream health; high impact on public enjoyment and visibility of stream

4.0 CONCEPTUAL SOLUTIONS

The instabilities and issues present at each of the top three ranked problem areas are clarified in the following paragraphs to provide a context for the proposed solutions for each location. The conceptual solutions shown in **Exhibits 10 through 12** and discussed in the paragraphs below are specific to the needs of the individual locations. Without a detailed and site-specific consideration of consequences, the installation of bank stabilization measures can result in increased erosion and instability downstream of the project. It must be noted that the conceptual solutions described below and in Exhibits 10 through 12, though based on field observations and measurements, are not construction-ready plans and a more thorough technical evaluation of the sites may indicate that deviations from the conceptual solutions provided here may be necessary.

4.1 STREAMBANK INSTABILITY (UPSTREAM OF COUNTY RD 200 E)

Figure 13: Streambank Instabilities near CR 200 E (top) and CR 100 N (bottom).

Extensive, systemic streambank instability was observed along Little River from County Road 200 E to the Huntington-Allen County Line, as shown in **Figure 13**. From field observations and discussions, this instability appears to be the result of recent tree clearing along the stream. In some locations, the bank is merely "raw" from recent erosion, but in others the bank has experienced extensive sloughing and failure. In places where the bank has failed to a maintainable slope, natural re-establishment of vegetation has taken place.

The extent of the instability issues, totaling in excess of nine miles of streambank, creates the potential for significant amounts of sediment and nutrients to enter Little River and, eventually, the Wabash River. Based on observations made by the Burke Team, this most likely represents the largest single contribution of sediment to the Upper Wabash River.

The proposed improvements consist of implementing a two-stage channel design where feasible along Little River between CR 200 E and the County Line. The two-stage channel consists of a low-flow channel, a floodplain "bench", and regraded, shallow, vegetated bank slopes. A schematic layout of the potential improvements is provided in **Exhibit 10**.

General recommendations for channel dimensions are provided in the Exhibit, but site-specific design calculations should be performed for each project. In some cases, the full recommended channel and bench widths will not be practicable due to site constraints such as roads and railways. Disturbance to existing wooded riparian corridor should be avoided. Where practicable, excavated soil may be spoiled in the regulated drain easement or across other agricultural ground, if permission is granted, to reduce hauling costs. Because this reach of Little River is managed as a regulated drain by the Little River Joint Drainage Board, permission from the Joint Drainage Board, headed by the Allen County Surveyor, would be required before any improvements are made.

Due to the length of unstable reaches and limitations in funding, the proposed improvements would likely need to be funded, designed, and constructed in several project phases over several years. The cost of designing, constructing, and permitting these improvements is expected to be approximately $204,400 per 100 linear feet of streambank. This is a rough estimate based on dimensions at selected sites. Actual costs will vary depending on actual channel and treatment dimensions, project length, and other construction contingencies. Each individual project should be designed by an engineer. The cost of the design will depend on the length of treatment. It is likely that Clean Water Act Section 401 and 404 permits will be needed from IDEM and USACE. Because the Little River Regulated Drain is greater than 10 miles in length, a Construction in a Floodway permit from IDNR will likely also be required. A summary of the anticipated project cost is provided in **Appendix 3**.

4.2 POWER LINE FOUNDATION (DOWNSTREAM OF BROADWAY ST)

The abandoned power line foundation in the middle of Little River downstream of Broadway Street in the City of Huntington was one of the initial problem areas identified by stakeholders and the UWRBC. As shown in **Figure 14**, the foundation regularly collects large wood. The collection of large wood and, at times, ice can lead to increased local flooding. The bifurcated flow paths created by the mid-channel bar have created instabilities in the adjacent streambanks, as flow is directed into the bank as it is forced around the obstruction. Over time, the stream has eroded approximately 20-30 feet into the adjacent streambanks to compensate for the lost flow area in the channel due to the foundation and accreted sediment.

Figure 14: Mid-channel Power Line Foundation with Large Wood Collecting Upstream

The proposed improvements consist of removing the foundation and associated large wood and sediment accumulation from the channel. Following the removal of material from the channel, the adjacent streambanks will be realigned to approximate the historical width of the channel through this reach. Maintaining a consistent width through this reach will reduce the likelihood of sediment accumulation. If the mid-channel obstruction were removed without this accommodation, larger sediment particles would likely settle out due to a decrease in stream velocity. Completion of this project would also increase the visual appeal of the stream adjacent to a potential future stream access point on the north bank. A schematic layout of the conceptual improvements is provided in **Exhibit 11**.

The cost of designing, permitting, and constructing these improvements is expected to be approximately $189,100. A summary of the anticipated project cost is provided in Appendix 3. Coordination with Duke Energy regarding access to their easement and removal of the foundation is strongly advised.

4.3 ACCESS SITE IMPROVEMENT (DOWNSTREAM OF BROADWAY ST)

Huntington County and the City of Huntington have expressed interest in increasing access to and recreation on Little River. Multiple potential locations have been proposed, both within and outside of the City of Huntington. Based on a preliminary review, the Burke Team believes that the best location for the first access site is just downstream of the Broadway Street bridge. The preferred location is shown in **Figure 15**.

Figure 15: Recommended Location for Stream Access Improvements

Another tentative location proposed by the City of Huntington is on the south bank of Little River upstream of Jefferson Street. This location was not preferred because of its proximity to an existing low head dam and the amount of large wood that is present in the channel upstream of the "island" at Jefferson Street. A third suggestion provided to the Burke Team was to find a location near Roanoke. This option was not preferred due to the condition of the generally steep and/or wooded streambanks in that reach.

A more targeted investigation may reveal additional suitable sites, but the results of an initial screening indicate that the Lindley Street location is the most ideal at this time. The City already owns the land, it is readily accessible from the street, little or no clearing of woody vegetation would be required, and the existing slopes are traversable.

The proposed improvements consist of constructing a parking lot on city land between Lindley Street and the Lindley Street Ditch and installing a vegetated concrete block mat walking path and launch site between the parking lot and the stream. Minor regrading may be needed to create a more consistent walking path slope. The timing of implementation of this design should include consideration of the removal of the low-head dam and removal of the power line foundation adjacent to this site. Changes to the bank geometry following removal of the foundation may impact the layout of the launch site. A schematic layout of the potential improvements is provided in **Exhibit 12**.

The cost of designing, permitting, and constructing these improvements is expected to be approximately $55,400. A summary of the anticipated project cost is provided in Appendix 3.

4.4 IMPROVEMENT COST SUMMARY

A summary of the cost estimate for the improvements at each of the problem areas is included in **Table 4**. The cost estimates are arranged based on the ranking of the problems from most to least critical.

Table 4: Summary of Cost for Each Problem Area

Project	Rank	Cost of Construction	Cost of Engineering	Total Cost
Little River Streambanks, CR 200 E to Allen County Line	1	$129,000*	$37,000*	$166,000*
Power Line Foundation Removal	2	$162,100	$27,000	$189,100
Stream Access Location	3	$28,400	$27,000	$55,400

*Per 100 feet of bank stabilization

4.5 CONSIDERATIONS FOR CONCEPTUAL STRATEGIES

The proposed conceptual strategies make several key assumptions that may greatly affect the details and cost of the improvements. It is anticipated that the proposed improvements will require the acquisition of the following environmental permits, at a minimum:

- IDNR Construction in a Floodway
- IDEM Section 401 Water Quality Certification
- USACE Section 404 Dredge & Fill Permit

4.6 LARGE WOOD

Though much of the wooded riparian corridor of Little River has been removed, significant forested corridor still exists between Huntington and County Road 200 E and in places near Roanoke. Where a stream is bordered by a forested riparian corridor, the periodic presence of large wood in the channel is inevitable. Several potential logjam locations were investigated by field observations, with historical aerial photography being used to estimate the prevalence of debris collection over time. In the City of Huntington, the power line foundation and the Jefferson Street island appear to be the primary locations of woody debris buildup. Large wood is nearly always present in the streams at these locations and periodic maintenance is recommended to prevent the development of large logjams. If the power line foundation is removed, more frequent large wood removal may be necessary at Jefferson Street.

Aerial photography indicates that the railroad trestle across Little River just south of Main Street/Mahon Road near Mahon periodically collects large wood. The presence of an existing access road at this location indicates that this area is already recognized as a large wood accumulation point and that periodic log removal is likely already conducted. No specific preventative maintenance or wood management program is prescribed for this location. Continuing to monitor and address the buildup of large wood as needed is advisable.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The results of the functional assessment described in Chapter 3 suggest that issues at the specific identified problem areas can be corrected using measures provided in Chapter 4. While the improvements are expected to remedy the issues at these specific locations, the improvements are not expected to meaningfully alter the stability of other areas along the river. The following paragraphs outline the improvements that are recommended for implementation based on the findings of the functional assessment and the practicability of the proposed improvements. Additional recommendations to promote the stability and sustainability of the river, as well as additional study needs for future stewardship of the river corridor are provided.

5.1 RECOMMENDED CHANNEL IMPROVEMENTS

1. **Implement Proposed Bank Stabilization Measures Upstream of County Road 200 E**

   The streambank stabilization improvements are the highest priority due to the potential to greatly reduce the amount of sediment entering Little River and Wabash River. Stabilizing the banks will improve water quality in downstream reaches. Specific project locations within the identified reaches will need to be identified to prepare appropriate construction drawings and permit applications.

2. **Implement Proposed Power Line Foundation Removal in Huntington**

   The improvements at the power line foundation are given a lower priority because of the overall lesser impact on the health of Little River. Though removal of the obstruction and restoration of the historical channel shape would be beneficial for the stream, any significant improvements to the failing banks upstream are likely to have more positive impacts on stream health. However, foundation removal may be easier to accomplish in the near term due to its specificity and notoriety in the community. Additionally, removal of the foundation is recommended to precede implementation of the stream access site improvements.

3. **Implement Proposed Stream Access Improvements in Huntington**

   The improvements at the proposed access site are given lowest priority because of lesser direct improvements to stream health and the preference to remove the power line foundation prior to establishing the access location. Additionally, it may be beneficial to remove the low head dam or develop other appropriate safety protocols pertaining thereto before in-channel recreation is encouraged.

5.2 RECOMMENDED PASSIVE MANAGEMENT PRACTICES

As discussed in Chapter 3, the observed (and projected) increasing trends in rainfall and discharge have and will continue to act as a watershed stressor, exacerbating the potential for slope failures along Little River. While the scope of this study did not include an examination of all the reasons for the observed and forecasted increases, based on experience with similar areas in Northern Indiana, the major factors contributing to peak discharge increases along the stream are the impacts of climate change in frequency, intensity, and depth of precipitation, increase in runoff peaks and volumes resulting from urban development and agricultural drainage practices, and encroachment and loss of floodplain storage within the river corridor. The following passive management practices should be promoted and implemented to help reduce the impacts of watershed stressors.

5.2.1 SOIL HEALTH PRACTICES

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 gaining increased acceptance in Indiana. These practices have the potential to change water management in agricultural regions of the United States in ways that benefit farmers and mitigate the effects of climate change.

Traditional farming practices focus on tilling, irrigating, and draining the land for a single target crop. Soil health practices instead focus on using natural processes to improve soil structure and agricultural productivity. Reducing tillage and increasing the use of cover crops increases the organic matter content, which in turn increases the ability of the soil to hold water and nutrients, reducing the need for inputs to the system. An example of a cover crop for improving soil health is shown in Figure 16. Experiments across the country attempt to document the benefits of soil health systems. 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; this is approximately equal to storing 1-inch of runoff. 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.

Figure 16: Cover Crop Growing in Harvested Corn Field

The Little River watershed, particularly the Little River Valley, is ideal for the implementation of these practices. The soils present in the area developed under wetland conditions, and the moisture and nutrient holding potential of these soils could be more fully harnessed by increasing cover crops and reducing tillage to rebuild the natural structure of these soils.

5.2.2 WETLAND ENHANCEMENT AND PRESERVATION

As discussed in Section 3.6, there is tremendous potential to improve the health of Little River by maintaining or increasing the amount of protected wetland area within the watershed. Lands may be purchased and managed as natural areas, nature parks, fish and wildlife areas, etc. There is also the possibility for agricultural lands that experience frequent flooding and low yields to enter into conservation programs such as the NRCS Wetland Reserve Program. This program and others like it have the potential to reduce losses for farmers, reduce fertilizer and other inputs into the stream due to flooding, and provide additional habitat for native species.

5.2.3 ORDINANCE AND STANDARDS REVISIONS

Maintaining current and strict stormwater ordinance and technical standards is critical to protecting the integrity of the stream corridor. To be effective, stormwater regulations must utilize current methods and technology, promote the use of infrastructure designs that mimic the natural / pre-development watershed, protect sensitive / critical environmental areas, and compensate for unavoidable adverse impacts to the stream system.

Low Impact Development (LID) and Green Infrastructure (GI) practices should also be promoted and employed to the greatest extent practicable to reduce the amount of stormwater runoff from a developed site. These methods offer a two-fold benefit. The total volume of runoff is reduced due to use of Best Management Practices (BMPs) that allow water to infiltrate into the soil, which results in lower required detention volumes and less runoff delivered to the stream. The second benefit is the flow rate leaving a site is lower than a conventionally designed site and mimics the natural release of stormwater runoff. When implemented well, the pre-development and post-development stormwater runoff metrics are nearly identical, resulting in no changes to the hydrology of the stream.

When large areas in the watershed are planned for development or redevelopment, a holistic approach should be used to design the stormwater infrastructure for the entire development, rather than a site-by-site design. By considering how the infrastructure will function as a whole, the incremental increases in flow rate and flow volume can be more comprehensively addressed. Regional detention may serve as an acceptable method of holistic design. If a site-by-site design concept is more practicable for a given situation, tertiary stormwater infrastructure should be allowed for to act as shock absorbers prior to releasing the flow from the development area.

Environmentally sensitive areas serve a critical role in the stream system. These areas include floodplains, floodways, wetlands, and riparian areas that provide stormwater storage to reduce flow rates, flow conveyance to minimize flood elevations, energy dissipation to reduce erosion, provide habitat for the organisms at the beginning of the food chain, and process natural and manmade pollutants. Development in these areas should be discouraged and prohibited where possible. Where it is not possible or practicable to avoid these areas, compensatory mitigation should occur that will provide the same benefits. It should be noted that a 1:1 ratio for compensatory mitigation (detention/floodplain storage, wetlands, trees, etc.) may not provide the same benefit to the system due to location, quality, and/or maturity. Mitigation ratios should be established to provide equal (or greater) benefit immediately after construction and onward.

5.2.4 INCREASED BUFFER WIDTH

The presence and/or extent of the wooded riparian corridor should be increased to reduce the detrimental impact of natural stream adjustments and to prevent incompatible land uses along the stream. While the removal of tillable land and reduced utility in urban areas has a cost, there is an economic benefit to increasing the buffer width for landowners adjacent to eroding areas. Planting crops along a bank that later fails and takes the young crop with it, caring for a lawn that sloughs into the channel, or constantly attempting to repair or stabilize the bank are all expenses that are potentially unnecessary. Individual landowners typically only have a problem with erosion along a stream if they have something too close to the channel and are at risk of losing their investment. If the buffer width is adequate, the problem with the erosion (even if the erosion continues) is typically eliminated.

5.3 NEXT STEPS

The following list provides the actions that should be taken after review of the functional assessment report:

1. Meet with Burke to discuss the findings and recommendations of this report.
2. Determine which project(s) are to be implemented and seek sufficient project funding. Begin detailed design after funds have been allocated.
3. Continue to promote passive conservation strategies described above within the watershed.

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EXHIBITS

CBB BURKE
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PROJECT: Little River Engineering Feasibility Study		PROJECT NO. 22-0046	APPROX. SCALE AS SHOWN
TITLE: Study Area			DATE: 11/2022
			EXHIBIT 1

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PROJECT: Little River Engineering Feasibility Study	PROJECT NO. 22-0046	APPROX. SCALE AS SHOWN
TITLE: Land Use Change (1992-2016)		DATE: 11/2022
		EXHIBIT 2

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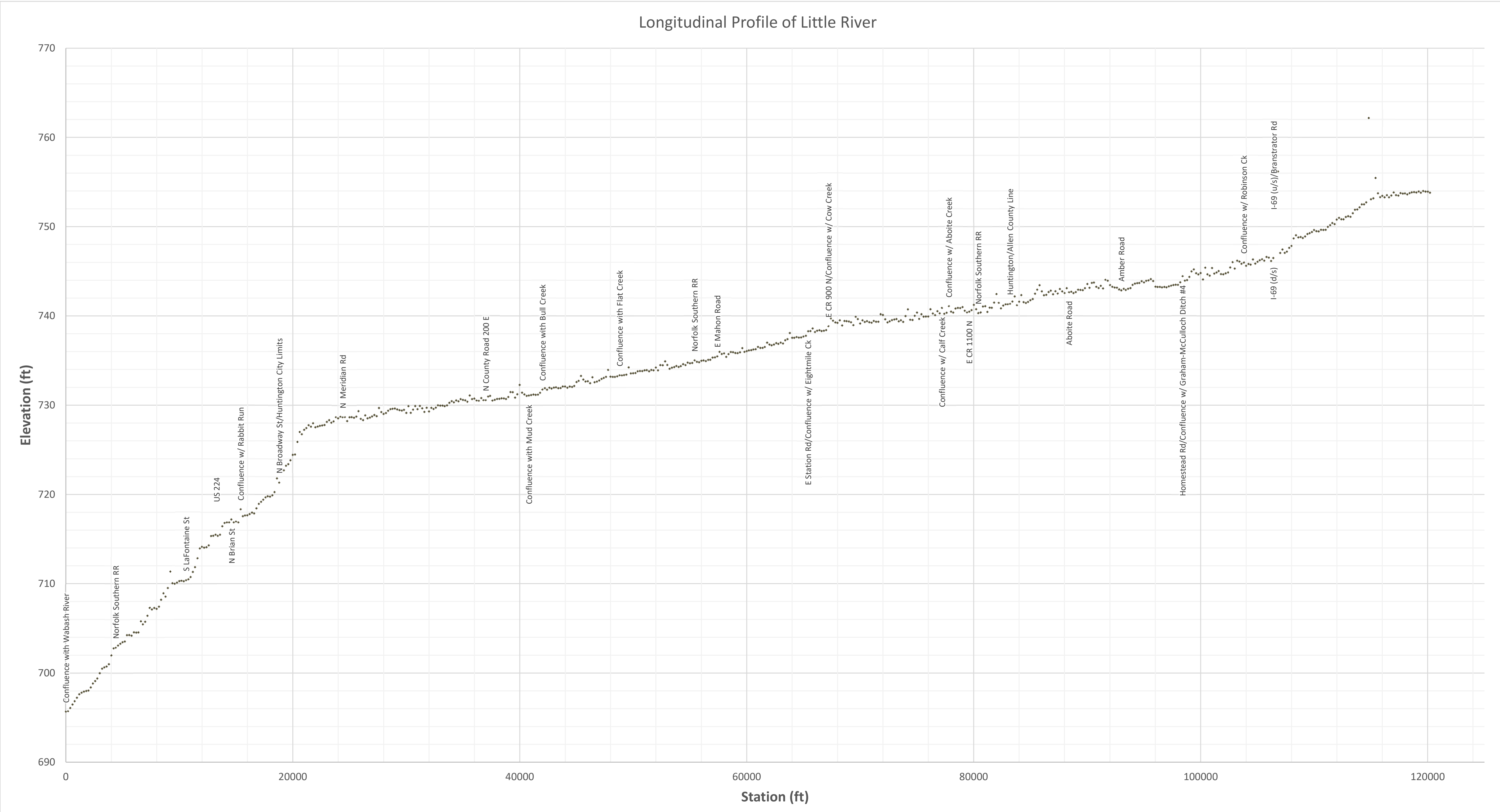
	TITLE: Surficial (Quaternary) Geology		DATE: 11/2022
			EXHIBIT 3



Longitudinal Profile of Little River
Elevation (ft)
Station (ft)
770
760
750
740
730
720
710
700
690
0
20000
40000
60000
80000
100000
120000
Confluence with Wabash River
Norfolk Southern RR
S LaFontaine St
US 224
N Brian St
Confluence w/ Rabbit Run
N Broadway St/Huntington City Limits
N Meridian Rd
N County Road 200 E
Confluence with Mud Creek
Confluence with Bull Creek
Confluence with Flat Creek
Norfolk Southern RR
E Mahon Road
E Station Rd/Confluence w/ Eightmile Ck
E CR 900 N/Confluence w/ Cow Creek
Confluence w/ Calf Creek
Confluence w/ Aboite Creek
E CR 1100 N
Norfolk Southern RR
Huntington/Allen County Line
Aboite Road
Amber Road
Homestead Rd/Confluence w/ Graham-McCulloch Ditch #4
Confluence w/ Robinson Ck
I-69 (d/s)
I-69 (u/s)/Branstrator Rd

Sources of Data:
1. Stream Centerlines: National Hydrography Dataset, USGS
2. Street Centerlines: County TIGER Shapefiles, U.S. Census Bureau
3. Road Centerlines: Highway Shapefiles, INDOT
4. Aerial Imagery: World Imagery Basemap, ESRI
5. Inset Map: World Street Basemap, ESRI

NOTE:
The Floodplain Connectivity polygons are generated by mapping approximate water surface elevations. The polygons are not based on hydraulic modeling, and do not account for localized effects of bridges or dams. Additionally, overbank areas with no surficial connection to the stream, such as those protected by accredited levees, may be shown as inundated due to these mapping methods. These maps are for general planning only; further analysis is recommended to confirm results at a given location.

Christopher B. Burke Engineering PNC Center, Suite 1368 South 115 West Washington Street Indianapolis, Indiana 46204 (t) 317.266.8000 www.cbbel-in.com	PROJECT: Little River Engineering Feasibility Study	PROJECT NO. 22-0046	APPROX. SCALE 1"=1,000'
			DATE: 11/2022
	TITLE: Floodplain Connectivity		EXHIBIT 5

Sources of Data:
1. Stream Centerlines: National Hydrography Dataset, USGS
2. Street Centerlines: County TIGER Shapefiles, U.S. Census Bureau
3. Road Centerlines: Highway Shapefiles, INDOT
4. Aerial Imagery: World Imagery Basemap, ESRI
5. Inset Map: World Street Basemap, ESRI

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The Floodplain Connectivity polygons are generated by mapping approximate water surface elevations. The polygons are not based on hydraulic modeling, and do not account for localized effects of bridges or dams. Additionally, overbank areas with no surficial connection to the stream, such as those protected by accredited levees, may be shown as inundated due to these mapping methods. These maps are for general planning only; further analysis is recommended to confirm results at a given location.

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PROJECT: Little River Engineering Feasibility Study	PROJECT NO. 22-0046	APPROX. SCALE 1"=1,000'
TITLE: Floodplain Connectivity		DATE: 11/2022
		EXHIBIT 5

Sources of Data:
1. Stream Centerlines: National Hydrography Dataset, USGS
2. Street Centerlines: County TIGER Shapefiles, U.S. Census Bureau
3. Road Centerlines: Highway Shapefiles, INDOT
4. Aerial Imagery: World Imagery Basemap, ESRI
5. Inset Map: World Street Basemap, ESRI

NOTE:
The Floodplain Connectivity polygons are generated by mapping approximate water surface elevations. The polygons are not based on hydraulic modeling, and do not account for localized effects of bridges or dams. Additionally, overbank areas with no surficial connection to the stream, such as those protected by accredited levees, may be shown as inundated due to these mapping methods. These maps are for general planning only; further analysis is recommended to confirm results at a given location.

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PROJECT: Little River Engineering Feasibility Study	PROJECT NO. 22-0046	APPROX. SCALE 1" = 1,000'
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		EXHIBIT 5

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PROJECT:	Little River Engineering Feasibility Study	PROJECT NO. 22-0046	APPROX. SCALE 1"=1,000'
TITLE:	Floodplain Connectivity		DATE: 11/2022
			EXHIBIT 5

Channel Entrenchment Calculations				
Analysis Location[a] (Downstream to Upstream)	Floodplain Width[b] (1 Bankfull Depth)[c]	Floodplain Width[b] (2 Bankfull Depths)[c]	Entrenchment Ratio[d]	Classification[e]
1	318	619	1.95	Moderately Entrenched
2	348	399	1.14	Heavily Entrenched
3	108	239	2.21	Slightly Entrenched
4	123	489	3.97	Slightly Entrenched
5	103	494	4.78	Slightly Entrenched
6	131	153	1.17	Heavily Entrenched
7	129	205	1.59	Moderately Entrenched
8	130	312	2.41	Slightly Entrenched
9	114	216	1.90	Moderately Entrenched
10	1450	1561	1.08	Heavily Entrenched
11	130	220	1.69	Moderately Entrenched
12	105	150	1.43	Moderately Entrenched
13	69	76	1.11	Heavily Entrenched
14	83	131	1.57	Moderately Entrenched
15	80	93	1.16	Heavily Entrenched
16	89	129	1.45	Moderately Entrenched
17	75	86	1.15	Heavily Entrenched
18	76	248	3.27	Slightly Entrenched
19	63	74	1.17	Heavily Entrenched
20	73	89	1.22	Heavily Entrenched
21	71	248	3.47	Slightly Entrenched
22	69	133	1.94	Moderately Entrenched
23	78	87	1.11	Heavily Entrenched
24	65	77	1.17	Heavily Entrenched
25	101	663	6.54	Slightly Entrenched
26	72	94	1.30	Heavily Entrenched
27	79	402	5.08	Slightly Entrenched
28	221	304	1.37	Heavily Entrenched
29	57	237	4.15	Slightly Entrenched
30	63	700	11.15	Slightly Entrenched
31	175	923	5.27	Slightly Entrenched
32	64	733	11.43	Slightly Entrenched
33	70	1312	18.64	Slightly Entrenched
34	607	1176	1.94	Moderately Entrenched
35	92	1858	20.23	Slightly Entrenched
36	88	126	1.43	Moderately Entrenched
37	71	361	5.07	Slightly Entrenched
38	114	956	8.35	Slightly Entrenched
39	321	1020	3.17	Slightly Entrenched
40	66	1145	17.26	Slightly Entrenched
41	330	900	2.73	Slightly Entrenched
42	1009	2691	2.67	Slightly Entrenched
43	1336	2717	2.03	Moderately Entrenched
44	489	2407	4.92	Slightly Entrenched
45	136	772	5.66	Slightly Entrenched
46	9	24	2.71	Slightly Entrenched
47	27	1401	51.53	Slightly Entrenched
48	2329	3687	1.58	Moderately Entrenched
49	2195	3532	1.61	Moderately Entrenched
50	179	1344	7.52	Slightly Entrenched
51	253	471	1.86	Moderately Entrenched

[a] Locations denoted as color-coded dots in Exhibit 5.

[b] Measurement axis was autogenerated and may not be perpendicular to channel at all locations. Widths are likely overestimated.

[c] Depths measured from water surface in county DEMs, not channel bed. Widths are likely overestimated.

[d] Entrenchment ratio is defined as floodplain width at 2 bankfull depths (floodprone width) divided by floodplain width at 1 bankfull depth (bankfull width).

[e] Classifications follow Rosgen scheme, with entrenchment ratio tresholds as follows: 1.0 - 1.4 (Heavily Entrenched), 1.41 - 2.2 (Moderately Entrenched), 2.21+ (Slightly Entrenched)

Sources of Data:
1. Stream Centerlines: National Hydrography Dataset, USGS
2. Managed Lands and Easements: IDNR and NRCS Shapefiles
3. Road Centerlines: Highway Shapefiles, INDOT
4. Soils Data: Web Soil Survey, USGS
5. Wetlands: National Wetlands Inventory, USFWS
6. Aerial Imagery: World Imagery Basemap, ESRI

Christopher B. Burke Engineering PNC Center, Suite 1368 South 115 West Washington Street Indianapolis, Indiana 46204 (t) 317.266.8000 www.cbbel-in.com	PROJECT: Little River Engineering Feasibility Study		PROJECT NO. 22-0046	APPROX. SCALE 1"=1,000'
	TITLE: Wetland Information			DATE: 11/2022
				EXHIBIT 7

Sources of Data:
1. Stream Centerlines: National Hydrography Dataset, USGS
2. Managed Lands and Easements: IDNR and NRCS Shapefiles
3. Road Centerlines: Highway Shapefiles, INDOT
4. Soils Data: Web Soil Survey, USGS
5. Wetlands: National Wetlands Inventory, USFWS
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Christopher B. Burke Engineering PNC Center, Suite 1368 South 115 West Washington Street Indianapolis, Indiana 46204 (t) 317.266.8000 www.cbbel-in.com	PROJECT: Little River Engineering Feasibility Study	PROJECT NO. 22-0046	APPROX. SCALE 1"=1,000'
	TITLE: Wetland Information		DATE: 11/2022
			EXHIBIT 7

Sources of Data:
1. Stream Centerlines: National Hydrography Dataset, USGS
2. Managed Lands and Easements: IDNR and NRCS Shapefiles
3. Road Centerlines: Highway Shapefiles, INDOT
4. Soils Data: Web Soil Survey, USGS
5. Wetlands: National Wetlands Inventory, USFWS
6. Aerial Imagery: World Imagery Basemap, ESRI

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PROJECT: Little River Engineering Feasibility Study		PROJECT NO. 22-0046	APPROX. SCALE 1"=1,000'
TITLE: Wetland Information			DATE: 11/2022
			EXHIBIT 7

Sources of Data:
1. Stream Centerlines: National Hydrography Dataset, USGS
2. Managed Lands and Easements: IDNR and NRCS Shapefiles
3. Road Centerlines: Highway Shapefiles, INDOT
4. Soils Data: Web Soil Survey, USGS
5. Wetlands: National Wetlands Inventory, USFWS
6. Aerial Imagery: World Imagery Basemap, ESRI

Christopher B. Burke Engineering PNC Center, Suite 1368 South 115 West Washington Street Indianapolis, Indiana 46204 (t) 317.266.8000 www.cbbel-in.com	PROJECT: Little River Engineering Feasibility Study	PROJECT NO. 22-0046	APPROX. SCALE 1"=1,000'
	TITLE: Wetland Information		DATE: 11/2022
			EXHIBIT 7

Land Ownership	Approximate Area[1] (ac)
Private	180 [10]
Private Trust	110 [40]
Public	1
LRWP	10
TOTAL	**300 [50]**

[1]Brackets denote areas previously identified.

Legend

Wetland Ownership

- LRWP
- Private*
- Private Trust*
- Private
- Private Trust
- Public

Streams

- Little River
- Other Streams
- Cities and Towns

N

Sources of Data:
1. Orthophotography: ESRI World Imagery Basemap
2. Stream Centerlines: National Hydrography Dataset, USGS
3. Road Centerlines: TIGER Shapefiles, U.S. Census Bureau
4. Wetland Locations: National Wetland Inventory, U.S. Fish and Wildlife Service
5. Land Ownership: Beacon Public GIS data, Schneider Geospatial

Notes:
*Wetlands identified for conservation/preservation by Commonwealth Biomonitoring and Empower Results for a 2009 LARE diagnostic study.

The wetlands identified in this map are adjacent to the stream, are largely wooded, and have not recently been in agricultural production. Identification of wetlands in this map should not preclude the conservation of other lands not identified. Much of the river valley was historically home to wetland habitats, and the hydric nature of the soils still present indicates that additional lands that are currently in agricultural production could be reverted back to wetland habitat by altering the existing drainage.

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PROJECT: Little River Engineering Feasibility Study		PROJECT NO. 22-0046	APPROX. SCALE NTS
TITLE: Wetland Conservation Opportunities			DATE: 11/2022
			EXHIBIT 8

Bank Treatment	Approximate Stream Length (ft)
One-Sided	17,000
Two-Sided	15,000
TOTAL	**32,000**

Legend

Project Sites

- Power Line Foundation
- Stream Access Location

Bank Stabilization

- One-Sided
- Two-Sided

Streams

- Little River
- Other Streams
- Cities and Towns

N

Sources of Data:
1. Orthophotography: ESRI World Imagery Basemap
2. Stream Centerlines: National Hydrography Dataset, USGS
3. Road Centerlines: TIGER Shapefiles, U.S. Census Bureau

Notes:
This map should not be interpreted as an exhaustive list of all areas of bank instability. Treatment areas were chosen to minimize disturbance to existing wooded riparian corridor, even if instability is present within the corridor. The full-width treatment described in the report may not be practicable in all locations labeled on this map due to channel proximity to roads, railways, etc. Much of the reach of Little River depicted in this map is a Huntington County regulated drain, and projects should not be undertaken without the consent of the Huntington County Surveyor's Office. Applicable permit procedures should be followed for all projects.

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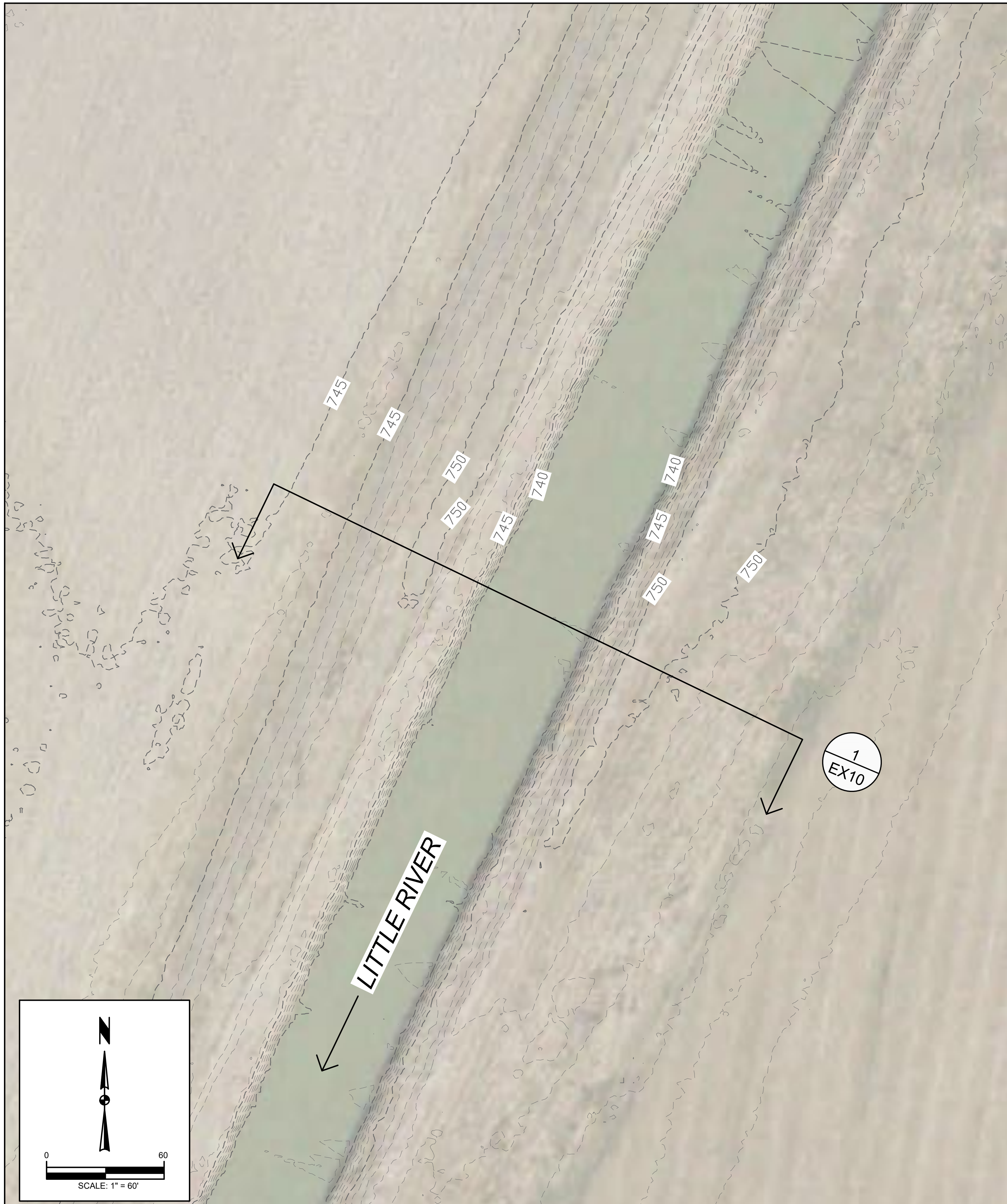
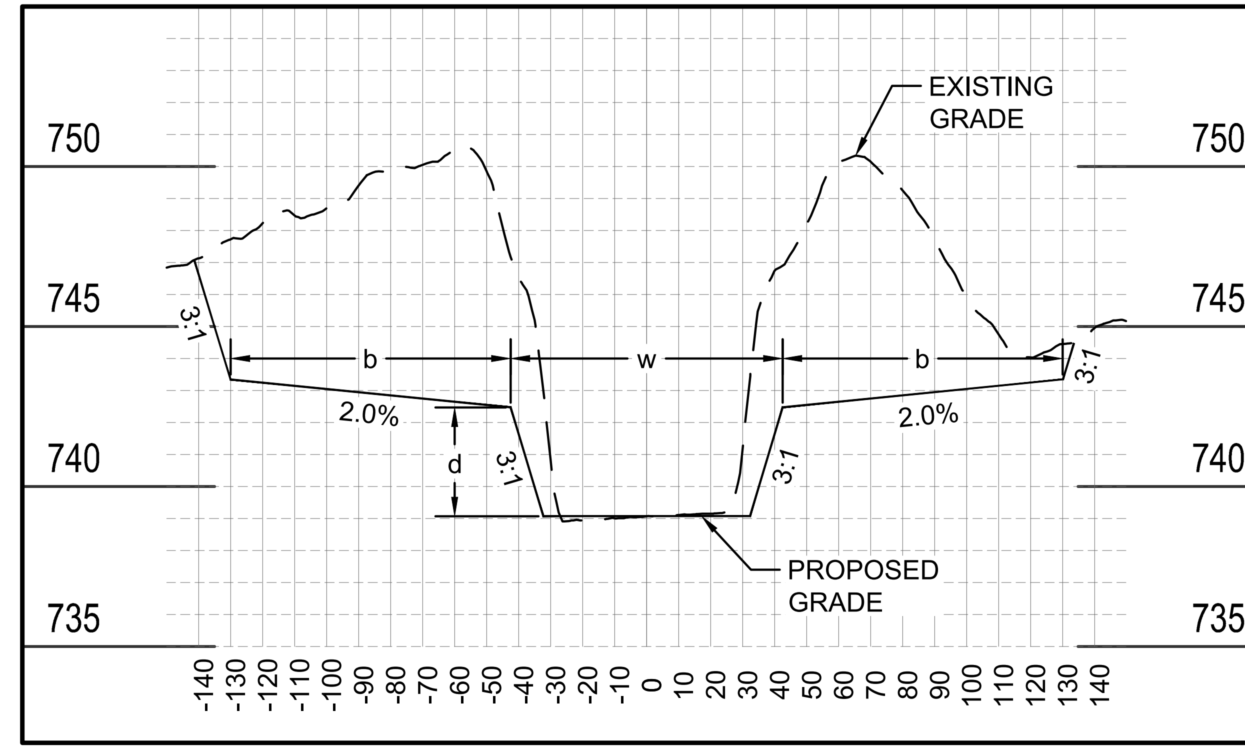
PROJECT: Little River Engineering Feasibility Study	PROJECT NO. 22-0046	APPROX. SCALE NTS	DATE: 11/2022
TITLE: Project Locations		EXHIBIT 9	



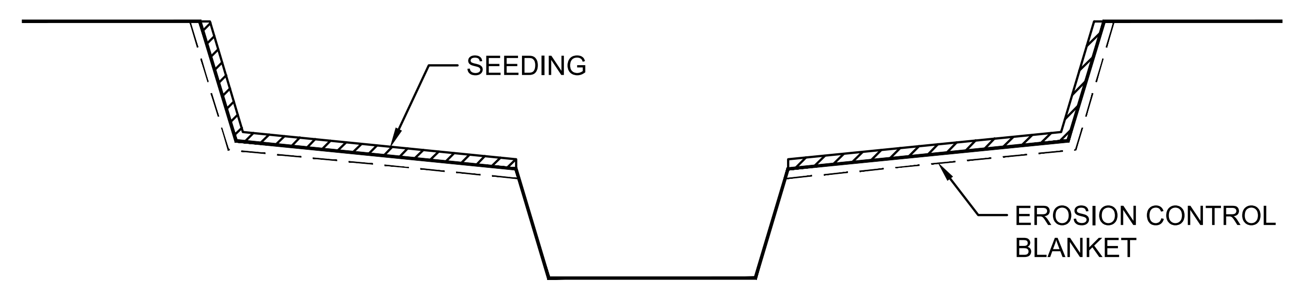


REACH	d	w	b
CR 200 E - EIGHTMILE CK	3.3'	80'	80' (70')
EIGHTMILE CK - ABOITE CK	2.9'	65'	65' (65')
ABOITE CK - COUNTY LINE	2.4'	45'	45' (45')

NOTE: BENCH WIDTHS IN PARENTHESES ARE APPROXIMATIONS TO KEEP CHANNEL MODIFICATIONS WITHIN EXISTING REGULATED DRAIN EASEMENTS.

1 PROPOSED APPROXIMATE CHANNEL DIMENSIONS

NOT TO SCALE



2 TWO-STAGE CHANNEL TYPICAL SECTION

NOT TO SCALE

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Indianapolis, Indiana 46204
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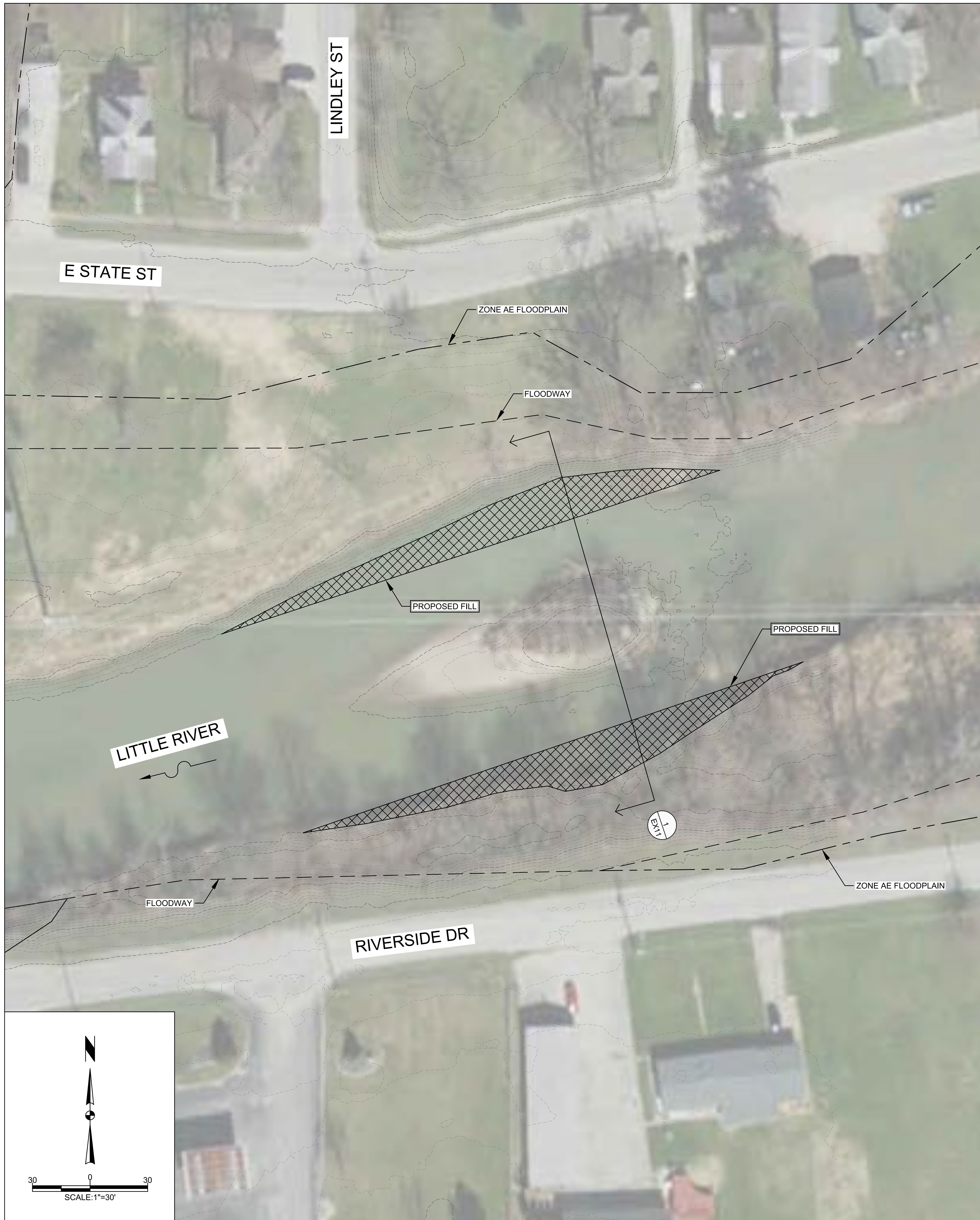
TITLE: TWO-STAGE CHANNEL TYPICAL SECTION

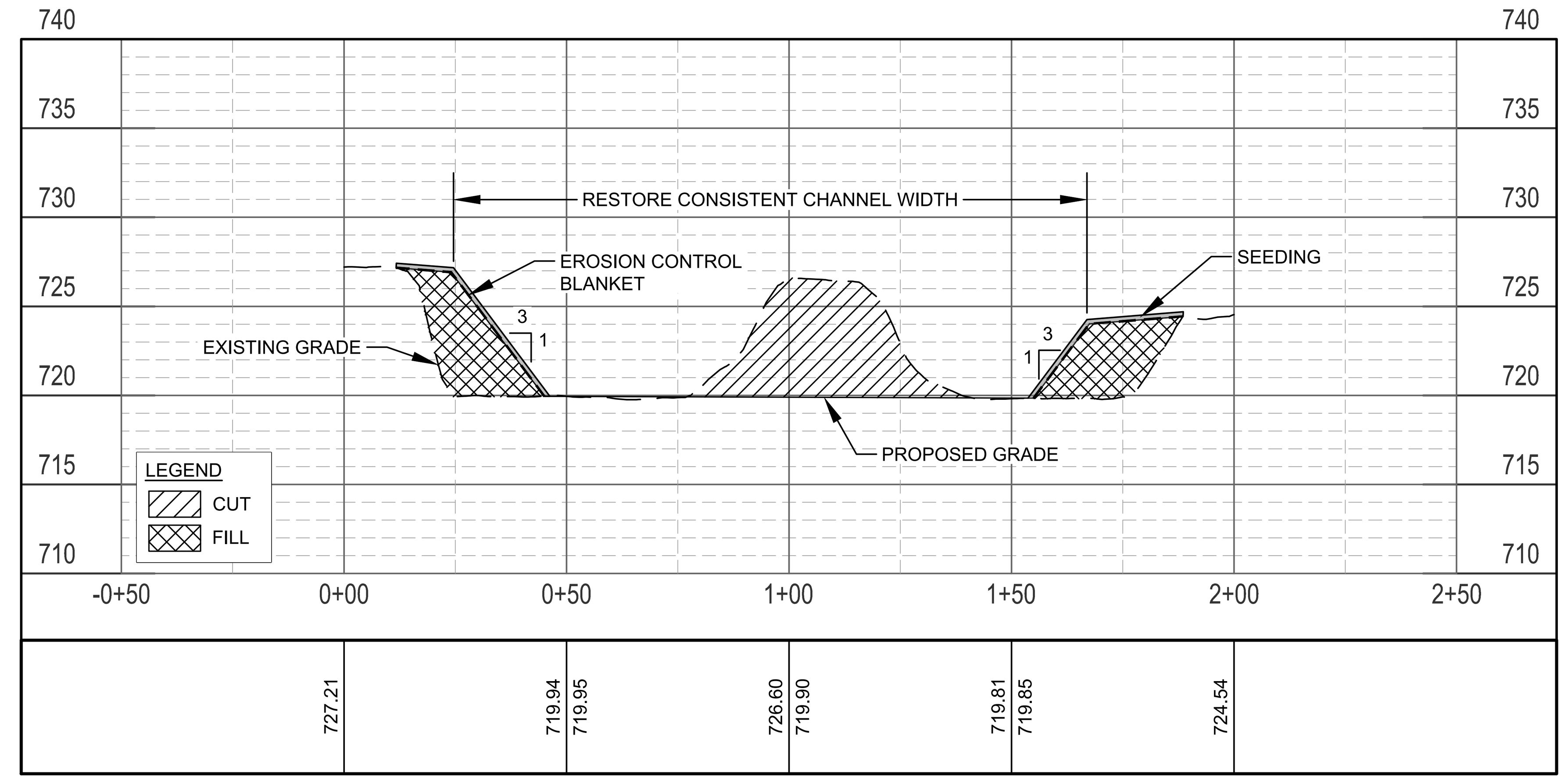
PROJECT: LITTLE RIVER ENGINEERING FEASIBILITY STUDY
HUNTINGTON COUNTY, INDIANA

PROJECT NO. 22-0046.00000

SHEET 1 OF 1

DRAWING NO. EX10





1 POWER LINE FOUNDATION REMOVAL
TYPICAL CROSS SECTION
NOT TO SCALE

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PROJECT:
LITTLE RIVER ENGINEERING FEASIBILITY STUDY
HUNTINGTON COUNTY, INDIANA

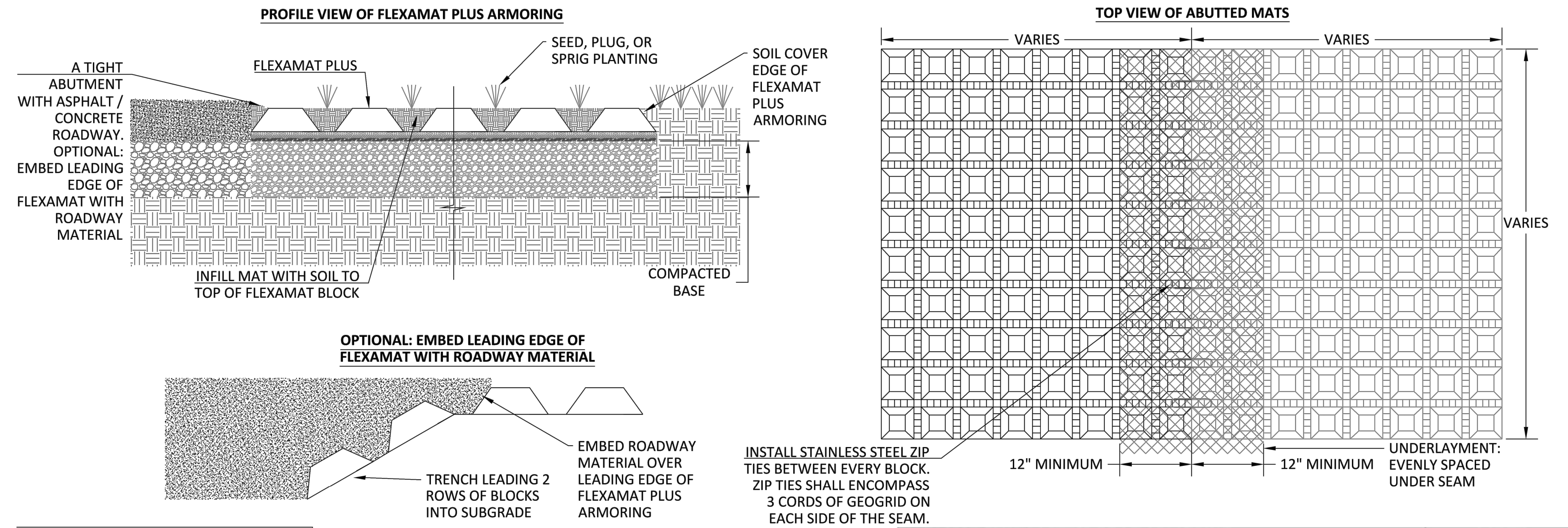
NO.	DATE	NATURE OF REVISION	CHKD.

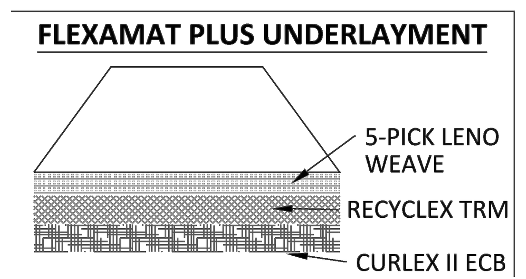
R:\2022\22-0046.00000\CAD\BOAT RAMP DETAIL.DWG

DSGN.	---
DWN.	---
CHKD.	---
SCALE:	AS NOTED
DATE:	10/11/2022

TITLE:
POWER LINE FOUNDATION REMOVAL

PROJECT NO. 22-0046.00000
SHEET 1 OF 1
DRAWING NO.
EX11





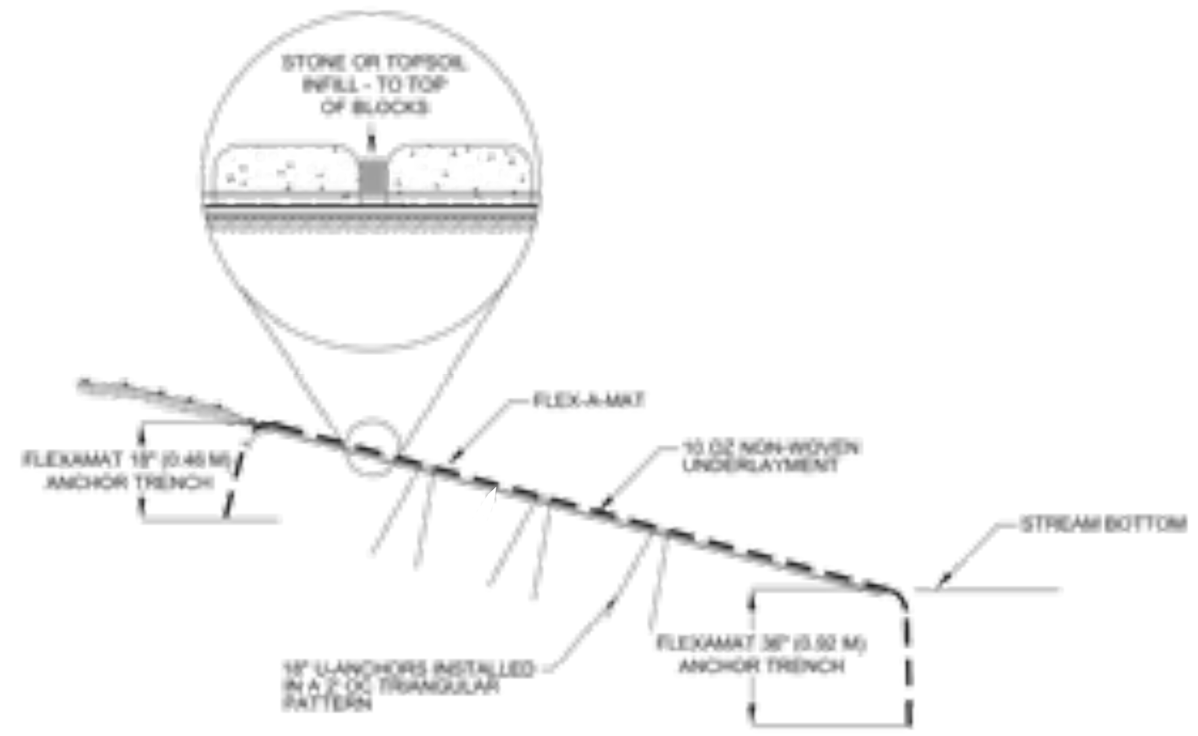
FLEXAMAT PLUS - ACCESS ROAD ARMORING

SUBGRADE THICKNESS OF CRUSHED STONE		
SITE SOIL TYPE	LIGHT LOAD VEHICLES: CARS/PICKUP TRUCKS	HEAVY LOAD VEHICLES: LARGE TRUCKS, RV'S, DELIVERY VEHICLES
GRAVEL AND SAND, COURSE WELL DRAINED SOILS	BASE: 3.5-7.5" OF CRUSHED STONE	BASE: 7.5" OF CRUSHED STONE
SILTY SOILS, FINE GRAIN SOILS, POOR DRAINAGE	BASE: 7.5" OF CRUSHED STONE	BASE: 9.5" OF CRUSHED STONE
CLAY SOILS FINE TO VERY FINE	BASE: 6-9.5" OF CRUSHED STONE	BASE: 10" OF CRUSHED STONE

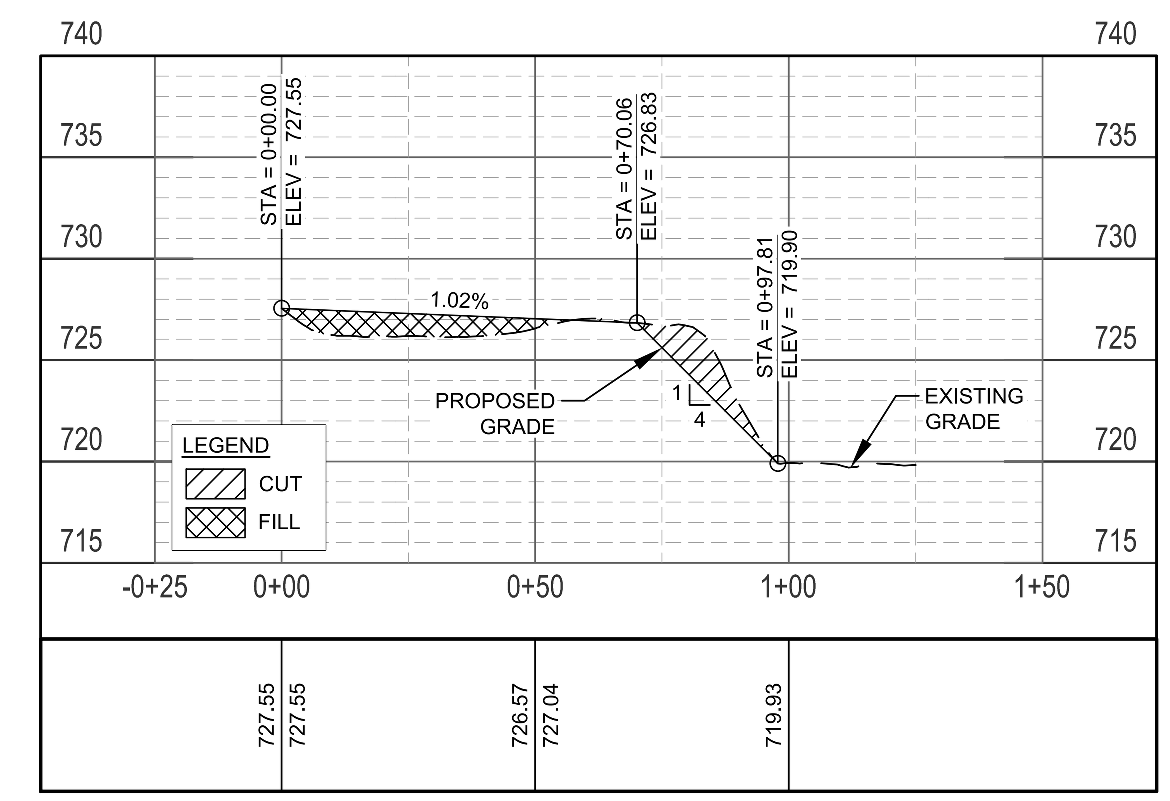
*ROLLS AVAILABLE IN MULTIPLE WIDTHS: 4', 5.5', 8', 10', 12', AND 16'. FOR ARMORING WIDER THAN 16', A 15.5' ROLL WITH A 6" PLUS EXTENSION AND A 12" GEOGRID EXTENSION FOR ABUTMENTS SHALL BE USED.

MOTZ ENTERPRISES, INC.
Flexamat
(513)772-6689
info@Flexamat.com
Flexamat.com

1 FLEXAMAT DETAIL
NOT TO SCALE



2 FLEXAMAT TRENCHING DETAIL
NOT TO SCALE



3 BOAT LAUNCH PROFILE
NOT TO SCALE

NOTE: Use of flexamat name and installation details is not an endorsement of the product and does not preclude the use of other products in final site design. The drawings and details are included for the purpose of representing typical vegetated concrete block mat appearance and construction practices.

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PROJECT:
LITTLE RIVER ENGINEERING FEASIBILITY STUDY
HUNTINGTON COUNTY, INDIANA

NO.	DATE	NATURE OF REVISION	CHKD.

R:\2022\22-0046.00000\CAD\BOAT RAMP DETAIL.DWG

DSGN.		---
DWN.		---
CHKD.		---
SCALE:		AS NOTED
DATE:		10/11/2022

TITLE:
PROPOSED BOAT LAUNCH LOCATION

PROJECT NO. 22-0046.00000
SHEET 1 OF 1
DRAWING NO.
EX12

APPENDIX 1: BANK EROSION HAZARD INDEX (BEHI) ANALYSES

Stream: [illegible]	Cross Section: D/S [illegible]	Date:	Observers: [illegible] / IKH

Bank Height/Max Depth Bankfull (C)

Study Bank Height (ft) 6.2 A	Bankfull Height (ft) 3.9 B	A/B = 1.6 C

Root Depth/Bank Height (E)

Root Depth (ft) 1.5 / 0 D	Study Bank Height (ft) 6.2 A	D/A = 0.24 E

Weighted Root Density (G)

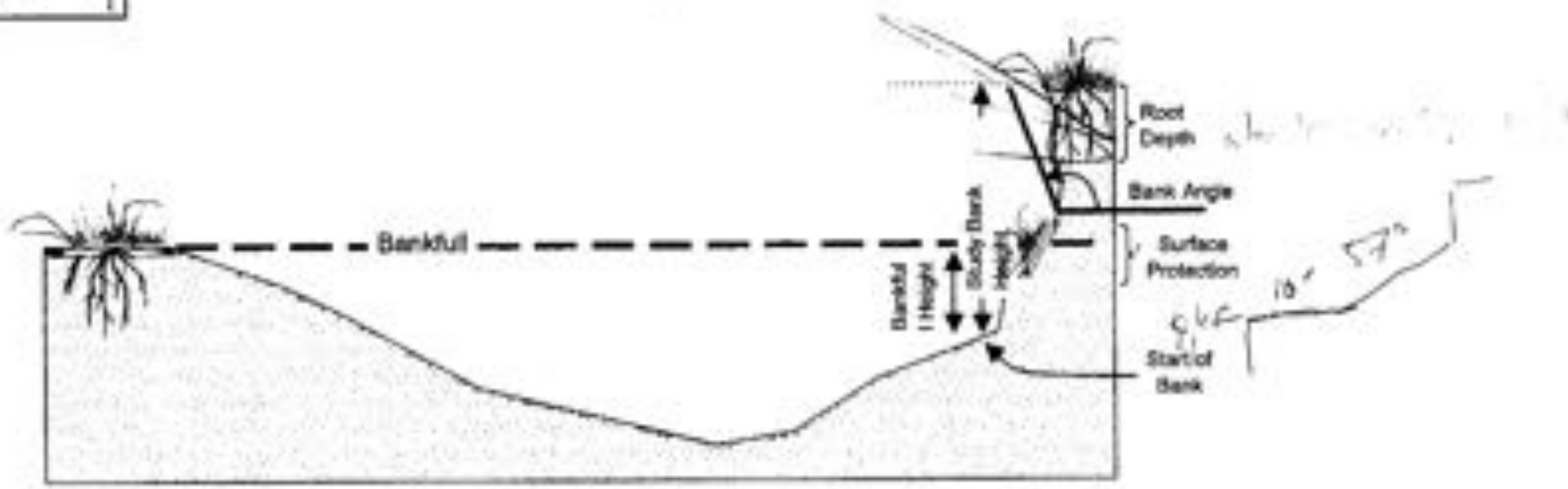
Root Density (%) 75 / 0 F	F*E = 18 G

Bank Angle (H)

Bank Angle (Degrees) 90 H

Surface Protection (I)

Surface Protection % 85 / 0 I



Little River at Rock AS   rcb/lkh

Bank Erosion Hazard Rating Guide

Stream   Reach   Date   Crew

Bank Height (ft): Bankfull Height (ft):		Bank Height/ Bankfull Ht	Root Depth/ Bank Height	Root Density %	Bank Angle (Degrees)	Surface Protection%
VERY LOW	Value	1.0-1.1	1.0-0.9	100-80	0-20	100-80
	Index	1.0-1.9	1.0-1.9	1.0-1.9	1.0-1.9	1.0-1.9
	Choice	V: I:	V: I:	V: I:	V: I:	V: 20 I: 1.5
LOW	Value	1.11-1.19	0.89-0.5	79-55	21-60	79-55
	Index	2.0-3.9	2.0-3.9	2.0-3.9	2.0-3.9	2.0-3.9
	Choice	V: I:	V: I:	V: I:	V: 57 I: 3.8	V: I:
MODERATE	Value	1.2-1.5	0.49-0.3	54-30	61-80	54-30
	Index	4.0-5.9	4.0-5.9	4.0-5.9	4.0-5.9	4.0-5.9
	Choice	V: I:	V: I:	V: I:	V: I:	V: I:
HIGH	Value	1.6-2.0	0.29-0.15	29-15	81-90	29-15
	Index	6.0-7.9	6.0-7.9	6.0-7.9	6.0-7.9	6.0-7.9
	Choice	V: 1.6 I: 6.0	V: 0.29 I: 6.5	V: 18 I: 7.0	V: I:	V: I:
VERY HIGH	Value	2.1-2.8	0.14-0.05	14-5.0	91-119	14-10
	Index	8.0-9.0	8.0-9.0	8.0-9.0	8.0-9.0	8.0-9.0
	Choice	V: I:	V: I:	V: I:	V: I:	V: I:
EXTREME	Value	>2.8	<0.05	<5	>119	<10
	Index	10	10	10	10	10
	Choice	V: 1.6 I: 6.0	V: .29 I: 6.5	V: 18 I: 7.0	V: 57 I: 5.8	V: 85 I: 1.5
V = value, I = index					SUB-TOTAL (Sum one index from each column)	20.8

Bank Material Description:

Bank Materials

- **Bedrock** (Bedrock banks have very low bank erosion potential)
- **Boulders** (Banks composed of boulders have low bank erosion potential)
- **Cobble** (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)
- **Gravel** (Add 5-10 points depending percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt Clay** (+ 0: no adjustment)

BANK MATERIAL ADJUSTMENT ~~0~~

Stratification Comments:

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

STRATIFICATION ADJUSTMENT ~~0~~

VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

Bank location description (circle one)

Straight Reach   Outside of Bend

GRAND TOTAL
BEHI RATING 20.8

Stream: [illegible]	Cross Section: U/S 200 ft	Date:	Observers: [illegible]

Bank Height/Max Depth Bankfull (C)

Study Bank Height (ft) 10.5 A	Bankfull Height (ft) 5.3 B	A/B = 2.7 C

Root Depth/Bank Height (E)

Root Depth (ft) 12"/1 D	Study Bank Height (ft) 10.5 A	D/A = .05 E

Weighted Root Density (G)

Root Density (%) 50 F	F*E = 4.5 G

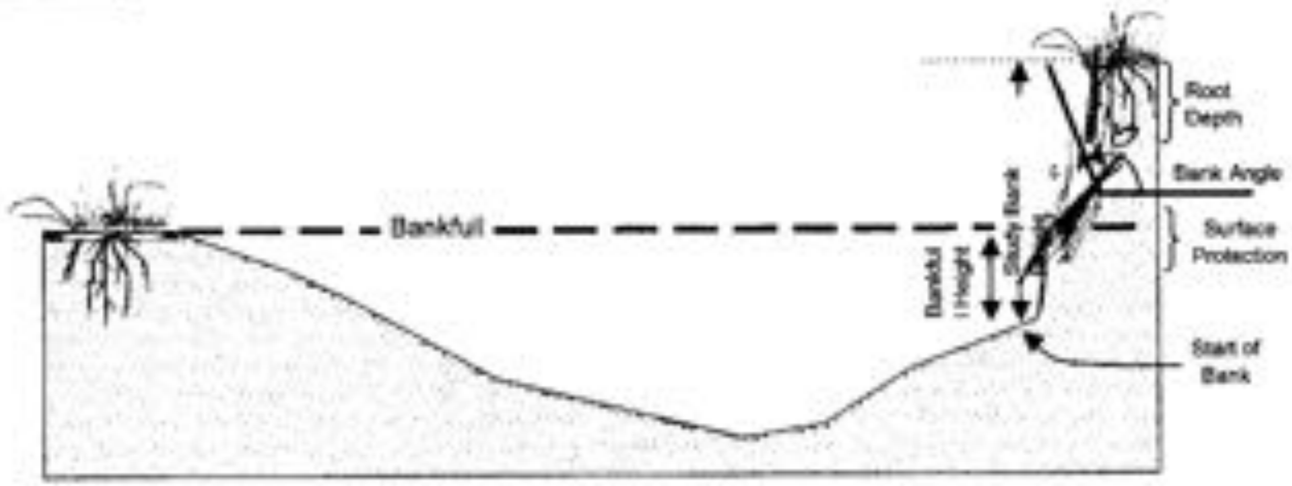
Bank Angle (H)

Bank Angle (Degrees) 40 H

Surface Protection (I)

Surface Protection % 50% I

Bank Sketch



Little River U/S [illegible] [illegible]

Bank Erosion Hazard Rating Guide

Stream | Reach | Date | Crew

Bank Erosion Potential	Bank Height (ft): Bankfull Height (ft):		Bank Height/ Bankfull Ht	Root Depth/ Bank Height	Root Density %	Bank Angle (Degrees)	Surface Protection%
	VERY LOW	Value	1.0-1.1	1.0-0.9	100-80	0-20	100-80
		Index	1.0-1.9	1.0-1.9	1.0-1.9	1.0-1.9	1.0-1.9
		Choice	V: I:	V: I:	V: I:	V: I:	V: I:
	LOW	Value	1.11-1.19	0.89-0.5	79-55	21-60	79-55
		Index	2.0-3.9	2.0-3.9	2.0-3.9	2.0-3.9	2.0-3.9
		Choice	V: I:	V: I:	V: I:	V: I:	V: I:
	MODERATE	Value	1.2-1.5	0.49-0.3	54-30	61-80	54-30
		Index	4.0-5.9	4.0-5.9	4.0-5.9	4.0-5.9	4.0-5.9
		Choice	V: I:	V: I:	V: I:	V: I:	V: I:
	HIGH	Value	1.6-2.0	0.29-0.15	29-15	81-90	29-15
		Index	6.0-7.9	6.0-7.9	6.0-7.9	6.0-7.9	6.0-7.9
		Choice	V: I:	V: I:	V: I:	V: I:	V: I:
	VERY HIGH	Value	2.1-2.8	0.14-0.05	14-5.0	91-119	14-10
		Index	8.0-9.0	8.0-9.0	8.0-9.0	8.0-9.0	8.0-9.0
		Choice	V: I:	V: I:	V: I:	V: I:	V: I:
	EXTREME	Value	>2.8	<0.05	<5	>119	<10
		Index	10	10	10	10	10
		Choice	V: 2.7 I: 9.0	V: .05 I: 8.5	V: 4.5 I: 10	V: 70 I: 3	V: 50 I: 5
	V = value, I = index				**SUB-TOTAL** (Sum one index from each column)		26.5

Bank Material Description:

Bank Materials

- **Bedrock** (Bedrock banks have very low bank erosion potential)
- **Boulders** (Banks composed of boulders have low bank erosion potential)
- **Cobble** (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)
- **Gravel** (Add 5-10 points depending percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt Clay** (+ 0: no adjustment)

BANK MATERIAL ADJUSTMENT 0

Stratification Comments:

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

STRATIFICATION ADJUSTMENT 0

VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

Bank location description (circle one)

Straight Reach Outside of Bend

GRAND TOTAL 26.5

BEHI RATING

Stream: Little River Cr[illegible]	Cross Section: LG/A/2	Date:	Observers:

Bank Height/Max Depth Bankfull (C)

Study Bank Height (ft) 15' A	Bankfull Height (ft) ~3' B	A/B = 4.5 C

Root Depth/Bank Height (E)

Root Depth (ft) 12"/1' D	Study Bank Height (ft) 15 A	D/A = .08 E

Weighted Root Density (G)

Root Density (%) 45 F	F*E = 5.2 G

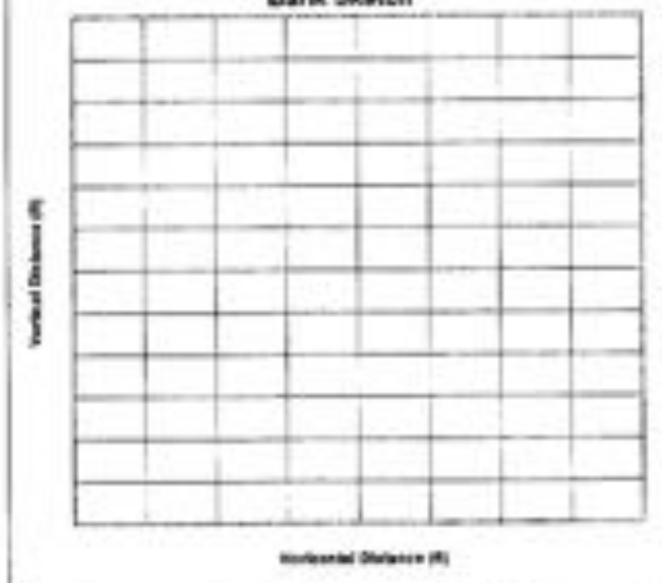
Bank Angle (H)

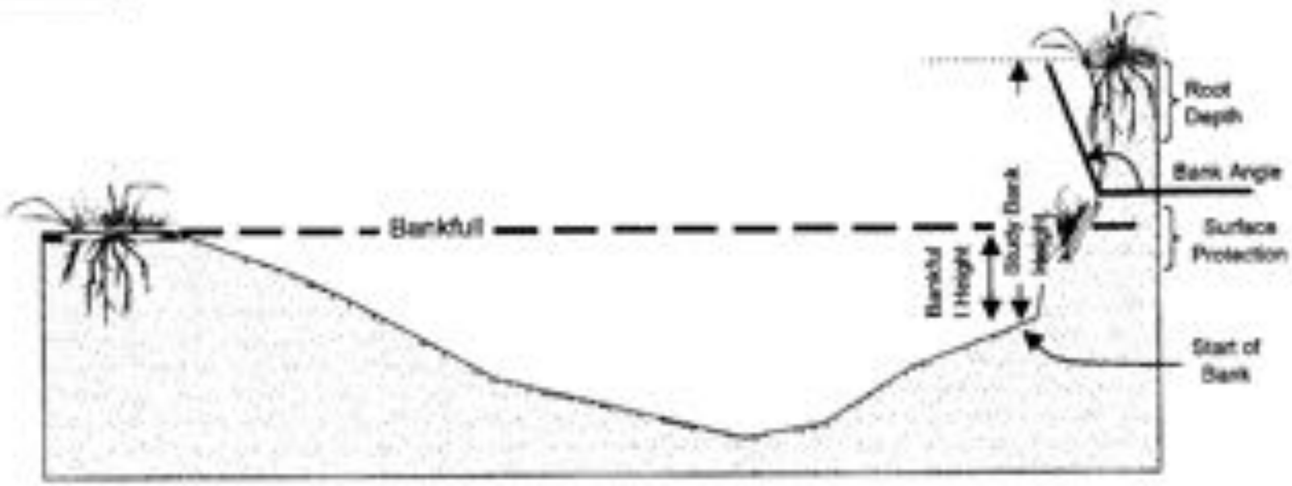
Bank Angle (Degrees) 52 H

Surface Protection (I)

Surface Protection % 45 I

Bank Sketch





LL @ 8 mile Cont LB/DS [illegible]

Bank Erosion Hazard Rating Guide

Stream | Reach | Date | Crew

Bank Erosion Potential	Bank Height (ft): / Bankfull Height (ft):		Bank Height/ Bankfull Ht	Root Depth/ Bank Height	Root Density %	Bank Angle (Degrees)	Surface Protection%
VERY LOW		Value	1.0-1.1	1.0-0.9	100-80	0-20	100-80
		Index	1.0-1.9	1.0-1.9	1.0-1.9	1.0-1.9	1.0-1.9
		Choice	V: I:	V: I:	V: I:	V: I:	V: I:
LOW		Value	1.11-1.19	0.89-0.5	79-55	21-60	79-55
		Index	2.0-3.9	2.0-3.9	2.0-3.9	2.0-3.9	2.0-3.9
		Choice	V: I:	V: I:	V: I:	V: 57 I: 3.5	V: 65 I: 5
MODERATE		Value	1.2-1.5	0.49-0.3	54-30	61-80	54-30
		Index	4.0-5.9	4.0-5.9	4.0-5.9	4.0-5.9	4.0-5.9
		Choice	V: I:	V: I:	V: I:	V: I:	V: I:
HIGH		Value	1.6-2.0	0.29-0.15	29-15	81-90	29-15
		Index	6.0-7.9	6.0-7.9	6.0-7.9	6.0-7.9	6.0-7.9
		Choice	V: I:	V: I:	V: I:	V: I:	V: I:
VERY HIGH		Value	2.1-2.8	0.14-0.05	14-5.0	91-119	14-10
		Index	8.0-9.0	8.0-9.0	8.0-9.0	8.0-9.0	8.0-9.0
		Choice	V: I:	V: I:	V: 5.2 I: 9	V: I:	V: I:
EXTREME		Value	>2.8	<0.05	<5	>119	<10
		Index	10	10	10	10	10
		Choice	V: 5/2 I: 10	V: .08 I: 10	V: 5.2 I: 9	V: 56 I: 3.5	V: 65 I: 3
V = value, I = index				SUB-TOTAL (Sum one index from each column)			

Bank Material Description:

Bank Materials

- **Bedrock** (Bedrock banks have very low bank erosion potential)
- **Boulders** (Banks composed of boulders have low bank erosion potential)
- **Cobble** (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)
- **Gravel** (Add 5-10 points depending percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- ~~**Silt Clay** (+ 0: no adjustment)~~

BANK MATERIAL ADJUSTMENT +10

Stratification Comments:

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

STRATIFICATION ADJUSTMENT

VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

45.5

Bank location description (circle one)

Straight Reach Outside of Bend

GRAND TOTAL 45.5

BEHI RATING

Stream: Little River Creek	Cross Section: 12/9/12	Date:	Observers: RCL IKH

Bank Height/Max Depth Bankfull (C)

Study Bank Height (ft) A	Bankfull Height (ft) B	A/B = C
14'	~5	47

Root Depth/Bank Height (E)

Root Depth (ft) D	Study Bank Height (ft) A	D/A = E
12" (1)	14	.07

Weighted Root Density (G)

Root Density (%) F	F*E = G
40	2.8

Bank Angle (H)

Bank Angle (Degrees) H
54

Surface Protection (I)

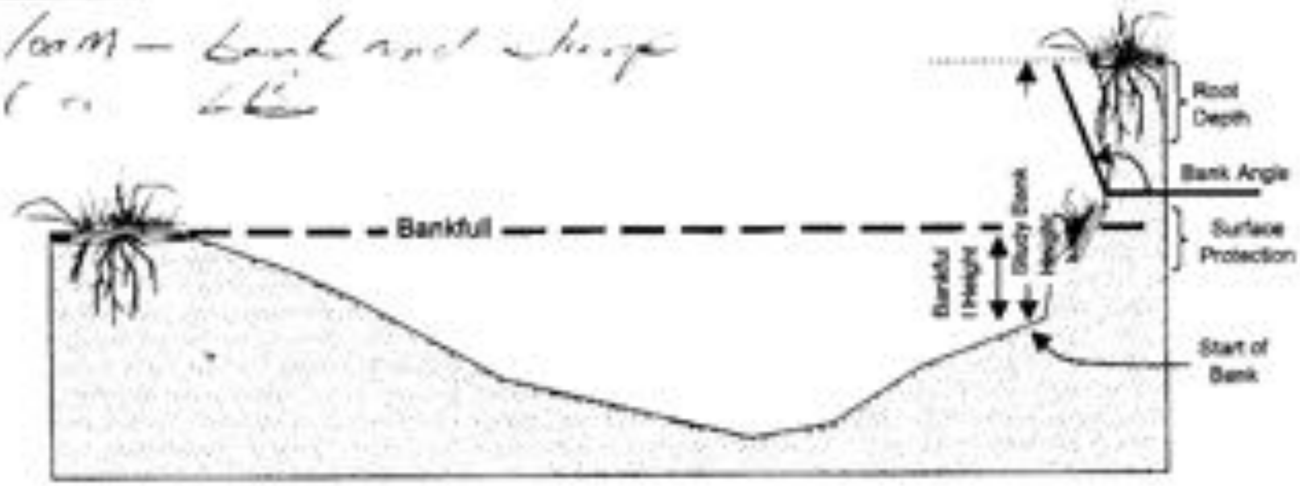
Surface Protection % I
10

Bank Sketch

Vertical Distance (ft)

Horizontal Distance (ft)

Silty loam – bank and slope
[illegible]



Little River @ Trib [illegible] K°/AS

Bank Erosion Hazard Rating Guide

Stream | Reach | Date | Crew

Bank Erosion Potential	Bank Height (ft): / Bankfull Height (ft):		Bank Height/ Bankfull Ht	Root Depth/ Bank Height	Root Density %	Bank Angle (Degrees)	Surface Protection%
	VERY LOW	Value	1.0-1.1	1.0-0.9	100-80	0-20	100-80
		Index	1.0-1.9	1.0-1.9	1.0-1.9	1.0-1.9	1.0-1.9
		Choice	V: I:	V: I:	V: I:	V: I:	V: I:
	LOW	Value	1.11-1.19	0.89-0.5	79-55	21-60	79-55
		Index	2.0-3.9	2.0-3.9	2.0-3.9	2.0-3.9	2.0-3.9
		Choice	V: I:	V: I:	V: I:	V: 59 I: 3	V: I:
	MODERATE	Value	1.2-1.5	0.49-0.3	54-30	61-80	54-30
		Index	4.0-5.9	4.0-5.9	4.0-5.9	4.0-5.9	4.0-5.9
		Choice	V: I:	V: I:	V: 46 I: 5	V: I:	V: 5% I: 5
	HIGH	Value	1.6-2.0	0.29-0.15	29-15	81-90	29-15
		Index	6.0-7.9	6.0-7.9	6.0-7.9	6.0-7.9	6.0-7.9
		Choice	V: I:	V: I:	V: I:	V: I:	V: I:
	VERY HIGH	Value	2.1-2.8	0.14-0.05	14-5.0	91-119	14-10
		Index	8.0-9.0	8.0-9.0	8.0-9.0	8.0-9.0	8.0-9.0
		Choice	V: I:	V: I:	V: I:	V: I:	V: I:
	EXTREME	Value	>2.8	<0.05	<5	>119	<10
		Index	10	10	10	10	10
		Choice	V: 9.7 I: 10	V: .07 I: 10	V: 5% I: 5	V: 59 I: 3	V: 5% I: 5
	V = value, I = index				SUB-TOTAL (Sum one index from each column)		

Bank Material Description:

Bank Materials

- **Bedrock** (Bedrock banks have very low bank erosion potential)
- **Boulders** (Banks composed of boulders have low bank erosion potential)
- **Cobble** (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)
- **Gravel** (Add 5-10 points depending percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt Clay** (+ 0: no adjustment)

BANK MATERIAL ADJUSTMENT 0

Stratification Comments:

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

STRATIFICATION ADJUSTMENT 0

VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

Bank location description (circle one)

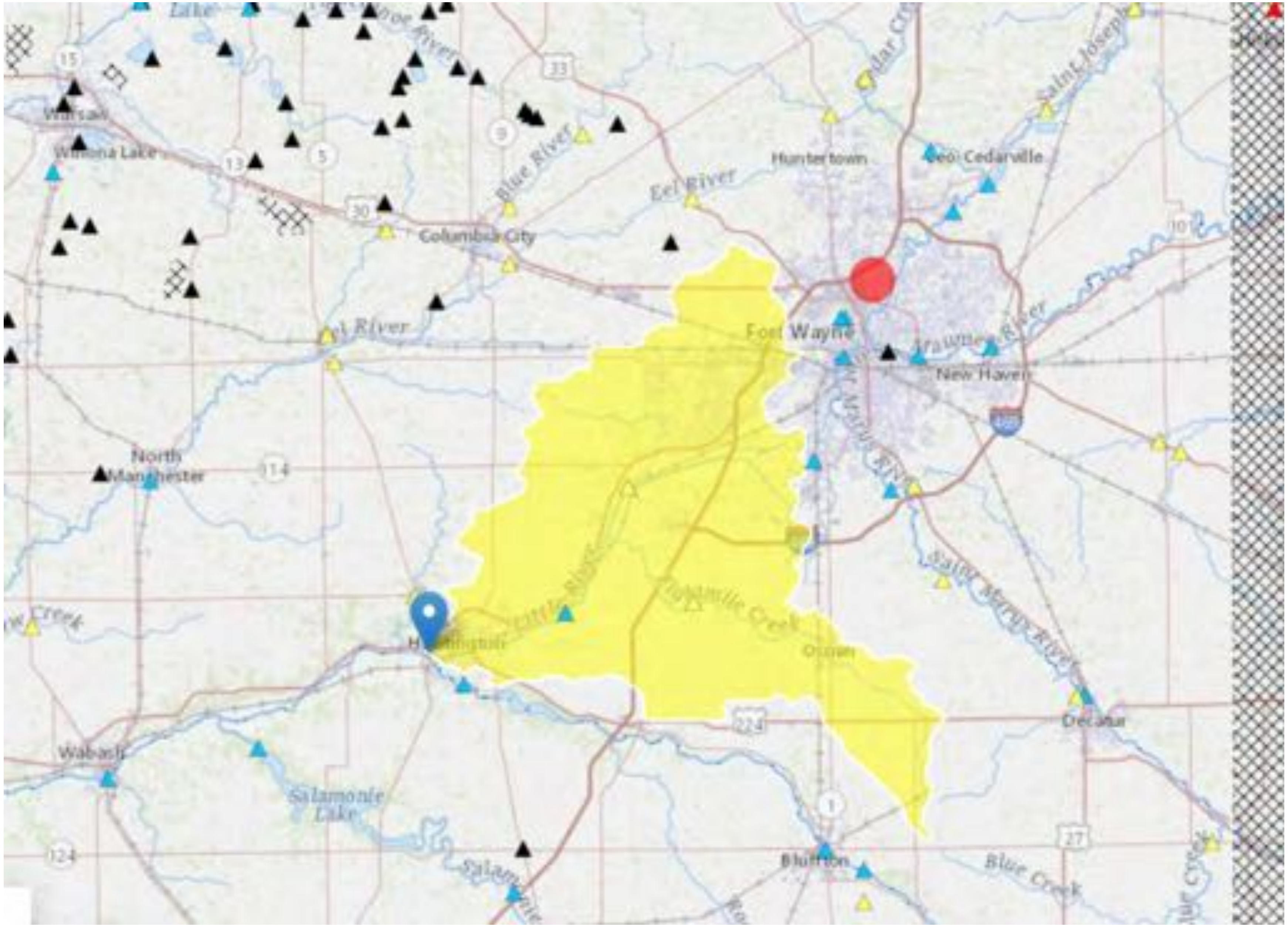
Straight Reach   Outside of Bend

GRAND TOTAL 33

BEHI RATING

APPENDIX 2: FIELD OBSERVATIONS

Field Observations and Physical Characteristics of Little River, Huntington and Allen Counties, Indiana



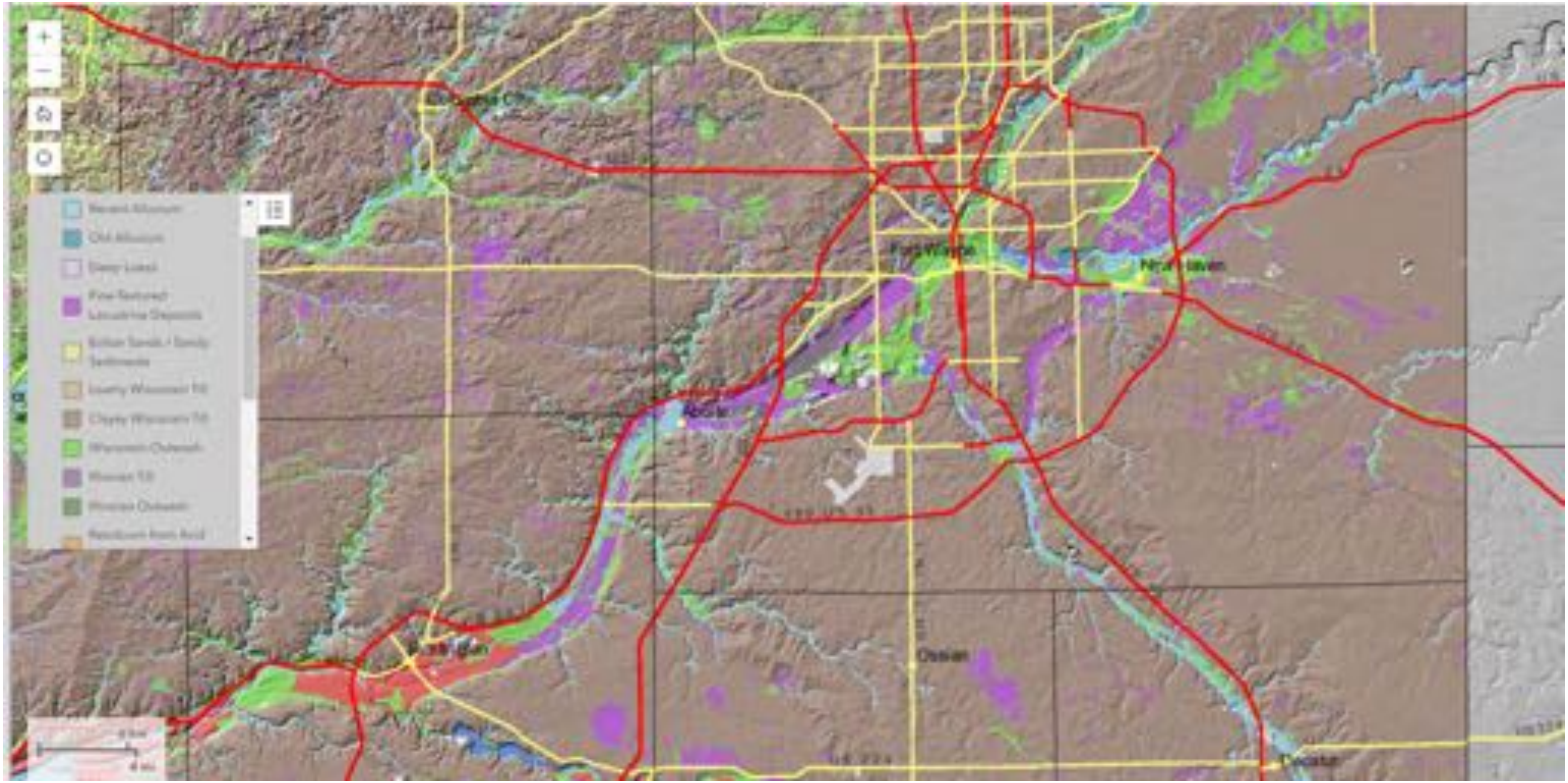
Warsaw
Winona Lake
Columbia City
Blue River
Eel River
Huntertown
Cedarville
Fort Wayne
New Haven
North Manchester
Little River
Decatur
Wabash
Salamonie Lake
Bluffton
Blue Creek
Saint Marys River
Saint Joseph
Maumee River
Ossian

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	287.969	square miles
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	3.28	feet per mi
BSLDEM10M	Mean basin slope computed from 10 m DEM	2.24	percent
DRNAREA	Area that drains to a point on a stream	287.969	square miles
URBAN	Percentage of basin with urban development	4.7	percent
WETLAND	Percentage of Wetlands	1.61	percent

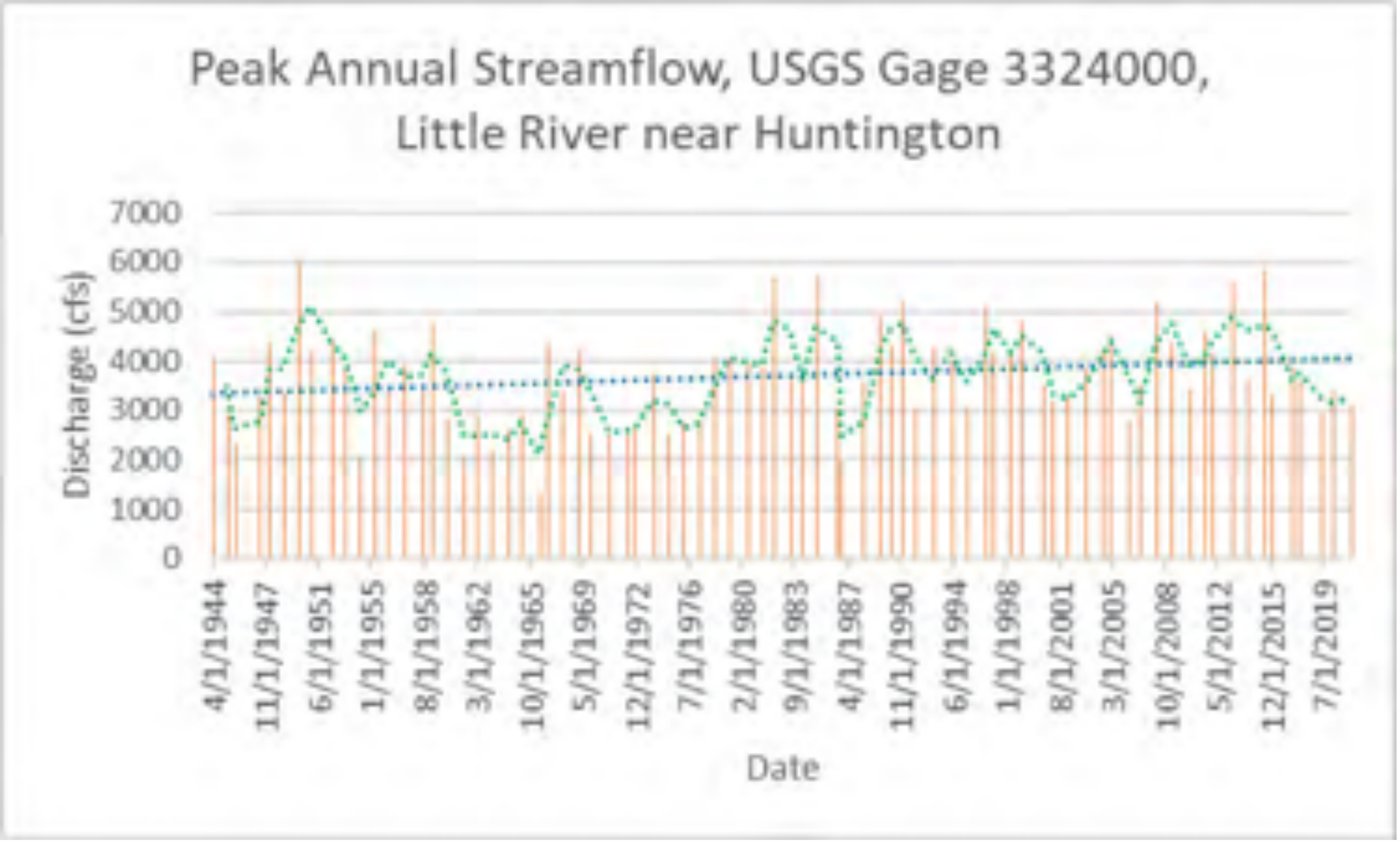
Channel Dimensions and Physical Characteristics at Huntington

- W_{bkf} 81 ft measured 29 ft (n=5)
- d_{bkf} 3.3 ft
- A_{bkf} 277 ft^2
- d_{bkf} (max) 4.7 ft
- MBW (meander belt width) predicted 3XW_{bkf} = 487 ft measured = ft
- Rc (radius of curvature) min 187 ft max 243 ft measured min ft max 78 ft
- k (sinuosity) = SL/VL = 1.2 (note that upstream and downstream reaches are straightened)
- s (slope) =.0006 (csl 10-85)

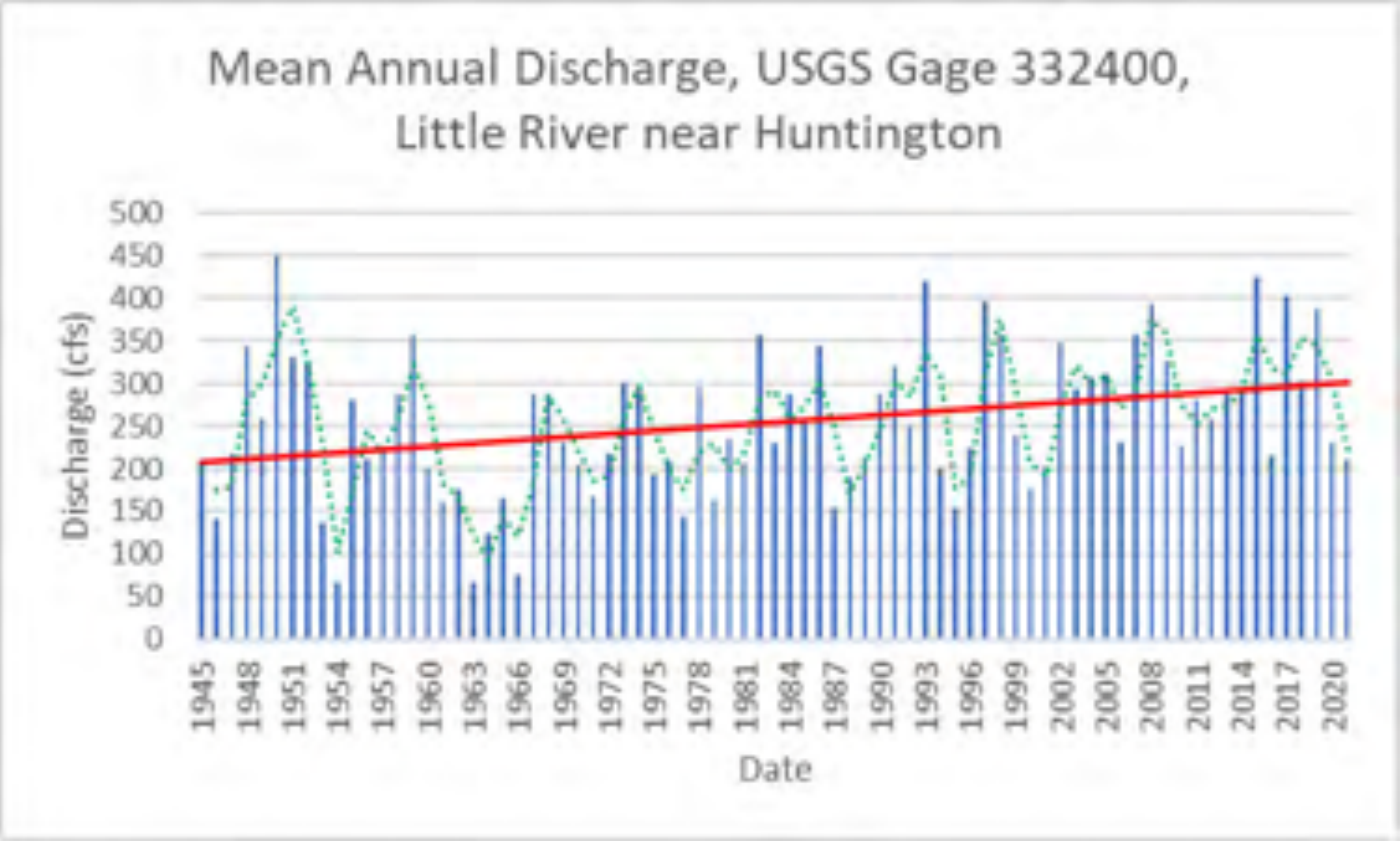


Dominant Soil Parent Materials (Surficial Geology)

Purdue Soil Explorer



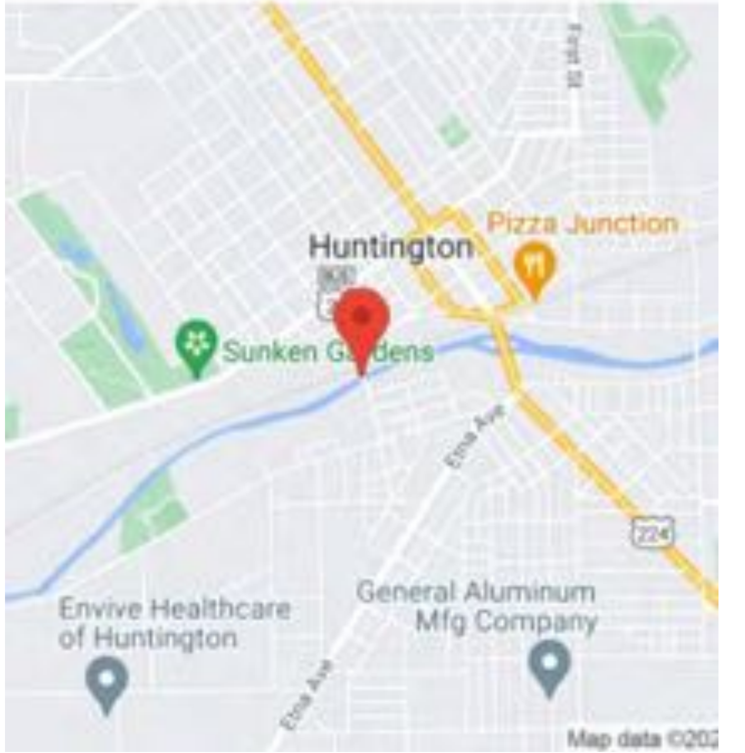
Peak Annual Streamflow, USGS Gage 3324000, Little River near Huntington
Discharge (cfs)
7000
6000
5000
4000
3000
2000
1000
0
4/1/1944
11/1/1947
6/1/1951
1/1/1955
8/1/1958
3/1/1962
10/1/1965
5/1/1969
12/1/1972
7/1/1976
2/1/1980
9/1/1983
4/1/1987
11/1/1990
6/1/1994
1/1/1998
8/1/2001
3/1/2005
10/1/2008
5/1/2012
12/1/2015
7/1/2019
Date



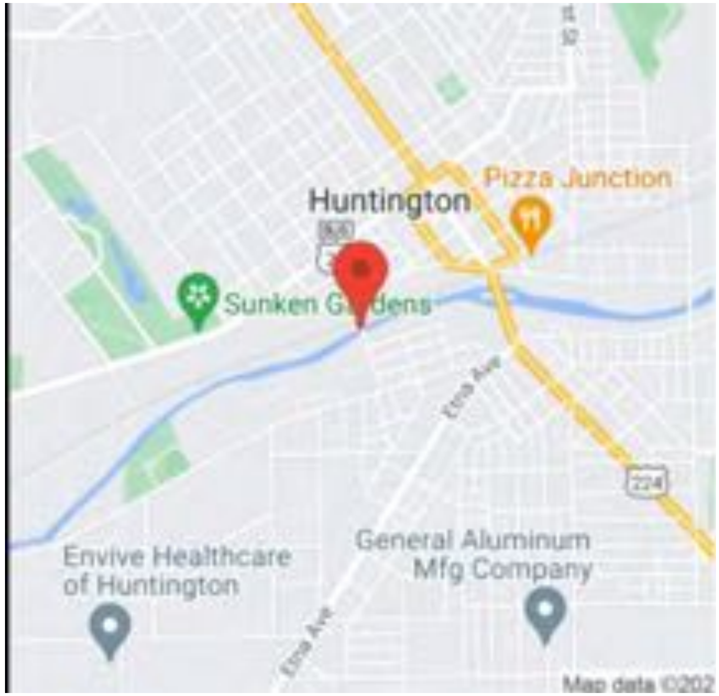
Mean Annual Discharge, USGS Gage 332400,
Little River near Huntington
Discharge (cfs)
500
450
400
350
300
250
200
150
100
50
0
1945
1948
1951
1954
1957
1960
1963
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
Date

Field Observations

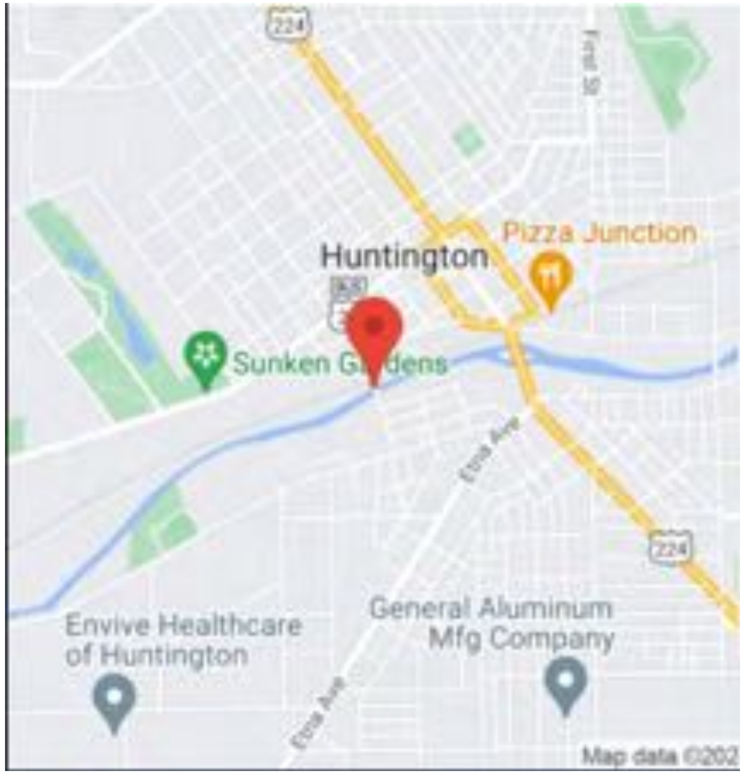
Little River, Huntington County, IN



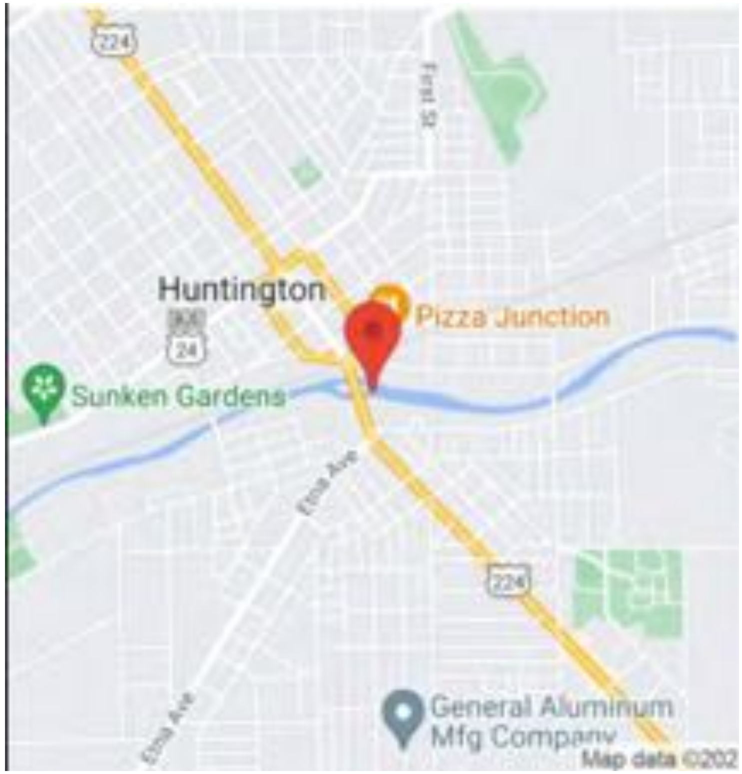
Little River, Huntington County, IN



Little River, Huntington County, IN

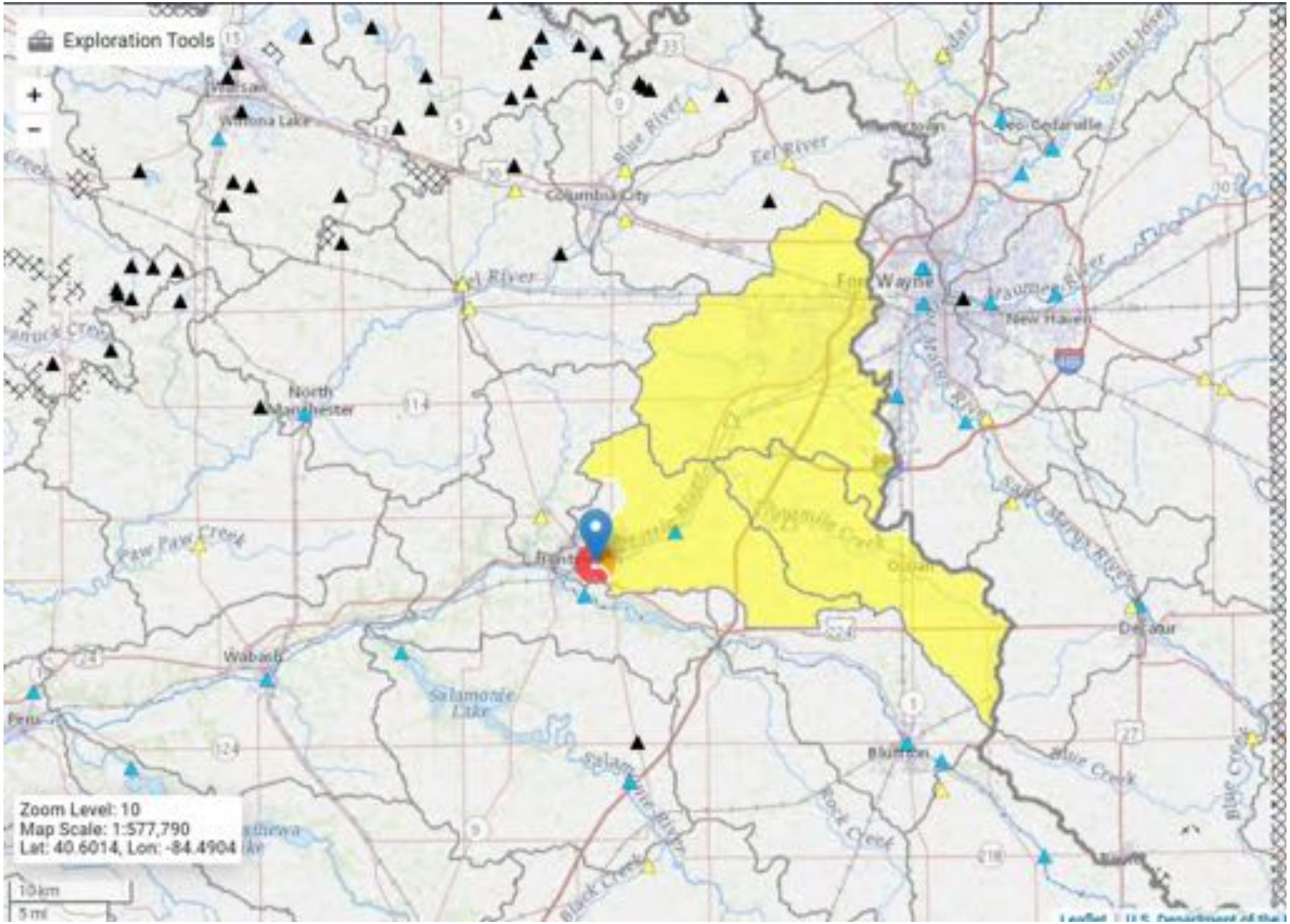
Little River, Huntington County, IN



Little River, Huntington County, IN

Little River, Huntington County, IN

Little River, Huntington County, IN (40.87905 -85.48784)



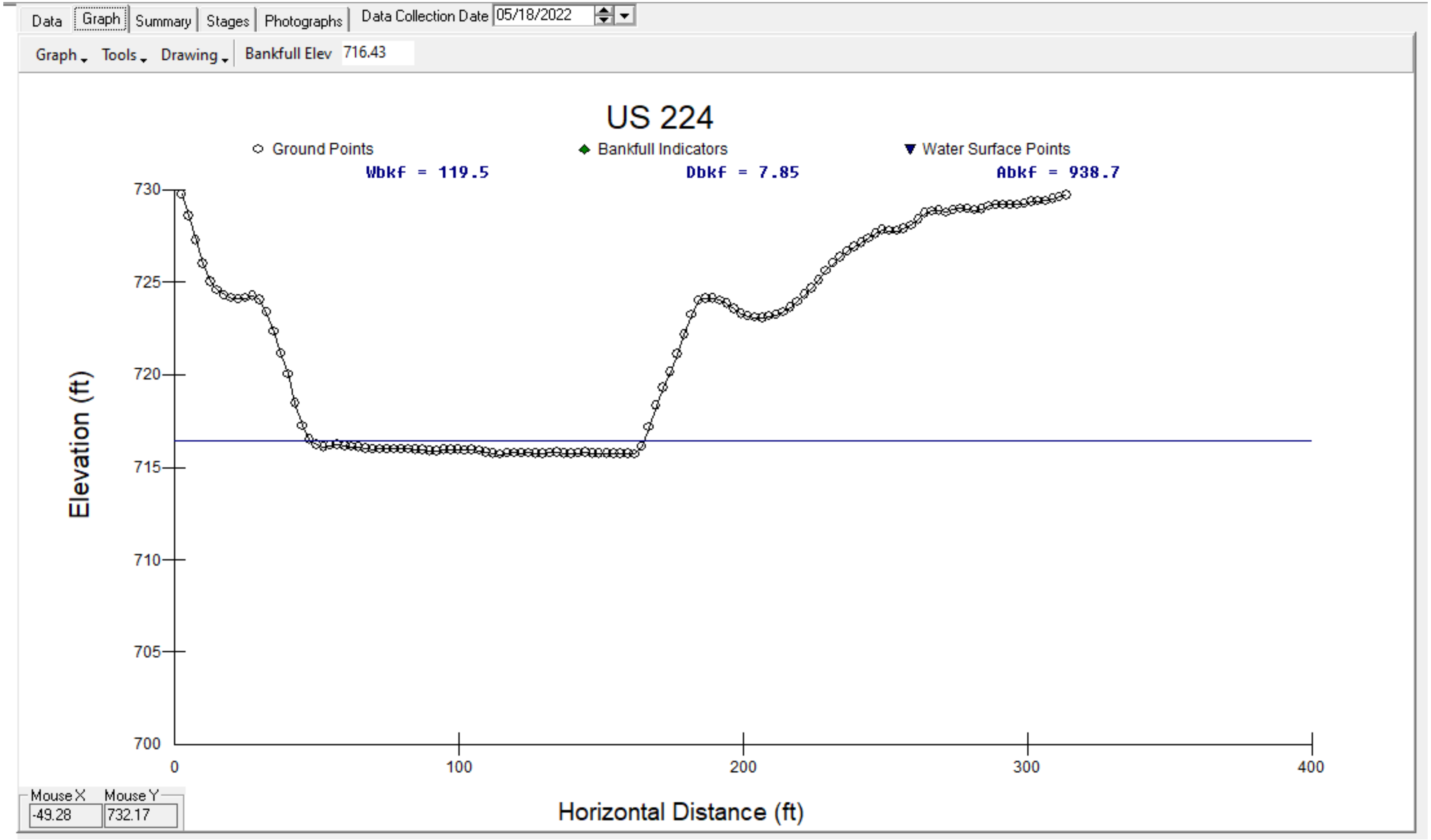
Little River at Huntington, IN, DA = 278 mi^2

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	2.23	percent
CONTDA	Area that contributes flow to a point on a stream	278.454	square miles
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	3.4	feet per mi
URBAN	Percentage of basin with urban development	3.8	percent
WETLAND	Percentage of Wetlands	1.64	percent

Predicted Channel Dimensions

- Bankfull Width: 80 ft.
- Bankfull Mean Depth: 3.3 ft.
- Bankfull X-sec Area: 272 ft^2
- Bankfull Max Depth: 4.7 ft.



Data
Graph
Summary
Stages
Photographs
Data Collection Date 05/18/2022
Graph
Tools
Drawing
Bankfull Elev 716.43
US 224
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 119.5
Dbkf = 7.85
Abkf = 938.7
730
725
720
715
710
705
700
0
100
200
300
400
Elevation (ft)
Horizontal Distance (ft)
Mouse X -49.28
Mouse Y 732.17

https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

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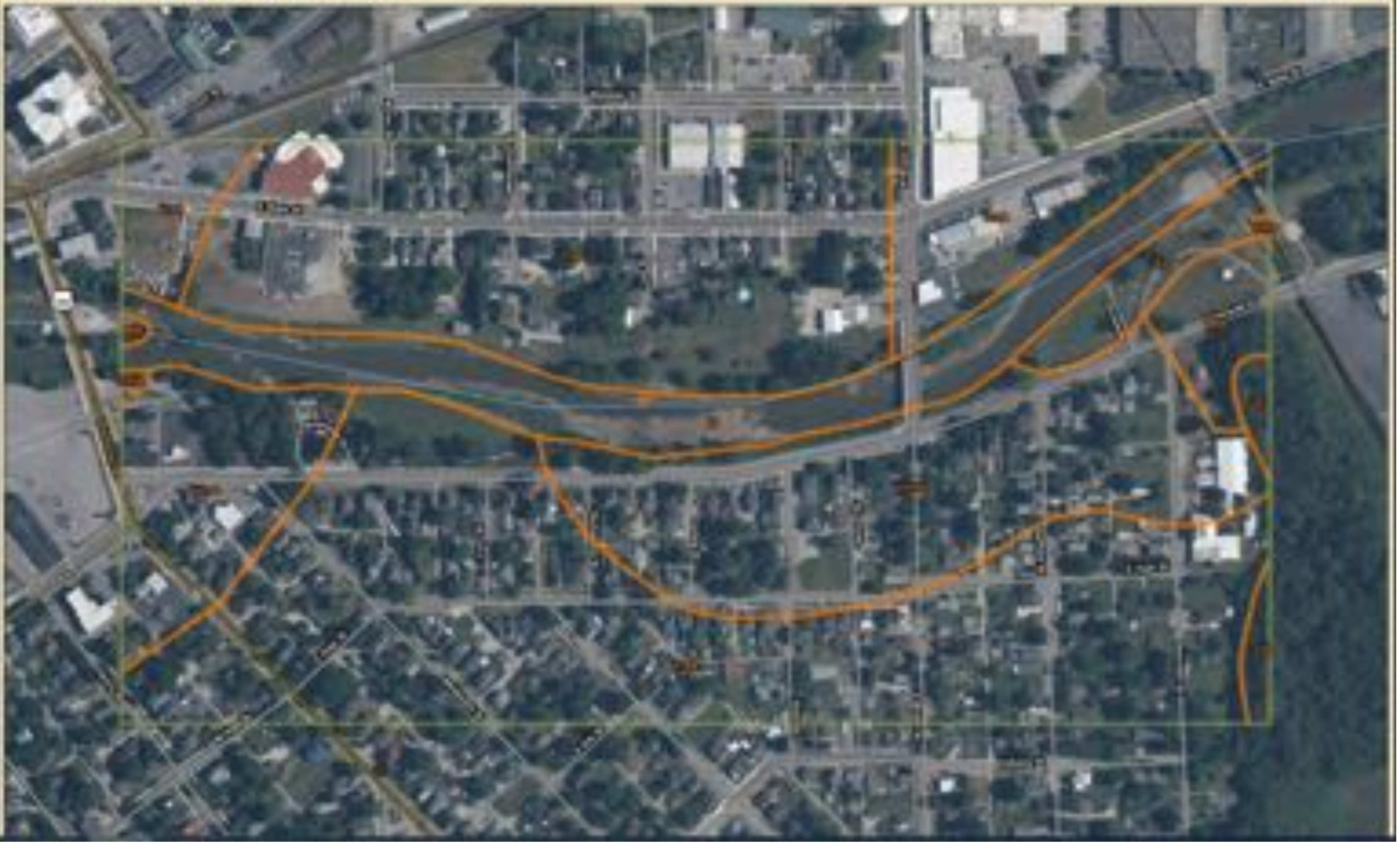
Map Unit Legend

	percent slopes		
Ud	Udorthents, loamy	1.0	1.0%
UmtB	Urban land-Milton complex, 2 to 6 percent slopes	0.1	0.1%
UraA	Urban land-Randolph complex, 0 to 2 percent slopes	14.4	13.8%
W	Water	10.4	10.0%
YmtB	Milton-Urban land complex, 2 to 6 percent slopes	16.9	16.2%
YraA	Randolph-Urban land complex, 0 to 2 percent slopes	56.5	54.3%
Totals for Area of Interest		**104.0**	**100.0%**

Soil Map

Scale



Report — Map Unit Description

Huntington County, Indiana

YmtB—Milton-Urban land complex, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 2yc3s
Elevation: 640 to 1,150 feet
Mean annual precipitation: 34 to 39 inches
Mean annual air temperature: 47 to 52 degrees F
Frost-free period: 165 to 175 days
Farmland classification: Not prime farmland

Map Unit Composition

Milton and similar soils: 50 percent
Urban land: 35 percent
Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Milton

Setting

Landform: Stream terraces, till plains
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess over clayey till over clayey residuum over limestone

Typical profile

Ap - 0 to 7 inches: silt loam
Bt1 - 7 to 13 inches: clay loam
2Bt2 - 13 to 24 inches: channery clay loam
2R - 24 to 60 inches: unweathered bedrock

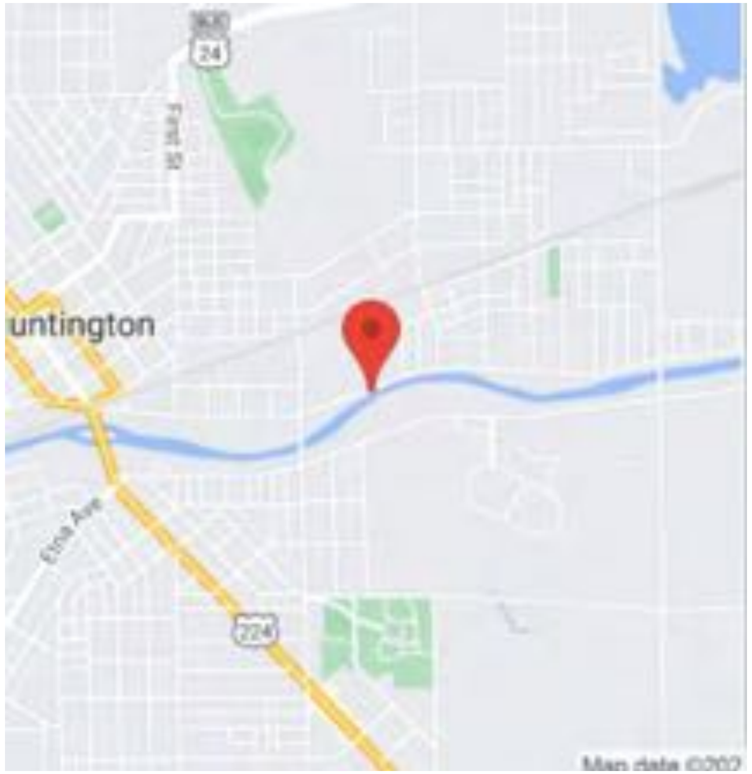
Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 40 percent
Available water supply, 0 to 60 inches: Low (about 3.3 inches)

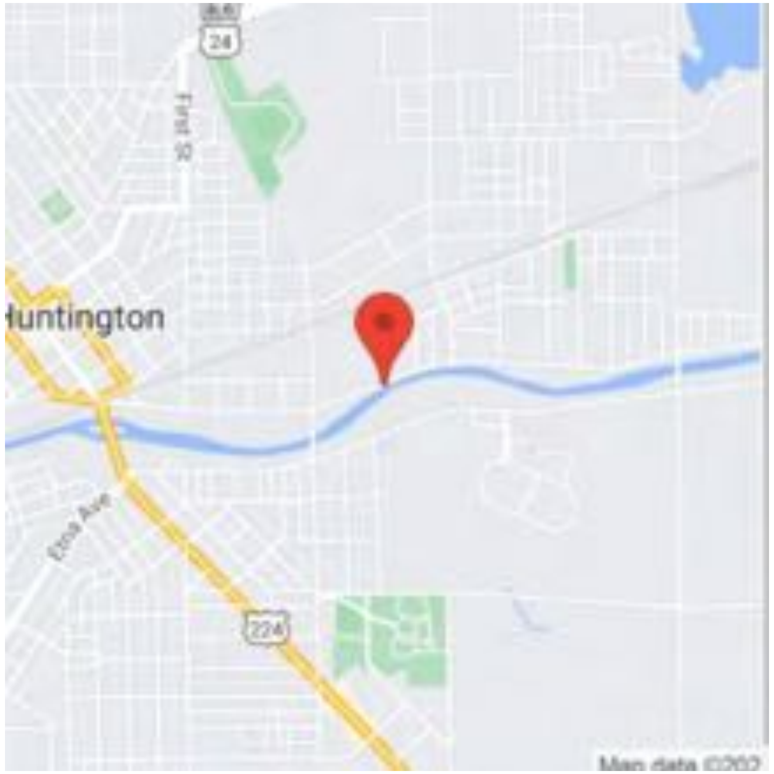
Notes

- Site is approximately 1000-ft upstream of recently (2021) removed LHD.

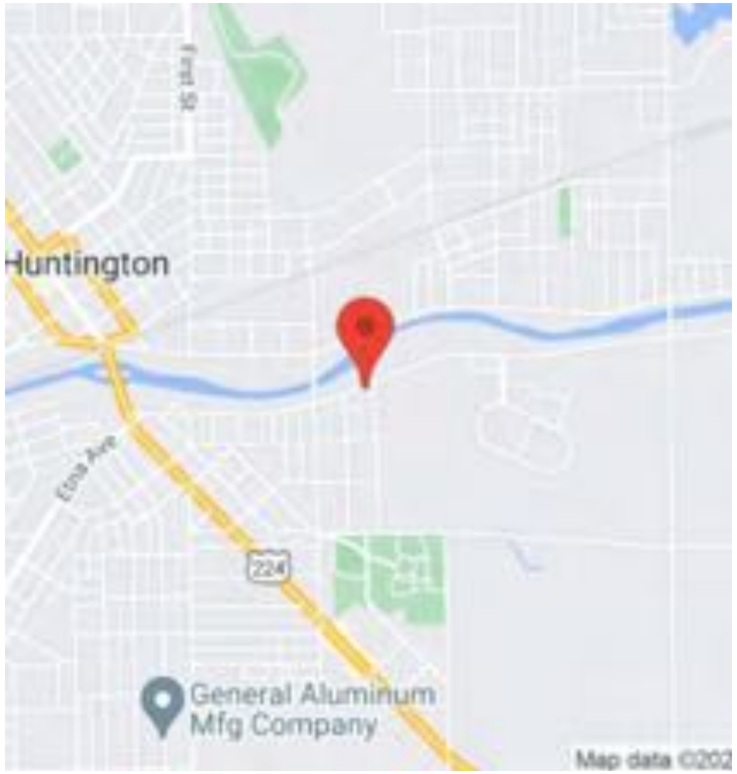
Little River, Huntington County, IN



Little River, Huntington County, IN

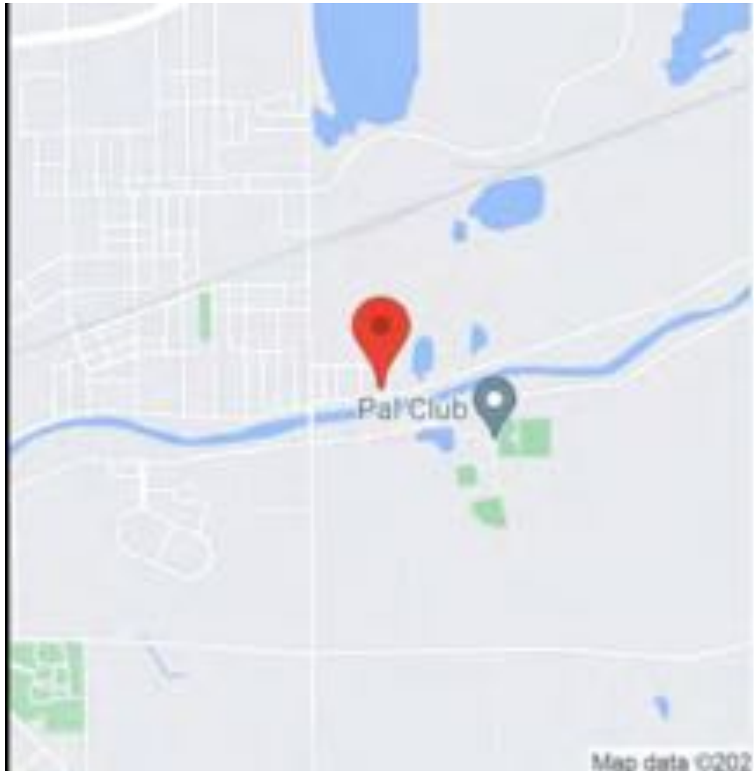


Little River, Huntington County, IN

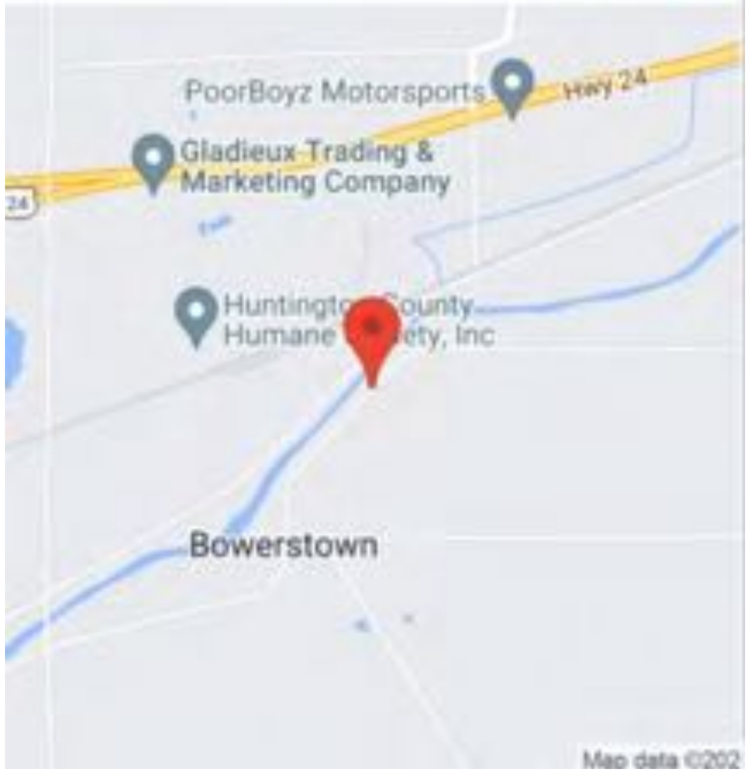


City attempted to remove footing
In 2019/2020 when the structure
was removed. Red-flagged by USACE
(Jay Poe)

Little River, Huntington County, IN



Little River, Huntington County, IN

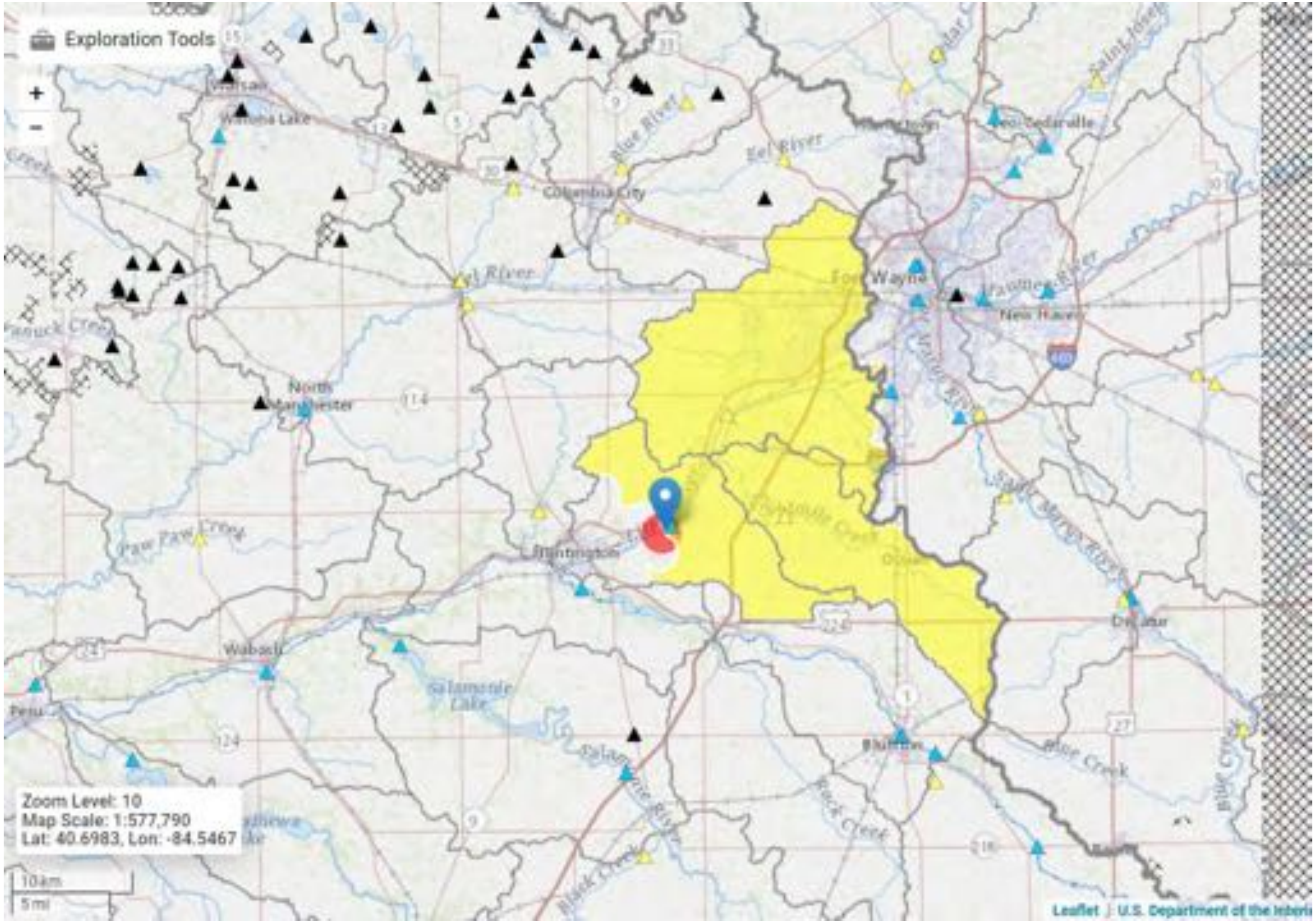


Little River valley, Huntington County, IN

Little River berm, Huntington County, IN

Little River at CR 200 E, Huntington County, IN (looking downstream)

Little River at CR 200 E, Huntington County, IN (looking upstream)



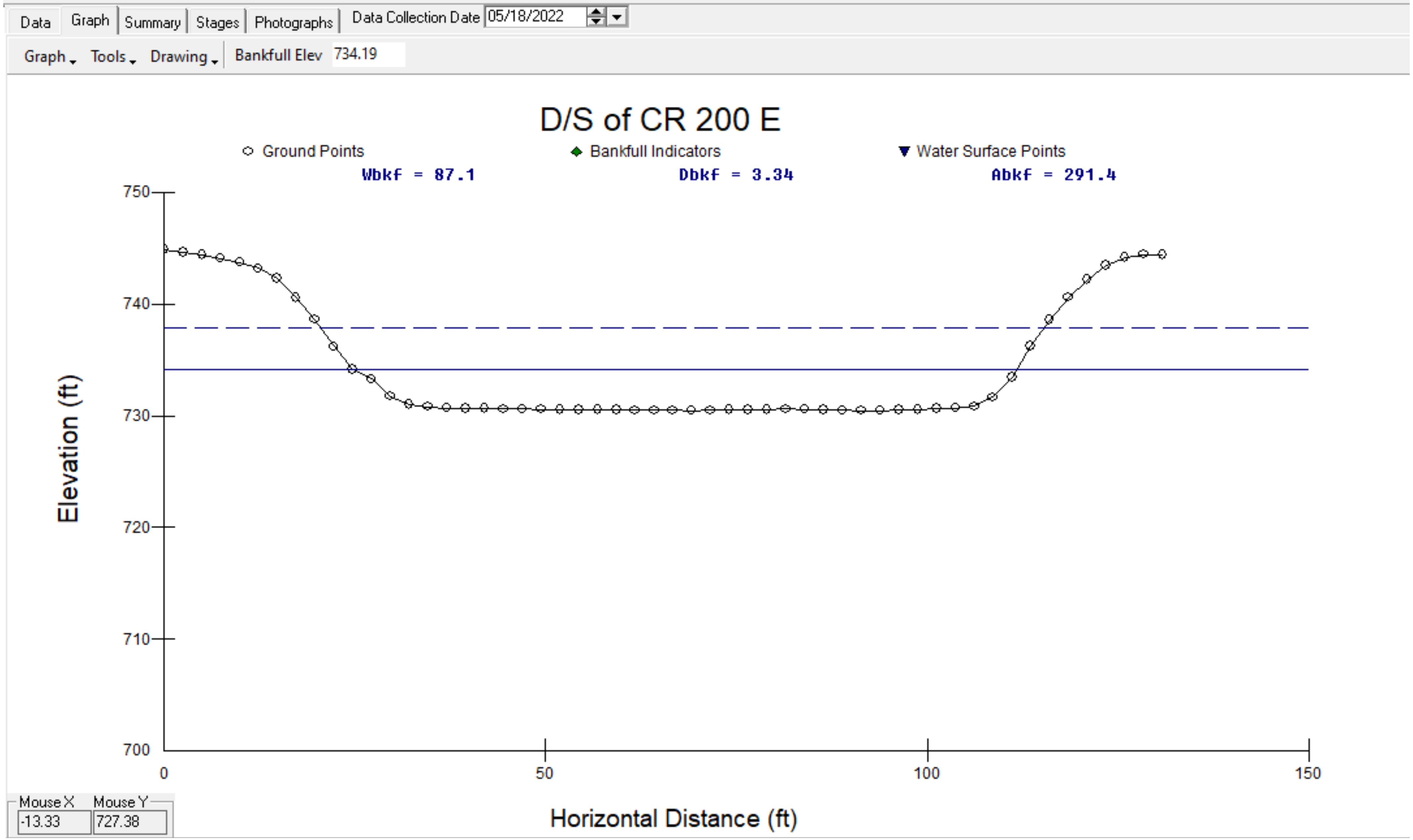
Little River at CR 200 E, Huntington County   DA = 263 mi^2

Basin Characteristics

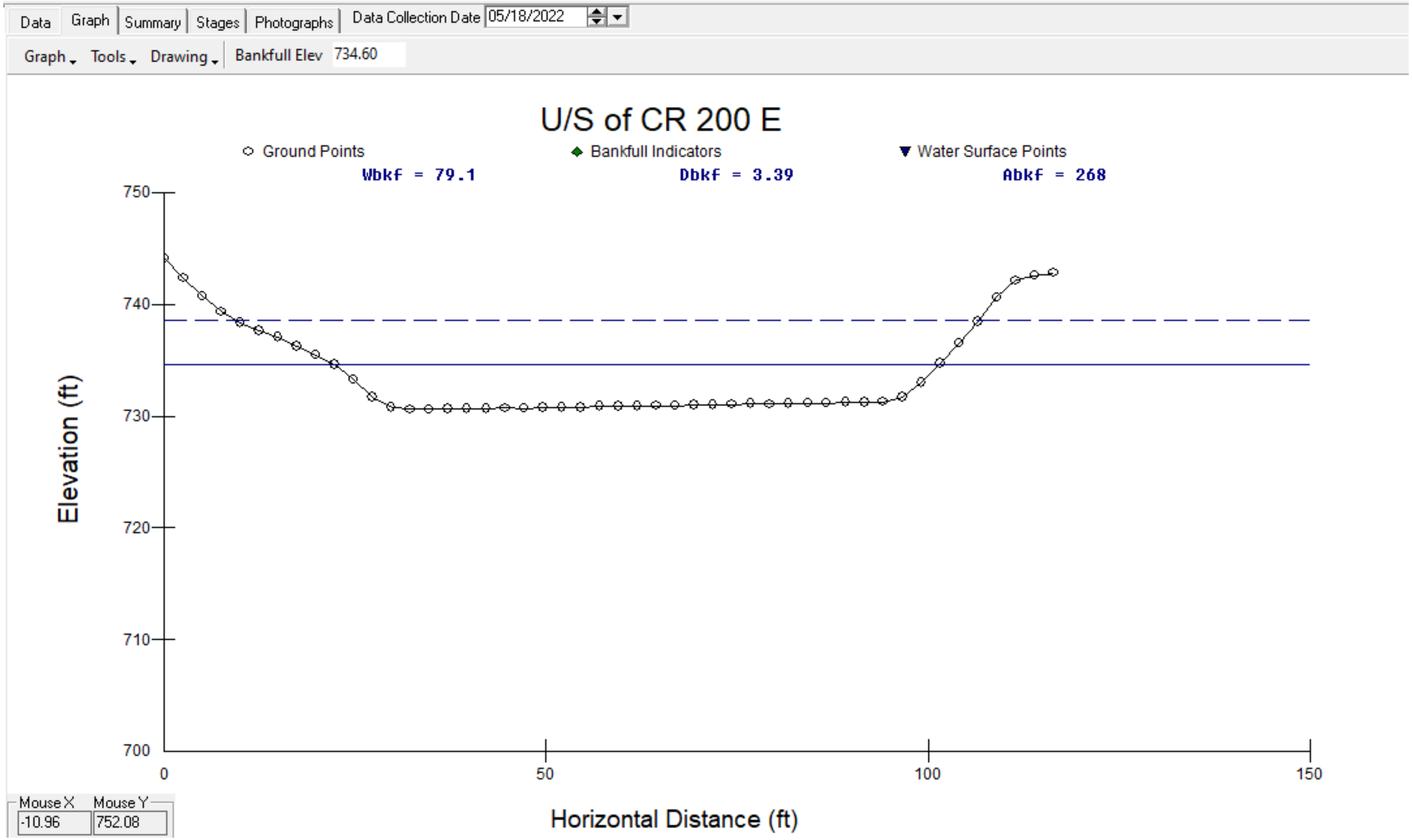
Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	2.22	percent
CONTDA	Area that contributes flow to a point on a stream	263.39	square miles
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	3.8	feet per mi
URBAN	Percentage of basin with urban development	3.5	percent
WETLAND	Percentage of Wetlands	1.68	percent

Predicted Channel Dimensions

- Bankfull Width: 79 ft.
- Bankfull Mean Depth: 3.3 ft.
- Bankfull X-sec Area: 264 ft^2
- Bankfull Max Depth: 4.6 ft.
- Min Radius of Curvature: 181 ft.
- Max Radius of Curvature: 236 ft.



Data
Graph
Summary
Stages
Photographs
Data Collection Date 05/18/2022
Graph
Tools
Drawing
Bankfull Elev 734.19
D/S of CR 200 E
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 87.1
Dbkf = 3.34
Abkf = 291.4
Elevation (ft)
750
740
730
720
710
700
0
50
100
150
Horizontal Distance (ft)
Mouse X
Mouse Y
-13.33
727.38


Data
Graph
Summary
Stages
Photographs
Data Collection Date 05/18/2022
Graph
Tools
Drawing
Bankfull Elev 734.60
U/S of CR 200 E
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 79.1
Dbkf = 3.39
Abkf = 268
Elevation (ft)
750
740
730
720
710
700
0
50
100
150
Horizontal Distance (ft)
Mouse X
Mouse Y
-10.96
752.08

Web Soil Survey

https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Area of Interest (AOI) | Soil Map | Soil Data Explorer | Download Soils Data | Shopping Cart (Free)

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Map Unit Legend

Huntington County, Indiana (IN069)

Huntington County, Indiana (IN069)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
McA	Martinsville silt loam, 0 to 2 percent slopes	3.8	5.7%
McB	Martinsville silt loam, 2 to 8 percent slopes	0.3	0.5%
Pe	Patton silty clay loam	0.0	0.0%
Pe	Patton silty clay loam, sandy substratum	10.5	15.9%
Rk	Rensselaer loam, 0 to 1 percent slopes	19.4	29.3%
Wo	Whitaker loam	32.1	48.6%
Totals for Area of Interest		**66.1**	**100.0%**

Soil Map

National map unit symbol: 2wp2b
Elevation: 600 to 1,010 feet
Mean annual precipitation: 34 to 40 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 150 to 185 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Rensselaer and similar soils: 85 percent
Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rensselaer

Setting

Landform: Depressions
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Loamy outwash

Typical profile

Ap - 0 to 15 inches: loam
Btg1 - 15 to 38 inches: clay loam
Btg2 - 38 to 42 inches: loam
Cg1 - 42 to 76 inches: stratified fine sand to silt loam
Cg2 - 76 to 79 inches: loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 25 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D
Ecological site: R111BY401IN - Wet Outwash Mollisol
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)
Hydric soil rating: Yes

BEHI location, LB, Little River upstream of CR 200 E, RB similar

BEHI location, LB, Little River downstream of CR 200 E, RB similar

Notes

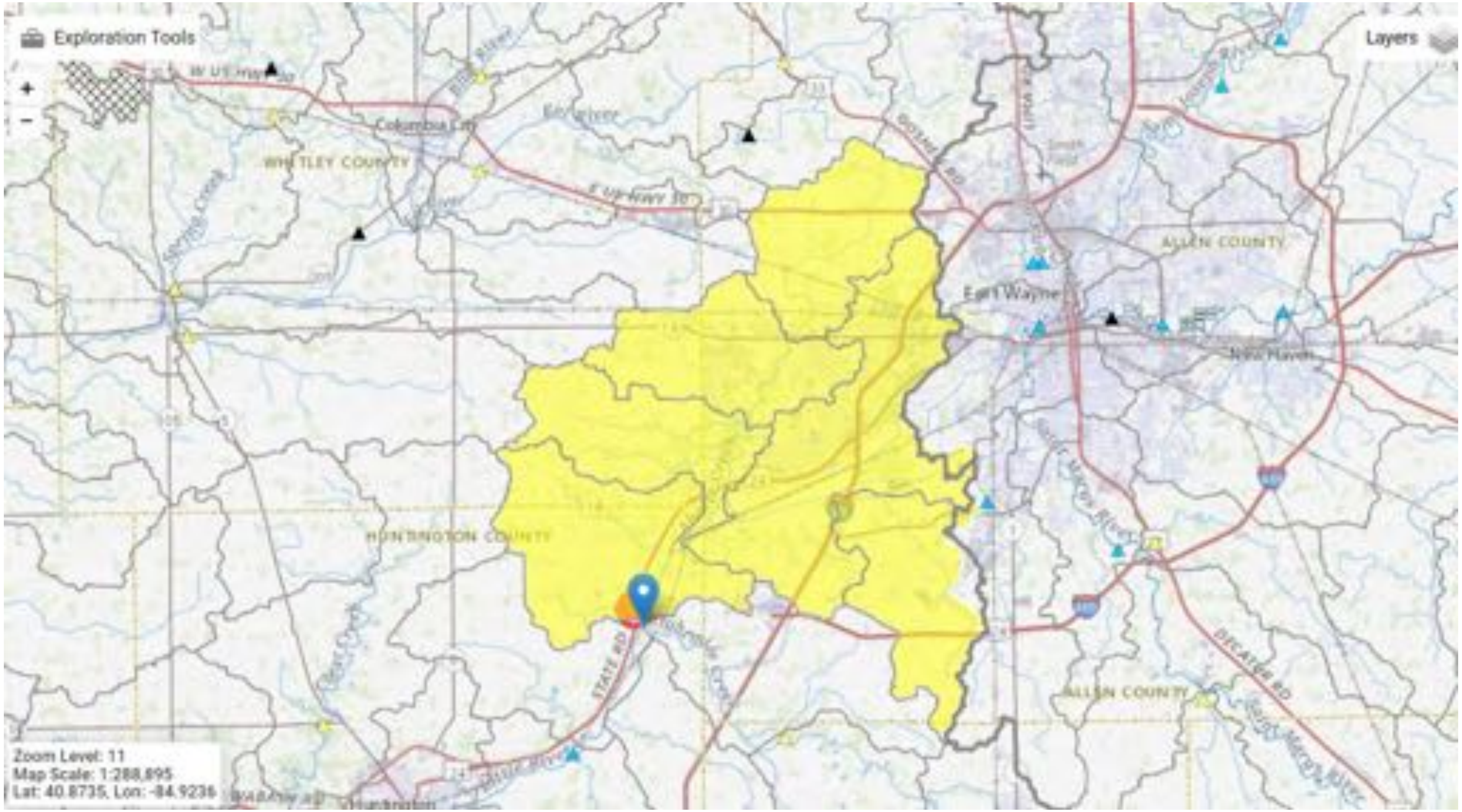
- Sharp contrast between upstream and downstream reaches at CR 200 E. Upstream is very unstable with bank slumping and tension cracking. No riparian trees or shrubs.

Little River, Huntington County, IN

Little River, Huntington County, IN

Little River, Huntington County, IN

Little River, Huntington County, IN. Confluence with Eight Mile Creek



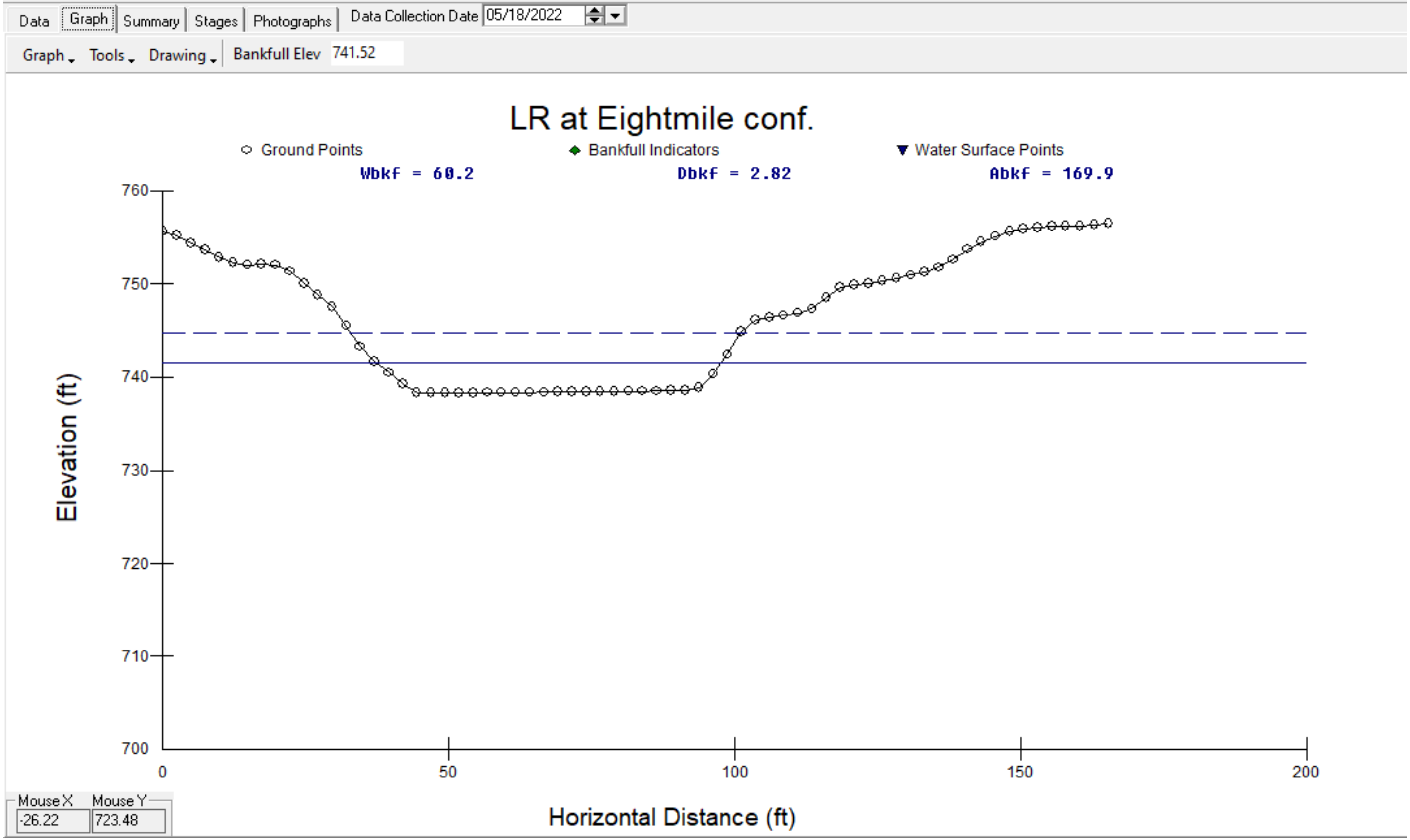
Little River at confluence with Eight Mile Creek, near Roanoke, IN DA = 129 mi^2

Basin Characteristics

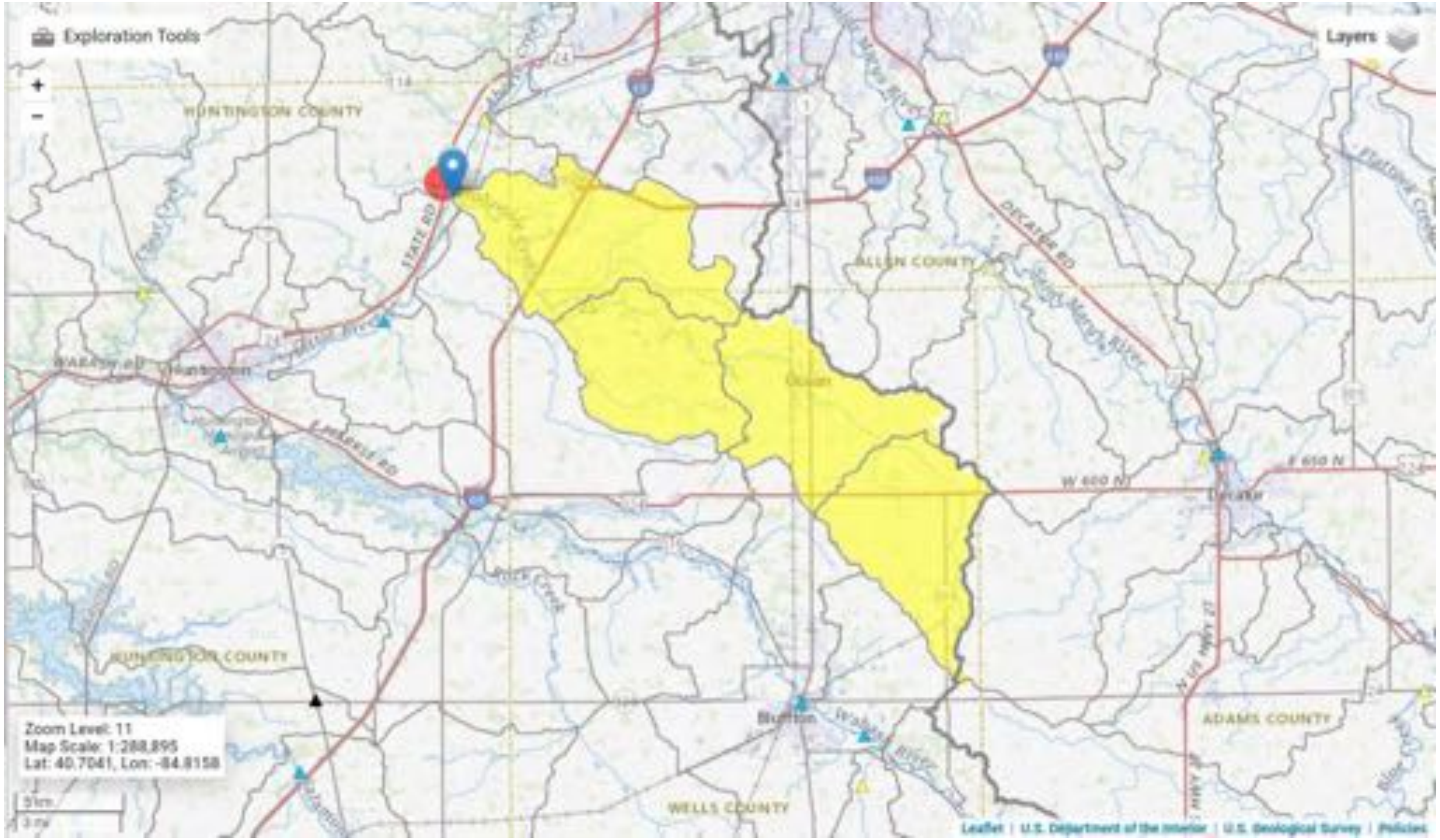
Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	2.92	percent
CONTDA	Area that contributes flow to a point on a stream	128.488	square miles
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	6.15	feet per mi
URBAN	Percentage of basin with urban development	5.6	percent
WETLAND	Percentage of Wetlands	2.4	percent

Predicted Channel Dimensions

- Bankfull Width: 63 ft.
- Bankfull Mean Depth: 2.9 ft.
- Bankfull X-sec Area: 185 ft^2
- Bankfull Max Depth: 4.0 ft.
- Min Radius of Curvature: 144 ft.
- Max Radius of Curvature: 188 ft.



Data
Graph
Summary
Stages
Photographs
Data Collection Date 05/18/2022
Graph
Tools
Drawing
Bankfull Elev 741.52
LR at Eightmile conf.
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 60.2
Dbkf = 2.82
Abkf = 169.9
Elevation (ft)
760
750
740
730
720
710
700
0
50
100
150
200
Horizontal Distance (ft)
Mouse X
Mouse Y
-26.22
723.48



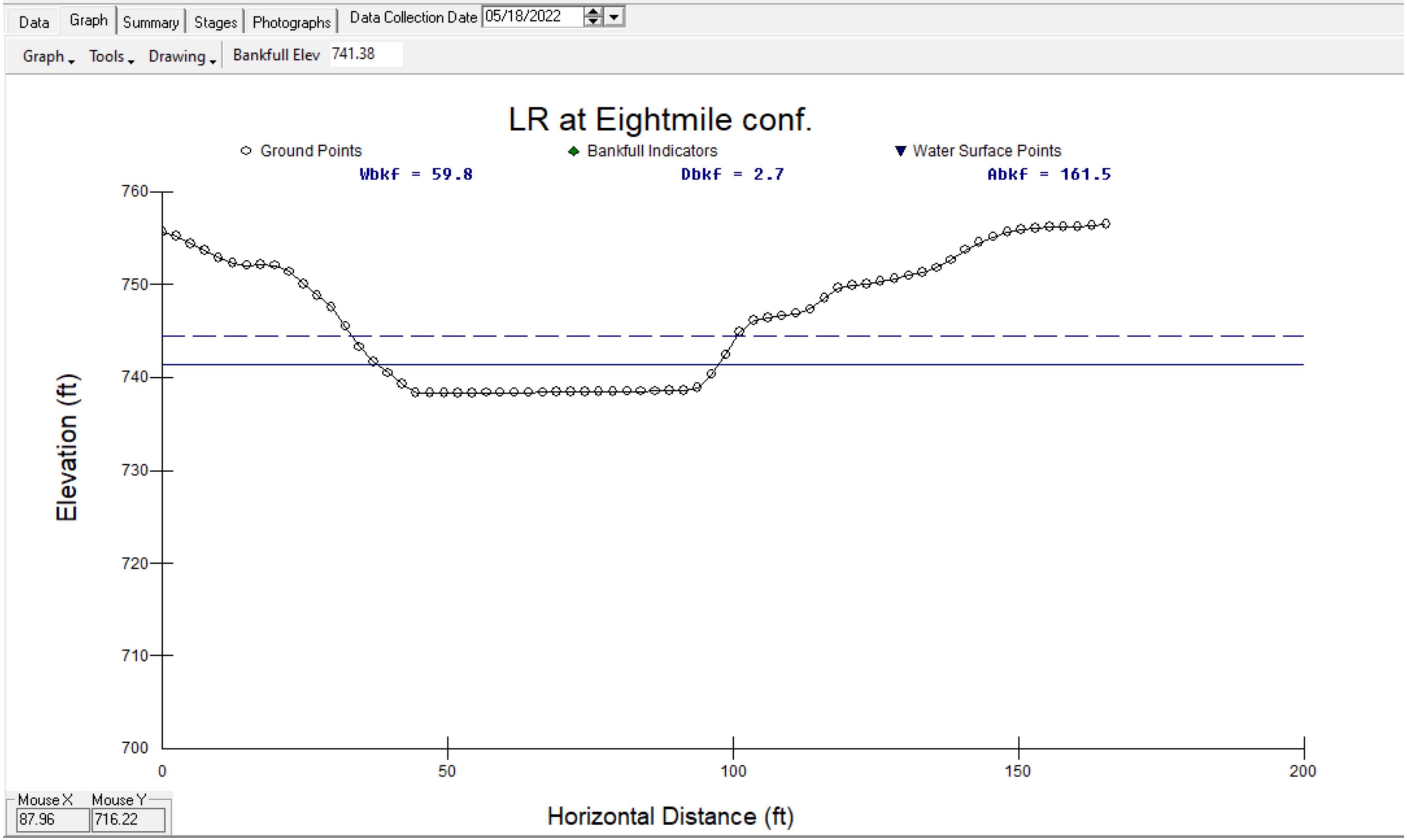
Eight Mile Creek at confluence with Little River, DA = 81 mi^2

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	1.72	percent
CONTDA	Area that contributes flow to a point on a stream	80.765	square miles
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	3.88	feet per mi
URBAN	Percentage of basin with urban development	2.1	percent
WETLAND	Percentage of Wetlands	0.98	percent

Predicted channel dimensions

- Bankfull Width: 54 ft. (54 N = 5)
- Bankfull Mean Depth: 2.7 ft.
- Bankfull X-sec Area: 147 ft^2
- Bankfull Max Depth: 3.7 ft.
- Min Radius of Curvature: 125 ft.
- Max Radius of Curvature: 163 ft.



Data
Graph
Summary
Stages
Photographs
Data Collection Date 05/18/2022
Graph
Tools
Drawing
Bankfull Elev 741.38
LR at Eightmile conf.
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 59.8
Dbkf = 2.7
Abkf = 161.5
Elevation (ft)
760
750
740
730
720
710
700
0
50
100
150
200
Horizontal Distance (ft)
Mouse X 87.96
Mouse Y 716.22

Web Soil Survey

https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Map Unit Legend

ApA	Aptakisic silt loam, 0 to 2 percent slopes	7.0	6.5%
Ee	Eel silt loam, 0 to 2 percent slopes, occasionally flooded	49.1	45.7%
Ge	Genesee silt loam, 0 to 2 percent slopes, occasionally flooded	25.2	23.4%
MdA	Martinsville silt loam, 0 to 2 percent slopes	0.0	0.0%
MdB	Martinsville silt loam, 2 to 6 percent slopes	7.6	7.0%
Pa	Patton silty clay loam	9.2	8.5%
Sh	Shoals silt loam, 0 to 2 percent slopes, occasionally flooded	9.1	8.5%

Warning: Soil Map may not be valid at this scale.

You have zoomed in beyond the scale at which the soil map for this area is intended to be used. Mapping of soils is done at a particular scale. The soil surveys that comprise

Report — Map Unit Description

Huntington County, Indiana

Ee—Eel silt loam, 0 to 2 percent slopes, occasionally flooded

Map Unit Setting

National map unit symbol: 2ygzp
Elevation: 440 to 1,280 feet
Mean annual precipitation: 37 to 46 inches
Mean annual air temperature: 48 to 55 degrees F
Frost-free period: 145 to 180 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Eel, occasionally flooded, and similar soils: 80 percent
Minor components: 20 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Eel, Occasionally Flooded

Setting

Landform: Flood-plain steps
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

Ap - 0 to 9 inches: silt loam
Bw1 - 9 to 15 inches: silt loam
Bw2 - 15 to 53 inches: silt loam
Cg - 53 to 72 inches: stratified sandy loam to silty clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 15 to 24 inches
Frequency of flooding: None, Occasional
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very high (about 12.1 inches)

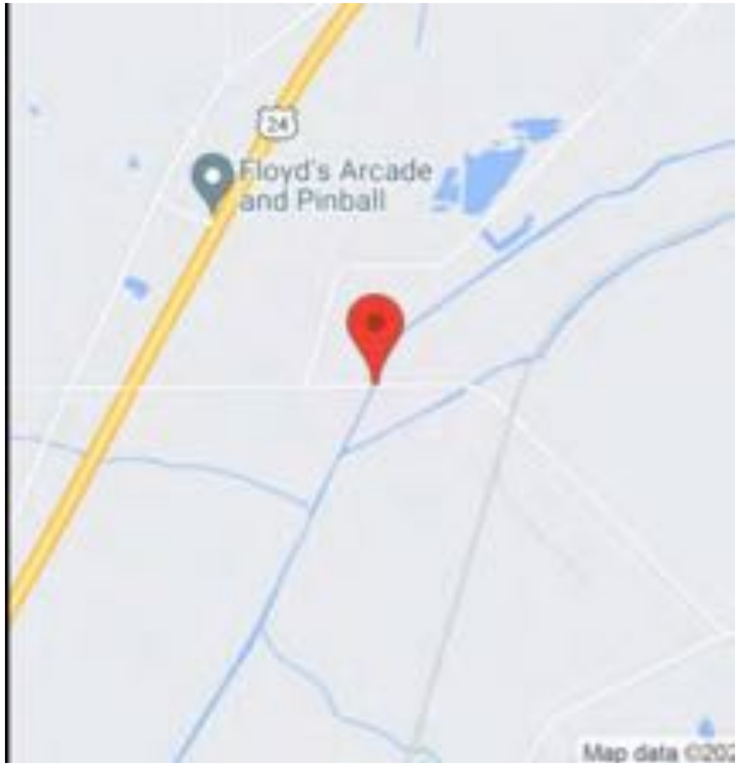
Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: A/D

BEHI location, LB, Little River downstream of Eightmile Creek

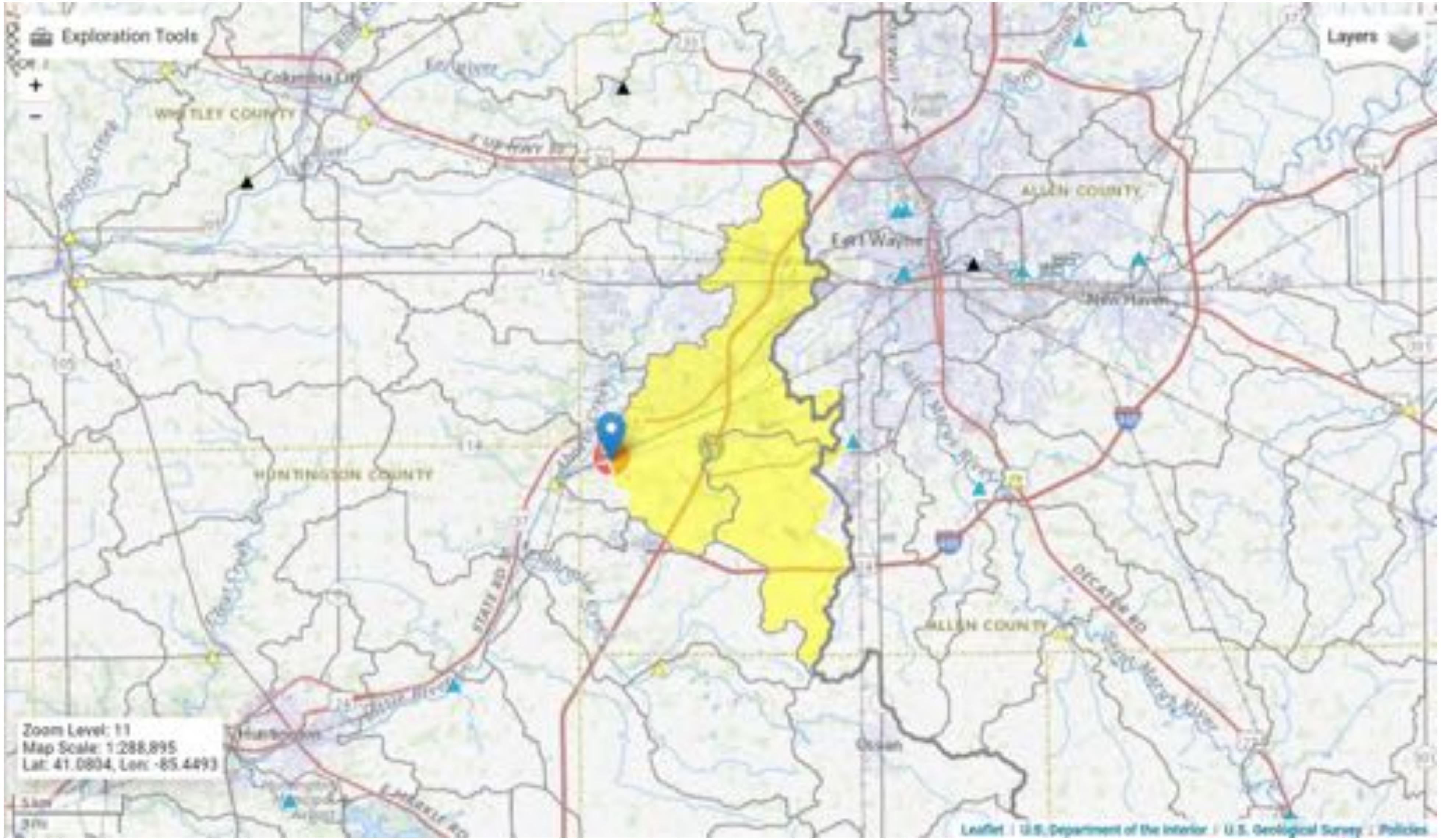
BEHI location, RB, Little River downstream of Eightmile Creek

Little River, Huntington County, IN



Little River, Huntington County, IN

Little River, near Aboite, Allen County, IN



Little River near Aboite, Allen County, IN DA = 50 mi^2

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	3.28	percent
CONTDA	Area that contributes flow to a point on a stream	49.973	square miles
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	5.7	feet per mi
URBAN	Percentage of basin with urban development	11.2	percent
WETLAND	Percentage of Wetlands	2.31	percent

Predicted Channel Dimensions

- Bankfull Width: 46 ft.
- Bankfull Mean Depth: 2.4 ft.
- Bankfull X-sec Area: 116 ft^2
- Bankfull Max Depth: 3.4 ft.
- Min Radius of Curvature: 107 ft.
- Max Radius of Curvature: 139 ft.

https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Area of Interest (AOI) | **Soil Map** | Soil Data Explorer | Download Soils Data | Shopping Cart (Free)

Printable Version | Add to Shopping Cart

Search

Map Unit Legend

Allen County, Indiana (IN003)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Es	Eel silt loam, 0 to 2 percent slopes, frequently flooded	4.1	4.1%
GlpC2	Glynwood clay loam, 6 to 12 percent slopes, eroded	6.9	7.0%
Le	Lenawee mucky silty clay loam	5.8	5.9%
Ls	Lenawee silty clay loam	43.3	43.9%
Ma	Made land	6.0	6.1%
Sh	Shoals silty clay loam	24.7	25.0%
Wh	Washtenaw silt loam	8.0	8.1%
Totals for Area of Interest		**98.7**	**100.0%**

Soil Map

Scale

Ls—Lenawee silty clay loam

Map Unit Setting

National map unit symbol: 5jd0
Elevation: 640 to 1,150 feet
Mean annual precipitation: 34 to 39 inches
Mean annual air temperature: 47 to 52 degrees F
Frost-free period: 165 to 175 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Lenawee and similar soils: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lenawee

Setting

Landform: Depressions on outwash plains, flats on lake plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Clayey lacustrine deposits over loamy lacustrine deposits

Typical profile

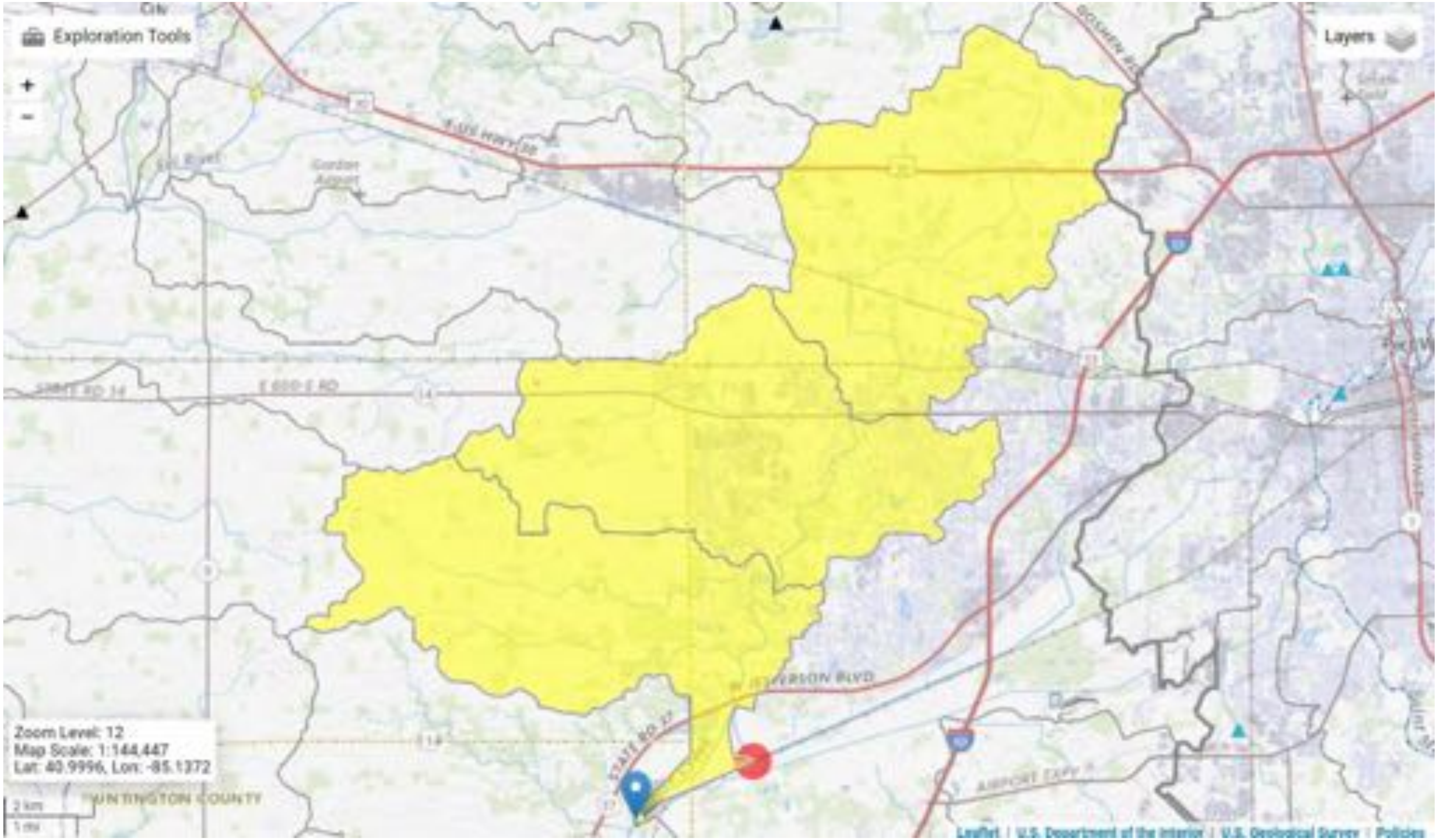
Ap - 0 to 8 inches: silty clay loam
Bg1,2Bg,BCg - 8 to 45 inches: silty clay loam
C - 45 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 6 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Available water supply, 0 to 60 inches: High (about 10.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C/D
Ecological site: F111BY101IN - Lacustrine Flatwood
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)
Hydric soil rating: Yes



Aboite Creek at confluence with Little River, DA = 53mi^2

Basin Characteristics

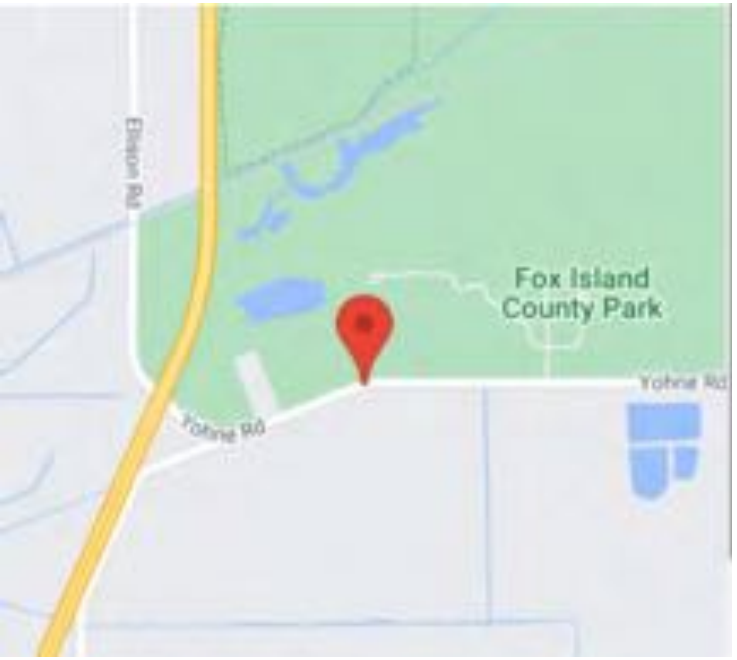
Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	2.52	percent
CONTDA	Area that contributes flow to a point on a stream	52.712	square miles
CSL10_85	Change in elevation divided by length between points 10 and 85 percent of distance along main channel to basin divide - main channel method not known	6.37	feet per mi
URBAN	Percentage of basin with urban development	2.2	percent
WETLAND	Percentage of Wetlands	2.95	percent

Predicted Channel Dimensions

- Bankfull Width: 47 ft.
- Bankfull Mean Depth: 2.5 ft.
- Bankfull X-sec Area: 119 ft^2
- Bankfull Max Depth: 3.4 ft.
- Min Radius of Curvature: 109 ft.
- Max Radius of Curvature: 142 ft.

Little River, Allen County, IN

Little River, Allen County, IN



Little River, Allen County, IN

APPENDIX 3: COST ESTIMATES

Little River - Streambank Stabilization

Conceptual Solution Cost Estimate

Line	Description	Estimated Quantities	Units	Unit Price	Estimated Cost (Rounded)	Conversion/ Percent
1	**Engineering**					
2	Final Engineering Design	1	LS	$ 15,000	$ 25,000	
3	401/404 IDEM Regional General Permit	1	LS	$ 6,000	$ 6,000	
4	IDNR Construction-in-a-Floodway Permit	1	LS	$ 6,000	$ 6,000	
5	IDEM Construction General Permit	1	LS	$ 6,000	$ 6,000	
6	Estimated Engineering Cost				$ 37,000	
7	**Stream Channel Improvements**					
8	Channel and Bank Excavation (Assuming onsite spoiling)	2,700	CY	$ 40	$ 108,000	
9	Coir Fabric	1,100	SY	$ 10	$ 11,000	
10	Seeding and Mulch	1,100	SY	$ 4	$ 4,400	
11	Estimated Stream Channel Improvements Cost				$ 123,400	
12	**Miscellaneous**					
13	Construction Contingencies (30%)	1	LS	$ 25,000	$ 25,000	30.0%
14	Construction Surveying (3%)	1	LS	$ 3,000	$ 3,000	3.0%
15	Construction Mobilization/Demobilization (10%)	1	LS	$ 9,000	$ 9,000	10.0%
16	Maintenance of Traffic (5%)	1	LS	$ 5,000	$ 5,000	5.0%
17	Bonding and Insurance (2%)	1	LS	$ 2,000	$ 2,000	2.0%
18	Estimated Miscellaneous Cost				$ 44,000	
19						
20	**Estimated Total Construction Cost**				**$ 204,400**	
21	**General Notes and Assumptions**					
22	All costs are estimates based on the engineer's knowledge of common construction					
23	Christopher B. Burke Engineering does not guarantee that the actual bid price will not					
24	vary from the costs used with this estimate.					
25	All costs are in 2022 dollars.					
26	Estimated costs have been rounded.					
27	This estimate does not include unforeseen costs increases that may result from					
28	shortages in fuel and materials due to natural or man-made disaster.					
29	Prices are on a per-100-linear-ft basis.					

Little River - Power Line Foundation Removal

Conceptual Solution Cost Estimate

Line	Description	Estimated Quantities	Units	Unit Price	Estimated Cost (Rounded)	Conversion/ Percent
1	**Engineering**					
2	Final Engineering Design	1	LS	$ 15,000	$ 15,000	
3	401/404 IDEM Regional General Permit	1	LS	$ 6,000	$ 6,000	
4	IDNR Construction-in-a-Floodway Permit	1	LS	$ 6,000	$ 6,000	
5	IDEM Construction General Permit	1	LS	$ 6,000	$ 6,000	
6				Estimated Engineering Cost	$ 27,000	
7	**Stream Channel Improvements**					
8	Dewatering	1	LS	$ 10,000	$ 10,000	
9	Foundation Removal	1	LS	$ 60,000	$ 60,000	
10	Sediment Removal and Hauling	750	CY	$ 35	$ 26,300	
11	Haul, Place, and Compact Fill Material	800	CY	$ 20	$ 16,000	
12	Coir Fabric	700	SY	$ 10	$ 7,000	
13	Seeding and Mulch	700	SY	$ 4	$ 2,800	
14		Estimated Stream Channel Improvements Cost			$ 122,100	
15	**Miscellaneous**					
16	Construction Contingencies (30%)	1	LS	$ 23,000	$ 23,000	30.0%
17	Construction Surveying (3%)	1	LS	$ 3,000	$ 3,000	3.0%
18	Construction Mobilization/Demobilization (10%)	1	LS	$ 8,000	$ 8,000	10.0%
19	Maintenance of Traffic (5%)	1	LS	$ 4,000	$ 4,000	5.0%
20	Bonding and Insurance (2%)	1	LS	$ 2,000	$ 2,000	2.0%
21			Estimated Miscellaneous Cost		$ 40,000	
22						
23		**Estimated Total Construction Cost**			**$ 189,100**	
24	**General Notes and Assumptions**					
25	All costs are estimates based on the engineer's knowledge of common construction					
26	Christopher B. Burke Engineering does not guarantee that the actual bid price will not					
27	vary from the costs used with this estimate.					
28	All costs are in 2022 dollars.					
29	Estimated costs have been rounded.					
30	This estimate does not include unforeseen costs increases that may result from					
31	shortages in fuel and materials due to natural or man-made disaster.					
32	Hauling costs have been estimated assuming a 20-minute 1-way haul distance.					

Little River - Stream Access Location
Conceptual Solution Cost Estimate

Line	Description	Estimated Quantities	Units	Unit Price	Estimated Cost (Rounded)	Conversion/ Percent
1	**Engineering**					
2	Final Engineering Design	1	LS	$ 15,000	$ 15,000	
3	401/404 IDEM Regional General Permit	1	LS	$ 6,000	$ 6,000	
4	IDNR Construction-in-a-Floodway Permit	1	LS	$ 6,000	$ 6,000	
5	IDEM Construction General Permit	1	LS	$ 6,000	$ 6,000	
6	Estimated Engineering Cost				$ 27,000	
7	**Stream Channel Improvements**					
8	Parking Lot (Gravel)	70	CY	$ 40	$ 2,800	
9	Place and Compact Fill	30	CY	$ 25	$ 800	
10	Finish Grading	200	SY	$ 5	$ 1,000	
11	Vegetated Concrete Block Access Stabilization	140	SY	$ 50	$ 7,000	
12	Coir Fabric	200	SY	$ 10	$ 2,000	
13	Seeding and Mulch	200	SY	$ 4	$ 800	
14	Estimated Stream Channel Improvements Cost				$ 14,400	
15	**Miscellaneous**					
16	Construction Contingencies (30%)	1	LS	$ 7,000	$ 7,000	30.0%
17	Construction Surveying (3%)	1	LS	$ 1,000	$ 1,000	3.0%
18	Construction Mobilization/Demobilization (10%)	1	LS	$ 3,000	$ 3,000	10.0%
19	Maintenance of Traffic (5%)	1	LS	$ 2,000	$ 2,000	5.0%
20	Bonding and Insurance (2%)	1	LS	$ 1,000	$ 1,000	2.0%
21	Estimated Miscellaneous Cost				$ 14,000	
22						
23	**Estimated Total Construction Cost**				**$ 55,400**	
24	**General Notes and Assumptions**					
25	All costs are estimates based on the engineer's knowledge of common construction					
26	B. Burke Engineering does not guarantee that the actual bid price will not vary from the costs used with this estimate.					
27	All costs are in 2022 dollars.					
28	Estimated costs have been rounded.					
29	This estimate does not include unforeseen costs increases that may result from shortages					
30	result of a natural or man-made disaster.					
31	Hauling costs have been estimated assuming a 20-minute 1-way haul distance.					