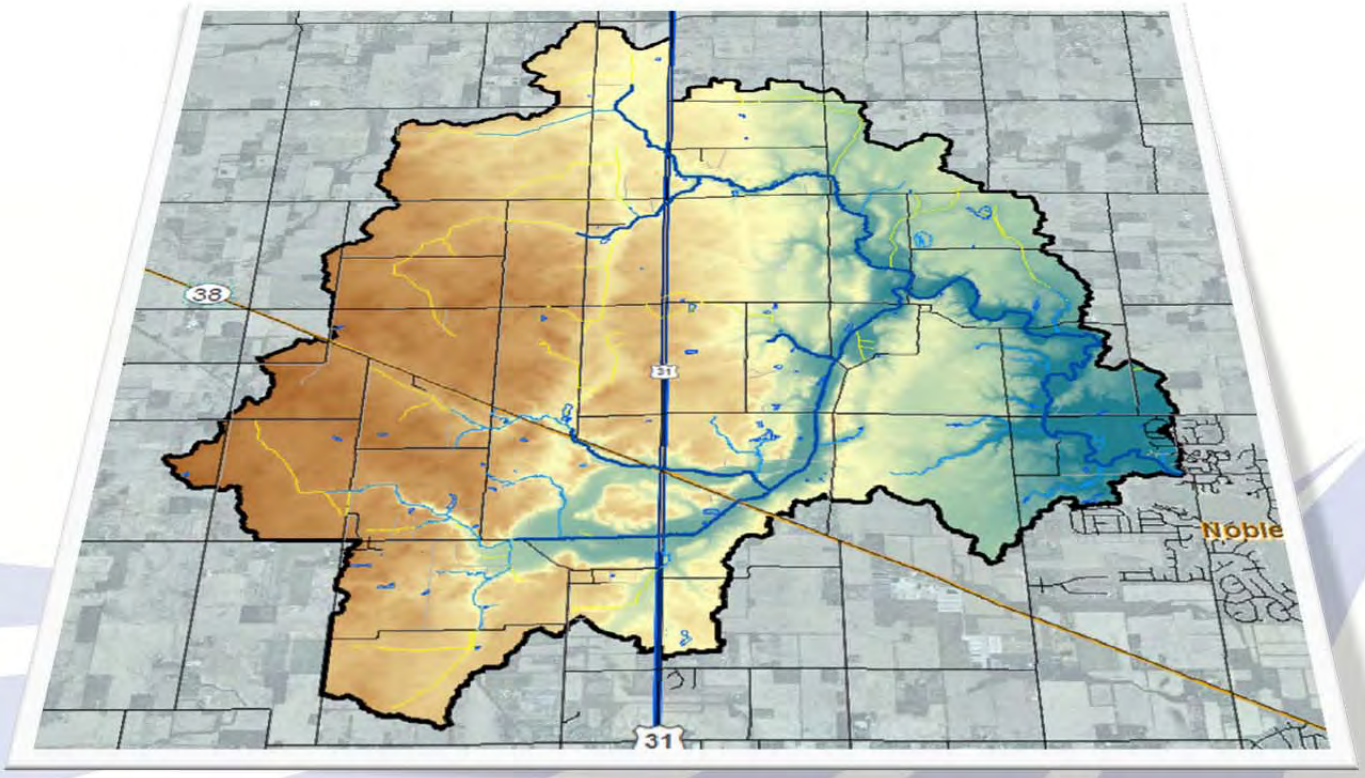
Hinkle Creek Watershed Master Plan

Hamilton County Drainage Board

November 2013



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EXCUTIVE SUMMARY

INTRODUCTION

The Hinkle Creek Watershed Master Plan presents the results of the watershed analysis completed by Clark Dietz, Inc. in conjunction with the Hamilton County Surveyor's Office and Williams Creek Consulting. The Hinkle Creek watershed drains 21.0 square miles and is located north of the City of Westfield and northwest of the City of Noblesville. The watershed flows directly into Morse Reservoir. United States Highway 31 (U.S. 31) splits the watershed vertically and State Road 38 splits the lower half of the watershed diagonally. The watershed includes four townships: Adams, Jackson, Washington, and Noblesville.

The Hinkle Creek Watershed Master Plan was prepared to guide decisions by the Hamilton County Drainage Board as the watershed develops into residential and commercial areas in the future. By considering the watershed quality now, the County can help guide development to address the needs and increase the overall the health of the watershed in the future.

DATA COLLECTED

Various data was collected and created to be used as a resource in the future. The following data is discussed in the report:

- Regulated Drains
- Water Quality
- Climate
- Land Use
- Soils
- Endangered Species
- Related Studies
- Regulations
- Organizations
- Stream Gage Data

WATER QUALITY ANALYSIS

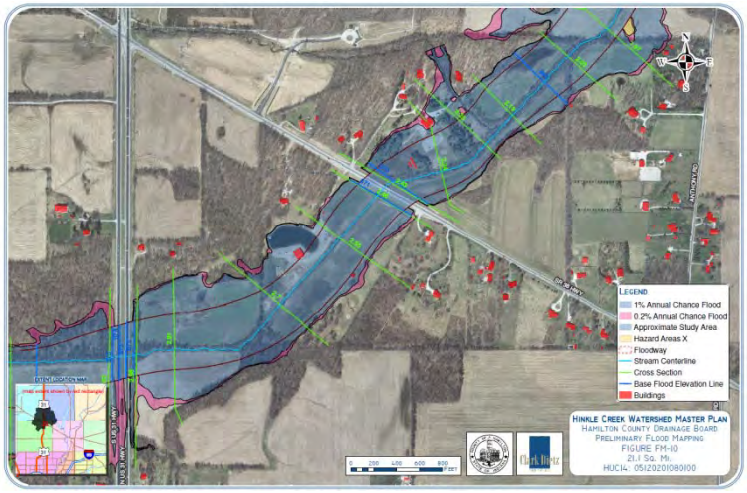
The Hinkle Creek watershed is characterized by a predominance of agricultural crop production with lesser amounts of pasture, low density residential, and limited commercial and industrial land use. To assess the impacts of these land uses on water quality, the physical and chemical characteristics of the watershed were analyzed (see Chapter 4). Water quality concerns identified involved nutrients

from plant and fertilizer waste, highly erodible soils resulting in field and stream erosion, and E. Coli from livestock.

HYDROLOGIC ANALYSIS

A hydrologic analysis of the Hinkle Creek watershed was performed to determine peak flows from various storm events that would then be used (along with hydraulic modeling) to determine the flood plain boundaries for Hinkle Creek and the Isaac Jones Drain. The hydrologic analysis is described in detail in Chapter 5.

HYDRAULIC ANALYSIS



Flood mapping for Hinkle Creek and Isaac Jones Drain was prepared based on the hydraulic analysis. Peak flows from the hydrologic modeling were used as inputs into the hydraulic model of the stream system. The hydraulic analysis identified a detailed floodplain and floodway using cross sectional area of the stream based the most recent Hamilton County contour data. This mapping was used to develop solutions for stream related flooding areas and will be a key tool for identifying development in the floodplain as the watershed develops. The hydraulic analysis is described in detail in Chapter 6.

AREAS OF CONCERN

Based on public meetings, water quality sampling, and hydrologic and hydraulic analysis, the areas of concern in the watershed were identified. The primary concerns identified include erosion problems contributing to sedimentation in Morse Reservoir, E. Coli from livestock and other sources, isolated structures in the floodplain, and increased backwater flooding caused by hydraulically restrictive bridges. Chapter 7 further describes these problems that were identified.

RECOMMENDATIONS

The Hinkle Creek Watershed Master Plan reviewed watershed-wide stormwater needs and identified recommendations that include projects to reduce sedimentation in Morse Reservoir, reduce or eliminate flooding at structures, control streambank and field erosion, and enhance water quality.

Recommendations are geared at preparing the watershed for future changes and addressing the immediate needs. Immediate needs include addressing erosion issues in the streams and fields that contribute to sediment build up in Morse Reservoir. Long term projects such as regional detention and wetlands can be incorporated as development occurs. The following recommendations have been made and are detailed further in Chapters 8 and 9:

Site-Specific Erosion Solutions

- *Stream and Swale Buffers at 5 Locations ($150K-$225K) – Section 8.5.1*
- *Stream Bank Stabilization at 3 Locations ($175-$250K) – Section 8.5.2-8.5.4*
- *Various Structure Upgrades to Reduce Backwater Flooding – Section 8.4*
    - *Replace Anthony Road Structure over Hinkle Creek to reduce floodplain at the Hinkle Creek Apartments ($750K) – Section 8.4.1*
    - *Replace 236th Street Structure over Hinkle Creek to reduce floodplain at the Hinkle Creek Apartments ($750K) – Section 8.4.1*
    - *Replace structure at 225th over Hinkle Creek Street to reduce backwater ($1.2M) – Section 8.4.3*
    - *Replace structure at Deming Road over Hinkle Creek to reduce backwater ($1.0M) – Section 8.4.3*

(Note: All of these structures are in good condition currently. These improvements are recommended for consideration at the end of existing structures' current design life.)

Watershed-Wide Recommendations

- *Implement stream and swale buffers at identified locations and promote throughout the watershed. – Section 8.3.4*
- *When new bridges are required to be replaced, utilize designs that will reduce backwater from the structure. – Section 8.4*

- *Add 2 gage stations along Hinkle Creek and 1 gage station along the Isaac Jones Drain. – Section 8.3.5*
- *Conduct additional water quality samples in the watershed. – Section 8.3.3*
- *Increase the regulated floodplain limits from the 100-year floodplain area to the 500-year floodplain. – Section 9.3.6*
- *Extend regulated drains to cover un-regulated streams and along Hinkle Creek to Morse Reservoir in areas that are un-regulated. – Section 8.3.1*
- *Keep following the Stormwater Management Ordinance and Technical Standards and adopt the Chapter 700 Channel Protection and Water Quantity chapter. – Section 8.3.1*
- *Continue public outreach and education on the importance of water resources and the benefits of protecting the watershed. – Section 8.3.2*
- *Look for opportunities for regional detention/constructed wetlands as the watershed develops.– Section 8.3.6*

CHAPTER 1 INTRODUCTION

1.1 OVERVIEW

The Hinkle Creek Watershed in Hamilton County is a mostly undeveloped watershed that drains agricultural lands. A smaller portion of the land use is residential, wood lands, and pasture land. Hinkle Creek watershed drains directly into Morse Reservoir. As much of Hamilton County has developed in recent years, Hinkle Creek Watershed will develop in years to come. The existing and future land use in the watershed will not only impact the local watershed but downstream receiving waters including Morse Reservoir.

The Hamilton County Drainage Board retained Clark Dietz, Inc. to develop the Hinkle Creek Watershed Master Plan which will document the existing watershed, problems, proactively plan for future development, and provide the County with overall stormwater planning strategies as the watershed develops.

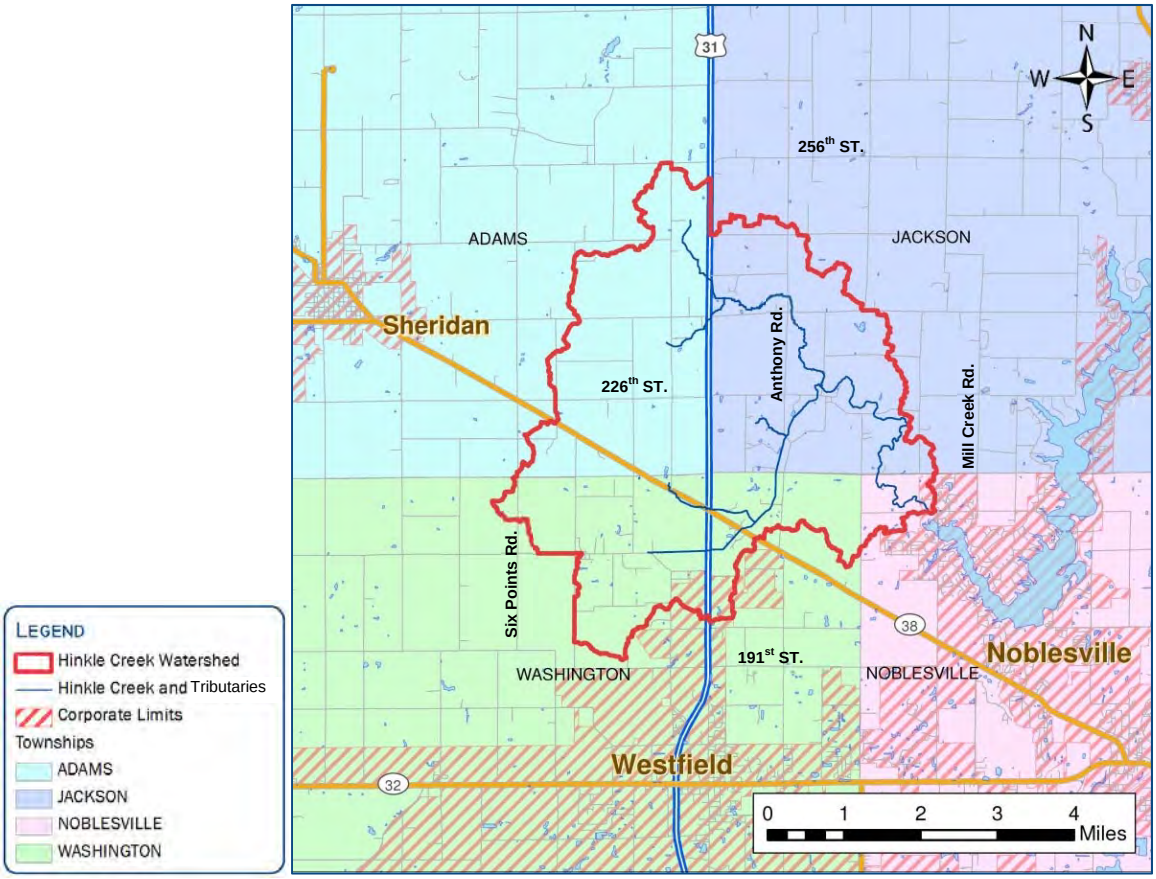
> The existing and future land use in the watershed will not only impact the local watershed but downstream receiving waters including Morse Reservoir.

The Hinkle Creek Watershed Master Plan included a hydrologic, hydraulic, and water quality analysis of the main streams in the watershed. The hydrologic and hydraulic analysis includes computer models that will be able to be revised as new developments occur to understand the impacts on the watershed. The water quality analysis will provide baseline conditions for the watershed.

1.2 WATERSHED LOCATION

The Hinkle Creek Watershed drains 21.0 square miles and is located north of the City of Westfield and northwest of the City of Noblesville. The watershed is bound by 256th Street to the north, 191st Street to the south, Six Points Road to the west, and by Morse Reservoir to the east. United States Highway 31 (U.S. 31) splits the watershed vertically and State Road 38 (S.R. 38) splits the lower half of the watershed diagonally. The watershed includes four townships: Adams, Jackson, Washington, and Noblesville. Figure 1-1 shows the Hinkle Creek Watershed location.

Figure 1-1 Hinkle Creek Location Map



1.3 PROJECT PURPOSE AND MISSION STATEMENT

The primary purposes of the Hinkle Creek Watershed Master Plan are to identify and analyze the existing conditions in the watershed and provide a specific plan to manage stormwater as the watershed develops. By identifying the existing conditions such as water quality, stream flows, flood prone areas, and erosion problems, the Hamilton County Drainage Board will have a baseline analysis to guide further planning decisions as the watershed develops. The Mission Statement of the plan is summarized as follows:

MISSION STATEMENT:

Preserve and improve the overall health of the Hinkle Creek Watershed by maintaining and improving the existing stormwater quantity and quality and by proactively guiding future stormwater management practices and decisions.

1.4 PROJECT SCOPE

The following is a summary of the scope of work for the project:

Inventory and Problem Identification	*Existing information was gathered and evaluated. Sources included previous reports and studies, interviews with staff, public meetings, and field reconnaissance. This information was used to compile problem area maps and identify areas for solution development.*
Problem Analysis	*Hydrologic and hydraulic computer models were developed to analyze identified problems and evaluate improvement alternatives. The 100-year and 500-year floodplain as well as the floodway was created based on the modeling performed.*
Solution Development	*Alternative solutions were developed and evaluated. Solutions included bridge and culvert replacements, streambank stabilization projects, regional detention facilities, and land use considerations.*
Recommendations and Implementation	*This work task included recommending capital and maintenance projects, modifications to stormwater management practices, and identifying costs and implementation issues.*
Watershed Master Plan Report	*This work element involved compiling the above information into this report.*

1.5 REPORT ORGANIZATION

Executive Summary	This short section of the document summarizes the full report in such a way that readers can quickly become acquainted with key findings of the study.
Chapter 1 *Introduction*	This chapter provides a project overview, watershed location, project purpose and scope, and the report organization.
Chapter 2 *Watershed Background Data*	Summarizes data available and gathered for the study including maps, plans, reports, organizations, and other information used in completing the project.
Chapter 3 *Watershed Characteristics*	Discusses the characteristics of the Hinkle Creek Watershed going into detail on regulated drains, topography, climate data, land use, soils, wetlands, and endangered species.

Chapter 4 *Water Quality Analysis*	Describes the general condition of the riparian corridor and channel morphology along Hinkle Creek, summarizes water quality sampling efforts, and identifies potential pollutant sources in the watershed.
Chapter 5 *Hydrologic* Analysis	Discusses the detailed watershed delineation, development of the HEC-HMS model, parameters required to develop the model, resulting peak flows produced by the modeling efforts, and flow validation.
Chapter 6 *Hydraulic Analysis*	Describes the hydraulic models that were developed to evaluate solutions to stream related problems. Also includes floodplain mapping of previously unmapped areas.
Chapter 7 *Problem Identification*	Describes watershed stressors and sources, summarizes public input, problems causing water quality degradation, watershed-wide problems, and site-specific problems. This chapter also describes the impacts of future development, future regulations, and sets measurable goals for the watershed.
Chapter 8 *Solution Development*	Presents solutions to the various problems that were identified through the problem identification and hydrologic/hydraulic analyses.
Chapter 9 *Recommendations*	Summarizes recommendations, implementation issues, and funding options for the various categories of improvement projects.

1.6 ACKNOWLEDGEMENTS

This study was prepared for the Hamilton County Drainage Board by Clark Dietz, Inc. The Hamilton County Surveyor's Office managed the project and assisted in information gathering, public meeting organization, and final review of the study. Williams Creek Consulting was sub consultant to Clark Dietz, Inc. and was primarily responsible for the water quality aspects of this study, including field investigations, stream sampling and related improvement recommendations. Clark Dietz performed the hydrologic and hydraulic analysis which resulted in new flood mapping for the Hinkle Creek and Isaac Jones Drain. Clark Dietz also supervised all aspects of the project, gathered data, prepared figures, identified problems related to the hydrology and hydraulics, and led the report preparation.

CHAPTER 2 WATERSHED BACKGROUND DATA

2.1 INTRODUCTION

Multiple sources of information were collected and analyzed to provide baseline data for the project. This chapter briefly summarizes data sources and their relevance to this study. These sources consisted of maps and plans, previous reports and studies, ordinances and standards, and other regulatory information.

2.2 WATERSHED DATA

2.2.1 GIS Data

Hamilton County has a comprehensive Geographic Information System (GIS) that was used extensively on the project. Data from the GIS is available to the public at the County's GIS web page (http://www.hamiltoncounty.in.gov/category/subcategory.php?categoryid=65). Figure 2-1 shows the Hamilton County GIS website and some of the available online products.

Figure 2-1 Hamilton County GIS Excerpt

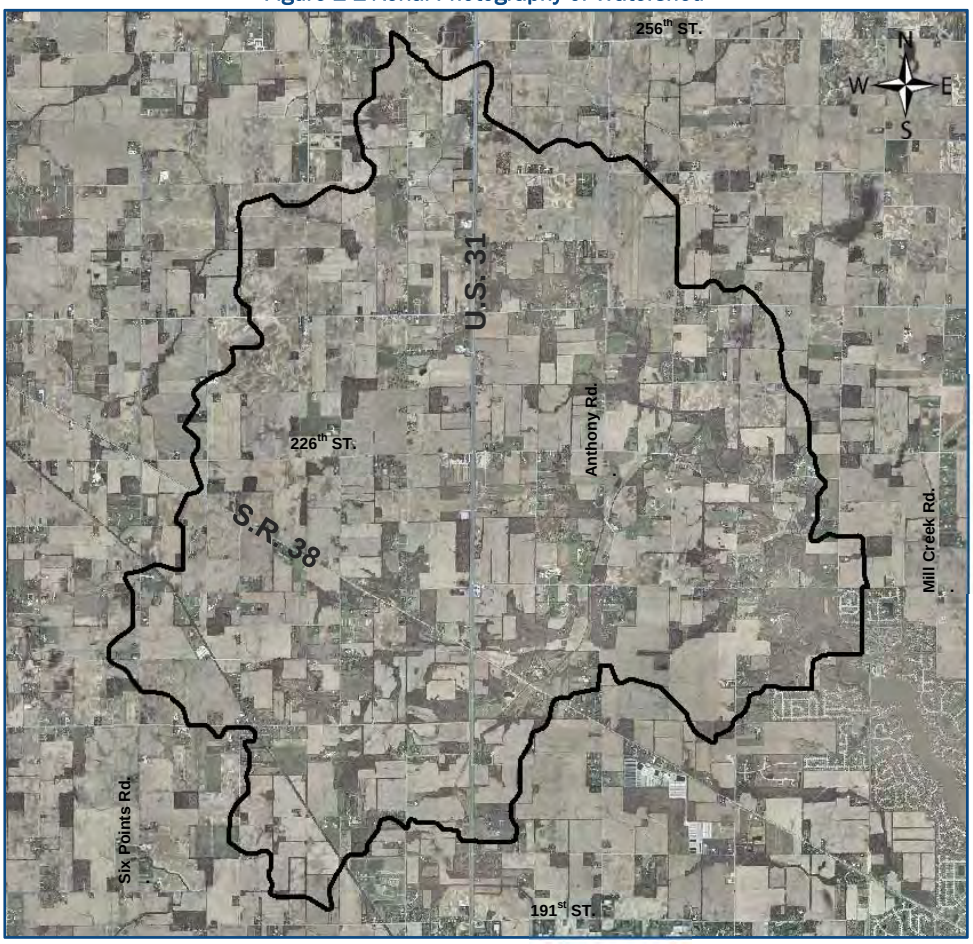
The GIS contains several layers of information including the transportation system (highways, primary roads, minor roads, railroads); drainage system (drainage structures, regulated drains, streams, ponds); planimetric features (building outlines, fences, walls); topography (1' contour intervals); soils types; and political and survey boundaries. High resolution aerial photography is also available in the GIS.

The GIS was used to delineate watersheds and subbasins, identify land use for hydrologic modeling, analyze drainage features, identify the extent of the riparian corridor and stream buffers, and provide base mapping for figures and exhibits in this report.

2.2.2 Aerial Photography

Hamilton County has updated aerial photography annually since 2004. This project utilized 2011 aerial photography for analysis as well as figures in this report. Past aerials were also used to analyze stream morphology over the years. Figure 2-2 shows an aerial view of the Hinkle Creek Watershed.

Figure 2-2 Aerial Photography of Watershed



2.2.3 National Wetland Inventory Maps

The National Wetland Inventory (NWI) Maps are provided by the U. S. Department of Interior, Fish and Wildlife Service. These maps provide the general location and extent of wetlands. Final verification of the wetland boundaries should be performed by a Professional Wetland Scientist prior to approval of site plans adjacent to these areas.

Wetlands provide valuable functions including filtering pollutants in stormwater, providing habitat for wildlife, recharging groundwater, and providing natural flood storage.

Wetlands provide valuable functions including filtering pollutants in stormwater, providing habitat for wildlife, recharging groundwater, and providing natural flood storage. Wetlands are protected under the Federal Clean Water Act and require special permits from the U.S. Army Corps of Engineers (Section 404 permit) and IDEM (Section 401 Water Quality Certification). Indiana has historically protected the state's waters, which include wetlands, by applying the Section 401 Water Quality Certification program in conjunction with the Section 404 U.S. Army Corps of Engineers permit program. IDEM is currently regulating isolated wetlands (those that no longer fall under Section 404 jurisdiction) through the use of NPDES permits, until a state wetland permit program is established and effective.

Potential wetlands identified by NWI mapping are classified according to the Cowardin Wetland Classification System. This system distinguishes wetlands by location, salinity, water depth, frequency of flooding, and vegetation type. Review of the NWI data indicated 113 potential wetland areas within the Hinkle Creek Watershed. The following table provides a summary of these features:

Table 2-1 Summary of NWI Mapping In Hinkle Creek Watershed

COWARDIN CLASSIFICATION	NUMBER OF MAPPED FEATURES	TOTAL ACRES IN WATERSHED
Palustrine, emergent/forested, broad-leaved deciduous (PEM/FO1)	1	6.9
Palustrine, emergent, temporarily flooded (PEMA)	26	28.8
Palustrine, emergent, seasonally flooded (PEMC)	17	16.7
Palustrine, emergent, semi-permanently flooded (PEMF)	2	1.6
Palustrine, forested, broad-leaved deciduous (PFO1)	37	312.6

Palustrine, unconsolidated bottom, semi-permanently flooded (PUBF)	4	1.2
Palustrine, unconsolidated bottom, intermittently exposed (PUBG)	14	3.9
Palustrine, unconsolidated bottom, permanently flooded (PUBH)	12	8.2

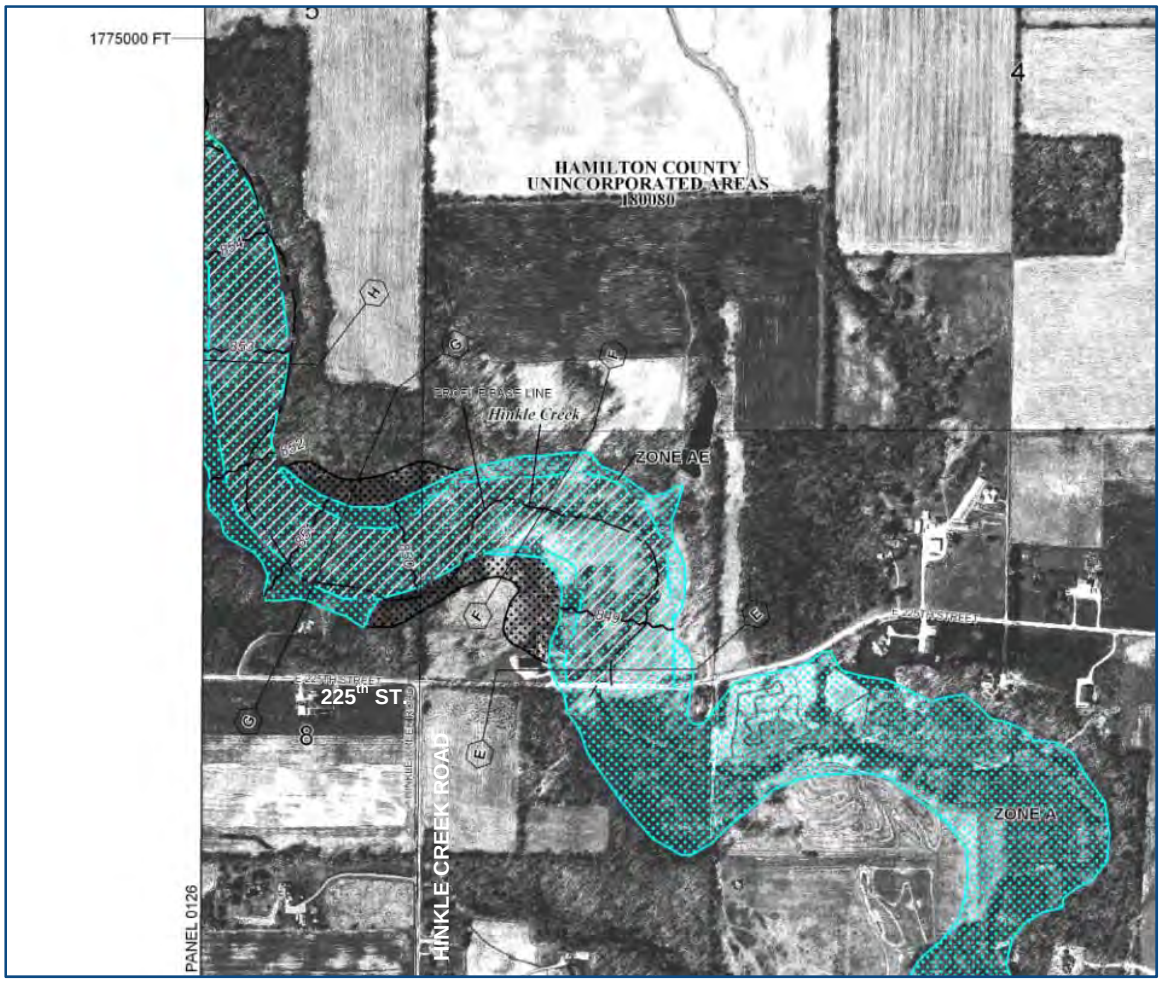
In order to better enforce compliance with wetland regulations and to protect their existence in future growth areas, it is recommended that wetland areas be added to the County GIS. The County will benefit from having this information readily available during the site plan review process. Furthermore, easy access to this information could be considered a Stormwater Best Management Practice (BMP) and could be used to comply with NPDES Phase II regulations.

2.2.4 Flood Insurance Mapping

Flood Insurance Rate Maps (FIRMs) depict the regulatory floodway, the 100-year and 500-year floodplain boundary, base flood elevations, cross-section locations and other related information. The regulatory floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment in order that the 100-year flood may be conveyed without substantial increases (0.14 feet or less in Indiana) in flood heights. The Indiana Department of Natural Resources (IDNR) regulates construction in the floodway. Local jurisdictions (Hamilton County, Westfield, and Noblesville) regulate the portion of the floodplain outside of the floodway, referred to as the floodway fringe. The County has regulations prohibiting fill in the floodplain and floodway.

During the course of this project, updated FIRM maps were being prepared for the County by IDNR. The FIRMs were last updated and finalized on February 19, 2003. On July 25, 2012 IDNR released draft preliminary FIRMs. An excerpt from one of the updated FIRMs is shown on Figure 2-3.

Figure 2-3 Preliminary FIRM of Hinkle Creek



IDNR publishes floodplain mapping in detailed and approximate forms. The detailed study includes cross sections, 1 % and 0.2 % chance floodplain delineations. The detailed studies take into account bridges and other structures along the stream. Approximate studies do not consider structures and only show an approximate 1% or 100-year floodplain boundary. Figure 2-3 shows a detailed study on the north side of the road shown (225th Street over Hinkle Creek) and an approximate study on the south side of the road.

The new draft preliminary FIRMs include a detailed floodplain study for the Isaac Jones Drain which has not had a detailed FIRM in the past. There are several small sections of Hinkle Creek which had detailed mapping available but for the most part only approximate mapping was available in the past.

To better assess the flood risks and potential damages along Hinkle Creek, a hydrologic (chapter 5) and a hydraulic (chapter 6) analysis were performed as part of the Hinkle Creek Master Plan.

2.2.5 Past USGS Stream Gage Data

From 1956 to 1981, the USGS operated and maintained a stream gage in Hinkle Creek at 225th Street. The gage station was 03350100 and called Hinkle Creek near Cicero, Ind. The drainage area was listed as 18.50 square miles and the Datum was 820.26 feet NGVD29. Table 2-2 shows the annual peak discharges recorded by the gage from 1956 to 1984, while gage was in operation. The top five flow values are highlighted in red. Rainfall data from NOAA's Frankfort IN US Station was gathered and analyzed for the peak flow values. Out of the top five peak discharges recorded none of the storm events were greater than a 10-year event.

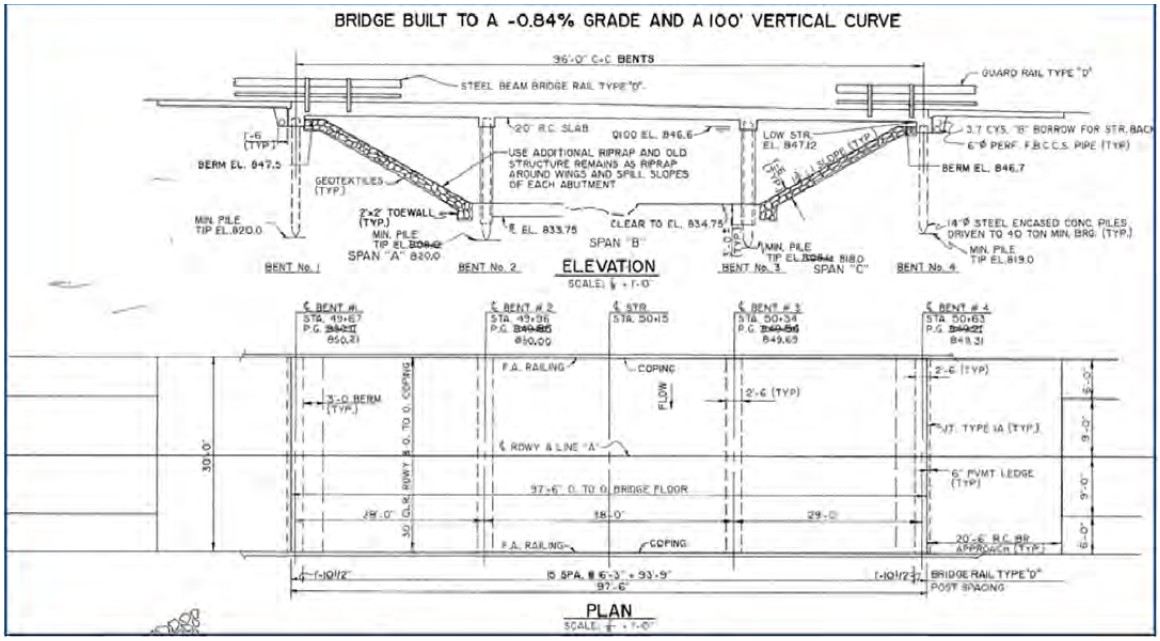
Table 2-2 Hinkle Creek Annual Peak Flows at 225th Street From 1956 To 1981

WATER YEAR	DATE	YEARLY PEAK DISCHARGE (CFS)	STORM PRECIP (INCHES)	DURATION (HOURS)
1956	5/28/1956	636	0.81	7
1957	6/28/1957	4,920	3.81	36
1958	8/2/1958	1,840	1.38	14
1959	2/10/1959	950	2.22	29
1960	7/3/1960	332	1.05	4
1961	7/19/1961	4,280	2.27	19
1962	2/26/1962	2,720	0.45	6
1963	3/4/1963	2,050	1.77	16
1964	4/20/1964	3,290	4.63	46
1965	2/10/1965	715	1.75	20
1966	12/8/1966	1,130	4.02	66
1967	12/21/1967	1,480	1.61	33
1968	5/24/1968	664	0.75	17
1969	10/12/1969	1,210	3.39	7
1970	1/29/1970	1,280	0.23	33
1971	2/18/1971	1,580	0.22	8
1972	11/2/1972	1,300	1.8	43
1973	12/25/1973	810	0.83	34
1974	6/22/1974	1,690	5.81	1
1975	2/23/1975	1,030	1.25	24
1976	2/16/1976	1,290	2.03	13
1977	3/29/1977	685	1.44	34
1978	8/28/1978	1,250	2.6	23
1979	7/28/1979	1,780	NA	NA
1980	3/8/1980	1,250	1	15
1981	9/1/1981	685	NA	NA

2.2.6 Road and Structure Plans

Road and structure plans were obtained from INDOT and the Hamilton County Highway Department. The areas of interest were the detailed study reaches of Hinkle Creek and Isaac Jones Drain. U.S. 31 plans were received from INDOT and county road plans from the Hamilton County Highway Department. These plans were used to input roadway structures into the hydraulic model.

Figure 2-4 Example Structure Design Information



2.3 ORGANIZATIONS

2.3.1 Upper White River Watershed Alliance

The Upper White River Watershed Alliance (UWRWA) is a 16-county consortium of local governments, industry, utilities, universities, agriculture and the regional community that exists to improve and protect water quality on a watershed basis in the larger Upper White River Region. Hamilton County is the only county that is completely in the UWRWA and plays a major role in the health of the watershed. The counties in the consortium are as follows:

- Hamilton
- Monroe
- Montgomery
- Tipton
- Grant
- Madison
- Delaware
- Randolph
- Henry
- Hancock
- Marion
- Owen

- Putnam
- Morgan
- Johnson
- Green
- Monroe
- Brown

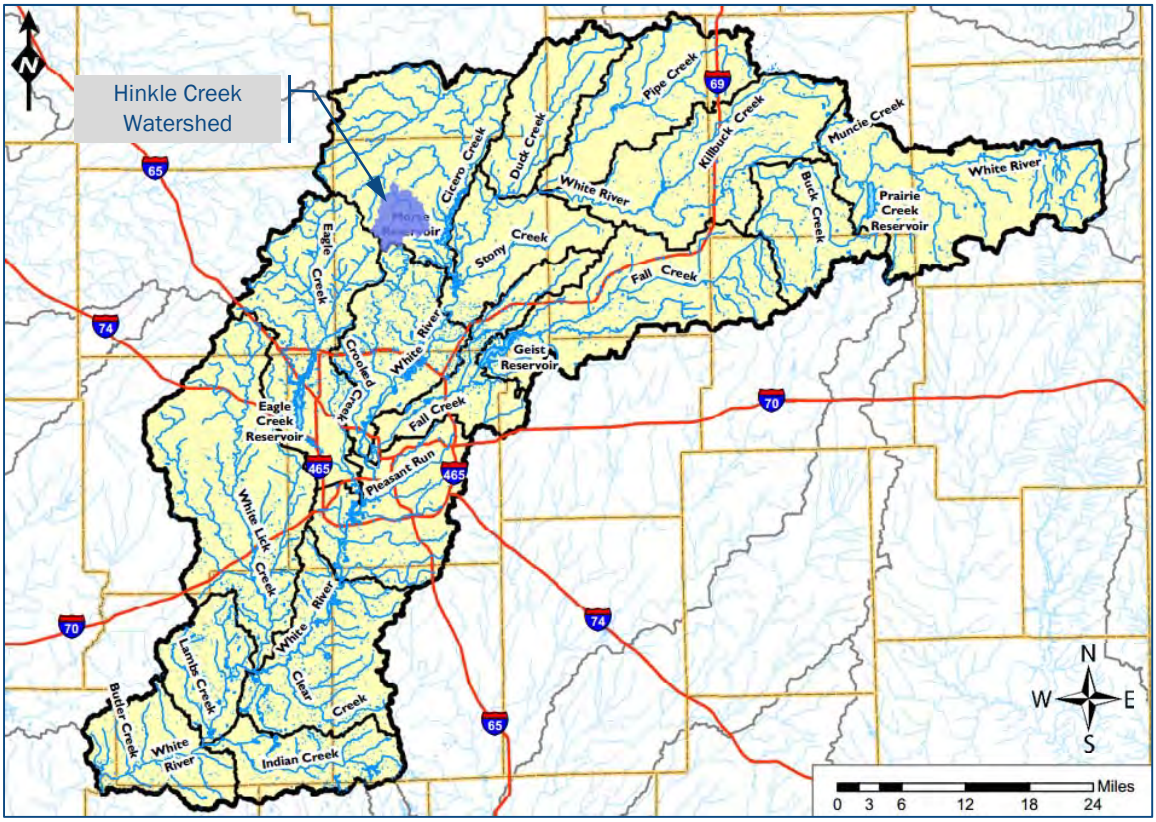
The Hinkle Creek watershed is a sub-watershed of the Upper White watershed. The Hydrologic Unit Codes (HUC) and drainage areas are as follows:

- Upper White
  - 8-digit HUC – 05120201
  - Drainage Area – 2719.6 mi^2

- Hinkle Creek
  - 14-digit HUC – 05120201080100
  - Drainage Area – 21.1 mi^2

Figure 2-5 shows the Upper White River Basin.

Figure 2-5 Upper White River Watershed Alliance Map



2.3.2 Morse Waterways Association

Morse Waterways Association (MWA) is a non-profit organization founded in May 2005 to serve the Morse Reservoir community. MWA supports the 1,400 homeowners living on the reservoir, the surrounding community and the weekend recreational boaters and fishermen.

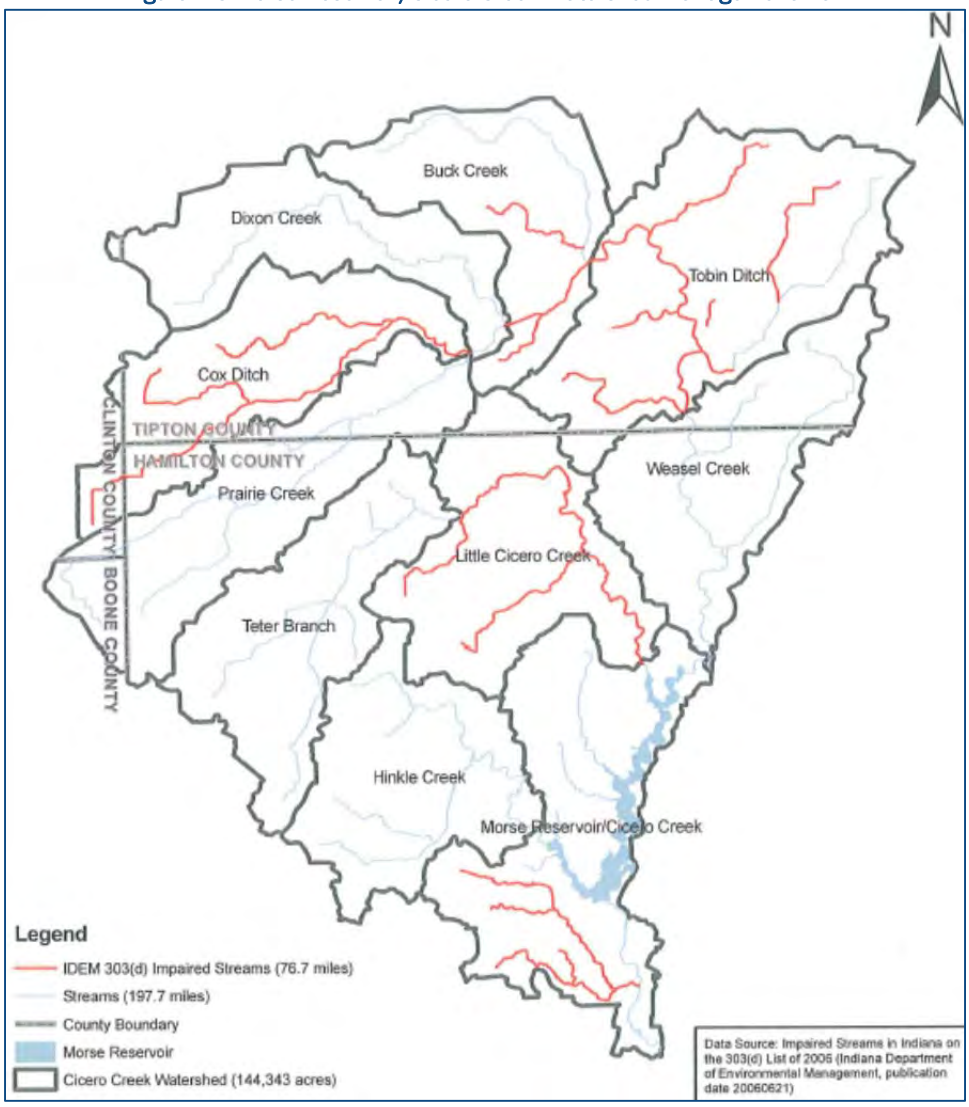
Their mission is to promote safety and the environment within the Morse Reservoir watershed which includes parts of Hamilton, Tipton and Boone Counties.

2.4 PREVIOUS REPORTS AND STUDIES

2.4.1 Morse Reservoir/Cicero Creek Watershed Management Plan

In February 2011, Boone, Clinton, Hamilton, and Tipton Counties released the Morse Reservoir/Cicero Creek Watershed Management Plan (WMP) prepared by V3 Compainies which was prepared for the UWRWA and the Morse Waterways Association. Figure 2-6 shows the study limits and impaired streams within the area.

Figure 2-6 Morse Reservoir/Cicero Creek Watershed Management Plan



The WMP identified problem and critical areas. Hinkle Creek Watershed was noted as medium priority and was shown to have a high level of water quality impairment primarily due to *E. coli, Nitrate+Nitrite, Total Phosphorous, and TSS*. These impairments are largely due to the runoff from agricultural and livestock land use.

The study recommended Best Management Practices (BMP) for Hinkle Creek. Stream buffers, filter strips, no-till/reduced till practices, wetland restoration, and education and outreach were among some of the suggested BMPs. The study also noted that 31.7% of the watershed is mapped as having hydric soils which are conducive for wetland restoration, which has the potential to reduce pollutant loads by 80% for sediment and E. coli, 55% for phosphorus and 45% for nitrogen. Appendix A includes the excerpts from this study that pertain to the Hinkle Creek Watershed.

2.4.2 Soil Survey of Hamilton County

The United States Department of Agriculture (USDA), in conjunction with the Natural Resources Conservation Service (NRCS) develops and publishes soil surveys on a county-wide basis. The Soil Survey of Hamilton County provides descriptions and mapping of individual soil units, descriptions of soil parent material, recommendations for soil management, and general discussions of physiography, relief, and drainage within the county. The Soil Survey of Hamilton County was reviewed during the development of this watershed management plan.

2.4.3 Flood Insurance Studies

Flood Insurance Studies (FIS) for Hamilton County were obtained and reviewed. The FIS reports list peak discharges and corresponding flood profiles for 10-, 50-, 100-, and 500-year recurrence interval storm events.

A summary of 10- and 100-year peak discharges for Hinkle Creek are provided in Table 2-3. The available discharge information from the FIS is limited, only providing two discharge points. However, this data was used during the hydrologic analysis discussed later in Chapter 5.

Table 2-3 FEMA FIS Study Excerpt - Summary of Discharges

LOCATION	DRAINAGE AREA (SQ. MI.)	10-YEAR PEAK FLOW (CFS)	100-YEAR PEAK FLOW (CFS)
HINKLE CREEK			
At a point approximately 0.98 miles downstream of East 216th Street	20.10	3,550	7,180
Just upstream of Deming Road	18.50	3,400	6,800

2.5 REGULATIONS IN THE WATERSHED

Work conducted within rivers, streams, wetlands, and certain agricultural drainage features is regulated by one or more agencies ranging from the U.S. Army Corps of Engineers at the federal level to the Hamilton County Surveyor and Drainage Board at the county level. Therefore, any solutions to stormwater quantity or quality should be reviewed for potential regulatory considerations. Additionally, early coordination with these agencies is critical in maintaining regulatory compliance and efficiency throughout the life of a project. The following sections summarize regulatory considerations likely to be encountered within the context of stream, wetland, and drainage improvement projects in the Hinkle Creek watershed.

2.5.1 U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (USACE) maintains regulatory authority over "waters of the U.S." through Section 404 of the Clean Water Act (CWA). The limit of jurisdiction described in 33 CFR 328.4 for non-tidal waters is the "ordinary high water mark" if no adjacent wetlands are present. If wetlands are present, the limit of jurisdiction applies to the boundary of the adjacent wetland. Any wetland that has a hydrological connection to a “waters of the U.S.” is also included.

A Section 404 permit must be obtained from the USACE before any fill or dredging activities are conducted within the boundary of a “waters of the U.S.” including federally jurisdictional wetlands. The USACE issues three types of permits within Indiana: nationwide permits, regional general permits, and individual permits. Furthermore, a Section 401 Water Quality Certification (WQC) must be issued by the Indiana Department of Environmental Management (IDEM) concurrently with the Section 404 permit(s). A summary of each permit is provided below.

- Nationwide Permits have been developed for projects that meet specific criteria and are deemed to have minimal impacts to the aquatic environment. There are 44 Nationwide Permits created to streamline the permit process for smaller, repetitive, low impact projects including, but not limited to Aids to Navigation, Fish and Wildlife Harvesting, Outfall Structures and Maintenance, Utility Line Activities, Stream and Wetland Restoration, Maintenance Dredging of Existing Basins, Agriculture Activities, and Mining Activities.

- Regional General Permits (RGP) for Indiana authorize proposed impacts associated with any construction activities including agriculture and mining activities. Wetland impacts must be less than one (1) acre to qualify for this type of permit. IDEM also recognizes the RGP program for issuance of WQC, but maintains more stringent limits for impacts. These include impacts that are less than 0.1 acre of wetland or

300 linear feet of stream, and are also deemed to have minimal impacts to the aquatic environment. Proposed impacts which qualify for the USACE RGP program but exceed the limits imposed by IDEM may be permitted under the RGP by the USACE but will require an individual WQC by IDEM.

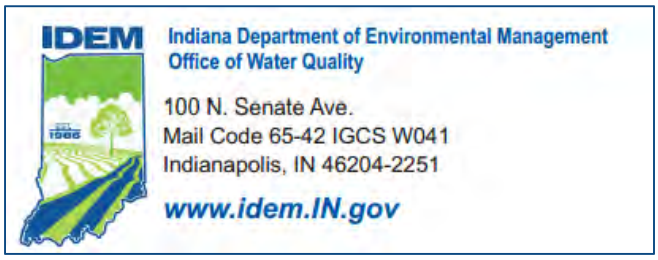
- Individual Permits (IP) are required for proposed wetland impacts of one (1) acre and greater. Due to the larger scope of impacts associated with individual permits, the level of scrutiny by regulatory agencies is greater. Additionally, the IP program includes a mandatory public notice period providing opportunities for concerned stakeholders and other governmental agencies to comment on the proposed activity. Therefore, IPs may require up to one year for approval.

The Louisville District of the USACE developed mitigation guidelines for federal jurisdictional wetlands and "waters of the U.S." The guidelines require stream and wetland characterizations for all drainage features and wetlands proposed to be impacted. The document required for permitting must contain extensive detail of the proposed impact sites, the proposed mitigation sites, and information regarding the construction and monitoring of the mitigation sites.

Impacts to USACE jurisdictional wetlands or other "waters of the U.S." beyond those allowed by the RGP program will require in-kind mitigation. The USACE and the IDEM prefer the mitigation to be on-site, but may allow off-site mitigation in some cases due to certain constraints of a property. The mitigation ratios for impacts to federally jurisdictional wetlands and other "waters of the U.S." are as follows:

Impact Type	Replacement
Emergent Wetland	2:1 Acres
Scrub-Shrub Wetland	3:1 Acres
Forested Wetland	4:1 Acres
Stream/Drainage Ways	1:1 Linear feet
Open Water	1:1 Acres

2.5.2 Indiana Department of Environmental Management



The IDEM is the State agency that reviews and issues permits for impacts to isolated wetlands (IAC 13-18). The Indiana law concerning the regulation of isolated wetlands recognizes three (3) types of wetlands: Class I, Class II, and Class III. Class I isolated wetlands occur in areas that have been disturbed by human activity/development, have low species diversity or greater than 50% nonnative species, do not provide critical habitat for the support of significant wildlife or aquatic vegetation, or do not possess significant hydrologic function. Class III isolated wetlands are located in areas that are undisturbed or minimally disturbed by human activity/development, are composed of rare or important ecological types, and support more than minimal wildlife or aquatic habitat and hydrologic function. Class II isolated wetlands are those that do not fit the criteria set for either Class I or Class III isolated wetlands.

Exemptions are in place to allow impacts to Class I and Class II wetlands without requiring permitting and mitigation. Class I wetlands qualify for the exemption if the entire wetland does not exceed 0.5 acre. Impacts to any Class I wetland exceeding 0.5 acre will require mitigation. Class II wetlands qualify for the exemption if the entire wetland acreage does not exceed 0.25 acre. Impacts to any Class II wetland exceeding 0.25 acre will require mitigation. Any proposed impacts to Class III or nonexempt Class I or Class II wetlands will require an isolated wetlands and/or "waters of the State" permit through IDEM. Such isolated wetland permit applications will be submitted concurrently with any USACE Section 404 jurisdictional wetland permits and IDEM Section 401 WQC if necessary.

According to IAC 13-18, impacts to isolated wetlands will require some form of compensatory mitigation. The law specifically states the amount of mitigation that must be created to offset impacts to isolated wetlands. These mitigation ratios do not apply to USACE jurisdictional wetlands. The mitigation ratios for impacts to state regulated wetlands (isolated) are as follows:

Table 2-4 Mitigation Ratios for Impacts To State Regulated Wetlands

IMPACT TYPE	REPLACEMENT	ON SITE RATIO	OFF –SITE RATIO
Class I	Class I	1.5:1 Acres	1.5:1 Acres
Class I	Class II or III	1:1 Acres	1:1 Acres
Class II	Class II or III	Non-forested	Non-forested
		1.5:1 Acres	2:1 Acres
		Forested	Forested
		2:1 Acres	2.5:1 Acres
Class III	Class III	Non-forested	Non-forested
		2:1 Acres	2.5:1 Acres
		Forested	Forested
		2.5:1 Acres	3:1 Acres

2.5.3 Indiana Department of Natural Resources Division of Water

The IDNR Division of Water Division of Water has authority over the floodways of waterways that drain a more than one (1) square mile. If construction activities are proposed in a regulated floodway, then a Construction in a Floodway permit is required. A watershed analysis is required to determine the actual drainage for each waterway proposed to be impacted. In addition, trees cleared within a regulated floodway require compensatory mitigation.

The IDNR Division of Nature Preserves provides a Natural Heritage Datacenter for the documentation of state and federally listed endangered, threatened, and rare species (ETR) and high quality natural communities. The IDNR serves to identify, protect, and manage significant natural areas and ETR species through coordination with the land owner. Currently over 23,000 acres of dedicated Nature Preserves are located throughout the state. The preservation of natural communities supports species diversity and provides examples of historic conditions for recreational, educational, and scientific opportunities.

2.5.4 Hamilton County Surveyor/Drainage Board

The Hamilton County Surveyor has authority over designated regulated drains. Drains could include subdivision drains, field tiles, or open ditches and creeks, within the County. The County Surveyor would require authorization for any work conducted within the easement of a regulated drain. Any construction affecting a regulated drain, and/or the corresponding easement on either side of the drain must be reviewed and approved by the County Surveyor prior to disturbance.

2.5.5 Indiana Department of Transportation (INDOT)

INDOT is responsible for new, replacement and rehabilitated bridge designs, hydraulic designs, the development and maintenance of bridge standards and policies, and bridge inspection for structures in state roadways. INDOT's primary objectives are to mitigate off-site flooding due to a new highway project, and to protect the highway against damage from surface waters, considering the effect of the project on traffic and property. Improvements in drainage outside the highway right of way will not be considered unless there is an advantage to the transportation system.

2.5.6 County Highway Department

The Hamilton County Highway Department is responsible for all roads, bridges, and small structures (less than 20 foot span) within Hamilton County which are not state highways and which are not within the corporate limits of a city or town. They are also responsible for bridges which have a span of 20 or more feet on all roads in Hamilton County which are not state highways. Hamilton County has nine townships with approximately 600 miles of roadway and rights of way, 280 bridges, and over 600 small structures to maintain.

2.5.7 Hamilton County Health Department

The Hamilton County Health Department works to promote disease prevention and health for residents of all ages in Hamilton County and protecting the environment in which they live. The department maintains programs of education, regulatory enforcement, and provides health services devoted to the promotion of a healthy environment in Hamilton County. Septic systems installed in Hamilton County are regulated, permitted and inspected by the County Health Department.

2.5.8 Plan Commissions

Several different planning commissions existing within the Hinkle Creek Watershed to oversee the current and future development of land. They include Westfield, Noblesville, Cicero/Jackson, and Hamilton County Planning Commissions. Planning commissions work with the community leaders to build a consensus on how an area should grow, both in the short and long term. This is accomplished through the coordination of a variety of land planning functions that range from creating a comprehensive plan for the future to reviewing new development proposals to ensure they reflect this vision.

CHAPTER 3 WATERSHED CHARACTERISTICS

3.1 INTRODUCTION

This chapter characterizes the Hinkle Creek Watershed based on data gathered in Chapter 2. Regulated drains, topography, climate data, land use, soils, wetlands, and endangered species are discussed in the following sections.

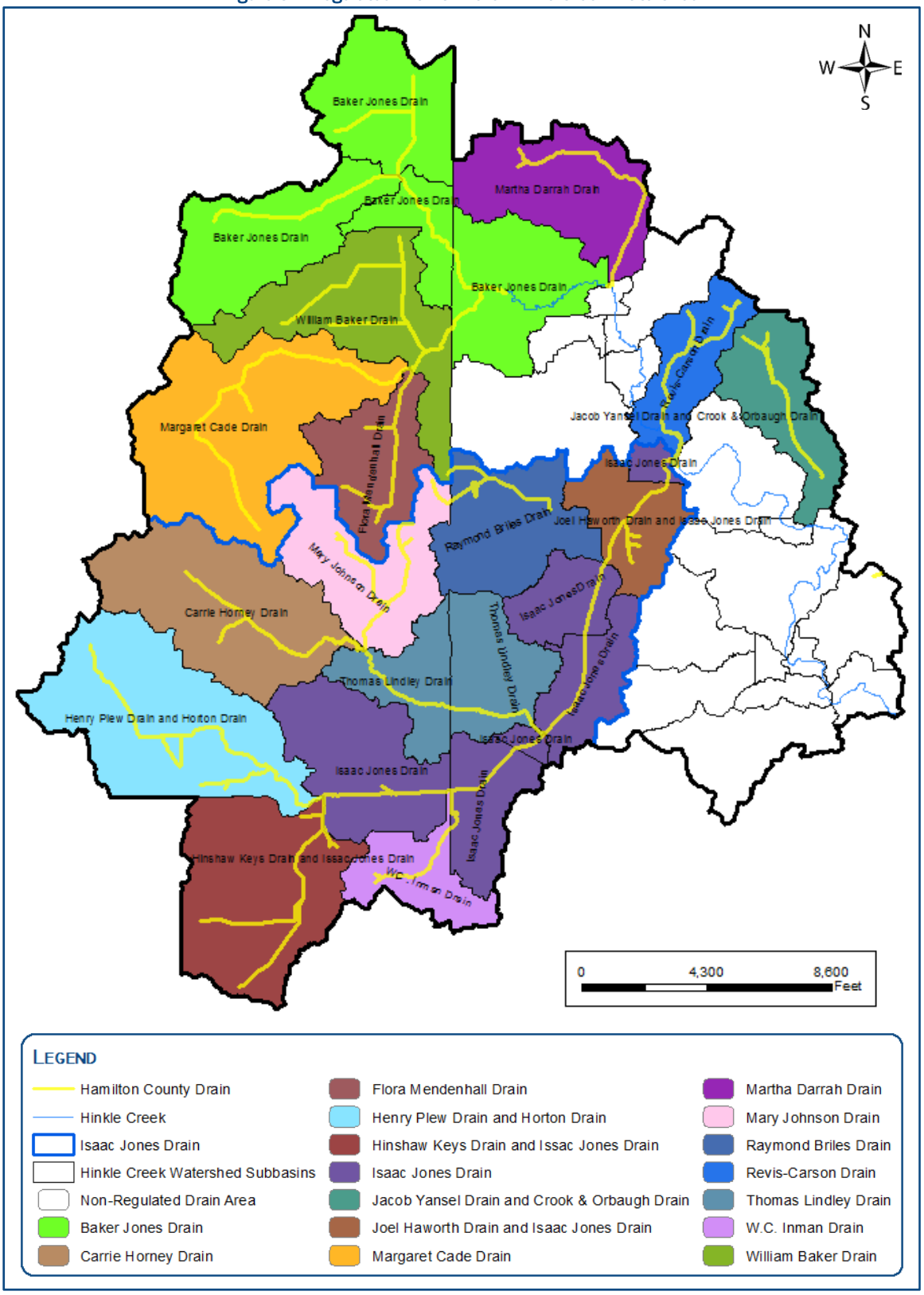
3.2 REGULATED DRAINS

Regulated drains are regulated waterways and are critical to proper drainage in Hamilton County. These waterways provide freshwater downstream for agricultural, residential, and commercial purposes. In addition, they convey floodwaters during large storm events. Maintenance of the regulated drains is performed by the Hamilton County Drainage Board. The following regulated drains are designated in the Hinkle Creek Watershed:

- Isaac Jones Drain
- Baker Jones Drain
- Carrie Horney Drain
- Flora Mendenhall Drain
- Henry Plew Drain
- Horton Drain
- Hinshaw Keys Drain
- Jacob Yansel Drain
- Crook & Orbaugh Drain
- Joel Haworth Drain
- Margaret Cade Drain
- Martha Darrah Drain
- Mary Johnson Drain
- Raymond Briles Drain
- Revis-Carson Drain
- Thomas Lindley Drain
- W.C. Inman Drain
- William Baker Drain

The Isaac Jones drain makes up a large portion of the Hinkle Creek Watershed with eight regulated drains discharging to the Isaac Jones Drain Ditch. The Isaac Jones Drain makes up 9.1 square acres of the watershed. Figure 3-1 shows the regulated drains in the Hinkle Creek Watershed.

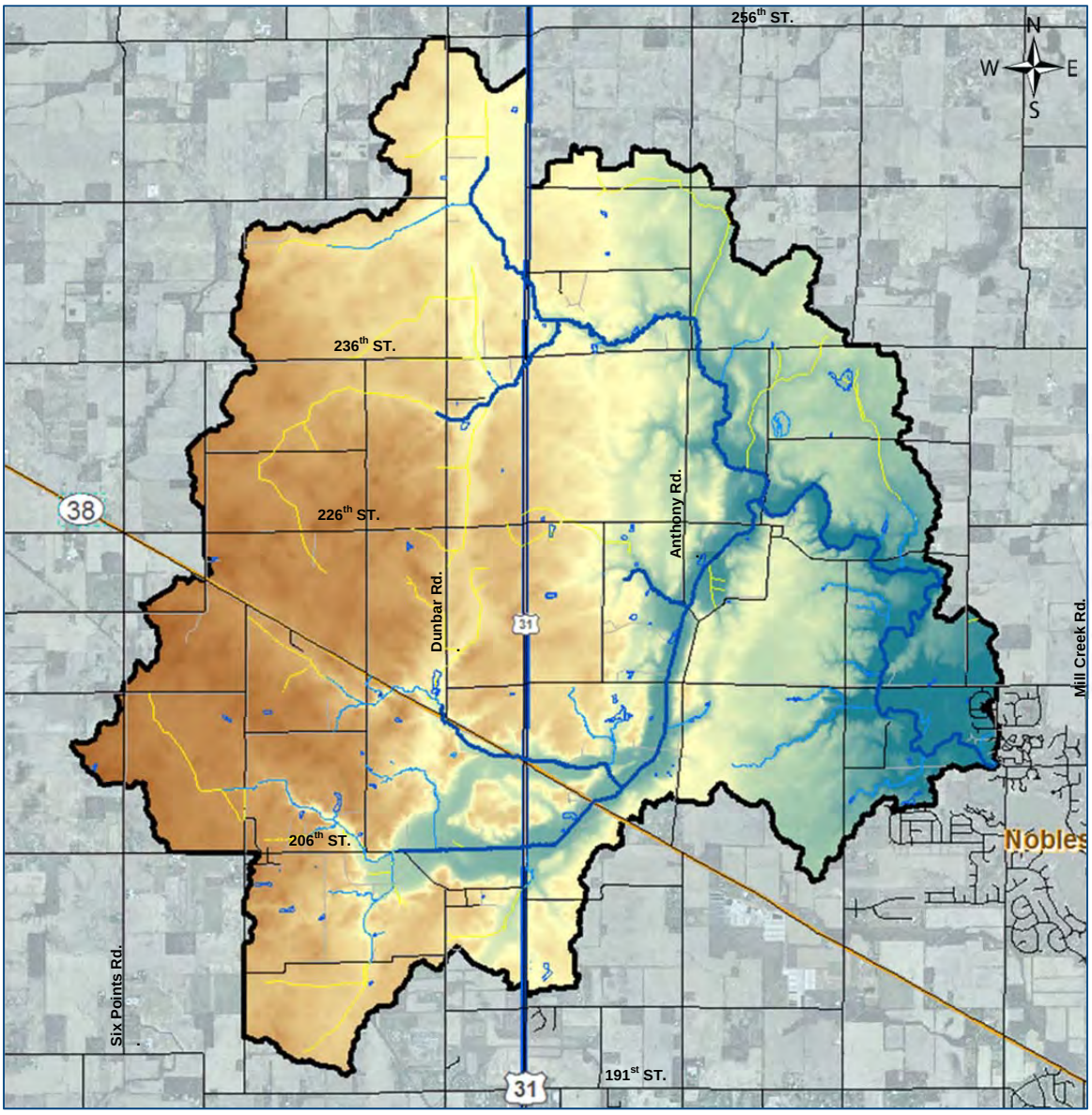
Figure 3-1 Regulated Drains in the Hinkle Creek Watershed



3.3 TOPOGRAPHY

The Hinkle Creek Watershed topography varies by approximately 140 feet in elevation from 810 feet to 950 feet. Flows generally drain from the west to the east. Figure 3-2 shows the digital elevation model (DEM) that was produced from the Hamilton County topographic data including contours and spot elevations. This DEM was used to delineate watersheds, create cross sections of the channel, and to map the limits of the floodplain.

Figure 3-2 Digital Elevation Model of Watershed



3.4 AVERAGE PRECIPITATION AND TEMPERATURE

Indiana has a humid continental climate with cool winters and warm summers. The annual average daily high is 62°F and average low is 40°F. The average high high/low temperature is 85.1 °F/63.4 °F in the July and the low high/low temperature is 34.4 °F /17.7 °F in January. Table 3-3 shows the full Indiana climate normals.

The average precipitation in the Indiana is 40 inches. The average dates of the first and last freezes are on October 16th and April 22nd. The average dates of the first and last snow are November 19th and March 30th.

Table 3-1 Indiana Climate Normals (1971-2000)

SAMPLE POINT	TEMPERATURE (°F) MEAN	MAX.	MIN.	PRECIPITATION (in.)
Jan	26.0	34.4	17.7	2.48
Feb	30.5	39.8	21.2	2.27
Mar	40.7	50.8	30.5	3.36
Apr	51.0	62.3	39.8	3.89
May	61.4	72.8	50.0	4.46
Jun	70.5	81.5	59.4	4.19
Jul	74.3	85.1	63.4	4.22
Aug	72.2	83.2	61.3	3.91
Sep	65.2	76.9	53.4	3.12
Oct	53.6	65.3	41.9	3.02
Nov	42.3	51.4	33.2	3.44
Dec	31.2	39.2	23.1	3.13

Source: Indiana State Climate Office

3.5 LAND USE

The Hinkle Creek Watershed land use is primarily comprised of undeveloped agricultural, prairie lands, and deciduous forests. A small of amount of residential and commercial development is present. Figure 3-3 shows the 2006 National Land Cover Database (NLCD 2006) in the Hinkle Creek Watershed in 2006. The NLCD was produced by the USGS Multi-Resolution Land Characteristics (MRLC) Consortium. The land cover classification was achieved by using a combination of Landsat imagery and ancillary data

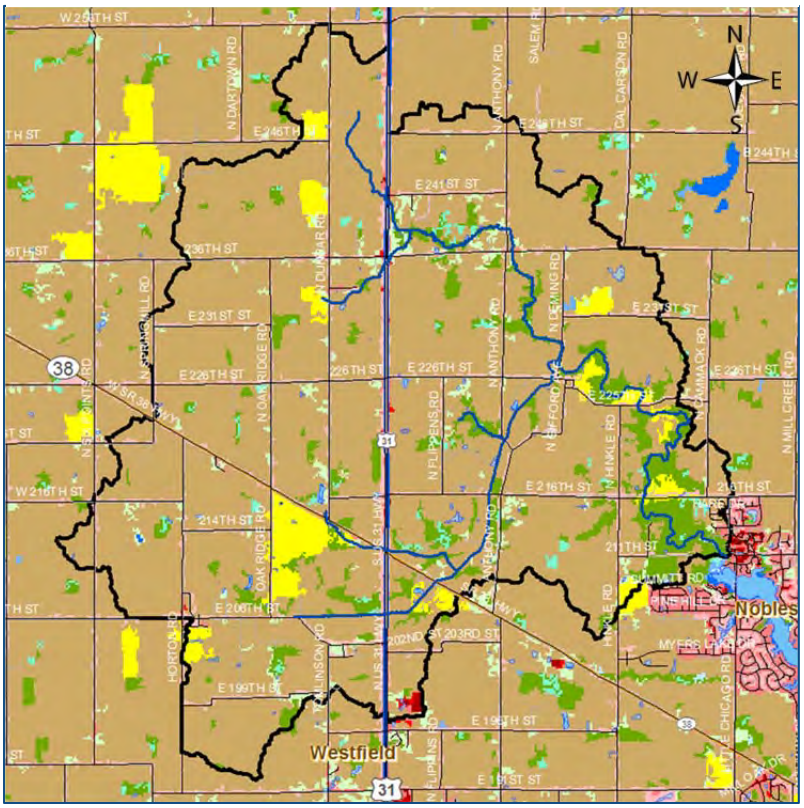
Figure 3-3 Land Use in Watershed

80% Agricultural Land

14% Residential Land

4 % Commercial/ Industrial Land

2% Wooded or Pasture Land



3.6 SOILS

The Natural Resources Conservation Service (NCRS) Soil Survey of Hamilton County was used, in conjunction with aerial photographs and zoning maps, to determine runoff Curve Numbers (CNs) for the hydrologic analysis. These soils designations are also provided on the County's GIS. Along Hinkle Creek, soils are mostly classified as Shoals-Genesee (Sh, Ge). The Shoals series of soils consists of deep, somewhat poorly drained, moderately permeable soils on floodplains. The Genesee series are adjacent to Shoals and consist of deep, well drained, moderately permeable soils on floodplains.

The upland watershed consists mostly of Crosby and Brookston (Cr, Br) soils. The Crosby series consists of deep, somewhat poorly drained, slowly permeable soils on glacial till plains. The Brookston series consists of deep, very poorly drained, moderately permeable soils on glacial till plains and are generally near Crosby soils. Crosby soils are better drained and are in a higher position than Brookston soils. The lower portion of the watershed, closer to the Morse Reservoir, has more Miami series soils (Mm). The Miami series consists of deep, well drained soils on till plains and have loose sand and gravelly sand in the underlying material.

Soil types are used to help determine runoff CNs through the identification of hydrologic soil groups. Soils are classified into four groups – A, B, C, or D, depending on their minimum infiltration rate. The groups are summarized below (Source: TR-55, Urban Hydrology for Small Watersheds, SCS, June 1986).

Group A	Low runoff potential and high infiltration rates even when thoroughly wetted. Consist of deep, well to excessively drained sands or gravels. Infiltration rate greater than 0.30 in/hr. Low runoff potential.
Group B	Moderate infiltration rates when thoroughly wetted. Consist of moderately deep to deep, moderately well to well drained soils. Infiltration rate of 0.15 to 0.30 in/hr. Low/Medium runoff potential.
Group C	Low infiltration rates when thoroughly wetted. Soils impede downward movement of water. Infiltration rate of 0.05 to 0.15 in/hr. Medium/High runoff potential.
Group D	Soils have high runoff potential and very low infiltration rates. Clay soils with high swelling potential and a permanent high water table. Infiltration rate of 0.00 to 0.05 in/hr. High runoff potential.

In the Hinkle Creek watershed, the Genesee and Miami soils are Group B, while the Crosby and Shoal soils are Group C. Brookston soils are listed as B/D with B for locations that are drained and D for areas that are undrained.

3.7 WETLANDS

The Hinkle Creek Watershed is located in the Central Till Plain Natural Region of Indiana. This area, characterized by poorly drained, hydric soils, was historically dominated by flatwood forests, mesic forests, and seasonally wet depressions. Open and subsurface drainage has allowed much of this region to be made suitable for agricultural row crops. Additionally, wetlands were drained to eliminate breeding areas for mosquitos, in order to reduce the spread of diseases such as Yellow Fever.

Consequently, the overall area of wetlands has declined throughout the 20th and early 21st Centuries. Remaining wetland habitats within this area provide valuable ecological functions to the watershed such as stormwater infiltration, sediment and pollutant removal, and provision of wildlife habitat. Additionally, State and Federal regulations exist for the preservation of wetlands. For these reasons, wetlands can be viewed as an asset to the long

term planning strategy of watershed management as their preservation can help achieve targets of both water quality and runoff reduction.

3.8 ENDANGERED SPECIES

The Endangered Species Act (ESA) of 1973 was created to conserve the habitats of federally endangered or threatened species and to assist in the recovery of species listed. The U.S. Fish and Wildlife Service (USFWS) is the regulating authority for this act and works with the states to provide additional conservation measures. The USFWS defines two (2) classifications of protected species, endangered and threatened. An endangered species is an organism that is in danger of extinction throughout all or a significant portion of its range. A threatened species is an organism that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. All species of plants and animals are eligible for listing.

Any activity that may incidentally harm federally threatened or endangered species is prohibited by the ESA. Additionally, projects that involve federal funding or permitting on a site where endangered or threatened species are known to occur or where significant habitat is present will require an alternatives analysis and extensive documentation of agency coordination.

In addition to species identified by the USFWS as federally threatened or endangered, the Indiana Department of Natural Resources (IDNR) Division of Nature Preserves provides a Natural Heritage Datacenter for the documentation of state listed endangered, threatened, and rare (ETR) species and high quality natural communities. The IDNR serves to identify, protect, and manage significant natural areas and ETR species through coordination with the land owner. Currently over 23,000 acres of dedicated Nature Preserves are located throughout the state. The preservation of natural communities supports species diversity and provides examples of historic conditions for recreational, educational, and scientific opportunities.

Review of the Natural Heritage Database indicates that 20 species of plants and animals and 2 high quality natural communities are listed for Hamilton County, Indiana. The following table summarizes the number of listing per taxonomic group.

Table 3-2 Threatened and Endangered Species

SPECIES	FEDERAL STATUS	STATE STATUS
Mollusks		
Northern Riffleshell *Epioblasma tortulosa rangiana*	Endangered	Endangered

Snuffbox *Epioblasma triquetra*	Endangered	Endangered
Sheepnose *Plethobasus cyphyus*	Endangered	Endangered
Clubshell *Pleurobema clava*	Endangered	Endangered
Rabbitsfoot *Quadrula cylindrica cylindrica*	Candidate	Endangered
Rayed Bean *Villosa fabalis*	Endangered	Species of Special Concern
Insects (None)		
Amphibians (None)		
Reptiles		
Spotted Turtle *Clemmys guttata*		Endangered
Eastern Massasauga *Sistrurus catenatus catenatus*	Candidate	Endangered
Birds		
Upland Sandpiper *Bartramia longicauda*		Endangered
Cerulean Warbler *Dendroica cerulean*		Endangered
Bald Eagle *Haliaeetus leucocephalus*	Threatened	Species of Special Concern
Least Bittern *Ixobrychus exilis*		Endangered
Loggerhead Shrike *Lanius ludovicianus*		Endangered
Black-crowned Night Heron *Nycticorax nycticorax*		Endangered
Mammals (None)		
Fish (None)		
Vascular Plants		
Lake Cress *Armoracia aquatic*		Endangered
Prairie White-fringed Orchid *Platanthera leucophaea*	Threatened	Endangered
High Quality Natural Communities		
Forest – Floodplain Wet-mesic		Significant
Forest – Upland Mesic		Significant

[1] U.S. Fish and Wildlife Service, ESA Basics, 2004; Endangered, Threatened, and Rare Species List for Hamilton County, Indiana Department of Natural Resources, 2013

In the event of specific projects, coordination may be required with the USFWS and IDNR Division of Nature Preserves to ensure that the proposed activity will not adversely affect these species.

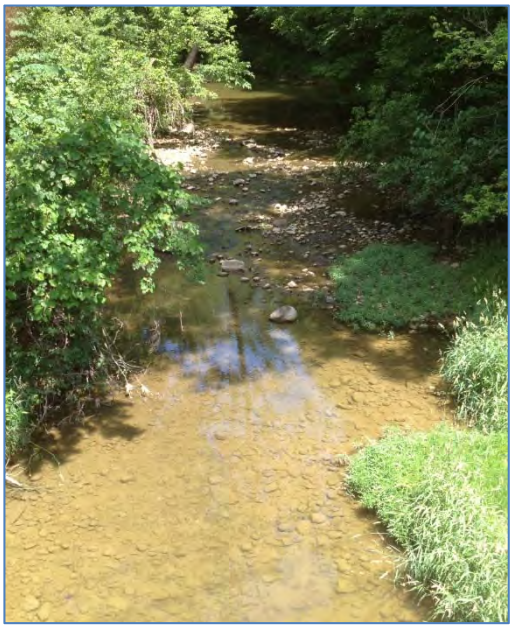
CHAPTER 4 WATER QUALITY ANALYSIS

4.1 INTRODUCTION

Stormwater quality is a function of the pollutants encountered along the water's flow path through the watershed. Chemicals such as chlorinated solvents and heavy metals are often associated with industrial sites, while excess nitrogen, phosphorus, and derivatives of herbicides are more commonly associated with agricultural areas. However, sediment and even heat energy can be considered pollutants as well. Although these factors are naturally present in streams and rivers, excessive concentrations can lead to a degradation of water quality.

The Hinkle Creek watershed is characterized by a predominance of agricultural crop production with lesser amounts of grazing, low density residential, and limited commercial and industrial land use. To assess the impacts of these uses on water quality, the physical and chemical characteristics of the watershed were analyzed and are summarized in the following sections.

4.2 RIPARIAN CORRIDOR EVALUATION



Riparian corridors are vegetative buffers located immediately adjacent to a stream channel. These corridors can be composed of herbaceous or woody vegetation and exist as a filter between the stream and adjacent land use. Streams with narrow or absent riparian corridors tend to be more likely to receive pollutants and sediment than those with wide corridors.

Riparian corridor widths were measured in five sample locations throughout the Hinkle Creek watershed as part of the Qualitative Habitat Evaluation Index (QHEI) and Headwater Habit Evaluation Index (HHEI). The QHEI was developed to provide a standardized method of evaluating stream quality and incorporates aspects including riparian corridor width, intensity of adjacent land use, stream stability, and channel substrate. The HHEI was developed as a way to evaluate habitat and is based on physical measurements that have been found to correlate well with biological measures of stream quality.

Measurements of riparian corridor width are divided into the following four categories; None, Narrow (<5 meters), Moderate (5-10 meters), Wide (>10 meters). An additional consideration recorded within the QHEI data is floodplain quality, which identifies the type and intensity of adjacent land use. Values recorded for the points sampled within the Hinkle Creek Watershed are summarized in the following table.

Table 4-1 Riparian and Floodplain Characteristics

SAMPLE POINT	STREAM	RIPARIAN WIDTH*		FLOODPLAIN QUALITY	
		LEFT BANK	RIGHT BANK	LEFT BANK	RIGHT BANK
1	Jones Ditch	Wide	Moderate	Immature forest, shrub, or old field	Open pasture, row crop
2	Lindley Ditch	Moderate	Moderate	Open pasture, row crop	Open pasture, row crop
3	Baker Ditch	Narrow	Narrow	Open pasture, row crop	Open pasture, row crop
4	Hinkle Creek	Narrow	Wide	Open pasture, row crop	Fenced pasture
5	Tributary 1	Moderate	Moderate	Fenced pasture	Conservation tillage

* Narrow = <5 meters, Moderate = 5-10 meters, Wide = >10 meters

Adjacent land uses vary in intensity and, therefore, potential to allow pollutants or sediment to enter the stream channel. Areas of forest, wetland, and fallow field are generally considered to have low potential for soil disturbance and therefore are typically associated with higher quality floodplains. Areas of open pasture, row cropping, and active mining operations create more frequent soil disturbance, and therefore are associated with lower quality floodplains.

4.3 CHANNEL MORPHOLOGY

Channel morphology is a series of measurements which define the three dimensional structures and shape of a stream or river. Aspects considered in the definition of channel morphology include slope or gradient across the landscape, channel profile, and sinuosity. Taken collectively, these characteristics define the form, and in turn, the function of streams both hydraulically and ecologically.

Channel slope will have obvious implications in the velocity of runoff. The HHEI considers streams with a slope of approximately 2% to have a moderate gradient while stream slopes nearing 10% are considered severe. As the gradient of a stream increases, the velocity of the runoff and potential for substrate scouring also increases.

Channel shape is a description of the stream channel in cross-section view. Shape can range from a mechanically sculpted V or U to a natural or braided channel shaped entirely by hydraulic forces. Additionally, stream channels not constructed by excavation tend to fluctuate in shape throughout a given reach, particularly with respect to the placement of bends. In general, constructed channels are designed to convey water at an optimal velocity to maximize drainage potential while also remaining stable and preventing erosion. Natural channels are more likely to be irregular in shape.

Channel sinuosity is the ratio of the total length of stream channel relative to the linear distance measured between an upstream and downstream point within the channel. A sinuosity ratio of 1:1 indicates a stream channel that is completely straight and has likely been constructed. A sinuosity ratio greater than 1:1 indicates the presence of bends within the channel. Natural stream channels formed by the transport of surface water across native features of a landscape will typically have sinuosity ratios greater than 1:1. However, naturally sinuous stream channels tend to be less efficient in transporting surface flows downstream than straight channels. For this reason, many constructed ditches are designed with minimal sinuosity. Benefits of sinuous stream channels include increased short term storage capacity and a longer, less direct drainage path which can alleviate downstream flooding.

Channel morphology is a key aspect in the evaluation of the ecological integrity of a stream. Additional aspects of a thorough stream quality evaluation include a stream's location within the watershed, substrate type, and riparian corridor width. Each of these metrics was included in an assessment of stream quality conducted at the five sampling points. The following three evaluation methods were used::

- Strahler Stream Order – This metric is a numerical representation of the complexity of a drainage system. In this classification system, streams are represented as branches of a drainage "tree" with the main trunk representing the furthest downstream collector in a watershed. Streams in the uppermost portions of the watershed are defined as First Order. Second Order streams are those formed by the confluence of two or more First Order streams. Similarly, Third Order streams are those formed by the confluence of two or more Second Order streams.

- Rosgen Classification – The Rosgen Classification System is used to stratify and describe the various river and stream types. It does so by integrating individual variables including combinations of dimension, pattern, profile, and materials amidst a wide range of valley slopes, sediment size, sediment load, and streamflow.

- Headwater Habitat Evaluation Index – The HHEI is an index intended to quantify the ecological integrity of a headwater stream. The index uses metrics such as channel width, riparian corridor width, channel substrate, sinuosity, and intensity of adjacent land use to calculate an HHEI score. Scores are calibrated to a reference data set of

streams of known ecological quality. HHEI scores ranging from 0 to 29 are categorized as Poor, from 30 to 50 as Moderate, from 50 to 70 as Good, and greater than 70 as Very Good.

Table 4-2 summarizes the results of the stream quality evaluation.

Table 4-2 Stream Quality Evaluation

STREAM	TYPE AT SAMPLING POINT	STRAHLER STREAM ORDER	ROSGEN CLASSIFICATION	HHEI SCORE*
Jones Ditch	Perennial Stream, Natural Channel	1	B3C	64
Lindley Ditch	Perennial Stream, Natural Channel	2	B3C	71
Baker Ditch	Perennial Stream, Excavated Ditch	2	A6A+	35
Hinkle Creek	Perennial Stream, Natural Channel	3	B5	53
Unnamed Tributary to Hinkle Creek	Intermittent Stream, Natural Channel	1	G5C	57

*HHEI Scoring Key: <30 = Poor, 30-50 = Moderate, 50-70 = Good, >70 = Very Good

4.4 WATER QUALITY SAMPLING

Several water quality parameters which have standard targets associated with them were screened to determine if impairments or degradations are present within the watershed and to provide baseline data for future comparisons. Sampling events were conducted in April and July of 2012 to determine if seasonal variations in water quality existed. The water quality target thresholds identified herein are those specified by the Indiana Department of Environmental Management as defined in the Indiana Administrative Code (327 IAC 2-1.5-8). The results of the April and July 2012 sampling events are summarized in the following table.

Table 4-3 Water Quality Sampling Results

PARAMETER (MG/L)	TARGET	APRIL 2012 SAMPLING			JULY 2012 SAMPLING		
		1	2	3	1	2	3
Total Kjeldahl Nitrogen	< 0.591	0.724	0.769	0.605	1.07	1.82	0.579
Total Phosphorus	< 0.30	< 0.10	< 0.10	< 0.10	< 0.10	0.347	< 0.1
Ammonia	0 – 0.21	0.615	0.178	0.123	0.21	0.34	< 0.1
Nitrate-Nitrite	< 10.0	0.985	2.50	0.905	0.139	< 0.10	0.14
Total Suspended Solids	< 30.0	5.49	15.7	3.53	14.3	6.98	2.99
Ortho-Phosphate	< 0.005	< 0.10	< 0.10	< 0.10	< 0.10	1.15	0.177
Dissolved Oxygen	4.0 – 12.0	6.8	7.1	7.4	6.2	6.2	6.6
Temp (˚C)	N/A	13.2	12.9	12.2	27.2	25.6	25.0

The 2011 Morse Reservoir/Cicero Creek Watershed Management Plan summarizes available water quality data from the Indiana Department of Environmental Management (IDEM) collected between 1992 and 2006. IDEM data was collected at 72 sampling locations throughout the Cicero Creek watershed, 5 of which were located within the Hinkle Creek watershed.

The Central Indiana Water Resources Partnership (CIWRP) is a long-term research and development partnership between IUPUI's Center for Earth and Environmental Sciences (CEES) and Veolia Water Indianapolis, LLC. In 2003, CIWRP completed a study encompassing Morse Reservoir and the Cicero Creek watershed. Water quality samples were collected within the watershed during seasonal base and event flow throughout 2003.

Water quality data from the Morse Reservoir/Cicero Creek Watershed Management Plan and the CIWRP study were reviewed for comparison with water quality data collected in April and July 2012 within the Hinkle Creek watershed. The following table summarizes the mean values of water quality data from the IDEM and CIWRP sampling as compared to values measured in April and July 2012.

Table 4-4 Water Quality Sampling Comparison

PARAMETER (MG/L)	IDEM MEAN LEVELS	CIWRP MEAN LEVELS	APRIL SAMPLING			JULY SAMPLING		
			1	2	3	1	2	3
Total Kjeldahl Nitrogen	Not Sampled		0.724	0.769	0.605	1.07	1.82	0.579
Total Phosphorus	0.186	0.334	< 0.10	< 0.10	< 0.10	< 0.10	0.347	< 0.1
Ammonia	Not Sampled		0.615	0.178	0.123	0.21	0.34	< 0.1
Nitrate-Nitrite	7.3	2.7	0.985	2.50	0.905	0.139	< 0.10	0.14
Total Suspended Solids	23.7	32.9	5.49	15.7	3.53	14.3	6.98	2.99
Ortho-Phosphate	Not Sampled		< 0.10	< 0.10	< 0.10	< 0.10	1.15	0.177
Dissolved Oxygen	8.5	11.5	6.8	7.1	7.4	6.2	6.2	6.6
Temp (˚C)	NA	NA	13.2	12.9	12.2	27.2	25.6	25.0

4.4.1 Oxygen Demand (BOD AND COD)

Biological oxygen demand (BOD) and chemical oxygen demand (COD) are measurements of the requirements of oxygen for biological and chemical processes within an aquatic community. Variations in temperature, nutrient loading, and turbidity all impact the viability of aquatic microorganisms such as algae and bacteria. Introductions of sediment to the water column generally reduce water clarity and increase the absorbtion of solar radiation, resulting in increased water temperatures. Such increased temperatures create conditions suitable for the development of algae and bacteria. Additionally, introductions of nutrients serve as a food source for these communities, often resulting in sudden population increases. Increased BOD and COD are frequently associated with these algal blooms as additional oxygen is required to supplement the biological and chemical processes associated with the organisms.

Temperature and dissolved oxygen are important parameters in determining the ability of water bodies to support fish and aquatic macroinvertebrate species. The amount of oxygen that dissolves in water can vary in daily and seasonal patterns and decreases as temperature increases. Fish and aquatic macroinvertebrate populations are highly dependent upon both temperature and dissolved oxygen to function properly and even to survive. As these levels may fluctuate significantly with diurnal cycles (daytime vs. nighttime), it is suggested that minimum levels should not drop below 4.0 mg/L and

maximum levels of DO not exceed 12.0 mg/L. For the Hinkle Creek Watershed, DO concentrations ranged between 6.2 mg/L and 7.4 mg/L with no sites identified as having concentrations below 4.0 mg/L or above 12.0 mg/L. Recorded water temperature ranged from 12.2 to 13.2 degrees Centigrade in April and from 25.0 to 27.2 degrees Centigrade in July. DO concentrations observed in the April sampling were below the mean levels identified by IDEM and CIWRP, suggesting that conditions in the sampled areas were less than ideal for fish and aquatic macroinvertebrate populations. Although similarly low, the DO concentrations observed in July more accurately represented the conditions expected during mid-summer.

4.4.2 Nutrients

Nutrients such as nitrogen and phosphorus, while essential to the growth of plants, can become detrimental by enhancing the growth of algae within an aquatic system. At the completion of the algae life cycle, biomass created by the algae begins the decomposition process, which consumes oxygen from the water column. In instances where excessive nutrient concentration results in excessive algae growth, dissolved oxygen levels can be severely depleted by the decomposition of the algae. This process, often called eutrophication, can stress or kill populations of aquatic life.

Nutrient levels within the Hinkle Creek watershed were measured as total Kjeldhal nitrogen (TKN), ammonia, nitrate-nitrite, total phosphorus, and ortho-phosphorus. Results of the water quality sampling indicated nutrient levels which exceeded IDEM target level ($\leq$ 0.591) for TKN at all three sample points in April and sample points 1 and 2 in July. Sample Point 2, although within the target ranges for phosphorus and ortho-phosphate in April, was found to have levels which exceeded the target range in July. Similarly, Sample Point 3 was determined to exceed the target level for ortho-phosphate in July.

Sources of TKN, or ammonia plus organic nitrogen, include the decay of organic matter such as plant material, animal waste, sewage, and organic waste. Additionally, large amounts of ammonia and organic nitrogen are applied to cropland as fertilizer. These nutrients, when not bound to soil surfaces or intercepted by vegetative buffers, can enter the aquatic environment. Primary land uses in the Hinkle Creek watershed include agricultural row crops and low density residential development, much of which utilizes septic systems. These land uses are both likely contributors to the above-target TKN levels observed in all April samples and Samples 1 and 2 in July.

Like nitrogen, phosphorus is present in rivers and streams in various forms: ortho-phosphate, which includes species of PO43-; polyphosphates and metaphosphates, formed by the condensation of two or more ortho-phosphate groups; and organic phosphorus. Ortho-phosphate is the most thermodynamically stable and biochemically available form of phosphorus in natural waters, and microorganisms catalyze the hydrolysis of condensed phosphates to orthophosphate. Common nonpoint sources for ortho-phosphate and organic phosphorus are weathering of natural soils and rocks and runoff from agricultural land.

Phosphate from fertilizers binds to soils, which erode during storm events adding considerable amounts of suspended phosphate to streams.

In July, sample point 2 tested in excess of target levels for total phosphorus and orthophosphate while sample point 3 tested in excess of the target level for orthophosphate. Total phosphorus and orthophosphate are presumably driven by fertilizers in a primarily agricultural landscape and summer 2012 was characterized by below average precipitation levels. Therefore, in years of more typical precipitation levels, additional samples could be expected to exceed target limits for these parameters.

4.4.3 Sediment

As discussed in Section 4.4.1, sediment within the water column impairs water clarity and contributes to increased water temperatures. However, the tendency of phosphorus to precipitate or adsorb onto soil surfaces causes a positive correlation between total phosphorus and suspended solids (TSS) in many streams. Because of this correlation, sources of TSS are often also sources of total phosphorus.

TSS levels recorded within the Hinkle Creek watershed ranged from 2.99 mg/L to 15.7 mg/L, well below the target threshold of 30 mg/L specified by IDEM. These results may indicate that TSS is not a critical issue within the Hinkle Creek Watershed at this time. However, continued monitoring during years characterized by more typical precipitation levels is recommended to ensure that the observed levels are not simply a climatological anomaly.

The results also suggest that the elevated total phosphorus level noted at Sample Point 2 in July, is more likely the result of agricultural runoff rather than natural weathering of native soil. It is recommended that this parameter be monitored in future sampling efforts to determine if the observed elevated phosphorus level in Sample 2 is a geographical anomaly related to a specific portion of the watershed or if under more typical precipitation conditions, the elevated level is observed throughout the watershed.

4.4.4 Bacteria

Bacterial contamination of surface water is a common occurrence throughout Indiana. In particular, *Escherichia coli (E. coli)* contamination was identified as a primary water contaminant within the 2011 Morse Reservoir/Cicero Creek Watershed Management Plan. Additionally, Hinkle Creek is included in the 2012 Draft Section 303(d) list of impaired waters for *E. coli* contamination. For this reason, it is understood that *E. coli* contamination is present within the watershed, which precluded the need to test for *E. coli*.

E. coli is a member of the fecal coliform group of bacteria, which, when detected within water samples, is an indication of fecal contamination. *E. coli* bacteria live in the intestines of people and animals. Although usually harmless, some strains cause severe, gastrointestinal issues and abdominal cramps and may ultimately result in organ damage, including kidney

failure. *E. coli* is transmitted through contaminated water or food, such as raw vegetables and undercooked ground beef. Although healthy adults can withstand a bout of the infection, children and the elderly can experience life-threatening kidney failure called hemolytic uremic syndrome (HUS).

Failing septic tanks and wildlife are some known sources of *E. coli* impairments in waterbodies. Common sources of animal waste are agricultural feedlots (pigs, cattle, etc.), pet waste, or bird waste (such as Canada geese or gulls). Rain storm events or snow melts frequently wash waste and the associated *E. coli* into surface water systems. Rain storm events that exceed the capacity of local sewer systems result in sewer overflows that can also be a source of *E. coli*.

Land use within the Hinkle Creek watershed is predominately agricultural and requires drain tiles due to soil type. Although field tiles are not sources of *E. coli* they can carry *E. coli* from land applied manure via runoff from fields and pastures. According to the Morse Reservoir/Cicero Creek Watershed Management Plan, *E. coli* levels in the watershed regularly exceed the state standard, and often exceed safety standards for recreational use in streams. It is recommended that in future studies, sampling for *E.coli* is conducted to monitor levels throughout the watershed.

4.4.5 IDEM 303(d) List

The IDEM Assessment Branch evaluates all collected water quality data to develop the 305(b) report, and the 303(d) list. The 305(b) report is a document that summarizes the quality of surface waters throughout Indiana and the designated uses of these waters. Evaluations are based on different stream segments or lakes, and are discussed in the context of watersheds. To complete the evaluation, IDEM considers not only the data they collected, but data collected by other entities as long as that data meets the rigorous quality controls that IDEM uses in the collection and analysis of their own data. Other data that does not meet these standards may be used informally to validate data that does meet the quality controls.

Section 303(d) of the 1972 Federal Clean Water Act (CWA) requires each state to identify those waters that do not meet the state's water quality targets for designated uses. These streams are to be listed on the State's 303(d) list of impaired waters. For such waters, the State is required to establish total maximum daily loads (TMDLs) to meet the state water quality targets. As defined by IDEM, a TMDL established under section 303(d) of the federal Clean Water Act, is a calculation of the maximum amount of pollutant that a waterbody can receive and still meet water quality targets, and allocates pollutant loadings among point and non-point sources.

To determine if a waterbody should be listed on Indiana's 303(d) list, the IDEM Assessment Branch has developed a surface water quality monitoring strategy to assess the quality of Indiana's ambient waters. The goals of this monitoring strategy are: measure the physical,

chemical, bacteriological and biological quality of the aquatic environment in all river basins and identify factors responsible for impairment; assess the impact of human and other activities on the surface water resource; identify trends through the analysis of environmental data; and provide environmental quality assessment to support water quality management programs. ***Hinkle Creek is included on the 2012 draft 303 (d) list for water quality impairment resulting from E. coli.***

CHAPTER 5 HYDROLOGIC ANALYSIS

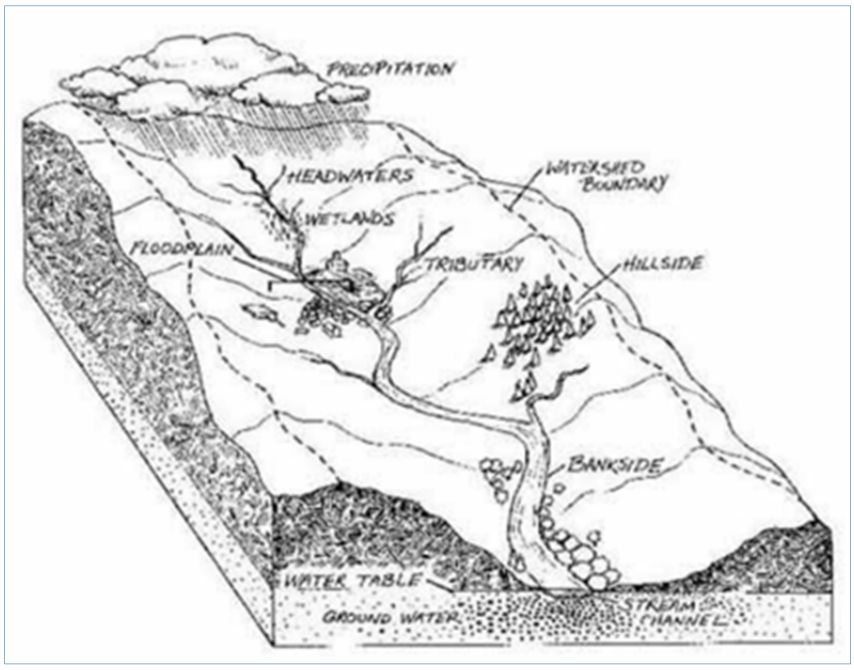
5.1 INTRODUCTION

Hydrologic analysis of the Hinkle Creek watershed was performed to assist in problem identification and develop solutions and recommendations. The hydrologic computer model HEC-HMS (U. S. Army Corps of Engineers, Hydrologic Engineering Center – Hydrologic Modeling System, Version 3.5) was used to perform the peak stormwater runoff analysis. HEC-HMS is a physically based storm event simulation model capable of simulating runoff from various land uses and soil types, combining subbasin hydrographs, and routing flow through storage and conveyance facilities. Flows from the HEC-HMS model were used as inputs to the hydraulic analyses of the stream system (Chapter 6). This chapter discuss the preparation of this model and flow results calculated for the Hinkle Creek Watershed.

5.2 WATERSHED DELINEATION

As part of the WMP a detailed watershed delineation was performed to define the watershed limits. A watershed is defined as "an area or region drained by a river, river system, or other body of water". The Hinkle Creek Watershed was delineated at a point just upstream of Morse Reservoir along Hinkle Creek. The following figure shows an example watershed.

Figure 5-1 Watershed Schematic



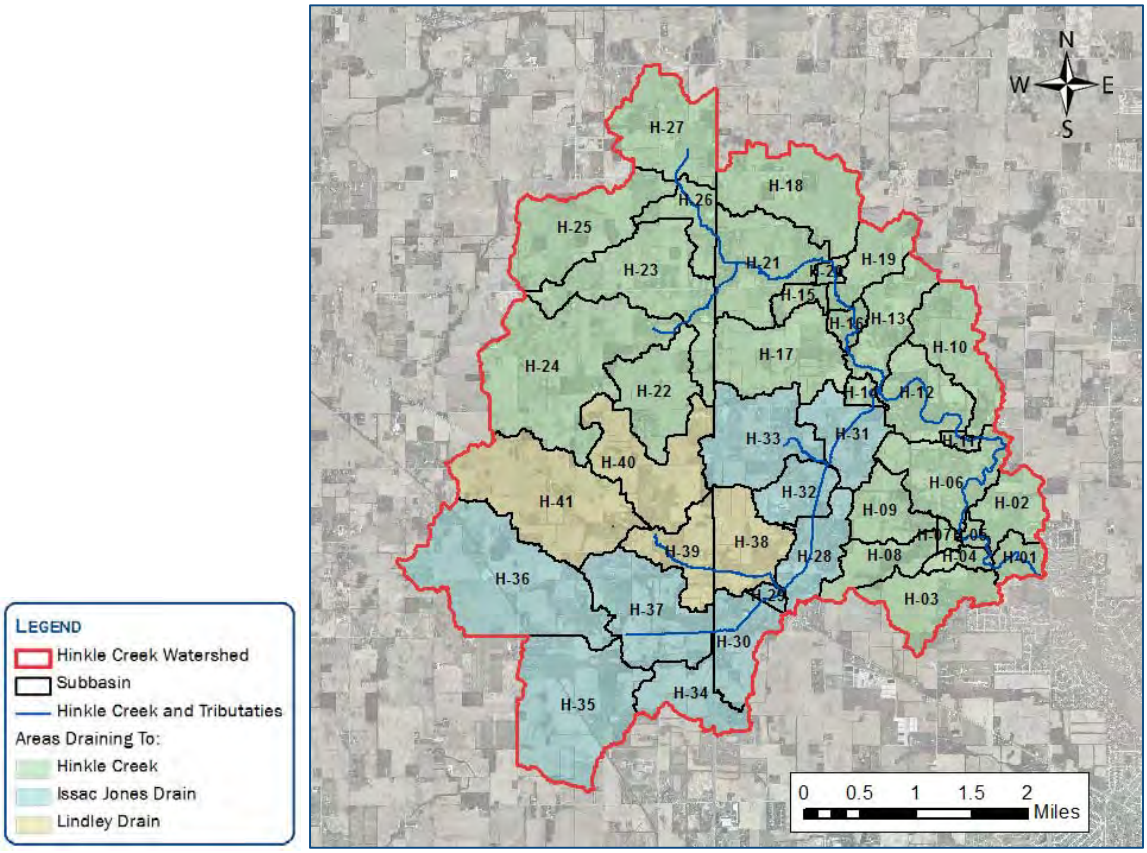
The Hamilton County 1 foot contours, spot elevations, and storm drains layers were used to define the detailed watershed delineation. Raw elevation data from the County was

processed to create a digital elevation model (DEM) which was used to visualize watershed boundaries develop the HEC-HMS model.

The Hinkle Creek Watershed was determined to be 21.1 square miles or 13,474 Acres. The watershed was then was subdivided into 41 individual subbasins in order to distribute flows throughout the watershed for the hydraulic analysis. Break points for the subbasin were selected based on critical locations and to provide an even distribution of flows along the stream reach. These critical areas typically include road crossings and stream confluences. Subbasins sizes ranged from 0.05 square miles (32 Acres) up to 1.5 square miles (960 Acres). Figure 5-2 shows the watershed delineation and 41 subbasins.

The Hinkle Creek Watershed was determined to be 21.1 square miles or 13,474 Acres.

Figure 5-2 Watershed and Subbasins Map

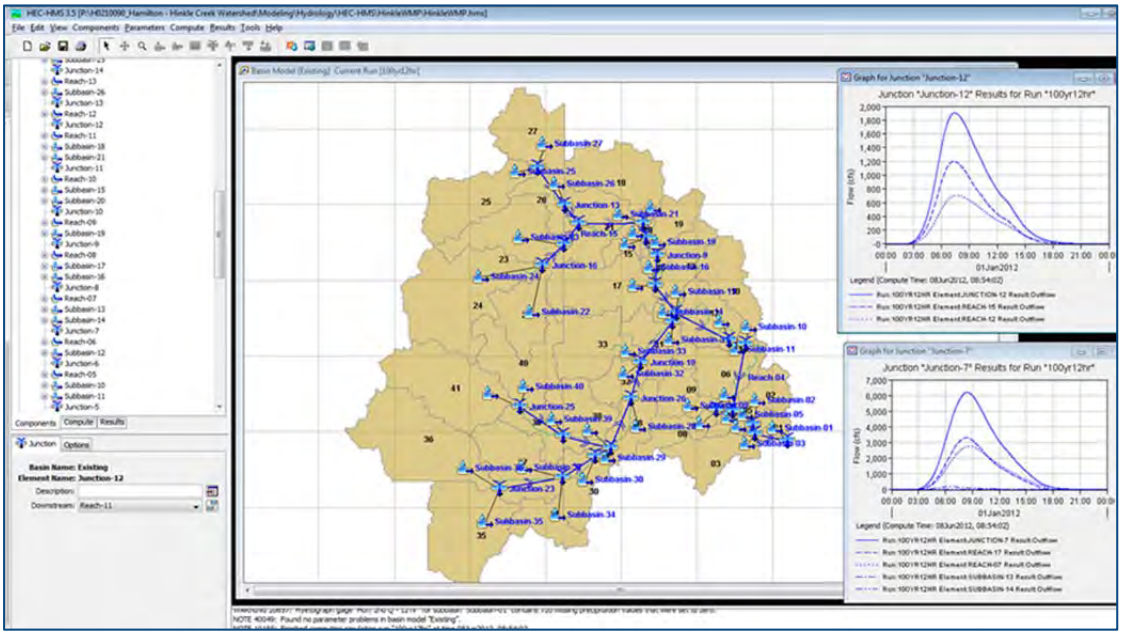


5.3 HYDROLOGIC COMPUTER MODEL (HEC-HMS)

The hydrologic computer model HEC-HMS was created to perform peak stormwater runoff analysis. Stormwater runoff from each subbasin is routed through the watershed to determine peak flows at different points in the basin under varying storm conditions.

Preparation of the HEC-HMS model includes input of the following required parameters; subbasin area, curve number, and basin lag time. The subbasin areas were taken from the watershed delineation. Figure 5-3 shows the screen view of the HEC-HMS program.

Figure 5-3 HEC-HMS Hydrologic Model Screenshot



5.3.1 Curve Numbers

To estimate runoff from each subbasin a SCS Curve Number (CN) is determined and entered into the model. CN has a range of 0 to 100 and factors in hydrologic soil groups, cover type, treatment, hydrologic conditions and antecedent runoff conditions. A weighted average of curve numbers assigned to individual sub-areas of homogeneous land use and soil types was used to determine the CN for the entire subbasin. Existing land use data was obtained from GIS maps and aerial photos. Soil types were obtained from the NRCS, United States Department of Agriculture, Web Soil Survey as discussed in Section 3.5. The individual curve numbers for each land use and soil were selected from tables in NRCS Technical Release 55, Urban Hydrology for Small Watersheds, 1986 (TR-55). A table of the Curve Numbers used is included in Appendix C.

5.3.2 Time of Concentration

The time of concentration for each subbasin was estimated using the SCS TR-55 method. Calculations were based on distance, surface characteristics, slope, and velocity of flow from the most remote point in the subbasin to the subbasin outlet. The time of concentration, measured in hours, was converted to the subbasin lag time using the HEC-HMS recommended factor of 0.6. A table of the times of concentrations is included in Appendix C.

5.3.3 Routings

A key feature of the HEC-HMS model is its capability to route stormwater runoff hydrographs through various drainage system components such as detention basins, culverts, and channel reaches. Appropriate flow routings enhance the accuracy of the representation of the watershed response to storm events by incorporating the attenuation of peak flows and time delay of hydrographs which occur as a flood wave travels through the storm system. Channel routings between subbasins were calculated on an approximate velocity of flow between the two subbasins.

5.3.4 Precipitation Data

The watershed analyses focused on system performance for synthetic (predetermined) rainfall events. A design storm event is defined by precipitation depth, duration, and time distribution. Precipitation depths for various storm durations were obtained from "Bulletin 71 - Rainfall Frequency Atlas of the Midwest" (Midwestern Climate Center and Illinois State Water Survey, 1992).

Time distributions (called Huff curves) were used as published in the above referenced Bulletin 71. These "Huff curves" distribute rainfall over the duration of the storm. Different curves (referred to as quartiles) are used for different duration storms. Storms less than 6 hours in duration use the first quartile distribution. Storms with durations of 6 to 12 hours use the second quartile distribution. Storms with durations greater than 12 hours but less than or equal to 24 hours use the third quartile distribution. A fourth quartile distribution is also available for storm durations greater than 24 hours; however, storms longer than 24 hours are not typically used in urban stormwater management analyses. Table 5-1 shows the precipitation data used for the Hinkle Creek Master Plan.

Table 5-1 Bulletin 71 Precipitation Data

STORM DURATION (HOURS)	RAINFALL DEPTH BY RECURRENCE INTERVAL (INCHES)						
	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR	500-YR*
1	1.37	1.71	2.00	2.43	2.80	3.21	3.82
3	1.87	2.33	2.72	3.30	3.81	4.28	5.22
6	2.19	2.73	3.19	3.87	4.46	5.13	6.31
12	2.54	3.17	3.70	4.49	5.18	5.95	6.89
24	2.92	3.64	4.25	5.16	5.95	6.84	7.45

*Values are from NOAA Atlas 14.

5.4 MODEL RESULTS

5.4.1 Critical Duration

Once the watershed parameters and precipitation data are entered into HEC-HMS model, it can be run to identify peak flows for various storm event recurrence intervals. Various duration storms are run for a given recurrence interval to determine the "critical duration" that causes the highest peak flow. A summary table of the peak flows calculated for each storm event as part of the critical duration is included in Appendix C.

5.4.2 Peak Flows

The peak flows represent the highest values for a given recurrence interval. It should be noted in recent years, larger more frequent storm events have been observed. IDNR has adjusted the terminology for these recurrence intervals from 10- and 100-year to 0.1 and 0.01 % storm events, respectively. This is because a 10-year sized event could happen multiple times over several years. For this study we have maintained the traditional storm event designations except for in the FEMA style flood profiles later presented in Chapter 6.

Table 5-2 shows the 100- and 10-year peak flows calculated for the Hinkle Creek Watershed Master Plan using the previously discussed HEC-HMS model. Appendix C includes full peak flow data that also includes the 25-, 50-, and 500-year peak flows.

Table 5-2 Hinkle Creek WMP Peak Flows

LOCATION	HEC-HMS COMPONENT	DA (SQ. MI.)	100-YEAR (CFS)	10-YEAR (CFS)
Hinkle Creek				
Just US of Morse Reservoir	Junction-1	21.1	6,722	3,204
0.98 mile DS of 216th Street*	Junction-2	20.9	6,708	3,198
216th Street	Junction-3	20.3	6,626	3,157
225th Street*	Junction-6	18.0	6,253	2,972
Deming Road	Junction-7	17.5	6,162	2,924
236th Street	Junction-10	6.8	2,385	1,147
Confluence of Baker and Hinkle	Junction-12	5.1	1,864	888
Baker Jones Drain				
at U.S. 31	Junction-13	2.0	647	310
William Baker Drain				
at U.S. 31	Junction-15	3.0	1,228	579
Isaac Jones Drain				
At Mouth	Junction-18	9.0	3,329	1,558
At 216th Street	Junction-26	7.5	3,017	1,376
Above Lindley Ditch at S.R. 38	Junction-21	4.2	1,751	781
At U.S. 31	Junction-22	3.8	1,610	712
Lindley Drain				
At U.S. 31	Junction-24	2.4	1,203	470

*Location corresponds with Hinkle Creek FIS discharge location.

5.4.3 Validation of Flows

The peak flow calculations were validated by comparison to the FIS, previous gage data, and IDNR data. Table 5-3 shows the peak flows as compared to the published FIS.

Table 5-3 WMP vs. FIS Drainage Areas and Discharge Comparison

LOCATION	DRAINAGE AREA		100-YEAR		10-YEAR	
	HC WMP (SQ. MI.)	FIS (SQ. MI.)	HC WMP (CFS)	FIS (CFS)	HC WMP (CFS)	FIS (CFS)
0.98 mile DS of 216th Street	20.60	20.1	6,722	7,180	3,204	3,550
Just US of Deming Road	17.50	18.5	6,253	6,800	3,157	3,400

The USGS stream gage data presented in Section 2.2.5 was also used for validation of the flows. The top five flows recorded from 1956 to 1981 were 4920, 4280, 3290, 2720, and 2050 cfs. These events were typically produced by storms that were slightly under ten year

events. High antecedent moisture conditions, from wet or frozen ground, play a major role in the amount of runoff and can produce much higher peak flows.

The April 20th, 1964 storm event produced a peak flow of 3290 cfs occurred during a 2.63 inch rain event over 46 hours. This storm event's precipitation and timing is comparable to a 10-year design storm event. The peak flow (3204 cfs) produced by the HEC-HMS model for a 10-year event compare favorably to the historical gaged flow in this event.

Several discharge calculation websites, as well a recently a prepared IDNR HEC-HMS model were also used to verify peak discharges calculated for Hinkle Creek Watershed. At the time of the study, IDNR was also preparing an update to the FIS which included a hydrologic and hydraulic model similar to the work being performed for this study. This update to the FIS was for the Isaac Jones Drain portion of the watershed which is about 42% of the overall watershed. A copy of the IDNR model was obtained and compared to the hydrologic model prepared for the overall Hinkle Creek Watershed. Flow estimates by IDNR were significantly lower than the flows calculated as part of this study. A meeting was held with IDNR to discuss flow calculations and compare several online discharge calculations.

IDNR reviewed the HEC-HMS model and hydrologic calculations performed in this study and concurred with the higher flow rates as part of an appeals process to the agency. The final floodplain and floodway mapping (Appendix E) in this report reflects this appeal.

Overall, the HEC-HMS model produces reasonable results consistent with the FEMA FIS, the USGS gage data and the IDNR review. Correspondence with IDNR was performed to check the results and confirm the best available flow projection was made with the data available.

CHAPTER 6 HYDRAULIC ANALYSIS

6.1 INTRODUCTION

A hydraulic analysis was performed on Hinkle Creek to identify and map a detailed floodplain and floodway using new topography. This mapping was used to develop solutions for stream related flooding areas. The analysis was performed using HEC-RAS (U. S. Army Corps of Engineers, Hydrologic Engineering Center – River Analysis System, version 4.1.0, January 2010).

The following sections provide an overview of HEC-RAS modeling effort and the resulting floodplain/floodway mapping.

6.2 HYDRAULIC ANALYSIS

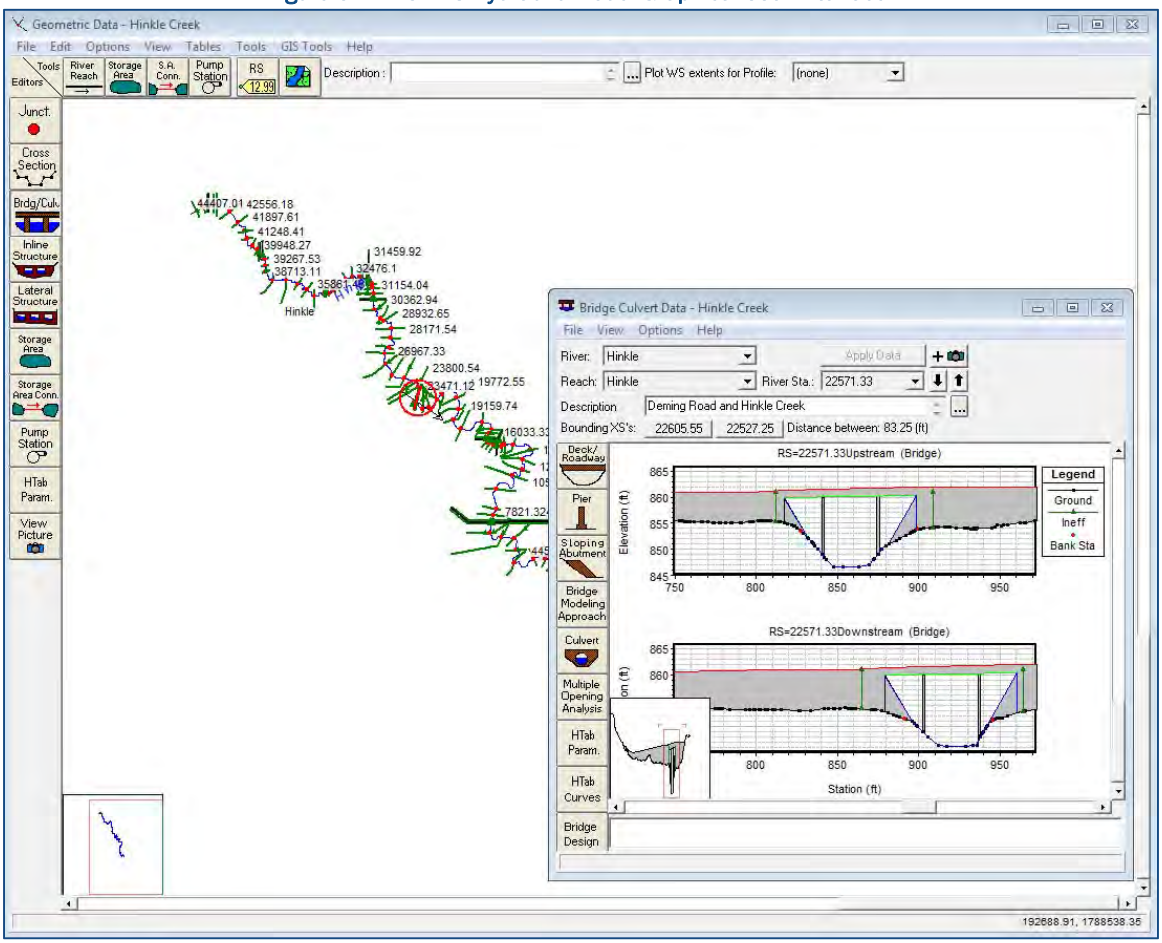
6.2.1 HEC-RAS & HEC-GeoRAS Modeling

HEC-RAS is an integrated package of hydraulic analysis programs and a Graphical User Interface (GUI). The system is capable of performing steady flow water surface profile calculations.

The HEC-RAS model incorporates geometric data and flow data to produce flood elevations at cross sections that are input into the model. Geometric data consist of stream cross-section data and hydraulic structure data (bridges, culverts, weirs, etc.). Channel and floodplain roughness coefficients (n-values), ineffective flow areas, and levees can also be specified in geometric data. Flow data includes the number of profiles to be calculated and the peak flow data for each stream reach and profile (i.e. 10-year, 100-year). Flow data is based on the peak flow results from Chapter 5. HEC-RAS results can be viewed in both tabular and graphical form. Figure 6-2 illustrates several of the graphical user interface elements.

The HEC-RAS model incorporates geometric data and flow data to produce flood elevations at cross sections that are input into the model.

Figure 6-1 HEC-RAS Hydraulic Model Graphical User Interface



HEC-GeoRAS 10 (for ArcGIS 10) was also used to prepare the HEC-RAS model and to map the floodplain. HEC-GeoRAS utilizes geospatial data to automate the creation of the hydraulic model. This approach not only saves time and effort on the creation process, but also improves accuracy over traditional methods. Stream centerlines, cross sections, reach lengths, roughness coefficients, and other variables can be extracted from GIS information directly into HEC-RAS. The model is processed and checked in HEC-RAS and exported back into the GIS environment so the floodplain limits can be delineated in conjunction with the DEM.

6.2.2 Cross Sections

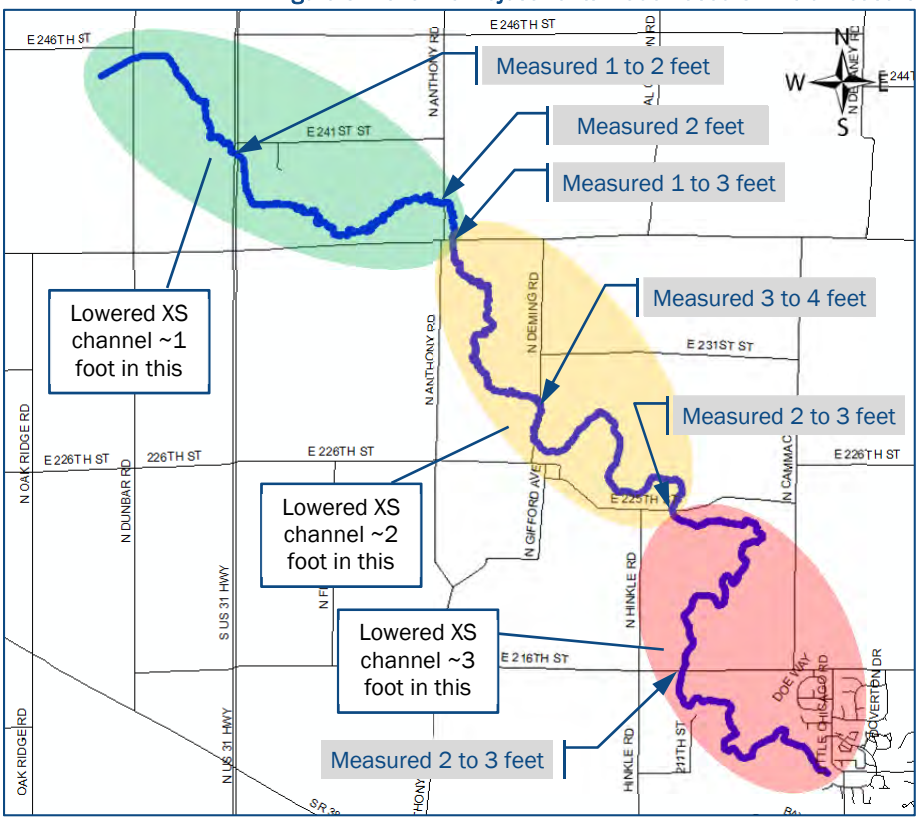
Cross sections were extracted from the Hamilton County 1-foot contour and spot elevation data using HEC-GeoRAS. Cross sections are drawn from left to right looking downstream and perpendicular to the flow. Roughness coefficients (Manning's "n" values) are added to represent different surface conditions. Ineffective flow areas are added in areas where flow is impeded by surrounding topographical features such as road embankments, bridges, or

hills. Reach lengths are entered representing the distance from one cross section to next. Reach lengths for each cross section are calculated by HEC-GeoRAS.

6.2.3 Channel Adjustments

Channel adjustments to the Hinkle Creek were necessary to accurately model the bridge and culvert crossings. The GIS contour data does not reflect below water channel geometry. This portion of the channel geometry was adjusted based on field measurements. These adjustments area summarized in Figure 6-2.

Figure 6-2 Channel Adjustments Made Based On Field Measurements



6.2.4 Roughness Coefficients

Roughness coefficients (Manning's "n") for the channel beds were determined by field observations and desktop review. To determine the roughness coefficient for areas outside of the channel the USGS 2001 land use GIS layer was used. A Manning's "n" was assigned to various types of land use. Like values were joined into GIS polygons. Then, using HEC-GeoRAS the Manning's "n" were extracted from the layer and applied to the cross sections. Table 6-1 shows the Manning's "n" values used in the model.

Table 6-1 Manning's N Values

STREAM REACH	CHANNEL "N"	OVERBANK "N"
Hinkle Creek	0.035	0.035-0.015
Isaac Jones Ditch	0.045	0.050-0.010

6.2.5 Structures

Any significant structures were added to the model including State Roads, County Roads, and private structures. Structures were deemed significant if the structure was higher than the channel bank, therefore impeding flow above the top of bank. Design/As-Built data was used for U.S. 31 and for the County Roads. Field measurements, GIS data, and IDNR permits were used depict the private drive structures in the model. Each structure was examined and photographed to ensure the data sources used to create the structures in the model were correct. Table 6-1 shows the structures entered into the HEC-RAS model and the data source/year.

Table 6-2 Structures Included In Hydraulic Model

STRUCTURE	RIVER STATION (FEET)	RIVER STATION (MILES)	YEAR OF PLANS
216th Street	7122	1.35	1995
Private Structure	14844	2.81	NA
225th Street	15499	2.94	1992
Deming Road	22571	4.27	1959/1995
236th Street	30310	5.74	1978
Anthony Road	31503	5.97	1997
Private Structure	33743	6.39	NA
Private Structure	34549	6.54	NA
U.S. 31	39557	7.49	1955
Dunbar Road	43799	8.30	1999

6.2.6 Flow Values

Flow values from the hydrology analysis presented in Chapter 5 were entered into the HEC-RAS model at various locations along the reach. Tables 6-3 and 6-4 show the flow values used in the Hinkle Creek and Isaac Jones Ditch model, respectively.

Table 6-3 HEC-RAS Flow Values in Model For Hinkle Creek

CROSS SECTION	PEAK FLOW IN CFS FOR STORM RECURRENCE INTERVAL			
	10-YEAR	50-YEAR	100-YEAR	500-YEAR
8.41	318	528	684	868
7.48	888	1,538	1,911	2,539
7.09	1,147	1,949	2,385	3,201
5.73	2,924	5,019	6,162	8,340
4.27	2,972	5,095	6,253	8,450
2.95	3,157	5,402	6,626	8,857
1.34	3,204	5,481	6,722	8,937

Table 6-4 HEC-RAS Flow Values in Model for Isaac Jones Drain

CROSS SECTION	PEAK FLOW IN CFS FOR STORM RECURRENCE INTERVAL			
	10-YEAR	50-YEAR	100-YEAR	500-YEAR
4.55	524	986	1,196	1,658
3.83	709	1,322	1,604	2,213
2.91	781	1,440	1,745	2,414
2.19	1,376	2,472	3,011	4,154
1.41	1,558	2,697	3,323	4,575
0.03	3,400	5,700	6,800	9,100

6.3 RESULTS

After the hydraulic model was run and checked for accuracy, hydraulic profiles were established for Hinkle Creek and Isaac Jones Ditch. Computed results include a floodway data table, flood profiles, base flood elevation (BFE) lines, floodway limits, and floodplain mapping.

6.3.1 Floodplain, Floodway, and BFEs

100-year and 500-year floodplain maps were created by delineating the computed flood elevations onto the County's GIS contour maps using automated processes within HEC-GeoRAS. Tools in this program create a sloped water surface along the stream reach. The water surface is then intersected with the DEM. The result is the water surface inundation area for each storm recurrence interval known as the floodplain.

The floodway was calculated based on encroaching on each cross section in succession to reduce the conveyance to an allowable surcharge level. This surcharge level in Indiana is a maximum of 0.14 feet. The encroachments locations along the cross section are then plotted. The floodway is hand drawn between cross sections to generally follow the shape of the valley and to be contained within the floodplain.

Base Flood Elevations or BFEs, were also hand drawn along the floodplain which show the approximate location of change in elevation of the floodplain. The base flood elevations of Hinkle Creek are from 858 to 903 feet. The base flood elevations along the Isaac Jones Ditch are from 860 to 905 feet. Flood maps with the floodplain, cross sections, BFEs, and the floodway can be found in Appendix E.

6.3.2 Flood Profiles and Floodway Data Tables

The flood profiles and floodway data tables for Hinkle Creek and Isaac Jones Drain were prepared from HEC-RAS modeling results. FEMA's RAS Plot software was used to prepare the flood profiles. Cross sections were lettered and structures were labeled on the profiles. The FEMA FIS formatted flood profiles and floodway data tables are included in Appendix E.

CHAPTER 7 PROBLEM IDENTIFICATION

7.1 INTRODUCTION

This chapter identifies and discusses stormwater problems that were found as a result of the desktop review, field investigation, water quality analysis, hydrologic/hydraulic modeling, and public input. This information was compiled and summarized in this chapter. A stormwater problem area map is presented at the end of this chapter that is the culmination of this effort. The following sections summarize the problems identified.

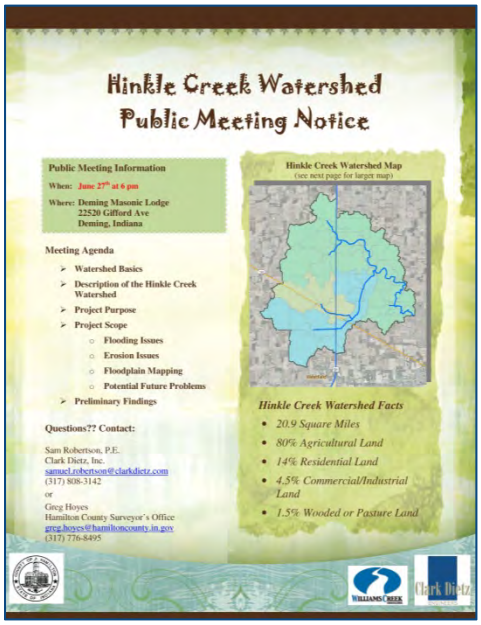
7.2 WATERSHED STRESSORS AND SOURCES

Sampling, field investigations, and flood analysis of the data have shown that some sedimentation, streambank erosion, and flooding problem area of a concern. Table 7-1 summarizes the stressors and sources generally categorized based on the problems identified.

Table 7-1 Watershed Stressors and Sources

STRESSOR	SOURCE
Erosion	➢ Field Erosion ➢ Steep Tilled Slopes ➢ Channel encroachments ➢ Erosion control on construction sites
Sedimentation	➢ Erosion (see above) ➢ Limited stream buffers in upper watershed ➢ Supported by reports of sedimentation in Morse Reservoir
Elevated Nutrients	➢ Fertilizers (agricultural, residential, commercial) ➢ Supported by high levels of nutrients during water quality sampling (see Table 4-3)
Bacteria	➢ Livestock, wildlife, pet waste ➢ Leaky septic systems, spills ➢ Supported by Draft 2012 303(d) list
Flooding problems	➢ Inadequate structures ➢ Developments in floodplain

7.3 PUBLIC INPUT



A public meeting was held in June 2012 to introduce the Hinkle Creek Watershed Master Plan and request input on any water related problems in the watershed. A total of approximately 26 people attended the meeting. A copy of the presentation and a meeting summary is provided in Appendix F. The meeting included introductions, a presentation of the scope of the project, and a description of findings to date.

After the public presentation and question and answer session, work maps were available for residents to identify specific problem areas. The water related problem areas were marked on the map during the meetings and reviewed. These problem areas have been incorporated into the report, analyzed, and solutions presented. Input on potential problem areas or watershed concerns are summarized as follows:

- Erosion behind a garage upstream of Anthony Road and north of 236th Street immediately downstream of 7 foot diameter private drive culvert.
- Local roadway drainage problems located along 216th Street which reportedly has undersized culvert that routinely cause stormwater to overtop the roadway in storms with 2 inches or more of precipitation.
- Sedimentation build-up and debris near the mouth of Hinkle Creek as it enters Morse Reservoir near Harbour Pointe Drive West.
- Two local drainage issues reported just south of the watershed.

7.4 AREAS OF CONCERN - WATER QUALITY

7.4.1 Nutrients

Nutrients within the water column can be divided into 2 primary groups; nitrogen-based and phosphorus-based. Nitrogen-based nutrients commonly originate from decaying plant matter, animal waste, and sewage. Therefore, as with *E. Coli*, the appropriate management of livestock waste and septic systems is a primary concern in addressing the issue of excess nitrogen in surface water. However, the addition of lime and ammonia as agricultural

fertilizers is also a primary source of nitrogen, reinforcing the need for judicious fertilizer application and the use of vegetative buffers between crops and waterways.

Phosphorus-based nutrients such as ortho-phosphate and organic phosphorus are the products of weathered soils and rocks. Runoff from these sources often carries phosphorus into surface waters. Phosphate from fertilizers binds to soils, which erode during storm events adding considerable amounts of suspended phosphate to streams. Therefore, as with nitrogen-based nutrients, the use of buffers in conjunction with judicious fertilizer application is important to the control of excess nutrients to surface waters.

7.4.2 Highly Erodible Land

The Natural Resources Conservation Service (NRCS) defines areas very susceptible to erosion as Highly Erodible Land (HEL) and specifies a set of criteria for the classification of HEL based on a soil's erodibility index (EI). The EI for a soil map unit is determined by dividing the potential erodibility for the soil map unit by the soil loss tolerance (T) value.

Approximately 80% of the land area within the Hinkle Creek watershed is used for agricultural row crop production. This type of land use has historically employed soil tillage to prepare fields for planting, manage weed populations, reduce soil compaction, and encourage the decomposition of crop residue. However, soil disturbance has the potential to facilitate erosion, particularly in areas defined as HEL.

Five soil maps units within Hamilton County are defined as HEL and six are defined as Potentially Highly Erodible Land (PHEL). Table 7-2 shows these map units and their corresponding land area (acres) in Hinkle Creek Watershed.

Table 7-2 Highly Erodible Soils in Hamilton County

MAP UNIT SYMBOL	SOIL NAME	CLASSIFICATION	ACRES IN WATERSHED
CrA	Crosby silt loam, 0 to 3% slopes	PHEL	4,786
FnB2	Fox loam, 2 to 6% slopes, eroded	PHEL	19
FxC3	Fox clay loam, 8 to 18% slopes, severely eroded	HEL	13
HeF	Hennepin loam, 18 to 50% slopes	HEL	155
MmB2	Miami silt loam, 2 to 6% slopes, eroded	PHEL	1,841
MmC2	Miami silt loam, 6 to 12% slopes, eroded	PHEL	439
MmD2	Miami silt loam, 12 to 18% slopes, eroded	HEL	243
MoC3	Miami clay loam, 6 to 12% slopes, severely eroded	HEL	318
MoD3	Miami clay loam, 12 to 18% slopes, severely eroded	HEL	87
OcB2	Ockley silt loam, 0 to 2% slopes, eroded	PHEL	132
Pt	Pits	PHEL	15
		HEL Total	816
		PHEL Total	7232

HEL and PHEL soils comprise approximately 6% and 54%, respectively, of the total land area of the Hinkle Creek watershed. Therefore, with approximately 80% of the total land area potentially subject to agricultural tillage, a significant risk exists for soil erosion.

7.4.3 E. Coli Contamination

Hinkle Creek is included in the 2012 draft 303(d) list for impairment due to E. Coli bacteria indicating fecal contamination within the watershed. Typical sources of E. Coli include septic systems and livestock, both of which are present within the watershed. Residential septic systems are designed for a limited number of users and require periodic maintenance to ensure they are functioning properly. When not used or maintained as recommended, these systems can leach bacteria into streams, lakes, and rivers.

An additional source of E. Coli is livestock. Free range livestock which are held in a pasture can contribute to bacterial contamination, particularly during large storm events, or if animals are allowed to roam freely within streams. Confinement livestock farms are required to manage animal waste rather than let it freely discharge as runoff. However, as with residential septic systems, confinement waste management systems must be maintained and inspected regularly to ensure proper function.

7.5 AREAS OF CONCERN – WATER QUANTITY

7.5.1 Across-the-Board

Overall the Hinkle Creek Watershed has few flood related issues for the size of the watershed. This is due to the watershed being mostly undeveloped and most roadway crossings being adequately sized to pass flood flows. The primary water quantity concern has to do with the majority of land use currently being agricultural, which typically results in higher peak flows as compared to wooded or grass lands. The flows in the watershed will change over time as the land is developed and detention ponds are added. Care will need to be taken by regulators to ensure the hydrologic processes in the watershed remain the same or improve the quality of the watershed.

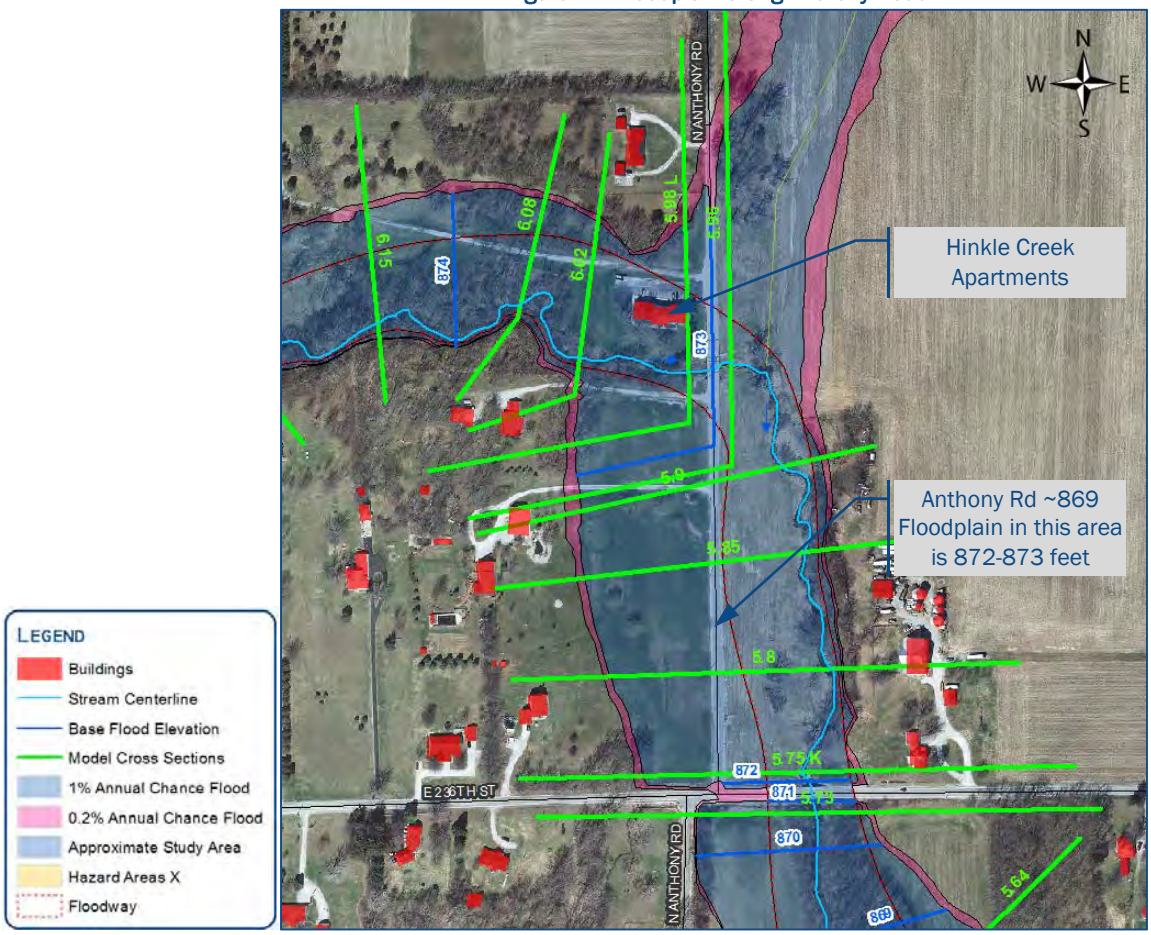
7.5.2 Site-Specific

Hinkle Creek along Anthony Road and Crossing 236th Street

The Hinkle Creek Apartments are located on the north side of Hinkle Creek along Anthony Road and are in the floodway of Hinkle Creek. The estimated ground floor elevation is 871 feet based on the Hamilton County topographic data. According to the maps, the building would flood in the 50-year and greater storm events. The 100-year flood elevation at this location is 873.5 feet and the first floor of the building is at approximately at 871 feet.

Anthony Road north of 236th Street to Hinkle Creek is overtopped by various storm events. The top of road is estimated to be 869 feet based on the Hamilton County topography data. Given this elevation, the roadway overtops in storm events greater than the 10-year event. Erosion of the Anthony Road shoulder was visible on the east side of road in this area. This erosion can be attributed to the frequent overtopping and flow crossing over the roadway from west to east. Figure 7-1 shows the Hinkle Creek Apartments and the floodplain in the area of Anthony Road and Hinkle Creek upstream of 236th Street.

Figure 7-1 Floodplain along Anthony Road

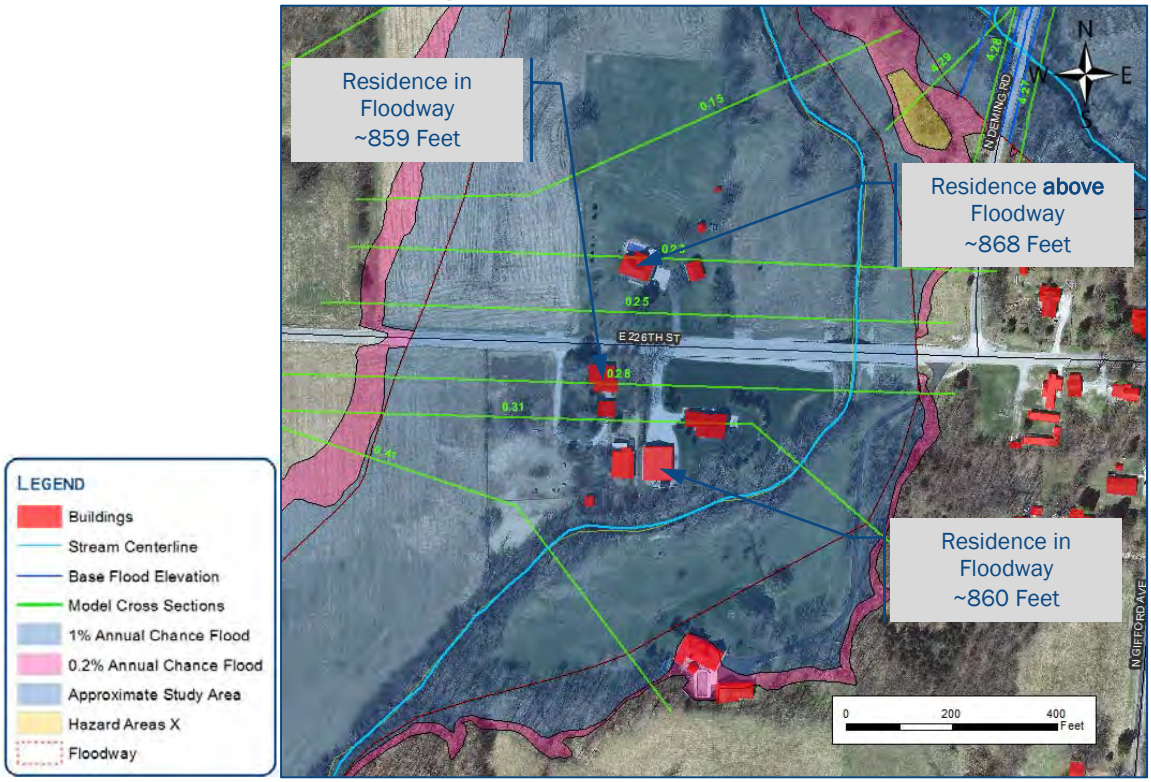


Flood Profiles 05P and 06P in Appendix E shows the flood profile in this area. The increase in the 1% (100-year) floodplain can be seen starting at 236th Street and continuing approximately 1500 feet upstream of Anthony Road. It appears that backwater along Hinkle Creek in this area is increased several feet by the 236th Street and Anthony Road structures.

226th Street and the Isaac Jones Drain

Several residential structures are in the floodway of the Isaac Jones Drain at 226th Street as shown in Figure 7-2. The floodplain elevation in this area is 861.20 feet on the upstream (south) side of 226th Street. The residence on the north side of the road is above the floodplain elevation while the two residences on the south side are below the 100-year floodplain elevation. The structure on the edge of the floodplain shown on the bottom of Figure 7-2 is not in the 100-year floodplain.

Figure 7-2 226th Street and Isaac Jones Drain Floodplain



High Backwater Created by Structures

Bridges can significantly affect the flood elevations during a storm event due to the structure being located within the channel and causing a flow obstruction. The majority of the bridges over Hinkle Creek and the Isaac Jones Drain have piers. Typically, the bridge piers and abutments protrude into the watercourse, catch debris, and often constrict flow during a flood event. The flow constriction usually creates higher flood elevation upstream, which is also known as "backwater". Table 7-3 shows structures in Hinkle Creek that have minor to moderate backwater effects based on the HEC-RAS modeling. None of these structures were shown to overtop in the 100-year storm event but moderate backwater is created by the 225th Street, Deming Road, and 236th Street structures all along Hinkle Creek. Table 7-3 shows the degree of backwater at the structures along Hinkle Creek.

Table 7-3 High Backwater Created by Structures in Hinkle Creek

STRUCTURE	SEVERITY	APPROXIMATE INCREASE IN FLOODPLAIN ELEVATION (FEET)	DISTANCE EFFECTED UPSTREAM (FEET)
225th Street	Moderate	3.0	2700
Deming Road	Moderate	2.5	3300
236th Street	Moderate	2.4	2300
Anthony Road	Minor	1.6	1000
U.S. 31	Minor	0.5	750

7.6 AREAS OF CONCERN - EROSION

7.6.1 Across-the-Board

Areas of steep tilled slopes were noted within the watershed during field investigations. Similarly, HEL data was used to identify areas susceptible to erosion, which were also under agricultural tillage. Determination of agricultural land use was made either by actual site observations or via inspection of aerial photography. Identification of an area as a steep tilled slope does not necessarily indicate an existing erosion problem. However, these areas were identified because they are characterized by a combination of factors which commonly result in erosion; relatively steep slope and frequent soil disturbance. Therefore, these areas are considered to have a high potential for erosion and therefore are identified as potential problem areas.

7.6.2 Site-Specific

Areas of soil erosion were identified during field investigations of the watershed as well as by individual land owners who brought specific problem areas to the attention of investigators. These areas ranged in severity as well as cause. The erosion problem areas identified are shown on the Problem Inventory Map located at the end of this chapter. The following is a brief description of the soil erosion areas identified.

Area E-1

This area is located in the northeastern portion of the watershed, in the path of the Martha Darrah Drain. The problem area consists of erosion in an agricultural field resulting from unchecked surface flow to the southeast. One potential cause of surface erosion adjacent to a subsurface drain is a tile in need of maintenance. Clogged or damaged tiles may obstruct flow, forcing surface conveyance and potentially resulting in erosion. Figures 7-3 and 7-4 show a picture and aerial photography of the Erosion Area E-1.

Figure 7-3 Soil Erosion Caused by Surface Drainage at Area E-1, facing north

Figure 7-4 Aerial view of Area E-1

Area E-2

This area is located in the northeastern portion of the watershed, in an agricultural field. Area E-2 appears to be a natural drainage path which flows southeast through a pipe under 241st Street. Likely causes of the observed erosion are concentration of flow from the agricultural field prior to entering the structure under 241st Street and subsurface tiles in need of maintenance. Figures 7-5 and 7-6 show a picture and aerial photography of Erosion Area E-2.

Figure 7-5 Soil Erosion and tile failure at Area E-2, facing east

Figure 7-6 Aerial View of Soil Erosion Caused by Surface Drainage in Area E-2

Area E-3

This area is located in the northeastern portion of the watershed, in an agricultural field. Area E-3 appears to be a natural drainage path for surface water. Erosion was observed transecting the agricultural field from northwest to southeast and intensified at the lower end of the slope prior to entering a culvert pipe under Anthony Road. Figures 7-7 and 7-8 show a picture and aerial photography of Erosion Area E-3.

Figure 7-7 Soil Erosion Caused by Surface Drainage in Area E-3, facing northwest

Figure 7-8 Aerial view of Area E-3

Area E-4

This area is located downslope from Area E-3, on the east side of Anthony Road. Area E-4 appears to be located near the intersection of a natural drainage path and the Martha Darrah Drain. Surface flow within this area proceeds from west to east and then turns south, following the alignment of the Martha Darrah drain. Aerial photography of the area shows a sinuous braided channel conveying water from west to east. However, field investigation revealed a recently excavated channel with vertical sides extending from Anthony Road southeast to an ag field. Similar to Areas E-2 and E-3, the likely cause of the observed erosion is the concentration of surface flow from the surrounding agricultural areas. Figures 7-9 and 7-10 show a picture and aerial photography of Erosion Area E-4.

Figure 7-9 Soil Erosion in excavated channel at Area E-4, facing north

Figure 7-10 Aerial View of Erosion Caused by Surface Drainage in Area E-4

Area E-5

This is an area of streambank erosion noted within the corridor of Hinkle Creek. The area was identified during an inspection of the riparian corridor and flows from west to east. This area is characterized by a high cut bank on the south side of Hinkle Creek resulting from high flow events in unconsolidated soils. Figures 7-11 and 7-12 show a picture and aerial photography of Erosion Area E-5.

Figure 7-11 Streambank Erosion in Area E-5, facing southeast

Figure 7-12 Aerial view of Area E-5

Area E-6

This is an area of streambank erosion, located in Hinkle Creek, which was identified by a land owner. The area of erosion is the south bank of Hinkle Creek, downstream (east) of a driveway culvert. Investigation of the area indicated that the culvert, approximately 70 inches in diameter, has concentrated and directed flow toward the south bank of Hinkle Creek, which was observed to be an approximately 45 degree slope. Of particular concern to the land owner was the issue of potential encroachment toward an outbuilding located approximately 40-50 feet from the top of bank. Figures 7-13 and 7-14 show a picture and aerial photography of Erosion Area E-6.

Figure 7-13 South Streambank Erosion in Area E-6, facing southeast

Figure 7-14 Aerial view of Area E-6

Area E-7

This is an area of streambank erosion within Hinkle Creek, located west of Anthony Road, adjacent to the Hinkle Creek Apartments. Stream flow in this area is from west to east. The area was observed to exhibit minor erosion at the time of the site investigation. However, vegetation on the adjacent streambanks was mowed turf grass and appeared to have been recently treated with herbicide. The lack of vegetation to maintain the stability of the area is likely to result in more severe erosion in the future. Figures 7-15 and 7-16 show a picture and aerial photography of Erosion Area E-7.

Figure 7-15 Unprotected Banks of Hinkle Creek in Area E-7, facing west (upstream)

Figure 7-16 Aerial view of Area E-7

E-8 Area

This area is located in the northwestern portion of the watershed, in an agricultural field and flows to the southeast. Area E-8 appears to be a natural drainage path located in the path of the William Baker Drain. This portion of the William Baker Drain is identified as a subsurface tile. Similar to Area E-1, the problem area consisted of erosion in an agricultural field resulting from unchecked surface flow. Figures 7-17 and 7-18 show a picture and aerial photography of Erosion Area E-8.

Figure 7-17 Soil Erosion at Area E-8, facing west

Figure 7-48 Aerial View of Soil Erosion Caused by Surface Drainage in Area E-8

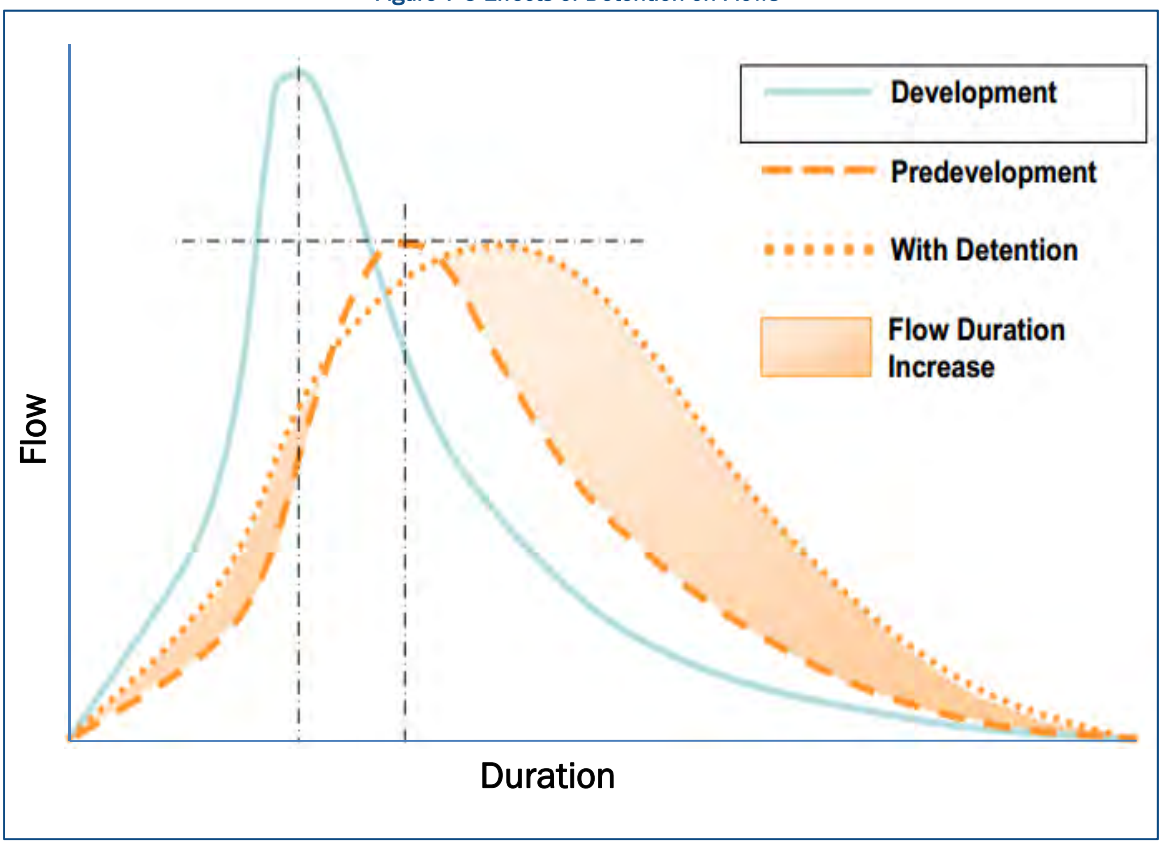
7.7 FUTURE IMPACTS

7.7.1 Impacts of Future Watershed Development

Development in the Hinkle Creek Watershed will have local, on-site impacts as well as impacts to the downstream receiving water body, Morse Reservoir. The Hinkle Creek Watershed is currently mostly undeveloped agricultural land. However, the watershed will likely be developed into residential and commercial land use in the future. These changes in land use will increase the impervious area and amount of runoff.

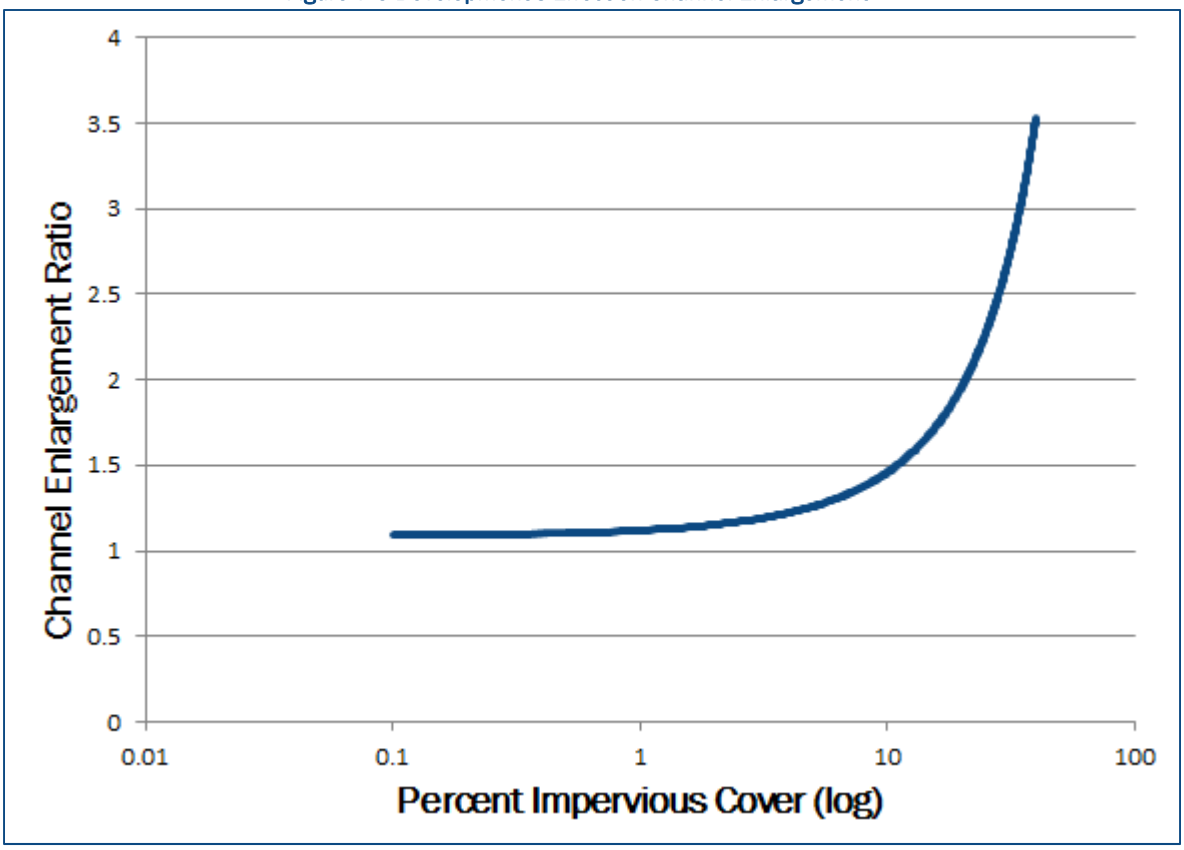
Current regulations require developments to be designed with detention ponds to reduce peak flows from the site during large flood events. These developments, despite the presence of stormwater detention ponds, often increase the magnitude of 1-year and 2-year peak flows. This is because the detention pond design standards are intended to reduce peak flows and thereby reducing flooding in the 10- and 100-year events. Although detention ponds typically do reduce peak flow rates for larger storm events, they often increase peak flow rates for more frequent smaller storm events and extend the overall duration of higher flow. Figure 7-11 shows the effects of detention on stream flow based on current standard detention design.

Figure 7-5 Effects of Detention on Flows



The increased flows of runoff from future development will enlarge the stream channels if measures are not taken to prevent this. The channel enlargement is performed by erosion and sediment transport to downstream receiving streams which is very problematic provided that Morse Reservoir is just downstream of Hinkle Creek. Figure 7-12 shows a graph of how channel enlargement occurs as percent impervious cover increases.

Figure 7-6 Development's Effect on Channel Enlargement



Source: The Southern California Coastal Water Research Project (SCCWRP)

To address these issues the Hamilton County Drainage Board has proposed new Chapter 700 to the Stormwater Management Ordinance and Technical Standards that requires developers to address Channel Protection and Water Quality Control. The proposed chapter states:

> "The proper way to accommodate the water quality, channel protection, and peak flow rate control of a site is to first consider addressing the water quality and channel protection volume requirements through conventional or LID approaches (as described in Chapter 700) and then add in the required detention storage for peak flow rate control to the overall site design. Meeting the channel protection/water quality volume requirements, either using Conventional or LID Approaches, often include providing extended detention storage features that are

usually combined with the detention storage needed for peak runoff rate control of the site into one facility."

It is recommended the Hamilton County Drainage Board adopt chapter 700 for the Hinkle Creek Watershed (and other areas in the County) to reduce channel erosion and offset the increase in water quantity from new developments.

7.7.2 Future Regulations

The U.S. Environmental Protection Agency (USEPA) has regulatory authority over the quality of stormwater. Originally enacted in 1948, the Federal Water Pollution Control Act was significantly reorganized and expanded in 1972. Subsequent to this reorganization, the Act is commonly referred to by the common name the Clean Water Act (CWA).

Under the CWA, the USEPA has implemented pollution control programs such as setting wastewater standards for industry and establishing water quality standards for all contaminants in surface waters. The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. EPA's National Pollutant Discharge Elimination System (NPDES) permit program controls discharges. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters.

Current standards for water quality specified by the USEPA focus exclusively on the chemical integrity of stormwater and the pollutants it contains. Concentrations of pollutants such as nutrients, metals, organic compounds, and bacteria are addressed and regulated by the NPDES program. However, USEPA has announced that it will propose and take final action soon on a first-time national rule that would control stormwater discharges from newly developed, previously developed and redeveloped sites.

USEPA plans to propose a regulation to strengthen the national stormwater permit program, including, at a minimum, new design or performance standards to control post-construction stormwater discharges from developed sites. The expected changes are agencies' response to a 2008 National Research Council (NRC) report that calls for "radical changes" to EPA's stormwater control program. The report, *Urban Stormwater Management in the United States*, concludes that the lack of requirement for post-construction stormwater controls in the construction industry's general permit is a "glaring shortcoming."

This regulation would limit the volume of runoff exiting a site, using the pre-development condition as a benchmark. This translates to on-site infiltration and water reuse, rather than discharge.

In general, the new performance standards are expected to increase the controls required for active construction sites as well as extend USEPA's current regulation of water quality to include stormwater quantity as well. The intention is to reduce construction related pollutant discharge and overall stormwater runoff volumes.

The primary change to post-construction stormwater regulation is centered on maintaining pre-construction runoff volumes under a post-construction condition. Effectively, this regulation would limit the volume of runoff exiting a site, using the pre-development condition as a benchmark. This translates to on-site infiltration and water reuse, rather than discharge. To achieve these elevated goals, site design would have to incorporate best management practices (BMPs) such as pervious pavement, rain gardens, infiltration swales, treatment wetlands, and water reuse.

Figure 7-7 Trending Changes in Stormwater Management

Changes are also anticipated for the General Construction Permit (GCP), the permit required for active construction sites larger than one acre, from commencement of earth disturbance to final stabilization. These changes include:

- Incorporation of the new Effluent Limitations Guidelines for the Construction and Development Industry which is comprised of a suite of mandatory erosion and sediment controls, soil stabilization practices, pollution prevention measures, surface outlet protections, and dewatering practices that will apply to all permitted construction sites. In addition, the GCP proposal includes a placeholder for a numeric turbidity limit (the specific limit to be inserted once it is recalculated and published), as well as applicability, sampling, and reporting requirements.

- Eligibility for emergency-related construction

- Changes to the GCP authorization procedure
  - Required use of the electronic notice of intent (NOI) process
  - Introduction of new "secondary operator" category to accommodate construction projects that multiple operators or contractors
  - Increased waiting period for new sources (from 7 to 30 days) from time submit permit application to time start construction

- New requirements for sites that discharge to sediment- or nutrient-impaired waters
  - Sampling of discharges in comparison to benchmark levels, if the site disturbs 10 or more acres at one time, and reporting on a quarterly basis to EPA
  - More rapid stabilization requirements and increased inspections

- Corrective action requirements
  - Specific triggering conditions for corrective action
  - Deadlines to fix such problems and document what was done

- More specific provisions on
  - Employee training and documentation
  - Inspection protocols and procedures
  - Final stabilization
  - Notice of termination procedures (e.g., new requirement to remove of all temporary stormwater controls and construction materials, waste, and waste handling devices)

Details of the changes to the USEPA rule will be available when the final ruling is published.

7.8 PROBLEM STATEMENTS AND GOALS

7.8.1 Problem Statements

Based on the issues identified in this chapter and the identified watershed stressors and sources for Hinkle Creek, the following problem statements have been developed.

- High nutrient levels (particularly ammonia) caused by both urban and agricultural runoff threaten aquatic life.

- Lack of riparian buffers in the agricultural areas increase downstream sediment loads to Morse Reservoir.

- Inadequate erosion and sediment controls threaten aquatic habitat in the channel and downstream.

- Urbanization of the Hinkle Creek watershed will increase streambank erosion, degrading aquatic habitat, and increase the stormwater pollutants in runoff.
- Undersized bridges result in increased floodwaters.
- Structures built in the floodplain are a threat to public safety.

7.8.2 Watershed Goals

The following goals have been developed to address the problem statements presented in the previous section:

Goal #1 Reduce Erosion and Sedimentation Throughout the Watershed

Goal #2 Reduce Risk to Flood Prone Structures and Areas

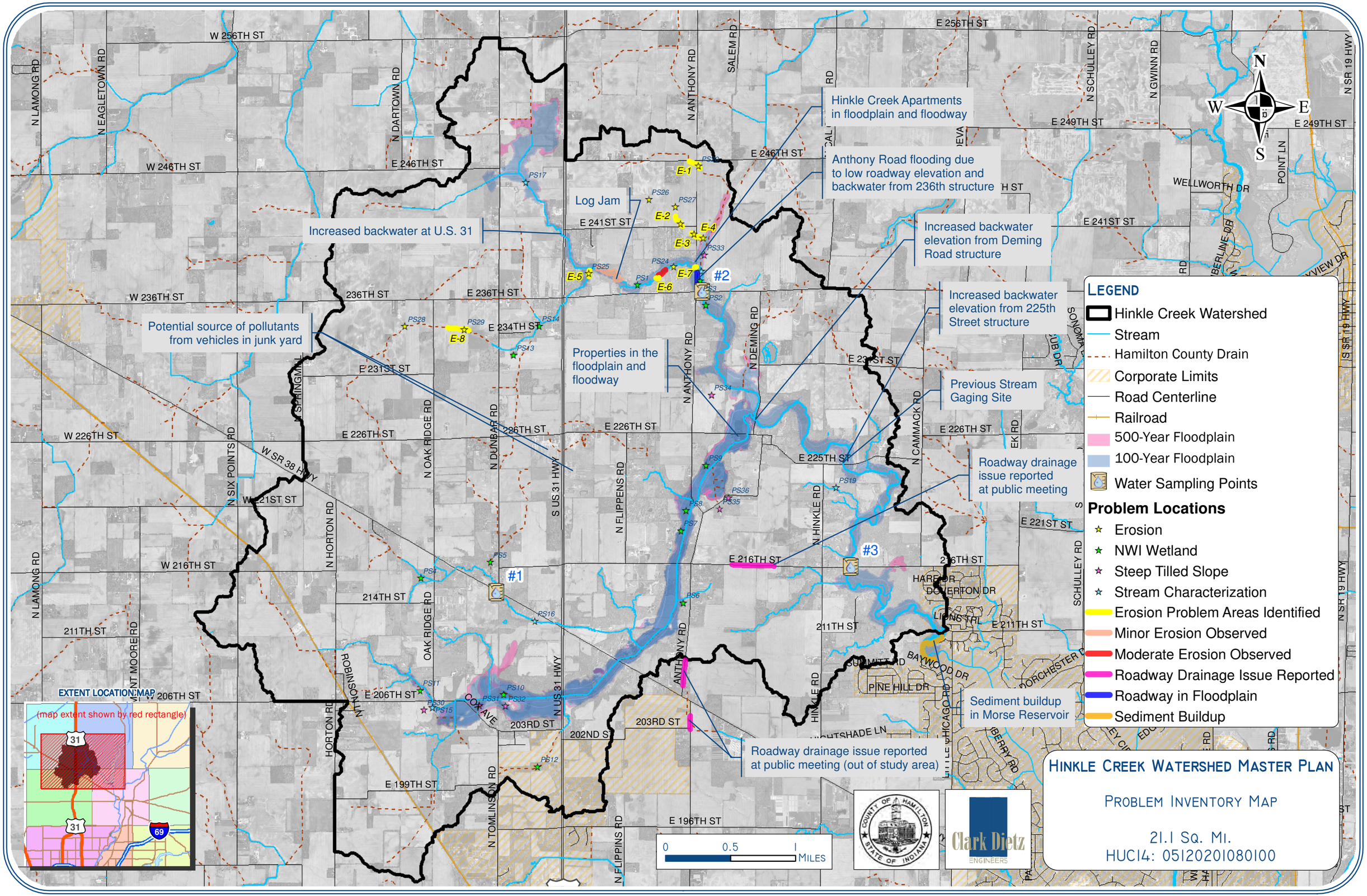
Goal #3 Provide Public Outreach to Promote a Healthy Watershed

Goal #4 Improve Water Quality

Goal #5 Support the Ecological Diversity Throughout the Watershed

Goal #6 Implement Site Specific Solutions to Problem Areas

Goal #7 Improve Riparian Areas Along Drainage Ways


Hinkle Creek Apartments in floodplain and floodway
Anthony Road flooding due to low roadway elevation and backwater from 236th structure
Log Jam
Increased backwater at U.S. 31
Increased backwater elevation from Deming Road structure
Increased backwater elevation from 225th Street structure
Potential source of pollutants from vehicles in junk yard
Properties in the floodplain and floodway
Previous Stream Gaging Site
Roadway drainage issue reported at public meeting
Sediment buildup in Morse Reservoir
Roadway drainage issue reported at public meeting (out of study area)
#1
#2
#3
E-1
E-2
E-3
E-4
E-5
E-6
E-7
E-8
PS1
PS2
PS4
PS5
PS6
PS7
PS8
PS9
PS10
PS11
PS12
PS13
PS14
PS15
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203RD ST
202ND ST
E 199TH ST
E 196TH ST
N LAMONG RD
N EAGLETOWN RD
N DARTOWN RD
N ANTHONY RD
SALEM RD
N SCHULLEY RD
N GWINN RD
N SR 19 HWY
S SR 19 HWY
WELLWORTH DR
POINT LN
N DEMING RD
N CAMMACK RD
N SIX POINTS RD
N OAK RIDGE RD
N DUNBAR RD
S US 31 HWY
N FLIPPENS RD
N HINKLE RD
W SR 38 HWY
N HORTON RD
OAK RIDGE RD
ROBINSON LN
COX AVE
N TOMLINSON RD
HARE DR
DOVERTON DR
LIONS TRL
BAYWOOD DR
PINE HILL DR
SUMMITT RD
DORCHESTER
EXTENT LOCATION MAP
(map extent shown by red rectangle)
31
69
0
0.5
1
MILES
N
S
E
W
LEGEND
Hinkle Creek Watershed
Stream
Hamilton County Drain
Corporate Limits
Road Centerline
Railroad
500-Year Floodplain
100-Year Floodplain
Water Sampling Points
Problem Locations
Erosion
NWI Wetland
Steep Tilled Slope
Stream Characterization
Erosion Problem Areas Identified
Minor Erosion Observed
Moderate Erosion Observed
Roadway Drainage Issue Reported
Roadway in Floodplain
Sediment Buildup
COUNTY OF HAMILTON STATE OF INDIANA
Clark Dietz ENGINEERS
HINKLE CREEK WATERSHED MASTER PLAN
PROBLEM INVENTORY MAP
21.1 SQ. MI.
HUC14: 05120201080100

CHAPTER 8 SOLUTION DEVELOPMENT

8.1 INTRODUCTION

This chapter focuses on reducing or eliminating the problems identified in Chapter 7. The chapter discusses design criteria and constraints, general across-the-board solutions to problems that are watershed-wide, and problems that are known site-specific problems.

It became clear throughout the watershed master planning project that the primary problem in the Hinkle Creek Watershed is erosion and sediment transport. Not only does sediment build up downstream in Morse Reservoir, but many pollutants attach to sediment and are carried downstream with the sediment. Excessive erosion can significantly alter stream quality and the watershed ecosystem. One of the key features of the solution development will be an emphasis on limiting excessive erosion in the watershed now and in the future.

8.2 DESIGN CRITERIA AND CONSTRAINTS

8.2.1 Erosion Prevention

The general concept of erosion prevention consists of land use practices which reduce or eliminate the direct exposure of soil to the erosive forces of wind and stormwater. These practices, while all similar in concept, vary greatly in detail and execution, and are dependent upon the circumstances specific to an individual location. For instance, erosion prevention in an active construction site will differ from that employed for streambank stabilization.

Therefore, the design criteria and constraints inherent to different erosion control applications will in large part be dictated by the short and long term use of an individual parcel. For this reason, the following general categories of erosion controls have been defined for the purposes of this discussion; temporary erosion controls, agricultural erosion controls, and stream channel erosion controls.

Temporary erosion controls are those intended for use for a defined interval, specifically during construction. The design criteria and constraints inherent to temporary erosion controls consist of the need to install and maintain these controls in an efficient manner, the need to control potentially large volumes of runoff in disturbed soils, and the need for construction equipment to access the site with the controls in place. The IDNR requires a Rule 5 Stormwater Runoff Permit including the development of a Stormwater Pollution Prevention Plan for land disturbances of one (1) acre or more.

Agricultural erosion controls are similar to temporary erosion controls in that they are intended to prevent erosion in significantly disturbed soils and must accommodate access by large farm equipment. They differ, however, in that agricultural erosion controls are

permanent installations, required beyond the time frame of a typical construction schedule. Natural topography, installation cost, and maintenance are also constraints commonly associated with agricultural controls.

Stream erosion controls are permanent controls constructed within a stream channel to prevent bank and channel erosion. Design criteria for these controls are generally defined by channel size and morphology. Typical constraints for in-stream controls include hydrology and surrounding land use. Stream erosion controls range from passive practices such as modification of bank profile to a more stable slope and installation of bank armor, to active practices such as bendway weirs which can redirect flow away from potential problem areas. An important consideration of stream erosion controls is the regulatory environment created by Section 401 of the Clean Water Act which requires coordination with the U.S. Army Corps of Engineers for work conducted within a stream channel.

8.2.2 Flood Control

Solutions for flood control can involve a variety of approaches including removing flood prone structures from the floodplain, enlarging stream crossings to allow floodwaters to pass underneath, or creating flood storage to reduce stream flows.

Endangered Structures are a main concern when it comes to flooding. These are typically structures where flooding occurs in the 100-year storm event or more frequent. The Hinkle Creek Watershed only has a few areas that have structures in the floodplain. These areas are the Hinkle Creek Apartments and residences along north and south side of the road at 226th Street along the Isaac Jones Drain.

Excessive Hydraulic Restrictions occur in a limited number of locations within the Hinkle Creek Watershed. The majority of structures do not cause significant backwater; however, several were identified. The hydraulic model was used to analyze structures and to determine necessary structure replacements that would lower the 100-year floodplain elevation upstream of the structure.

8.2.3 Water Quality

Solutions for water quality improvement are focused on preventing the introduction of pollutants into streams and rivers. The design criteria for solutions intended to improve water quality range from those implemented at the source of the pollutant to creating various barriers to those pollutants entering streams. Similarly, the pollutants encountered vary broadly, ranging from eroded soil and sediment, to agricultural herbicides, to nutrients, to hydrocarbons. These sources are addressed in greater detail in Section 4.4.

The ideal solution for control of pollutants is generally considered to be implementation of practices at the source. Such point-source solutions essentially prevent the spread of pollutants from the point of origin by minimizing disturbance. These include conservation

tillage practices and maintenance of manure collection lagoons and septic systems. However, implementation of point-source solutions is not always feasible.

Sometimes implementation of a non-point source solution downstream of the source is required. These solutions typically consist of a constructed barrier intended to intercept pollutants prior to entering the stream or river and may include vegetative buffers in agricultural settings, regional detention, or wetlands constructed for water quality improvement.

Regardless of the solutions implemented, consistent monitoring of water quality parameters is essential to determining their effectiveness. Therefore, it is recommended that water quality sampling be continued within the Hinkle Creek watershed at the existing sampling points to track water quality within the watershed over time as the watershed develops and solutions are implemented.

8.3 ACROSS-THE-BOARD SOLUTIONS

8.3.1 Land Use Considerations

Land use solutions are typically associated with zoning ordinances which define acceptable land uses for a parcel or group of parcels within a given area. These ordinances are typically driven in large part by access to major transportation networks, proximity to residential or other zoning types, and environmental constraints which may include soil type, erosion potential, access to subsurface water resources, or protected ecosystems. Recommended land use practices to consider as Hinkle Creek Watershed develops is:

- Identifying and protecting critical conservation areas (wetlands, forested areas, floodplains, riparian forest, meadow/prairie areas, etc.)
- Preserving environmentally significant areas (conservation easements, management areas, maintaining native plant species, etc.)
- Promoting urban forestry (decreases runoff, mitigates stream warming)
- Encouraging waterbody and natural drainage protection when siting developments (cluster zoning, other zoning options, urban growth boundaries, etc.
- Utilizing sound site planning practices that encourage green infrastructure
- Utilizing other structural and non-structural Best Management Practices as appropriate, (e.g. porous pavement, sand filters, infiltration practices, water quality swales, manufactured BMPs, vegetated filter strips, bioretention areas, etc.)

8.3.2 Education

Many land owners are unaware of the factors which affect water quality in a watershed. As such, management practices to reduce non-point source pollutants are not implemented as frequently as possible. Therefore, it is recommended that informational materials be made available to provide guidance to land owners. Recommended topics to be addressed include:

- Septic system maintenance and the pollutants associated with poorly maintained or failed systems.
- Maintenance of vegetative buffers adjacent to streams in both agricultural and residential situations.
- Placement of obstructions (crossings, culvert pipes, etc.) within streams and the permitting requirements of IDNR, USACE, IDEM, and the Hamilton County Drainage Board.

8.3.3 Water Sampling

It is recommended that water sampling be continued to track the progress of water quality issues as this management plan is implemented. The sampling conducted in 2012 consisted of two events, one occurring in spring and one in summer. Due to the exceptionally low precipitation levels observed in 2012, the data collected in these samples may not represent typical water chemistry conditions in the watershed. Therefore, the benefit of long term data collection would be a better understanding of the full range of water quality issues within the watershed. Recommended water sampling parameters include:

- Continuation of annual spring and summer sampling events.
- Addition of post storm sampling to capture variation occurring after large rain events.

8.3.4 Stream and Swale Buffers

Vegetative buffers located adjacent to streams and swales are an effective and efficient means of reducing the volume of pollutants entering water bodies. Therefore, it is recommended that vegetative buffers be implemented between all streams or agricultural drainage ditches and a land disturbing activity such as row cropping. Additionally, pastures should be fenced so as to prevent livestock from entering streams and drainage ditches. Specific attributes of stream and swale buffers include:

- Vegetative buffers should extend from the top of bank a minimum of 20 feet on each side of the channel.

- Vegetative buffers can incorporate herbaceous and/or woody species. However, adjacent to drains under the jurisdiction of the Hamilton County Surveyor, only herbaceous species may be used.

- Livestock fencing should be placed so as to allow a buffer 20 feet in width between the fencing and top of bank. Livestock crossings should be constructed in a manner that protects the stream channel from excessive disturbance and subsequent erosion.

8.3.5 Gaging Stations

USGS stream gages for the Hinkle Creek Watershed and Isaac Jones Drain is recommended to help validate and calibrate future hydrologic model updates. During the course of this study, considerable analysis was given to the hydrological methodology used to compute runoff and peak flow rates. Stream gages would increase the accuracy of the peak flows modeled. Accurate flow data is important to determine flood elevations and to size future capital improvement projects along the stream such as bridges and detention facilities. Gaging stations along Hinkle Creek and the Isaac Jones Drain could save thousands of dollars in future capital improvement costs by improving the accuracy of peak flow values used to design improvements.

A gaging station along Hinkle Creek could save thousands of dollars in future capital improvement costs by improving the accuracy of peak flow values used to design improvements.

8.3.6 Regional Detention Facilities

Natural drainage channels are highly sensitive to changes in the magnitude of frequent stormwater runoff (i.e. 1-year and 2-year recurrence interval) events. As discussed in Section 7.7.1, future development in the watershed will be required to provide detention. These detention ponds reduce peak flow rates for larger storm events, but often increase peak flow rates for more frequent smaller storm events and extend the overall duration of higher flow.

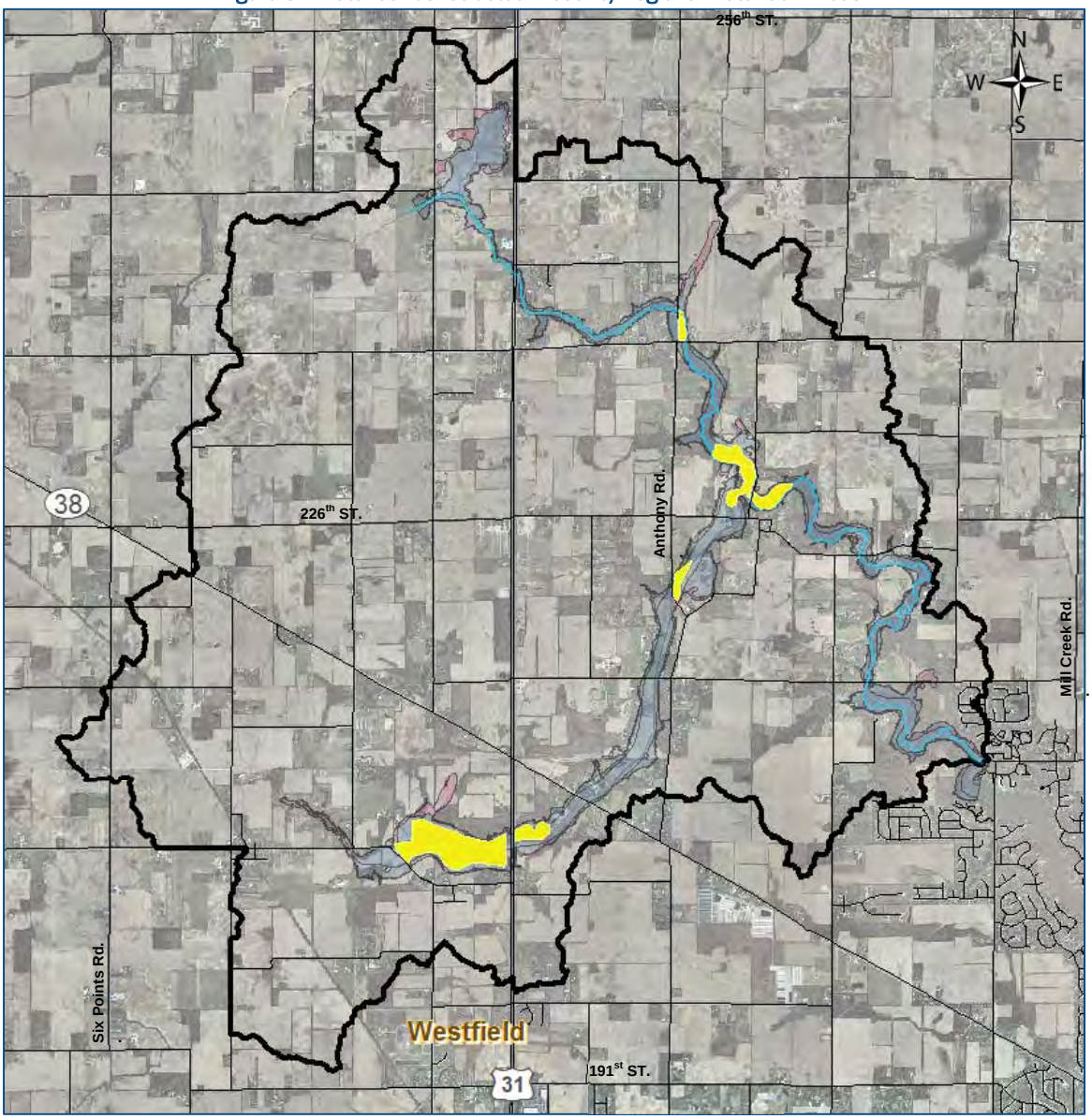
The hydrologic analysis completed for this project showed that major regional detention is not warranted to control the larger storms. Flooding is not a major problem and the existing detention policy for new development will be effective in controlling peak flows from these larger storms. However, it is recommended that regional detention facilities be considered as the watershed develops to help control the magnitude of 1-year and 2-year recurrence interval rainfall events. These facilities should be constructed “off-line” so as to maintain baseflow in the channel, avoid disrupting the existing riparian corridor, and avoid extensive dam safety requirements.

Regional stormwater detention facilities will provide the following benefits to the Hinkle Creek watershed:

- Reduce peak flow rates for more frequent storms
- Improve water quality by reducing concentrations of sediment, nutrients, and metals
- Increase aquatic habitat by providing wetland and open water areas
- Reduce downstream erosion potential by decreasing the magnitude and duration of the 1-year and 2-year flows, thus further reducing sediment pollution

Figure 8-1 shows some areas that have been identified that are in the floodplain and may make suitable locations for regional detention/constructed wetlands.

Figure 8-1 Potential Constructed Wetland/Regional Detention Areas



8.3.7 Constructed Wetlands

Constructed wetlands can be classified as an ecological buffer intended to intercept and trap pollutants already in an aquatic system. However, the potential benefits of these aquatic features also include the absorption of excess nutrients, sediment detention, and providing additional stormwater storage capacity.

Wetlands can vary in size, location, and plant community, which all affect their contribution to watershed management. Those located in the upstream portions of a watershed may be smaller, broadly distributed, and provide localized benefits while those located lower in the

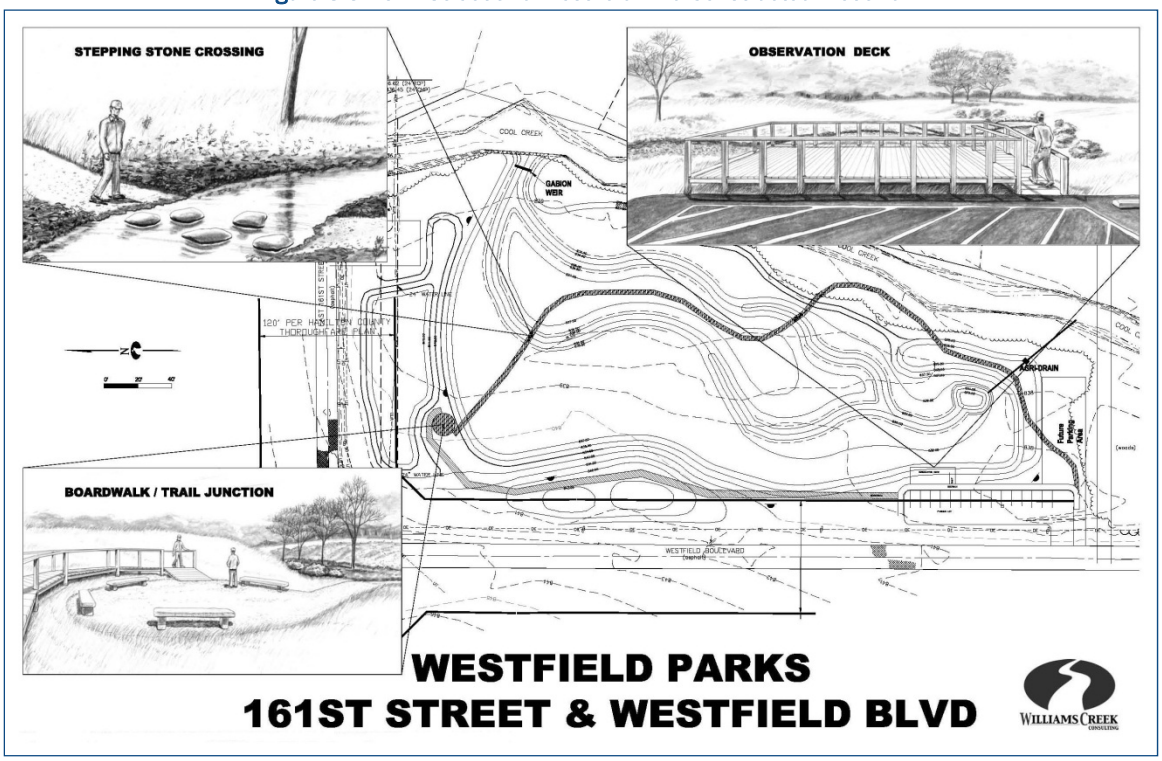
watershed would be most beneficial as larger, concentrated storage basins, intercepting sediment prior to introduction into other water bodies.

Additional benefits of wetlands less critical to watershed management include the provision of high quality wildlife habitat and the potential for use as mitigation areas. Master planning which designates areas as suitable for wetland construction is attractive to groups considering developments which would require Section 404/401 permitting.

Constructed wetlands and regional detention can be utilized in the same site. Some of these projects have already been implemented in Hamilton County. Figures 8-2 and 8-3 show two examples of regional detention/wetland facilities that have been implemented in Hamilton County.

Figure 8-2 Oak Manor Stormwater Quality Facility

Figure 8-3 161st Street and Westfield Blvd Constructed Wetland



8.4 SITE-SPECIFIC FLOOD SOLUTIONS

8.4.1 Hinkle Creek Apartments and Anthony Road

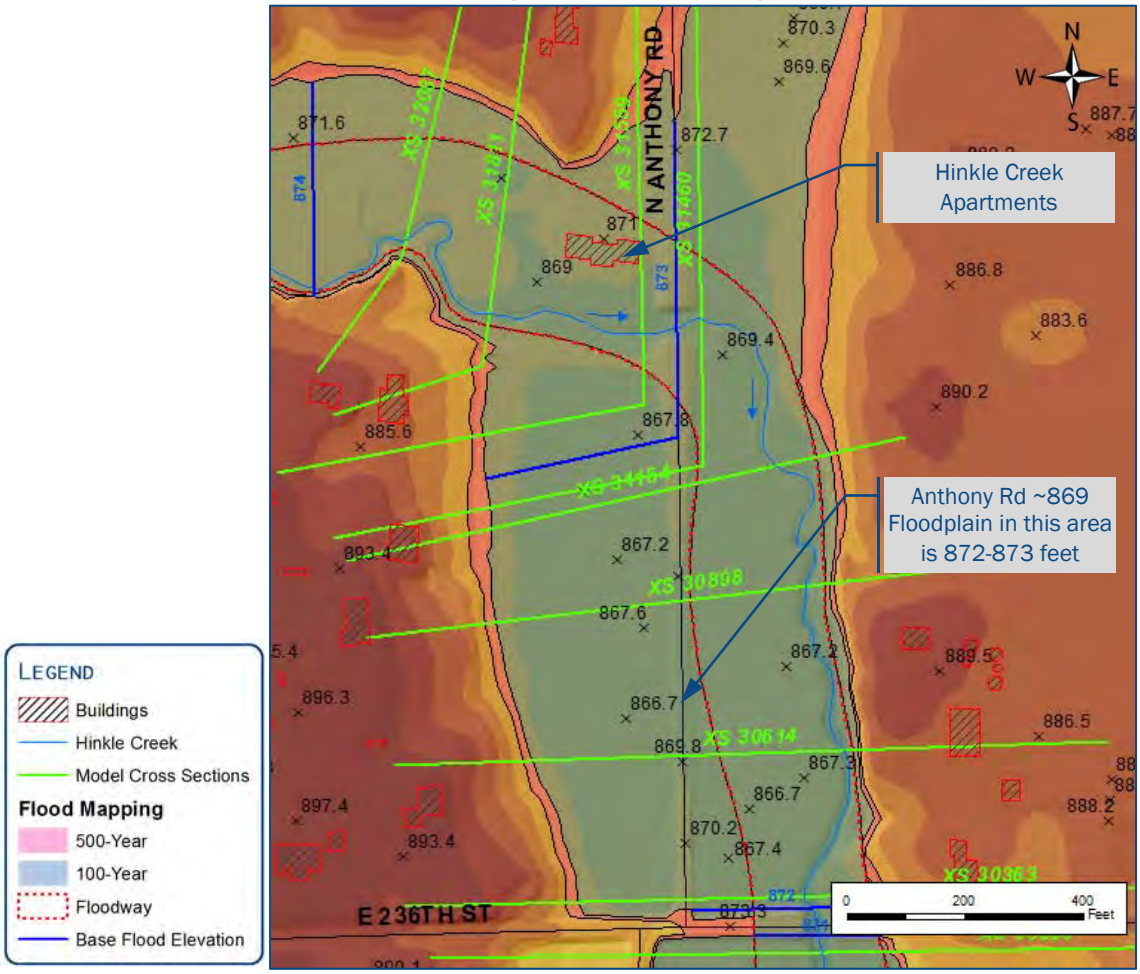
As noted in the problem identification, the Hinkle Creek Apartments are located on the north side of Hinkle Creek along Anthony Road and are in the floodway of Hinkle Creek. The 100-year flood elevation at this location is 873.5 feet and the first floor of the building is at estimated from the Hamilton County contours to be 871 feet. The flood elevation is above the ground floor elevation in the 50-year, 100-year, and 500-year storm events.

Reductions in the floodplain elevations in this area would need to be made primarily by replacing structures at 236th Street and Anthony Road to enlarge the waterway opening. There is not enough room for a levee around the Hinkle Creek Apartments. The model was run with a natural channel opening (larger flow area) at 236th Street which resulted in a reduction in the floodway elevation at the Hinkle Creek Apartments by approximately 0.7 feet (to 872.8 feet). Replacing and enlarging both the 236th Street Structure and the Anthony Road Structure would reduce the floodplain at the Hinkle Creek Apartments by approximately 2.3 feet (to 871.2 feet). However, these improvements would not reduce the floodplain elevation enough to prevent flooding at the finish floor.

Replacing both of these structures with structures large enough to reduce the backwater is not a cost effective solution. The cost for these larger structures to reduce the backwater is

estimated at over $750K dollars per structure. Therefore, a relocation of this apartment building or individual building flood proofing is a more realistic solution.

Figure 8-4 Floodplain along Anthony Road



8.4.2 226th Street and the Isaac Jones Drain

The residential homes in the floodplain/floodway of the Isaac Jones Drain in this area (approximately two homes and related out buildings) are at risk of first floor flooding. The flooding at this location is related to backwater from Hinkle Creek, rather than a particular restrictive bridge. There is no cost effective solution to prevent flooding. Individual property floodproofing and flood insurance would reduce flood damage risk. A floodplain buyout program may also be an option at this location.

8.4.3 High Backwater Created by Structures

Bridge crossings across waterways provide vital transportation routes across the watershed. Careful design is required in order to ensure that bridges over watercourses are not destabilized or destroyed by flood events. The effects of a bridge structure on the hydraulics of a watercourse can be dramatic due to head losses which occur in the vicinity of the bridge from contraction and expansion of flow. An increased water level or backwater is caused upstream of the bridge from the constriction. The locations are labeled in the Problem Inventory Map at the end of Chapter 7.

Future bridge designs or bridge alterations be designed to reduce the backwater caused by the structure, however due to the high costs to replace these structures (identified in section 7.5.2), the bridges should be replaced when the bridge has met the designed lifespan or when roadway improvements require bridge modifications. Typically, the new structure design is approximately 1.3 times larger and will cause a slight reduction in backwater. However to reduce backwater further the costs for structure replacement would be approximate double the cost to replace the existing structure in-kind. The cost to replace the 236th Street structure was noted in Section 8.4.1. Costs for the 225th Street and Deming Road structure would be approximately 1 to 1.2M each.

8.5 SITE-SPECIFIC EROSION SOLUTIONS

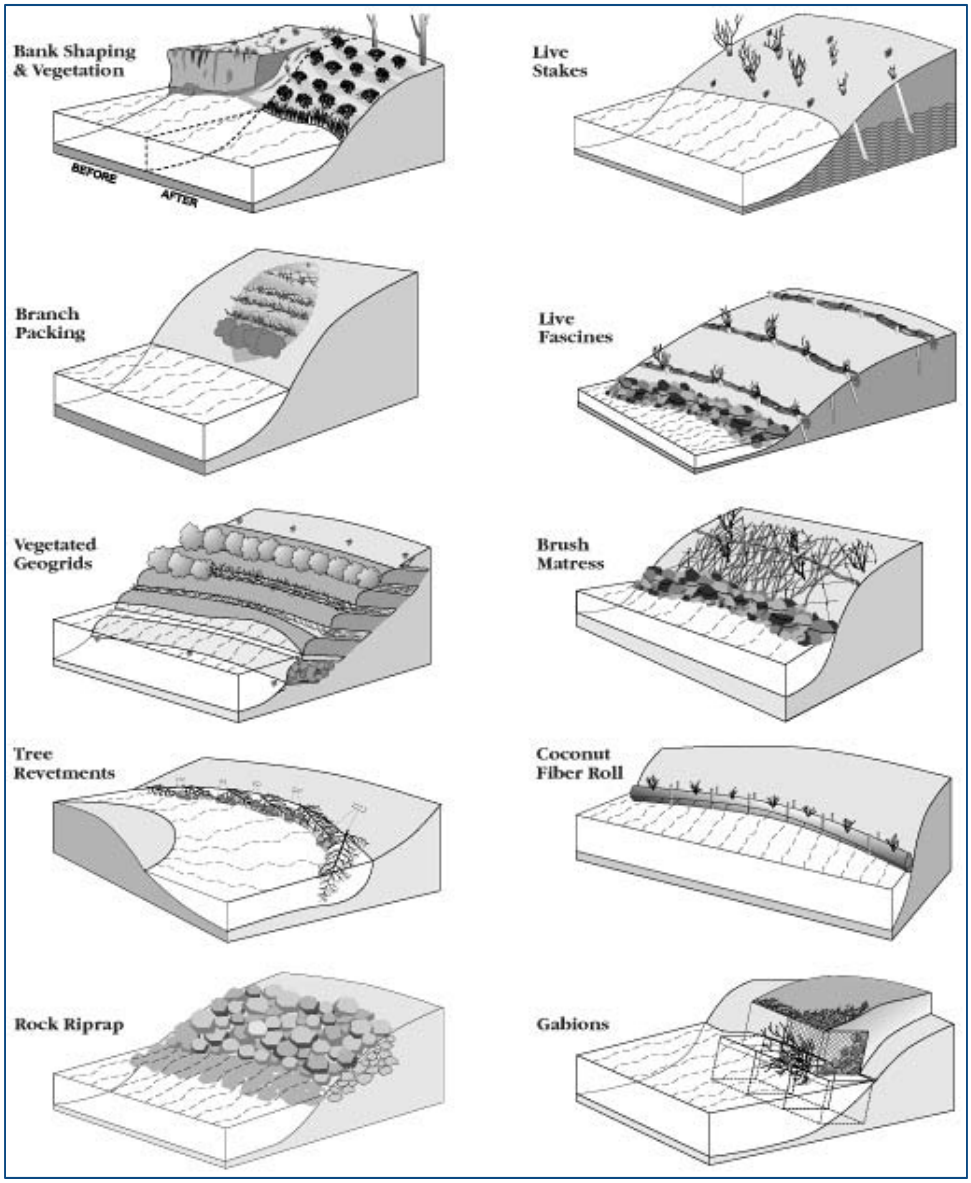
Eight streambank erosion sites were selected for improvements, based on the criteria described in Section 8.2.1. These locations are shown on the Problem Inventory Map at the end of Chapter 7. The proposed improvement sites are described as follows:

Area E-1	Martha Darrah Drain near Anthony Road and E 246th Street
Area E-2	Tributary north of E 241St Street (east of Anthony Road)
Area E-3	Tributary US of Anthony Road just south of E 241st Street
Area E-4	Tributary DS of Anthony Road just south of E 241st Street
Area E-5	Baker Drain 50 feet US of confluence with Hinkle Creek
Area E-6	Hinkle Creek ~2000 feet US of Anthony Road
Area E-7	Hinkle Creek at Hinkle Creek Apartments
Area E-8	Margaret Cade Drain between Dunbar Road and Oakridge Road

Solutions for streambank erosion projects consist of modifications to the bank profile resulting in a more stable slope, installation of hard armor in portions of the streambank susceptible to erosion, and placing controls within the stream channel to redirect the flowpath. In some instances combinations of multiple practices, will be required to attain a desired solution. Stream channel erosion is generally the result of high flow velocity in areas of exposed soil. Therefore, the proposed solutions are focused on reducing flow velocity or concentration and the addition of measures to stabilize vulnerable soils on banks.

Methods for stabilizing eroding banks typically consist of either re-shaping the bank to a more stable profile, addition of hard armor for scour protection, establishing robust vegetation to protect and hold soil, or some combination of these alternatives. Any work conducted within a stream channel will require coordination with the U.S. Army Corps of Engineers and Indiana Department of Environmental Management, in addition to the IDNR Division of Water. Figure 8-5 shows typical streambank stabilization techniques.

Figure 8-5 Typical Streambank Stabilization Techniques



Another alternative solution for addressing streambank erosion is the use of bendway weirs. These are longitudinal structures, placed in a stream channel, which are oriented to divert

the flow of water away from a sensitive bank. Bendway weirs can be constructed of groups of logs secured to the stream channel or piles of stone.

The proposed solutions described in this section are preliminary only. Upon choosing specific streambank restoration sites, detailed information will need to be collected and each site will need to be analyzed separately. Detailed information needed for a final design would be as follows:

- Channel cross sections at each restoration site, including location of private features, property corners, and nearby utilities.
- Hydraulic analysis for each restoration site, including velocity calculations and shear stress calculations for more frequent (i.e. 1-year, 2-year) recurrence interval rainfall events.
- Soil analysis for each restoration site.
- Determination of land availability (i.e. easements, right-of-way, and land acquisition) for proposed grading.
- Determination of construction access points.
- Public input on proposed improvements (most important when improvements are immediately adjacent to existing homes)

The following is a discussion of the identified stream erosion problem areas and potential solutions. The identified erosion problem areas are shown on the Problem Inventory Map at the end of Chapter 7.

8.5.1 Erosion Area E-1 through E-4 and E-8 – Stream and Swale Buffers

Solutions intended to protect streams and rivers from the introduction of sediment are typically comprised of a vegetated strip oriented parallel to the watercourse. These vegetative buffers are intended to intercept sediment and other pollutants. Buffers are most commonly associated for stream and large channels; however the concept can be applied in agricultural areas. The field inspections of the Hinkle Creek Watershed found erosion issues in agricultural field swales where buffers should be considered. These locations identified as E-1, E2, E3, E4, and E8 can be found on the Problem Inventory Map at the end of Chapter 7.

While vegetative stream buffers can contain any combination of woody or herbaceous species, some common associations include cool season or turf grasses, warm season or native prairie grasses, and combinations of trees and shrubs. Each of these common associations is appropriate for specific circumstances which are summarized below.

- ***Cool season or turf grass buffers*** typically have a low height at maturity (3 feet or less) making them good solutions for areas where visibility or vehicle access are critical. They also tend to be inexpensive to plant and maintain, often only requiring annual or semiannual mowing. Additionally, these grasses form a dense thatch of vegetation and grow during conditions too cool for other plants, providing protection

against sediment throughout the year. This combination of factors make cool season grasses an effective, economical, and frequently used solution for stream buffers.

- *Warm season or native prairie grasses* are characterized by being relatively tall at maturity (4 feet or taller) and having a very deep fibrous root system which allows a great range of drought tolerance. These species are varieties of grasses which would have been native to Central Indiana and include big bluestem (Andropogon gerardii), little bluestem (Schyzachyrium scoparium), Indian grass (Sorghastrum nutans), switch grass (Panicum virgatum), and prairie cord grass (Spartina pectinata). Similar to turf grasses, native warm season grasses form a dense mat of vegetation which is highly effective at intercepting and filtering pollutants. However, their height, which can be valuable as wildlife habitat can restrict visibility and vehicular access. The seed for these species is also more expensive and requires a specific seed drill to plant. Although not essential, these species typically perform best when managed with prescribed burning which may not be feasible in some locations.

- *Forested riparian corridors* in central Indiana are most commonly remnant tracts in areas where agricultural tillage is not feasible due to steep slope or other factors. However, with the development of conservation agricultural and tillage practices, some producers and land owners are planting trees adjacent to stream corridors. Woody vegetation produces large, strong root systems which can be highly effective at stabilizing soil. However, tree and shrub communities should be used in conjunction with an herbaceous ground cover. Factors of interest for individuals considering woody species as vegetative buffers include the cost and difficulty of installation. Additionally, Regulated Drains within Hamilton County are under the authority of the County Surveyor. Because the County Surveyor has the responsibility for maintenance of Regulated Drains, planting trees within the 75 foot wide easement located on each side of a Regulated Drain is not permitted.

8.5.2 Erosion Area E-5 – Bank Stabilization

Erosion Area E-5 was identified as an area of streambank erosion on the outside of a bend near the confluence of the William Baker Drain to Hinkle Creek. This location is labeled in the Problem Inventory Map at the end of Chapter 7. This area is located adjacent to a wooden deck and appears to be approaching the support posts of the deck. Due to the steep slope of the bank, stabilization is likely to require re-shaping or installation of hard armor, or a combination of both. This requirement may result in the need to remove the wooden deck.

Recommendations for stabilization of this area consist of regrading of the bank, effectively reducing the slope to a more stable gradient. At a minimum, hard armor is recommended for the toe of slope to an approximate height of 6 feet above the base of the stream channel. This armor could consist of rip-rap or other similar angular stone keyed into the channel to

prevent head cutting by the passing current. Above the hard armor, it is recommended that native vegetation suitable for a riparian corridor be established to the re-graded top of bank.

8.5.3 Erosion Area E-6 – Bank Stabilization

E-6 was identified as an area of streambank erosion located on the outside of a bend in Hinkle Creek approximately 2000 feet upstream of Anthony Road. This location is labeled in the Problem Inventory Map at the end of Chapter 7. This area is located immediately downstream of a culvert approximately 70 inches in diameter. Based on visual inspection of the culvert and channel downstream, the concentrated flow resulting from the culvert may be contributing to the observed erosion.

As with Area E-5, the recommended solution for E-6 consists of reshaping the eroded bank of Hinkle Creek to reduce the existing severe slope. A potential complication of this course of action is the existence of a fence and out building located within approximately 40 feet of the current top of bank. After the reshaping of the bank, it is proposed that hard armor be installed from the toe of slope to a height of approximately 6 feet, and keyed into the base of the stream channel. Above the hard armor, it is recommended that native vegetation suitable for a riparian corridor be established to the re-graded top of bank. Because the upstream culvert pipe appears to be contributing to the observed erosion in E-6, it is also recommended that this structure be replaced with a structure of size and shape that will minimize the concentration of downstream flow and potential for future erosion.

An additional consideration for protection of the eroded area is the installation of bendway weirs upstream of the eroded bank to redirect flow away from the damaged streambank. This method may be an effective alternative to replacement of the culvert, but would still be most effective in combination with the installation of hard armor and establishment of native vegetation.

8.5.4 Erosion Area E-7 – Bank Stabilization

E-7 was identified as an area of exposed streambank having little or no vegetation to provide soil stability and prevent erosion. This is adjacent to the Hinkle Creek Apartments and is labeled in the Problem Inventory Map at the end of Chapter 7. Based on observations, this lack of vegetation appeared to have been the result of herbicide application and mowing associated with residential lawn care. The recommended solution for this area consists of cessation of mowing within 20 feet of the top of bank and installation of native woody vegetation within this corridor. The proposed measures are intended to establish robust vegetation to improve soil stability and prevent future erosion.

CHAPTER 9 RECOMMENDATIONS

9.1 INTRODUCTION

This chapter summarizes recommendations for the Hinkle Creek Watershed. The recommendations were built on the problem identification and solution development chapters.

9.2 RECOMMENDATIONS

9.2.1 Cost Estimating Approach

Estimated costs for the recommended practices were developed based on actual costs to construct similar practices throughout Indiana. Streambank stabilization costs are largely dependent upon the size and flow regime of the stream, as well as the severity of the necessary repairs. Therefore, estimated costs for streambank stabilization are provided in a range, comprising a variety of situations. Similarly, wetland construction costs are functions of the volume of soil to be excavated, desired plant community, and any water control structures required to manage wetland hydrology. As with the streambank stabilization, a range of costs, inclusive of a variety of conditions will be provided for constructed wetlands and regional detention basins.

Type of Stream	Low Intensity Stabilization	Hard Armor	In Stream/Bendway weirs
Intermittent Streams	$150-$200/lf	$200-$300/lf	NA
Perennial Streams	$200-$250/lf	$250-$300/lf	$400-$600/lf

Intermittent Streams

Intermittent streams are those characterized by flow only following a storm event. Sometimes referred to as seasonal, intermittent streams are those having flowing water for only a portion of the year. As such, intermittent streams are generally more narrow and shallow than perennial streams.

Because of their relatively smaller size, costs for stabilization of intermittent streams are generally lower than those of perennial streams. Additionally, stabilization practices can be divided into those which do and do not employ hard armor. Instances where streambanks can be stabilized by bank reshaping require sufficient room at the top of bank to create a less severe slope. After a stable grade has been established, erosion control blanket or mat should be installed to provide temporary protection during the development of permanent

vegetation. Typical costs for reshaping and stabilizing intermittent streambanks with native vegetation range from $150 to $200 per lineal foot.

In situations where space limits or prohibits moving the top of bank to a suitably stable grade, hard armor may be required. Hard armor may take many forms including rip-rap, gabion baskets, sheet piling, or one of many interlocking precast concrete products. Hard armor is typically recommended to be keyed into the stream channel, approximately 12 to 24 inches below the existing toe of slope. Depending on the severity of the slope, the armor may extend only partially up the bank or to the top of bank. Traditional erosion control mat/blanket and permanent vegetation are required above the hard armor. Typical costs for stabilization of intermittent streams with hard armor range from $200 to $300 per lineal foot.

Perennial Streams

Perennial streams are defined as those having flow or at least containing water throughout the entire year. The limitations and constraints associated with perennial streams are similar to those inherent to intermittent streams, although they typically exist on a larger scale. Therefore, practices such as reshaping banks and the employment of hard armor are also feasible, albeit on a commensurate scale. The typical costs associated with the reshaping of perennial streambanks and stabilization with vegetation range from $200 to $250 per lineal foot. Typical costs of stabilizing perennial streambanks with hard armor range from $250 to $300 per lineal foot.

Because perennial streams convey comparatively larger volumes of water than intermittent streams, the use of in-stream flow modification may be an appropriate practice. These flow modifications or bendway weirs are constructed in a stream channel to divert flow away from sensitive banks and are often used in conjunction with other stabilization practices. Typical costs of bendway weirs range from $400 to $600 per lineal foot.

Constructed Wetlands

Restored or constructed wetlands can serve a vital role in improving water quality, removing sediment, and alleviating flooding within a watershed. Cost estimates of wetland construction are contingent upon several factors including the volume of soil to be excavated, anticipated vegetation community, and the need for water control structures used to manage hydrology. In general, constructed wetlands do not exceed 24 inches in depth and are sited in locations containing topography suitable for the collection and detention of surface runoff.

While costs associated with wetland construction will vary based on individual site characteristics, typical costs range from $40,000 per acre to $65,000 per acre. Costs for the construction of emergent wetlands will be on the lower end of this range while wetlands containing woody vegetation (shrubs and trees) will be on the higher end of the range. The

following table provides a general summary of wetland construction costs by vegetation type. Please note that these costs include the installation of live herbaceous plant material rather than reliance exclusively on seeding for the establishment of an herbaceous understory.

Type of Wetland	Cost
Emergent Wetland	$40-45,000/ac
Shrub Wetland	$45-55,000/ac
Forested Wetland	$50-65,000/ac
Regional Detention	$70-90,000/ac

Regional Detention

Construction of regional detention basins is very similar to the construction of emergent wetlands. The primary differences between the two relate to the capacity of water each are intended to hold. Constructed wetlands are typically not intended to exceed 24 inches in depth, and more commonly are designed with normal pool depths ranging from 6 to 18 inches. Regional detention, however, is focused on the containment of comparatively larger volumes of water, necessitating greater depth and, consequently more excavation. Similarly, the larger volumes of water may also require more robust infrastructure for inlet and outlet structures. These distinctions translate to higher overall construction costs, when compared to constructed wetlands. Therefore, costs for construction of regional detention are anticipated to range from $70,000 to $90,000 per acre.

Stream Buffers

Stream buffers consist of herbaceous vegetation installed in a strip adjacent to a stream channel. Indiana Code (IC 36-9-27-33) stipulates that trees or other woody vegetation may not be planted within the easement of a Regulated Drain. Stream buffers are typically installed over existing topography and as such do not require alterations to existing grading. Based on estimates compiled by the NRCS, the cost of installing grass stream buffers is approximately $300 per acre. Furthermore, installation of Certified Filter Strips, per IC 6-1.1-6.7 allows for reclassification of the property tax base for the area planted, effectively providing an overall property tax reduction.

Grass Waterways

Grass waterways contain elements of streams in that they are intended to convey water following storm events, but differ in that they are comparatively shallow and dominated by robust vegetation. Although waterways are typically located in natural drainage pathways, grading is often necessary to establish a stable slope prior to planting. For this reason, grass waterways can be significantly more costly to construct than stream buffers. The NRCS estimates installation costs for grass waterways to be approximately $2,500 per acre.

9.2.2 Summary of Recommendations

The Hinkle Creek Watershed Master Plan looked at various data across the watershed, water quality samples, hydrologic/hydraulic models, and requested input from the public about water problems in the area. The following list shows the general recommendations in the Hinkle Creek Watershed:

- Implement stream and swale buffers at identified locations and promote throughout the watershed.
- When new bridges are required to be replaced, utilize designs that will reduce backwater from the structure.
- Add 2 gage stations along Hinkle Creek and 1 gage station along the Isaac Jones Drain.
- Conduct additional water quality samples in the watershed.
- Increase the regulated floodplain limits from the 100-year floodplain area to the 500-year floodplain.
- Extend regulated drains to cover un-regulated streams and along Hinkle Creek to Morse Reservoir in areas that are un-regulated.
- Keep following the Stormwater Management Ordinance and Technical Standards and adopt the Chapter 700 Channel Protection and Water Quantity chapter.
- Continue public outreach and education on the importance of water resources and the benefits of protecting the watershed.
- Look for opportunities for regional detention/constructed wetlands as the watershed develops.

Specific recommendations and Capital Projects are summarized in Table 9-1.

Table 9-1 Summary of Recommendations

RECOMMENDATION	SITE SPECIFIC	COST	WHEN	MASTER PLAN SECTION
Replace Anthony Road Structure over Hinkle Creek to reduce floodplain at the Hinkle Creek Apartments	Yes	$750K(2)	End of Current Bridge Life	8.4.1
Replace 236th Street Structure over Hinkle Creek to reduce floodplain at the Hinkle Creek Apartments	Yes	$750K(2)	End of Current Bridge Life	8.4.1
Replace structure at 225th over Hinkle Creek Street to reduce backwater	Yes	$1.2M(2)	End of Current Bridge Life	8.4.3
Replace structure at Deming Road over Hinkle Creek to reduce backwater	Yes	$1.0M(2)	End of Current Bridge Life	8.4.3
Implement Stream and Swale Buffers for Erosion Area E-1 through E-4 and E-8	Yes	$150K-$225K	ASAP	8.5.1
Implement Bank Stabilization/Erosion Control Projects for Erosion Area E-5	Yes	$90K	ASAP	8.5.2
Implement Bank Stabilization/Erosion Control Projects for Erosion Area E-6	Yes	$45K	ASAP	8.5.3
Implement Bank Stabilization/Erosion Control Projects for Erosion Area E-7	Yes	$30K	ASAP	8.5.4
Other Unidentified Stream and Swale Buffers(3)	No	$250K	Continuing	8.3.4
Implement discussed land use practices to further protect the watershed quality	No	NA	As Watershed Develops	8.3.1
Educate the public on the benefits of protecting the watershed	No	Included with Ham. Co. Outreach	Continuing	8.3.2
Conduct additional and continuing water quality samples in the watershed	No	$5K-$10K/YR	Immediate	8.3.3
Promote the use of Stream and Swale Buffers throughout the watershed	No	NA	Immediate	8.3.4
Add two (2) Gaging Station along Hinkle Creek	No	$24K	Immediate	8.3.5
Add one (1) Gaging Station along Isaac Jones Drain	No	$12K	Immediate	8.3.5
Regional Detention Facilities/Constructed Wetlands	No	NA	As Watershed Develops	8.3.6/8.3.7

Notes:

1. All costs are estimated in 2013 dollars and not extrapolated to future costs.
2. The costs listed for structure replacement are approximately double the cost to replace the existing structure in-kind in order to reduce backwater significantly.
3. This is an undistributed amount for additional stream and swale buffers.

9.3 IMPLEMENTATION PLAN

9.3.1 Bridge Improvements

Bridge improvements noted in Table 9-1 should be implemented when the bridges reach their useful design life or when roadway improvements in the area allow for bridge replacement. These bridges are along Hinkle Creek at 225th Street, Deming Road, 236th Street, and Anthony Road. Cost estimates were based on increasing the size of the structure in order to significantly reduce backwater. The following criteria will be required for implementation:

- New bridge designed shall be modeled to maximize the reduction in the floodplain for the 100-year flood event.
- New bridge design shall be designed and constructed to minimize negative impacts to water quality during and after construction.
- An IDNR construction in the floodway permit should be obtained.

9.3.2 Streambank Erosion Projects

Streambank erosion projects are generally autonomous in that they are not typically linked to other infrastructure projects such as bridge replacements. Therefore, stream erosion projects can be completed as funding is available and seasonal conditions permit. The current state of the identified streambank erosion areas, their contributions to sedimentation downstream, and relative flexibility of scheduling these projects suggest that improvements in these areas should be of high priority. The following criteria will be required for implementation:

- All streambank erosion repairs shall be coordinated with the property owner.
- Streambank erosion repairs shall be designed and constructed to minimize negative impacts to water quality during and after construction.
- Section 404/401 permits shall be obtained from the USACE and IDEM prior to initiation of any work within a stream channel.
- Coordination with the IDNR shall be completed to determine if a construction in a floodway permit is required.

9.3.3 Regional Detention/Constructed Wetland Projects

Regional detention and/or constructed wetlands will be implemented as the watershed develops. The best opportunities will be to incorporate these projects into specific site development projects whereby the facility can meet the detention and water quality requirements for both the specific site as well as regional watershed benefit. Also, it may be possible to use excavated materials from the project to meet fill requirements for the development. The following criteria will be required for implementation:

- A regional detention planning study should be performed that includes modeling of the facilities to assess effectiveness in reducing storm flows and increasing water quality.
- A site evaluation and wetland delineation should be performed.
- An IDNR construction in the floodway permit should be obtained.

9.3.4 Gaging Stations

The County needs to work with the USGS to install a gaging station within the watershed. The preferred location would be around 225th Street. The following criteria will be required for implementation:

- Work with USGS in implementation of the gaging station

9.3.5 Water Quality Sampling

Baseline water quality sampling should continue at the locations and intervals specified for the 2012 sampling. This will allow long term tracking of baseline water quality conditions throughout the watershed.

Additionally, wet weather sampling should be initiated following storm events. The wet weather sampling events should be conducted two to four times per year, with at least one event between March 15 and April 30 and at least one event between June 1 and July 31. The wet weather sampling events should occur at the previously established sampling points within 24 hours of a storm event which exceeds 0.10.

9.3.6 Regulations and Planning

Implementation of some portions of the watershed management plan may require revisions to various City/County regulations. The following is a list of alternatives for consideration:

- Move regulation of development from the 100-year floodplain to the 500-year floodplain.
- Increase drainage assessments for those who farm steep slopes.
- Require the installation and maintenance of vegetative buffers adjacent to all USACE jurisdictional streams and County Regulated Drains.
- Require wetland delineation by a qualified professional on any site prior to development.
- Require wetland mitigation at a higher ratio than required by the USACE and IDEM.
- Require additional monitoring and maintenance of wetland mitigation sites.
- Increase wetland buffer and setback requirements.
- Update the Stormwater Management Ordinance and technical standards to include removal requirements for specific contaminants.
- Incorporate aspects of Low Impact Development/green infrastructure design into development regulations so as to comply with future anticipated USEPA stormwater regulations.

9.3.7 Education

Dissemination of information can be accomplished through a variety of means. Initially, changes to policies or regulations can be published in local print media. Beyond initial publication, the Hamilton County website can be used to distribute information such as:

- Floodway limits as defined by IDNR.
- Summaries of Section 404/401 Clean Water Act regulations as they apply to development and stream improvement projects.
- Fact sheets addressing septic system maintenance.
- Information explaining the benefits of vegetated buffers and grass waterways as well as resources useful for designing these features.

- Links to information on various USDA conservation programs.

- Information outlining opportunities for wetland and stream mitigation, possibly including mapping.

9.4 GENERAL DISCUSSION OF FUNDING OPTIONS

Each of the recommended practices listed above is suitable for specific situations. For example, stream buffers and grass waterways are commonly established by individual land owners. Conversely, some practices, by virtue of their size, intensity of land use, and cost will be suitable only on a large scale. Constructed wetlands and regional detention are more likely to be employed on a landscape scale rather than by an individual land owner. The following section summarizes potential sources of funding for the recommended practices

9.4.1 USDA Farm Service Agency/Natural Resources Conservation Service

The USDA, through the Farm Service Agency and Natural Resources Conservation Service oversees several programs intended to facilitate conservation practices on private lands. The following list summarizes some of the programs available to private land owners throughout Indiana:

- Conservation Reserve Program (CRP) – Various practices ranging from waterways and stream buffers to whole field set aside. Compensation may be available for loss of crop production as well as cost share for establishment. Enrollment is based on nationwide allocation of funding for practices.

- Conservation Reserve Enhancement Program (CREP) – An adaptation of CRP, more narrowly focused to address specific regional conservation concerns, rather than nationwide enrollment.

- Wetland Reserve Program (WRP) – Similar to CRP but specific to wetland restoration in areas where agricultural practices have converted wetlands to tillable land.

9.4.2 Independent Conservation Organizations

Independent conservation organizations can vary in their stated interests and missions, but may have common goals of improved water quality or reductions in flooding events. Watershed groups such as Friends of the White River have a stated interest in protecting the White River. Collaboration with watershed improvement projects in the Hinkle Creek Watershed would be practical implementation of that purpose.

Although not directly intended to improve water quality, organizations formed for the preservation and establishment of wildlife habitat may find that by supporting watershed

improvement practices, their stated interests are also supported. The following list summarizes potential collaborators for watershed improvement projects:

- Pheasants Forever/Quail Forever – An organization dedicated to the establishment and preservation of upland bird habitat. Potential collaborator for stream buffer projects. Local chapters often have access to specialized planting and seeding equipment for native grass installation.

- Whitetails Unlimited – An organization focused on improving habitat for white tailed deer, Whitetails Unlimited could also be a collaborator for stream buffer projects.

- Ducks Unlimited – An organization focused primarily on waterfowl and wetland habitat. Ducks Unlimited has been a partner with conservation departments in multiple states, providing both engineering and technical resources for wetland restoration and creation.

9.4.3 Hamilton County Drainage Board

The Hamilton County Drainage Board manages annual budgets for the maintenance of regulated drains within Hamilton County. If specific improvement projects are identified, funding may be made available for implementation by the Drainage Board.

9.4.4 Private Development

Subject to the provisions of Section 404/401 of the Clean Water Act and Indiana Isolated Wetland regulations, private developers are required to mitigate for impacts to jurisdictional "waters of the U.S." and isolated wetlands within Indiana. Mitigation must be in-kind and occur within the same 8-digit watershed as the impacts. Coordination with private developers who may be in search of mitigation opportunities could be an effective source of funding for completing some of the wetland construction and stream restoration projects identified in this document.

9.5 CONCLUSIONS

The Hinkle Creek Watershed Master Plan reviewed watershed-wide stormwater needs and identified recommendations that include projects to reduce sedimentation in Morse Reservoir, reduce or eliminate flooding at structures, control streambank and field erosion, and enhance water quality.

Recommendations are geared at preparing the watershed for future changes and addressing the immediate needs. Immediate needs include addressing erosion issues in the streams and fields that contribute to sediment build up in Morse Reservoir. Long term projects such as regional detention and wetlands can be incorporated as development occurs. The following recommendations have been made and are detailed further in Chapters 8 and 9:

Site-Specific Erosion Solutions

- *Stream and Swale Buffers at 5 Locations ($150K-$225K)*
- *Stream Bank Stabilization at 3 Locations ($175-$250K)*
- *Various Structure Upgrades to Reduce Backwater Flooding*
  - *Replace Anthony Road Structure over Hinkle Creek to reduce floodplain at the Hinkle Creek Apartments ($750K)*
  - *Replace 236th Street Structure over Hinkle Creek to reduce floodplain at the Hinkle Creek Apartments ($750K)*
  - *Replace structure at 225th over Hinkle Creek Street to reduce backwater ($1.2M)*
  - *Replace structure at Deming Road over Hinkle Creek to reduce backwater ($1.0M)*

(Note: All of these structures are in good condition currently. These improvements are recommended for consideration at the end of existing structures' current design life.)

Watershed-Wide Recommendations

- *Implement stream and swale buffers at identified locations and promote throughout the watershed.*
- *When new bridges are required to be replaced, utilize designs that will reduce backwater from the structure.*
- *Add 2 gage stations along Hinkle Creek and 1 gage station along the Isaac Jones Drain.*
- *Conduct additional water quality samples in the watershed.*

- *Increase the regulated floodplain limits from the 100-year floodplain area to the 500-year floodplain.*
- *Extend regulated drains to cover un-regulated streams and along Hinkle Creek to Morse Reservoir in areas that are un-regulated.*
- *Keep following the Stormwater Management Ordinance and Technical Standards and adopt the Chapter 700 Channel Protection and Water Quantity chapter.*
- *Continue public outreach and education on the importance of water resources and the benefits of protecting the watershed.*
- *Look for opportunities for regional detention/constructed wetlands as the watershed develops.*

APPENDIX A MORSE RESERVOIR REPORT EXCERPT

Morse Reservoir/Cicero Creek Watershed Management Plan

Boone, Clinton, Hamilton, and Tipton Counties, Indiana

February 2011

Prepared by:
V3 COMPANIES

Prepared for:
UPPER WHITE RIVER WATERSHED ALLIANCE
MORSE WATERWAYS ASSOCIATION

Morse Waterways Association

[redacted]

the subwatershed scale. And part three of the watershed inventory summarizes and explains the relationships of the data gathered in parts one and two.

Identify Problems and Causes

Problem statements were developed during the planning process in an effort to link watershed concerns with existing and historical water quality data. Four major concern categories were identified during this process.

1. Stakeholders in the Morse Reservoir/Cicero Creek Watershed are not knowledgeable about their daily impact on the watershed and its water quality.
2. Agriculture and typical urban area practices (i.e. lawn care, pet waste disposal, erosion control during construction...etc.) within the watershed contributes a significant amount of pollutants, thereby contributing to the frequent exceedances of water quality targets and growth of algae within the reservoir.
3. *E. coli* levels in the watershed regularly exceed the state standard, based on current and historical water quality data results, and often exceed safety standards for recreational use in streams.
4. Soil erosion and sedimentation within the watershed is degrading the water quality/quantity and limiting the aesthetics, wildlife habitat, and aquatic health of the streams and reservoir within the watershed.

Watershed Goals

Based on the identified concerns and possible sources, goal statements were developed for each problem statement. Implementation of policies and programs to meet these goal statements will improve watershed management in the Morse Reservoir/Cicero Creek Watershed.

The goal statements indicate the ultimate goal for a specific project. In some cases this goal may not be obtainable in the short term; therefore there a list of short term and long term objectives were included with each goal.

1. Develop and implement an education and outreach program within the watershed.
2. Reduce the nutrient loads so that there are no exceedances of EPAs suggested targets for Nitrate + Nitrite of 1.6 mg/L and Total Phosphorus of 0.076mg/L.
3. Reduce *E. Coli* concentrations to meet the state standard of 235 CFU/100mL.
4. Reduce sediment loads to meet the IDEM statewide draft TMDL target of 30 mg/L for TSS.

Critical Areas

Critical areas are defined as areas where project implementation can remediate current water quality impairments or reduce the impact of future water quality impairments. The critical areas within the Morse Reservoir/Cicero Creek watershed were identified based on the Watershed Inventory, the identified problems and the goals of the Watershed Management Plan. Critical areas were split into two categories: Subwatershed Critical Areas and Specific Source Critical areas.

High Priority Subwatersheds
Little Cicero Creek
Tobin Ditch
Teter Branch
Morse Reservoir/Cicero Creek

Medium Priority Subwatersheds
Cox Ditch
Prairie Creek
Hinkle Creek

Low Priority Subwatersheds
Buck Creek
Dixon Creek
Weasel Creek

Specific Source Critical Areas
Livestock Access
Absent or Insufficient Stream Buffers
Excessive Streambank Erosion
Agricultural Areas Practicing Conventional Till

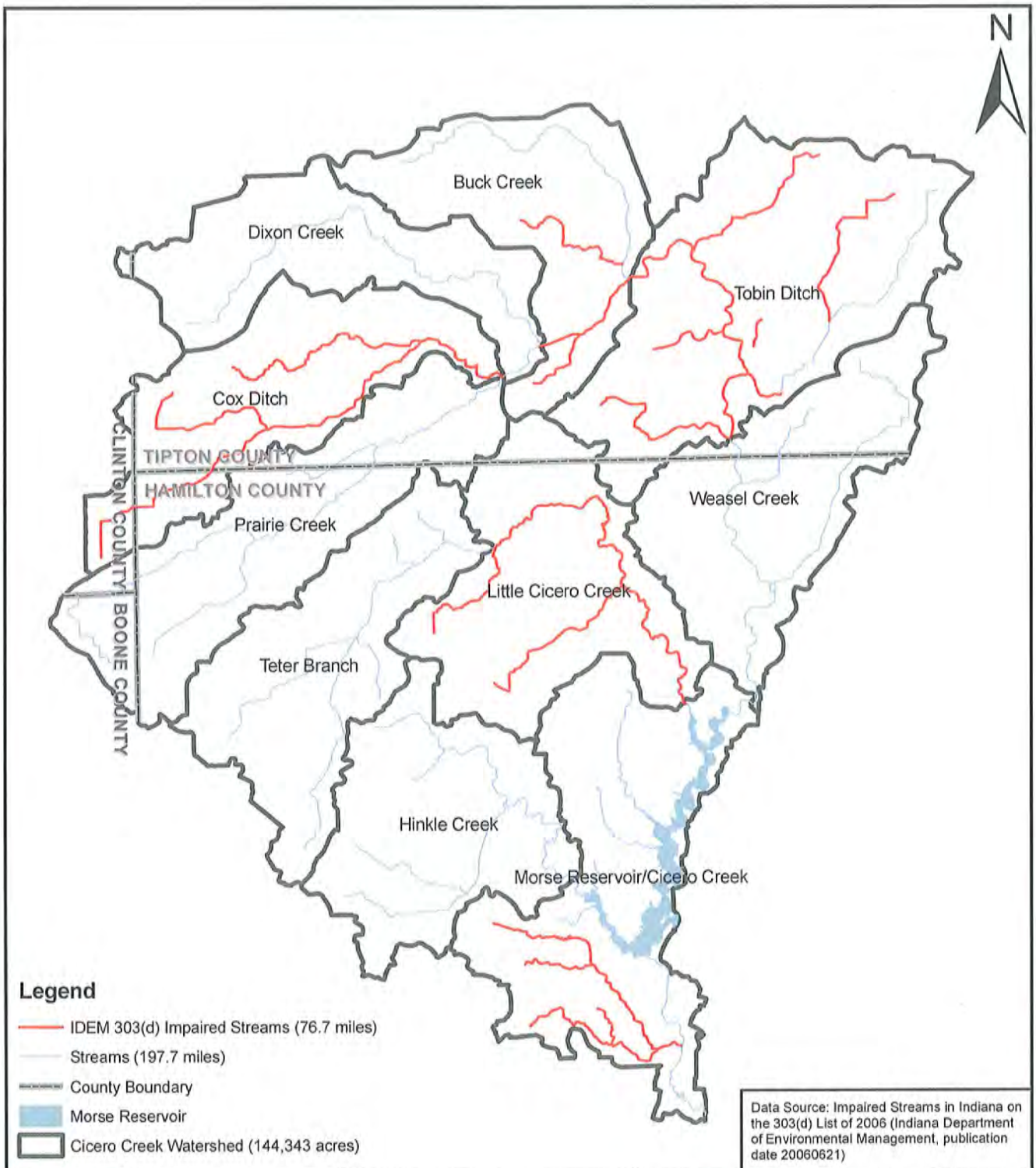
Best Management Practices

To choose an appropriate BMP, it is essential to determine in advance the objectives to be met by the BMP and to calculate the cost and related effectiveness of alternative BMPs. Once a BMP has been selected, expertise is needed to insure that the BMP is properly installed, monitored, and maintained over time.

BMPs identified for implementation within the Morse Reservoir/Cicero Creek Watershed were divided into two categories: Agricultural/Rural and Urban, with cost estimates and pollutant removal rates provided for each BMP.

Action Register and Schedule

The success of a watershed management plan can be measured by how readily it is used by its intended audience and how well it is implemented. The Morse Reservoir/Cicero Creek WMP is very ambitious and continued implementation of the plan will require and even greater degree of cooperation and coordination among partners and funding for projects. The action register is a tool used to easily identify each objective, milestone, estimated cost, and possible partners for easier implementation of the plan.



Data Source: Impaired Streams in Indiana on the 303(d) List of 2006 (Indiana Department of Environmental Management, publication date 20060621)

V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
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TITLE: IDEM 303(d) Impaired Streams Map	PROJECT: Morse Reservoir/Cicero Creek Watershed Management Plan		
BASE LAYER: 303(d) Impaired Streams	PROJECT NO. 09005	EXHIBIT: 11	SHEET: 1 OF: 1
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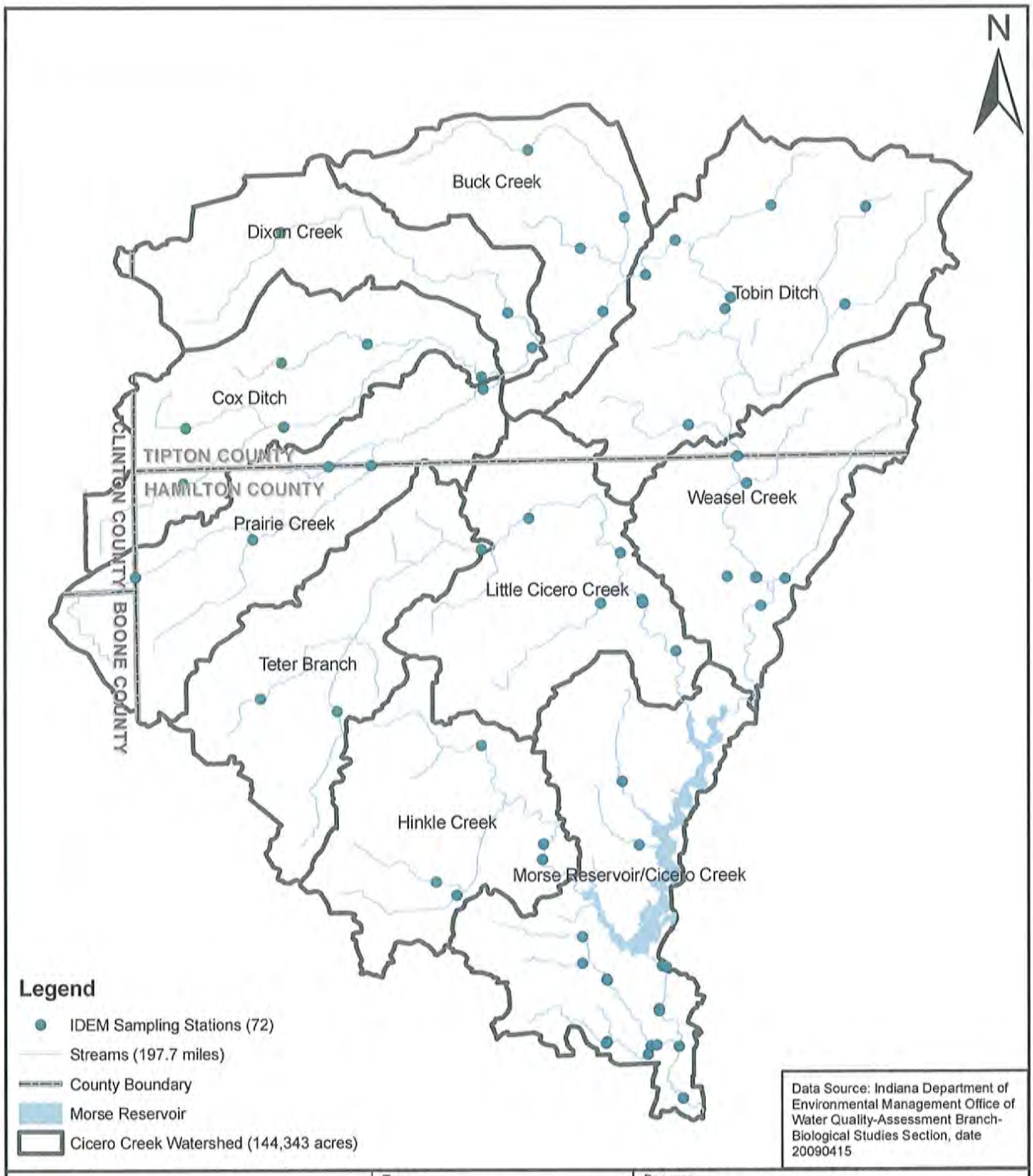

Data Source: Indiana Department of Environmental Management Office of Water Quality-Assessment Branch-Biological Studies Section, date 20090415

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7325 Janes Avenue
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TITLE: IDEM Sampling Stations	PROJECT: Morse Reservoir/Cicero Creek Watershed Management Plan		
BASE LAYER: IDEM Sampling Locations	PROJECT NO. 09005	EXHIBIT: 12	SHEET: 1 OF: 1
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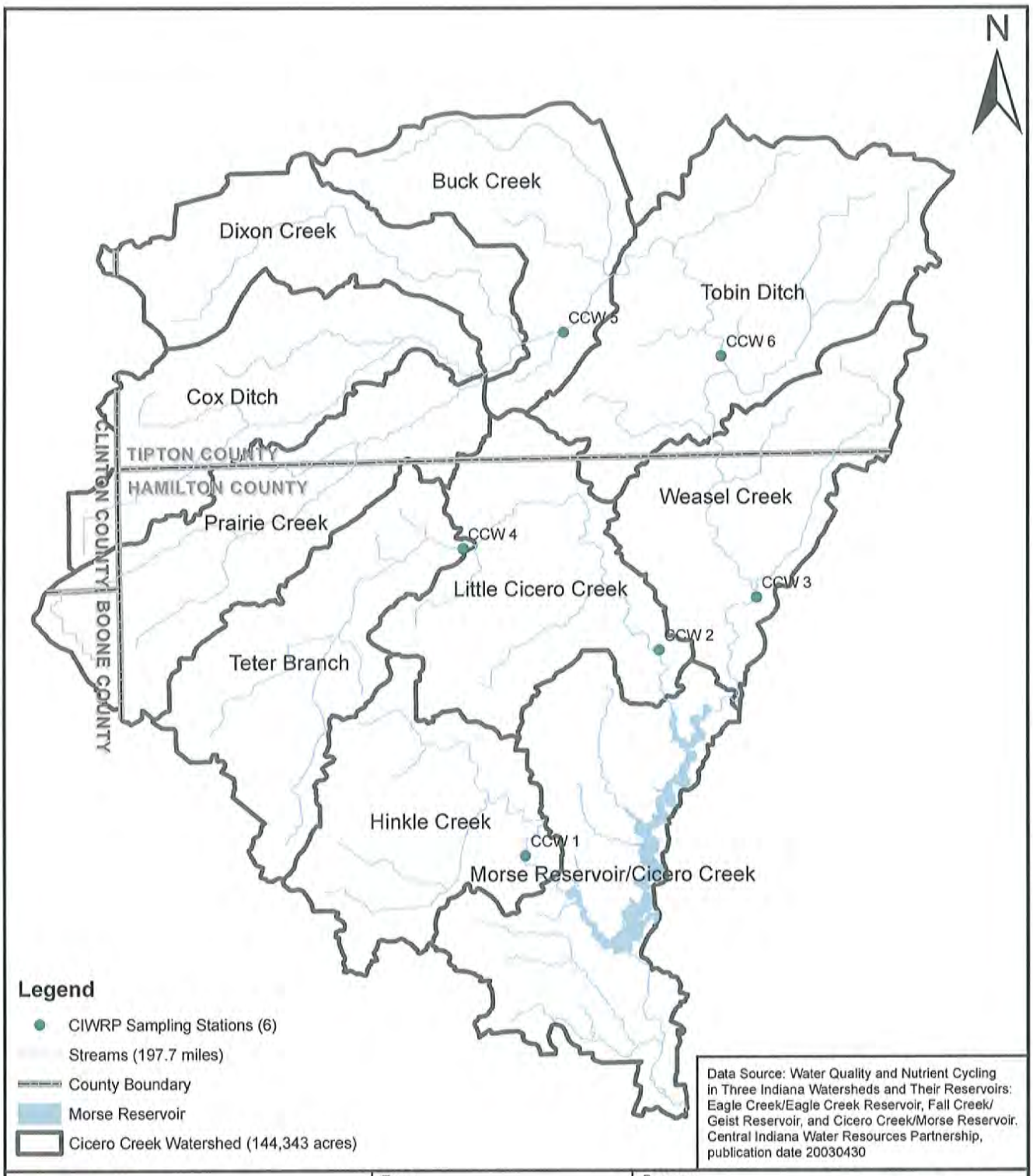

Data Source: Water Quality and Nutrient Cycling in Three Indiana Watersheds and Their Reservoirs: Eagle Creek/Eagle Creek Reservoir, Fall Creek/ Geist Reservoir, and Cicero Creek/Morse Reservoir. Central Indiana Water Resources Partnership, publication date 20030430

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TITLE: CIWRP Sampling Stations	PROJECT: Morse Reservoir/Cicero Creek Watershed Management Plan		
BASE LAYER: CIWRP Sampling Locations	PROJECT NO. 09005	EXHIBIT: 13	SHEET: 1 OF: 1
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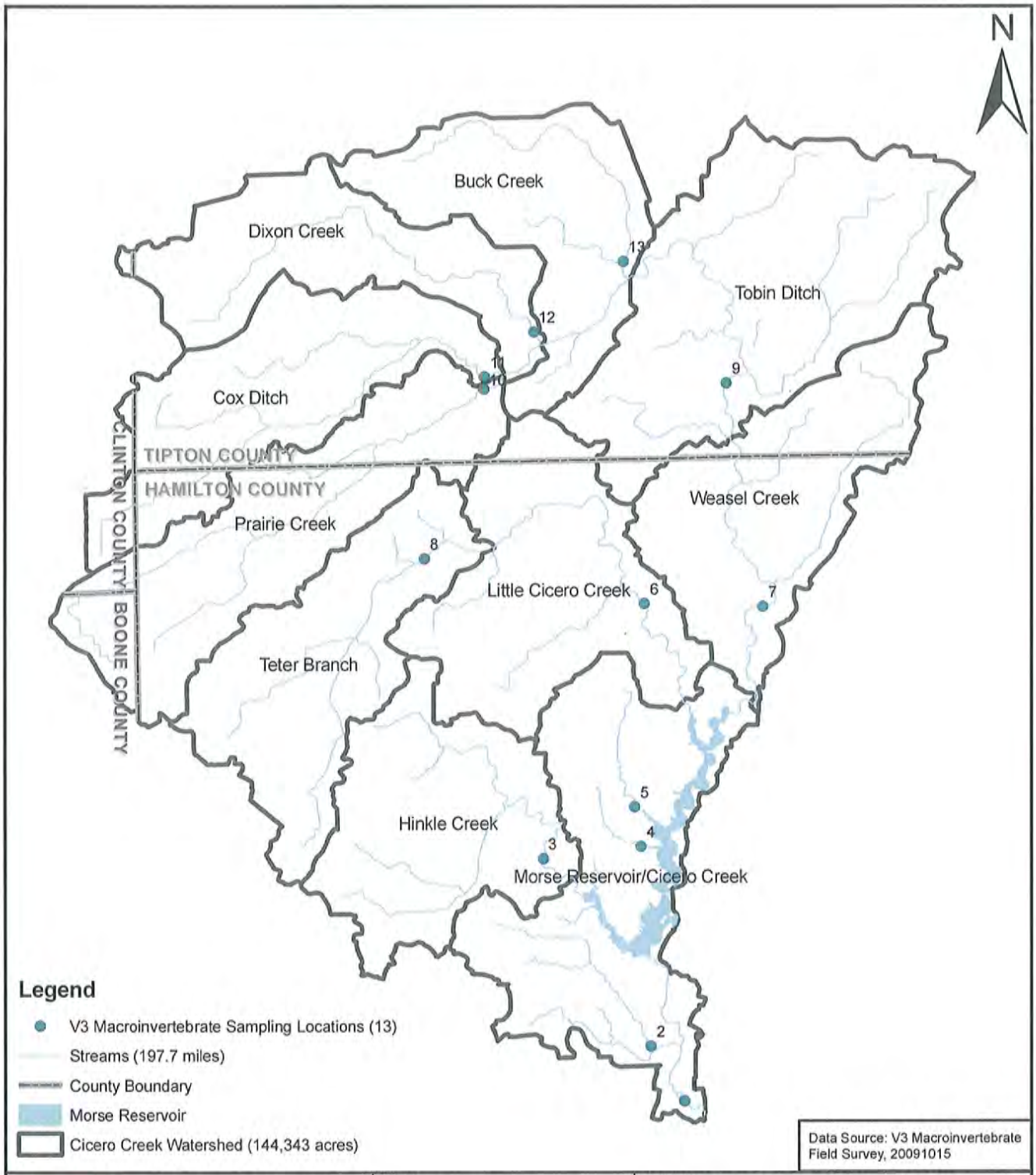

Data Source: V3 Macroinvertebrate Field Survey, 20091015

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7325 Janes Avenue
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TITLE: V3 Macroinvertebrate Sampling Stations	PROJECT: Morse Reservoir/Cicero Creek Watershed Management Plan		
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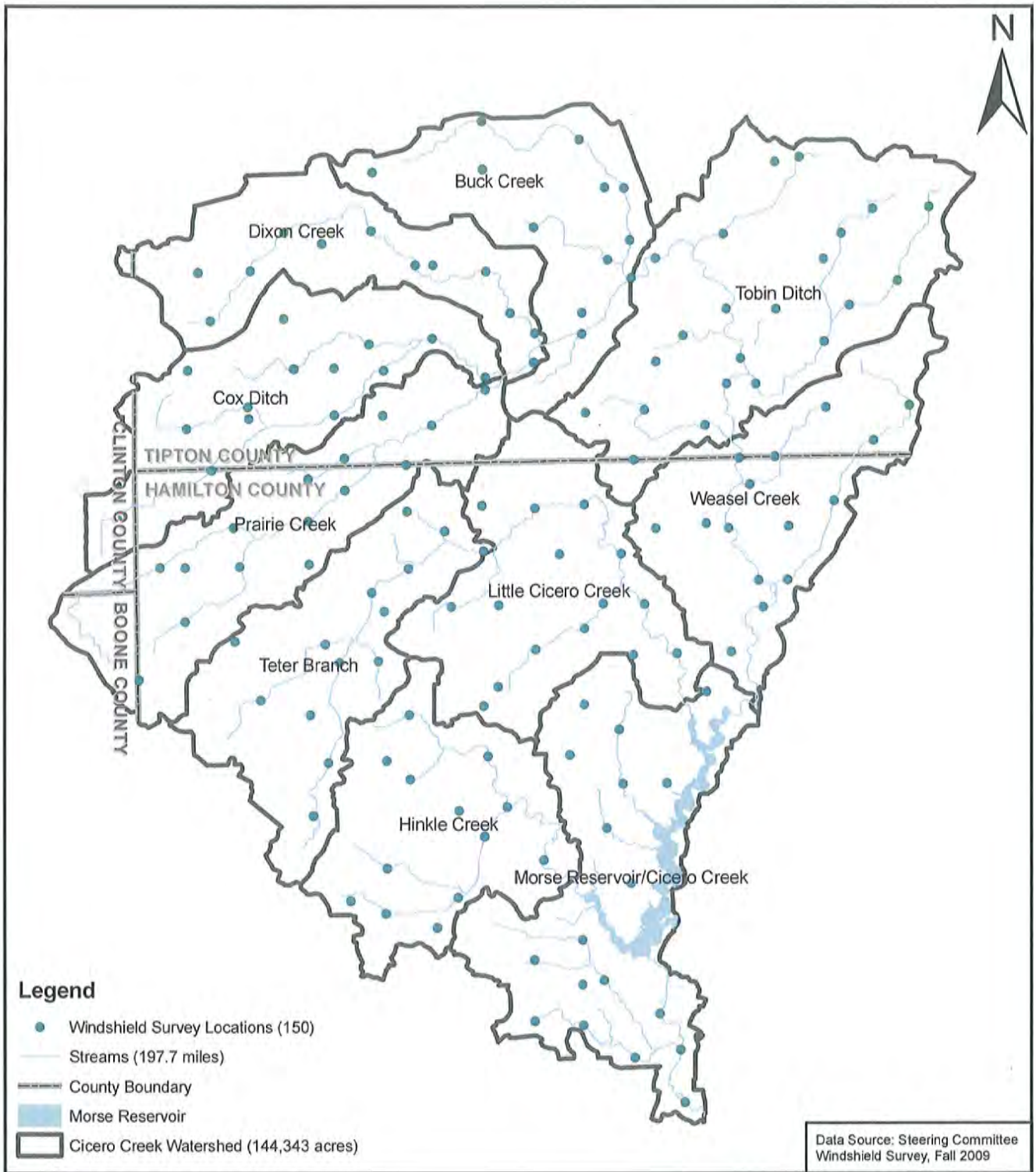

Data Source: Steering Committee Windshield Survey, Fall 2009

V3 Companies
7325 Janes Avenue
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630.724.9202 fax
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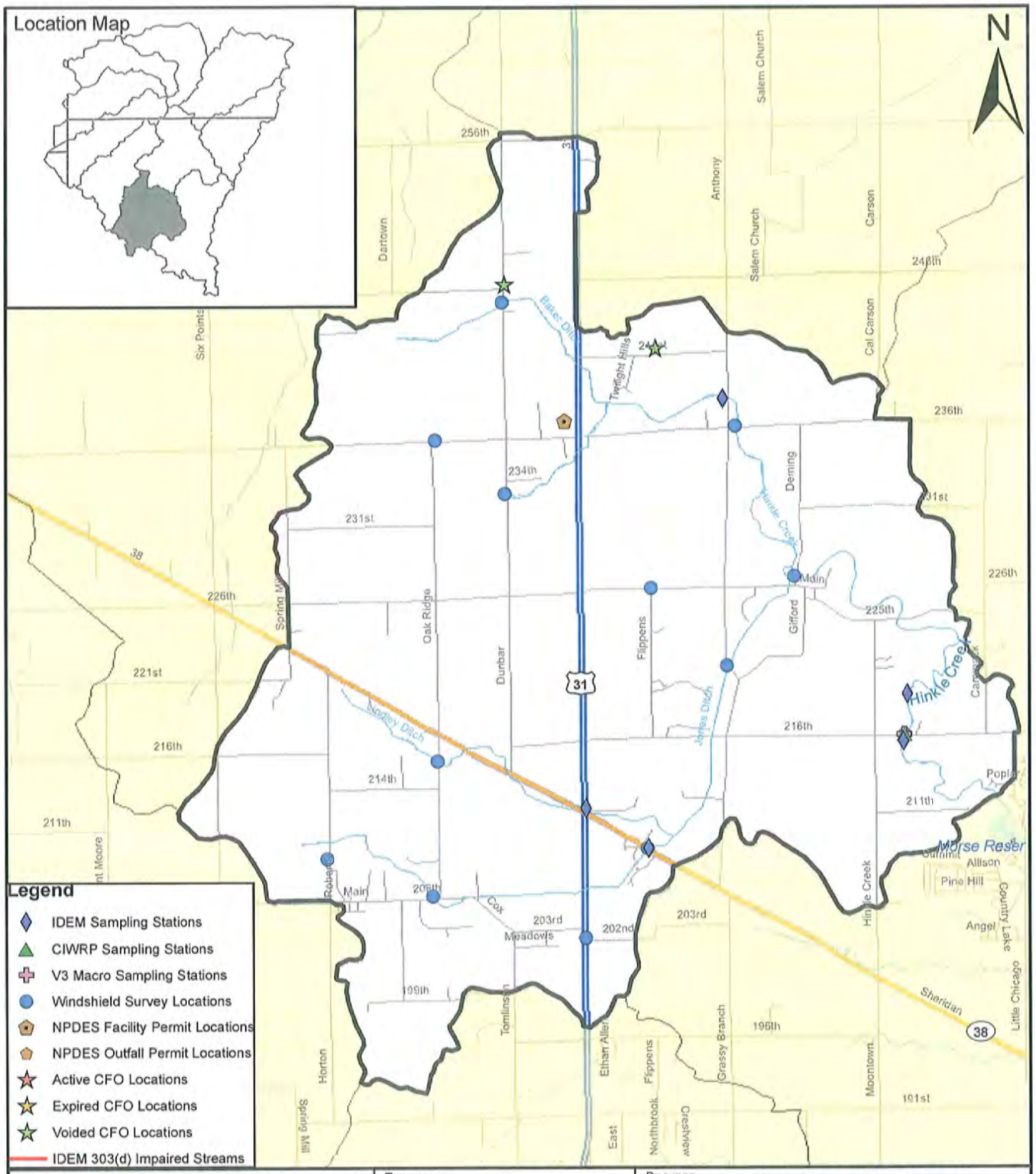
TITLE: **Windshield Survey Stations**	PROJECT: **Morse Reservoir/Cicero Creek Watershed Management Plan**		
BASE LAYER: Windshield Survey Locations	PROJECT NO. 09005	EXHIBIT: 15	SHEET: 1 OF: 1
CLIENT: Upper White River Watershed Alliance P.O. Box 2065 Indianapolis, Indiana 46206	QUADRANGLE: N/A	DATE: 09/27/10	SCALE: 1" = 15000'



V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
630.724.9202 fax
www.v3co.com

TITLE: Hinkle Creek Subwatershed Map (HUC-12: 051202010609)	PROJECT: Morse Reservoir/Cicero Creek Watershed Management Plan		
BASE LAYER: StreetMap USA	PROJECT NO. 09005	EXHIBIT: 25	SHEET: 1 OF: 1
CLIENT: Upper White River Watershed Alliance P.O. Box 2065 Indianapolis, Indiana 46206	QUADRANGLE: N/A	DATE: 09/27/10	SCALE: 1" = 5000'

A total of 5 IDEM water quality sampling stations are located within the Hinkle Creek subwatershed. Available IDEM data at these stations included sampling from the 2001 Corvallis and 2001 *E. coli* – Upper WFWR Studies and the 2006 IDEM *E.coli* sampling data for future Cicero Creek TMDL Study.

One sampling site is located within the Hinkle Creek subwatershed, CCW1.

Table 28 summarizes the IDEM and CIWRP sampling mean value of each parameter screened and the corresponding water quality target.

Table 28: Hinkle Creek IDEM and CIWRP Water Quality Sampling Summary

Water Quality Parameter	IDEM Mean Value	CIWRP Mean Value	Water Quality Target
Dissolved Oxygen	8.5 mg/L	11.5 mg/L	between 4.0 and 12.0 mg/L
E. coli	1919 CFU/100mL	4810 CFU/100mL	235 CFU/100mL
Nitrate + Nitrite	7.3 mg/L	2.7 mg/L	1.6 mg/L
pH	8.1	7.6	between 6.0 and 9.0
Total Phosphorus	0.186 mg/L	0.334 mg/L	0.076 mg/L
TSS	23.7 mg/L	32.9 mg/L	30.0 mg/L
Turbidity	14.4 NTU	32.8 NTU	10.4 NTU
Atrazine	Not Sampled	Not Sampled	0.003 mg/L

Based on the available water quality information, the Hinkle Creek subwatershed consistently tests higher than the water quality targets in *E. coli*, Nitrate + Nitrite and Total Phosphorus. TSS tested higher than the water quality targets in the CIWRP Study however it tested lower in the IDEM data. Dissolved Oxygen and pH fall within the acceptable ranges and therefore are not a concern for this subwatershed.

Landuse Information

Landuse within the Hinkle Creek Subwatershed consists primarily of agricultural uses. Several areas of deciduous forest are located along the corridor of Hinkle Creek.

During October/November 2009, the Steering Committee volunteers conducted a windshield survey at 150 site locations within the Morse Reservoir/Cicero Creek Watershed. This windshield survey included 9 stream crossing sites and 4 land/field sites within the Hinkle Creek Subwatershed.

Observations including streambank erosion, stream buffers, debris, animal access and fields under conventional till were recorded for each site and the results are summarized in Table 29.

Table 29: Hinkle Creek Windshield Survey Summary	
Parameter	**Observations**
Streambank Erosion	3/9 sites with erosion >3' 1/9 site with erosion <3'
Stream Buffers	1/9 site with no buffers 8/9 sites with buffers <50'
In-stream Debris	6/9 sites with debris
Animal Access	3/9 sites with animal access
Conventional Till	0/13 sites under conventional till

The Hinkle Creek subwatershed contains no active confined feeding operations; however there are 2 voided CFOs located within the watershed.

There is one NPDES permit active within the Hinkle Creek subwatershed. The Gas America Hinkle Creek Wastewater Treatment Plant, permit number IN0059943, is located at 1650 E 236th Street in Noblesville. According to compliance records, there have been no formal enforcement actions within the last 5 years; however there have been 9 noted effluent exceedances within the last 3 years. These exceedances were reported for Chlorine, *E. coli*, Nitrogen and Dissolved Oxygen.

Habitat/Biological Information

V3 completed a macroinvertebrate study in October 2009 that included thirteen stations within the Morse Reservoir/Cicero Creek Watershed. One station (Station 3), located at the crossing of Cicero Creek at Royal Pine and Cedar Road in Hamilton County, was analyzed within Hinkle Creek Subwatershed.

The calculated mIBI score of 4.0 indicates that the Hinkle Creek Subwatershed is slightly impaired for macroinvertebrate communities. One IDEM sampling station, one CIWRP sampling station and a windshield survey site were located in the vicinity of the macroinvertebrate station. The windshield survey indicated that adequate habitat was available for macroinvertebrates in the form of underwater tree roots, sufficient cover, and deep and shallow areas which indicates that slight impairment seen in the macroinvertebrate community is not likely caused by lack of habitat. At the IDEM sampling station, *E. coli* was the only water quality parameter analyzed. Levels of *E. coli* at this station average 384.8 CFU/100mL which does exceed the water quality target. At the CIWRP sampling station *E. coli*, TSS, Nitrogen and Phosphorus were all analyzed. Levels of *E. coli* at this station average 4809.7 CFU/100mL, TSS averages 32.9 mg/L, Nitrogen averages 2.7 mg/L and Phosphorus averages 0.3 mg/L. All of these values exceed the water quality targets indicating the slight impairment may be caused by the poor water chemistry at the site. Detailed analysis for each station can be found in Appendix H.

Morse Reservoir/Cicero Creek Subwatershed

The Morse Reservoir/Cicero Creek Subwatershed (HUC 12 – 051202010610) is located in Hamilton County as shown in Exhibit 26. The subwatershed contains approximately 17,713 acres and includes Cicero Creek, West Fork, East Fork, Sly Run, Hinkle Creek, Bear Slide Creek

within the subwatershed as a best management practice for reducing *E. coli*, Nitrate+Nitrite, Total Phosphorus and TSS.

Since the subwatershed is 92% agricultural land with at least 3 locations from the windshield survey showing conventional tillage practices, promoting no-till or reduced till (conservation tillage) practices within this subwatershed would also help to reduce Nitrate+Nitrite loadings. Based on the information obtained from the Hamilton County SWCD, approximately 49% of corn fields in the County operate using conventional tillage practices. Nutrient/Waste Management plans would also be a beneficial BMP for reduction of all pollutants.

Approximately 54.4% of the subwatershed is mapped as having hydric soils. These areas would be conducive for wetland restoration, which has the potential to reduce pollutant loads by 80% for sediment and *E. coli*, 55% for phosphorus and 45% for nitrogen.

Based on this information, BMP implementation projects are very feasible within the Prairie Creek subwatershed. However, specific locations and types of BMPs should be carefully planned out in coordination with the landowners and applicable local, state and federal agencies and with the load reduction needs of the subwatershed in mind.

Hinkle Creek

The Hinkle Creek Subwatershed shows a high level of current water quality impairment (ranked second) and a low level of land use and industrial impairments (ranked tenth). The Hinkle Creek subwatershed exceeded the State standard for *E. coli* and the water quality targets for Nitrate + Nitrite, Phosphorus and TSS in the CIWRP study and exceeded the State standards for *E. coli* and the water quality targets for Nitrate + Nitrite and Phosphorus in the IDEM data. Reductions of 87.8%, 40.7%, 77.2% and 8.8% are needed for *E. coli*, Nitrate + Nitrite, Phosphorus and TSS respectively to meet the target loads set for the subwatershed.

During the windshield survey, 3 of the 9 stream sites showed areas of streambank erosion that exceeded 3 feet (see Exhibit 30), 9 sites showed areas with no or inadequate stream buffers (see Exhibit 29), and 10 locations had in-stream debris within the Hinkle Creek subwatershed. Based on these findings and as outlined in Part Three of the Watershed Inventory (Watershed Ranking tables and summaries), the Hinkle Creek Subwatershed is a Medium Priority Subwatershed for Best Management Practice implementation.

The Hinkle Creek subwatershed is approximately 81% agricultural. Therefore, the BMPs suggested in Table 51 for this subwatershed are agricultural/rural focused and are beneficial in reducing pollutant loadings for more than one impairment.

The windshield survey information showed that there is are at least 3 locations within the subwatershed where animals could access streams. Implementation of alternative watering systems as well as exclusionary fencing and eliminating the potential for animals to have direct access to the streams will reduce pollutant loadings within the subwatershed. For example, the load reduction needed for *E. coli* in this subwatershed is 87.8% in order to meet the target loads. Implementation of the exclusionary fencing alone provides a 90% reduction in *E. coli* for area tributary to the fencing based on Table 50 Best Management Practice Load Reduction Summary in Section 6. Exclusionary fencing also provides 70% removal of TSS, 60% of Phosphorus and 65% of Nitrogen.

The windshield survey results also showed that the subwatershed has at least 9 sites with inadequate stream buffers or evidence of streambank erosion greater than 3 feet in depth. The subwatershed has approximately 18 miles of major stream corridor (Hinkle Creek, Jones Ditch, Lindley Ditch and Baker Ditch) which doesn't include the minor tributaries or other regulated drains within the subwatershed. Therefore, there is great potential for implementation of buffer/filter strips, reforestation along streams and stream restoration within the subwatershed as a best management practice for reducing *E. coli*, Nitrate+Nitrite, Total Phosphorus and TSS.

Even though the windshield survey did not show any locations practicing conventional tillage, the subwatershed is 81% agricultural land. Promoting no-till or reduced till (conservation tillage) practices within this subwatershed would also help to reduce Nitrate+Nitrite loadings. Based on the information obtained from the Hamilton County SWCD, approximately 49% of corn fields in the County operate using conventional tillage practices. Nutrient/Waste Management plans would also be a beneficial BMP for reduction of all pollutants.

Approximately 31.7% of the subwatershed is mapped as having hydric soils. These areas would be conducive for wetland restoration, which has the potential to reduce pollutant loads by 80% for sediment and *E. coli*, 55% for phosphorus and 45% for nitrogen.

Based on this information, BMP implementation projects are very feasible within the Hinkle Creek subwatershed. However, specific locations and types of BMPs should be carefully planned out in coordination with the landowners and applicable local, state and federal agencies and with the load reduction needs of the subwatershed in mind.

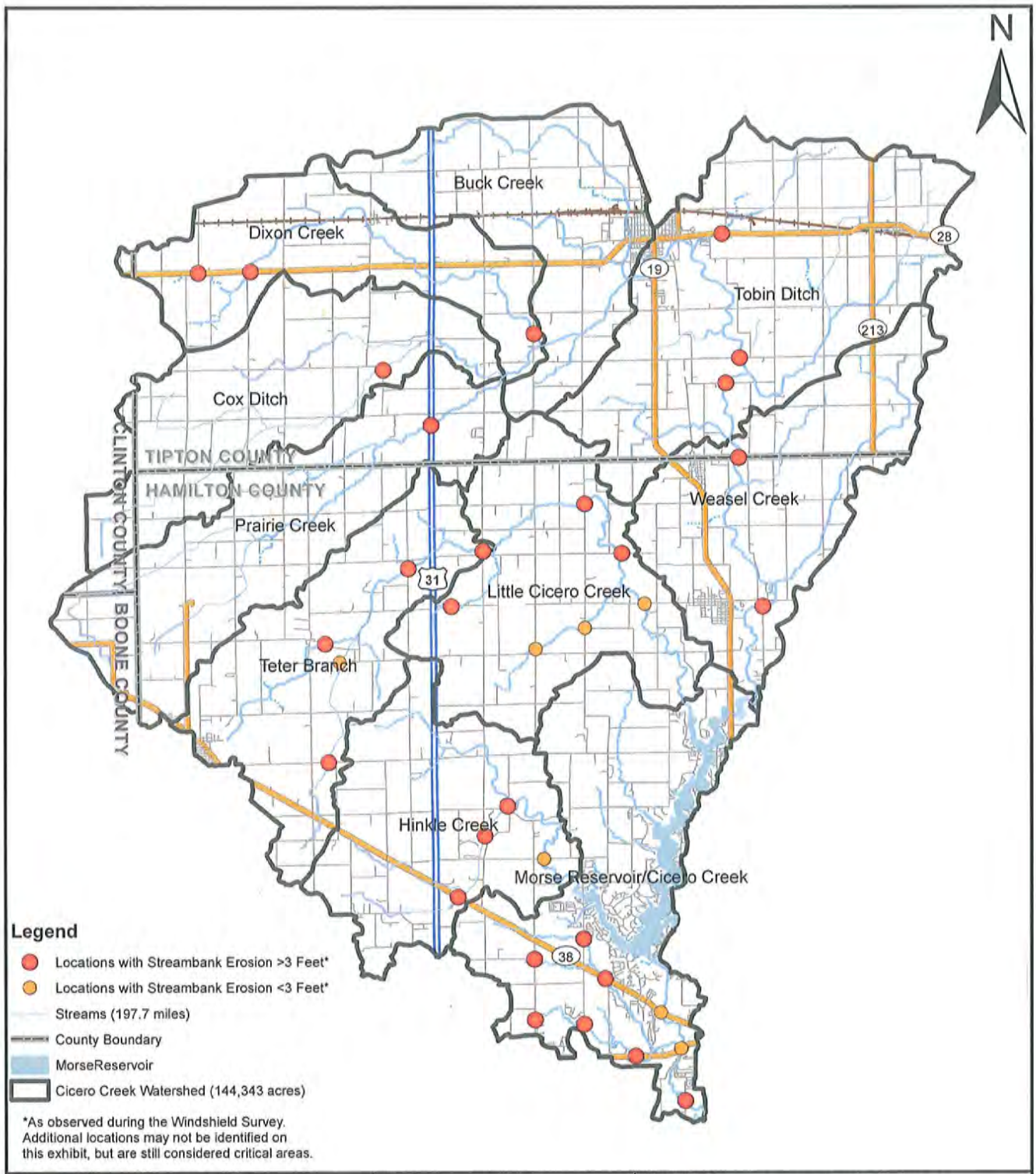
Lower Priority Subwatersheds

The Buck Creek, Dixon Creek and Weasel Creek Subwatersheds are all considered Low Priority areas.

The Buck Creek Subwatershed shows a moderate level of current water quality impairment (ranked fifth) and a low potential for future water quality impairment (ranked ninth). The Dixon Creek Subwatershed shows a moderate level of current water quality impairment (ranked seventh) and a low potential for future water quality impairment (ranked eighth). And the Weasel Creek Subwatershed shows a low level of current water quality impairment (ranked eighth) and a moderate potential for future water quality impairment (ranked fifth).

Specific Source Critical Areas

Sources that would reduce loading of several pollutants of concern or address several identified problems at once if modified or eliminated were designated Specific Source Critical Areas. The specific source critical areas are found throughout the watershed and not confined to a specific subwatershed. These critical areas can and do overlap the Subwatershed Critical Areas. However, problem areas in the lowest ranking subwatersheds cannot be addressed until the high and medium priority areas have been addressed. The locations of the Specific Source Critical Areas were identified during the Windshield Survey, completed as part of the Watershed Inventory. The windshield survey only covered a finite number of locations within the watershed, so instances and locations of these sources may not be specifically identified, but are still considered critical areas.



V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
630.724.9200 phone
630.724.9202 fax
www.v3co.com

TITLE: **Streambank Erosion Critical Area Exhibit**	PROJECT: **Morse Reservoir/Cicero Creek Watershed Management Plan**		
BASE LAYER: HUC-12 Watershed Boundaries	PROJECT NO. 09005	EXHIBIT: 30	SHEET: 1 OF: 1
CLIENT: Upper White River Watershed Alliance P.O. Box 2065 Indianapolis, Indiana 46206	QUADRANGLE: N/A	DATE: 09/27/10	SCALE: 1" = 15000'

Table 51: BMP Selection, cont.		
Critical Area	**Reason for being Critical**	**Suggested BMP**
Medium Priority Subwatersheds		
Cox Ditch Prairie Creek Hinkle Creek	Nitrate+Nitrite	Alternative Watering System
		Buffer/Filter Strips
		Education and Outreach
		Exclusionary Fencing
		Nutrient/Waste Management
		No-till/Reduced Till (Conservation Tillage)
		Reforestation
		Stream Restoration
	E. coli	Alternative Watering System
		Buffer/Filter Strips
		Education and Outreach
		Exclusionary Fencing
		Nutrient/Waste Management
		Wetland Restoration
	Total Phosphorus	Alternative Watering System
		Buffer/Filter Strips
		Education and Outreach
		Exclusionary Fencing
		Nutrient/Waste Management
		Reforestation
		Stream Restoration
		Wetland Restoration
	Livestock Access	Alternative Watering System
		Education and Outreach
		Exclusionary Fencing
		Nutrient/Waste Management
		Stream Restoration
	Conventional Tillage Practices	Education and Outreach
		Nutrient/Waste Management
		No-till/Reduced Till (Conservation Tillage)
	Lack of Stream Buffers	Education and Outreach
		Buffer/Filter Strips
		Stream Restoration

APPENDIX B WATER QUALITY ANALYSIS

- CERTIFICATE OF ANALYSIS -

Disp. Codes: C E M

Report Date: *23-Apr-12*

Client ID: WILLIAMS_CREEK

Williams Creek Consulting
919 N. East Street
Indianapolis, Indiana 46202
Attn: Jason Steckel

Phone: (317) 423-0690
FAX: (317) 423-0696

Our Lab # 12004500-001
Your Sample ID: Sample #1 Grab

Your Project #
Collection Date: 04/13/12 11:00

Your Project Name: **Hinkle Creek**
Collected By: Client

Sample Type: Water
Receipt Date: 04/13/12 12:16

Total Kjeldahl Nitrogen

Analytical Method	Prep Method	Prep Date	By
SM4500-NH3 D	SM4500-NH3 B	4/19/2012	cgarner

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Total Kjeldahl Nitrogen	0.724	mg/L		0.100		04/20/12	cgarner

Total Phosphorus, as P

Analytical Method	Prep Method	Prep Date	By
SM 4500-P E	SM 4500-P B	4/17/2012	amyers

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Phosphorus, as P	< 0.100	mg/L		0.100	7723-14-0	04/17/12	amyers

Ammonia

Analytical Method	Prep Method	Prep Date	By
SM4500-NH3 D	SM4500-NH3 B	4/20/2012	cgarner

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Ammonia	0.615	mg/L		0.100	7664-41-7	04/20/12	cgarner

Nitrate-Nitrite, Manual Cadmium Column

Analytical Method	Prep Method	Prep Date	By
SM 4500-NO3			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Nitrate-Nitrite, Manual Cadmium Column	0.985	mg/L		0.200		04/20/12	dgoode

ESG Laboratories
5927 WEST 71ST STREET
INDIANAPOLIS, INDIANA 46278
PHONE (317) 290-1471
FAX (317) 290-1670

Total Suspended Solids

Analytical Method	Prep Method	Prep Date	By
SM 2540D			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Total Suspended Solids	5.49	mg/L		1.00		04/17/12	astults

ortho-Phosphate

Analytical Method	Prep Method	Prep Date	By
SM 4500-P E			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
ortho-Phosphate	< 0.100	mg/L		0.100		04/13/12	amyers

ESG Laboratories
5927 WEST 71ST STREET
INDIANAPOLIS, INDIANA 46278
PHONE (317) 290-1471
FAX (317) 290-1670

Our Lab #	12004500-002	**Your Sample ID:**	Sample #2 Grab
Your Project #		**Collection Date:**	04/13/12 11:20
Your Project Name:	**Hinkle Creek**	**Collected By:**	Client
Sample Type:	Water	**Receipt Date:**	04/13/12 12:16

Total Kjeldahl Nitrogen

Analytical Method	Prep Method	Prep Date	By
SM4500-NH3 D	SM4500-NH3 B	4/19/2012	cgarner

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Total Kjeldahl Nitrogen	0.760	mg/L		0.100		04/20/12	cgarner

Total Phosphorus, as P

Analytical Method	Prep Method	Prep Date	By
SM 4500-P E	SM 4500-P B	4/17/2012	amyers

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Phosphorus, as P	< 0.100	mg/L		0.100	7723-14-0	04/17/12	amyers

Ammonia

Analytical Method	Prep Method	Prep Date	By
SM4500-NH3 D	SM4500-NH3 B	4/20/2012	cgarner

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Ammonia	0.178	mg/L		0.100	7664-41-7	04/20/12	cgarner

Nitrate-Nitrite, Manual Cadmium Column

Analytical Method	Prep Method	Prep Date	By
SM 4500-NO3			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Nitrate-Nitrite, Manual Cadmium Column	2.50	mg/L		0.500		04/20/12	dgoode

Total Suspended Solids

Analytical Method	Prep Method	Prep Date	By
SM 2540D			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Total Suspended Solids	15.7	mg/L		1.00		04/17/12	astults

ortho-Phosphate

Analytical Method	Prep Method	Prep Date	By
SM 4500-P E			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
ortho-Phosphate	< 0.100	mg/L		0.100		04/13/12	amyers

ESG Laboratories

5927 WEST 71ST STREET
INDIANAPOLIS, INDIANA 46278

PHONE (317) 290-1471
FAX (317) 290-1670

Our Lab #	12004500-003	**Your Sample ID:**	Sample #3 Grab
Your Project #		**Collection Date:**	04/13/12 11:35
Your Project Name:	**Hinkle Creek**	**Collected By:**	Client
Sample Type:	Water	**Receipt Date:**	04/13/12 12:16

Total Kjeldahl Nitrogen

Analytical Method	Prep Method	Prep Date	By
SM4500-NH3 D	SM4500-NH3 B	4/19/2012	cgarner

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Total Kjeldahl Nitrogen	0.605	mg/L		0.100		04/20/12	cgarner

Total Phosphorus, as P

Analytical Method	Prep Method	Prep Date	By
SM 4500-P E	SM 4500-P B	4/17/2012	amyers

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Phosphorus, as P	< 0.100	mg/L		0.100	7723-14-0	04/17/12	amyers

Ammonia

Analytical Method	Prep Method	Prep Date	By
SM4500-NH3 D	SM4500-NH3 B	4/20/2012	cgarner

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Ammonia	0.123	mg/L		0.100	7664-41-7	04/20/12	cgarner

Nitrate-Nitrite, Manual Cadmium Column

Analytical Method	Prep Method	Prep Date	By
SM 4500-NO3			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Nitrate-Nitrite, Manual Cadmium Column	0.905	mg/L		0.500		04/20/12	dgoode

Total Suspended Solids

Analytical Method	Prep Method	Prep Date	By
SM 2540D			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Total Suspended Solids	3.53	mg/L		1.00		04/17/12	astults

ortho-Phosphate

Analytical Method	Prep Method	Prep Date	By
SM 4500-P E			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
ortho-Phosphate	< 0.100	mg/L		0.100		04/13/12	amyers

ESG Laboratories
5927 WEST 71ST STREET
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PHONE (317) 290-1471
FAX (317) 290-1670

4/23/2012

Lab Manager **Date**

ESG Laboratories

5927 WEST 71ST STREET
INDIANAPOLIS, INDIANA 46278

PHONE (317) 290-1471
FAX (317) 290-1670

ESG Laboratories
5927 West 71st Street * Indianapolis, IN 46278
Phone (317) 290-1471 * Fax (317) 290-1670

CHAIN OF CUSTODY RECORD

Client Name: Williams Creek
ESG Work Order #: 12004509
Project Name: Hinkle Creek
Project #:
Sampler(s) Signature: [signature]

Total Number of Containers

Filtered (Y or N): N N
Preserv. Code: 5 U
Analyses: TPH & Nitrogen, TSS, 0204

N = HNO_3 / Nitric Acid
S = H_2SO_4 / Sulfuric Acid
H = HCl / Hydrochloric Acid
U = Unpreserved, Cooled to 4°C
OH = NaOH / Sodium Hydroxide
SO = $Na_2S_2O_3$ / Sodium Thiosulfate

Stat.No	DATE	TIME	COMP	GRAB	SAMPLE ID	Total Number of Containers	TPH & Nitrogen	TSS	0204							Comments
	4/13	11:00		X	#1	2	X	X								
		11:20		X	2	2	X	X								
		11:35		X	3	2	X	X								

TRANSFER OF CUSTODY

Relinquished By:	Date / Time
[signature]	4/13/12 12:16
Received By: [signature]	
Relinquished By:	Date / Time
Received By:	
Relinquished By:	Date / Time
Received By:	

SAMPLE CONDITION UPON RECEIPT

Sample Temp: 2.4 °C
Received on Ice: (Y) / N
Samples Intact: (Y) / N
Adequate Volume: (Y) / N
Appropriate Containers: (Y) / N
Appropriate Preservation: (Y) / N
Within Hold Time: (Y) / N
Head Space Absent: Y / N / NA

SAMPLE COMMENTS

Please note if sample(s) suspected to be hazardous, corrosive, or requires special handling for any reason.

pH METER CALIBRATION

4.00 _____ 7.00 _____ 10.00 _____

TURN-AROUND TIME

Normal _____ Rush _____

Requested Due Date: _____

REPORT/RESULTS DELIVERY

E-MAIL FAX MAIL

- CERTIFICATE OF ANALYSIS -

Disp. Code: CFAI

Report Date: *08-Aug-12*

Client ID: WILLIAMS_CREEK

Williams Creek Consulting
919 N. East Street
Indianapolis, Indiana 46202

Phone: (317) 423-0690
Attn: Jason Steckel
FAX: (317) 423-0696

Our Lab # 12009635-001
Your Sample ID: Sample #1 Grab

Your Project #
Collection Date: 07/31/12
Your Project Name: **Hinkle Creek**
Collected By: Client
Sample Type: Water
Receipt Date: 07/31/12 17:15

Total Kjeldahl Nitrogen

Analytical Method	Prep Method	Prep Date	By
SM4500-NH3 D	SM4500-NH3 B	8/1/2012	spotts

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Total Kjeldahl Nitrogen	1.07	mg/L		0.100		08/02/12	spotts

Total Phosphorus, as P

Analytical Method	Prep Method	Prep Date	By
SM 4500-P E	SM 4500-P B	8/6/2012	amyers

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Phosphorus, as P	< 0.100	mg/L		0.100	7723-14-0	08/06/12	amyers

Ammonia, Undistilled

Analytical Method	Prep Method	Prep Date	By
SM4500-NH3 D			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Ammonia	0.212	mg/L		0.100	7664-41-7	08/02/12	spotts

Nitrate-Nitrite, Manual Cadmium Column

Analytical Method	Prep Method	Prep Date	By
SM 4500-NO3			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Nitrate-Nitrite, Manual Cadmium Column	0.139	mg/L		0.100		08/07/12	dgoode

ESG Laboratories
5927 WEST 71ST STREET
INDIANAPOLIS, INDIANA 46278

PHONE (317) 290-1471
FAX (317) 290-1670
www.ESGLaboratories.com

Total Suspended Solids

Analytical Method	Prep Method	Prep Date	By
SM 2540D			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Total Suspended Solids	14.3	mg/L		1.00		08/03/12	astults

ortho-Phosphate

Analytical Method	Prep Method	Prep Date	By
SM 4500-P E			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
ortho-Phosphate	< 0.100	mg/L		0.100		08/01/12	bruhl

ESG Laboratories
5927 WEST 71ST STREET
INDIANAPOLIS, INDIANA 46278

PHONE (317) 290-1471
FAX (317) 290-1670
www.ESGLaboratories.com

Our Lab #	12009635-002	**Your Sample ID:**	Sample #2 Grab
Your Project #		**Collection Date:**	07/31/12
Your Project Name:	**Hinkle Creek**	**Collected By:**	Client
Sample Type:	Water	**Receipt Date:**	07/31/12 17:15

Total Kjeldahl Nitrogen

Analytical Method	Prep Method	Prep Date	By
SM4500-NH3 D	SM4500-NH3 B	8/1/2012	spotts

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Total Kjeldahl Nitrogen	1.82	mg/L		0.100		08/02/12	spotts

Total Phosphorus, as P

Analytical Method	Prep Method	Prep Date	By
SM 4500-P E	SM 4500-P B	8/6/2012	amyers

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Phosphorus, as P	0.347	mg/L		0.100	7723-14-0	08/06/12	amyers

Ammonia, Undistilled

Analytical Method	Prep Method	Prep Date	By
SM4500-NH3 D			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Ammonia	0.340	mg/L		0.100	7664-41-7	08/02/12	spotts

Nitrate-Nitrite, Manual Cadmium Column

Analytical Method	Prep Method	Prep Date	By
SM 4500-NO3			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Nitrate-Nitrite, Manual Cadmium Column	< 0.100	mg/L		0.100		08/07/12	dgoode

Total Suspended Solids

Analytical Method	Prep Method	Prep Date	By
SM 2540D			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Total Suspended Solids	6.98	mg/L		1.00		08/03/12	astults

ortho-Phosphate

Analytical Method	Prep Method	Prep Date	By
SM 4500-P E			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
ortho-Phosphate	1.15	mg/L		0.100		08/01/12	bruhl

ESG Laboratories
5927 WEST 71ST STREET
INDIANAPOLIS, INDIANA 46278

PHONE (317) 290-1471
FAX (317) 290-1670
www.ESGLaboratories.com

Our Lab #	12009635-003	**Your Sample ID:**	Sample #3 Grab
Your Project #		**Collection Date:**	07/31/12
Your Project Name:	**Hinkle Creek**	**Collected By:**	Client
Sample Type:	Water	**Receipt Date:**	07/31/12 17:15

Total Kjeldahl Nitrogen

Analytical Method	Prep Method	Prep Date	By
SM4500-NH3 D	SM4500-NH3 B	8/1/2012	spotts

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Total Kjeldahl Nitrogen	0.579	mg/L		0.100		08/02/12	spotts

Total Phosphorus, as P

Analytical Method	Prep Method	Prep Date	By
SM 4500-P E	SM 4500-P B	8/6/2012	amyers

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Phosphorus, as P	< 0.100	mg/L		0.100	7723-14-0	08/06/12	amyers

Ammonia, Undistilled

Analytical Method	Prep Method	Prep Date	By
SM4500-NH3 D			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Ammonia	< 0.100	mg/L		0.100	7664-41-7	08/02/12	spotts

Nitrate-Nitrite, Manual Cadmium Column

Analytical Method	Prep Method	Prep Date	By
SM 4500-NO3			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Nitrate-Nitrite, Manual Cadmium Column	0.142	mg/L		0.100		08/07/12	dgoode

Total Suspended Solids

Analytical Method	Prep Method	Prep Date	By
SM 2540D			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
Total Suspended Solids	2.99	mg/L		1.00		08/03/12	astults

ortho-Phosphate

Analytical Method	Prep Method	Prep Date	By
SM 4500-P E			

Parameter	Result	Units	Qual	Quant. Limit	CAS #	Analysis Date	By
ortho-Phosphate	0.177	mg/L		0.100		08/01/12	bruhl

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8/8/2012

Lab Manager **Date**

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ESG Laboratories
5927 West 71st Street * Indianapolis, IN 46278
Phone (317) 290-1471 * Fax (317) 290-1670

CHAIN OF CUSTODY RECORD

Client Name: Williams Creek Consulting
ESG Work Order # 12009635
Project Name: Hinkle Creek
Project #
Sampler(s) Signature: [signature]

Filtered (Y or N): N N
Preserv. Code: S C
Analyses: TKN, NO3/NH3, TSS, PO4

N = HNO_3 / Nitric Acid
S = H_2SO_4 / Sulfuric Acid
H = HCl / Hydrochloric Acid
U = Unpreserved, Cooled to 4°C
OH = NaOH / Sodium Hydroxide
SO = $Na_2S_2O_3$ / Sodium Thiosulfate

Stat.No	DATE	TIME	COMP	GRAB	SAMPLE ID	Total Number of Containers	TKN	NO3/NH3	TSS	PO4						Comments
1	7/31					2	X	X								
2						2	X	X								
3						2	X	X								

TRANSFER OF CUSTODY

Relinquished By: [signature]	Date / Time 7/31/12 / 5:15P
Received By:	
Relinquished By:	Date / Time
Received By:	
Relinquished By:	Date / Time
Received By: [signature]	7/31/12 5:15

SAMPLE CONDITION UPON RECEIPT

Sample Temp: 3 °C
Received on Ice: (Y) / N
Samples Intact: (Y) / N
Adequate Volume: (Y) / N
Appropriate Containers: (Y) / N
Appropriate Preservation: (Y) / N
Within Hold Time: (Y) / N
Head Space Absent: Y / N / NA

TURN-AROUND TIME

Normal _____ Rush _____
Requested Due Date: _____

SAMPLE COMMENTS

Please note if sample(s) suspected to be hazardous, corrosive, or requires special handling for any reason.

pH METER CALIBRATION

4.00 _____ 7.00 _____ 10.00 _____

REPORT/RESULTS DELIVERY

E-MAIL FAX MAIL

APPENDIX C HYDROLOGIC MODELING

Hydrology Calculations
(TR-55 Method) Time of Concentration

Hinkle Creek Watershed Master Plan

P_2 = ***2.92*** *2-year 24-hr*

Basins						Sheet Flow				Shallow flow					Channel/Pipe Flow			Final		Lag Time	
Number	CN	Area (acres)	Area (SQ. MI.)	I_a	Total Length	Slope	Manning's n value	Length (ft)	Tc* (hr)	Paved	Slope	Length (ft)	Velocity (ft/s)	Tc (hr)	Length (ft)	Velocity (ft/s)	Tc (hr)	Tt (hr)	Tt (min)	Tt (hr)	Tt (min)
1	74	98.4	0.154	0.70	4,088	0.025	0.240	150	0.315	no	0.039	777	3.17	0.068	3161	2.50	0.35	**0.73**	**44**	**0.44**	**26**
2	77	209.3	0.327	0.60	6,606	0.033	0.170	150	0.214	no	0.010	1640	1.61	0.282	4816	2.50	0.54	**1.03**	**62**	**0.62**	**37**
3	79	312.6	0.488	0.53	9,838	0.025	0.400	150	0.474	no	0.005	3800	1.11	0.954	5888	2.50	0.65	**2.08**	**125**	**1.25**	**75**
4	78	66.4	0.104	0.56	4,237	0.027	0.170	150	0.232	no	0.011	1356	1.69	0.223	2731	2.50	0.30	**0.76**	**45**	**0.45**	**27**
5	66	33.3	0.052	1.03	2,888	0.150	0.400	150	0.231	no	0.020	1157	2.28	0.141	1581	2.50	0.18	**0.55**	**33**	**0.33**	**20**
6	76	387.5	0.606	0.63	9,258	0.020	0.400	150	0.518	no	0.007	2730	1.32	0.574	6378	2.50	0.71	**1.80**	**108**	**1.08**	**65**
7	72	30.8	0.048	0.78	1,955	0.033	0.150	150	0.194	no	0.049	962	3.57	0.075	843	2.50	0.09	**0.36**	**22**	**0.22**	**13**
8	79	205.2	0.321	0.53	7,385	0.002	0.170	150	0.656	no	0.007	3500	1.35	0.720	3735	2.50	0.42	**1.79**	**108**	**1.08**	**65**
9	81	226.9	0.355	0.47	5,497	0.020	0.400	150	0.518	no	0.006	3350	1.25	0.745	1997	2.50	0.22	**1.48**	**89**	**0.89**	**53**
10	81	364.3	0.569	0.47	9,561	0.020	0.150	150	0.236	no	0.004	6150	0.98	1.741	3261	2.50	0.36	**2.34**	**140**	**1.40**	**84**
11	79	29.9	0.047	0.53	2,151	0.033	0.170	150	0.214	no	0.035	867	3.00	0.080	1134	2.50	0.13	**0.42**	**25**	**0.25**	**15**
12	78	323.6	0.506	0.56	7,440	0.017	0.240	150	0.371	no	0.004	1600	0.99	0.447	5690	2.50	0.63	**1.45**	**87**	**0.87**	**52**
13	77	290.8	0.454	0.60	8,980	0.007	0.170	150	0.407	no	0.005	6300	1.15	1.519	2530	2.50	0.28	**2.21**	**132**	**1.32**	**79**
14	77	47.6	0.074	0.60	2,385	0.033	0.150	150	0.194	no	0.029	1657	2.75	0.168	578	2.50	0.06	**0.43**	**26**	**0.26**	**15**
15	75	70.3	0.110	0.67	3,479	0.007	0.400	150	0.789	no	0.010	3000	1.61	0.516	329	2.50	0.04	**1.34**	**81**	**0.81**	**48**
16	70	65.5	0.102	0.86	4,066	0.020	0.170	150	0.261	no	0.019	1550	2.22	0.194	2366	2.50	0.26	**0.72**	**43**	**0.43**	**26**
17	79	478.2	0.747	0.53	9,352	0.020	0.400	150	0.518	no	0.005	2450	1.14	0.597	6752	2.50	0.75	**1.86**	**112**	**1.12**	**67**
18	81	529.2	0.827	0.47	11,451	0.020	0.240	150	0.344	no	0.003	4000	0.88	1.257	7301	2.50	0.81	**2.41**	**145**	**1.45**	**87**
19	81	225.5	0.352	0.47	6,348	0.007	0.400	150	0.789	no	0.003	3250	0.90	1.005	2948	2.50	0.33	**2.12**	**127**	**1.27**	**76**
20	76	34.7	0.054	0.63	2,123	0.010	0.150	150	0.312	no	0.025	1000	2.55	0.109	973	2.50	0.11	**0.53**	**32**	**0.32**	**19**
21	76	471.8	0.737	0.63	7,126	0.013	0.400	150	0.610	no	0.007	2150	1.35	0.442	4826	2.50	0.54	**1.59**	**95**	**0.95**	**57**
22	81	361.7	0.565	0.47	5,935	0.020	0.400	150	0.518	no	0.005	2800	1.14	0.682	2985	2.50	0.33	**1.53**	**92**	**0.92**	**55**
23	80	623.5	0.974	0.50	12,939	0.020	0.170	150	0.261	no	0.002	4500	0.72	1.732	8289	2.50	0.92	**2.91**	**175**	**1.75**	**105**
24	80	965.6	1.509	0.50	15,263	0.020	0.400	150	0.518	no	0.001	4000	0.58	1.910	11113	2.50	1.23	**3.66**	**220**	**2.20**	**132**
25	79	516.7	0.807	0.53	10,077	0.013	0.240	150	0.409	no	0.005	6100	1.14	1.485	3827	2.50	0.43	**2.32**	**139**	**1.39**	**84**
26	80	185.2	0.289	0.50	6,355	0.013	0.170	150	0.310	no	0.005	3500	1.14	0.852	2705	2.50	0.30	**1.46**	**88**	**0.88**	**53**
27	82	596.1	0.723	0.44	6,870	0.013	0.400	150	0.616	no	0.0004	5000	0.32	4.304	1720	2.50	0.19	**5.11**	**307**	**3.07**	**184**
28	75	263.3	0.411	0.67	5,541	0.013	0.170	150	0.310	no	0.006	2455	1.25	0.546	2936	2.50	0.33	**1.18**	**71**	**0.71**	**43**
29	74	32.6	0.051	0.70	1,852	0.100	0.410	150	0.278	no	0.066	600	4.15	0.040	1102	2.50	0.12	**0.44**	**26**	**0.26**	**16**
30	78	264.1	0.413	0.56	7,770	0.013	0.400	150	0.616	no	0.008	2500	1.48	0.470	5120	2.50	0.57	**1.65**	**99**	**0.99**	**60**
31	78	276.0	0.431	0.56	5,968	0.013	0.170	150	0.310	no	0.008	3200	1.40	0.636	2618	2.50	0.29	**1.24**	**74**	**0.74**	**45**
32	76	202.7	0.317	0.63	5,959	0.013	0.170	150	0.310	no	0.010	1500	1.61	0.258	4309	2.50	0.48	**1.05**	**63**	**0.63**	**38**
33	75	460.4	0.719	0.67	8,163	0.027	0.400	150	0.463	no	0.007	3250	1.30	0.694	4763	2.50	0.53	**1.69**	**101**	**1.01**	**61**
34	79	253.4	0.396	0.53	5,393	0.007	0.400	150	0.807	no	0.008	1050	1.44	0.202	4193	2.50	0.47	**1.48**	**89**	**0.89**	**53**
35	79	722.0	1.165	0.53	8,272	0.007	0.400	150	0.807	no	0.002	3000	0.72	1.155	5122	2.50	0.57	**2.53**	**152**	**1.52**	**91**
36	78	896.9	1.401	0.56	15,413	0.020	0.240	150	0.344	no	0.005	3500	1.14	0.852	11763	2.50	1.31	**2.50**	**150**	**1.50**	**90**
37	75	518.1	0.810	0.67	7,591	0.013	0.400	150	0.610	no	0.014	1550	1.91	0.226	5891	2.50	0.65	**1.49**	**89**	**0.89**	**54**
38	78	315.0	0.492	0.56	7,844	0.013	0.240	150	0.409	no	0.005	2550	1.14	0.621	5144	2.50	0.57	**1.60**	**96**	**0.96**	**58**
39	79	264.9	0.414	0.53	3,490	0.027	0.400	150	0.462	no	0.005	1550	1.08	0.398	1790	2.50	0.20	**1.06**	**64**	**0.64**	**38**
40	80	498.5	0.779	0.50	9,529	0.013	0.400	150	0.616	no	0.003	4000	0.81	1.377	5379	2.50	0.60	**2.59**	**155**	**1.55**	**93**
41	79	755.6	1.181	0.53	12,112	0.017	0.400	150	0.558	no	0.003	4500	0.93	1.349	7462	2.50	0.83	**2.74**	**164**	**1.64**	**98**

Total Area of Basins = 13474.2 Acres
21.1 Sq.Mi.

Hamilton County Drainage Board
Hinkle Creek Watershed Masterplan

Peak Flow Rates

Location	HEC-HMS Component	DA (sq. mi.)	500-Year	100-Year	50-Year	25-Year	10-Year
Hinkle Creek							
Just US of Morse Reservoir	Junction-1	20.9	8936.7	6,722	5,481	4,397	3,204
0.98 mile DS of 216th Street*	Junction-2	20.7	8936.0	6,708	5,470	4,389	3,198
216th Street	Junction-3	20.1	8857.5	6,626	5,402	4,334	3,157
225th Street*	Junction-6	17.8	8449.7	6,253	5,095	4,084	2,972
Deming Road	Junction-7	17.3	8340.0	6,162	5,019	4,022	2,924
236th Street	Junction-10	6.6	3200.7	2,385	1,949	1,568	1,147
Confluence of Baker and Hinkle	Junction-12	4.9	2539.9	1,864	1,538	1,215	888
Baker Jones Drain							
Baker at U.S. 31	Junction-13	1.8	868.2	647	528	424	310
William Baker Drain							
Hinkle at U.S. 31	Junction-15	3.0	1672.0	1,228	1,013	795	579
Issac Jones Drain							
At Mouth	Junction-18	9.0	4575.1	3,329	2,697	2,154	1,558
At 216th Street	Junction-26	7.5	4154.3	3,017	2,472	1,922	1,376
Above Lindley Ditch at S.R. 38	Junction-21	4.2	2414.2	1,751	1,440	1,117	781
At U.S. 31	Junction-22	3.8	2213.4	1,610	1,322	1,025	712
At 206th Street (downstream)	Junction-23	2.6	1658.2	1,203	986	763	527
Lindley Drain							
At U.S. 31	Junction-24	2.4	1418.0	1,039	858	670	470

10 Year Critical Duration Analysis Table

Location	HEC-HMS Component	10 Year Flows (cfs) 24 hour	12 hour	6 hour	3 hour	1 hour
Hinkle Creek						
Just US of Morse Reservoir	Junction-1	2964	3204	2929	2647	1406
0.98 mile DS of 216th Street	Junction-2	2955	3198	2929	2647	1512
216th Street	Junction-3	2913	3157	2903	2645	1534
225th Street	Junction-6	2727	2972	2761	2622	1535
Deming Road	Junction-7	2684	2924	2723	2619	1535
236th Street	Junction-10	1049	1147	1066	1055	677
Confluence of Baker and Hinkle	Junction-12	803	888	845	855	588
Baker Jones Drain						
Baker at U.S. 31	Junction-13	288	310	288	291	203
William Baker Drain						
Hinkle at U.S. 31	Junction-15	516	579	557	563	387
Issac Jones Drain						
At Mouth	Junction-18		1558	1471	1417	
At 216th Street	Junction-26		1376	1324	1340	
Above Lindley Ditch at S.R. 38	Junction-21		781	760	777	
At U.S. 31	Junction-22		709	692	712	
At 206th Street (downstream)	Junction-23		510	499	527	
Lindley Drain						
At U.S. 31	Junction-24	406	461	449	470	311

25 Year Critical Duration Analysis Table

Location	HEC-HMS Component	25 Year Flows (cfs)				
		24 hour	12 hour	6 hour	3 hour	1 hour
Hinkle Creek						
Just US of Morse Reservoir	Junction-1		4397	4126	3093	
0.98 mile DS of 216th Street	Junction-2		4389	4125	3462	
216th Street	Junction-3		4334	4089	3569	
225th Street	Junction-6		4084	3892	3753	
Deming Road	Junction-7		4022	3839	3749	
236th Street	Junction-10		1568	1490	1498	
Confluence of Baker and Hinkle	Junction-12		1215	1184	1207	
Baker Jones Drain						
Baker at U.S. 31	Junction-13		424	404	412	
William Baker Drain						
Hinkle at U.S. 31	Junction-15		791	780	795	
Issac Jones Drain						
At Mouth	Junction-18		2154	2085	2041	
At 216th Street	Junction-26		1902	1883	1922	
Above Lindley Ditch at S.R. 38	Junction-21		1085	1086	1117	
At U.S. 31	Junction-22		984	989	1025	
At 206th Street (downstream)	Junction-23		705	712	763	
Lindley Drain						
At U.S. 31	Junction-24		632	636	670	

50 Year Critical Duration Analysis Table

Location	HEC-HMS Component	50 Year Flows (cfs)				
		24 hour	12 hour	6 hour	3 hour	1 hour
Hinkle Creek						
Just US of Morse Reservoir	Junction-1		5481	5229	4029	
0.98 mile DS of 216th Street	Junction-2		5470	5228	4489	
216th Street	Junction-3		5402	5182	4620	
225th Street	Junction-6		5095	4935	4817	
Deming Road	Junction-7		5019	4869	4810	
236th Street	Junction-10		1949	1881	1913	
Confluence of Baker and Hinkle	Junction-12		1512	1496	1538	
Baker Jones Drain						
Baker at U.S. 31	Junction-13		528	510	526	
William Baker Drain						
Hinkle at U.S. 31	Junction-15		984	986	1013	
Issac Jones Drain						
At Mouth	Junction-18		2697	2654	2629	
At 216th Street	Junction-26		2381	2401	2472	
Above Lindley Ditch at S.R. 38	Junction-21		1362	1388	1440	
At U.S. 31	Junction-22		1235	1265	1322	
At 206th Street (downstream)	Junction-23		882	910	986	
Lindley Drain						
At U.S. 31	Junction-24		788	810	858	

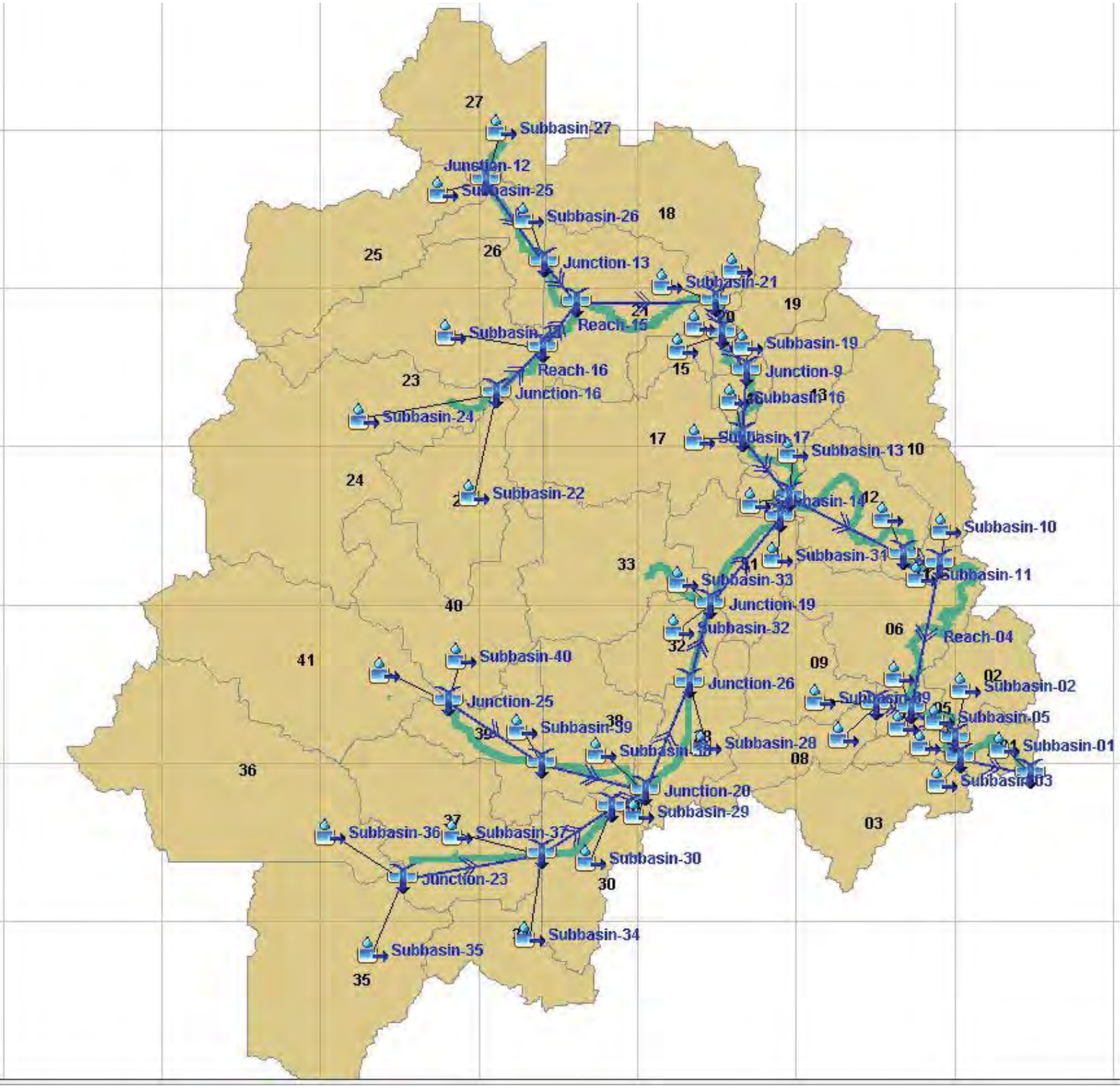
100 Year Critical Duration Analysis Table

Location	HEC-HMS Component	100 Year Flows (cfs)				
		24 hour	12 hour	6 hour	3 hour	1 hour
Hinkle Creek						
Just US of Morse Reservoir	Junction-1	5777	6722	6535	5895	3704
0.98 mile DS of 216th Street	Junction-2	5760	6708	6535	5895	3916
216th Street	Junction-3	5681	6626	6477	5891	3934
225th Street	Junction-6	5330	6253	6173	5840	3920
Deming Road	Junction-7	5244	6162	6091	5832	3920
236th Street	Junction-10	2023	2385	2346	2311	1675
Confluence of Baker and Hinkle	Junction-12	1544	1851	1864	1856	1446
Baker Jones Drain						
Baker at U.S. 31	Junction-13	554	647	637	635	489
William Baker Drain						
Hinkle at U.S. 31	Junction-15	991	1204	1228	1221	959
Issac Jones Drain						
At Mouth	Junction-18	2782	3318	3329	3196	2138
At 216th Street	Junction-26	2418	2931	3017	3002	2105
Above Lindley Ditch at S.R. 38	Junction-21	1368	1680	1748	1751	1298
At U.S. 31	Junction-22	1237	1523	1594	1610	1217
At 206th Street (downstream)	Junction-23	865	1085	1146	1203	1014
Lindley Drain						
At U.S. 31	Junction-24	784	965	1016	1039	788

500 Year Critical Duration Analysis Table

Location	HEC-HMS Component	500 Year Flows (cfs) 24 hour	12 hour	6 hour	3 hour	1 hour
Hinkle Creek						
Just US of Morse Reservoir	Junction-1		8268	8937	6854	
0.98 mile DS of 216th Street	Junction-2		8249	8936	7569	
216th Street	Junction-3		8150	8858	7762	
225th Street	Junction-6		7694	8450	7980	
Deming Road	Junction-7		7585	8340	7969	
236th Street	Junction-10		2927	3201	3141	
Confluence of Baker and Hinkle	Junction-12		2272	2540	2521	
Baker Jones Drain						
Baker at U.S. 31	Junction-13		795	868	864	
William Baker Drain						
Hinkle at U.S. 31	Junction-15		1478	1672	1658	
Issac Jones Drain						
At Mouth	Junction-18		4093	4575	4385	
At 216th Street	Junction-26		3616	4154	4112	
Above Lindley Ditch at S.R. 38	Junction-21		2076	2414	2406	
At U.S. 31	Junction-22		1883	2203	2213	
At 206th Street (downstream)	Junction-23		1338	1586	1658	
Lindley Drain						
At U.S. 31	Junction-24		1186	1397	1418	

Hinkle Creek Master Plan
HEC-HMS Basin Map



Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 1-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	206.5	01Jan2012, 01:59	0.48
Subbasin-35	1.165	183.3	01Jan2012, 02:00	0.52
Junction-23	2.566	389.8	01Jan2012, 02:00	0.50
Reach-24	2.566	389.8	01Jan2012, 02:30	0.49
Subbasin-37	0.810	142.8	01Jan2012, 01:27	0.38
Subbasin-34	0.396	96.3	01Jan2012, 01:23	0.52
Junction-22	3.772	461.8	01Jan2012, 02:15	0.47
Reach-23	3.772	461.8	01Jan2012, 02:34	0.47
Subbasin-30	0.413	85.2	01Jan2012, 01:31	0.48
Junction-21	4.185	490.6	01Jan2012, 02:26	0.47
Reach-21	4.185	490.6	01Jan2012, 02:34	0.47
Subbasin-41	1.181	173.9	01Jan2012, 02:07	0.52
Subbasin-40	0.779	129.4	01Jan2012, 02:01	0.56
Junction-25	1.960	302.9	01Jan2012, 02:04	0.53
Reach-25	1.960	302.9	01Jan2012, 02:33	0.53
Subbasin-39	0.414	123.2	01Jan2012, 01:07	0.52
Junction-24	2.374	310.4	01Jan2012, 02:31	0.53
Reach-22	2.374	310.4	01Jan2012, 02:58	0.52
Subbasin-38	0.492	104.1	01Jan2012, 01:29	0.48
Subbasin-29	0.051	14.6	01Jan2012, 00:39	0.35
Junction-20	7.102	806.8	01Jan2012, 02:44	0.49
Reach-20	7.102	806.8	01Jan2012, 03:10	0.48
Subbasin-28	0.411	84.1	01Jan2012, 01:15	0.38
Junction-26	7.513	809.0	01Jan2012, 03:10	0.48
Reach-19	7.513	809.0	01Jan2012, 03:27	0.47
Subbasin-33	0.719	115.7	01Jan2012, 01:33	0.38
Subbasin-32	0.317	75.1	01Jan2012, 01:09	0.41
Junction-19	8.549	818.9	01Jan2012, 03:25	0.46
Reach-18	8.549	818.9	01Jan2012, 03:50	0.45
Subbasin-31	0.431	108.3	01Jan2012, 01:15	0.48
Junction-18	8.980	819.6	01Jan2012, 03:50	0.45
Reach-17	8.980	819.6	01Jan2012, 03:59	0.45
Subbasin-24	1.509	181.6	01Jan2012, 02:40	0.53
Subbasin-22	0.565	154.4	01Jan2012, 01:24	0.60
Junction-16	2.074	244.1	01Jan2012, 01:42	0.55
Reach-16	2.074	244.1	01Jan2012, 01:57	0.55

Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 1-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	145.0	01Jan2012, 02:13	0.55
Junction-15	3.048	385.9	01Jan2012, 02:07	0.55
Reach-15	3.048	385.9	01Jan2012, 02:21	0.54
Subbasin-25	0.807	136.2	01Jan2012, 01:53	0.52
Subbasin-27	0.723	72.9	01Jan2012, 03:31	0.53
Junction-14	1.530	172.3	01Jan2012, 02:05	0.53
Reach-13	1.530	172.3	01Jan2012, 02:30	0.51
Subbasin-26	0.289	75.5	01Jan2012, 01:23	0.56
Junction-13	1.819	193.3	01Jan2012, 02:15	0.52
Reach-12	1.819	193.3	01Jan2012, 02:28	0.51
Junction-12	4.867	578.4	01Jan2012, 02:24	0.53
Reach-11	4.867	578.4	01Jan2012, 03:08	0.51
Subbasin-18	0.827	156.5	01Jan2012, 01:55	0.60
Subbasin-21	0.737	135.4	01Jan2012, 01:29	0.41
Junction-11	6.431	668.7	01Jan2012, 02:53	0.51
Reach-10	6.431	668.7	01Jan2012, 03:02	0.50
Subbasin-15	0.110	21.0	01Jan2012, 01:20	0.38
Subbasin-20	0.054	17.2	01Jan2012, 00:42	0.41
Junction-10	6.595	669.9	01Jan2012, 03:02	0.50
Reach-09	6.595	669.9	01Jan2012, 03:14	0.49
Subbasin-19	0.352	74.8	01Jan2012, 01:45	0.60
Junction-9	6.947	688.3	01Jan2012, 03:11	0.50
Reach-08	6.947	688.3	01Jan2012, 03:31	0.48
Subbasin-17	0.747	152.3	01Jan2012, 01:37	0.52
Subbasin-16	0.102	16.8	01Jan2012, 01:00	0.24
Junction-8	7.796	704.6	01Jan2012, 03:28	0.48
Reach-07	7.796	704.6	01Jan2012, 03:50	0.46
Subbasin-13	0.454	69.4	01Jan2012, 01:49	0.45
Subbasin-14	0.074	28.3	01Jan2012, 00:36	0.45
Junction-7	17.304	1529.9	01Jan2012, 03:54	0.46
Reach-06	17.304	1529.9	01Jan2012, 04:45	0.41
Subbasin-12	0.506	115.7	01Jan2012, 01:23	0.48
Junction-6	17.810	1530.1	01Jan2012, 04:45	0.41
Reach-05	17.810	1530.1	01Jan2012, 04:54	0.40
Subbasin-10	0.569	111.0	01Jan2012, 01:52	0.60
Subbasin-11	0.047	21.1	01Jan2012, 00:35	0.52

Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 1-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	1535.4	01Jan2012, 04:53	0.40
Reach-04	18.426	1535.4	01Jan2012, 05:48	0.30
Subbasin-09	0.355	99.6	01Jan2012, 01:22	0.60
Subbasin-08	0.321	67.0	01Jan2012, 01:35	0.52
Junction-17	0.676	163.8	01Jan2012, 01:27	0.57
Reach-14	0.676	163.8	01Jan2012, 01:35	0.57
Subbasin-06	0.606	100.6	01Jan2012, 01:37	0.41
Subbasin-07	0.048	12.2	01Jan2012, 00:36	0.29
Junction-4	19.756	1535.8	01Jan2012, 05:48	0.31
Reach-03	19.756	1533.2	01Jan2012, 06:00	0.28
Subbasin-02	0.327	84.9	01Jan2012, 01:07	0.45
Subbasin-05	0.052	6.1	01Jan2012, 01:00	0.15
Junction-3	20.135	1533.2	01Jan2012, 06:00	0.28
Reach-02	20.135	1516.0	01Jan2012, 06:00	0.27
Subbasin-03	0.488	90.7	01Jan2012, 01:45	0.52
Subbasin-04	0.104	33.6	01Jan2012, 00:52	0.48
Junction-2	20.727	1516.6	01Jan2012, 06:00	0.27
Reach-01	20.727	1416.1	01Jan2012, 06:00	0.23
Subbasin-01	0.154	36.3	01Jan2012, 00:54	0.35
Junction-1	20.881	1416.1	01Jan2012, 06:00	0.24

Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	280.9	01Jan2012, 02:38	0.93
Subbasin-35	1.165	246.2	01Jan2012, 02:38	0.99
Junction-23	2.566	527.1	01Jan2012, 02:38	0.96
Reach-24	2.566	527.1	01Jan2012, 03:08	0.96
Subbasin-37	0.810	171.8	01Jan2012, 01:54	0.78
Subbasin-34	0.396	108.8	01Jan2012, 01:49	0.99
Junction-22	3.772	711.7	01Jan2012, 03:00	0.92
Reach-23	3.772	711.7	01Jan2012, 03:19	0.92
Subbasin-30	0.413	101.1	01Jan2012, 01:58	0.93
Junction-21	4.185	776.7	01Jan2012, 03:15	0.92
Reach-21	4.185	776.7	01Jan2012, 03:23	0.92
Subbasin-41	1.181	240.2	01Jan2012, 02:48	0.99
Subbasin-40	0.779	172.4	01Jan2012, 02:40	1.04
Junction-25	1.960	411.8	01Jan2012, 02:45	1.01
Reach-25	1.960	411.8	01Jan2012, 03:14	1.01
Subbasin-39	0.414	128.5	01Jan2012, 01:30	0.99
Junction-24	2.374	469.9	01Jan2012, 03:08	1.01
Reach-22	2.374	469.9	01Jan2012, 03:35	1.01
Subbasin-38	0.492	122.3	01Jan2012, 01:56	0.93
Subbasin-29	0.051	14.1	01Jan2012, 01:02	0.74
Junction-20	7.102	1314.1	01Jan2012, 03:25	0.95
Reach-20	7.102	1314.1	01Jan2012, 03:51	0.95
Subbasin-28	0.411	95.3	01Jan2012, 01:41	0.78
Junction-26	7.513	1339.5	01Jan2012, 03:47	0.94
Reach-19	7.513	1339.5	01Jan2012, 04:04	0.94
Subbasin-33	0.719	144.5	01Jan2012, 02:03	0.78
Subbasin-32	0.317	81.7	01Jan2012, 01:34	0.83
Junction-19	8.549	1406.7	01Jan2012, 03:56	0.92
Reach-18	8.549	1406.7	01Jan2012, 04:21	0.92
Subbasin-31	0.431	118.9	01Jan2012, 01:40	0.93
Junction-18	8.980	1417.2	01Jan2012, 04:19	0.93
Reach-17	8.980	1417.2	01Jan2012, 04:28	0.93
Subbasin-24	1.509	275.4	01Jan2012, 03:31	1.04
Subbasin-22	0.565	172.0	01Jan2012, 01:49	1.10
Junction-16	2.074	368.1	01Jan2012, 03:11	1.06
Reach-16	2.074	368.1	01Jan2012, 03:26	1.06

Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	202.1	01Jan2012, 02:57	1.04
Junction-15	3.048	563.3	01Jan2012, 03:12	1.05
Reach-15	3.048	563.3	01Jan2012, 03:26	1.05
Subbasin-25	0.807	177.7	01Jan2012, 02:29	0.99
Subbasin-27	0.723	116.8	01Jan2012, 04:24	1.15
Junction-14	1.530	245.5	01Jan2012, 03:06	1.06
Reach-13	1.530	245.5	01Jan2012, 03:31	1.06
Subbasin-26	0.289	84.3	01Jan2012, 01:48	1.04
Junction-13	1.819	291.3	01Jan2012, 03:09	1.06
Reach-12	1.819	291.3	01Jan2012, 03:22	1.06
Junction-12	4.867	854.5	01Jan2012, 03:25	1.06
Reach-11	4.867	854.5	01Jan2012, 04:09	1.05
Subbasin-18	0.827	200.6	01Jan2012, 02:30	1.10
Subbasin-21	0.737	162.9	01Jan2012, 01:57	0.83
Junction-11	6.431	1047.2	01Jan2012, 03:42	1.03
Reach-10	6.431	1047.2	01Jan2012, 03:51	1.03
Subbasin-15	0.110	24.5	01Jan2012, 01:47	0.78
Subbasin-20	0.054	16.6	01Jan2012, 01:04	0.83
Junction-10	6.595	1055.3	01Jan2012, 03:49	1.03
Reach-09	6.595	1055.3	01Jan2012, 04:01	1.03
Subbasin-19	0.352	91.7	01Jan2012, 02:15	1.10
Junction-9	6.947	1102.2	01Jan2012, 03:56	1.03
Reach-08	6.947	1102.2	01Jan2012, 04:16	1.03
Subbasin-17	0.747	184.3	01Jan2012, 02:06	0.99
Subbasin-16	0.102	19.1	01Jan2012, 01:28	0.56
Junction-8	7.796	1166.8	01Jan2012, 04:06	1.02
Reach-07	7.796	1166.8	01Jan2012, 04:28	1.02
Subbasin-13	0.454	91.5	01Jan2012, 02:25	0.88
Subbasin-14	0.074	25.5	01Jan2012, 00:59	0.88
Junction-7	17.304	2619.2	01Jan2012, 04:26	0.97
Reach-06	17.304	2619.2	01Jan2012, 05:17	0.96
Subbasin-12	0.506	131.9	01Jan2012, 01:49	0.93
Junction-6	17.810	2622.3	01Jan2012, 05:17	0.96
Reach-05	17.810	2622.3	01Jan2012, 05:26	0.96
Subbasin-10	0.569	140.6	01Jan2012, 02:26	1.10
Subbasin-11	0.047	18.4	01Jan2012, 00:58	0.99

Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	2641.4	01Jan2012, 05:25	0.97
Reach-04	18.426	2641.4	01Jan2012, 06:20	0.96
Subbasin-09	0.355	109.8	01Jan2012, 01:47	1.10
Subbasin-08	0.321	80.4	01Jan2012, 02:03	0.99
Junction-17	0.676	187.2	01Jan2012, 01:54	1.05
Reach-14	0.676	187.2	01Jan2012, 02:02	1.05
Subbasin-06	0.606	126.1	01Jan2012, 02:07	0.83
Subbasin-07	0.048	11.9	01Jan2012, 01:00	0.65
Junction-4	19.756	2644.7	01Jan2012, 06:20	0.96
Reach-03	19.756	2644.7	01Jan2012, 06:36	0.96
Subbasin-02	0.327	90.5	01Jan2012, 01:32	0.88
Subbasin-05	0.052	7.5	01Jan2012, 01:29	0.42
Junction-3	20.135	2644.7	01Jan2012, 06:36	0.96
Reach-02	20.135	2644.7	01Jan2012, 06:44	0.96
Subbasin-03	0.488	113.8	01Jan2012, 02:16	0.99
Subbasin-04	0.104	33.4	01Jan2012, 01:14	0.93
Junction-2	20.727	2646.7	01Jan2012, 06:43	0.96
Reach-01	20.727	2646.7	01Jan2012, 07:05	0.95
Subbasin-01	0.154	38.2	01Jan2012, 01:20	0.74
Junction-1	20.881	2646.7	01Jan2012, 07:05	0.95

Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 6-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	266.4	01Jan2012, 03:14	1.27
Subbasin-35	1.165	232.7	01Jan2012, 03:13	1.33
Junction-23	2.566	499.1	01Jan2012, 03:14	1.29
Reach-24	2.566	499.1	01Jan2012, 03:44	1.29
Subbasin-37	0.810	152.3	01Jan2012, 02:28	1.09
Subbasin-34	0.396	94.4	01Jan2012, 02:19	1.33
Junction-22	3.772	691.5	01Jan2012, 03:26	1.25
Reach-23	3.772	691.5	01Jan2012, 03:45	1.25
Subbasin-30	0.413	89.6	01Jan2012, 02:31	1.27
Junction-21	4.185	759.8	01Jan2012, 03:41	1.25
Reach-21	4.185	759.8	01Jan2012, 03:49	1.25
Subbasin-41	1.181	229.3	01Jan2012, 03:22	1.33
Subbasin-40	0.779	162.7	01Jan2012, 03:13	1.39
Junction-25	1.960	391.6	01Jan2012, 03:19	1.35
Reach-25	1.960	391.6	01Jan2012, 03:48	1.35
Subbasin-39	0.414	108.1	01Jan2012, 01:59	1.33
Junction-24	2.374	448.5	01Jan2012, 03:33	1.35
Reach-22	2.374	448.5	01Jan2012, 04:00	1.35
Subbasin-38	0.492	107.9	01Jan2012, 02:28	1.27
Subbasin-29	0.051	11.5	01Jan2012, 01:39	1.03
Junction-20	7.102	1284.0	01Jan2012, 03:50	1.29
Reach-20	7.102	1284.0	01Jan2012, 04:16	1.28
Subbasin-28	0.411	82.2	01Jan2012, 02:11	1.09
Junction-26	7.513	1323.7	01Jan2012, 04:15	1.27
Reach-19	7.513	1323.7	01Jan2012, 04:32	1.27
Subbasin-33	0.719	130.5	01Jan2012, 02:40	1.09
Subbasin-32	0.317	69.5	01Jan2012, 02:03	1.15
Junction-19	8.549	1428.1	01Jan2012, 04:30	1.25
Reach-18	8.549	1428.1	01Jan2012, 04:55	1.25
Subbasin-31	0.431	101.7	01Jan2012, 02:09	1.27
Junction-18	8.980	1470.6	01Jan2012, 04:55	1.25
Reach-17	8.980	1470.6	01Jan2012, 05:04	1.25
Subbasin-24	1.509	270.2	01Jan2012, 04:02	1.39
Subbasin-22	0.565	148.8	01Jan2012, 02:18	1.46
Junction-16	2.074	365.9	01Jan2012, 03:33	1.41
Reach-16	2.074	365.9	01Jan2012, 03:48	1.41

Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 6-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	193.7	01Jan2012, 03:28	1.39
Junction-15	3.048	556.9	01Jan2012, 03:42	1.40
Reach-15	3.048	556.9	01Jan2012, 03:56	1.40
Subbasin-25	0.807	165.9	01Jan2012, 03:03	1.33
Subbasin-27	0.723	119.6	01Jan2012, 05:05	1.49
Junction-14	1.530	245.8	01Jan2012, 03:42	1.40
Reach-13	1.530	245.8	01Jan2012, 04:07	1.40
Subbasin-26	0.289	72.9	01Jan2012, 02:17	1.39
Junction-13	1.819	288.0	01Jan2012, 03:46	1.40
Reach-12	1.819	288.0	01Jan2012, 03:59	1.39
Junction-12	4.867	844.8	01Jan2012, 03:56	1.40
Reach-11	4.867	844.8	01Jan2012, 04:40	1.39
Subbasin-18	0.827	186.5	01Jan2012, 03:03	1.46
Subbasin-21	0.737	144.7	01Jan2012, 02:30	1.15
Junction-11	6.431	1050.6	01Jan2012, 04:27	1.37
Reach-10	6.431	1050.6	01Jan2012, 04:36	1.37
Subbasin-15	0.110	21.4	01Jan2012, 02:19	1.09
Subbasin-20	0.054	13.4	01Jan2012, 01:41	1.15
Junction-10	6.595	1065.5	01Jan2012, 04:37	1.36
Reach-09	6.595	1065.5	01Jan2012, 04:49	1.36
Subbasin-19	0.352	83.3	01Jan2012, 02:48	1.46
Junction-9	6.947	1112.7	01Jan2012, 04:45	1.37
Reach-08	6.947	1112.7	01Jan2012, 05:05	1.36
Subbasin-17	0.747	165.4	01Jan2012, 02:39	1.33
Subbasin-16	0.102	16.4	01Jan2012, 01:54	0.82
Junction-8	7.796	1203.6	01Jan2012, 05:00	1.35
Reach-07	7.796	1203.6	01Jan2012, 05:22	1.35
Subbasin-13	0.454	85.5	01Jan2012, 03:02	1.20
Subbasin-14	0.074	19.9	01Jan2012, 01:37	1.20
Junction-7	17.304	2722.5	01Jan2012, 05:07	1.29
Reach-06	17.304	2722.5	01Jan2012, 05:58	1.28
Subbasin-12	0.506	114.7	01Jan2012, 02:19	1.27
Junction-6	17.810	2761.2	01Jan2012, 05:57	1.28
Reach-05	17.810	2761.2	01Jan2012, 06:06	1.28
Subbasin-10	0.569	130.0	01Jan2012, 02:59	1.46
Subbasin-11	0.047	14.0	01Jan2012, 01:37	1.33

Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 6-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	2823.7	01Jan2012, 06:05	1.28
Reach-04	18.426	2823.7	01Jan2012, 07:00	1.26
Subbasin-09	0.355	94.5	01Jan2012, 02:15	1.46
Subbasin-08	0.321	71.8	01Jan2012, 02:36	1.33
Junction-17	0.676	164.5	01Jan2012, 02:24	1.40
Reach-14	0.676	164.5	01Jan2012, 02:32	1.40
Subbasin-06	0.606	114.5	01Jan2012, 02:44	1.15
Subbasin-07	0.048	9.8	01Jan2012, 01:37	0.92
Junction-4	19.756	2899.1	01Jan2012, 06:56	1.26
Reach-03	19.756	2899.1	01Jan2012, 07:12	1.24
Subbasin-02	0.327	76.6	01Jan2012, 02:00	1.20
Subbasin-05	0.052	6.4	01Jan2012, 01:50	0.64
Junction-3	20.135	2903.3	01Jan2012, 07:12	1.24
Reach-02	20.135	2903.3	01Jan2012, 07:20	1.24
Subbasin-03	0.488	104.3	01Jan2012, 02:52	1.33
Subbasin-04	0.104	27.5	01Jan2012, 01:48	1.27
Junction-2	20.727	2928.5	01Jan2012, 07:18	1.24
Reach-01	20.727	2928.5	01Jan2012, 07:40	1.22
Subbasin-01	0.154	32.4	01Jan2012, 01:50	1.03
Junction-1	20.881	2928.6	01Jan2012, 07:40	1.22

Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	273.3	01Jan2012, 06:54	1.65
Subbasin-35	1.165	236.6	01Jan2012, 06:53	1.72
Junction-23	2.566	509.9	01Jan2012, 06:54	1.68
Reach-24	2.566	509.9	01Jan2012, 07:24	1.68
Subbasin-37	0.810	154.7	01Jan2012, 06:16	1.45
Subbasin-34	0.396	90.6	01Jan2012, 06:07	1.72
Junction-22	3.772	708.9	01Jan2012, 07:05	1.64
Reach-23	3.772	708.9	01Jan2012, 07:24	1.64
Subbasin-30	0.413	88.7	01Jan2012, 06:18	1.65
Junction-21	4.185	781.2	01Jan2012, 07:18	1.64
Reach-21	4.185	781.2	01Jan2012, 07:26	1.64
Subbasin-41	1.181	234.4	01Jan2012, 07:02	1.72
Subbasin-40	0.779	164.0	01Jan2012, 06:54	1.80
Junction-25	1.960	398.2	01Jan2012, 06:59	1.75
Reach-25	1.960	398.2	01Jan2012, 07:28	1.75
Subbasin-39	0.414	98.7	01Jan2012, 05:43	1.72
Junction-24	2.374	461.4	01Jan2012, 07:21	1.75
Reach-22	2.374	461.4	01Jan2012, 07:48	1.75
Subbasin-38	0.492	106.3	01Jan2012, 06:15	1.65
Subbasin-29	0.051	10.4	01Jan2012, 05:10	1.38
Junction-20	7.102	1324.4	01Jan2012, 07:30	1.67
Reach-20	7.102	1324.4	01Jan2012, 07:56	1.67
Subbasin-28	0.411	80.8	01Jan2012, 06:01	1.45
Junction-26	7.513	1376.4	01Jan2012, 07:54	1.66
Reach-19	7.513	1376.4	01Jan2012, 08:11	1.66
Subbasin-33	0.719	134.4	01Jan2012, 06:25	1.45
Subbasin-32	0.317	66.1	01Jan2012, 05:50	1.51
Junction-19	8.549	1508.4	01Jan2012, 08:05	1.64
Reach-18	8.549	1508.4	01Jan2012, 08:30	1.64
Subbasin-31	0.431	96.5	01Jan2012, 05:57	1.65
Junction-18	8.980	1558.1	01Jan2012, 08:26	1.64
Reach-17	8.980	1558.1	01Jan2012, 08:35	1.64
Subbasin-24	1.509	281.6	01Jan2012, 07:43	1.80
Subbasin-22	0.565	139.6	01Jan2012, 06:06	1.87
Junction-16	2.074	383.1	01Jan2012, 07:13	1.82
Reach-16	2.074	383.1	01Jan2012, 07:28	1.82

Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	197.3	01Jan2012, 07:09	1.80
Junction-15	3.048	578.6	01Jan2012, 07:20	1.81
Reach-15	3.048	578.6	01Jan2012, 07:34	1.81
Subbasin-25	0.807	167.7	01Jan2012, 06:45	1.72
Subbasin-27	0.723	127.4	01Jan2012, 08:43	1.95
Junction-14	1.530	263.5	01Jan2012, 07:27	1.83
Reach-13	1.530	263.5	01Jan2012, 07:52	1.83
Subbasin-26	0.289	68.9	01Jan2012, 06:05	1.80
Junction-13	1.819	310.0	01Jan2012, 07:35	1.82
Reach-12	1.819	310.0	01Jan2012, 07:48	1.82
Junction-12	4.867	887.8	01Jan2012, 07:37	1.82
Reach-11	4.867	887.8	01Jan2012, 08:21	1.82
Subbasin-18	0.827	185.1	01Jan2012, 06:46	1.87
Subbasin-21	0.737	146.1	01Jan2012, 06:18	1.51
Junction-11	6.431	1128.4	01Jan2012, 08:05	1.79
Reach-10	6.431	1128.4	01Jan2012, 08:14	1.79
Subbasin-15	0.110	21.4	01Jan2012, 06:08	1.45
Subbasin-20	0.054	12.0	01Jan2012, 05:12	1.51
Junction-10	6.595	1146.8	01Jan2012, 08:12	1.78
Reach-09	6.595	1146.8	01Jan2012, 08:24	1.78
Subbasin-19	0.352	81.6	01Jan2012, 06:33	1.87
Junction-9	6.947	1202.9	01Jan2012, 08:20	1.78
Reach-08	6.947	1202.9	01Jan2012, 08:40	1.78
Subbasin-17	0.747	163.9	01Jan2012, 06:25	1.72
Subbasin-16	0.102	16.2	01Jan2012, 05:48	1.13
Junction-8	7.796	1309.1	01Jan2012, 08:32	1.77
Reach-07	7.796	1309.1	01Jan2012, 08:54	1.77
Subbasin-13	0.454	87.8	01Jan2012, 06:43	1.58
Subbasin-14	0.074	17.7	01Jan2012, 05:08	1.58
Junction-7	17.304	2924.3	01Jan2012, 08:42	1.70
Reach-06	17.304	2924.3	01Jan2012, 09:33	1.70
Subbasin-12	0.506	111.2	01Jan2012, 06:08	1.65
Junction-6	17.810	2971.9	01Jan2012, 09:32	1.69
Reach-05	17.810	2971.9	01Jan2012, 09:41	1.69
Subbasin-10	0.569	128.6	01Jan2012, 06:42	1.87
Subbasin-11	0.047	12.3	01Jan2012, 05:08	1.72

Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	3040.8	01Jan2012, 09:39	1.70
Reach-04	18.426	3040.8	01Jan2012, 10:34	1.70
Subbasin-09	0.355	88.2	01Jan2012, 06:04	1.87
Subbasin-08	0.321	70.9	01Jan2012, 06:23	1.72
Junction-17	0.676	158.2	01Jan2012, 06:12	1.80
Reach-14	0.676	158.2	01Jan2012, 06:20	1.80
Subbasin-06	0.606	117.2	01Jan2012, 06:28	1.51
Subbasin-07	0.048	9.0	01Jan2012, 05:07	1.25
Junction-4	19.756	3135.4	01Jan2012, 10:31	1.70
Reach-03	19.756	3135.4	01Jan2012, 10:47	1.70
Subbasin-02	0.327	71.5	01Jan2012, 05:46	1.58
Subbasin-05	0.052	6.7	01Jan2012, 06:06	0.91
Junction-3	20.135	3156.8	01Jan2012, 10:47	1.69
Reach-02	20.135	3156.8	01Jan2012, 10:55	1.69
Subbasin-03	0.488	104.4	01Jan2012, 06:35	1.72
Subbasin-04	0.104	24.6	01Jan2012, 05:23	1.65
Junction-2	20.727	3197.8	01Jan2012, 10:54	1.69
Reach-01	20.727	3197.8	01Jan2012, 11:16	1.69
Subbasin-01	0.154	30.0	01Jan2012, 05:27	1.38
Junction-1	20.881	3203.8	01Jan2012, 11:15	1.69

Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 24-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	237.4	01Jan2012, 16:39	2.09
Subbasin-35	1.165	203.4	01Jan2012, 16:39	2.17
Junction-23	2.566	440.8	01Jan2012, 16:39	2.12
Reach-24	2.566	440.8	01Jan2012, 17:09	2.12
Subbasin-37	0.810	132.1	01Jan2012, 15:48	1.86
Subbasin-34	0.396	74.2	01Jan2012, 15:41	2.17
Junction-22	3.772	626.0	01Jan2012, 16:48	2.07
Reach-23	3.772	626.0	01Jan2012, 17:07	2.07
Subbasin-30	0.413	73.8	01Jan2012, 15:55	2.09
Junction-21	4.185	692.6	01Jan2012, 17:02	2.07
Reach-21	4.185	692.6	01Jan2012, 17:10	2.07
Subbasin-41	1.181	203.6	01Jan2012, 16:48	2.17
Subbasin-40	0.779	139.7	01Jan2012, 16:40	2.25
Junction-25	1.960	343.2	01Jan2012, 16:45	2.20
Reach-25	1.960	343.2	01Jan2012, 17:14	2.20
Subbasin-39	0.414	80.5	01Jan2012, 15:22	2.17
Junction-24	2.374	405.6	01Jan2012, 17:06	2.20
Reach-22	2.374	405.6	01Jan2012, 17:33	2.20
Subbasin-38	0.492	88.3	01Jan2012, 15:51	2.09
Subbasin-29	0.051	8.8	01Jan2012, 15:05	1.78
Junction-20	7.102	1178.6	01Jan2012, 17:10	2.11
Reach-20	7.102	1178.6	01Jan2012, 17:36	2.11
Subbasin-28	0.411	68.8	01Jan2012, 15:30	1.86
Junction-26	7.513	1230.7	01Jan2012, 17:32	2.10
Reach-19	7.513	1230.7	01Jan2012, 17:49	2.10
Subbasin-33	0.719	115.8	01Jan2012, 16:04	1.86
Subbasin-32	0.317	55.7	01Jan2012, 15:24	1.93
Junction-19	8.549	1362.3	01Jan2012, 17:41	2.07
Reach-18	8.549	1362.3	01Jan2012, 18:06	2.07
Subbasin-31	0.431	79.7	01Jan2012, 15:31	2.09
Junction-18	8.980	1413.2	01Jan2012, 18:03	2.07
Reach-17	8.980	1413.2	01Jan2012, 18:12	2.07
Subbasin-24	1.509	252.1	01Jan2012, 17:27	2.25
Subbasin-22	0.565	112.1	01Jan2012, 15:42	2.33
Junction-16	2.074	346.0	01Jan2012, 17:02	2.27
Reach-16	2.074	346.0	01Jan2012, 17:17	2.27

Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 24-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	170.9	01Jan2012, 16:55	2.25
Junction-15	3.048	515.9	01Jan2012, 17:07	2.27
Reach-15	3.048	515.9	01Jan2012, 17:21	2.27
Subbasin-25	0.807	142.7	01Jan2012, 16:30	2.17
Subbasin-27	0.723	116.9	01Jan2012, 18:23	2.42
Junction-14	1.530	243.7	01Jan2012, 17:16	2.29
Reach-13	1.530	243.7	01Jan2012, 17:41	2.29
Subbasin-26	0.289	55.9	01Jan2012, 15:40	2.25
Junction-13	1.819	288.0	01Jan2012, 17:20	2.28
Reach-12	1.819	288.0	01Jan2012, 17:33	2.28
Junction-12	4.867	803.4	01Jan2012, 17:25	2.27
Reach-11	4.867	803.4	01Jan2012, 18:09	2.27
Subbasin-18	0.827	154.5	01Jan2012, 16:31	2.33
Subbasin-21	0.737	123.8	01Jan2012, 15:53	1.93
Junction-11	6.431	1030.1	01Jan2012, 17:44	2.24
Reach-10	6.431	1030.1	01Jan2012, 17:53	2.24
Subbasin-15	0.110	18.2	01Jan2012, 15:38	1.86
Subbasin-20	0.054	10.0	01Jan2012, 15:07	1.93
Junction-10	6.595	1048.6	01Jan2012, 17:52	2.23
Reach-09	6.595	1048.6	01Jan2012, 18:04	2.23
Subbasin-19	0.352	67.1	01Jan2012, 16:16	2.33
Junction-9	6.947	1102.2	01Jan2012, 17:59	2.24
Reach-08	6.947	1102.2	01Jan2012, 18:19	2.24
Subbasin-17	0.747	136.1	01Jan2012, 16:07	2.17
Subbasin-16	0.102	14.7	01Jan2012, 15:14	1.50
Junction-8	7.796	1209.8	01Jan2012, 18:09	2.22
Reach-07	7.796	1209.8	01Jan2012, 18:31	2.22
Subbasin-13	0.454	76.0	01Jan2012, 16:26	2.01
Subbasin-14	0.074	14.3	01Jan2012, 15:04	2.01
Junction-7	17.304	2684.1	01Jan2012, 18:15	2.14
Reach-06	17.304	2684.1	01Jan2012, 19:06	2.14
Subbasin-12	0.506	91.9	01Jan2012, 15:41	2.09
Junction-6	17.810	2727.0	01Jan2012, 19:04	2.14
Reach-05	17.810	2727.0	01Jan2012, 19:13	2.14
Subbasin-10	0.569	106.9	01Jan2012, 16:27	2.33
Subbasin-11	0.047	9.7	01Jan2012, 15:04	2.17

Hinkle Creek Watershed Master Plan
HEC-HMS Output
10-yr 24-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	2795.0	01Jan2012, 19:09	2.14
Reach-04	18.426	2795.0	01Jan2012, 20:04	2.14
Subbasin-09	0.355	70.7	01Jan2012, 15:39	2.33
Subbasin-08	0.321	58.7	01Jan2012, 16:03	2.17
Junction-17	0.676	128.8	01Jan2012, 15:49	2.25
Reach-14	0.676	128.8	01Jan2012, 15:57	2.25
Subbasin-06	0.606	100.4	01Jan2012, 16:09	1.93
Subbasin-07	0.048	7.8	01Jan2012, 15:04	1.64
Junction-4	19.756	2889.3	01Jan2012, 20:03	2.14
Reach-03	19.756	2889.3	01Jan2012, 20:19	2.14
Subbasin-02	0.327	59.7	01Jan2012, 15:22	2.01
Subbasin-05	0.052	6.4	01Jan2012, 15:10	1.24
Junction-3	20.135	2912.5	01Jan2012, 20:19	2.13
Reach-02	20.135	2912.5	01Jan2012, 20:27	2.13
Subbasin-03	0.488	87.7	01Jan2012, 16:18	2.17
Subbasin-04	0.104	20.2	01Jan2012, 15:12	2.09
Junction-2	20.727	2955.0	01Jan2012, 20:26	2.13
Reach-01	20.727	2955.0	01Jan2012, 20:48	2.13
Subbasin-01	0.154	26.0	01Jan2012, 15:13	1.78
Junction-1	20.881	2964.2	01Jan2012, 20:48	2.13

Hinkle Creek Watershed Master Plan
HEC-HMS Output
25-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	408.0	01Jan2012, 02:34	1.31
Subbasin-35	1.165	354.4	01Jan2012, 02:34	1.37
Junction-23	2.566	762.5	01Jan2012, 02:34	1.34
Reach-24	2.566	762.5	01Jan2012, 03:04	1.31
Subbasin-37	0.810	259.1	01Jan2012, 01:51	1.16
Subbasin-34	0.396	157.7	01Jan2012, 01:45	1.41
Junction-22	3.772	1025.4	01Jan2012, 02:55	1.29
Reach-23	3.772	1025.4	01Jan2012, 03:14	1.27
Subbasin-30	0.413	147.8	01Jan2012, 01:55	1.34
Junction-21	4.185	1117.4	01Jan2012, 03:10	1.28
Reach-21	4.185	1117.4	01Jan2012, 03:18	1.27
Subbasin-41	1.181	345.0	01Jan2012, 02:44	1.36
Subbasin-40	0.779	245.9	01Jan2012, 02:36	1.43
Junction-25	1.960	589.9	01Jan2012, 02:40	1.39
Reach-25	1.960	589.9	01Jan2012, 03:09	1.35
Subbasin-39	0.414	186.6	01Jan2012, 01:26	1.41
Junction-24	2.374	670.1	01Jan2012, 03:05	1.36
Reach-22	2.374	670.1	01Jan2012, 03:32	1.32
Subbasin-38	0.492	178.9	01Jan2012, 01:52	1.34
Subbasin-29	0.051	21.9	01Jan2012, 01:00	1.10
Junction-20	7.102	1882.7	01Jan2012, 03:20	1.29
Reach-20	7.102	1882.7	01Jan2012, 03:46	1.24
Subbasin-28	0.411	143.7	01Jan2012, 01:37	1.16
Junction-26	7.513	1922.4	01Jan2012, 03:43	1.24
Reach-19	7.513	1922.4	01Jan2012, 04:00	1.20
Subbasin-33	0.719	217.7	01Jan2012, 01:59	1.16
Subbasin-32	0.317	121.9	01Jan2012, 01:30	1.22
Junction-19	8.549	2024.2	01Jan2012, 03:52	1.20
Reach-18	8.549	2024.2	01Jan2012, 04:17	1.13
Subbasin-31	0.431	174.0	01Jan2012, 01:37	1.35
Junction-18	8.980	2040.5	01Jan2012, 04:15	1.14
Reach-17	8.980	2040.5	01Jan2012, 04:24	1.11
Subbasin-24	1.509	390.0	01Jan2012, 03:27	1.31
Subbasin-22	0.565	244.8	01Jan2012, 01:46	1.55
Junction-16	2.074	517.5	01Jan2012, 03:06	1.37
Reach-16	2.074	517.5	01Jan2012, 03:21	1.35

Hinkle Creek Watershed Master Plan
HEC-HMS Output
25-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	287.4	01Jan2012, 02:52	1.40
Junction-15	3.048	795.1	01Jan2012, 03:06	1.36
Reach-15	3.048	795.1	01Jan2012, 03:20	1.34
Subbasin-25	0.807	256.3	01Jan2012, 02:25	1.38
Subbasin-27	0.723	162.5	01Jan2012, 04:21	1.16
Junction-14	1.530	346.7	01Jan2012, 02:55	1.28
Reach-13	1.530	346.7	01Jan2012, 03:20	1.22
Subbasin-26	0.289	121.1	01Jan2012, 01:44	1.48
Junction-13	1.819	412.1	01Jan2012, 03:03	1.26
Reach-12	1.819	412.1	01Jan2012, 03:16	1.23
Junction-12	4.867	1207.0	01Jan2012, 03:18	1.30
Reach-11	4.867	1207.0	01Jan2012, 04:02	1.18
Subbasin-18	0.827	284.1	01Jan2012, 02:27	1.51
Subbasin-21	0.737	243.0	01Jan2012, 01:53	1.22
Junction-11	6.431	1485.7	01Jan2012, 03:39	1.22
Reach-10	6.431	1485.7	01Jan2012, 03:48	1.20
Subbasin-15	0.110	36.9	01Jan2012, 01:44	1.16
Subbasin-20	0.054	25.1	01Jan2012, 01:02	1.22
Junction-10	6.595	1497.9	01Jan2012, 03:46	1.20
Reach-09	6.595	1497.9	01Jan2012, 03:58	1.16
Subbasin-19	0.352	130.2	01Jan2012, 02:12	1.53
Junction-9	6.947	1563.9	01Jan2012, 03:53	1.18
Reach-08	6.947	1563.9	01Jan2012, 04:13	1.11
Subbasin-17	0.747	266.9	01Jan2012, 02:02	1.40
Subbasin-16	0.102	30.5	01Jan2012, 01:20	0.89
Junction-8	7.796	1656.6	01Jan2012, 04:03	1.14
Reach-07	7.796	1656.6	01Jan2012, 04:25	1.06
Subbasin-13	0.454	134.6	01Jan2012, 02:20	1.26
Subbasin-14	0.074	38.1	01Jan2012, 00:57	1.28
Junction-7	17.304	3748.5	01Jan2012, 04:23	1.09
Reach-06	17.304	3748.5	01Jan2012, 05:14	0.88
Subbasin-12	0.506	192.9	01Jan2012, 01:45	1.35
Junction-6	17.810	3753.1	01Jan2012, 05:13	0.89
Reach-05	17.810	3753.1	01Jan2012, 05:22	0.85
Subbasin-10	0.569	199.3	01Jan2012, 02:22	1.52
Subbasin-11	0.047	26.9	01Jan2012, 00:56	1.41

Hinkle Creek Watershed Master Plan
HEC-HMS Output
25-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	3780.5	01Jan2012, 05:21	0.87
Reach-04	18.426	3721.0	01Jan2012, 06:00	0.59
Subbasin-09	0.355	156.3	01Jan2012, 01:43	1.55
Subbasin-08	0.321	116.4	01Jan2012, 02:00	1.41
Junction-17	0.676	268.5	01Jan2012, 01:51	1.48
Reach-14	0.676	268.5	01Jan2012, 01:59	1.48
Subbasin-06	0.606	188.0	01Jan2012, 02:03	1.22
Subbasin-07	0.048	18.9	01Jan2012, 00:58	0.99
Junction-4	19.756	3729.0	01Jan2012, 06:00	0.64
Reach-03	19.756	3569.2	01Jan2012, 06:00	0.56
Subbasin-02	0.327	133.8	01Jan2012, 01:27	1.28
Subbasin-05	0.052	12.4	01Jan2012, 01:14	0.69
Junction-3	20.135	3569.2	01Jan2012, 06:00	0.57
Reach-02	20.135	3454.8	01Jan2012, 06:00	0.54
Subbasin-03	0.488	164.6	01Jan2012, 02:13	1.40
Subbasin-04	0.104	49.4	01Jan2012, 01:11	1.35
Junction-2	20.727	3461.7	01Jan2012, 06:00	0.56
Reach-01	20.727	3092.8	01Jan2012, 06:00	0.47
Subbasin-01	0.154	58.8	01Jan2012, 01:13	1.10
Junction-1	20.881	3092.8	01Jan2012, 06:00	0.48

Hinkle Creek Watershed Master Plan
HEC-HMS Output
25-yr 6-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	381.2	01Jan2012, 03:07	1.78
Subbasin-35	1.165	330.4	01Jan2012, 03:06	1.86
Junction-23	2.566	711.6	01Jan2012, 03:06	1.82
Reach-24	2.566	711.6	01Jan2012, 03:36	1.82
Subbasin-37	0.810	225.8	01Jan2012, 02:21	1.57
Subbasin-34	0.396	135.2	01Jan2012, 02:14	1.86
Junction-22	3.772	989.0	01Jan2012, 03:21	1.77
Reach-23	3.772	989.0	01Jan2012, 03:40	1.77
Subbasin-30	0.413	129.3	01Jan2012, 02:24	1.78
Junction-21	4.185	1085.8	01Jan2012, 03:36	1.77
Reach-21	4.185	1085.8	01Jan2012, 03:44	1.77
Subbasin-41	1.181	325.3	01Jan2012, 03:15	1.86
Subbasin-40	0.779	229.2	01Jan2012, 03:07	1.93
Junction-25	1.960	553.8	01Jan2012, 03:12	1.89
Reach-25	1.960	553.8	01Jan2012, 03:41	1.89
Subbasin-39	0.414	154.7	01Jan2012, 01:55	1.86
Junction-24	2.374	636.3	01Jan2012, 03:28	1.88
Reach-22	2.374	636.3	01Jan2012, 03:55	1.88
Subbasin-38	0.492	155.7	01Jan2012, 02:22	1.78
Subbasin-29	0.051	17.0	01Jan2012, 01:38	1.50
Junction-20	7.102	1828.3	01Jan2012, 03:45	1.81
Reach-20	7.102	1828.3	01Jan2012, 04:11	1.80
Subbasin-28	0.411	122.2	01Jan2012, 02:06	1.57
Junction-26	7.513	1883.3	01Jan2012, 04:11	1.79
Reach-19	7.513	1883.3	01Jan2012, 04:28	1.79
Subbasin-33	0.719	193.0	01Jan2012, 02:31	1.57
Subbasin-32	0.317	102.3	01Jan2012, 01:58	1.64
Junction-19	8.549	2029.1	01Jan2012, 04:25	1.77
Reach-18	8.549	2029.1	01Jan2012, 04:50	1.77
Subbasin-31	0.431	147.1	01Jan2012, 02:05	1.78
Junction-18	8.980	2085.3	01Jan2012, 04:50	1.77
Reach-17	8.980	2085.3	01Jan2012, 04:59	1.77
Subbasin-24	1.509	379.4	01Jan2012, 03:56	1.93
Subbasin-22	0.565	209.5	01Jan2012, 02:13	2.01
Junction-16	2.074	512.9	01Jan2012, 03:29	1.95
Reach-16	2.074	512.9	01Jan2012, 03:44	1.95

Hinkle Creek Watershed Master Plan
HEC-HMS Output
25-yr 6-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	272.6	01Jan2012, 03:22	1.93
Junction-15	3.048	780.4	01Jan2012, 03:37	1.94
Reach-15	3.048	780.4	01Jan2012, 03:51	1.94
Subbasin-25	0.807	235.9	01Jan2012, 02:57	1.86
Subbasin-27	0.723	164.8	01Jan2012, 04:59	2.03
Junction-14	1.530	343.8	01Jan2012, 03:36	1.94
Reach-13	1.530	343.8	01Jan2012, 04:01	1.93
Subbasin-26	0.289	103.5	01Jan2012, 02:12	1.93
Junction-13	1.819	403.8	01Jan2012, 03:38	1.93
Reach-12	1.819	403.8	01Jan2012, 03:51	1.93
Junction-12	4.867	1184.3	01Jan2012, 03:51	1.94
Reach-11	4.867	1184.3	01Jan2012, 04:35	1.93
Subbasin-18	0.827	261.0	01Jan2012, 02:57	2.01
Subbasin-21	0.737	212.6	01Jan2012, 02:24	1.64
Junction-11	6.431	1470.1	01Jan2012, 04:20	1.91
Reach-10	6.431	1470.1	01Jan2012, 04:29	1.90
Subbasin-15	0.110	31.7	01Jan2012, 02:13	1.57
Subbasin-20	0.054	19.5	01Jan2012, 01:39	1.64
Junction-10	6.595	1490.0	01Jan2012, 04:28	1.90
Reach-09	6.595	1490.0	01Jan2012, 04:40	1.89
Subbasin-19	0.352	116.8	01Jan2012, 02:41	2.01
Junction-9	6.947	1555.9	01Jan2012, 04:35	1.90
Reach-08	6.947	1555.9	01Jan2012, 04:55	1.89
Subbasin-17	0.747	236.3	01Jan2012, 02:32	1.86
Subbasin-16	0.102	25.8	01Jan2012, 01:50	1.24
Junction-8	7.796	1681.1	01Jan2012, 04:49	1.88
Reach-07	7.796	1681.1	01Jan2012, 05:11	1.87
Subbasin-13	0.454	123.6	01Jan2012, 02:54	1.71
Subbasin-14	0.074	28.4	01Jan2012, 01:36	1.71
Junction-7	17.304	3838.8	01Jan2012, 05:01	1.81
Reach-06	17.304	3838.8	01Jan2012, 05:52	1.80
Subbasin-12	0.506	165.6	01Jan2012, 02:14	1.78
Junction-6	17.810	3891.9	01Jan2012, 05:51	1.80
Reach-05	17.810	3891.9	01Jan2012, 06:00	1.79
Subbasin-10	0.569	182.0	01Jan2012, 02:53	2.01
Subbasin-11	0.047	19.6	01Jan2012, 01:36	1.86

Hinkle Creek Watershed Master Plan
HEC-HMS Output
25-yr 6-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	3974.9	01Jan2012, 05:59	1.80
Reach-04	18.426	3974.9	01Jan2012, 06:54	1.76
Subbasin-09	0.355	133.2	01Jan2012, 02:11	2.01
Subbasin-08	0.321	102.6	01Jan2012, 02:29	1.86
Junction-17	0.676	233.4	01Jan2012, 02:19	1.94
Reach-14	0.676	233.4	01Jan2012, 02:27	1.94
Subbasin-06	0.606	167.6	01Jan2012, 02:35	1.64
Subbasin-07	0.048	14.8	01Jan2012, 01:36	1.37
Junction-4	19.756	4082.1	01Jan2012, 06:50	1.76
Reach-03	19.756	4082.1	01Jan2012, 07:06	1.75
Subbasin-02	0.327	111.6	01Jan2012, 01:56	1.71
Subbasin-05	0.052	10.8	01Jan2012, 01:45	1.01
Junction-3	20.135	4089.3	01Jan2012, 07:05	1.75
Reach-02	20.135	4089.3	01Jan2012, 07:13	1.74
Subbasin-03	0.488	148.4	01Jan2012, 02:44	1.86
Subbasin-04	0.104	39.5	01Jan2012, 01:45	1.78
Junction-2	20.727	4125.4	01Jan2012, 07:12	1.74
Reach-01	20.727	4125.4	01Jan2012, 07:34	1.72
Subbasin-01	0.154	48.4	01Jan2012, 01:47	1.50
Junction-1	20.881	4125.6	01Jan2012, 07:34	1.71

Hinkle Creek Watershed Master Plan
HEC-HMS Output
25-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	379.1	01Jan2012, 06:49	2.28
Subbasin-35	1.165	325.8	01Jan2012, 06:49	2.37
Junction-23	2.566	704.8	01Jan2012, 06:49	2.32
Reach-24	2.566	704.8	01Jan2012, 07:19	2.32
Subbasin-37	0.810	219.0	01Jan2012, 06:09	2.04
Subbasin-34	0.396	124.5	01Jan2012, 06:02	2.37
Junction-22	3.772	983.9	01Jan2012, 06:59	2.27
Reach-23	3.772	983.9	01Jan2012, 07:18	2.27
Subbasin-30	0.413	122.8	01Jan2012, 06:12	2.28
Junction-21	4.185	1084.6	01Jan2012, 07:11	2.27
Reach-21	4.185	1084.6	01Jan2012, 07:19	2.27
Subbasin-41	1.181	322.9	01Jan2012, 06:57	2.37
Subbasin-40	0.779	224.2	01Jan2012, 06:50	2.45
Junction-25	1.960	546.7	01Jan2012, 06:54	2.40
Reach-25	1.960	546.7	01Jan2012, 07:23	2.40
Subbasin-39	0.414	136.0	01Jan2012, 05:37	2.37
Junction-24	2.374	632.4	01Jan2012, 07:14	2.40
Reach-22	2.374	632.4	01Jan2012, 07:41	2.40
Subbasin-38	0.492	147.1	01Jan2012, 06:10	2.28
Subbasin-29	0.051	15.1	01Jan2012, 05:09	1.96
Junction-20	7.102	1830.5	01Jan2012, 07:22	2.31
Reach-20	7.102	1830.5	01Jan2012, 07:48	2.31
Subbasin-28	0.411	114.5	01Jan2012, 05:53	2.04
Junction-26	7.513	1902.2	01Jan2012, 07:46	2.30
Reach-19	7.513	1902.2	01Jan2012, 08:03	2.30
Subbasin-33	0.719	190.5	01Jan2012, 06:18	2.04
Subbasin-32	0.317	93.1	01Jan2012, 05:42	2.12
Junction-19	8.549	2085.5	01Jan2012, 07:58	2.27
Reach-18	8.549	2085.5	01Jan2012, 08:23	2.27
Subbasin-31	0.431	133.7	01Jan2012, 05:51	2.28
Junction-18	8.980	2154.0	01Jan2012, 08:20	2.27
Reach-17	8.980	2154.0	01Jan2012, 08:29	2.27
Subbasin-24	1.509	385.1	01Jan2012, 07:37	2.45
Subbasin-22	0.565	189.1	01Jan2012, 06:01	2.54
Junction-16	2.074	523.7	01Jan2012, 07:06	2.48
Reach-16	2.074	523.7	01Jan2012, 07:21	2.48

Hinkle Creek Watershed Master Plan
HEC-HMS Output
25-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	269.8	01Jan2012, 07:03	2.45
Junction-15	3.048	791.4	01Jan2012, 07:14	2.47
Reach-15	3.048	791.4	01Jan2012, 07:28	2.47
Subbasin-25	0.807	230.8	01Jan2012, 06:41	2.37
Subbasin-27	0.723	171.8	01Jan2012, 08:36	2.63
Junction-14	1.530	360.3	01Jan2012, 07:18	2.49
Reach-13	1.530	360.3	01Jan2012, 07:43	2.49
Subbasin-26	0.289	94.0	01Jan2012, 06:00	2.45
Junction-13	1.819	424.1	01Jan2012, 07:24	2.48
Reach-12	1.819	424.1	01Jan2012, 07:37	2.48
Junction-12	4.867	1214.9	01Jan2012, 07:30	2.47
Reach-11	4.867	1214.9	01Jan2012, 08:14	2.47
Subbasin-18	0.827	251.1	01Jan2012, 06:41	2.54
Subbasin-21	0.737	205.3	01Jan2012, 06:12	2.12
Junction-11	6.431	1542.4	01Jan2012, 07:58	2.44
Reach-10	6.431	1542.4	01Jan2012, 08:07	2.44
Subbasin-15	0.110	30.2	01Jan2012, 06:01	2.04
Subbasin-20	0.054	17.1	01Jan2012, 05:11	2.12
Junction-10	6.595	1567.9	01Jan2012, 08:06	2.43
Reach-09	6.595	1567.9	01Jan2012, 08:18	2.43
Subbasin-19	0.352	110.6	01Jan2012, 06:28	2.54
Junction-9	6.947	1643.3	01Jan2012, 08:14	2.44
Reach-08	6.947	1643.3	01Jan2012, 08:34	2.44
Subbasin-17	0.747	225.3	01Jan2012, 06:20	2.37
Subbasin-16	0.102	24.0	01Jan2012, 05:27	1.67
Junction-8	7.796	1788.7	01Jan2012, 08:25	2.42
Reach-07	7.796	1788.7	01Jan2012, 08:47	2.42
Subbasin-13	0.454	122.7	01Jan2012, 06:38	2.20
Subbasin-14	0.074	24.8	01Jan2012, 05:07	2.20
Junction-7	17.304	4021.6	01Jan2012, 08:34	2.34
Reach-06	17.304	4021.6	01Jan2012, 09:25	2.34
Subbasin-12	0.506	153.9	01Jan2012, 06:02	2.28
Junction-6	17.810	4084.3	01Jan2012, 09:25	2.33
Reach-05	17.810	4084.3	01Jan2012, 09:34	2.33
Subbasin-10	0.569	174.4	01Jan2012, 06:38	2.54
Subbasin-11	0.047	17.0	01Jan2012, 05:07	2.37

Hinkle Creek Watershed Master Plan
HEC-HMS Output
25-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	4176.3	01Jan2012, 09:33	2.34
Reach-04	18.426	4176.3	01Jan2012, 10:28	2.34
Subbasin-09	0.355	119.5	01Jan2012, 05:58	2.54
Subbasin-08	0.321	97.4	01Jan2012, 06:17	2.37
Junction-17	0.676	215.7	01Jan2012, 06:08	2.46
Reach-14	0.676	215.7	01Jan2012, 06:16	2.46
Subbasin-06	0.606	164.8	01Jan2012, 06:22	2.12
Subbasin-07	0.048	13.2	01Jan2012, 05:07	1.81
Junction-4	19.756	4305.9	01Jan2012, 10:24	2.34
Reach-03	19.756	4305.9	01Jan2012, 10:40	2.34
Subbasin-02	0.327	100.1	01Jan2012, 05:39	2.20
Subbasin-05	0.052	10.2	01Jan2012, 05:41	1.39
Junction-3	20.135	4333.6	01Jan2012, 10:40	2.33
Reach-02	20.135	4333.6	01Jan2012, 10:48	2.33
Subbasin-03	0.488	143.6	01Jan2012, 06:30	2.37
Subbasin-04	0.104	34.2	01Jan2012, 05:20	2.28
Junction-2	20.727	4388.8	01Jan2012, 10:47	2.33
Reach-01	20.727	4388.8	01Jan2012, 11:09	2.33
Subbasin-01	0.154	43.4	01Jan2012, 05:21	1.96
Junction-1	20.881	4397.4	01Jan2012, 11:08	2.33

Hinkle Creek Watershed Master Plan
HEC-HMS Output
50-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	529.1	01Jan2012, 02:31	1.69
Subbasin-35	1.165	456.9	01Jan2012, 02:31	1.76
Junction-23	2.566	986.0	01Jan2012, 02:31	1.72
Reach-24	2.566	986.0	01Jan2012, 03:01	1.69
Subbasin-37	0.810	343.7	01Jan2012, 01:48	1.52
Subbasin-34	0.396	204.2	01Jan2012, 01:43	1.81
Junction-22	3.772	1322.4	01Jan2012, 02:52	1.66
Reach-23	3.772	1322.4	01Jan2012, 03:11	1.64
Subbasin-30	0.413	192.5	01Jan2012, 01:52	1.73
Junction-21	4.185	1439.7	01Jan2012, 03:07	1.65
Reach-21	4.185	1439.7	01Jan2012, 03:15	1.64
Subbasin-41	1.181	444.3	01Jan2012, 02:41	1.74
Subbasin-40	0.779	315.1	01Jan2012, 02:33	1.83
Junction-25	1.960	758.0	01Jan2012, 02:37	1.78
Reach-25	1.960	758.0	01Jan2012, 03:06	1.74
Subbasin-39	0.414	242.1	01Jan2012, 01:24	1.81
Junction-24	2.374	858.2	01Jan2012, 03:02	1.75
Reach-22	2.374	858.2	01Jan2012, 03:29	1.70
Subbasin-38	0.492	232.9	01Jan2012, 01:50	1.73
Subbasin-29	0.051	29.4	01Jan2012, 00:58	1.46
Junction-20	7.102	2418.8	01Jan2012, 03:18	1.66
Reach-20	7.102	2418.8	01Jan2012, 03:44	1.61
Subbasin-28	0.411	190.7	01Jan2012, 01:35	1.53
Junction-26	7.513	2471.7	01Jan2012, 03:40	1.60
Reach-19	7.513	2471.7	01Jan2012, 03:57	1.55
Subbasin-33	0.719	288.7	01Jan2012, 01:56	1.52
Subbasin-32	0.317	160.9	01Jan2012, 01:27	1.59
Junction-19	8.549	2606.8	01Jan2012, 03:50	1.55
Reach-18	8.549	2606.8	01Jan2012, 04:15	1.47
Subbasin-31	0.431	226.7	01Jan2012, 01:34	1.74
Junction-18	8.980	2628.6	01Jan2012, 04:13	1.48
Reach-17	8.980	2628.6	01Jan2012, 04:22	1.45
Subbasin-24	1.509	497.2	01Jan2012, 03:24	1.67
Subbasin-22	0.565	313.4	01Jan2012, 01:44	1.96
Junction-16	2.074	657.0	01Jan2012, 03:03	1.75
Reach-16	2.074	657.0	01Jan2012, 03:18	1.72

Hinkle Creek Watershed Master Plan
HEC-HMS Output
50-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	367.5	01Jan2012, 02:49	1.79
Junction-15	3.048	1012.5	01Jan2012, 03:02	1.74
Reach-15	3.048	1012.5	01Jan2012, 03:16	1.71
Subbasin-25	0.807	330.8	01Jan2012, 02:22	1.78
Subbasin-27	0.723	204.8	01Jan2012, 04:18	1.47
Junction-14	1.530	442.2	01Jan2012, 02:48	1.63
Reach-13	1.530	442.2	01Jan2012, 03:13	1.56
Subbasin-26	0.289	155.8	01Jan2012, 01:42	1.88
Junction-13	1.819	525.8	01Jan2012, 02:58	1.61
Reach-12	1.819	525.8	01Jan2012, 03:11	1.57
Junction-12	4.867	1537.9	01Jan2012, 03:15	1.66
Reach-11	4.867	1537.9	01Jan2012, 03:59	1.51
Subbasin-18	0.827	362.4	01Jan2012, 02:24	1.92
Subbasin-21	0.737	320.4	01Jan2012, 01:51	1.59
Junction-11	6.431	1896.3	01Jan2012, 03:36	1.57
Reach-10	6.431	1896.3	01Jan2012, 03:45	1.54
Subbasin-15	0.110	49.0	01Jan2012, 01:41	1.52
Subbasin-20	0.054	33.3	01Jan2012, 01:01	1.59
Junction-10	6.595	1912.6	01Jan2012, 03:43	1.54
Reach-09	6.595	1912.6	01Jan2012, 03:55	1.49
Subbasin-19	0.352	166.3	01Jan2012, 02:10	1.94
Junction-9	6.947	1996.1	01Jan2012, 03:50	1.52
Reach-08	6.947	1996.1	01Jan2012, 04:10	1.43
Subbasin-17	0.747	345.2	01Jan2012, 02:00	1.80
Subbasin-16	0.102	42.2	01Jan2012, 01:14	1.20
Junction-8	7.796	2115.2	01Jan2012, 04:01	1.47
Reach-07	7.796	2115.2	01Jan2012, 04:23	1.37
Subbasin-13	0.454	175.9	01Jan2012, 02:17	1.64
Subbasin-14	0.074	50.0	01Jan2012, 00:56	1.66
Junction-7	17.304	4810.3	01Jan2012, 04:20	1.42
Reach-06	17.304	4810.3	01Jan2012, 05:11	1.15
Subbasin-12	0.506	251.3	01Jan2012, 01:43	1.74
Junction-6	17.810	4816.5	01Jan2012, 05:11	1.17
Reach-05	17.810	4816.5	01Jan2012, 05:20	1.11
Subbasin-10	0.569	254.3	01Jan2012, 02:20	1.93
Subbasin-11	0.047	34.8	01Jan2012, 00:55	1.81

Hinkle Creek Watershed Master Plan
HEC-HMS Output
50-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	4851.6	01Jan2012, 05:19	1.14
Reach-04	18.426	4796.0	01Jan2012, 06:00	0.77
Subbasin-09	0.355	200.1	01Jan2012, 01:41	1.96
Subbasin-08	0.321	150.6	01Jan2012, 01:58	1.80
Junction-17	0.676	345.3	01Jan2012, 01:49	1.89
Reach-14	0.676	345.3	01Jan2012, 01:57	1.88
Subbasin-06	0.606	247.6	01Jan2012, 02:00	1.59
Subbasin-07	0.048	25.7	01Jan2012, 00:56	1.33
Junction-4	19.756	4805.7	01Jan2012, 06:00	0.84
Reach-03	19.756	4619.5	01Jan2012, 06:00	0.74
Subbasin-02	0.327	175.7	01Jan2012, 01:24	1.66
Subbasin-05	0.052	18.0	01Jan2012, 01:08	0.97
Junction-3	20.135	4619.5	01Jan2012, 06:00	0.75
Reach-02	20.135	4480.2	01Jan2012, 06:00	0.71
Subbasin-03	0.488	212.7	01Jan2012, 02:10	1.79
Subbasin-04	0.104	64.7	01Jan2012, 01:09	1.74
Junction-2	20.727	4488.7	01Jan2012, 06:00	0.74
Reach-01	20.727	4029.4	01Jan2012, 06:00	0.62
Subbasin-01	0.154	79.2	01Jan2012, 01:11	1.46
Junction-1	20.881	4029.4	01Jan2012, 06:00	0.63

Hinkle Creek Watershed Master Plan
HEC-HMS Output
50-yr 6-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	488.4	01Jan2012, 03:02	2.26
Subbasin-35	1.165	421.2	01Jan2012, 03:02	2.34
Junction-23	2.566	909.6	01Jan2012, 03:02	2.30
Reach-24	2.566	909.6	01Jan2012, 03:32	2.30
Subbasin-37	0.810	295.8	01Jan2012, 02:17	2.02
Subbasin-34	0.396	173.3	01Jan2012, 02:10	2.34
Junction-22	3.772	1265.2	01Jan2012, 03:18	2.24
Reach-23	3.772	1265.2	01Jan2012, 03:37	2.24
Subbasin-30	0.413	166.4	01Jan2012, 02:20	2.26
Junction-21	4.185	1388.1	01Jan2012, 03:33	2.24
Reach-21	4.185	1388.1	01Jan2012, 03:41	2.24
Subbasin-41	1.181	414.4	01Jan2012, 03:11	2.34
Subbasin-40	0.779	290.7	01Jan2012, 03:02	2.43
Junction-25	1.960	704.3	01Jan2012, 03:07	2.38
Reach-25	1.960	704.3	01Jan2012, 03:36	2.37
Subbasin-39	0.414	198.0	01Jan2012, 01:52	2.34
Junction-24	2.374	810.0	01Jan2012, 03:25	2.37
Reach-22	2.374	810.0	01Jan2012, 03:52	2.37
Subbasin-38	0.492	200.5	01Jan2012, 02:18	2.26
Subbasin-29	0.051	22.1	01Jan2012, 01:37	1.94
Junction-20	7.102	2332.4	01Jan2012, 03:42	2.28
Reach-20	7.102	2332.4	01Jan2012, 04:08	2.28
Subbasin-28	0.411	160.2	01Jan2012, 02:03	2.02
Junction-26	7.513	2401.2	01Jan2012, 04:07	2.27
Reach-19	7.513	2401.2	01Jan2012, 04:24	2.27
Subbasin-33	0.719	252.6	01Jan2012, 02:26	2.02
Subbasin-32	0.317	133.3	01Jan2012, 01:56	2.10
Junction-19	8.549	2585.1	01Jan2012, 04:21	2.24
Reach-18	8.549	2585.1	01Jan2012, 04:46	2.24
Subbasin-31	0.431	189.5	01Jan2012, 02:02	2.26
Junction-18	8.980	2653.6	01Jan2012, 04:46	2.24
Reach-17	8.980	2653.6	01Jan2012, 04:55	2.24
Subbasin-24	1.509	480.0	01Jan2012, 03:53	2.42
Subbasin-22	0.565	265.7	01Jan2012, 02:10	2.51
Junction-16	2.074	647.7	01Jan2012, 03:27	2.44
Reach-16	2.074	647.7	01Jan2012, 03:42	2.44

Hinkle Creek Watershed Master Plan
HEC-HMS Output
50-yr 6-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	345.4	01Jan2012, 03:18	2.43
Junction-15	3.048	985.5	01Jan2012, 03:35	2.44
Reach-15	3.048	985.5	01Jan2012, 03:49	2.43
Subbasin-25	0.807	300.9	01Jan2012, 02:52	2.34
Subbasin-27	0.723	205.9	01Jan2012, 04:55	2.53
Junction-14	1.530	433.7	01Jan2012, 03:32	2.43
Reach-13	1.530	433.7	01Jan2012, 03:57	2.42
Subbasin-26	0.289	131.9	01Jan2012, 02:09	2.43
Junction-13	1.819	510.4	01Jan2012, 03:34	2.42
Reach-12	1.819	510.4	01Jan2012, 03:47	2.42
Junction-12	4.867	1495.9	01Jan2012, 03:48	2.43
Reach-11	4.867	1495.9	01Jan2012, 04:32	2.42
Subbasin-18	0.827	329.7	01Jan2012, 02:53	2.51
Subbasin-21	0.737	276.7	01Jan2012, 02:20	2.10
Junction-11	6.431	1856.2	01Jan2012, 04:14	2.39
Reach-10	6.431	1856.2	01Jan2012, 04:23	2.39
Subbasin-15	0.110	41.6	01Jan2012, 02:09	2.02
Subbasin-20	0.054	25.0	01Jan2012, 01:38	2.10
Junction-10	6.595	1881.4	01Jan2012, 04:21	2.38
Reach-09	6.595	1881.4	01Jan2012, 04:33	2.38
Subbasin-19	0.352	147.8	01Jan2012, 02:37	2.51
Junction-9	6.947	1965.3	01Jan2012, 04:28	2.38
Reach-08	6.947	1965.3	01Jan2012, 04:48	2.38
Subbasin-17	0.747	302.5	01Jan2012, 02:28	2.34
Subbasin-16	0.102	34.9	01Jan2012, 01:48	1.65
Junction-8	7.796	2121.5	01Jan2012, 04:43	2.36
Reach-07	7.796	2121.5	01Jan2012, 05:05	2.36
Subbasin-13	0.454	159.3	01Jan2012, 02:49	2.18
Subbasin-14	0.074	36.2	01Jan2012, 01:36	2.18
Junction-7	17.304	4868.9	01Jan2012, 04:56	2.29
Reach-06	17.304	4868.9	01Jan2012, 05:47	2.27
Subbasin-12	0.506	213.4	01Jan2012, 02:10	2.26
Junction-6	17.810	4935.2	01Jan2012, 05:46	2.27
Reach-05	17.810	4935.2	01Jan2012, 05:55	2.27
Subbasin-10	0.569	229.9	01Jan2012, 02:49	2.51
Subbasin-11	0.047	24.7	01Jan2012, 01:35	2.34

Hinkle Creek Watershed Master Plan
HEC-HMS Output
50-yr 6-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	5036.4	01Jan2012, 05:54	2.27
Reach-04	18.426	5036.4	01Jan2012, 06:49	2.23
Subbasin-09	0.355	168.9	01Jan2012, 02:07	2.51
Subbasin-08	0.321	131.4	01Jan2012, 02:25	2.34
Junction-17	0.676	297.3	01Jan2012, 02:16	2.43
Reach-14	0.676	297.3	01Jan2012, 02:24	2.43
Subbasin-06	0.606	217.9	01Jan2012, 02:30	2.10
Subbasin-07	0.048	19.4	01Jan2012, 01:35	1.79
Junction-4	19.756	5171.9	01Jan2012, 06:46	2.23
Reach-03	19.756	5171.9	01Jan2012, 07:02	2.21
Subbasin-02	0.327	144.5	01Jan2012, 01:53	2.18
Subbasin-05	0.052	15.0	01Jan2012, 01:43	1.37
Junction-3	20.135	5182.3	01Jan2012, 07:01	2.21
Reach-02	20.135	5182.3	01Jan2012, 07:09	2.20
Subbasin-03	0.488	189.7	01Jan2012, 02:39	2.34
Subbasin-04	0.104	50.5	01Jan2012, 01:43	2.26
Junction-2	20.727	5228.4	01Jan2012, 07:08	2.20
Reach-01	20.727	5228.4	01Jan2012, 07:30	2.17
Subbasin-01	0.154	63.5	01Jan2012, 01:45	1.94
Junction-1	20.881	5228.7	01Jan2012, 07:30	2.17

Hinkle Creek Watershed Master Plan
HEC-HMS Output
50-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	475.4	01Jan2012, 06:46	2.87
Subbasin-35	1.165	406.6	01Jan2012, 06:46	2.96
Junction-23	2.566	882.1	01Jan2012, 06:46	2.91
Reach-24	2.566	882.1	01Jan2012, 07:16	2.91
Subbasin-37	0.810	278.4	01Jan2012, 06:05	2.60
Subbasin-34	0.396	155.2	01Jan2012, 05:58	2.96
Junction-22	3.772	1235.0	01Jan2012, 06:54	2.85
Reach-23	3.772	1235.0	01Jan2012, 07:13	2.85
Subbasin-30	0.413	153.8	01Jan2012, 06:09	2.87
Junction-21	4.185	1361.5	01Jan2012, 07:07	2.85
Reach-21	4.185	1361.5	01Jan2012, 07:15	2.85
Subbasin-41	1.181	403.2	01Jan2012, 06:53	2.96
Subbasin-40	0.779	278.6	01Jan2012, 06:46	3.05
Junction-25	1.960	681.3	01Jan2012, 06:51	2.99
Reach-25	1.960	681.3	01Jan2012, 07:20	2.99
Subbasin-39	0.414	169.8	01Jan2012, 05:34	2.96
Junction-24	2.374	787.7	01Jan2012, 07:09	2.99
Reach-22	2.374	787.7	01Jan2012, 07:36	2.99
Subbasin-38	0.492	184.3	01Jan2012, 06:06	2.87
Subbasin-29	0.051	19.4	01Jan2012, 05:08	2.51
Junction-20	7.102	2292.0	01Jan2012, 07:18	2.89
Reach-20	7.102	2292.0	01Jan2012, 07:44	2.89
Subbasin-28	0.411	145.7	01Jan2012, 05:48	2.60
Junction-26	7.513	2381.3	01Jan2012, 07:42	2.88
Reach-19	7.513	2381.3	01Jan2012, 07:59	2.88
Subbasin-33	0.719	242.2	01Jan2012, 06:14	2.60
Subbasin-32	0.317	118.0	01Jan2012, 05:38	2.68
Junction-19	8.549	2611.0	01Jan2012, 07:54	2.85
Reach-18	8.549	2611.0	01Jan2012, 08:19	2.85
Subbasin-31	0.431	167.6	01Jan2012, 05:47	2.87
Junction-18	8.980	2696.5	01Jan2012, 08:16	2.85
Reach-17	8.980	2696.5	01Jan2012, 08:25	2.85
Subbasin-24	1.509	478.9	01Jan2012, 07:33	3.05
Subbasin-22	0.565	233.6	01Jan2012, 05:58	3.14
Junction-16	2.074	651.1	01Jan2012, 07:01	3.08
Reach-16	2.074	651.1	01Jan2012, 07:16	3.08

Hinkle Creek Watershed Master Plan
HEC-HMS Output
50-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	335.4	01Jan2012, 07:00	3.05
Junction-15	3.048	984.2	01Jan2012, 07:10	3.07
Reach-15	3.048	984.2	01Jan2012, 07:24	3.07
Subbasin-25	0.807	288.0	01Jan2012, 06:37	2.96
Subbasin-27	0.723	211.8	01Jan2012, 08:32	3.24
Junction-14	1.530	448.2	01Jan2012, 07:12	3.09
Reach-13	1.530	448.2	01Jan2012, 07:37	3.09
Subbasin-26	0.289	116.7	01Jan2012, 05:57	3.05
Junction-13	1.819	527.9	01Jan2012, 07:18	3.08
Reach-12	1.819	527.9	01Jan2012, 07:31	3.08
Junction-12	4.867	1511.6	01Jan2012, 07:26	3.07
Reach-11	4.867	1511.6	01Jan2012, 08:10	3.07
Subbasin-18	0.827	310.4	01Jan2012, 06:38	3.14
Subbasin-21	0.737	259.7	01Jan2012, 06:08	2.68
Junction-11	6.431	1917.5	01Jan2012, 07:54	3.04
Reach-10	6.431	1917.5	01Jan2012, 08:03	3.04
Subbasin-15	0.110	38.4	01Jan2012, 05:56	2.60
Subbasin-20	0.054	21.7	01Jan2012, 05:11	2.68
Junction-10	6.595	1949.4	01Jan2012, 08:02	3.03
Reach-09	6.595	1949.4	01Jan2012, 08:14	3.03
Subbasin-19	0.352	136.7	01Jan2012, 06:25	3.14
Junction-9	6.947	2042.2	01Jan2012, 08:10	3.03
Reach-08	6.947	2042.2	01Jan2012, 08:30	3.03
Subbasin-17	0.747	280.9	01Jan2012, 06:16	2.96
Subbasin-16	0.102	31.6	01Jan2012, 05:22	2.17
Junction-8	7.796	2223.4	01Jan2012, 08:21	3.02
Reach-07	7.796	2223.4	01Jan2012, 08:43	3.02
Subbasin-13	0.454	154.5	01Jan2012, 06:34	2.77
Subbasin-14	0.074	31.3	01Jan2012, 05:07	2.77
Junction-7	17.304	5019.2	01Jan2012, 08:30	2.92
Reach-06	17.304	5019.2	01Jan2012, 09:21	2.92
Subbasin-12	0.506	192.8	01Jan2012, 05:58	2.87
Junction-6	17.810	5095.2	01Jan2012, 09:21	2.92
Reach-05	17.810	5095.2	01Jan2012, 09:30	2.92
Subbasin-10	0.569	215.6	01Jan2012, 06:35	3.14
Subbasin-11	0.047	21.2	01Jan2012, 05:06	2.96

Hinkle Creek Watershed Master Plan
HEC-HMS Output
50-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	5207.9	01Jan2012, 09:28	2.93
Reach-04	18.426	5207.9	01Jan2012, 10:23	2.93
Subbasin-09	0.355	147.7	01Jan2012, 05:55	3.14
Subbasin-08	0.321	121.5	01Jan2012, 06:14	2.96
Junction-17	0.676	267.7	01Jan2012, 06:04	3.06
Reach-14	0.676	267.7	01Jan2012, 06:12	3.06
Subbasin-06	0.606	208.5	01Jan2012, 06:18	2.68
Subbasin-07	0.048	17.2	01Jan2012, 05:06	2.34
Junction-4	19.756	5369.6	01Jan2012, 10:19	2.92
Reach-03	19.756	5369.6	01Jan2012, 10:35	2.92
Subbasin-02	0.327	126.2	01Jan2012, 05:35	2.77
Subbasin-05	0.052	13.9	01Jan2012, 05:15	1.85
Junction-3	20.135	5402.3	01Jan2012, 10:35	2.92
Reach-02	20.135	5402.3	01Jan2012, 10:43	2.92
Subbasin-03	0.488	179.1	01Jan2012, 06:27	2.96
Subbasin-04	0.104	43.1	01Jan2012, 05:19	2.87
Junction-2	20.727	5470.2	01Jan2012, 10:42	2.92
Reach-01	20.727	5470.2	01Jan2012, 11:04	2.92
Subbasin-01	0.154	55.8	01Jan2012, 05:19	2.51
Junction-1	20.881	5481.3	01Jan2012, 11:04	2.91

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 1-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	544.1	01Jan2012, 01:56	1.27
Subbasin-35	1.165	470.2	01Jan2012, 01:57	1.33
Junction-23	2.566	1014.3	01Jan2012, 01:56	1.30
Reach-24	2.566	1014.3	01Jan2012, 02:26	1.29
Subbasin-37	0.810	407.5	01Jan2012, 01:22	1.10
Subbasin-34	0.396	245.8	01Jan2012, 01:20	1.34
Junction-22	3.772	1217.3	01Jan2012, 02:10	1.26
Reach-23	3.772	1217.3	01Jan2012, 02:29	1.25
Subbasin-30	0.413	223.5	01Jan2012, 01:27	1.28
Junction-21	4.185	1297.5	01Jan2012, 02:21	1.25
Reach-21	4.185	1297.5	01Jan2012, 02:29	1.25
Subbasin-41	1.181	446.4	01Jan2012, 02:04	1.33
Subbasin-40	0.779	323.4	01Jan2012, 01:58	1.40
Junction-25	1.960	768.7	01Jan2012, 02:01	1.36
Reach-25	1.960	768.7	01Jan2012, 02:30	1.34
Subbasin-39	0.414	316.1	01Jan2012, 01:02	1.34
Junction-24	2.374	788.4	01Jan2012, 02:27	1.34
Reach-22	2.374	788.4	01Jan2012, 02:54	1.33
Subbasin-38	0.492	273.0	01Jan2012, 01:25	1.28
Subbasin-29	0.051	45.5	01Jan2012, 00:35	1.04
Junction-20	7.102	2098.1	01Jan2012, 02:40	1.28
Reach-20	7.102	2098.1	01Jan2012, 03:06	1.27
Subbasin-28	0.411	239.6	01Jan2012, 01:10	1.10
Junction-26	7.513	2104.8	01Jan2012, 03:05	1.26
Reach-19	7.513	2104.8	01Jan2012, 03:22	1.24
Subbasin-33	0.719	330.8	01Jan2012, 01:29	1.10
Subbasin-32	0.317	208.5	01Jan2012, 01:04	1.16
Junction-19	8.549	2135.1	01Jan2012, 03:19	1.23
Reach-18	8.549	2135.1	01Jan2012, 03:44	1.21
Subbasin-31	0.431	284.0	01Jan2012, 01:11	1.28
Junction-18	8.980	2137.5	01Jan2012, 03:44	1.21
Reach-17	8.980	2137.5	01Jan2012, 03:53	1.20
Subbasin-24	1.509	454.6	01Jan2012, 02:37	1.33
Subbasin-22	0.565	375.1	01Jan2012, 01:21	1.48
Junction-16	2.074	602.5	01Jan2012, 01:41	1.37
Reach-16	2.074	602.5	01Jan2012, 01:56	1.36

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 1-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	362.7	01Jan2012, 02:10	1.38
Junction-15	3.048	958.9	01Jan2012, 02:04	1.37
Reach-15	3.048	958.9	01Jan2012, 02:18	1.36
Subbasin-25	0.807	349.2	01Jan2012, 01:50	1.34
Subbasin-27	0.723	173.7	01Jan2012, 03:29	1.28
Junction-14	1.530	434.2	01Jan2012, 02:01	1.31
Reach-13	1.530	434.2	01Jan2012, 02:26	1.28
Subbasin-26	0.289	188.0	01Jan2012, 01:19	1.41
Junction-13	1.819	488.9	01Jan2012, 02:12	1.30
Reach-12	1.819	488.9	01Jan2012, 02:25	1.28
Junction-12	4.867	1446.1	01Jan2012, 02:21	1.33
Reach-11	4.867	1446.1	01Jan2012, 03:05	1.27
Subbasin-18	0.827	381.2	01Jan2012, 01:52	1.47
Subbasin-21	0.737	375.3	01Jan2012, 01:25	1.16
Junction-11	6.431	1671.0	01Jan2012, 02:50	1.28
Reach-10	6.431	1671.0	01Jan2012, 02:59	1.27
Subbasin-15	0.110	59.9	01Jan2012, 01:16	1.10
Subbasin-20	0.054	50.2	01Jan2012, 00:38	1.16
Junction-10	6.595	1674.5	01Jan2012, 02:59	1.26
Reach-09	6.595	1674.5	01Jan2012, 03:11	1.24
Subbasin-19	0.352	182.0	01Jan2012, 01:42	1.47
Junction-9	6.947	1719.6	01Jan2012, 03:08	1.26
Reach-08	6.947	1719.6	01Jan2012, 03:28	1.22
Subbasin-17	0.747	389.5	01Jan2012, 01:34	1.34
Subbasin-16	0.102	57.8	01Jan2012, 00:50	0.83
Junction-8	7.796	1761.5	01Jan2012, 03:25	1.23
Reach-07	7.796	1761.5	01Jan2012, 03:47	1.18
Subbasin-13	0.454	187.8	01Jan2012, 01:46	1.22
Subbasin-14	0.074	79.9	01Jan2012, 00:33	1.22
Junction-7	17.304	3919.5	01Jan2012, 03:50	1.19
Reach-06	17.304	3919.5	01Jan2012, 04:41	1.07
Subbasin-12	0.506	303.4	01Jan2012, 01:19	1.28
Junction-6	17.810	3920.1	01Jan2012, 04:41	1.07
Reach-05	17.810	3920.1	01Jan2012, 04:50	1.04
Subbasin-10	0.569	270.4	01Jan2012, 01:49	1.47
Subbasin-11	0.047	56.4	01Jan2012, 00:32	1.34

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 1-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	3933.4	01Jan2012, 04:49	1.06
Reach-04	18.426	3933.4	01Jan2012, 05:44	0.80
Subbasin-09	0.355	241.9	01Jan2012, 01:19	1.48
Subbasin-08	0.321	171.4	01Jan2012, 01:32	1.34
Junction-17	0.676	406.8	01Jan2012, 01:23	1.41
Reach-14	0.676	406.8	01Jan2012, 01:31	1.41
Subbasin-06	0.606	279.4	01Jan2012, 01:33	1.16
Subbasin-07	0.048	40.9	01Jan2012, 00:32	0.94
Junction-4	19.756	3934.4	01Jan2012, 05:44	0.84
Reach-03	19.756	3934.4	01Jan2012, 06:00	0.75
Subbasin-02	0.327	229.6	01Jan2012, 01:02	1.22
Subbasin-05	0.052	25.4	01Jan2012, 00:43	0.65
Junction-3	20.135	3934.4	01Jan2012, 06:00	0.76
Reach-02	20.135	3914.2	01Jan2012, 06:00	0.72
Subbasin-03	0.488	232.3	01Jan2012, 01:41	1.34
Subbasin-04	0.104	90.6	01Jan2012, 00:48	1.28
Junction-2	20.727	3915.6	01Jan2012, 06:00	0.74
Reach-01	20.727	3704.0	01Jan2012, 06:00	0.63
Subbasin-01	0.154	110.3	01Jan2012, 00:48	1.04
Junction-1	20.881	3704.0	01Jan2012, 06:00	0.64

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	646.6	01Jan2012, 02:29	2.11
Subbasin-35	1.165	556.0	01Jan2012, 02:30	2.19
Junction-23	2.566	1202.5	01Jan2012, 02:29	2.15
Reach-24	2.566	1202.5	01Jan2012, 02:59	2.15
Subbasin-37	0.810	426.9	01Jan2012, 01:46	1.88
Subbasin-34	0.396	249.3	01Jan2012, 01:41	2.19
Junction-22	3.772	1609.7	01Jan2012, 02:50	2.10
Reach-23	3.772	1609.7	01Jan2012, 03:09	2.10
Subbasin-30	0.413	235.9	01Jan2012, 01:51	2.11
Junction-21	4.185	1751.1	01Jan2012, 03:05	2.10
Reach-21	4.185	1751.1	01Jan2012, 03:13	2.10
Subbasin-41	1.181	540.2	01Jan2012, 02:39	2.19
Subbasin-40	0.779	381.8	01Jan2012, 02:31	2.28
Junction-25	1.960	920.4	01Jan2012, 02:36	2.23
Reach-25	1.960	920.4	01Jan2012, 03:05	2.23
Subbasin-39	0.414	296.3	01Jan2012, 01:22	2.19
Junction-24	2.374	1039.3	01Jan2012, 03:00	2.22
Reach-22	2.374	1039.3	01Jan2012, 03:27	2.22
Subbasin-38	0.492	285.5	01Jan2012, 01:48	2.11
Subbasin-29	0.051	36.8	01Jan2012, 00:57	1.80
Junction-20	7.102	2935.5	01Jan2012, 03:16	2.14
Reach-20	7.102	2935.5	01Jan2012, 03:42	2.14
Subbasin-28	0.411	237.0	01Jan2012, 01:33	1.88
Junction-26	7.513	3001.5	01Jan2012, 03:38	2.12
Reach-19	7.513	3001.5	01Jan2012, 03:55	2.12
Subbasin-33	0.719	358.6	01Jan2012, 01:54	1.88
Subbasin-32	0.317	199.3	01Jan2012, 01:25	1.96
Junction-19	8.549	3168.7	01Jan2012, 03:48	2.10
Reach-18	8.549	3168.7	01Jan2012, 04:13	2.10
Subbasin-31	0.431	278.1	01Jan2012, 01:32	2.11
Junction-18	8.980	3195.9	01Jan2012, 04:11	2.10
Reach-17	8.980	3195.9	01Jan2012, 04:20	2.10
Subbasin-24	1.509	600.3	01Jan2012, 03:22	2.27
Subbasin-22	0.565	379.5	01Jan2012, 01:42	2.36
Junction-16	2.074	790.6	01Jan2012, 03:00	2.30
Reach-16	2.074	790.6	01Jan2012, 03:15	2.30

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	444.7	01Jan2012, 02:47	2.28
Junction-15	3.048	1221.4	01Jan2012, 02:59	2.29
Reach-15	3.048	1221.4	01Jan2012, 03:13	2.29
Subbasin-25	0.807	402.9	01Jan2012, 02:20	2.19
Subbasin-27	0.723	245.2	01Jan2012, 04:16	2.42
Junction-14	1.530	534.4	01Jan2012, 02:44	2.30
Reach-13	1.530	534.4	01Jan2012, 03:09	2.30
Subbasin-26	0.289	189.5	01Jan2012, 01:40	2.28
Junction-13	1.819	635.2	01Jan2012, 02:55	2.29
Reach-12	1.819	635.2	01Jan2012, 03:08	2.29
Junction-12	4.867	1856.0	01Jan2012, 03:11	2.29
Reach-11	4.867	1856.0	01Jan2012, 03:55	2.29
Subbasin-18	0.827	437.6	01Jan2012, 02:23	2.36
Subbasin-21	0.737	396.1	01Jan2012, 01:49	1.96
Junction-11	6.431	2290.4	01Jan2012, 03:34	2.26
Reach-10	6.431	2290.4	01Jan2012, 03:43	2.26
Subbasin-15	0.110	60.8	01Jan2012, 01:39	1.88
Subbasin-20	0.054	41.4	01Jan2012, 00:59	1.96
Junction-10	6.595	2310.8	01Jan2012, 03:41	2.25
Reach-09	6.595	2310.8	01Jan2012, 03:53	2.25
Subbasin-19	0.352	201.0	01Jan2012, 02:08	2.36
Junction-9	6.947	2410.9	01Jan2012, 03:49	2.25
Reach-08	6.947	2410.9	01Jan2012, 04:09	2.25
Subbasin-17	0.747	421.1	01Jan2012, 01:59	2.19
Subbasin-16	0.102	54.1	01Jan2012, 01:12	1.52
Junction-8	7.796	2555.1	01Jan2012, 03:59	2.24
Reach-07	7.796	2555.1	01Jan2012, 04:21	2.23
Subbasin-13	0.454	216.1	01Jan2012, 02:15	2.03
Subbasin-14	0.074	61.6	01Jan2012, 00:55	2.03
Junction-7	17.304	5832.3	01Jan2012, 04:19	2.16
Reach-06	17.304	5832.3	01Jan2012, 05:10	2.15
Subbasin-12	0.506	308.1	01Jan2012, 01:41	2.11
Junction-6	17.810	5839.9	01Jan2012, 05:09	2.15
Reach-05	17.810	5839.9	01Jan2012, 05:18	2.15
Subbasin-10	0.569	307.2	01Jan2012, 02:19	2.36
Subbasin-11	0.047	42.6	01Jan2012, 00:53	2.19

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	5882.7	01Jan2012, 05:17	2.16
Reach-04	18.426	5882.7	01Jan2012, 06:12	2.15
Subbasin-09	0.355	242.4	01Jan2012, 01:39	2.36
Subbasin-08	0.321	183.8	01Jan2012, 01:56	2.19
Junction-17	0.676	419.3	01Jan2012, 01:47	2.28
Reach-14	0.676	419.3	01Jan2012, 01:55	2.28
Subbasin-06	0.606	306.1	01Jan2012, 01:58	1.96
Subbasin-07	0.048	32.5	01Jan2012, 00:55	1.66
Junction-4	19.756	5890.8	01Jan2012, 06:12	2.15
Reach-03	19.756	5890.8	01Jan2012, 06:28	2.14
Subbasin-02	0.327	216.8	01Jan2012, 01:22	2.03
Subbasin-05	0.052	23.7	01Jan2012, 01:06	1.26
Junction-3	20.135	5890.8	01Jan2012, 06:28	2.14
Reach-02	20.135	5890.8	01Jan2012, 06:36	2.14
Subbasin-03	0.488	259.3	01Jan2012, 02:09	2.19
Subbasin-04	0.104	79.7	01Jan2012, 01:08	2.11
Junction-2	20.727	5895.2	01Jan2012, 06:35	2.14
Reach-01	20.727	5895.2	01Jan2012, 06:57	2.13
Subbasin-01	0.154	99.5	01Jan2012, 01:09	1.80
Junction-1	20.881	5895.2	01Jan2012, 06:57	2.13

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 06-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	616.7	01Jan2012, 02:58	2.82
Subbasin-35	1.165	529.5	01Jan2012, 02:58	2.91
Junction-23	2.566	1146.2	01Jan2012, 02:58	2.86
Reach-24	2.566	1146.2	01Jan2012, 03:28	2.86
Subbasin-37	0.810	380.5	01Jan2012, 02:13	2.56
Subbasin-34	0.396	218.8	01Jan2012, 02:07	2.91
Junction-22	3.772	1594.3	01Jan2012, 03:15	2.80
Reach-23	3.772	1594.3	01Jan2012, 03:34	2.80
Subbasin-30	0.413	211.0	01Jan2012, 02:17	2.82
Junction-21	4.185	1748.2	01Jan2012, 03:30	2.80
Reach-21	4.185	1748.2	01Jan2012, 03:38	2.80
Subbasin-41	1.181	520.7	01Jan2012, 03:07	2.91
Subbasin-40	0.779	363.8	01Jan2012, 02:59	3.01
Junction-25	1.960	883.4	01Jan2012, 03:04	2.95
Reach-25	1.960	883.4	01Jan2012, 03:33	2.95
Subbasin-39	0.414	249.5	01Jan2012, 01:50	2.91
Junction-24	2.374	1016.2	01Jan2012, 03:22	2.94
Reach-22	2.374	1016.2	01Jan2012, 03:49	2.94
Subbasin-38	0.492	254.2	01Jan2012, 02:14	2.82
Subbasin-29	0.051	28.2	01Jan2012, 01:36	2.47
Junction-20	7.102	2931.7	01Jan2012, 03:39	2.85
Reach-20	7.102	2931.7	01Jan2012, 04:05	2.85
Subbasin-28	0.411	206.2	01Jan2012, 02:00	2.56
Junction-26	7.513	3017.0	01Jan2012, 04:04	2.83
Reach-19	7.513	3017.0	01Jan2012, 04:21	2.83
Subbasin-33	0.719	324.8	01Jan2012, 02:22	2.56
Subbasin-32	0.317	170.4	01Jan2012, 01:53	2.64
Junction-19	8.549	3246.2	01Jan2012, 04:18	2.80
Reach-18	8.549	3246.2	01Jan2012, 04:43	2.80
Subbasin-31	0.431	240.2	01Jan2012, 01:59	2.82
Junction-18	8.980	3329.0	01Jan2012, 04:42	2.80
Reach-17	8.980	3329.0	01Jan2012, 04:51	2.80
Subbasin-24	1.509	599.1	01Jan2012, 03:49	2.99
Subbasin-22	0.565	332.5	01Jan2012, 02:07	3.10
Junction-16	2.074	806.8	01Jan2012, 03:25	3.02
Reach-16	2.074	806.8	01Jan2012, 03:40	3.02

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 06-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	431.8	01Jan2012, 03:15	3.00
Junction-15	3.048	1227.8	01Jan2012, 03:31	3.02
Reach-15	3.048	1227.8	01Jan2012, 03:45	3.01
Subbasin-25	0.807	378.5	01Jan2012, 02:48	2.91
Subbasin-27	0.723	254.2	01Jan2012, 04:52	3.11
Junction-14	1.530	539.8	01Jan2012, 03:29	3.01
Reach-13	1.530	539.8	01Jan2012, 03:54	3.00
Subbasin-26	0.289	165.8	01Jan2012, 02:05	3.01
Junction-13	1.819	636.6	01Jan2012, 03:29	3.00
Reach-12	1.819	636.6	01Jan2012, 03:42	2.99
Junction-12	4.867	1864.2	01Jan2012, 03:45	3.01
Reach-11	4.867	1864.2	01Jan2012, 04:29	2.99
Subbasin-18	0.827	411.1	01Jan2012, 02:49	3.10
Subbasin-21	0.737	354.3	01Jan2012, 02:16	2.64
Junction-11	6.431	2313.8	01Jan2012, 04:09	2.97
Reach-10	6.431	2313.8	01Jan2012, 04:18	2.96
Subbasin-15	0.110	53.5	01Jan2012, 02:06	2.56
Subbasin-20	0.054	31.6	01Jan2012, 01:37	2.64
Junction-10	6.595	2345.9	01Jan2012, 04:16	2.95
Reach-09	6.595	2345.9	01Jan2012, 04:28	2.95
Subbasin-19	0.352	184.6	01Jan2012, 02:33	3.10
Junction-9	6.947	2450.6	01Jan2012, 04:23	2.96
Reach-08	6.947	2450.6	01Jan2012, 04:43	2.95
Subbasin-17	0.747	381.6	01Jan2012, 02:24	2.91
Subbasin-16	0.102	46.0	01Jan2012, 01:46	2.13
Junction-8	7.796	2643.1	01Jan2012, 04:38	2.93
Reach-07	7.796	2643.1	01Jan2012, 05:00	2.92
Subbasin-13	0.454	202.3	01Jan2012, 02:45	2.73
Subbasin-14	0.074	45.3	01Jan2012, 01:35	2.73
Junction-7	17.304	6090.6	01Jan2012, 04:52	2.85
Reach-06	17.304	6090.6	01Jan2012, 05:43	2.83
Subbasin-12	0.506	270.6	01Jan2012, 02:07	2.82
Junction-6	17.810	6172.5	01Jan2012, 05:42	2.83
Reach-05	17.810	6172.5	01Jan2012, 05:51	2.82
Subbasin-10	0.569	286.8	01Jan2012, 02:45	3.10
Subbasin-11	0.047	31.7	01Jan2012, 01:00	2.91

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 06-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	6295.0	01Jan2012, 05:51	2.83
Reach-04	18.426	6295.0	01Jan2012, 06:46	2.78
Subbasin-09	0.355	211.3	01Jan2012, 02:04	3.10
Subbasin-08	0.321	165.8	01Jan2012, 02:22	2.91
Junction-17	0.676	373.4	01Jan2012, 02:12	3.01
Reach-14	0.676	373.4	01Jan2012, 02:20	3.01
Subbasin-06	0.606	278.8	01Jan2012, 02:26	2.64
Subbasin-07	0.048	25.0	01Jan2012, 01:35	2.30
Junction-4	19.756	6462.6	01Jan2012, 06:43	2.78
Reach-03	19.756	6462.6	01Jan2012, 06:59	2.76
Subbasin-02	0.327	183.8	01Jan2012, 01:51	2.73
Subbasin-05	0.052	20.3	01Jan2012, 01:42	1.82
Junction-3	20.135	6477.2	01Jan2012, 06:58	2.76
Reach-02	20.135	6477.2	01Jan2012, 07:06	2.75
Subbasin-03	0.488	239.0	01Jan2012, 02:35	2.91
Subbasin-04	0.104	63.6	01Jan2012, 01:41	2.82
Junction-2	20.727	6534.8	01Jan2012, 07:05	2.75
Reach-01	20.727	6534.8	01Jan2012, 07:27	2.71
Subbasin-01	0.154	81.7	01Jan2012, 01:43	2.47
Junction-1	20.881	6535.2	01Jan2012, 07:27	2.71

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	585.9	01Jan2012, 06:43	3.53
Subbasin-35	1.165	499.1	01Jan2012, 06:42	3.64
Junction-23	2.566	1085.0	01Jan2012, 06:43	3.58
Reach-24	2.566	1085.0	01Jan2012, 07:13	3.58
Subbasin-37	0.810	347.1	01Jan2012, 06:02	3.24
Subbasin-34	0.396	190.3	01Jan2012, 05:55	3.64
Junction-22	3.772	1523.2	01Jan2012, 06:51	3.51
Reach-23	3.772	1523.2	01Jan2012, 07:10	3.51
Subbasin-30	0.413	189.4	01Jan2012, 06:06	3.53
Junction-21	4.185	1679.5	01Jan2012, 07:04	3.52
Reach-21	4.185	1679.5	01Jan2012, 07:12	3.52
Subbasin-41	1.181	495.0	01Jan2012, 06:50	3.64
Subbasin-40	0.779	340.6	01Jan2012, 06:43	3.74
Junction-25	1.960	835.1	01Jan2012, 06:48	3.68
Reach-25	1.960	835.1	01Jan2012, 07:17	3.68
Subbasin-39	0.414	208.5	01Jan2012, 05:32	3.64
Junction-24	2.374	965.2	01Jan2012, 07:05	3.67
Reach-22	2.374	965.2	01Jan2012, 07:32	3.67
Subbasin-38	0.492	226.9	01Jan2012, 06:03	3.53
Subbasin-29	0.051	24.3	01Jan2012, 05:08	3.14
Junction-20	7.102	2821.2	01Jan2012, 07:14	3.56
Reach-20	7.102	2821.2	01Jan2012, 07:40	3.56
Subbasin-28	0.411	181.9	01Jan2012, 05:44	3.24
Junction-26	7.513	2930.7	01Jan2012, 07:38	3.55
Reach-19	7.513	2930.7	01Jan2012, 07:55	3.55
Subbasin-33	0.719	301.9	01Jan2012, 06:11	3.24
Subbasin-32	0.317	146.7	01Jan2012, 05:35	3.34
Junction-19	8.549	3213.6	01Jan2012, 07:50	3.51
Reach-18	8.549	3213.6	01Jan2012, 08:15	3.51
Subbasin-31	0.431	206.6	01Jan2012, 05:44	3.53
Junction-18	8.980	3318.2	01Jan2012, 08:12	3.51
Reach-17	8.980	3318.2	01Jan2012, 08:21	3.51
Subbasin-24	1.509	586.1	01Jan2012, 07:29	3.74
Subbasin-22	0.565	284.2	01Jan2012, 05:56	3.84
Junction-16	2.074	796.8	01Jan2012, 06:58	3.76
Reach-16	2.074	796.8	01Jan2012, 07:13	3.76

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	410.3	01Jan2012, 06:57	3.74
Junction-15	3.048	1204.3	01Jan2012, 07:07	3.76
Reach-15	3.048	1204.3	01Jan2012, 07:21	3.76
Subbasin-25	0.807	353.3	01Jan2012, 06:34	3.64
Subbasin-27	0.723	257.3	01Jan2012, 08:28	3.94
Junction-14	1.530	548.9	01Jan2012, 07:07	3.78
Reach-13	1.530	548.9	01Jan2012, 07:32	3.78
Subbasin-26	0.289	142.6	01Jan2012, 05:54	3.74
Junction-13	1.819	646.8	01Jan2012, 07:14	3.77
Reach-12	1.819	646.8	01Jan2012, 07:27	3.77
Junction-12	4.867	1850.6	01Jan2012, 07:23	3.76
Reach-11	4.867	1850.6	01Jan2012, 08:07	3.76
Subbasin-18	0.827	377.9	01Jan2012, 06:35	3.84
Subbasin-21	0.737	322.4	01Jan2012, 06:05	3.34
Junction-11	6.431	2345.9	01Jan2012, 07:51	3.72
Reach-10	6.431	2345.9	01Jan2012, 08:00	3.72
Subbasin-15	0.110	48.0	01Jan2012, 05:52	3.24
Subbasin-20	0.054	27.0	01Jan2012, 05:10	3.34
Junction-10	6.595	2385.2	01Jan2012, 07:58	3.71
Reach-09	6.595	2385.2	01Jan2012, 08:10	3.71
Subbasin-19	0.352	166.3	01Jan2012, 06:22	3.84
Junction-9	6.947	2498.0	01Jan2012, 08:06	3.72
Reach-08	6.947	2498.0	01Jan2012, 08:26	3.72
Subbasin-17	0.747	344.5	01Jan2012, 06:14	3.64
Subbasin-16	0.102	40.6	01Jan2012, 05:20	2.77
Junction-8	7.796	2720.3	01Jan2012, 08:17	3.70
Reach-07	7.796	2720.3	01Jan2012, 08:39	3.70
Subbasin-13	0.454	191.1	01Jan2012, 06:31	3.44
Subbasin-14	0.074	38.7	01Jan2012, 05:06	3.44
Junction-7	17.304	6161.8	01Jan2012, 08:26	3.59
Reach-06	17.304	6161.8	01Jan2012, 09:17	3.59
Subbasin-12	0.506	237.4	01Jan2012, 05:55	3.53
Junction-6	17.810	6252.7	01Jan2012, 09:16	3.59
Reach-05	17.810	6252.7	01Jan2012, 09:25	3.59
Subbasin-10	0.569	262.4	01Jan2012, 06:32	3.84
Subbasin-11	0.047	26.0	01Jan2012, 05:06	3.64

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	6389.0	01Jan2012, 09:23	3.60
Reach-04	18.426	6389.0	01Jan2012, 10:18	3.60
Subbasin-09	0.355	179.6	01Jan2012, 05:53	3.84
Subbasin-08	0.321	149.0	01Jan2012, 06:11	3.64
Junction-17	0.676	326.8	01Jan2012, 06:01	3.74
Reach-14	0.676	326.8	01Jan2012, 06:09	3.74
Subbasin-06	0.606	258.9	01Jan2012, 06:15	3.34
Subbasin-07	0.048	21.8	01Jan2012, 05:06	2.95
Junction-4	19.756	6587.5	01Jan2012, 10:14	3.59
Reach-03	19.756	6587.5	01Jan2012, 10:30	3.59
Subbasin-02	0.327	156.3	01Jan2012, 05:33	3.44
Subbasin-05	0.052	18.3	01Jan2012, 05:14	2.40
Junction-3	20.135	6625.7	01Jan2012, 10:31	3.59
Reach-02	20.135	6625.7	01Jan2012, 10:39	3.59
Subbasin-03	0.488	219.7	01Jan2012, 06:24	3.64
Subbasin-04	0.104	53.1	01Jan2012, 05:18	3.53
Junction-2	20.727	6707.9	01Jan2012, 10:38	3.59
Reach-01	20.727	6707.9	01Jan2012, 11:00	3.59
Subbasin-01	0.154	70.2	01Jan2012, 05:18	3.14
Junction-1	20.881	6722.2	01Jan2012, 10:59	3.59

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 24-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	468.5	01Jan2012, 16:29	4.33
Subbasin-35	1.165	396.1	01Jan2012, 16:30	4.44
Junction-23	2.566	864.7	01Jan2012, 16:29	4.38
Reach-24	2.566	864.7	01Jan2012, 16:59	4.38
Subbasin-37	0.810	273.4	01Jan2012, 15:39	4.01
Subbasin-34	0.396	145.1	01Jan2012, 15:36	4.44
Junction-22	3.772	1237.1	01Jan2012, 16:38	4.31
Reach-23	3.772	1237.1	01Jan2012, 16:57	4.31
Subbasin-30	0.413	146.1	01Jan2012, 15:46	4.33
Junction-21	4.185	1367.9	01Jan2012, 16:52	4.31
Reach-21	4.185	1367.9	01Jan2012, 17:00	4.31
Subbasin-41	1.181	396.5	01Jan2012, 16:39	4.44
Subbasin-40	0.779	268.6	01Jan2012, 16:31	4.55
Junction-25	1.960	664.9	01Jan2012, 16:36	4.48
Reach-25	1.960	664.9	01Jan2012, 17:05	4.48
Subbasin-39	0.414	157.3	01Jan2012, 15:20	4.44
Junction-24	2.374	784.4	01Jan2012, 16:51	4.47
Reach-22	2.374	784.4	01Jan2012, 17:18	4.47
Subbasin-38	0.492	174.9	01Jan2012, 15:43	4.33
Subbasin-29	0.051	18.4	01Jan2012, 15:04	3.90
Junction-20	7.102	2312.7	01Jan2012, 17:01	4.36
Reach-20	7.102	2312.7	01Jan2012, 17:27	4.36
Subbasin-28	0.411	142.5	01Jan2012, 15:26	4.01
Junction-26	7.513	2418.0	01Jan2012, 17:24	4.34
Reach-19	7.513	2418.0	01Jan2012, 17:41	4.34
Subbasin-33	0.719	239.0	01Jan2012, 15:50	4.01
Subbasin-32	0.317	113.6	01Jan2012, 15:20	4.12
Junction-19	8.549	2683.2	01Jan2012, 17:33	4.31
Reach-18	8.549	2683.2	01Jan2012, 17:58	4.31
Subbasin-31	0.431	158.0	01Jan2012, 15:27	4.33
Junction-18	8.980	2781.8	01Jan2012, 17:55	4.31
Reach-17	8.980	2781.8	01Jan2012, 18:04	4.31
Subbasin-24	1.509	485.3	01Jan2012, 17:18	4.55
Subbasin-22	0.565	213.4	01Jan2012, 15:37	4.66
Junction-16	2.074	663.9	01Jan2012, 16:48	4.58
Reach-16	2.074	663.9	01Jan2012, 17:03	4.58

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 24-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	328.6	01Jan2012, 16:46	4.55
Junction-15	3.048	991.2	01Jan2012, 16:56	4.57
Reach-15	3.048	991.2	01Jan2012, 17:10	4.57
Subbasin-25	0.807	277.9	01Jan2012, 16:20	4.44
Subbasin-27	0.723	220.0	01Jan2012, 18:13	4.77
Junction-14	1.530	468.0	01Jan2012, 17:00	4.59
Reach-13	1.530	468.0	01Jan2012, 17:25	4.59
Subbasin-26	0.289	107.8	01Jan2012, 15:35	4.55
Junction-13	1.819	553.8	01Jan2012, 17:07	4.59
Reach-12	1.819	553.8	01Jan2012, 17:20	4.59
Junction-12	4.867	1544.4	01Jan2012, 17:13	4.57
Reach-11	4.867	1544.4	01Jan2012, 17:57	4.57
Subbasin-18	0.827	293.3	01Jan2012, 16:23	4.66
Subbasin-21	0.737	252.3	01Jan2012, 15:43	4.12
Junction-11	6.431	1985.9	01Jan2012, 17:35	4.53
Reach-10	6.431	1985.9	01Jan2012, 17:44	4.53
Subbasin-15	0.110	37.7	01Jan2012, 15:31	4.01
Subbasin-20	0.054	20.2	01Jan2012, 15:05	4.12
Junction-10	6.595	2022.9	01Jan2012, 17:42	4.52
Reach-09	6.595	2022.9	01Jan2012, 17:54	4.52
Subbasin-19	0.352	127.4	01Jan2012, 16:08	4.66
Junction-9	6.947	2124.8	01Jan2012, 17:49	4.53
Reach-08	6.947	2124.8	01Jan2012, 18:09	4.53
Subbasin-17	0.747	265.5	01Jan2012, 15:56	4.44
Subbasin-16	0.102	32.9	01Jan2012, 15:11	3.49
Junction-8	7.796	2335.1	01Jan2012, 17:56	4.50
Reach-07	7.796	2335.1	01Jan2012, 18:18	4.50
Subbasin-13	0.454	152.0	01Jan2012, 16:16	4.22
Subbasin-14	0.074	28.4	01Jan2012, 15:03	4.22
Junction-7	17.304	5244.2	01Jan2012, 18:06	4.39
Reach-06	17.304	5244.2	01Jan2012, 18:57	4.39
Subbasin-12	0.506	182.3	01Jan2012, 15:35	4.33
Junction-6	17.810	5329.5	01Jan2012, 18:54	4.39
Reach-05	17.810	5329.5	01Jan2012, 19:03	4.39
Subbasin-10	0.569	202.9	01Jan2012, 16:19	4.66
Subbasin-11	0.047	18.7	01Jan2012, 15:03	4.44

Hinkle Creek Watershed Master Plan
HEC-HMS Output
100-yr 24-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	5459.1	01Jan2012, 19:00	4.40
Reach-04	18.426	5459.1	01Jan2012, 19:55	4.40
Subbasin-09	0.355	134.7	01Jan2012, 15:35	4.66
Subbasin-08	0.321	114.5	01Jan2012, 15:53	4.44
Junction-17	0.676	248.3	01Jan2012, 15:42	4.55
Reach-14	0.676	248.3	01Jan2012, 15:50	4.55
Subbasin-06	0.606	204.0	01Jan2012, 15:56	4.12
Subbasin-07	0.048	16.7	01Jan2012, 15:03	3.69
Junction-4	19.756	5637.3	01Jan2012, 19:52	4.40
Reach-03	19.756	5637.3	01Jan2012, 20:08	4.40
Subbasin-02	0.327	119.9	01Jan2012, 15:19	4.22
Subbasin-05	0.052	15.3	01Jan2012, 15:08	3.08
Junction-3	20.135	5680.7	01Jan2012, 20:08	4.39
Reach-02	20.135	5680.7	01Jan2012, 20:16	4.39
Subbasin-03	0.488	170.8	01Jan2012, 16:08	4.44
Subbasin-04	0.104	39.8	01Jan2012, 15:10	4.33
Junction-2	20.727	5759.6	01Jan2012, 20:15	4.39
Reach-01	20.727	5759.6	01Jan2012, 20:37	4.39
Subbasin-01	0.154	54.5	01Jan2012, 15:10	3.90
Junction-1	20.881	5776.9	01Jan2012, 20:37	4.39

Hinkle Creek Watershed Master Plan
HEC-HMS Output
500-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	894.2	01Jan2012, 02:27	2.83
Subbasin-35	1.165	764.0	01Jan2012, 02:27	2.92
Junction-23	2.566	1658.2	01Jan2012, 02:27	2.87
Reach-24	2.566	1658.2	01Jan2012, 02:57	2.81
Subbasin-37	0.810	605.1	01Jan2012, 01:43	2.63
Subbasin-34	0.396	344.6	01Jan2012, 01:38	2.99
Junction-22	3.772	2213.4	01Jan2012, 02:46	2.79
Reach-23	3.772	2213.4	01Jan2012, 03:05	2.75
Subbasin-30	0.413	327.9	01Jan2012, 01:48	2.89
Junction-21	4.185	2405.9	01Jan2012, 03:00	2.77
Reach-21	4.185	2405.9	01Jan2012, 03:08	2.75
Subbasin-41	1.181	741.5	01Jan2012, 02:36	2.89
Subbasin-40	0.779	521.3	01Jan2012, 02:29	3.00
Junction-25	1.960	1260.8	01Jan2012, 02:33	2.93
Reach-25	1.960	1260.8	01Jan2012, 03:02	2.87
Subbasin-39	0.414	411.2	01Jan2012, 01:18	2.99
Junction-24	2.374	1418.0	01Jan2012, 02:58	2.89
Reach-22	2.374	1418.0	01Jan2012, 03:25	2.81
Subbasin-38	0.492	396.8	01Jan2012, 01:45	2.89
Subbasin-29	0.051	52.8	01Jan2012, 00:55	2.54
Junction-20	7.102	4017.6	01Jan2012, 03:13	2.78
Reach-20	7.102	4017.6	01Jan2012, 03:39	2.69
Subbasin-28	0.411	336.5	01Jan2012, 01:29	2.63
Junction-26	7.513	4111.5	01Jan2012, 03:35	2.69
Reach-19	7.513	4111.5	01Jan2012, 03:52	2.61
Subbasin-33	0.719	508.1	01Jan2012, 01:51	2.62
Subbasin-32	0.317	281.8	01Jan2012, 01:21	2.72
Junction-19	8.549	4345.9	01Jan2012, 03:45	2.62
Reach-18	8.549	4345.9	01Jan2012, 04:10	2.48
Subbasin-31	0.431	387.4	01Jan2012, 01:29	2.90
Junction-18	8.980	4385.4	01Jan2012, 04:08	2.50
Reach-17	8.980	4385.4	01Jan2012, 04:17	2.45
Subbasin-24	1.509	815.3	01Jan2012, 03:18	2.75
Subbasin-22	0.565	518.1	01Jan2012, 01:39	3.18
Junction-16	2.074	1068.6	01Jan2012, 02:57	2.87
Reach-16	2.074	1068.6	01Jan2012, 03:12	2.82

Hinkle Creek Watershed Master Plan
HEC-HMS Output
500-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	606.1	01Jan2012, 02:44	2.94
Junction-15	3.048	1657.5	01Jan2012, 02:55	2.86
Reach-15	3.048	1657.5	01Jan2012, 03:09	2.81
Subbasin-25	0.807	554.4	01Jan2012, 02:18	2.94
Subbasin-27	0.723	328.6	01Jan2012, 04:13	2.39
Junction-14	1.530	727.2	01Jan2012, 02:38	2.68
Reach-13	1.530	727.2	01Jan2012, 03:03	2.57
Subbasin-26	0.289	260.4	01Jan2012, 01:38	3.08
Junction-13	1.819	864.0	01Jan2012, 02:51	2.65
Reach-12	1.819	864.0	01Jan2012, 03:04	2.59
Junction-12	4.867	2520.5	01Jan2012, 03:07	2.73
Reach-11	4.867	2520.5	01Jan2012, 03:51	2.49
Subbasin-18	0.827	594.7	01Jan2012, 02:20	3.12
Subbasin-21	0.737	557.7	01Jan2012, 01:46	2.71
Junction-11	6.431	3112.4	01Jan2012, 03:31	2.60
Reach-10	6.431	3112.4	01Jan2012, 03:40	2.55
Subbasin-15	0.110	86.3	01Jan2012, 01:35	2.63
Subbasin-20	0.054	58.6	01Jan2012, 00:57	2.72
Junction-10	6.595	3141.2	01Jan2012, 03:38	2.55
Reach-09	6.595	3141.2	01Jan2012, 03:50	2.48
Subbasin-19	0.352	273.6	01Jan2012, 02:06	3.15
Junction-9	6.947	3275.3	01Jan2012, 03:46	2.51
Reach-08	6.947	3275.3	01Jan2012, 04:06	2.38
Subbasin-17	0.747	581.1	01Jan2012, 01:56	2.98
Subbasin-16	0.102	80.4	01Jan2012, 01:09	2.20
Junction-8	7.796	3471.9	01Jan2012, 03:57	2.44
Reach-07	7.796	3471.9	01Jan2012, 04:19	2.28
Subbasin-13	0.454	301.5	01Jan2012, 02:13	2.77
Subbasin-14	0.074	86.3	01Jan2012, 00:52	2.81
Junction-7	17.304	7969.3	01Jan2012, 04:16	2.38
Reach-06	17.304	7969.3	01Jan2012, 05:07	1.96
Subbasin-12	0.506	428.6	01Jan2012, 01:38	2.90
Junction-6	17.810	7980.1	01Jan2012, 05:06	1.98
Reach-05	17.810	7980.1	01Jan2012, 05:15	1.89
Subbasin-10	0.569	417.7	01Jan2012, 02:16	3.13
Subbasin-11	0.047	59.0	01Jan2012, 00:49	2.99

Hinkle Creek Watershed Master Plan
HEC-HMS Output
500-yr 3-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	8038.7	01Jan2012, 05:14	1.94
Reach-04	18.426	7995.8	01Jan2012, 06:00	1.34
Subbasin-09	0.355	331.0	01Jan2012, 01:37	3.18
Subbasin-08	0.321	253.6	01Jan2012, 01:54	2.98
Junction-17	0.676	574.8	01Jan2012, 01:45	3.08
Reach-14	0.676	574.8	01Jan2012, 01:53	3.08
Subbasin-06	0.606	430.6	01Jan2012, 01:56	2.71
Subbasin-07	0.048	47.0	01Jan2012, 00:53	2.37
Junction-4	19.756	8010.6	01Jan2012, 06:00	1.44
Reach-03	19.756	7762.4	01Jan2012, 06:00	1.28
Subbasin-02	0.327	304.7	01Jan2012, 01:19	2.81
Subbasin-05	0.052	36.6	01Jan2012, 01:04	1.88
Junction-3	20.135	7762.4	01Jan2012, 06:00	1.30
Reach-02	20.135	7556.1	01Jan2012, 06:00	1.22
Subbasin-03	0.488	357.4	01Jan2012, 02:06	2.96
Subbasin-04	0.104	111.6	01Jan2012, 01:05	2.90
Junction-2	20.727	7569.2	01Jan2012, 06:00	1.27
Reach-01	20.727	6854.1	01Jan2012, 06:00	1.07
Subbasin-01	0.154	143.2	01Jan2012, 01:07	2.54
Junction-1	20.881	6854.1	01Jan2012, 06:00	1.09

Hinkle Creek Watershed Master Plan
HEC-HMS Output
500-yr 6-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	855.3	01Jan2012, 02:53	3.85
Subbasin-35	1.165	730.2	01Jan2012, 02:53	3.96
Junction-23	2.566	1585.5	01Jan2012, 02:53	3.90
Reach-24	2.566	1585.5	01Jan2012, 03:23	3.90
Subbasin-37	0.810	540.5	01Jan2012, 02:08	3.55
Subbasin-34	0.396	303.3	01Jan2012, 02:03	3.96
Junction-22	3.772	2203.1	01Jan2012, 03:10	3.83
Reach-23	3.772	2203.1	01Jan2012, 03:29	3.83
Subbasin-30	0.413	294.3	01Jan2012, 02:12	3.85
Junction-21	4.185	2414.2	01Jan2012, 03:25	3.83
Reach-21	4.185	2414.2	01Jan2012, 03:33	3.83
Subbasin-41	1.181	717.3	01Jan2012, 03:02	3.96
Subbasin-40	0.779	498.7	01Jan2012, 02:54	4.06
Junction-25	1.960	1214.5	01Jan2012, 02:59	4.00
Reach-25	1.960	1214.5	01Jan2012, 03:28	4.00
Subbasin-39	0.414	344.7	01Jan2012, 01:46	3.96
Junction-24	2.374	1396.6	01Jan2012, 03:18	3.99
Reach-22	2.374	1396.6	01Jan2012, 03:45	3.99
Subbasin-38	0.492	354.6	01Jan2012, 02:10	3.85
Subbasin-29	0.051	39.5	01Jan2012, 01:04	3.45
Junction-20	7.102	4038.4	01Jan2012, 03:35	3.88
Reach-20	7.102	4038.4	01Jan2012, 04:01	3.88
Subbasin-28	0.411	292.6	01Jan2012, 01:56	3.55
Junction-26	7.513	4154.3	01Jan2012, 04:00	3.86
Reach-19	7.513	4154.3	01Jan2012, 04:17	3.86
Subbasin-33	0.719	461.2	01Jan2012, 02:17	3.55
Subbasin-32	0.317	239.9	01Jan2012, 01:50	3.65
Junction-19	8.549	4466.2	01Jan2012, 04:13	3.83
Reach-18	8.549	4466.2	01Jan2012, 04:38	3.82
Subbasin-31	0.431	334.8	01Jan2012, 01:55	3.85
Junction-18	8.980	4575.1	01Jan2012, 04:38	3.83
Reach-17	8.980	4575.1	01Jan2012, 04:47	3.82
Subbasin-24	1.509	818.1	01Jan2012, 03:45	4.05
Subbasin-22	0.565	455.7	01Jan2012, 02:03	4.17
Junction-16	2.074	1098.1	01Jan2012, 03:22	4.08
Reach-16	2.074	1098.1	01Jan2012, 03:37	4.08

Hinkle Creek Watershed Master Plan
HEC-HMS Output
500-yr 6-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	591.1	01Jan2012, 03:10	4.06
Junction-15	3.048	1672.0	01Jan2012, 03:27	4.07
Reach-15	3.048	1672.0	01Jan2012, 03:41	4.07
Subbasin-25	0.807	522.7	01Jan2012, 02:43	3.96
Subbasin-27	0.723	342.1	01Jan2012, 04:48	4.16
Junction-14	1.530	734.1	01Jan2012, 03:24	4.06
Reach-13	1.530	734.1	01Jan2012, 03:49	4.04
Subbasin-26	0.289	228.5	01Jan2012, 02:01	4.06
Junction-13	1.819	868.2	01Jan2012, 03:24	4.05
Reach-12	1.819	868.2	01Jan2012, 03:37	4.04
Junction-12	4.867	2539.9	01Jan2012, 03:40	4.06
Reach-11	4.867	2539.9	01Jan2012, 04:24	4.04
Subbasin-18	0.827	561.1	01Jan2012, 02:44	4.17
Subbasin-21	0.737	500.1	01Jan2012, 02:11	3.65
Junction-11	6.431	3156.0	01Jan2012, 04:02	4.01
Reach-10	6.431	3156.0	01Jan2012, 04:11	4.01
Subbasin-15	0.110	76.0	01Jan2012, 02:01	3.55
Subbasin-20	0.054	44.5	01Jan2012, 01:08	3.65
Junction-10	6.595	3200.7	01Jan2012, 04:10	4.00
Reach-09	6.595	3200.7	01Jan2012, 04:22	3.99
Subbasin-19	0.352	252.6	01Jan2012, 02:29	4.17
Junction-9	6.947	3343.0	01Jan2012, 04:18	4.00
Reach-08	6.947	3343.0	01Jan2012, 04:38	3.99
Subbasin-17	0.747	528.6	01Jan2012, 02:20	3.96
Subbasin-16	0.102	66.9	01Jan2012, 01:43	3.05
Junction-8	7.796	3602.4	01Jan2012, 04:31	3.97
Reach-07	7.796	3602.4	01Jan2012, 04:53	3.96
Subbasin-13	0.454	282.9	01Jan2012, 02:39	3.75
Subbasin-14	0.074	66.0	01Jan2012, 00:58	3.75
Junction-7	17.304	8340.0	01Jan2012, 04:47	3.88
Reach-06	17.304	8340.0	01Jan2012, 05:38	3.85
Subbasin-12	0.506	377.5	01Jan2012, 02:02	3.85
Junction-6	17.810	8449.7	01Jan2012, 05:37	3.85
Reach-05	17.810	8449.7	01Jan2012, 05:46	3.85
Subbasin-10	0.569	391.7	01Jan2012, 02:40	4.17
Subbasin-11	0.047	45.7	01Jan2012, 00:57	3.96

Hinkle Creek Watershed Master Plan
HEC-HMS Output
500-yr 6-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	8610.8	01Jan2012, 05:46	3.86
Reach-04	18.426	8610.8	01Jan2012, 06:41	3.79
Subbasin-09	0.355	289.6	01Jan2012, 02:00	4.17
Subbasin-08	0.321	229.7	01Jan2012, 02:18	3.96
Junction-17	0.676	514.2	01Jan2012, 02:08	4.07
Reach-14	0.676	514.2	01Jan2012, 02:16	4.07
Subbasin-06	0.606	393.3	01Jan2012, 02:21	3.65
Subbasin-07	0.048	35.2	01Jan2012, 01:34	3.25
Junction-4	19.756	8834.3	01Jan2012, 06:39	3.79
Reach-03	19.756	8834.3	01Jan2012, 06:55	3.76
Subbasin-02	0.327	256.9	01Jan2012, 01:48	3.75
Subbasin-05	0.052	30.4	01Jan2012, 01:40	2.67
Junction-3	20.135	8857.5	01Jan2012, 06:53	3.76
Reach-02	20.135	8857.5	01Jan2012, 07:01	3.75
Subbasin-03	0.488	330.8	01Jan2012, 02:30	3.96
Subbasin-04	0.104	87.9	01Jan2012, 01:35	3.85
Junction-2	20.727	8936.0	01Jan2012, 07:00	3.75
Reach-01	20.727	8936.0	01Jan2012, 07:22	3.70
Subbasin-01	0.154	115.4	01Jan2012, 01:40	3.45
Junction-1	20.881	8936.7	01Jan2012, 07:22	3.70

Hinkle Creek Watershed Master Plan
HEC-HMS Output
500-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-36	1.401	723.6	01Jan2012, 06:40	4.38
Subbasin-35	1.165	614.1	01Jan2012, 06:40	4.48
Junction-23	2.566	1337.7	01Jan2012, 06:40	4.42
Reach-24	2.566	1337.7	01Jan2012, 07:10	4.42
Subbasin-37	0.810	433.4	01Jan2012, 05:58	4.05
Subbasin-34	0.396	233.9	01Jan2012, 05:52	4.48
Junction-22	3.772	1882.8	01Jan2012, 06:48	4.35
Reach-23	3.772	1882.8	01Jan2012, 07:07	4.35
Subbasin-30	0.413	233.6	01Jan2012, 06:03	4.38
Junction-21	4.185	2076.2	01Jan2012, 07:01	4.35
Reach-21	4.185	2076.2	01Jan2012, 07:09	4.35
Subbasin-41	1.181	609.2	01Jan2012, 06:47	4.48
Subbasin-40	0.779	417.5	01Jan2012, 06:41	4.59
Junction-25	1.960	1026.2	01Jan2012, 06:45	4.53
Reach-25	1.960	1026.2	01Jan2012, 07:14	4.53
Subbasin-39	0.414	256.5	01Jan2012, 05:30	4.48
Junction-24	2.374	1186.1	01Jan2012, 07:01	4.52
Reach-22	2.374	1186.1	01Jan2012, 07:28	4.52
Subbasin-38	0.492	279.9	01Jan2012, 06:01	4.38
Subbasin-29	0.051	30.5	01Jan2012, 05:07	3.95
Junction-20	7.102	3480.8	01Jan2012, 07:10	4.41
Reach-20	7.102	3480.8	01Jan2012, 07:36	4.41
Subbasin-28	0.411	227.3	01Jan2012, 05:41	4.05
Junction-26	7.513	3615.6	01Jan2012, 07:35	4.39
Reach-19	7.513	3615.6	01Jan2012, 07:52	4.39
Subbasin-33	0.719	377.0	01Jan2012, 06:08	4.05
Subbasin-32	0.317	182.7	01Jan2012, 05:33	4.16
Junction-19	8.549	3964.5	01Jan2012, 07:46	4.35
Reach-18	8.549	3964.5	01Jan2012, 08:11	4.35
Subbasin-31	0.431	255.0	01Jan2012, 05:41	4.38
Junction-18	8.980	4092.8	01Jan2012, 08:09	4.35
Reach-17	8.980	4092.8	01Jan2012, 08:18	4.35
Subbasin-24	1.509	719.4	01Jan2012, 07:26	4.59
Subbasin-22	0.565	346.7	01Jan2012, 05:53	4.70
Junction-16	2.074	977.9	01Jan2012, 06:55	4.62
Reach-16	2.074	977.9	01Jan2012, 07:10	4.62

Hinkle Creek Watershed Master Plan
HEC-HMS Output
500-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Subbasin-23	0.974	503.2	01Jan2012, 06:54	4.59
Junction-15	3.048	1477.8	01Jan2012, 07:03	4.61
Reach-15	3.048	1477.8	01Jan2012, 07:17	4.61
Subbasin-25	0.807	434.6	01Jan2012, 06:32	4.48
Subbasin-27	0.723	313.6	01Jan2012, 08:24	4.81
Junction-14	1.530	674.3	01Jan2012, 07:04	4.64
Reach-13	1.530	674.3	01Jan2012, 07:29	4.64
Subbasin-26	0.289	174.6	01Jan2012, 05:51	4.59
Junction-13	1.819	794.9	01Jan2012, 07:10	4.63
Reach-12	1.819	794.9	01Jan2012, 07:23	4.63
Junction-12	4.867	2272.1	01Jan2012, 07:19	4.62
Reach-11	4.867	2272.1	01Jan2012, 08:03	4.62
Subbasin-18	0.827	461.4	01Jan2012, 06:33	4.70
Subbasin-21	0.737	400.9	01Jan2012, 06:01	4.16
Junction-11	6.431	2878.6	01Jan2012, 07:47	4.58
Reach-10	6.431	2878.6	01Jan2012, 07:56	4.58
Subbasin-15	0.110	59.9	01Jan2012, 05:49	4.05
Subbasin-20	0.054	33.6	01Jan2012, 05:09	4.16
Junction-10	6.595	2927.1	01Jan2012, 07:54	4.57
Reach-09	6.595	2927.1	01Jan2012, 08:06	4.57
Subbasin-19	0.352	203.0	01Jan2012, 06:20	4.70
Junction-9	6.947	3064.7	01Jan2012, 08:02	4.57
Reach-08	6.947	3064.7	01Jan2012, 08:22	4.57
Subbasin-17	0.747	423.5	01Jan2012, 06:11	4.48
Subbasin-16	0.102	52.1	01Jan2012, 05:18	3.53
Junction-8	7.796	3338.3	01Jan2012, 08:13	4.55
Reach-07	7.796	3338.3	01Jan2012, 08:35	4.55
Subbasin-13	0.454	236.8	01Jan2012, 06:28	4.27
Subbasin-14	0.074	47.9	01Jan2012, 05:06	4.27
Junction-7	17.304	7585.0	01Jan2012, 08:21	4.44
Reach-06	17.304	7585.0	01Jan2012, 09:12	4.44
Subbasin-12	0.506	293.0	01Jan2012, 05:52	4.38
Junction-6	17.810	7694.3	01Jan2012, 09:12	4.44
Reach-05	17.810	7694.3	01Jan2012, 09:21	4.44
Subbasin-10	0.569	320.3	01Jan2012, 06:29	4.70
Subbasin-11	0.047	31.9	01Jan2012, 05:06	4.48

Hinkle Creek Watershed Master Plan
HEC-HMS Output
500-yr 12-hr Storm Event

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Junction-5	18.426	7860.6	01Jan2012, 09:19	4.45
Reach-04	18.426	7860.6	01Jan2012, 10:14	4.44
Subbasin-09	0.355	219.1	01Jan2012, 05:50	4.70
Subbasin-08	0.321	183.1	01Jan2012, 06:09	4.48
Junction-17	0.676	400.1	01Jan2012, 05:59	4.60
Reach-14	0.676	400.1	01Jan2012, 06:07	4.60
Subbasin-06	0.606	321.9	01Jan2012, 06:11	4.16
Subbasin-07	0.048	27.6	01Jan2012, 05:05	3.74
Junction-4	19.756	8104.8	01Jan2012, 10:10	4.44
Reach-03	19.756	8104.8	01Jan2012, 10:26	4.44
Subbasin-02	0.327	193.9	01Jan2012, 05:30	4.27
Subbasin-05	0.052	24.0	01Jan2012, 05:13	3.12
Junction-3	20.135	8149.7	01Jan2012, 10:26	4.43
Reach-02	20.135	8149.7	01Jan2012, 10:34	4.43
Subbasin-03	0.488	270.1	01Jan2012, 06:21	4.48
Subbasin-04	0.104	65.6	01Jan2012, 05:17	4.38
Junction-2	20.727	8249.4	01Jan2012, 10:33	4.43
Reach-01	20.727	8249.4	01Jan2012, 10:55	4.43
Subbasin-01	0.154	88.2	01Jan2012, 05:17	3.95
Junction-1	20.881	8267.8	01Jan2012, 10:55	4.43

APPENDIX D HYDRAULIC MODELING

Hinkle Creek

HEC-RAS Modeling Output Files

HEC-RAS Plan: HC River: Hinkle Reach: Hinkle

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Hinkle	44407.01	10-YR	318.00	898.53	903.37	903.15	903.43	0.001561	2.78	217.88	535.67	0.31
Hinkle	44407.01	25-YR	424.00	898.53	903.48	903.23	903.55	0.001788	3.04	253.89	549.95	0.33
Hinkle	44407.01	50-YR	528.00	898.53	903.55	903.30	903.63	0.002142	3.37	277.00	558.83	0.37
Hinkle	44407.01	100-YR	684.00	898.53	903.79	903.38	903.86	0.001707	3.13	353.63	587.40	0.33
Hinkle	44407.01	500-YR	868.00	898.53	904.14	903.47	904.17	0.000547	1.91	745.47	618.97	0.19
Hinkle	44034.02	10-YR	318.00	897.68	901.95	901.73	902.33	0.005711	5.34	77.23	80.65	0.62
Hinkle	44034.02	25-YR	424.00	897.68	902.45		902.64	0.002895	4.31	165.00	249.18	0.46
Hinkle	44034.02	50-YR	528.00	897.68	902.88		902.97	0.001346	3.24	298.64	331.40	0.32
Hinkle	44034.02	100-YR	684.00	897.68	903.40		903.44	0.000695	2.57	504.86	446.69	0.24
Hinkle	44034.02	500-YR	868.00	897.68	903.97		903.99	0.000348	2.00	780.84	513.82	0.17
Hinkle	43842.07	10-YR	318.00	897.00	901.89	898.94	901.98	0.000569	2.38	140.62	51.01	0.21
Hinkle	43842.07	25-YR	424.00	897.00	902.23	899.39	902.36	0.000738	2.87	158.05	70.74	0.25
Hinkle	43842.07	50-YR	528.00	897.00	902.60	899.76	902.75	0.000833	3.22	177.66	80.75	0.26
Hinkle	43842.07	100-YR	684.00	897.00	903.07	900.27	903.26	0.000958	3.68	204.01	196.70	0.29
Hinkle	43842.07	500-YR	868.00	897.00	903.63	900.75	903.86	0.001011	4.06	236.47	290.82	0.30
Hinkle	43799		Culvert									
Hinkle	43766.71	10-YR	318.00	897.00	901.74		901.84	0.000553	2.48	135.71	56.24	0.21
Hinkle	43766.71	25-YR	424.00	897.00	901.98		902.12	0.000801	3.10	145.21	60.77	0.26
Hinkle	43766.71	50-YR	528.00	897.00	902.22		902.42	0.001018	3.62	154.96	156.28	0.30
Hinkle	43766.71	100-YR	684.00	897.00	902.45		902.74	0.001433	4.44	163.99	196.61	0.35
Hinkle	43766.71	500-YR	868.00	897.00	902.62		903.05	0.002031	5.40	170.87	214.16	0.42
Hinkle	43518.14	10-YR	318.00	895.59	901.43		901.59	0.001687	3.50	139.15	218.08	0.35
Hinkle	43518.14	25-YR	424.00	895.59	901.67		901.83	0.001701	3.65	197.58	262.27	0.35
Hinkle	43518.14	50-YR	528.00	895.59	901.99		902.09	0.001263	3.29	289.72	319.79	0.31
Hinkle	43518.14	100-YR	684.00	895.59	902.30		902.37	0.000962	3.03	430.09	480.47	0.27
Hinkle	43518.14	500-YR	868.00	895.59	902.55		902.62	0.000838	2.95	556.67	508.51	0.25
Hinkle	43371.07	10-YR	318.00	896.35	901.21	899.57	901.34	0.001465	3.25	187.68	462.58	0.33
Hinkle	43371.07	25-YR	424.00	896.35	901.59		901.64	0.000670	2.38	376.45	526.74	0.23
Hinkle	43371.07	50-YR	528.00	896.35	901.95		901.98	0.000357	1.86	575.57	572.54	0.17
Hinkle	43371.07	100-YR	684.00	896.35	902.26		902.28	0.000306	1.81	784.47	722.87	0.16
Hinkle	43371.07	500-YR	868.00	896.35	902.51		902.53	0.000280	1.80	976.64	784.87	0.15
Hinkle	42556.18	10-YR	318.00	894.41	899.81		900.00	0.001589	3.51	90.69	28.13	0.34
Hinkle	42556.18	25-YR	424.00	894.41	900.56		900.78	0.001568	3.76	112.69	31.03	0.35
Hinkle	42556.18	50-YR	528.00	894.41	901.16		901.39	0.001548	3.92	153.43	186.85	0.35
Hinkle	42556.18	100-YR	684.00	894.41	901.49		901.74	0.001618	4.23	225.92	244.21	0.36
Hinkle	42556.18	500-YR	868.00	894.41	901.76		902.02	0.001731	4.56	296.42	293.50	0.38
Hinkle	41897.61	10-YR	318.00	893.12	898.54		898.77	0.001975	3.85	82.58	25.65	0.38
Hinkle	41897.61	25-YR	424.00	893.12	899.28		899.55	0.001961	4.12	102.95	28.72	0.38
Hinkle	41897.61	50-YR	528.00	893.12	899.90		900.19	0.001916	4.29	132.28	93.77	0.38
Hinkle	41897.61	100-YR	684.00	893.12	900.50		900.69	0.001353	3.88	275.63	292.04	0.33
Hinkle	41897.61	500-YR	868.00	893.12	900.86		901.01	0.001151	3.77	386.34	326.38	0.31
Hinkle	41248.41	10-YR	318.00	891.18	897.00	894.91	897.27	0.002366	4.20	75.79	22.81	0.41
Hinkle	41248.41	25-YR	424.00	891.18	897.71	895.51	898.03	0.002466	4.56	92.92	25.46	0.42
Hinkle	41248.41	50-YR	528.00	891.18	898.29	896.00	898.66	0.002548	4.87	108.40	27.62	0.43
Hinkle	41248.41	100-YR	684.00	891.18	898.93	896.65	899.38	0.002833	5.40	126.77	71.32	0.46
Hinkle	41248.41	500-YR	868.00	891.18	899.51	897.29	899.91	0.002464	5.36	210.11	148.65	0.44
Hinkle	40868	10-YR	318.00	890.82	895.89		896.20	0.002989	4.42	72.01	25.19	0.46
Hinkle	40868	25-YR	424.00	890.82	896.66		896.98	0.002729	4.58	92.50	28.55	0.45
Hinkle	40868	50-YR	528.00	890.82	897.23		897.59	0.002753	4.81	110.22	37.31	0.46
Hinkle	40868	100-YR	684.00	890.82	897.79		898.22	0.002884	5.26	136.50	55.39	0.48
Hinkle	40868	500-YR	868.00	890.82	898.63		898.96	0.002171	4.88	220.32	127.96	0.42
Hinkle	40277.21	10-YR	318.00	889.08	895.58		895.64	0.000343	1.97	162.91	43.73	0.17
Hinkle	40277.21	25-YR	424.00	889.08	896.37		896.44	0.000338	2.19	203.53	66.77	0.17
Hinkle	40277.21	50-YR	528.00	889.08	896.95		897.04	0.000342	2.37	250.60	94.81	0.18
Hinkle	40277.21	100-YR	684.00	889.08	897.52		897.62	0.000373	2.64	307.24	102.91	0.19
Hinkle	40277.21	500-YR	868.00	889.08	898.38		898.47	0.000332	2.71	401.12	121.60	0.18
Hinkle	39948.27	10-YR	318.00	888.02	895.50		895.54	0.000231	1.70	190.28	57.43	0.14
Hinkle	39948.27	25-YR	424.00	888.02	896.29		896.34	0.000227	1.88	246.11	80.30	0.14
Hinkle	39948.27	50-YR	528.00	888.02	896.87		896.93	0.000231	2.03	295.69	89.35	0.15
Hinkle	39948.27	100-YR	684.00	888.02	897.43		897.50	0.000268	2.32	349.00	103.90	0.16
Hinkle	39948.27	500-YR	868.00	888.02	898.29		898.37	0.000249	2.43	451.85	135.59	0.16
Hinkle	39706.05	10-YR	318.00	887.05	895.47	889.94	895.49	0.000136	1.27	263.67	184.38	0.11
Hinkle	39706.05	25-YR	424.00	887.05	896.26	890.44	896.29	0.000124	1.36	345.70	283.92	0.11
Hinkle	39706.05	50-YR	528.00	887.05	896.85	890.86	896.88	0.000124	1.45	410.31	333.97	0.11
Hinkle	39706.05	100-YR	684.00	887.05	897.41	891.45	897.45	0.000141	1.65	474.54	362.87	0.12
Hinkle	39706.05	500-YR	868.00	887.05	898.28	892.03	898.32	0.000132	1.74	580.61	384.84	0.11

HEC-RAS Plan: HC River: Hinkle Reach: Hinkle (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Hinkle	39556.94		Culvert									
Hinkle	39485.18	10-YR	888.00	886.93	895.22		895.44	0.000964	4.03	266.50	281.46	0.30
Hinkle	39485.18	25-YR	1215.00	886.93	895.96		896.21	0.001012	4.47	329.90	334.94	0.31
Hinkle	39485.18	50-YR	1538.00	886.93	896.44		896.76	0.001155	5.01	371.35	373.62	0.33
Hinkle	39485.18	100-YR	1911.00	886.93	896.83		897.23	0.001379	5.68	405.07	381.61	0.37
Hinkle	39485.18	500-YR	2539.00	886.93	897.38		897.94	0.001745	6.70	452.26	394.22	0.42
Hinkle	39267.53	10-YR	888.00	886.49	893.20	891.38	893.80	0.003359	6.25	154.19	105.71	0.52
Hinkle	39267.53	25-YR	1215.00	886.49	893.69	892.19	894.42	0.003827	7.15	213.53	139.38	0.57
Hinkle	39267.53	50-YR	1538.00	886.49	894.17	893.89	894.88	0.003600	7.38	289.13	167.65	0.56
Hinkle	39267.53	100-YR	1911.00	886.49	894.70		895.32	0.003108	7.29	380.32	182.41	0.53
Hinkle	39267.53	500-YR	2539.00	886.49	895.43		895.98	0.002581	7.18	522.64	203.87	0.49
Hinkle	38965.05	10-YR	888.00	886.02	892.84		892.99	0.001447	4.10	370.67	181.91	0.33
Hinkle	38965.05	25-YR	1215.00	886.02	893.47		893.60	0.001239	4.12	486.44	190.40	0.32
Hinkle	38965.05	50-YR	1538.00	886.02	893.97		894.11	0.001171	4.26	583.55	198.42	0.31
Hinkle	38965.05	100-YR	1911.00	886.02	894.46		894.62	0.001146	4.44	683.17	205.44	0.31
Hinkle	38965.05	500-YR	2539.00	886.02	895.16		895.35	0.001147	4.77	831.80	216.08	0.32
Hinkle	38713.11	10-YR	888.00	885.06	891.49	890.67	892.27	0.004825	7.36	176.67	147.27	0.63
Hinkle	38713.11	25-YR	1215.00	885.06	891.85	891.55	892.88	0.006061	8.71	254.06	165.27	0.71
Hinkle	38713.11	50-YR	1538.00	885.06	892.28	892.28	893.40	0.006240	9.38	327.69	173.88	0.73
Hinkle	38713.11	100-YR	1911.00	885.06	892.70	892.70	893.90	0.006423	10.04	402.24	179.65	0.76
Hinkle	38713.11	500-YR	2539.00	885.06	893.30	893.30	894.62	0.006677	10.96	511.79	186.97	0.78
Hinkle	38103.36	10-YR	888.00	884.08	889.55		889.82	0.003044	5.26	248.15	154.15	0.48
Hinkle	38103.36	25-YR	1215.00	884.08	890.03		890.31	0.002739	5.42	326.18	167.72	0.47
Hinkle	38103.36	50-YR	1538.00	884.08	890.44		890.73	0.002580	5.59	395.88	178.04	0.46
Hinkle	38103.36	100-YR	1911.00	884.08	890.86		891.16	0.002445	5.77	472.65	188.85	0.46
Hinkle	38103.36	500-YR	2539.00	884.08	891.54		891.86	0.002144	5.89	607.26	204.70	0.44
Hinkle	37442.48	10-YR	1147.00	882.06	886.97		887.42	0.003743	6.41	395.58	197.42	0.57
Hinkle	37442.48	25-YR	1568.00	882.06	887.54		888.04	0.003703	6.98	512.36	206.32	0.58
Hinkle	37442.48	50-YR	1949.00	882.06	888.00		888.52	0.003681	7.42	607.45	212.59	0.58
Hinkle	37442.48	100-YR	2385.00	882.06	888.47		889.03	0.003631	7.82	710.19	218.71	0.59
Hinkle	37442.48	500-YR	3201.00	882.06	889.26		889.87	0.003569	8.48	885.65	228.80	0.60
Hinkle	36731.35	10-YR	1147.00	878.85	884.68		885.12	0.002968	6.30	431.72	215.67	0.51
Hinkle	36731.35	25-YR	1568.00	878.85	885.27		885.75	0.003041	6.90	562.19	222.45	0.53
Hinkle	36731.35	50-YR	1949.00	878.85	885.71		886.24	0.003176	7.43	660.51	226.81	0.55
Hinkle	36731.35	100-YR	2385.00	878.85	886.17		886.74	0.003284	7.95	764.83	230.76	0.56
Hinkle	36731.35	500-YR	3201.00	878.85	886.91		887.56	0.003461	8.80	937.55	235.61	0.59
Hinkle	35861.48	10-YR	1147.00	877.09	882.37		882.67	0.003412	6.29	516.46	227.36	0.54
Hinkle	35861.48	25-YR	1568.00	877.09	882.76		883.15	0.004072	7.29	607.14	231.32	0.59
Hinkle	35861.48	50-YR	1949.00	877.09	883.15		883.57	0.004230	7.84	697.91	235.07	0.61
Hinkle	35861.48	100-YR	2385.00	877.09	883.51		883.99	0.004535	8.50	783.31	238.78	0.64
Hinkle	35861.48	500-YR	3201.00	877.09	884.13		884.69	0.004894	9.48	932.37	244.77	0.68
Hinkle	35272.7	10-YR	1147.00	875.05	880.88		881.10	0.001956	5.14	468.04	270.77	0.42
Hinkle	35272.7	25-YR	1568.00	875.05	881.54		881.71	0.001431	4.79	648.62	276.85	0.36
Hinkle	35272.7	50-YR	1949.00	875.05	881.76		881.97	0.001689	5.35	709.43	278.57	0.40
Hinkle	35272.7	100-YR	2385.00	875.05	882.20		882.41	0.001550	5.39	833.54	282.82	0.39
Hinkle	35272.7	500-YR	3201.00	875.05	882.81		883.05	0.001562	5.76	1007.09	288.92	0.39
Hinkle	34652.27	10-YR	1147.00	874.08	880.51		880.56	0.000385	2.64	958.20	279.57	0.19
Hinkle	34652.27	25-YR	1568.00	874.08	881.15		881.21	0.000430	2.98	1137.96	284.37	0.20
Hinkle	34652.27	50-YR	1949.00	874.08	881.21		881.29	0.000637	3.65	1154.36	284.81	0.25
Hinkle	34652.27	100-YR	2385.00	874.08	881.62		881.72	0.000709	4.01	1273.10	287.89	0.27
Hinkle	34652.27	500-YR	3201.00	874.08	882.11		882.26	0.000921	4.78	1416.38	291.47	0.31
Hinkle	34573.11	10-YR	1147.00	873.46	880.30	878.32	880.48	0.001205	4.17	525.06	308.60	0.33
Hinkle	34573.11	25-YR	1568.00	873.46	880.98	879.83	881.13	0.000976	4.09	737.39	314.56	0.31
Hinkle	34573.11	50-YR	1949.00	873.46	880.93	880.06	881.18	0.001594	5.20	721.81	314.12	0.39
Hinkle	34573.11	100-YR	2385.00	873.46	881.36	880.30	881.61	0.001508	5.31	858.12	317.74	0.38
Hinkle	34573.11	500-YR	3201.00	873.46	881.81	880.68	882.12	0.001770	6.04	1001.76	320.70	0.42
Hinkle	34549		Culvert									
Hinkle	34530.09	10-YR	1147.00	873.55	880.15		880.43	0.001908	5.26	441.34	300.51	0.41
Hinkle	34530.09	25-YR	1568.00	873.55	880.90		881.09	0.001314	4.78	673.09	321.37	0.35
Hinkle	34530.09	50-YR	1949.00	873.55	880.85		881.17	0.002149	6.08	658.04	319.97	0.44
Hinkle	34530.09	100-YR	2385.00	873.55	881.23		881.54	0.002091	6.25	779.34	329.78	0.44
Hinkle	34530.09	500-YR	3201.00	873.55	881.68		882.05	0.002341	6.94	933.15	339.62	0.47
Hinkle	34368.64	10-YR	1147.00	873.04	880.27		880.30	0.000228	2.18	1133.45	346.44	0.15
Hinkle	34368.64	25-YR	1568.00	873.04	880.96		880.99	0.000233	2.35	1376.11	355.58	0.15

HEC-RAS Plan: HC River: Hinkle Reach: Hinkle (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Hinkle	34368.64	50-YR	1949.00	873.04	880.95		881.01	0.000361	2.93	1374.64	355.52	0.19
Hinkle	34368.64	100-YR	2385.00	873.04	881.31		881.38	0.000406	3.21	1503.66	358.63	0.20
Hinkle	34368.64	500-YR	3201.00	873.04	881.78		881.87	0.000522	3.78	1670.19	361.98	0.23
Hinkle	33902.73	10-YR	1147.00	872.11	880.22		880.24	0.000148	1.83	1019.01	302.11	0.12
Hinkle	33902.73	25-YR	1568.00	872.11	880.90		880.94	0.000158	2.01	1231.61	314.37	0.13
Hinkle	33902.73	50-YR	1949.00	872.11	880.87		880.92	0.000250	2.53	1220.80	313.85	0.16
Hinkle	33902.73	100-YR	2385.00	872.11	881.22		881.28	0.000288	2.79	1331.45	318.29	0.17
Hinkle	33902.73	500-YR	3201.00	872.11	881.65		881.74	0.000385	3.34	1470.33	323.96	0.20
Hinkle	33764.18	10-YR	1147.00	872.02	879.88	877.27	880.16	0.001226	4.97	402.40	310.29	0.34
Hinkle	33764.18	25-YR	1568.00	872.02	878.19	878.19	880.62	0.011546	12.54	126.00	219.72	0.99
Hinkle	33764.18	50-YR	1949.00	872.02	880.46	880.04	880.81	0.001620	6.03	584.92	324.88	0.39
Hinkle	33764.18	100-YR	2385.00	872.02	880.85	880.25	881.17	0.001497	6.01	713.80	333.87	0.38
Hinkle	33764.18	500-YR	3201.00	872.02	881.22	880.58	881.60	0.001778	6.76	838.81	342.88	0.42
Hinkle	33743		Culvert									
Hinkle	33720.23	10-YR	1147.00	872.03	876.28	876.28	877.93	0.011067	10.45	114.05	222.23	0.95
Hinkle	33720.23	25-YR	1568.00	872.03	877.07	877.07	879.05	0.010493	11.54	141.58	260.99	0.95
Hinkle	33720.23	50-YR	1949.00	872.03	877.68	877.68	879.98	0.010357	12.46	162.85	292.59	0.96
Hinkle	33720.23	100-YR	2385.00	872.03	878.38	878.38	880.97	0.009826	13.21	187.53	347.32	0.96
Hinkle	33720.23	500-YR	3201.00	872.03	880.37	880.37	881.13	0.002921	8.75	679.70	388.13	0.55
Hinkle	33681.18	10-YR	1147.00	871.97	876.41		876.71	0.002017	4.65	277.18	341.46	0.42
Hinkle	33681.18	25-YR	1568.00	871.97	876.78		877.21	0.002585	5.60	314.59	351.00	0.48
Hinkle	33681.18	50-YR	1949.00	871.97	877.07		877.62	0.003069	6.37	343.03	357.42	0.53
Hinkle	33681.18	100-YR	2385.00	871.97	877.34		878.05	0.003633	7.20	370.20	360.57	0.58
Hinkle	33681.18	500-YR	3201.00	871.97	877.73		878.76	0.004760	8.69	409.88	365.09	0.67
Hinkle	33472.55	10-YR	1147.00	871.70	875.90		876.21	0.004865	6.67	443.71	250.33	0.62
Hinkle	33472.55	25-YR	1568.00	871.70	876.26		876.61	0.005249	7.39	534.66	256.63	0.66
Hinkle	33472.55	50-YR	1949.00	871.70	876.55		876.94	0.005479	7.92	609.49	261.65	0.68
Hinkle	33472.55	100-YR	2385.00	871.70	876.82		877.26	0.005827	8.52	682.40	266.28	0.71
Hinkle	33472.55	500-YR	3201.00	871.70	877.25		877.77	0.006504	9.56	796.16	271.77	0.76
Hinkle	32827.83	10-YR	1147.00	870.31	873.99		874.18	0.002483	4.62	377.03	246.81	0.45
Hinkle	32827.83	25-YR	1568.00	870.31	874.36		874.57	0.002406	4.89	469.65	251.33	0.45
Hinkle	32827.83	50-YR	1949.00	870.31	874.65		874.89	0.002373	5.11	544.04	254.43	0.45
Hinkle	32827.83	100-YR	2385.00	870.31	875.02		875.26	0.002187	5.20	637.18	258.40	0.44
Hinkle	32827.83	500-YR	3201.00	870.31	876.01		876.22	0.001350	4.70	899.59	269.03	0.36
Hinkle	32476.1	10-YR	1147.00	869.31	873.04		873.18	0.002490	4.04	414.79	259.70	0.44
Hinkle	32476.1	25-YR	1568.00	869.31	873.32		873.52	0.002943	4.70	490.26	272.92	0.48
Hinkle	32476.1	50-YR	1949.00	869.31	873.62		873.84	0.002987	5.04	574.10	289.94	0.49
Hinkle	32476.1	100-YR	2385.00	869.31	874.24		874.42	0.001963	4.59	760.65	307.12	0.41
Hinkle	32476.1	500-YR	3201.00	869.31	875.65		875.78	0.000852	3.72	1207.40	324.59	0.29
Hinkle	32086.67	10-YR	1147.00	867.93	871.56		871.86	0.004467	5.89	310.11	243.30	0.60
Hinkle	32086.67	25-YR	1568.00	867.93	872.13		872.37	0.002789	5.23	456.07	259.49	0.48
Hinkle	32086.67	50-YR	1949.00	867.93	872.76		872.94	0.001728	4.58	621.59	272.91	0.39
Hinkle	32086.67	100-YR	2385.00	867.93	873.81		873.93	0.000801	3.61	920.18	292.02	0.28
Hinkle	32086.67	500-YR	3201.00	867.93	875.46		875.55	0.000382	2.99	1418.34	310.62	0.20
Hinkle	31811.13	10-YR	1147.00	866.87	871.30	870.60	871.39	0.001147	3.41	542.27	334.97	0.31
Hinkle	31811.13	25-YR	1568.00	866.87	872.02	870.78	872.09	0.000692	2.98	785.32	345.98	0.25
Hinkle	31811.13	50-YR	1949.00	866.87	872.69	870.92	872.75	0.000472	2.70	1022.50	356.08	0.21
Hinkle	31811.13	100-YR	2385.00	866.87	873.79	871.07	873.84	0.000254	2.26	1422.43	372.76	0.16
Hinkle	31811.13	500-YR	3201.00	866.87	875.46	871.32	875.50	0.000145	1.99	2125.55	448.31	0.12
Hinkle	31558.63	10-YR	1147.00	865.85	870.73	869.85	870.97	0.002295	4.90	310.30	492.19	0.44
Hinkle	31558.63	25-YR	1568.00	865.85	871.60	870.18	871.82	0.001560	4.62	435.98	630.00	0.37
Hinkle	31558.63	50-YR	1949.00	865.85	872.35	870.42	872.56	0.001172	4.42	545.74	711.35	0.33
Hinkle	31558.63	100-YR	2385.00	865.85	873.49	870.73	873.69	0.001407	5.50	1002.69	748.91	0.38
Hinkle	31558.63	500-YR	3201.00	865.85	875.42	871.27	875.45	0.000182	2.35	2552.73	839.70	0.14
Hinkle	31503.31		Bridge									
Hinkle	31459.92	10-YR	1147.00	865.54	870.18		870.48	0.002338	4.58	267.93	945.34	0.44
Hinkle	31459.92	25-YR	1568.00	865.54	870.82		871.18	0.002317	5.11	325.29	1038.34	0.45
Hinkle	31459.92	50-YR	1949.00	865.54	871.41		871.83	0.002153	5.41	379.67	1085.10	0.45
Hinkle	31459.92	100-YR	2385.00	865.54	872.63	870.07	873.00	0.001380	5.07	490.78	1176.84	0.37
Hinkle	31459.92	500-YR	3201.00	865.54	875.39		875.41	0.000106	1.82	3532.76	1374.94	0.11
Hinkle	31154.04	10-YR	1147.00	864.98	869.84		869.95	0.001040	3.43	483.12	502.85	0.30
Hinkle	31154.04	25-YR	1568.00	864.98	870.58		870.67	0.000827	3.41	839.78	551.87	0.27
Hinkle	31154.04	50-YR	1949.00	864.98	871.39		871.44	0.000369	2.53	1292.14	563.84	0.19
Hinkle	31154.04	100-YR	2385.00	864.98	872.72		872.75	0.000133	1.75	2055.08	582.04	0.12
Hinkle	31154.04	500-YR	3201.00	864.98	875.38		875.39	0.000040	1.19	3670.40	633.94	0.07

HEC-RAS Plan: HC River: Hinkle Reach: Hinkle (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Hinkle	30897.58	10-YR	1147.00	863.76	869.70		869.75	0.000614	2.78	758.01	528.49	0.23
Hinkle	30897.58	25-YR	1568.00	863.76	870.51		870.55	0.000298	2.16	1193.82	538.51	0.17
Hinkle	30897.58	50-YR	1949.00	863.76	871.35		871.38	0.000168	1.80	1650.80	549.04	0.13
Hinkle	30897.58	100-YR	2385.00	863.76	872.71		872.72	0.000077	1.39	2406.07	567.21	0.09
Hinkle	30897.58	500-YR	3201.00	863.76	875.38		875.39	0.000028	1.04	3959.09	593.33	0.06
Hinkle	30613.61	10-YR	1147.00	862.81	869.59		869.63	0.000290	2.23	841.74	509.73	0.17
Hinkle	30613.61	25-YR	1568.00	862.81	870.44		870.48	0.000206	2.06	1148.14	527.42	0.14
Hinkle	30613.61	50-YR	1949.00	862.81	871.30		871.33	0.000148	1.90	1459.17	537.83	0.12
Hinkle	30613.61	100-YR	2385.00	862.81	872.68		872.70	0.000086	1.62	1958.45	549.49	0.10
Hinkle	30613.61	500-YR	3201.00	862.81	875.36		875.37	0.000053	1.52	3210.67	569.74	0.08
Hinkle	30362.94	10-YR	1147.00	862.79	869.37	866.99	869.50	0.000708	3.46	408.41	379.42	0.26
Hinkle	30362.94	25-YR	1568.00	862.79	870.19	867.45	870.35	0.000702	3.78	495.79	427.69	0.26
Hinkle	30362.94	50-YR	1949.00	862.79	871.05	867.81	871.22	0.000625	3.87	586.46	467.95	0.25
Hinkle	30362.94	100-YR	2385.00	862.79	872.45	868.21	872.62	0.000443	3.67	735.15	504.87	0.22
Hinkle	30362.94	500-YR	3201.00	862.79	875.35	868.72	875.36	0.000029	1.15	3794.26	544.74	0.06
Hinkle	30309.5		Bridge									
Hinkle	30266.22	10-YR	2924.00	862.50	868.76	868.26	870.01	0.005493	9.72	347.14	363.17	0.73
Hinkle	30266.22	25-YR	4022.00	862.50	869.24	869.06	871.08	0.007301	11.85	389.35	376.69	0.85
Hinkle	30266.22	50-YR	5019.00	862.50	869.71	869.71	872.03	0.008374	13.33	429.38	383.36	0.92
Hinkle	30266.22	100-YR	6162.00	862.50	870.39	870.39	873.04	0.008367	14.24	488.94	393.11	0.94
Hinkle	30266.22	500-YR	8340.00	862.50	871.56	871.56	874.82	0.008337	15.72	591.04	498.35	0.96
Hinkle	29785.8	10-YR	2924.00	861.09	866.85		867.20	0.004194	7.10	725.66	467.88	0.58
Hinkle	29785.8	25-YR	4022.00	861.09	867.30		867.70	0.004177	7.54	899.17	486.60	0.59
Hinkle	29785.8	50-YR	5019.00	861.09	867.73		868.15	0.003831	7.63	1069.26	502.83	0.57
Hinkle	29785.8	100-YR	6162.00	861.09	868.24		868.67	0.003403	7.63	1268.36	520.60	0.55
Hinkle	29785.8	500-YR	8340.00	861.09	869.15		869.60	0.002821	7.63	1633.62	551.55	0.51
Hinkle	29165.64	10-YR	2924.00	860.35	865.82		865.95	0.001636	4.02	1065.21	523.28	0.37
Hinkle	29165.64	25-YR	4022.00	860.35	866.52		866.65	0.001214	3.90	1440.71	540.09	0.33
Hinkle	29165.64	50-YR	5019.00	860.35	867.12		867.25	0.001002	3.85	1766.01	552.86	0.30
Hinkle	29165.64	100-YR	6162.00	860.35	867.75		867.88	0.000850	3.84	2115.44	560.45	0.29
Hinkle	29165.64	500-YR	8340.00	860.35	868.78		868.94	0.000715	3.95	2703.08	573.17	0.27
Hinkle	28932.65	10-YR	2924.00	859.26	865.45		865.56	0.001052	3.99	1214.66	492.29	0.31
Hinkle	28932.65	25-YR	4022.00	859.26	866.24		866.35	0.000842	3.93	1611.61	515.11	0.29
Hinkle	28932.65	50-YR	5019.00	859.26	866.88		866.99	0.000735	3.93	1944.69	529.65	0.27
Hinkle	28932.65	100-YR	6162.00	859.26	867.54		867.66	0.000656	3.97	2297.09	540.11	0.26
Hinkle	28932.65	500-YR	8340.00	859.26	868.60		868.74	0.000589	4.12	2880.04	554.37	0.25
Hinkle	28171.54	10-YR	2924.00	857.17	864.96		865.04	0.000574	3.24	1400.25	416.25	0.23
Hinkle	28171.54	25-YR	4022.00	857.17	865.80		865.89	0.000549	3.45	1760.50	436.99	0.23
Hinkle	28171.54	50-YR	5019.00	857.17	866.47		866.57	0.000541	3.64	2055.12	449.46	0.23
Hinkle	28171.54	100-YR	6162.00	857.17	867.14		867.26	0.000540	3.84	2363.37	467.08	0.23
Hinkle	28171.54	500-YR	8340.00	857.17	868.21		868.36	0.000562	4.24	2894.09	520.99	0.24
Hinkle	27665.71	10-YR	2924.00	856.64	864.29		864.51	0.002008	6.08	1396.41	437.18	0.43
Hinkle	27665.71	25-YR	4022.00	856.64	865.18		865.40	0.001810	6.32	1802.17	467.12	0.42
Hinkle	27665.71	50-YR	5019.00	856.64	865.87		866.09	0.001702	6.52	2131.87	486.82	0.41
Hinkle	27665.71	100-YR	6162.00	856.64	866.57		866.79	0.001629	6.76	2475.66	506.64	0.41
Hinkle	27665.71	500-YR	8340.00	856.64	867.63		867.88	0.001610	7.27	3030.11	536.98	0.42
Hinkle	26967.33	10-YR	2924.00	855.15	863.07		863.38	0.001575	5.40	1138.53	311.48	0.39
Hinkle	26967.33	25-YR	4022.00	855.15	863.95		864.32	0.001647	6.06	1419.81	330.28	0.41
Hinkle	26967.33	50-YR	5019.00	855.15	864.60		865.02	0.001733	6.61	1639.06	342.82	0.43
Hinkle	26967.33	100-YR	6162.00	855.15	865.24		865.72	0.001839	7.19	1860.38	353.05	0.45
Hinkle	26967.33	500-YR	8340.00	855.15	866.09		866.73	0.002182	8.38	2168.07	363.51	0.50
Hinkle	26448.97	10-YR	2924.00	854.20	862.31		862.57	0.001999	6.08	1370.24	402.03	0.43
Hinkle	26448.97	25-YR	4022.00	854.20	863.22		863.50	0.001944	6.58	1743.70	417.01	0.44
Hinkle	26448.97	50-YR	5019.00	854.20	863.87		864.17	0.002009	7.09	2014.18	424.39	0.45
Hinkle	26448.97	100-YR	6162.00	854.20	864.47	861.98	864.82	0.002137	7.69	2273.65	430.82	0.47
Hinkle	26448.97	500-YR	8340.00	854.20	865.16		865.64	0.002740	9.19	2570.69	437.71	0.54
Hinkle	25786.13	10-YR	2924.00	853.46	859.87	859.51	860.64	0.004781	8.43	880.06	404.94	0.66
Hinkle	25786.13	25-YR	4022.00	853.46	860.13	860.11	861.30	0.007036	10.58	986.83	413.80	0.81
Hinkle	25786.13	50-YR	5019.00	853.46	860.53	860.53	861.86	0.007611	11.56	1155.05	422.28	0.86
Hinkle	25786.13	100-YR	6162.00	853.46	861.04	861.04	862.44	0.007541	12.19	1375.85	439.77	0.86
Hinkle	25786.13	500-YR	8340.00	853.46	863.16	861.79	863.83	0.003073	9.47	2437.83	534.95	0.58
Hinkle	25111.84	10-YR	2924.00	852.52	858.36	857.77	858.52	0.002164	4.74	996.50	592.91	0.42
Hinkle	25111.84	25-YR	4022.00	852.52	858.89	857.99	859.05	0.001768	4.67	1317.31	617.08	0.39
Hinkle	25111.84	50-YR	5019.00	852.52	859.59	858.18	859.72	0.001137	4.13	1756.35	640.45	0.32
Hinkle	25111.84	100-YR	6162.00	852.52	860.98	858.37	861.06	0.000464	3.09	2672.36	675.45	0.21

HEC-RAS Plan: HC River: Hinkle Reach: Hinkle (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Hinkle	25111.84	500-YR	8340.00	852.52	863.30	858.68	863.36	0.000191	2.43	4302.87	910.97	0.14
Hinkle	24440.96	10-YR	2924.00	851.29	857.40		857.51	0.001274	3.77	1145.70	556.84	0.33
Hinkle	24440.96	25-YR	4022.00	851.29	858.22		858.32	0.000847	3.48	1613.36	700.65	0.28
Hinkle	24440.96	50-YR	5019.00	851.29	859.18		859.27	0.000512	3.05	2186.93	788.80	0.22
Hinkle	24440.96	100-YR	6162.00	851.29	860.80		860.86	0.000240	2.46	3196.01	1064.62	0.16
Hinkle	24440.96	500-YR	8340.00	851.29	863.22		863.27	0.000121	2.09	4849.89	1295.82	0.12
Hinkle	23800.54	10-YR	2924.00	849.29	856.47	855.54	856.66	0.001456	4.86	1119.36	473.34	0.37
Hinkle	23800.54	25-YR	4022.00	849.29	857.67	855.87	857.80	0.000828	4.19	1717.35	697.93	0.29
Hinkle	23800.54	50-YR	5019.00	849.29	858.86	856.14	858.95	0.000517	3.69	2366.92	885.30	0.23
Hinkle	23800.54	100-YR	6162.00	849.29	860.65	856.39	860.71	0.000253	2.96	3437.88	1046.18	0.17
Hinkle	23800.54	500-YR	8340.00	849.29	863.18	856.81	863.20	0.000076	1.89	7394.86	1235.09	0.10
Hinkle	23471.12	10-YR	2924.00	848.52	856.27		856.36	0.000647	3.27	1330.46	760.91	0.23
Hinkle	23471.12	25-YR	4022.00	848.52	857.56		857.63	0.000380	2.85	1964.27	902.04	0.19
Hinkle	23471.12	50-YR	5019.00	848.52	858.78		858.84	0.000251	2.56	2607.27	1029.04	0.15
Hinkle	23471.12	100-YR	6162.00	848.52	860.61		860.66	0.000136	2.14	3620.09	1134.82	0.12
Hinkle	23471.12	500-YR	8340.00	848.52	863.14		863.18	0.000086	1.97	5084.39	1252.89	0.10
Hinkle	22636.78	10-YR	2924.00	846.28	856.03		856.09	0.000283	2.84	1859.69	709.60	0.17
Hinkle	22636.78	25-YR	4022.00	846.28	857.45		857.49	0.000152	2.32	2893.28	747.64	0.13
Hinkle	22636.78	50-YR	5019.00	846.28	858.72		858.75	0.000104	2.08	3903.09	822.75	0.11
Hinkle	22636.78	100-YR	6162.00	846.28	860.58		860.60	0.000056	1.69	5460.89	864.89	0.08
Hinkle	22636.78	500-YR	8340.00	846.28	863.12		863.14	0.000037	1.55	7665.70	943.46	0.07
Hinkle	22605.55	10-YR	2924.00	846.52	855.29	853.02	856.00	0.002551	6.84	442.52	193.67	0.50
Hinkle	22605.55	25-YR	4022.00	846.52	856.55	854.07	857.39	0.002366	7.50	565.01	504.78	0.50
Hinkle	22605.55	50-YR	5019.00	846.52	857.76	854.90	858.65	0.002071	7.79	681.76	716.48	0.48
Hinkle	22605.55	100-YR	6162.00	846.52	859.70	855.79	860.52	0.001441	7.47	870.81	821.95	0.41
Hinkle	22605.55	500-YR	8340.00	846.52	863.11	857.03	863.14	0.000075	2.06	6138.79	916.54	0.10
Hinkle	22571.33		Bridge									
Hinkle	22527.25	10-YR	2972.00	846.16	854.12		855.06	0.003317	8.07	410.91	419.39	0.57
Hinkle	22527.25	25-YR	4084.00	846.16	854.72		856.07	0.004288	9.76	470.07	448.86	0.66
Hinkle	22527.25	50-YR	5095.00	846.16	855.21		856.91	0.005016	11.05	518.41	470.51	0.72
Hinkle	22527.25	100-YR	6253.00	846.16	855.71	855.26	857.82	0.005760	12.38	567.71	510.64	0.78
Hinkle	22527.25	500-YR	8450.00	846.16	856.46	856.39	859.43	0.007233	14.75	641.85	571.44	0.89
Hinkle	22126.85	10-YR	2972.00	846.10	853.71		853.86	0.001164	4.02	1050.32	425.46	0.32
Hinkle	22126.85	25-YR	4084.00	846.10	854.58		854.73	0.000879	3.91	1435.09	450.60	0.29
Hinkle	22126.85	50-YR	5095.00	846.10	855.30		855.44	0.000746	3.90	1763.96	472.42	0.27
Hinkle	22126.85	100-YR	6253.00	846.10	856.03		856.18	0.000660	3.94	2122.10	498.42	0.26
Hinkle	22126.85	500-YR	8450.00	846.10	857.27		857.43	0.000531	3.94	2744.25	535.86	0.24
Hinkle	21788.84	10-YR	2972.00	845.45	853.55		853.63	0.000516	3.24	1429.10	505.93	0.22
Hinkle	21788.84	25-YR	4084.00	845.45	854.47		854.55	0.000417	3.18	1903.03	523.40	0.21
Hinkle	21788.84	50-YR	5095.00	845.45	855.20		855.29	0.000375	3.21	2294.87	545.96	0.20
Hinkle	21788.84	100-YR	6253.00	845.45	855.95		856.04	0.000340	3.24	2711.44	562.50	0.19
Hinkle	21788.84	500-YR	8450.00	845.45	857.21		857.31	0.000295	3.30	3415.92	594.42	0.18
Hinkle	21250.31	10-YR	2972.00	845.11	853.33		853.42	0.000466	3.22	1332.16	454.83	0.21
Hinkle	21250.31	25-YR	4084.00	845.11	854.27		854.37	0.000418	3.31	1688.45	478.34	0.21
Hinkle	21250.31	50-YR	5095.00	845.11	855.00		855.12	0.000400	3.43	1968.15	494.13	0.20
Hinkle	21250.31	100-YR	6253.00	845.11	855.75		855.88	0.000389	3.58	2253.69	508.78	0.20
Hinkle	21250.31	500-YR	8450.00	845.11	857.00		857.16	0.000382	3.84	2731.04	536.27	0.21
Hinkle	20873.17	10-YR	2972.00	844.21	852.49		852.96	0.001773	6.16	953.89	311.27	0.42
Hinkle	20873.17	25-YR	4084.00	844.21	853.30		853.89	0.002018	7.10	1214.25	338.72	0.46
Hinkle	20873.17	50-YR	5095.00	844.21	853.94		854.61	0.002170	7.78	1437.84	357.27	0.48
Hinkle	20873.17	100-YR	6253.00	844.21	854.60		855.36	0.002287	8.41	1678.64	370.77	0.50
Hinkle	20873.17	500-YR	8450.00	844.21	855.72		856.61	0.002411	9.37	2107.07	388.45	0.53
Hinkle	19772.55	10-YR	2972.00	843.16	850.36		850.70	0.002281	5.87	1230.38	457.23	0.46
Hinkle	19772.55	25-YR	4084.00	843.16	851.20		851.55	0.002101	6.23	1615.42	462.01	0.45
Hinkle	19772.55	50-YR	5095.00	843.16	851.86		852.22	0.002024	6.56	1921.41	465.70	0.45
Hinkle	19772.55	100-YR	6253.00	843.16	852.54		852.93	0.001975	6.92	2240.55	470.34	0.45
Hinkle	19772.55	500-YR	8450.00	843.16	853.72		854.15	0.001900	7.50	2801.39	480.81	0.45
Hinkle	19159.74	10-YR	2972.00	841.15	849.81		849.96	0.000693	3.98	1161.85	402.69	0.26
Hinkle	19159.74	25-YR	4084.00	841.15	850.76		850.90	0.000583	3.97	1556.19	425.92	0.25
Hinkle	19159.74	50-YR	5095.00	841.15	851.47		851.61	0.000537	4.03	1863.78	437.29	0.24
Hinkle	19159.74	100-YR	6253.00	841.15	852.19		852.34	0.000507	4.13	2182.77	447.19	0.24
Hinkle	19159.74	500-YR	8450.00	841.15	853.43		853.59	0.000467	4.31	2747.76	465.84	0.23
Hinkle	18623.57	10-YR	2972.00	840.51	848.64		849.29	0.001996	6.89	746.45	286.18	0.45
Hinkle	18623.57	25-YR	4084.00	840.51	849.43		850.25	0.002333	7.98	988.47	319.34	0.49
Hinkle	18623.57	50-YR	5095.00	840.51	850.03	848.51	850.97	0.002574	8.79	1182.78	336.21	0.53

HEC-RAS Plan: HC River: Hinkle Reach: Hinkle (Continued)

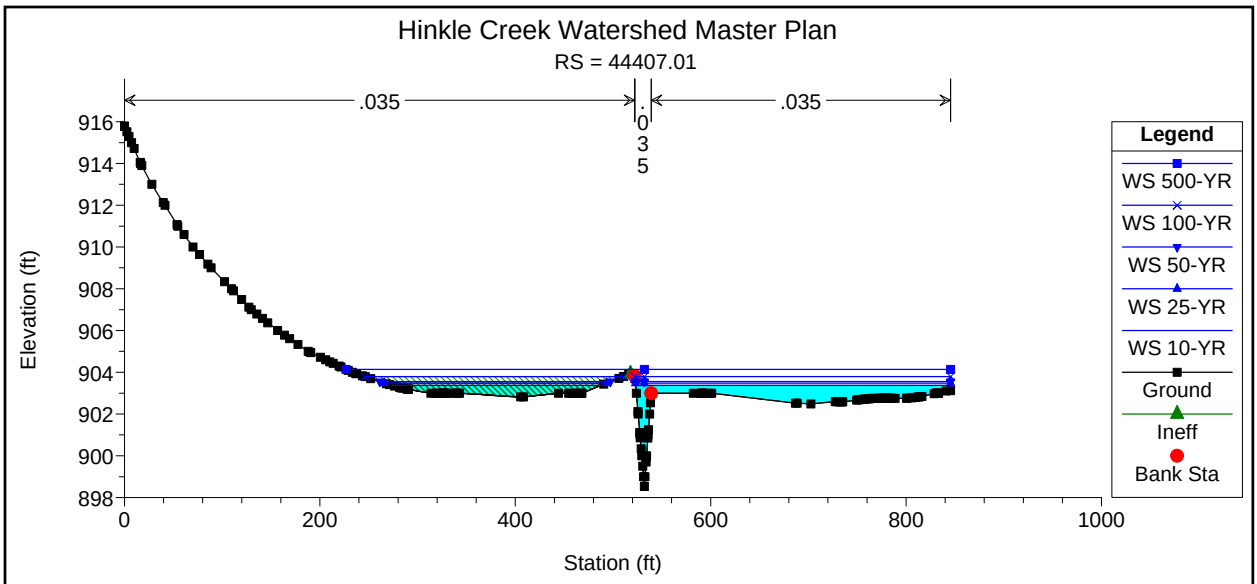
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Hinkle	18623.57	100-YR	6253.00	840.51	850.67	849.42	851.71	0.002713	9.46	1406.14	356.18	0.55
Hinkle	18623.57	500-YR	8450.00	840.51	851.96		853.01	0.002544	9.99	1885.15	383.42	0.54
Hinkle	17955.75	10-YR	2972.00	839.99	847.22		847.80	0.002382	6.84	965.88	437.55	0.48
Hinkle	17955.75	25-YR	4084.00	839.99	847.74		848.49	0.002982	8.07	1196.08	454.34	0.55
Hinkle	17955.75	50-YR	5095.00	839.99	848.35		849.12	0.002973	8.53	1475.29	467.06	0.55
Hinkle	17955.75	100-YR	6253.00	839.99	849.18		849.91	0.002622	8.61	1875.40	495.97	0.53
Hinkle	17955.75	500-YR	8450.00	839.99	850.97		851.54	0.001821	8.18	2812.97	550.20	0.46
Hinkle	16695.58	10-YR	2972.00	837.04	844.85	843.86	845.22	0.001775	6.04	773.13	324.08	0.42
Hinkle	16695.58	25-YR	4084.00	837.04	846.07	844.59	846.32	0.001062	5.24	1184.15	361.75	0.33
Hinkle	16695.58	50-YR	5095.00	837.04	847.22	844.91	847.41	0.000712	4.70	1599.79	395.40	0.28
Hinkle	16695.58	100-YR	6253.00	837.04	848.40	845.24	848.57	0.000518	4.35	2064.09	426.44	0.24
Hinkle	16695.58	500-YR	8450.00	837.04	850.50	845.77	850.65	0.000335	3.97	2959.70	478.37	0.20
Hinkle	16033.33	10-YR	2972.00	835.88	844.45	842.72	844.53	0.000422	3.20	1494.45	478.98	0.21
Hinkle	16033.33	25-YR	4084.00	835.88	845.84	843.04	845.91	0.000254	2.78	2170.87	490.80	0.16
Hinkle	16033.33	50-YR	5095.00	835.88	847.06	843.28	847.12	0.000185	2.58	2774.54	524.28	0.14
Hinkle	16033.33	100-YR	6253.00	835.88	848.28	843.51	848.34	0.000149	2.50	3396.38	544.83	0.13
Hinkle	16033.33	500-YR	8450.00	835.88	850.41	843.91	850.46	0.000132	2.64	4633.92	705.07	0.13
Hinkle	15793.06	10-YR	2972.00	835.22	844.41		844.45	0.000196	2.29	1890.02	537.75	0.14
Hinkle	15793.06	25-YR	4084.00	835.22	845.81		845.86	0.000144	2.19	2562.67	557.69	0.13
Hinkle	15793.06	50-YR	5095.00	835.22	847.04		847.08	0.000116	2.13	3157.66	573.89	0.12
Hinkle	15793.06	100-YR	6253.00	835.22	848.26		848.31	0.000118	2.30	3784.94	589.45	0.12
Hinkle	15793.06	500-YR	8450.00	835.22	850.39		850.44	0.000094	2.30	5084.58	649.10	0.11
Hinkle	15568	10-YR	3157.00	834.35	844.15	841.25	844.36	0.000638	4.30	921.11	567.93	0.26
Hinkle	15568	25-YR	4334.00	834.35	845.54	841.97	845.78	0.000573	4.52	1172.41	580.93	0.26
Hinkle	15568	50-YR	5402.00	834.35	846.76	842.45	847.01	0.000519	4.65	1390.61	590.87	0.25
Hinkle	15568	100-YR	6626.00	834.35	847.95	842.94	848.24	0.000492	4.85	1606.11	601.85	0.25
Hinkle	15568	500-YR	8857.00	834.35	849.97	843.70	850.36	0.000687	6.36	2439.45	624.37	0.30
Hinkle	15498.85		Bridge									
Hinkle	15445.39	10-YR	3157.00	833.97	842.59		843.65	0.004637	8.56	403.72	432.54	0.65
Hinkle	15445.39	25-YR	4334.00	833.97	843.05	842.66	844.63	0.006447	10.51	452.31	434.84	0.78
Hinkle	15445.39	50-YR	5402.00	833.97	843.40	843.33	845.47	0.008097	12.09	489.57	437.78	0.88
Hinkle	15445.39	100-YR	6626.00	833.97	843.96	843.96	846.40	0.008495	13.16	552.07	443.58	0.91
Hinkle	15445.39	500-YR	8857.00	833.97	845.16	845.16	847.91	0.007751	14.07	698.62	466.40	0.90
Hinkle	15348.84	10-YR	3157.00	833.35	842.65		843.10	0.001705	6.31	760.45	525.52	0.41
Hinkle	15348.84	25-YR	4334.00	833.35	843.26		843.82	0.002010	7.22	920.58	528.55	0.45
Hinkle	15348.84	50-YR	5402.00	833.35	843.77		844.41	0.002178	7.83	1056.98	531.07	0.47
Hinkle	15348.84	100-YR	6626.00	833.35	844.33		845.05	0.002289	8.38	1206.26	533.81	0.49
Hinkle	15348.84	500-YR	8857.00	833.35	845.27		846.11	0.002392	9.15	1459.39	538.41	0.51
Hinkle	15219.79	10-YR	3157.00	833.17	842.45		842.90	0.001789	6.70	898.75	452.61	0.42
Hinkle	15219.79	25-YR	4334.00	833.17	842.93		843.56	0.002386	8.06	1033.34	461.93	0.49
Hinkle	15219.79	50-YR	5402.00	833.17	843.35		844.12	0.002820	9.06	1150.70	468.71	0.54
Hinkle	15219.79	100-YR	6626.00	833.17	843.81		844.73	0.003184	9.97	1285.51	476.01	0.58
Hinkle	15219.79	500-YR	8857.00	833.17	844.65		845.77	0.003567	11.18	1532.05	486.42	0.62
Hinkle	15008.2	10-YR	3157.00	832.92	842.27		842.52	0.001074	4.92	1444.47	383.36	0.33
Hinkle	15008.2	25-YR	4334.00	832.92	842.66		843.04	0.001568	6.16	1595.39	385.64	0.40
Hinkle	15008.2	50-YR	5402.00	832.92	842.99		843.49	0.001984	7.13	1724.62	387.52	0.45
Hinkle	15008.2	100-YR	6626.00	832.92	843.38		844.00	0.002379	8.07	1876.93	389.77	0.50
Hinkle	15008.2	500-YR	8857.00	832.92	844.14		844.94	0.002853	9.37	2171.31	394.75	0.55
Hinkle	14867.52	10-YR	3157.00	832.55	842.03	840.84	842.33	0.001170	5.54	1308.34	536.04	0.34
Hinkle	14867.52	25-YR	4334.00	832.55	842.35	841.49	842.78	0.001673	6.79	1477.33	538.32	0.41
Hinkle	14867.52	50-YR	5402.00	832.55	842.65	841.84	843.17	0.002025	7.65	1639.27	540.26	0.45
Hinkle	14867.52	100-YR	6626.00	832.55	843.04	842.21	843.63	0.002241	8.29	1853.42	542.85	0.48
Hinkle	14867.52	500-YR	8857.00	832.55	843.86	842.74	844.47	0.002281	8.84	2297.85	550.19	0.49
Hinkle	14844		Bridge									
Hinkle	14830.05	10-YR	3157.00	832.41	841.67	841.42	842.06	0.013139	7.24	733.89	528.83	0.92
Hinkle	14830.05	25-YR	4334.00	832.41	841.94	841.68	842.45	0.013893	8.13	873.20	536.84	0.97
Hinkle	14830.05	50-YR	5402.00	832.41	842.32	841.94	842.84	0.010751	7.97	1075.02	550.81	0.88
Hinkle	14830.05	100-YR	6626.00	832.41	842.82		843.32	0.007802	7.64	1338.61	569.59	0.77
Hinkle	14830.05	500-YR	8857.00	832.41	843.76		844.23	0.004759	7.13	1842.17	600.30	0.63
Hinkle	14621.45	10-YR	3157.00	832.11	840.00	840.00	840.82	0.003278	8.22	598.10	456.76	0.56
Hinkle	14621.45	25-YR	4334.00	832.11	840.85		841.46	0.002478	7.74	886.40	460.98	0.49
Hinkle	14621.45	50-YR	5402.00	832.11	841.49		842.03	0.002139	7.58	1102.27	464.14	0.46
Hinkle	14621.45	100-YR	6626.00	832.11	842.14		842.66	0.001894	7.50	1325.90	467.38	0.44
Hinkle	14621.45	500-YR	8857.00	832.11	843.21		843.73	0.001625	7.50	1691.92	472.73	0.42

HEC-RAS Plan: HC River: Hinkle Reach: Hinkle (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Hinkle	14450.62	10-YR	3157.00	832.00	840.09		840.32	0.001075	4.84	1045.11	428.97	0.32
Hinkle	14450.62	25-YR	4334.00	832.00	840.86		841.07	0.000953	4.87	1374.98	432.04	0.30
Hinkle	14450.62	50-YR	5402.00	832.00	841.47		841.69	0.000880	4.92	1642.91	434.54	0.30
Hinkle	14450.62	100-YR	6626.00	832.00	842.13		842.35	0.000818	4.99	1927.96	437.19	0.29
Hinkle	14450.62	500-YR	8857.00	832.00	843.21		843.45	0.000742	5.11	2402.61	441.74	0.28
Hinkle	14021.61	10-YR	3157.00	831.06	839.57		839.77	0.001163	4.60	998.01	348.82	0.33
Hinkle	14021.61	25-YR	4334.00	831.06	840.37		840.59	0.001038	4.71	1281.40	354.34	0.31
Hinkle	14021.61	50-YR	5402.00	831.06	841.01		841.23	0.000982	4.86	1506.83	358.76	0.31
Hinkle	14021.61	100-YR	6626.00	831.06	841.67		841.92	0.000937	5.02	1746.18	363.44	0.31
Hinkle	14021.61	500-YR	8857.00	831.06	842.76		843.04	0.000883	5.29	2146.21	371.13	0.30
Hinkle	12950.98	10-YR	3157.00	830.52	838.22	836.58	838.44	0.001362	4.97	1639.91	531.66	0.37
Hinkle	12950.98	25-YR	4334.00	830.52	839.14	837.04	839.37	0.001290	5.34	2156.68	590.34	0.36
Hinkle	12950.98	50-YR	5402.00	830.52	839.85	837.41	840.10	0.001220	5.56	2593.48	625.68	0.36
Hinkle	12950.98	100-YR	6626.00	830.52	840.60	837.79	840.84	0.001154	5.77	3070.67	657.78	0.36
Hinkle	12950.98	500-YR	8857.00	830.52	841.79	838.35	842.05	0.001058	6.05	3888.65	705.64	0.35
Hinkle	12067.7	10-YR	3157.00	828.37	836.25		836.81	0.002873	6.74	809.34	226.97	0.51
Hinkle	12067.7	25-YR	4334.00	828.37	837.03		837.73	0.003217	7.71	987.32	230.66	0.55
Hinkle	12067.7	50-YR	5402.00	828.37	837.63		838.46	0.003495	8.49	1127.49	233.48	0.59
Hinkle	12067.7	100-YR	6626.00	828.37	838.24		839.22	0.003764	9.30	1271.27	238.59	0.62
Hinkle	12067.7	500-YR	8857.00	828.37	839.23		840.46	0.004111	10.59	1513.89	260.47	0.66
Hinkle	11476.94	10-YR	3157.00	827.18	835.03		835.42	0.001845	6.12	1293.33	462.92	0.42
Hinkle	11476.94	25-YR	4334.00	827.18	835.74		836.18	0.002043	6.89	1621.17	472.37	0.45
Hinkle	11476.94	50-YR	5402.00	827.18	836.31		836.80	0.002153	7.45	1893.16	476.92	0.47
Hinkle	11476.94	100-YR	6626.00	827.18	836.92		837.46	0.002218	7.95	2187.69	479.40	0.49
Hinkle	11476.94	500-YR	8857.00	827.18	838.01		838.59	0.002211	8.61	2709.29	483.86	0.49
Hinkle	10599.23	10-YR	3157.00	825.24	833.83		834.15	0.001487	5.43	1015.33	427.51	0.38
Hinkle	10599.23	25-YR	4334.00	825.24	834.67		834.97	0.001321	5.56	1401.77	479.04	0.37
Hinkle	10599.23	50-YR	5402.00	825.24	835.35		835.64	0.001208	5.65	1730.57	487.40	0.36
Hinkle	10599.23	100-YR	6626.00	825.24	836.06		836.35	0.001114	5.75	2079.29	497.68	0.35
Hinkle	10599.23	500-YR	8857.00	825.24	837.27		837.56	0.001007	5.97	2698.21	525.98	0.34
Hinkle	8891.111	10-YR	3157.00	822.86	831.23		831.64	0.001524	6.01	1201.12	390.94	0.40
Hinkle	8891.111	25-YR	4334.00	822.86	832.20		832.65	0.001527	6.55	1588.92	403.48	0.41
Hinkle	8891.111	50-YR	5402.00	822.86	832.96		833.44	0.001539	6.98	1898.19	411.04	0.41
Hinkle	8891.111	100-YR	6626.00	822.86	833.72		834.24	0.001567	7.44	2214.36	418.34	0.42
Hinkle	8891.111	500-YR	8857.00	822.86	834.99		835.56	0.001584	8.12	2751.11	430.14	0.43
Hinkle	7821.324	10-YR	3157.00	820.00	828.58	826.71	829.44	0.002573	8.12	763.36	285.86	0.51
Hinkle	7821.324	25-YR	4334.00	820.00	829.88	828.50	830.65	0.002149	8.23	1154.41	310.11	0.48
Hinkle	7821.324	50-YR	5402.00	820.00	830.50	829.20	831.37	0.002332	8.97	1349.32	313.96	0.51
Hinkle	7821.324	100-YR	6626.00	820.00	831.00		832.02	0.002679	9.94	1506.63	316.37	0.55
Hinkle	7821.324	500-YR	8857.00	820.00	832.70		833.57	0.002136	9.84	2048.47	323.82	0.50
Hinkle	7467.088	10-YR	3157.00	818.99	826.84	825.94	828.13	0.004694	9.38	444.17	153.89	0.67
Hinkle	7467.088	25-YR	4334.00	818.99	827.30	827.30	829.23	0.006589	11.66	520.90	181.81	0.80
Hinkle	7467.088	50-YR	5402.00	818.99	828.44	828.26	830.07	0.004908	11.20	766.25	247.50	0.71
Hinkle	7467.088	100-YR	6626.00	818.99	829.84		830.95	0.003059	9.88	1163.75	314.69	0.58
Hinkle	7467.088	500-YR	8857.00	818.99	832.42		832.88	0.001152	7.15	2292.73	570.11	0.37
Hinkle	7182.67	10-YR	3157.00	817.10	827.02	822.03	827.36	0.000799	4.75	704.33	1049.98	0.29
Hinkle	7182.67	25-YR	4334.00	817.10	827.56	823.06	828.10	0.001183	6.03	769.03	1170.72	0.36
Hinkle	7182.67	50-YR	5402.00	817.10	828.46	823.92	829.11	0.001265	6.65	878.35	1343.48	0.38
Hinkle	7182.67	100-YR	6626.00	817.10	829.54	824.88	830.27	0.001263	7.13	1010.16	1453.83	0.38
Hinkle	7182.67	500-YR	8857.00	817.10	831.70	826.37	832.51	0.001110	7.55	1273.99	1768.83	0.37
Hinkle	7122.285		Bridge									
Hinkle	7056.561	10-YR	3204.00	817.17	826.45		826.94	0.001425	5.76	599.55	1095.15	0.38
Hinkle	7056.561	25-YR	4397.00	817.17	826.34		827.30	0.002850	8.06	585.98	1084.31	0.54
Hinkle	7056.561	50-YR	5481.00	817.17	826.70		828.00	0.003649	9.43	630.00	1117.98	0.61
Hinkle	7056.561	100-YR	6722.00	817.17	826.99		828.75	0.004689	10.98	667.06	1195.66	0.70
Hinkle	7056.561	500-YR	8937.00	817.17	827.34	827.24	830.08	0.006963	13.78	709.60	1407.30	0.86
Hinkle	6565.434	10-YR	3204.00	815.60	824.99	822.39	825.87	0.002402	7.77	633.82	912.27	0.50
Hinkle	6565.434	25-YR	4397.00	815.60	825.53	823.65	825.97	0.001603	6.65	1974.44	1242.76	0.41
Hinkle	6565.434	50-YR	5481.00	815.60	826.03	825.40	826.41	0.001487	6.66	2522.88	1321.36	0.40
Hinkle	6565.434	100-YR	6722.00	815.60	826.56	825.70	826.88	0.001340	6.58	3125.15	1357.44	0.38
Hinkle	6565.434	500-YR	8937.00	815.60	827.43	826.15	827.69	0.001121	6.39	4145.45	1439.05	0.36
Hinkle	5727.515	10-YR	3204.00	814.97	823.53	821.49	824.03	0.001811	6.63	1462.49	839.86	0.43
Hinkle	5727.515	25-YR	4397.00	814.97	824.28	823.49	824.74	0.001744	6.94	2104.67	885.24	0.43
Hinkle	5727.515	50-YR	5481.00	814.97	824.87	823.87	825.29	0.001664	7.10	2632.27	900.12	0.42
Hinkle	5727.515	100-YR	6722.00	814.97	825.46	824.26	825.87	0.001612	7.30	3173.23	916.98	0.42
Hinkle	5727.515	500-YR	8937.00	814.97	826.44	824.78	826.83	0.001515	7.57	4084.22	946.16	0.42

HEC-RAS Plan: HC River: Hinkle Reach: Hinkle (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Hinkle	5083.815	10-YR	3204.00	814.32	822.32	820.95	822.72	0.001902	6.24	1517.30	733.49	0.43
Hinkle	5083.815	25-YR	4397.00	814.32	823.09	820.95	823.48	0.001813	6.58	2100.37	785.97	0.43
Hinkle	5083.815	50-YR	5481.00	814.32	823.72	822.45	824.10	0.001739	6.81	2608.30	838.72	0.43
Hinkle	5083.815	100-YR	6722.00	814.32	824.37	822.77	824.73	0.001619	6.93	3165.35	859.33	0.42
Hinkle	5083.815	500-YR	8937.00	814.32	825.45	823.34	825.78	0.001446	7.09	4098.52	1137.82	0.40
Hinkle	4455.624	10-YR	3204.00	813.09	821.09	819.74	821.44	0.001829	5.73	1309.65	516.88	0.42
Hinkle	4455.624	25-YR	4397.00	813.09	821.80	820.33	822.21	0.001953	6.40	1687.88	547.84	0.44
Hinkle	4455.624	50-YR	5481.00	813.09	822.41	820.80	822.85	0.001965	6.82	2029.72	572.39	0.45
Hinkle	4455.624	100-YR	6722.00	813.09	823.09	821.24	823.54	0.001915	7.16	2425.56	598.64	0.45
Hinkle	4455.624	500-YR	8937.00	813.09	824.21	821.90	824.68	0.001805	7.60	3115.49	640.52	0.45
Hinkle	3600.797	10-YR	3204.00	811.04	819.21		819.70	0.003062	6.68	1091.82	455.39	0.53
Hinkle	3600.797	25-YR	4397.00	811.04	820.14		820.60	0.002548	6.83	1520.73	462.55	0.50
Hinkle	3600.797	50-YR	5481.00	811.04	820.90		821.35	0.002275	7.00	1872.85	466.15	0.48
Hinkle	3600.797	100-YR	6722.00	811.04	821.71		822.16	0.002061	7.19	2248.97	469.96	0.46
Hinkle	3600.797	500-YR	8937.00	811.04	822.94		823.42	0.001882	7.61	2834.09	475.87	0.45
Hinkle	2334.067	10-YR	3204.00	808.45	817.20		817.57	0.001120	5.50	1236.02	370.54	0.34
Hinkle	2334.067	25-YR	4397.00	808.45	818.20		818.62	0.001196	6.15	1613.11	387.72	0.36
Hinkle	2334.067	50-YR	5481.00	808.45	818.97		819.45	0.001262	6.68	1919.80	407.65	0.38
Hinkle	2334.067	100-YR	6722.00	808.45	819.76		820.29	0.001333	7.23	2253.14	439.09	0.39
Hinkle	2334.067	500-YR	8937.00	808.45	820.96		821.58	0.001434	8.06	2805.39	480.92	0.42
Hinkle	1378.39	10-YR	3204.00	807.32	815.59		816.15	0.001875	6.55	961.02	383.50	0.44
Hinkle	1378.39	25-YR	4397.00	807.32	816.54		817.16	0.001900	7.18	1338.72	404.43	0.45
Hinkle	1378.39	50-YR	5481.00	807.32	817.32		817.97	0.001879	7.60	1655.07	413.48	0.45
Hinkle	1378.39	100-YR	6722.00	807.32	818.11		818.79	0.001860	8.01	1984.99	421.16	0.46
Hinkle	1378.39	500-YR	8937.00	807.32	819.24		820.00	0.001932	8.80	2467.07	430.42	0.48
Hinkle	763.6207	10-YR	3204.00	806.75	814.29	812.44	814.84	0.002144	6.56	883.14	279.16	0.46
Hinkle	763.6207	25-YR	4397.00	806.75	814.76	813.22	815.59	0.003009	8.15	1014.67	308.87	0.55
Hinkle	763.6207	50-YR	5481.00	806.75	815.21	813.85	816.26	0.003584	9.29	1149.38	375.78	0.61
Hinkle	763.6207	100-YR	6722.00	806.75	815.71	814.58	816.98	0.004067	10.35	1301.54	397.70	0.66
Hinkle	763.6207	500-YR	8937.00	806.75	816.62	815.79	818.10	0.004317	11.49	1739.22	410.60	0.69
Hinkle	588.756*	10-YR	3204.00	806.58	814.03		814.46	0.001653	5.69	968.84	370.60	0.41
Hinkle	588.756*	25-YR	4397.00	806.58	814.37		815.05	0.002462	7.20	1098.44	379.80	0.50
Hinkle	588.756*	50-YR	5481.00	806.58	814.74		815.62	0.003008	8.26	1240.45	388.81	0.56
Hinkle	588.756*	100-YR	6722.00	806.58	815.20		816.24	0.003413	9.19	1418.31	394.32	0.60
Hinkle	588.756*	500-YR	8937.00	806.58	816.07		817.31	0.003676	10.29	1766.46	404.73	0.64
Hinkle	413.891*	10-YR	3204.00	806.41	813.84		814.17	0.001281	4.94	1115.13	378.77	0.36
Hinkle	413.891*	25-YR	4397.00	806.41	814.05		814.61	0.002091	6.46	1194.89	382.22	0.46
Hinkle	413.891*	50-YR	5481.00	806.41	814.29		815.06	0.002762	7.62	1289.54	386.05	0.53
Hinkle	413.891*	100-YR	6722.00	806.41	814.63		815.61	0.003367	8.70	1419.14	390.83	0.59
Hinkle	413.891*	500-YR	8937.00	806.41	815.40		816.63	0.003798	9.94	1725.23	401.50	0.64
Hinkle	239.027*	10-YR	3204.00	806.23	813.68		813.94	0.001015	4.34	1262.03	393.31	0.32
Hinkle	239.027*	25-YR	4397.00	806.23	813.76		814.22	0.001815	5.85	1292.25	395.15	0.43
Hinkle	239.027*	50-YR	5481.00	806.23	813.85		814.54	0.002641	7.14	1330.97	397.54	0.52
Hinkle	239.027*	100-YR	6722.00	806.23	814.00		814.97	0.003599	8.47	1390.98	400.90	0.60
Hinkle	239.027*	500-YR	8937.00	806.23	814.39	813.68	815.82	0.005022	10.42	1554.93	461.80	0.72
Hinkle	64.16237	10-YR	3204.00	806.06	813.60	810.50	813.76	0.000678	3.52	1865.24	603.33	0.26
Hinkle	64.16237	25-YR	4397.00	806.06	813.60	811.46	813.89	0.001278	4.83	1865.24	603.33	0.36
Hinkle	64.16237	50-YR	5481.00	806.06	813.60	812.01	814.05	0.001986	6.02	1865.24	603.33	0.44
Hinkle	64.16237	100-YR	6722.00	806.06	813.60	812.46	814.28	0.002986	7.38	1865.24	603.33	0.54
Hinkle	64.16237	500-YR	8937.00	806.06	813.60	813.16	814.81	0.005279	9.82	1865.24	603.33	0.72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Station (ft)
Legend
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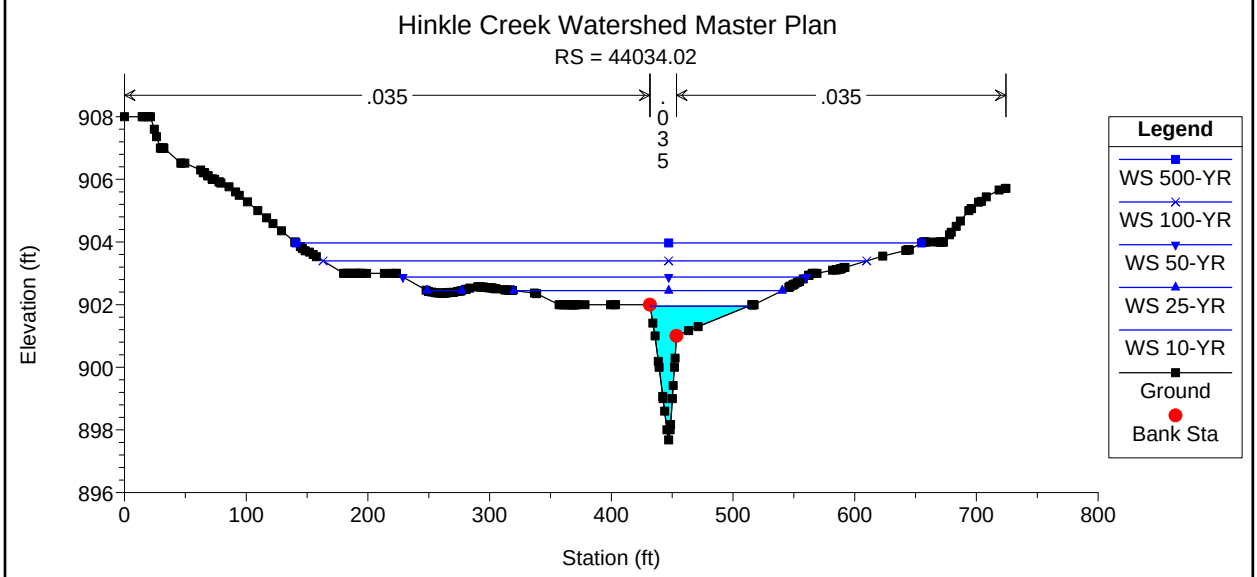
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta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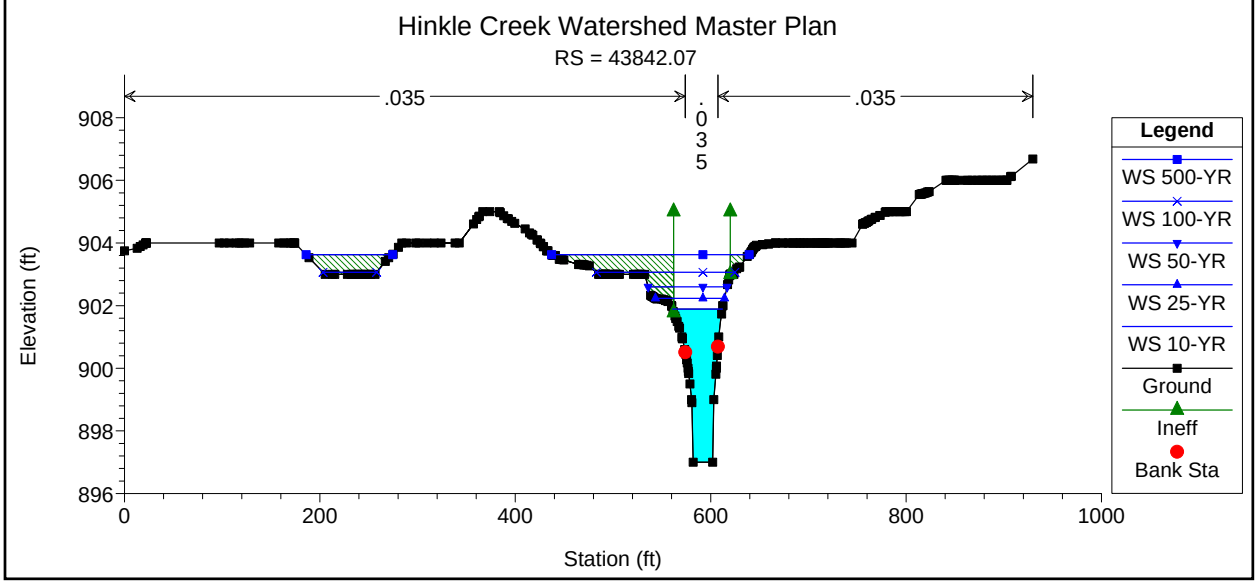
Bank Sta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Legend
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WS 10-YR
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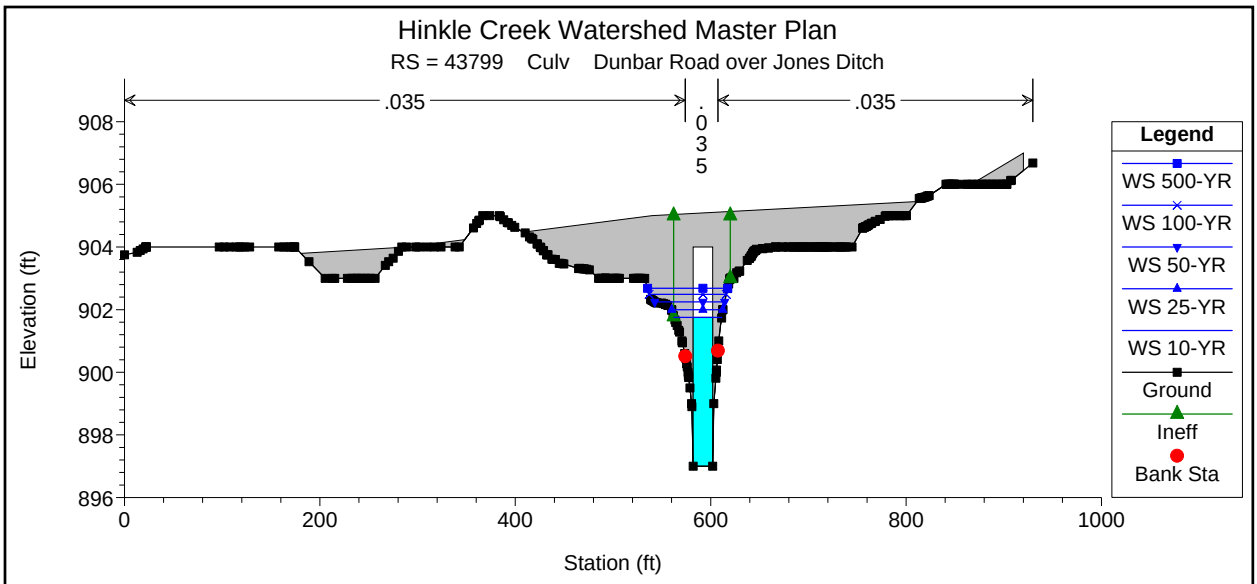
Ineff
Bank Sta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Station (ft)
Legend
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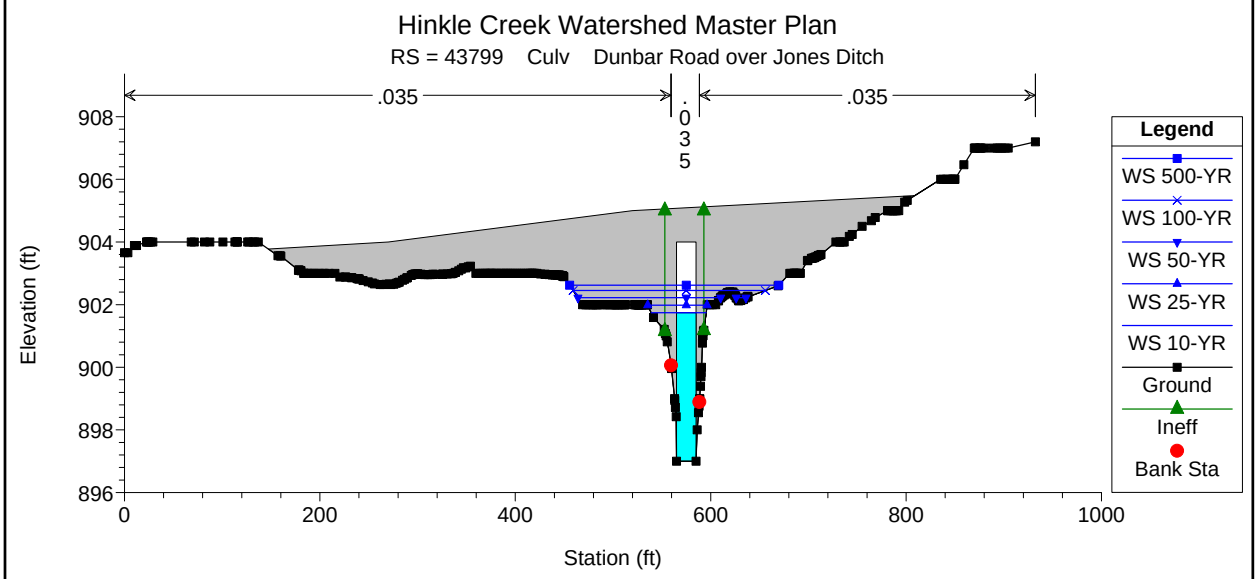
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta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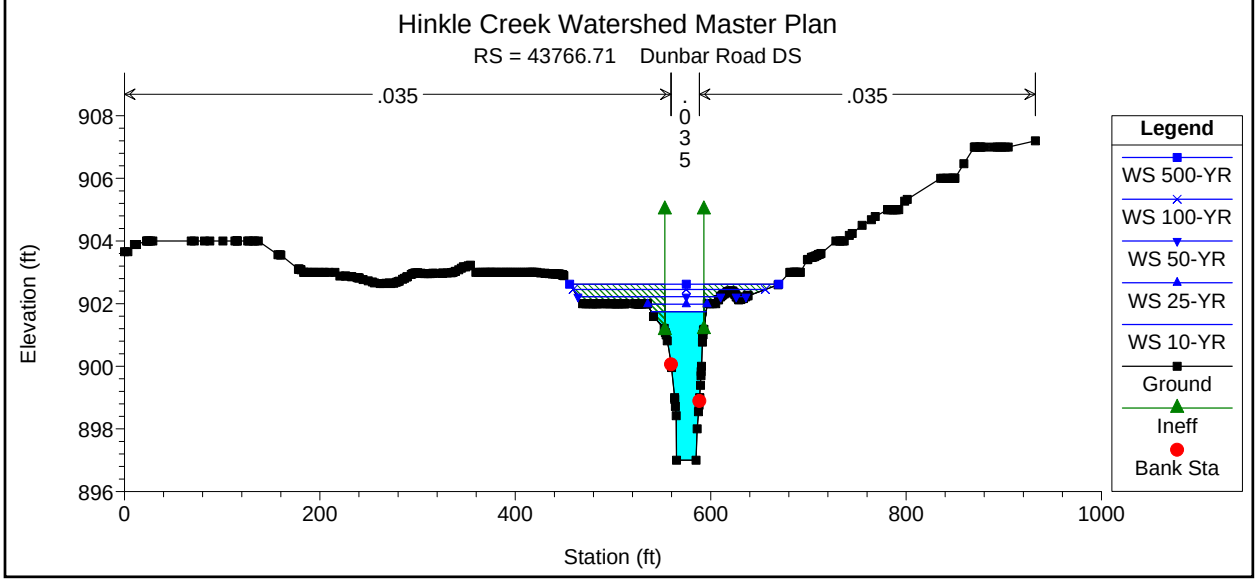
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta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Station (ft)
Legend
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WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
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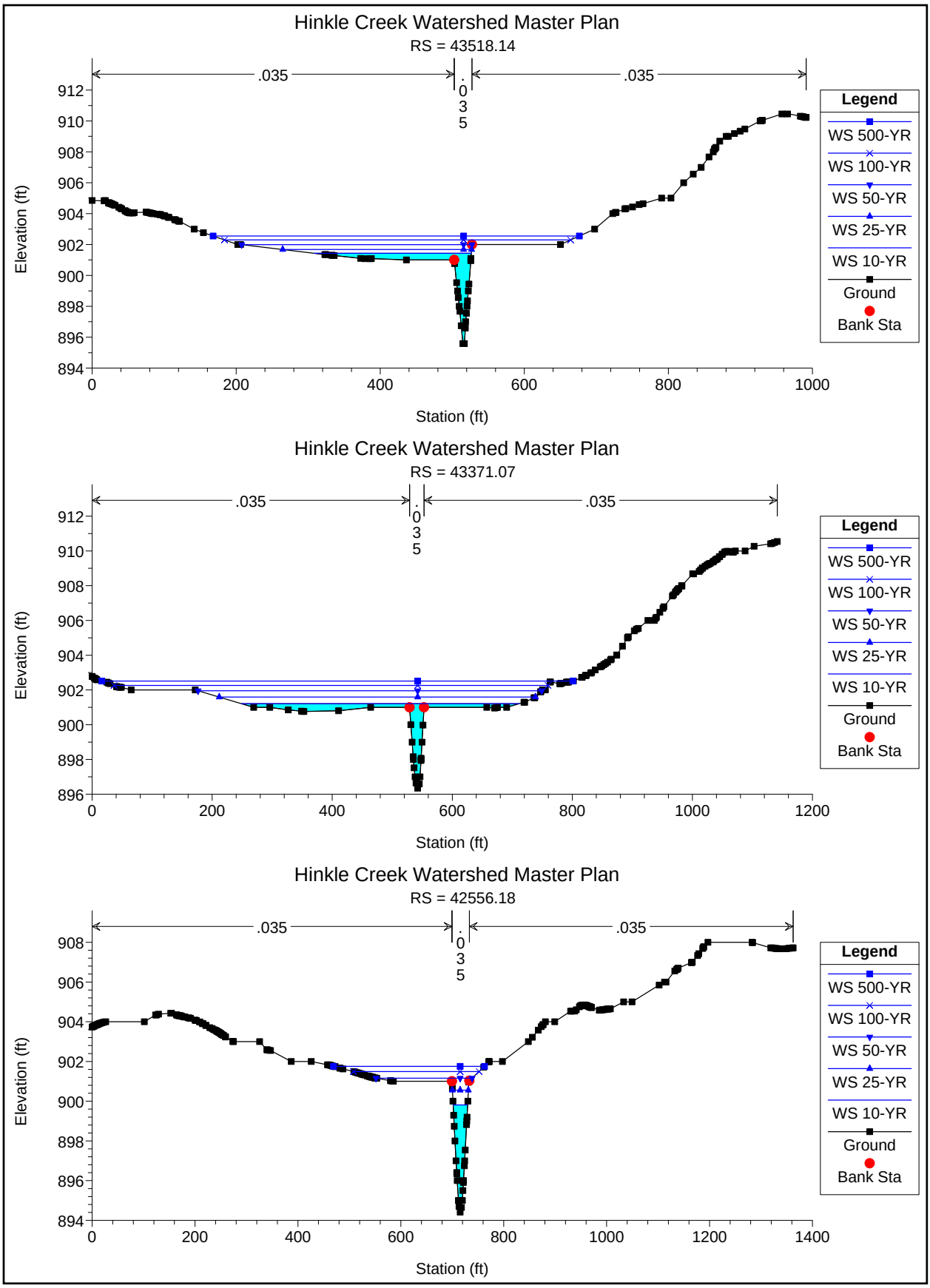
Bank Sta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Station (ft)
Legend
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WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
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Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
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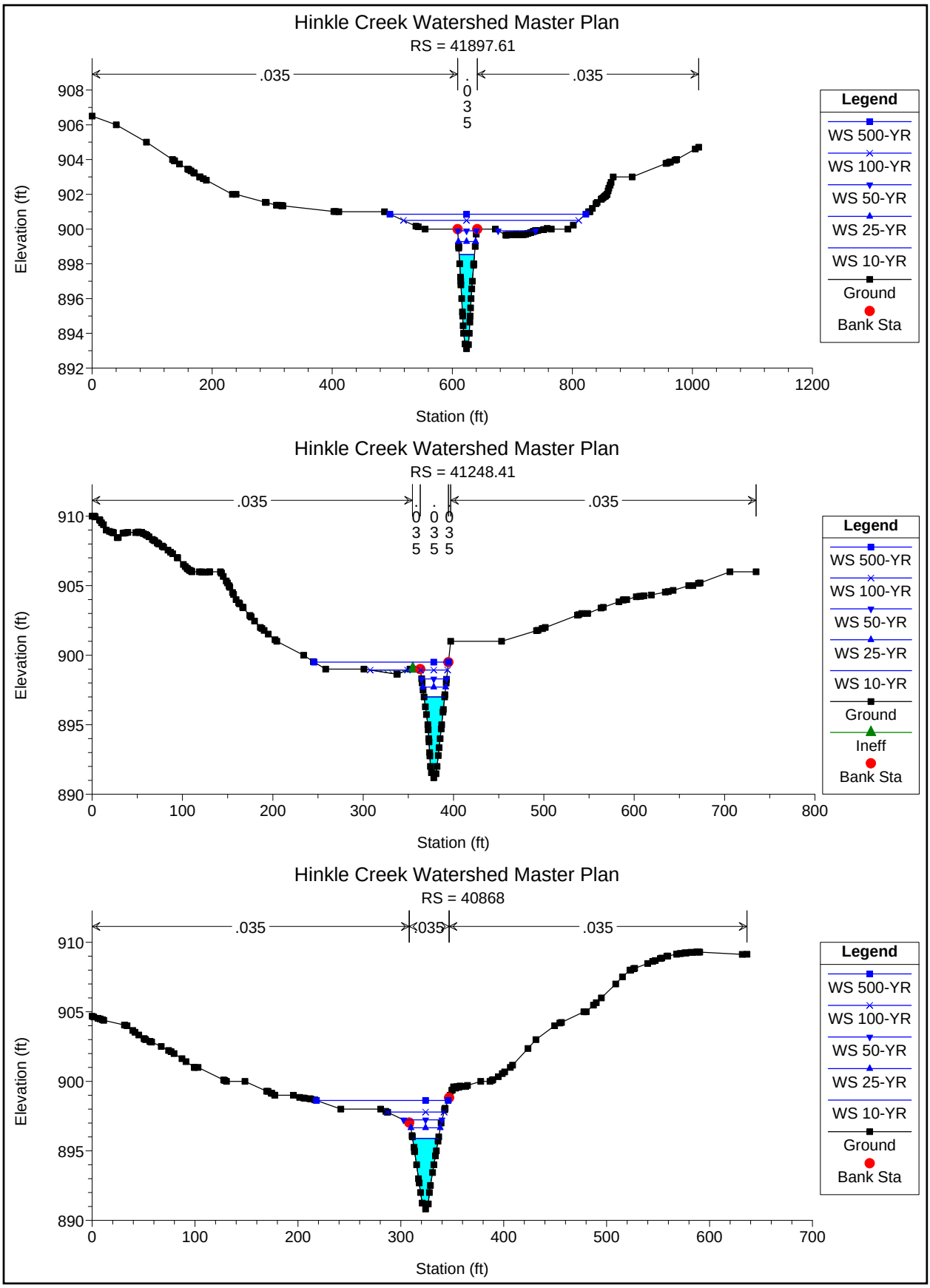
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta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Elevation (ft)
Station (ft)
Legend
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WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
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Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta
Hinkle Creek Watershed Master Plan
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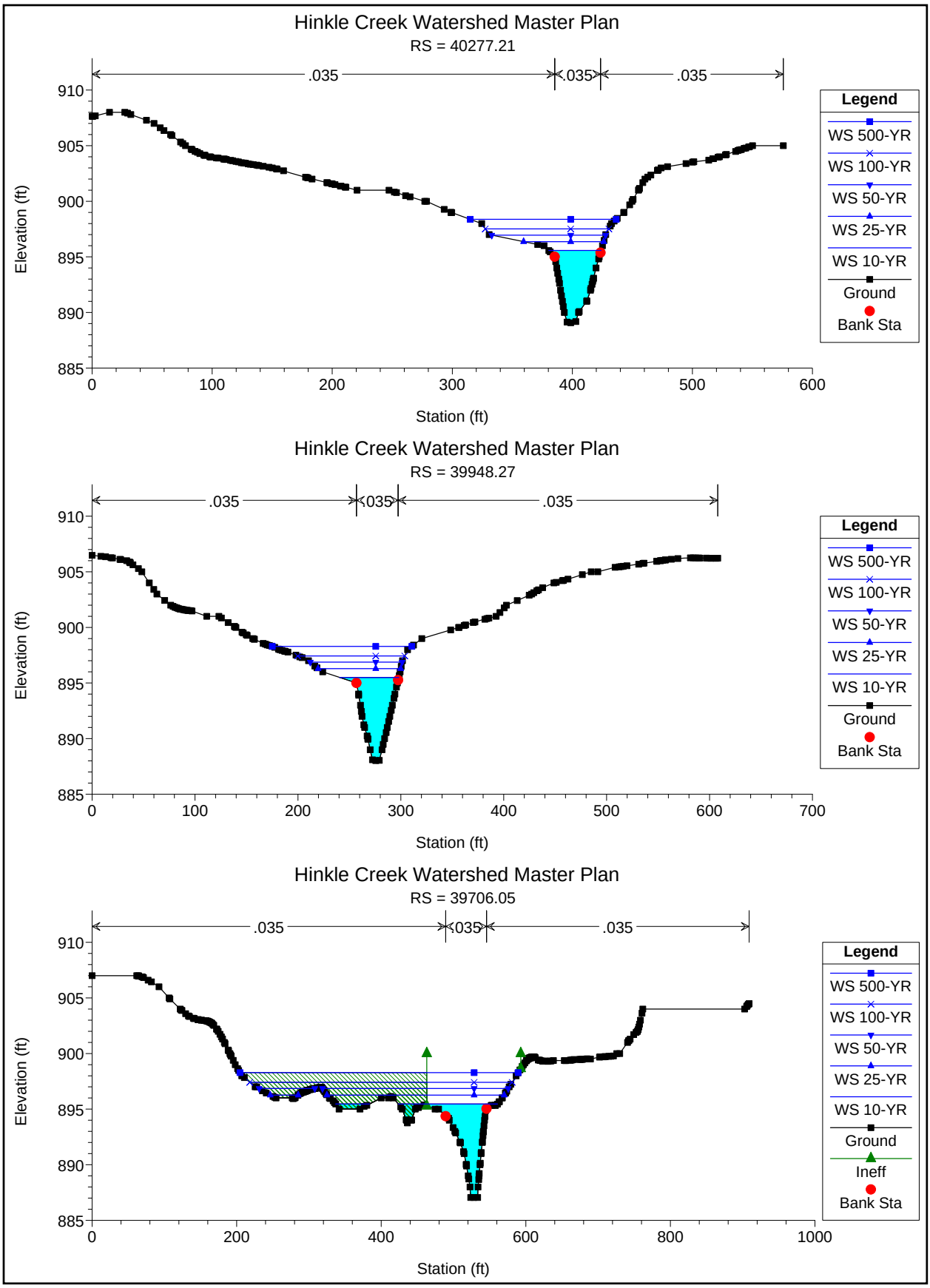
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta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Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
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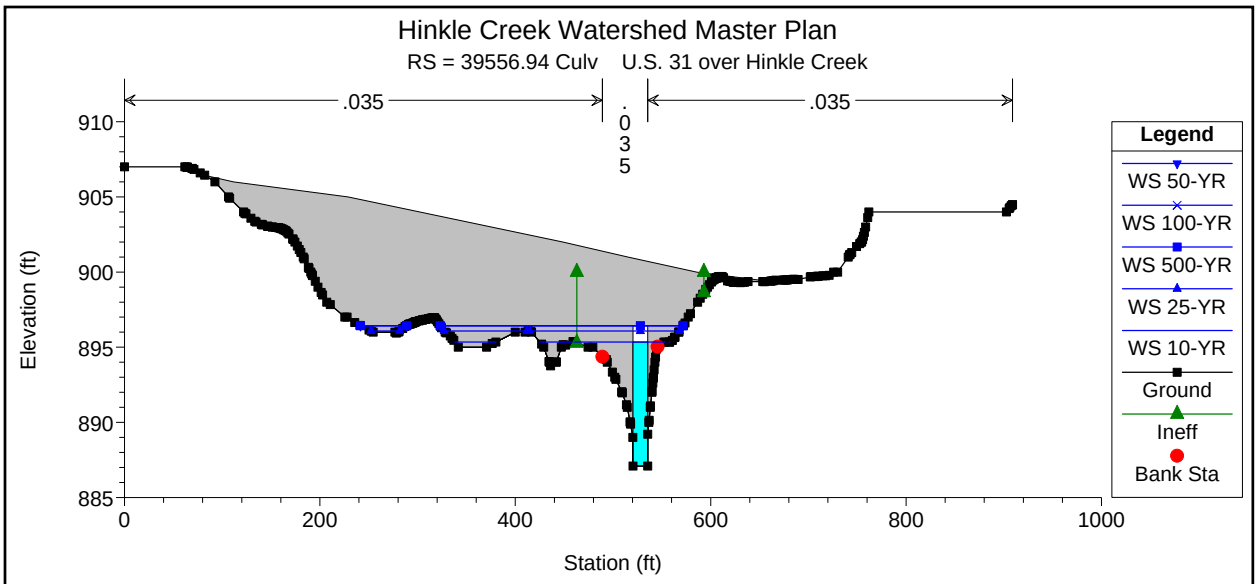
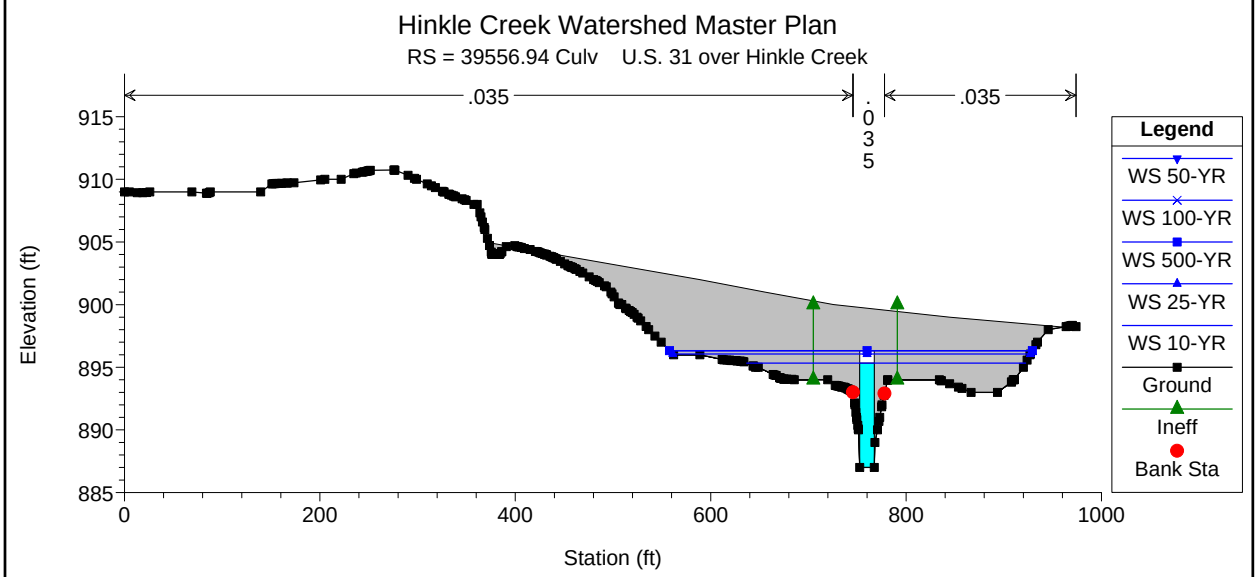
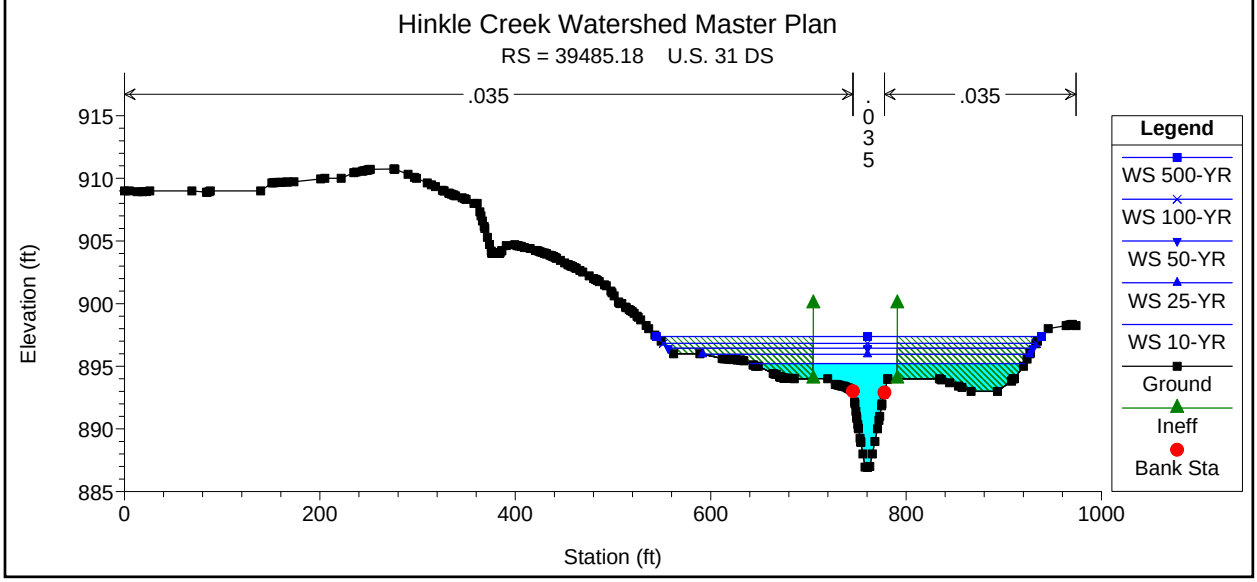
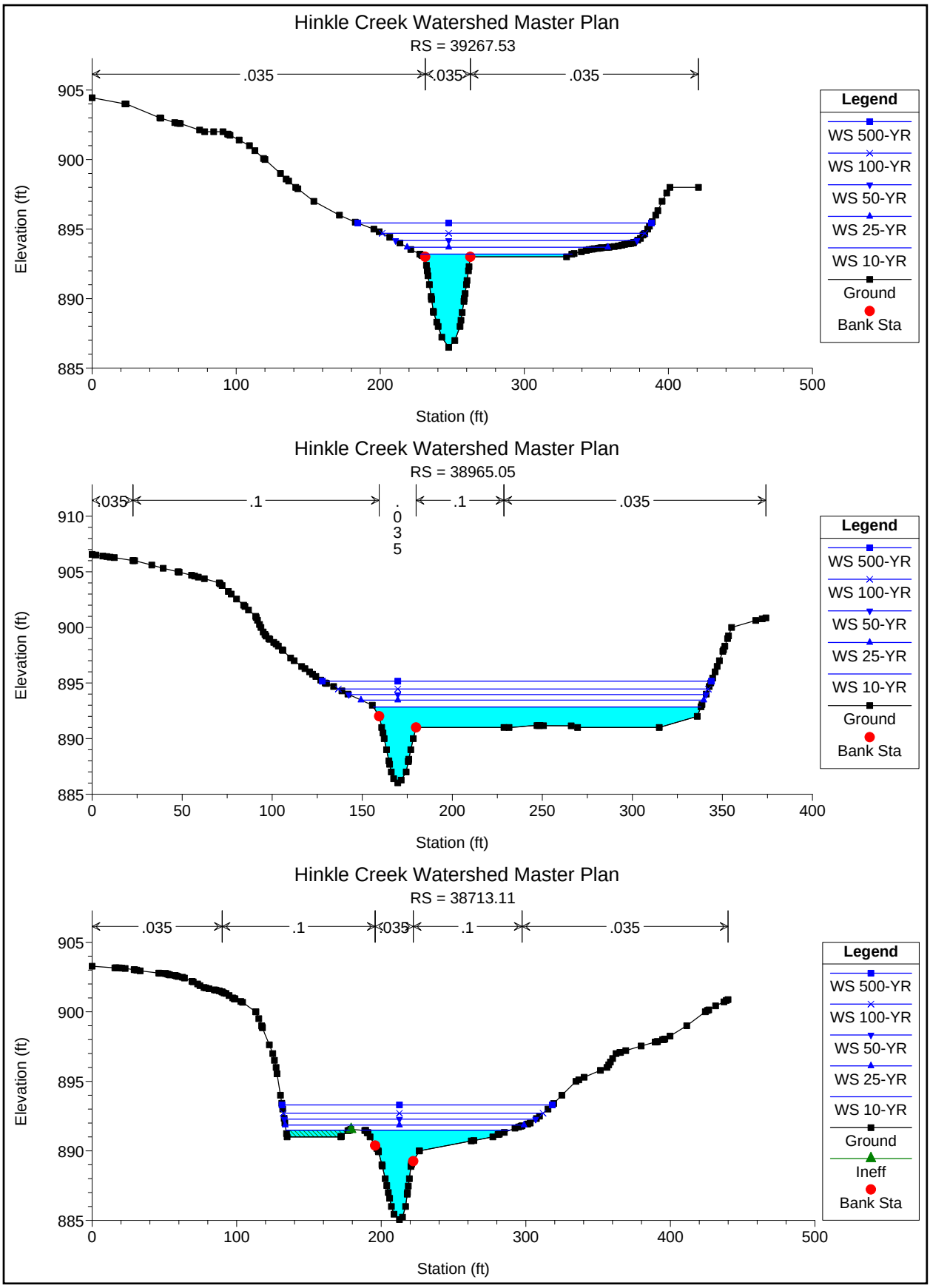
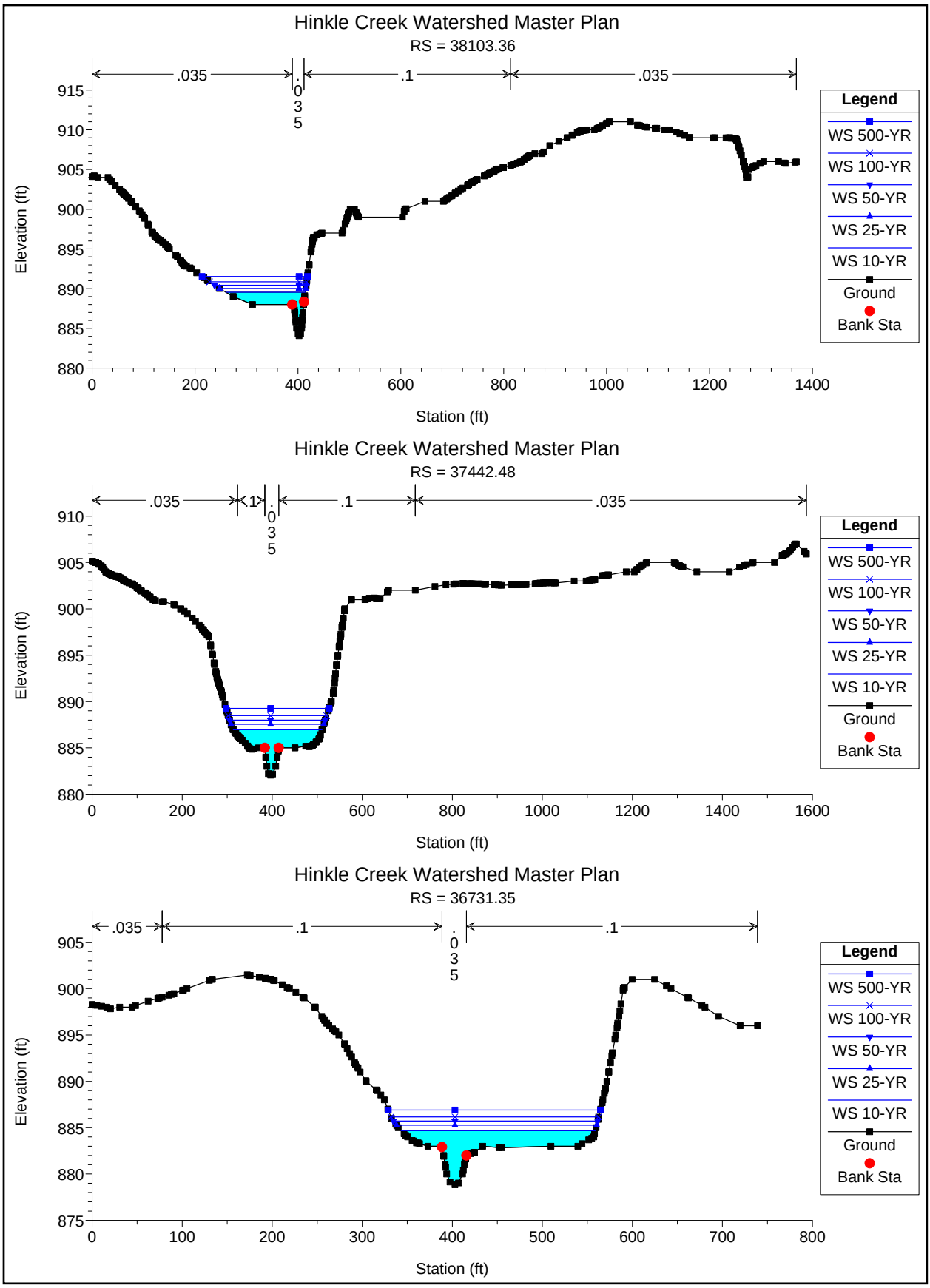
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 39706.05
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

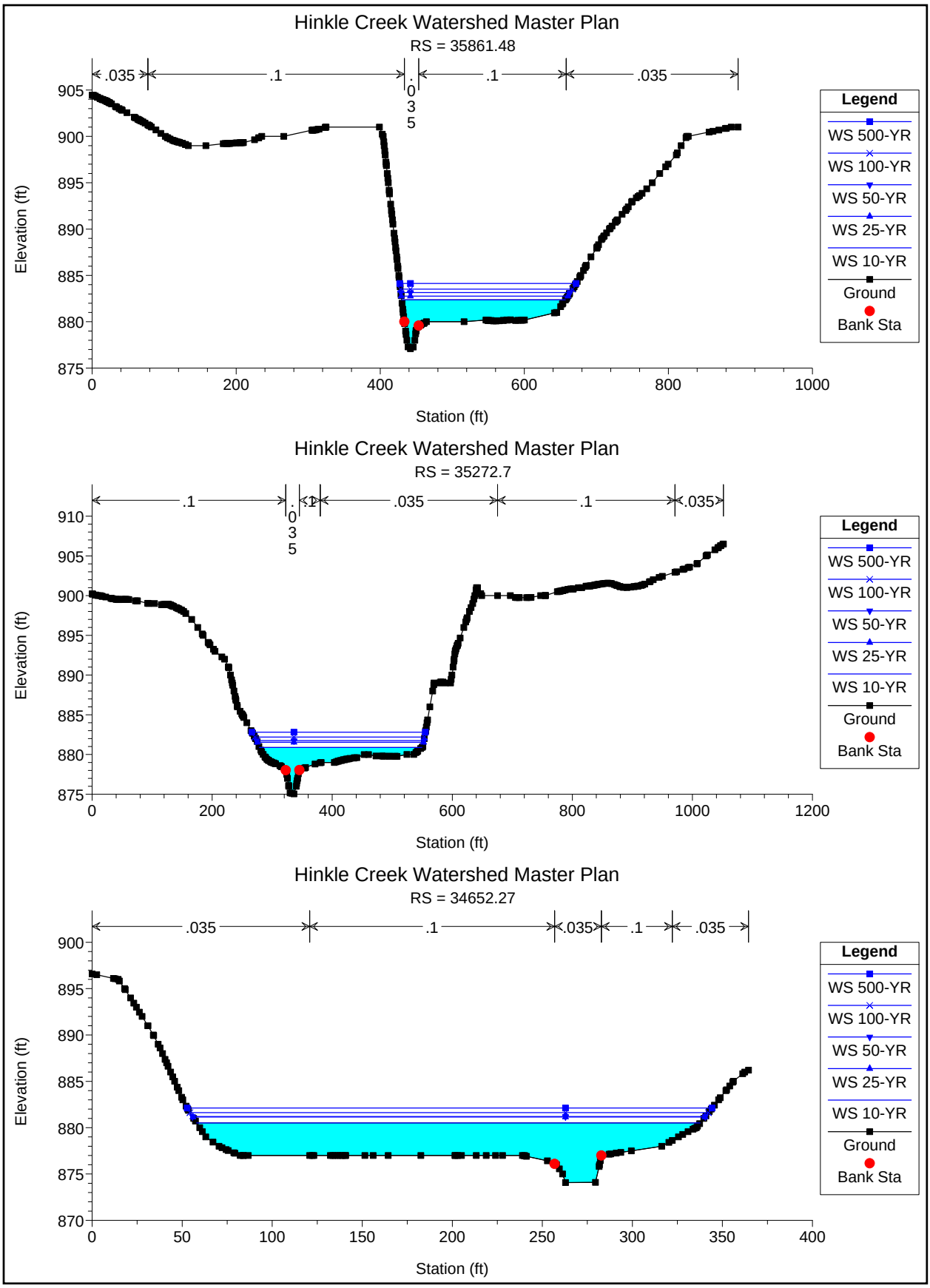

Hinkle Creek Watershed Master Plan
RS = 39556.94 Culv U.S. 31 over Hinkle Creek
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 50-YR
WS 100-YR
WS 500-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

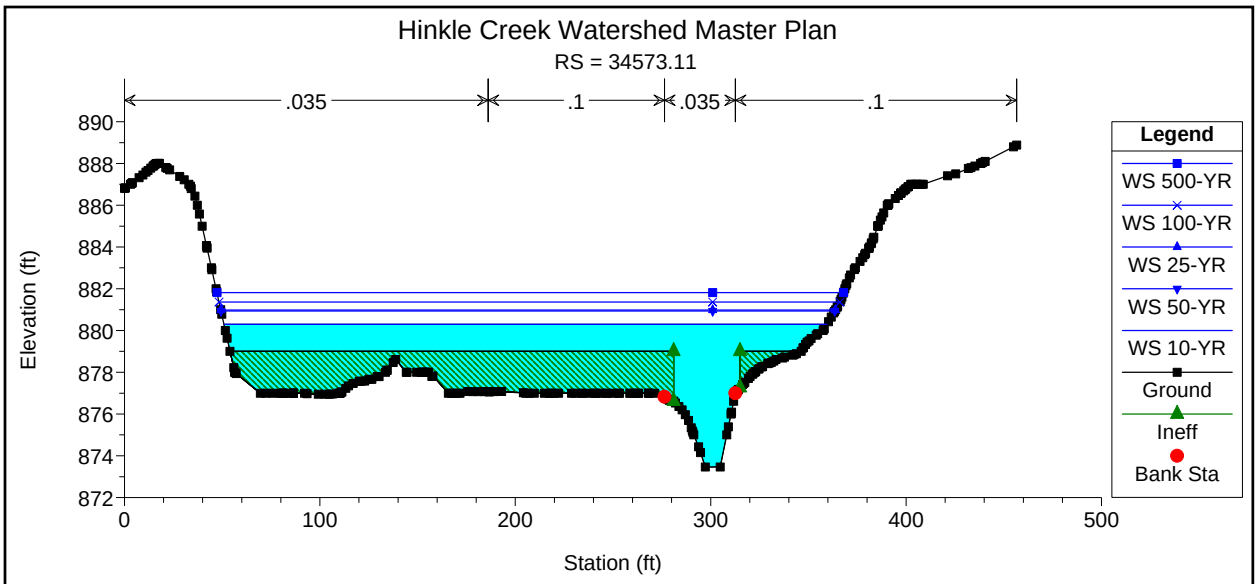

Hinkle Creek Watershed Master Plan
RS = 39556.94 Culv U.S. 31 over Hinkle Creek
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 50-YR
WS 100-YR
WS 500-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

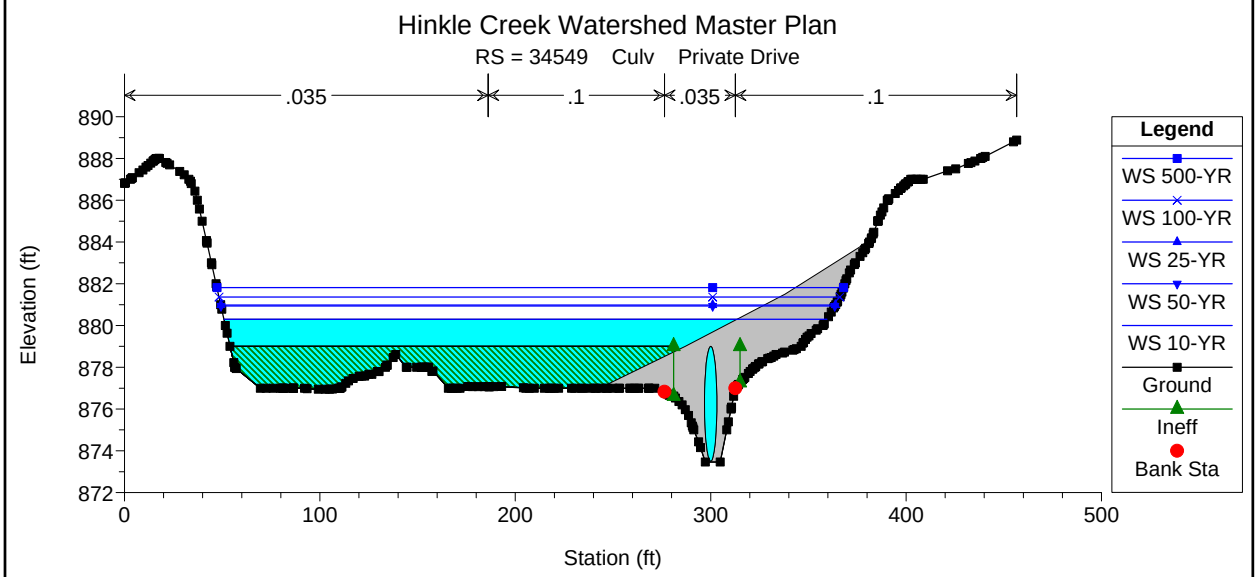

Hinkle Creek Watershed Master Plan
RS = 39485.18 U.S. 31 DS
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

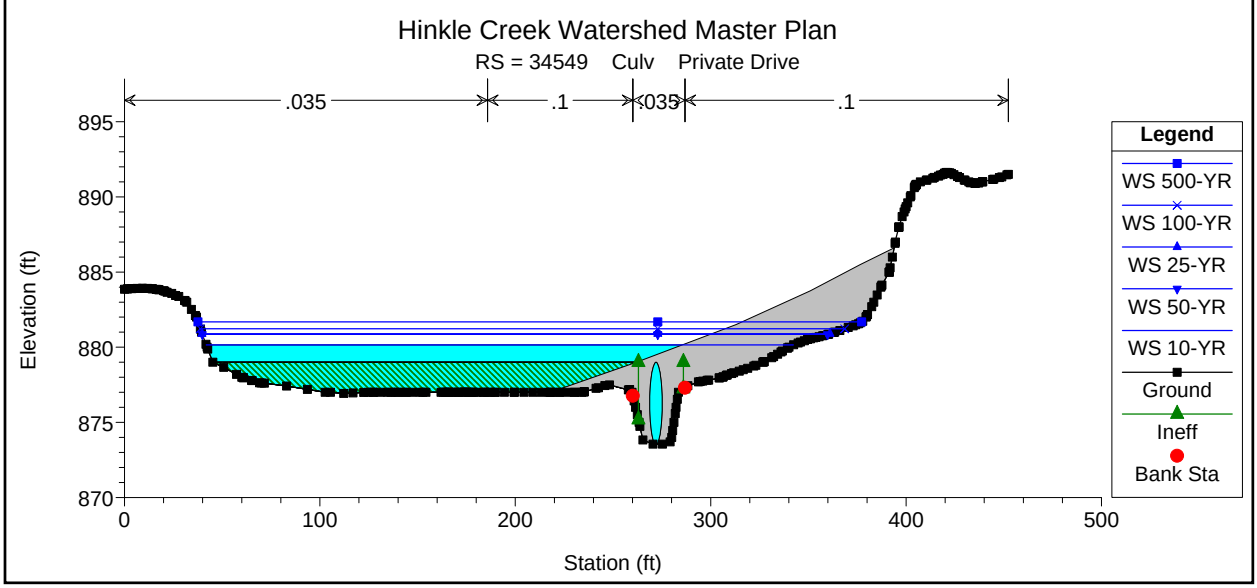

Hinkle Creek Watershed Master Plan
RS = 39267.53
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 38965.05
.035
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 38713.11
.035
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

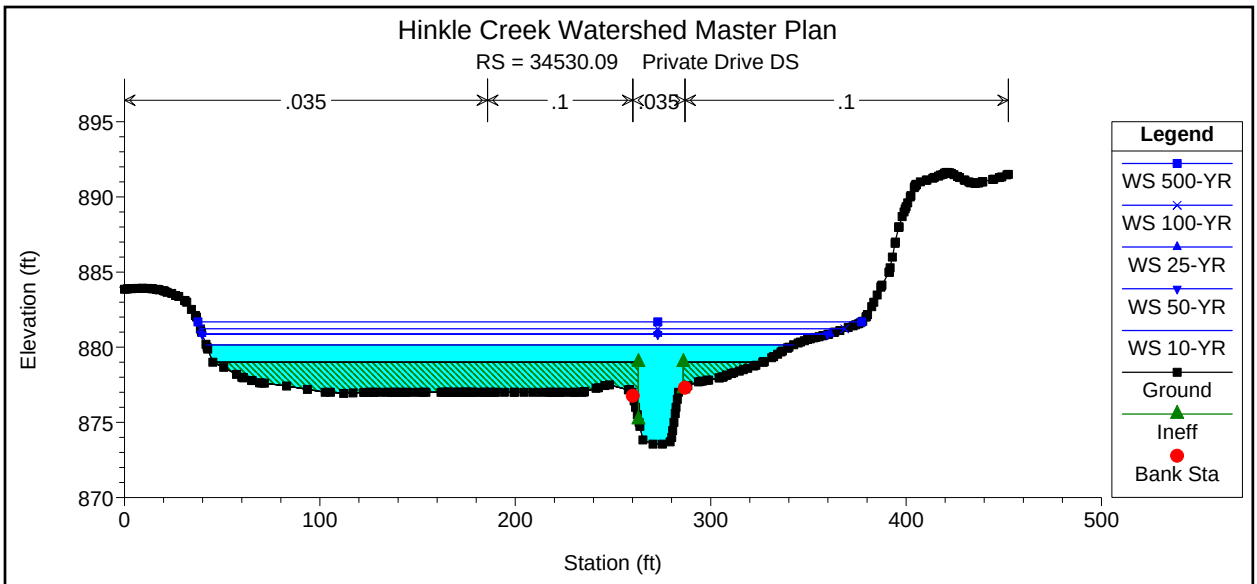

Hinkle Creek Watershed Master Plan
RS = 38103.36
.035
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 37442.48
.035
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 36731.35
.035
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta

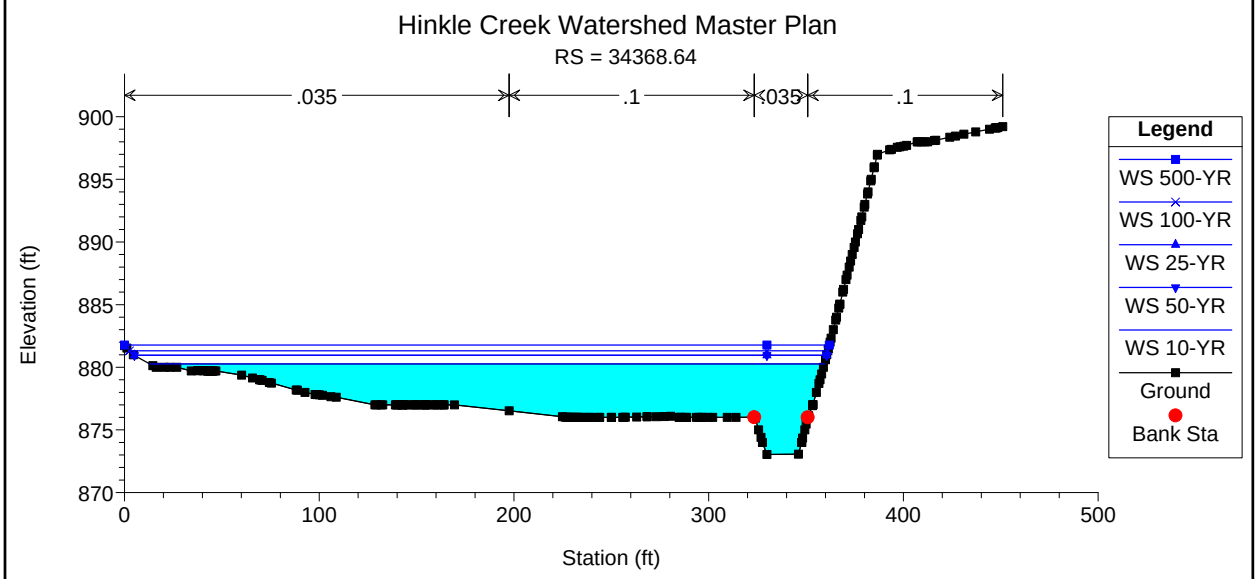

Hinkle Creek Watershed Master Plan
RS = 35861.48
.035
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 35272.7
.1
.035
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 34652.27
.035
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta

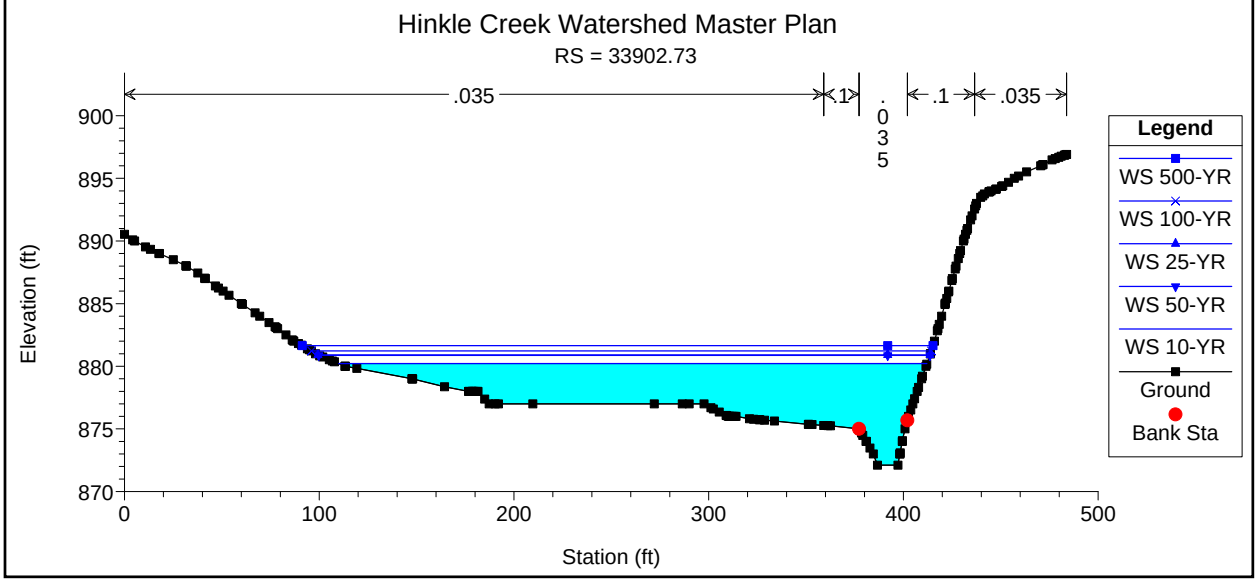

Hinkle Creek Watershed Master Plan
RS = 34573.11
.035
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 25-YR
WS 50-YR
WS 10-YR
Ground
Ineff
Bank Sta

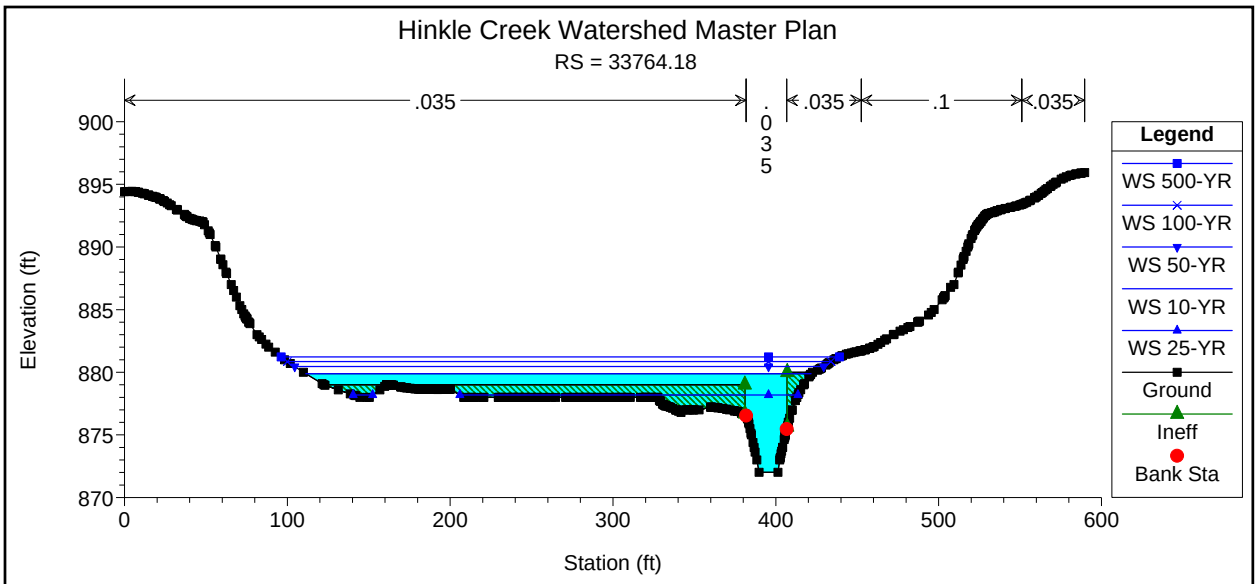

Hinkle Creek Watershed Master Plan
RS = 34549 Culv Private Drive
.035
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 25-YR
WS 50-YR
WS 10-YR
Ground
Ineff
Bank Sta

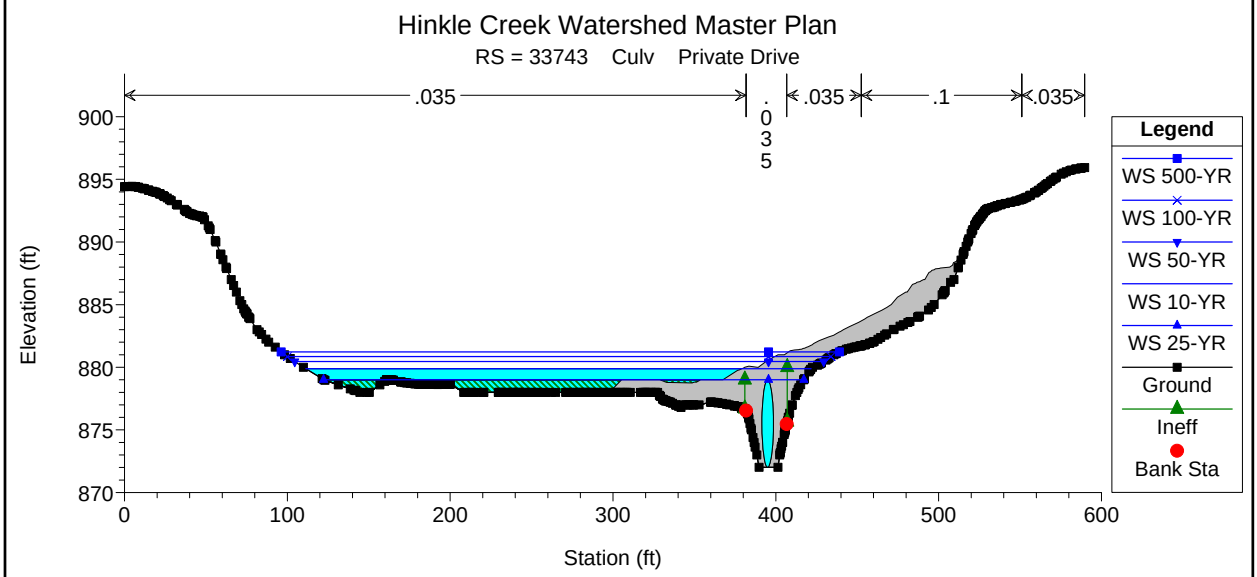

Hinkle Creek Watershed Master Plan
RS = 34549 Culv Private Drive
.035
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 25-YR
WS 50-YR
WS 10-YR
Ground
Ineff
Bank Sta

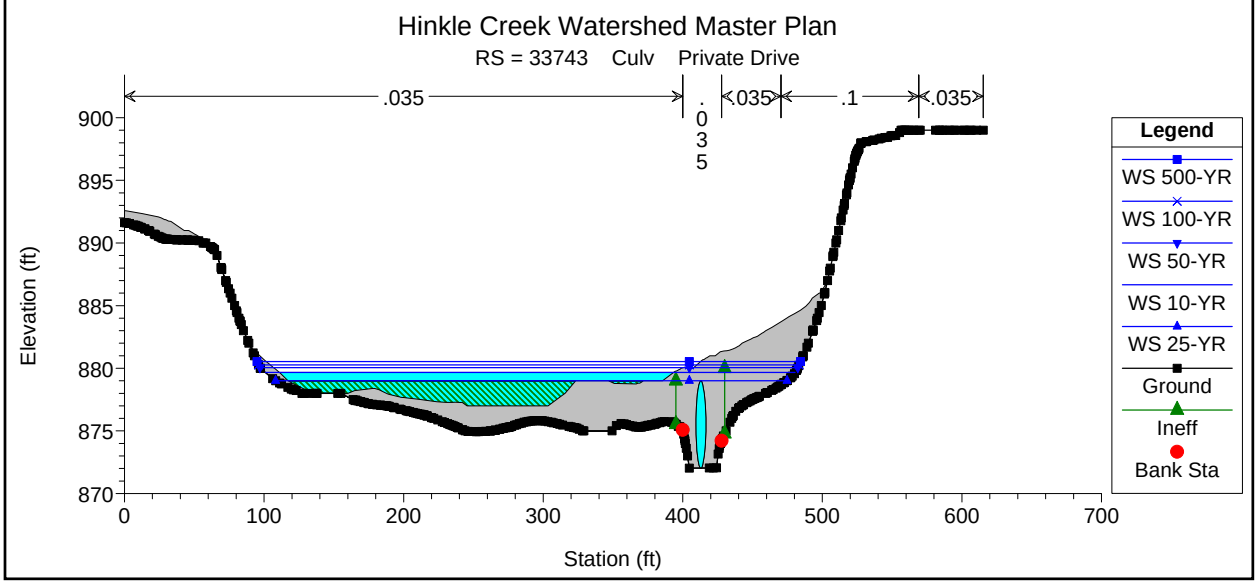

Hinkle Creek Watershed Master Plan
RS = 34530.09 Private Drive DS
.035
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 25-YR
WS 50-YR
WS 10-YR
Ground
Ineff
Bank Sta

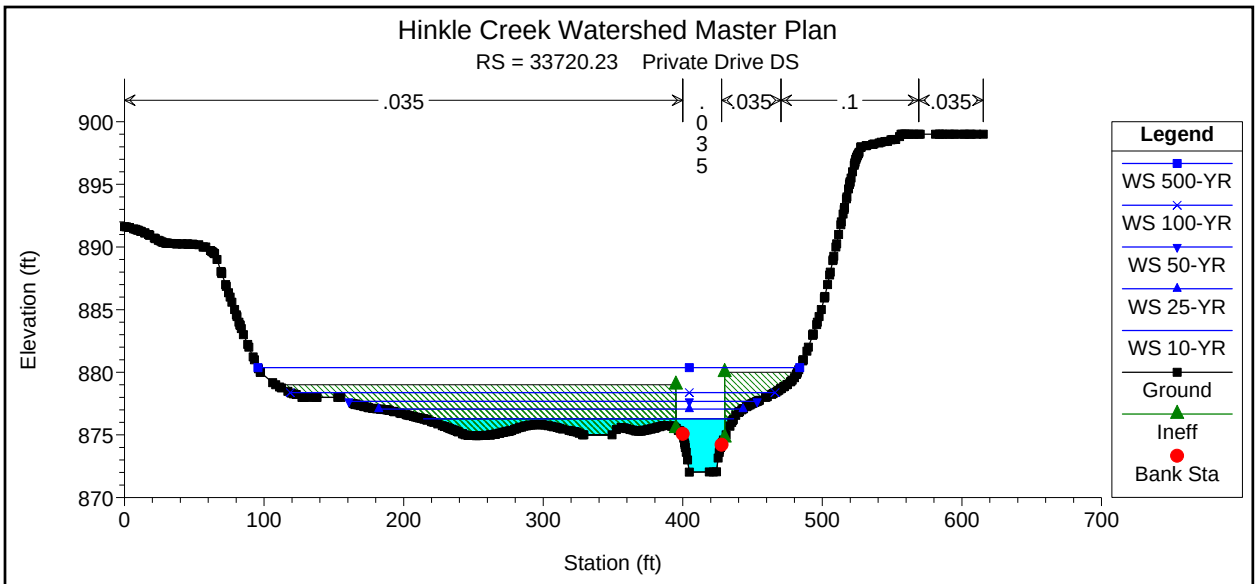

Hinkle Creek Watershed Master Plan
RS = 34368.64
.035
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 25-YR
WS 50-YR
WS 10-YR
Ground
Bank Sta

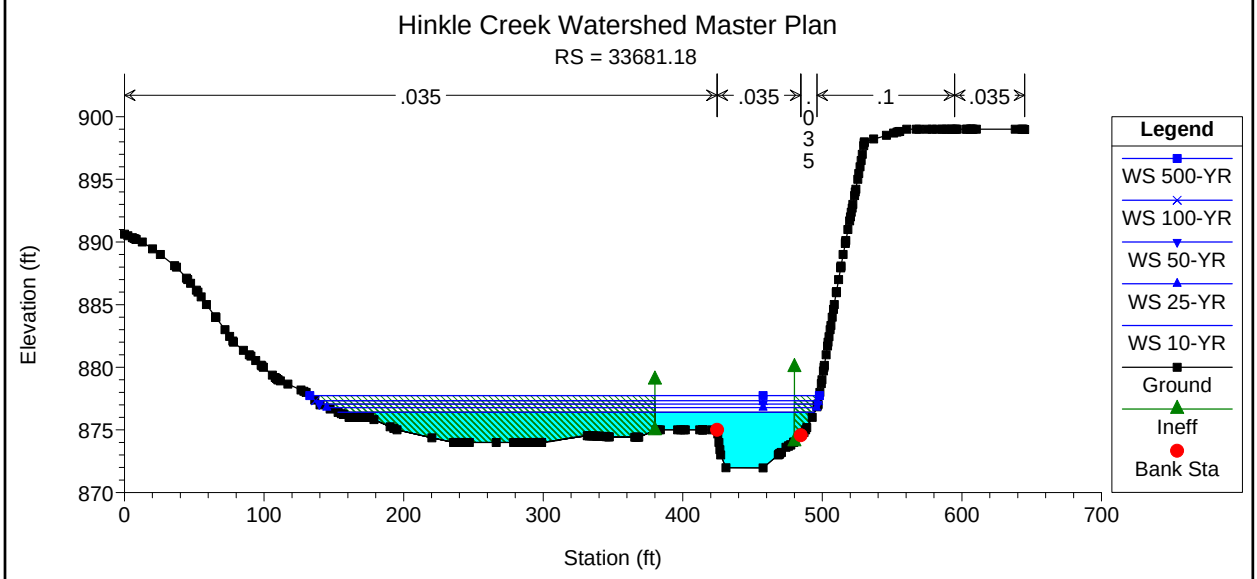

Hinkle Creek Watershed Master Plan
RS = 33902.73
.035
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 25-YR
WS 50-YR
WS 10-YR
Ground
Bank Sta

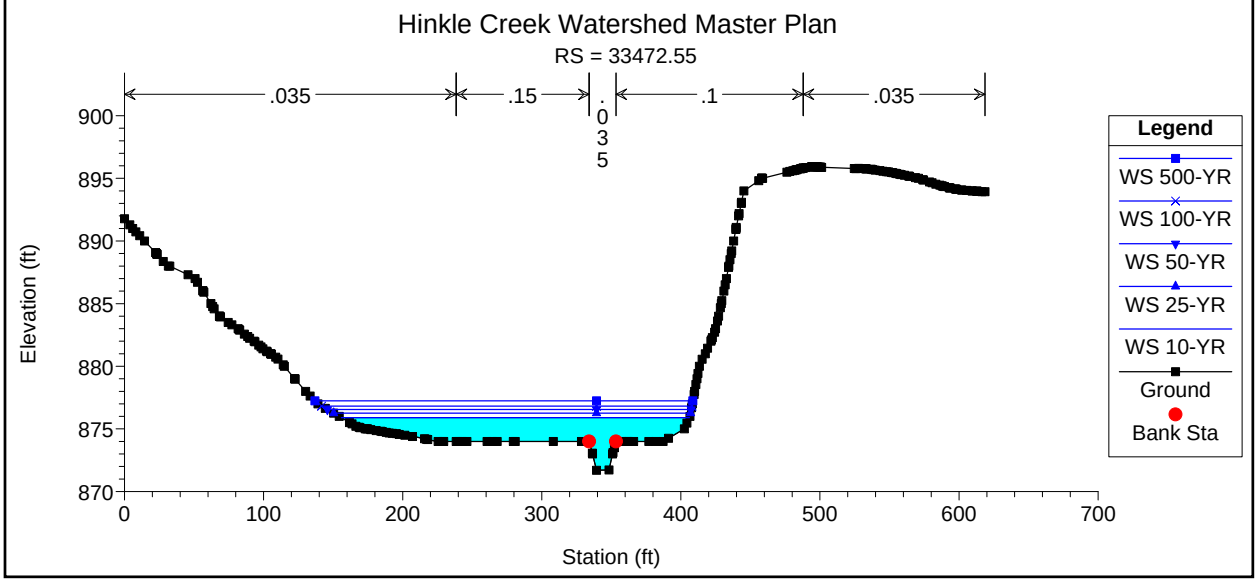

Hinkle Creek Watershed Master Plan
RS = 33764.18
.035
.035
.1
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 10-YR
WS 25-YR
Ground
Ineff
Bank Sta

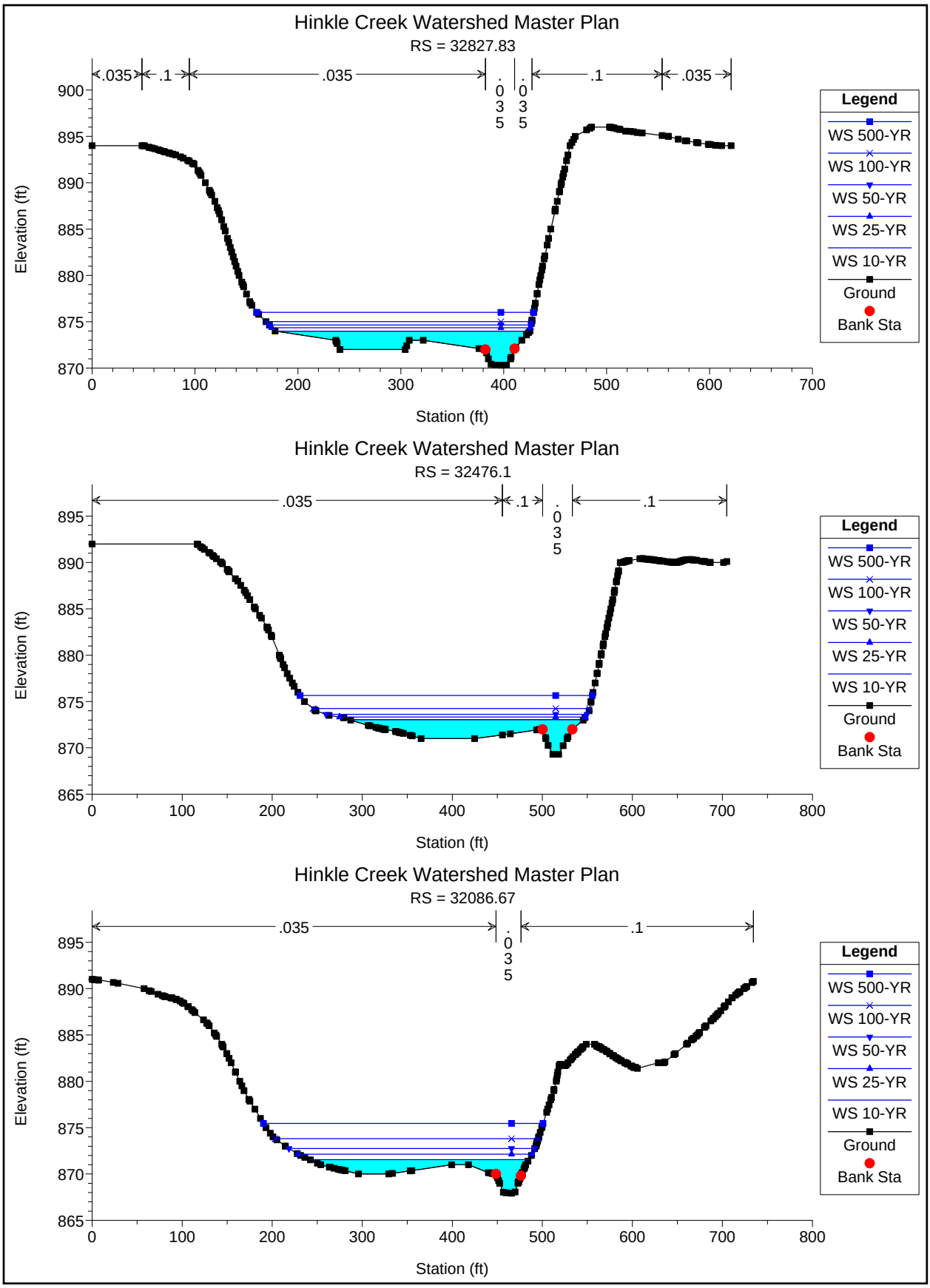

Hinkle Creek Watershed Master Plan
RS = 33743 Culv Private Drive
.035
.035
.1
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 10-YR
WS 25-YR
Ground
Ineff
Bank Sta

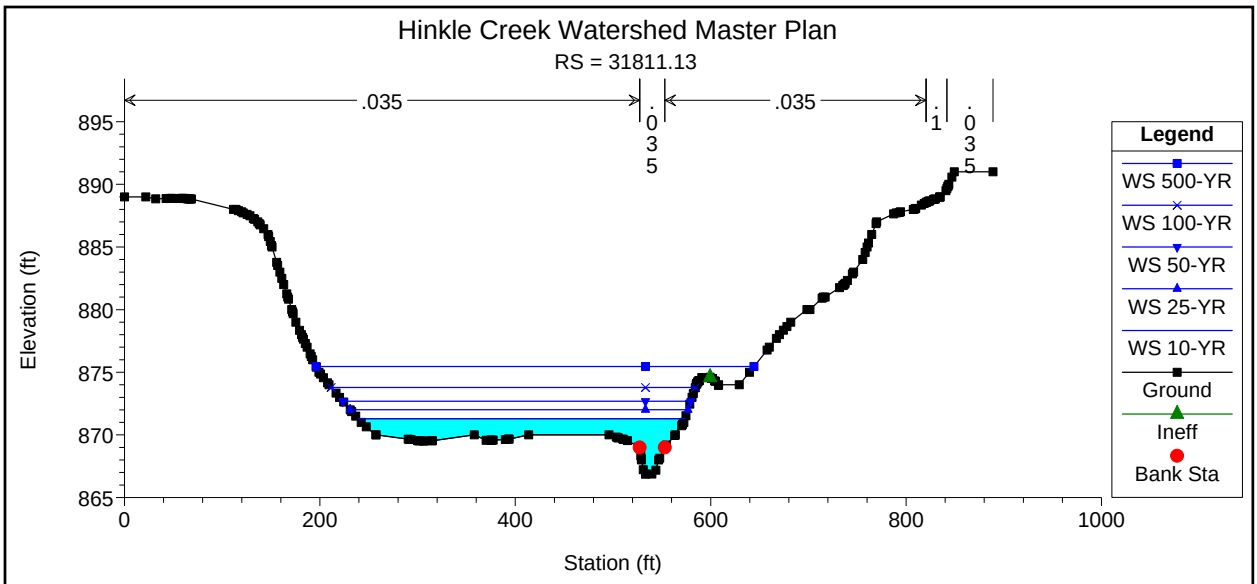

Hinkle Creek Watershed Master Plan
RS = 33743 Culv Private Drive
.035
.035
.1
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 10-YR
WS 25-YR
Ground
Ineff
Bank Sta

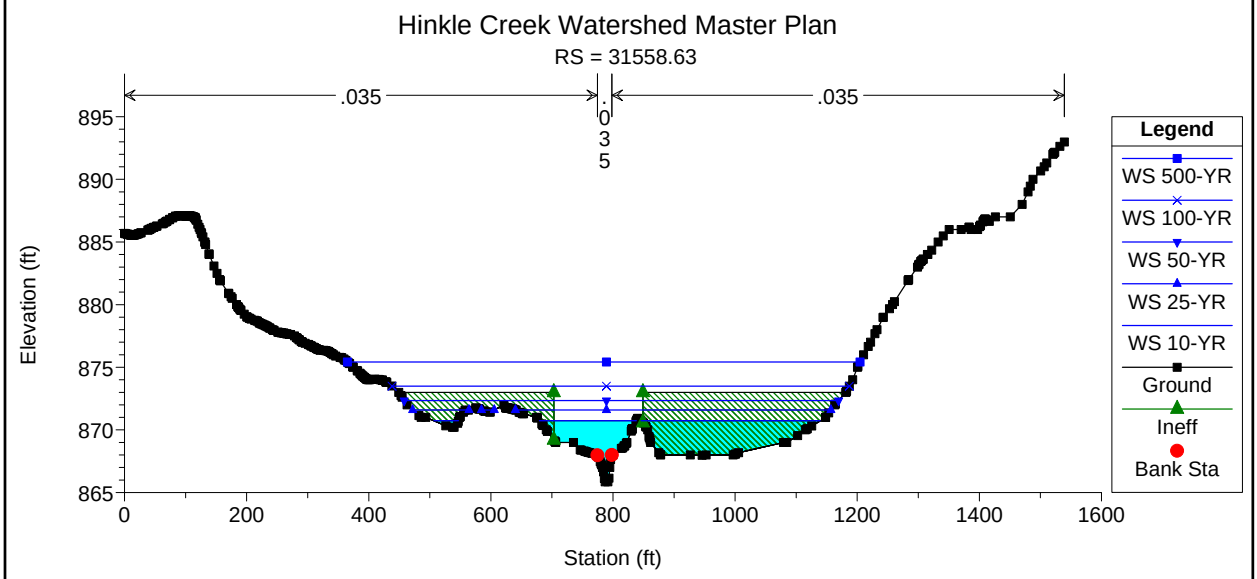

Hinkle Creek Watershed Master Plan
RS = 33720.23 Private Drive DS
.035
.035
.1
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

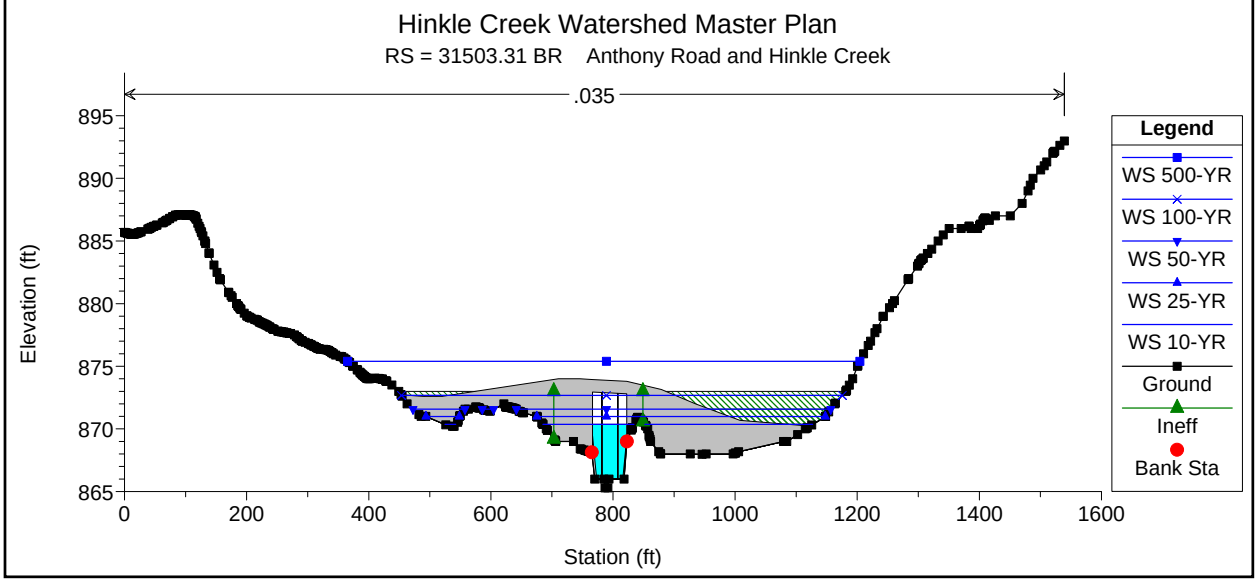

Hinkle Creek Watershed Master Plan
RS = 33681.18
.035
.035
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

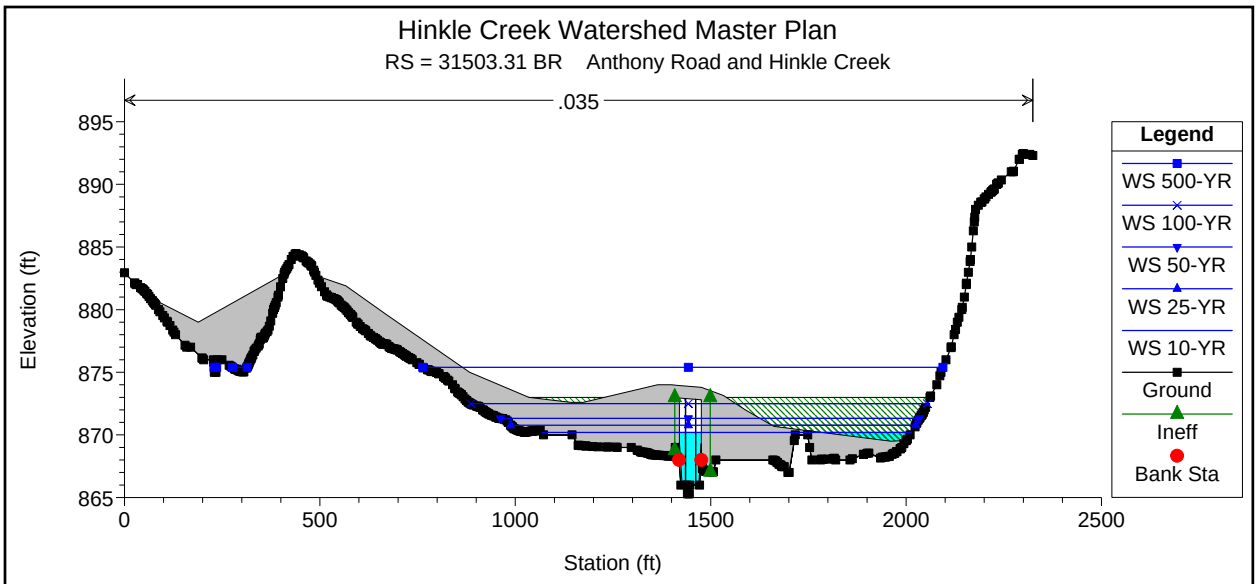

Hinkle Creek Watershed Master Plan
RS = 33472.55
.035
.15
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta

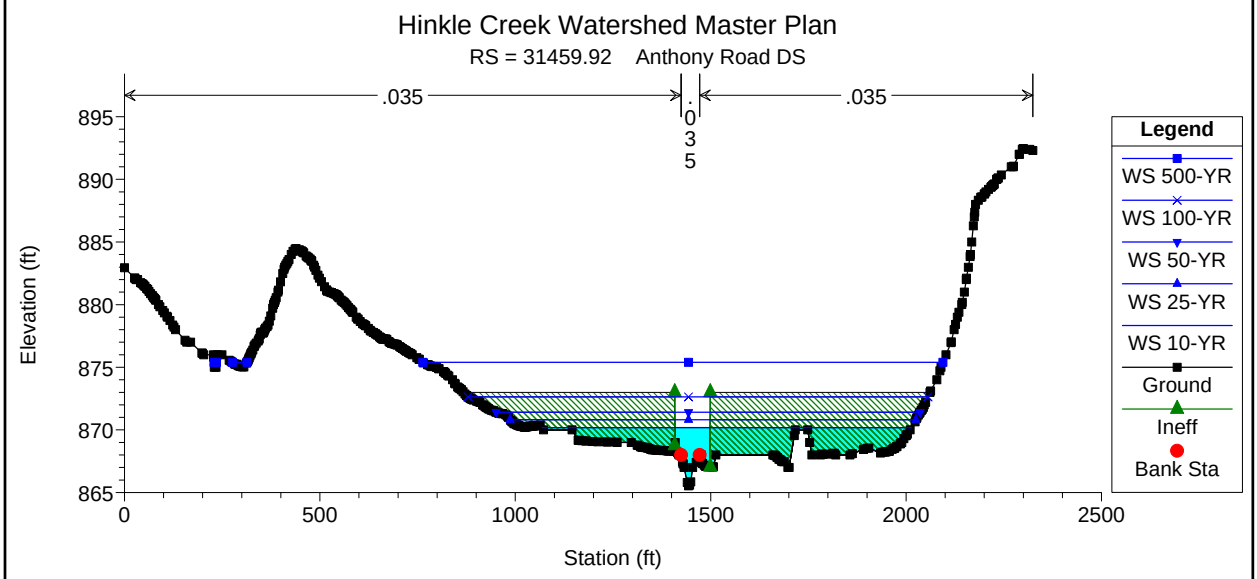

Hinkle Creek Watershed Master Plan
RS = 32827.83
.035
.1
.035
.035
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 32476.1
.035
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 32086.67
.035
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta

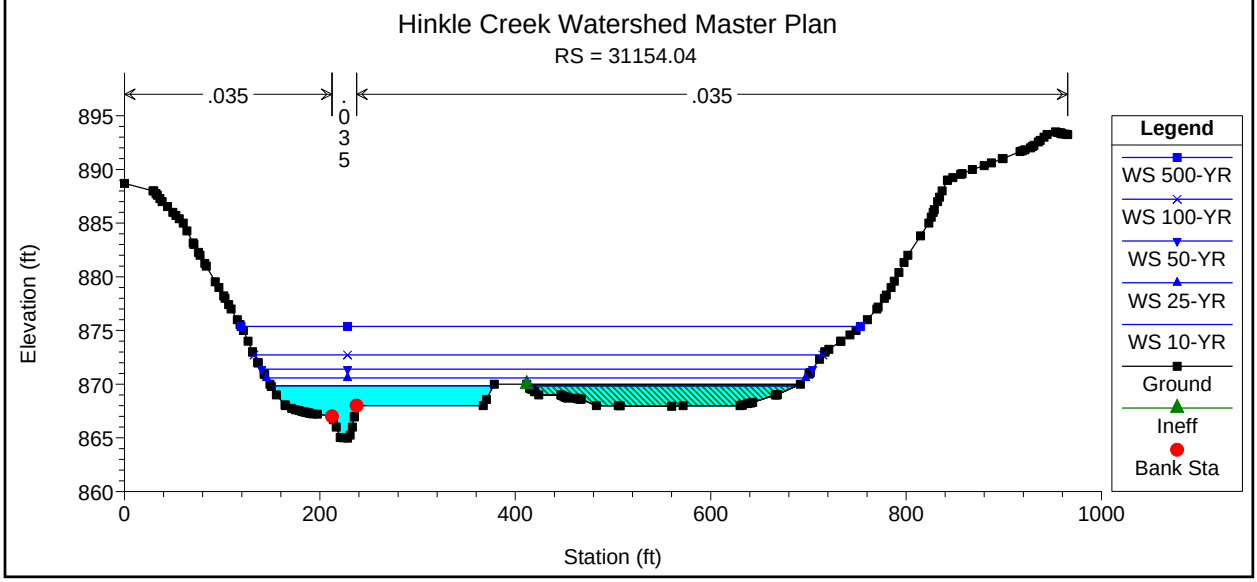

Hinkle Creek Watershed Master Plan
RS = 31811.13
.035
.035
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

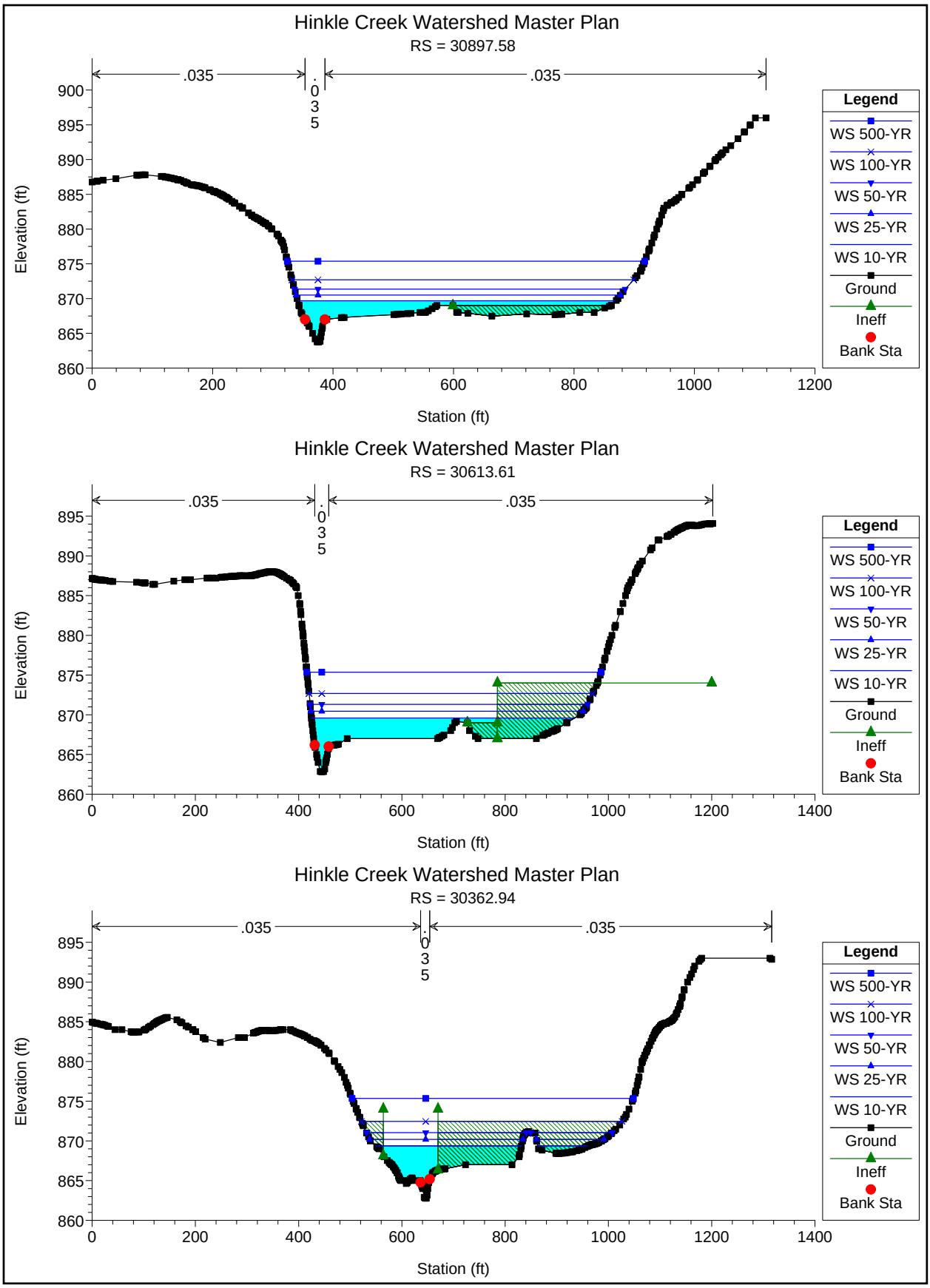

Hinkle Creek Watershed Master Plan
RS = 31558.63
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

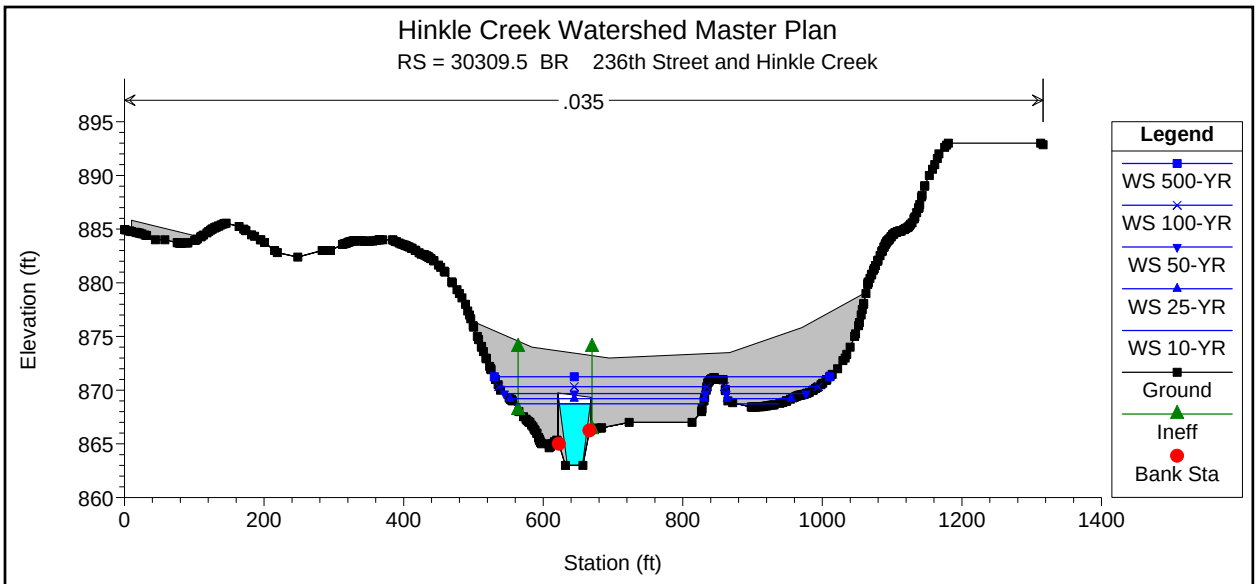

Hinkle Creek Watershed Master Plan
RS = 31503.31 BR Anthony Road and Hinkle Creek
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

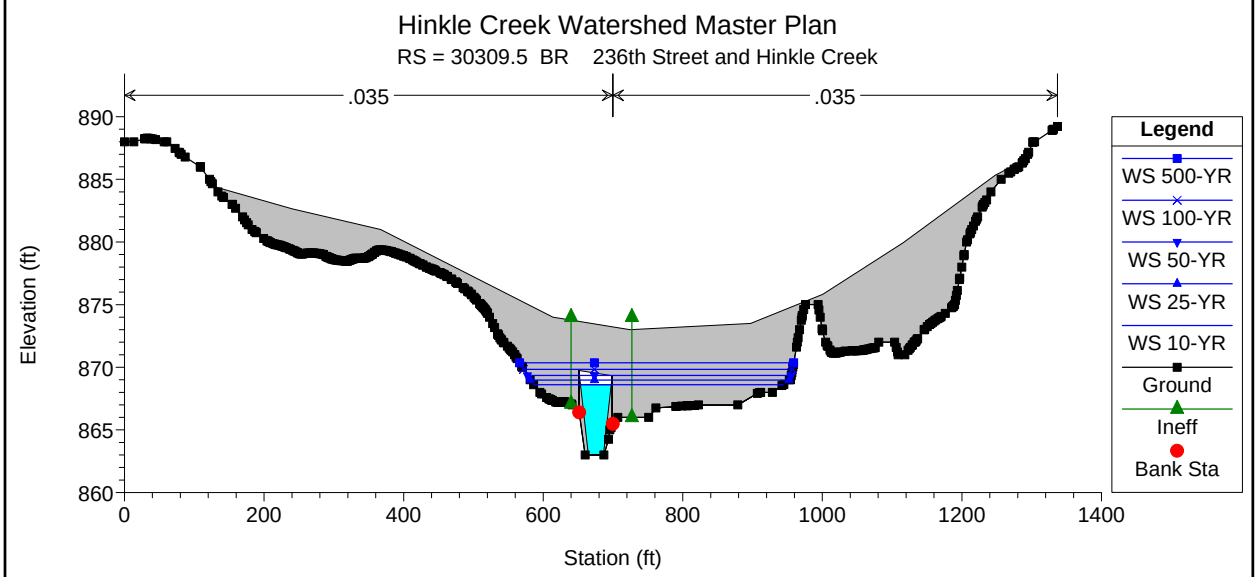

Hinkle Creek Watershed Master Plan
RS = 31503.31 BR Anthony Road and Hinkle Creek
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

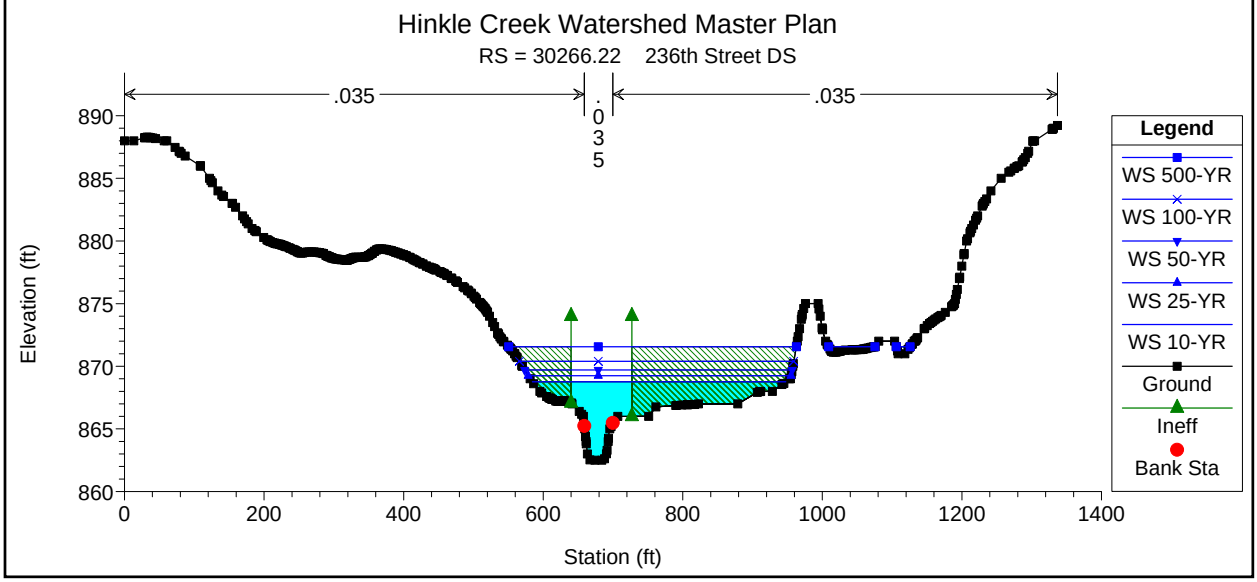

Hinkle Creek Watershed Master Plan
RS = 31459.92 Anthony Road DS
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

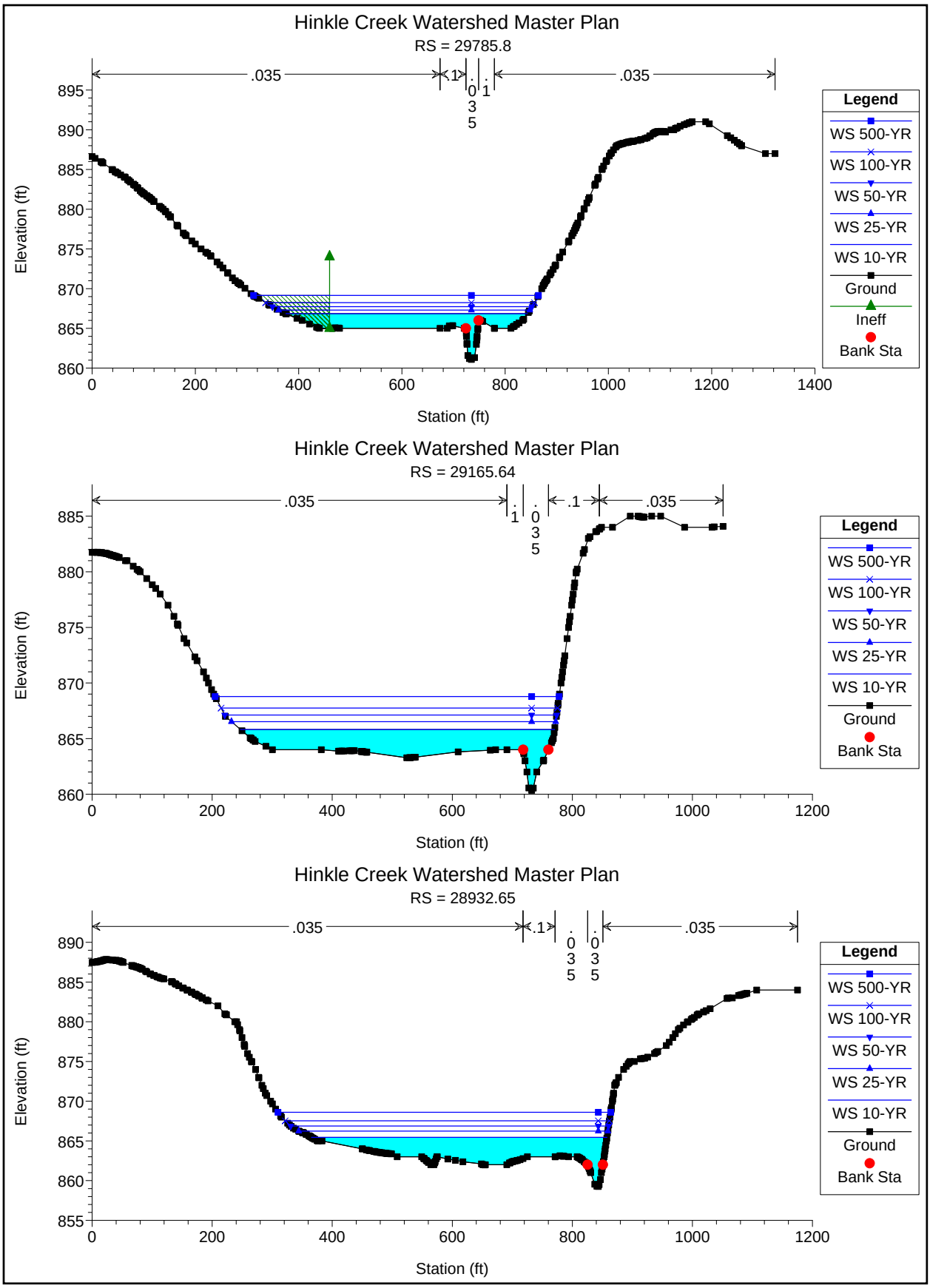

Hinkle Creek Watershed Master Plan
RS = 31154.04
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

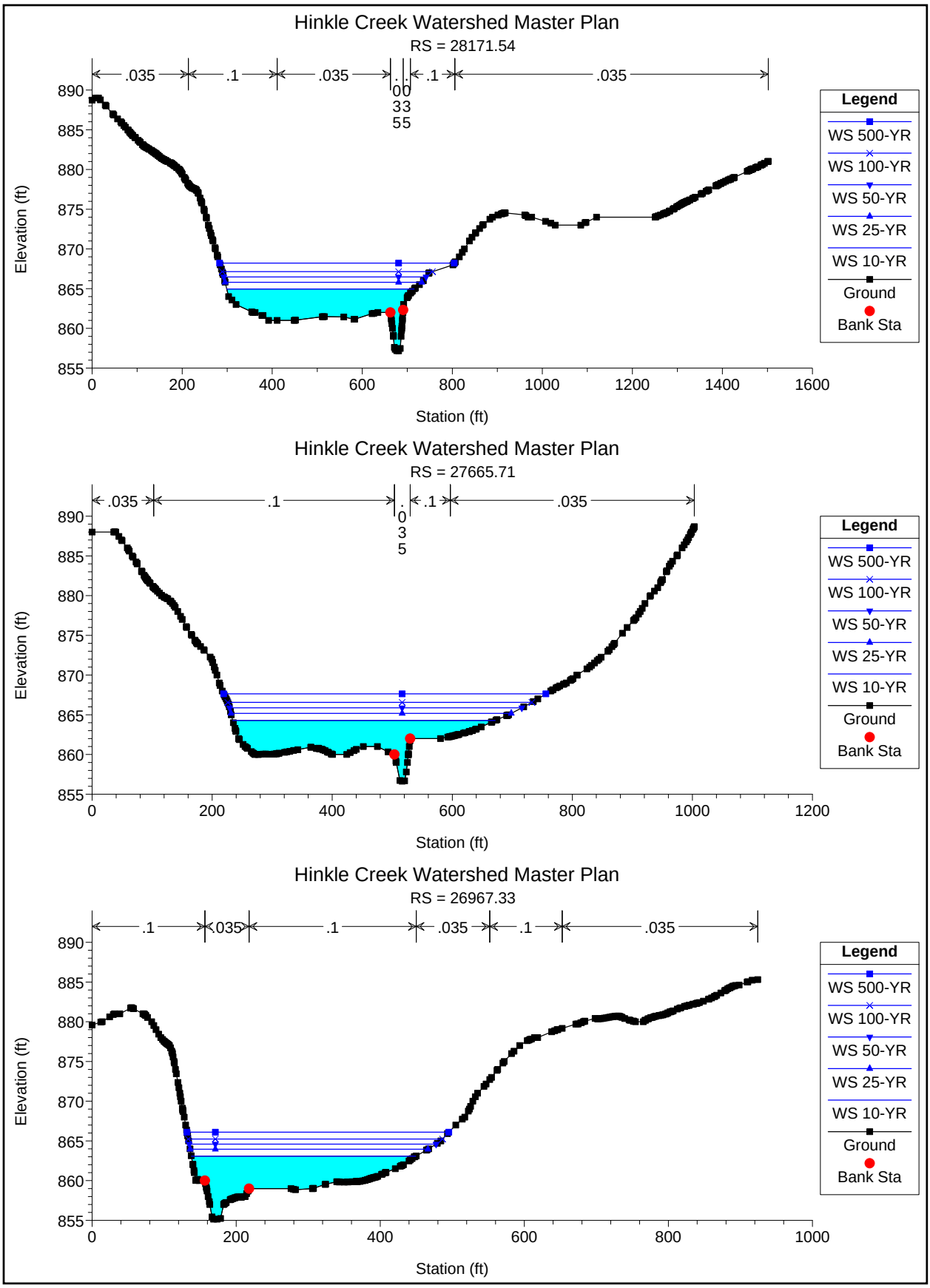

Hinkle Creek Watershed Master Plan
RS = 30897.58
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 30613.61
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 30362.94
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 30309.5 BR 236th Street and Hinkle Creek
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 30309.5 BR 236th Street and Hinkle Creek
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 30266.22 236th Street DS
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 29785.8
.035
.1
.035
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 29165.64
.035
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 28932.65
.035
.1
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 28171.54
.035
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 27665.71
.035
.1
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 26967.33
.1
.035
.1
.035
.1
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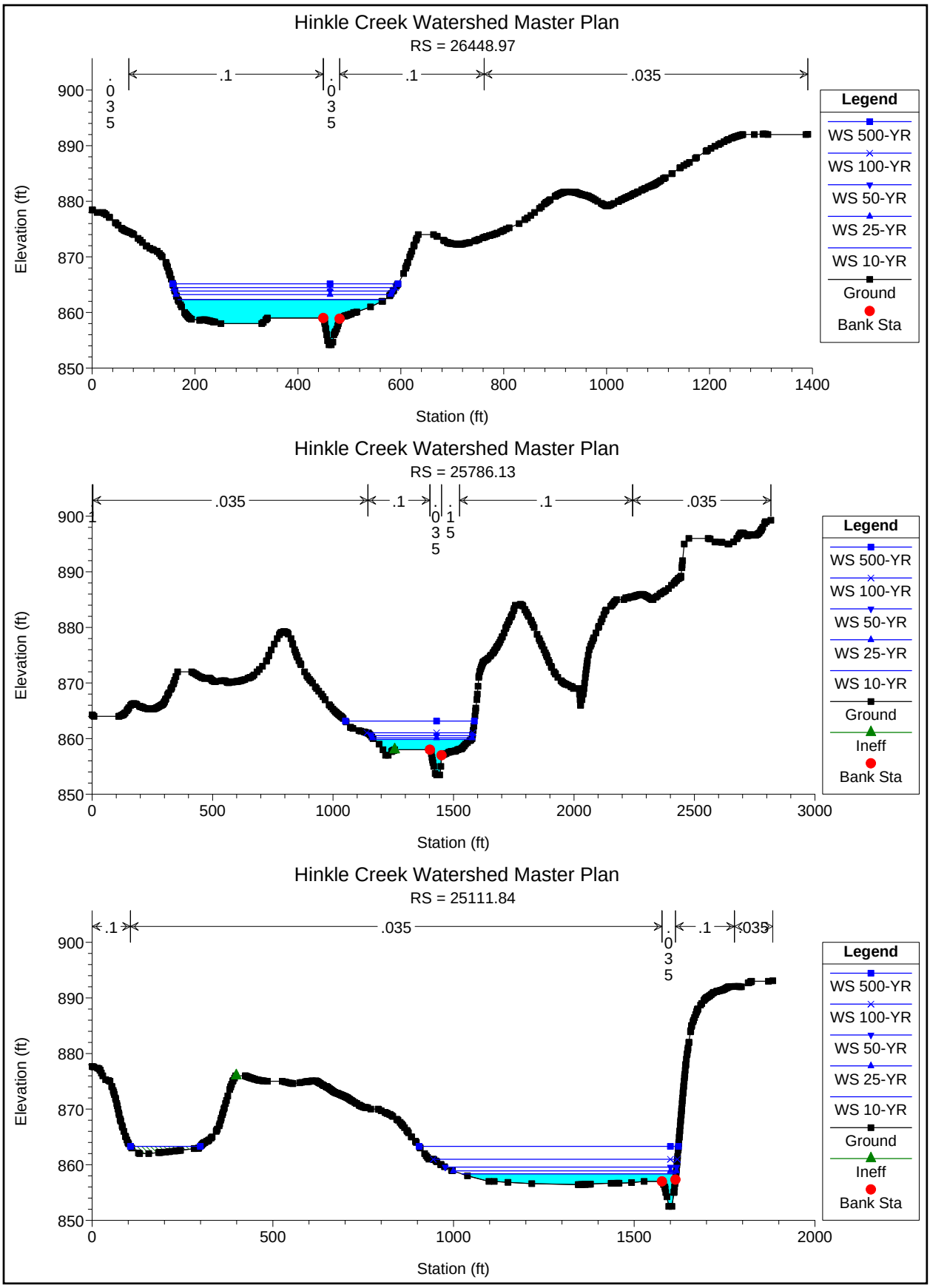
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 26448.97
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Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 25786.13
.035
.1
.035
.15
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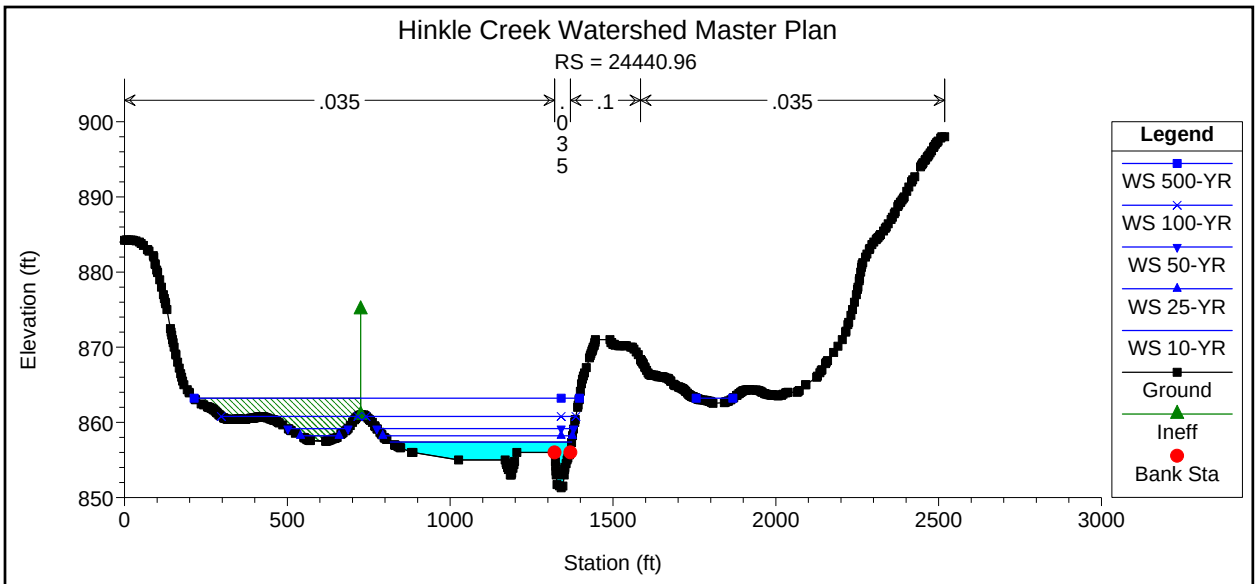
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 25111.84
.1
.035
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 24440.96
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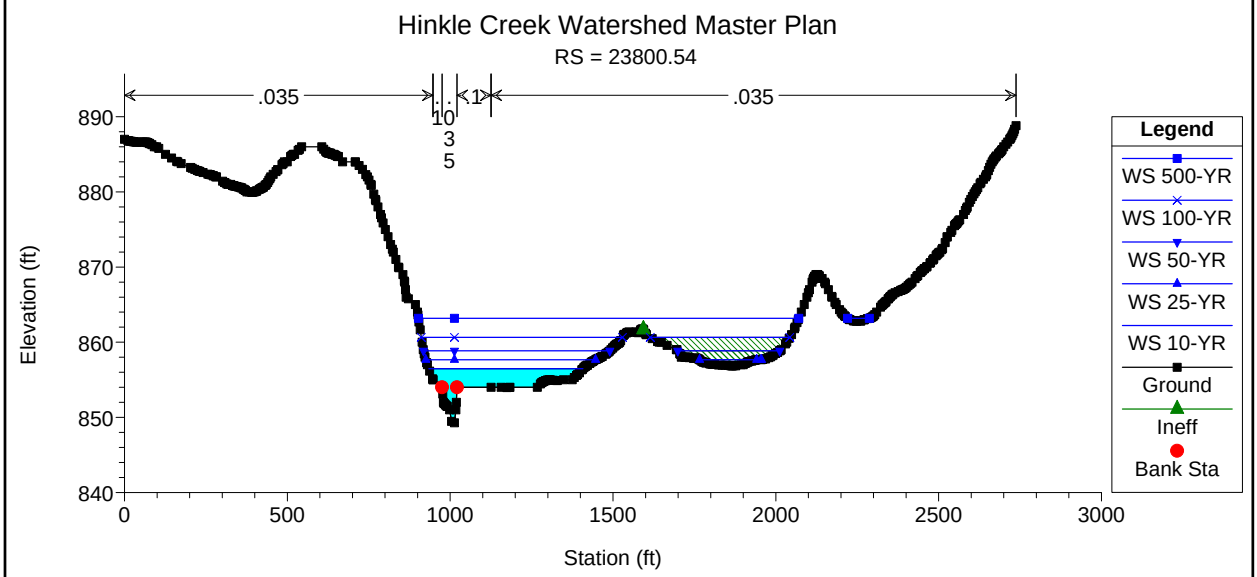
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 23800.54
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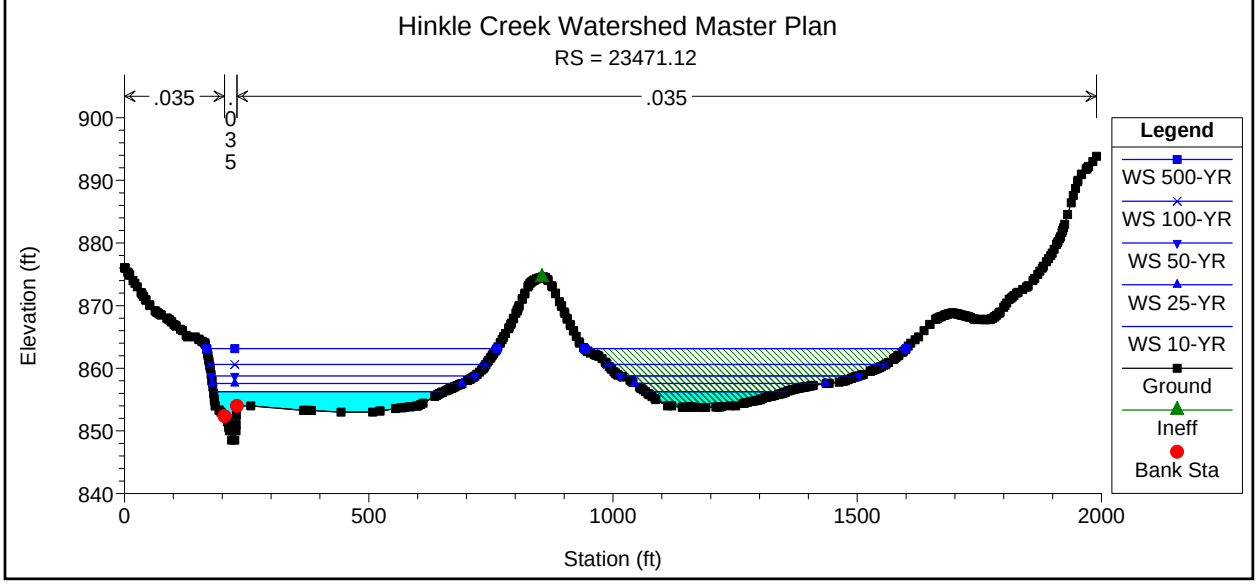
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 23471.12
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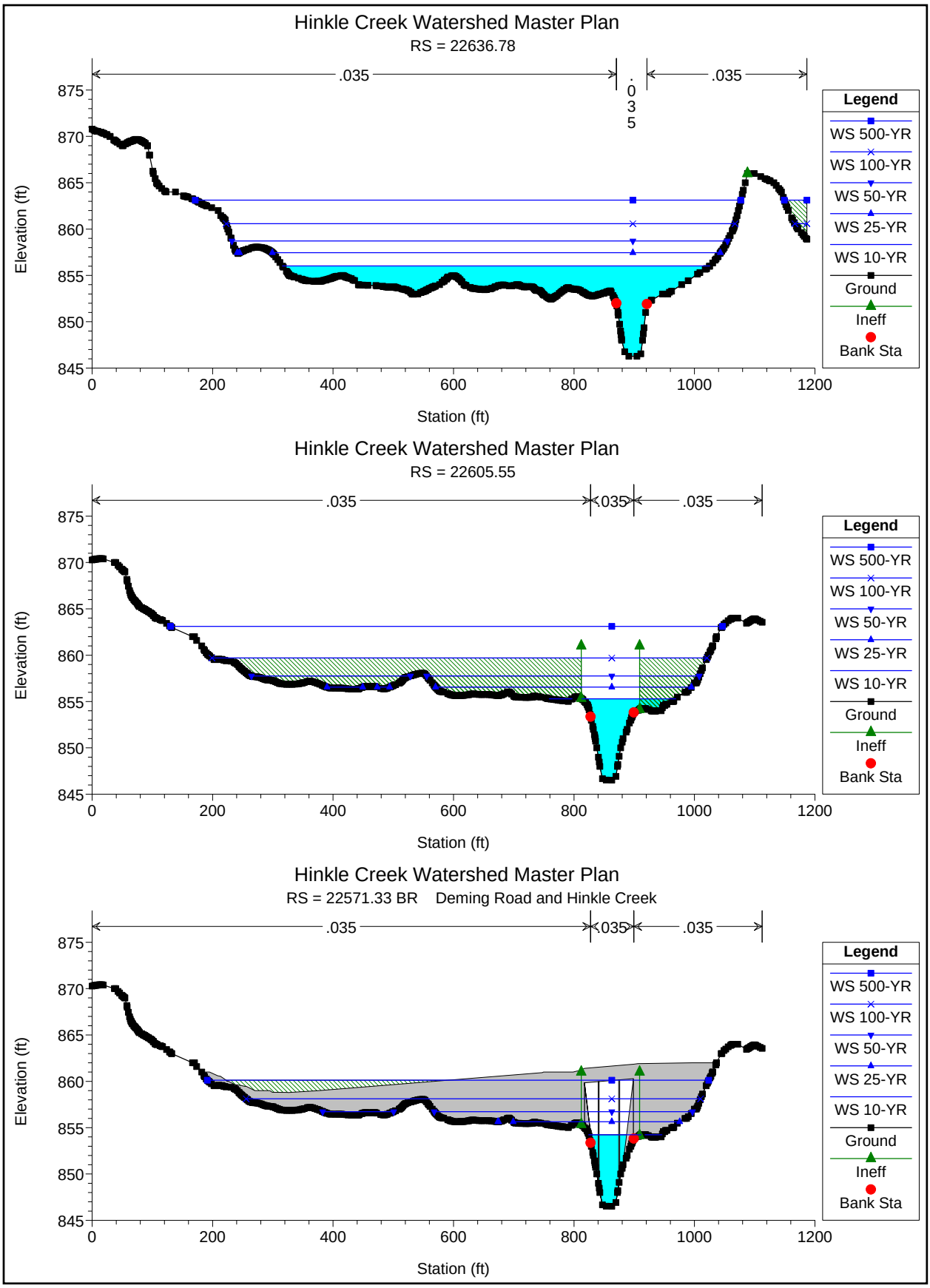
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 22636.78
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.035
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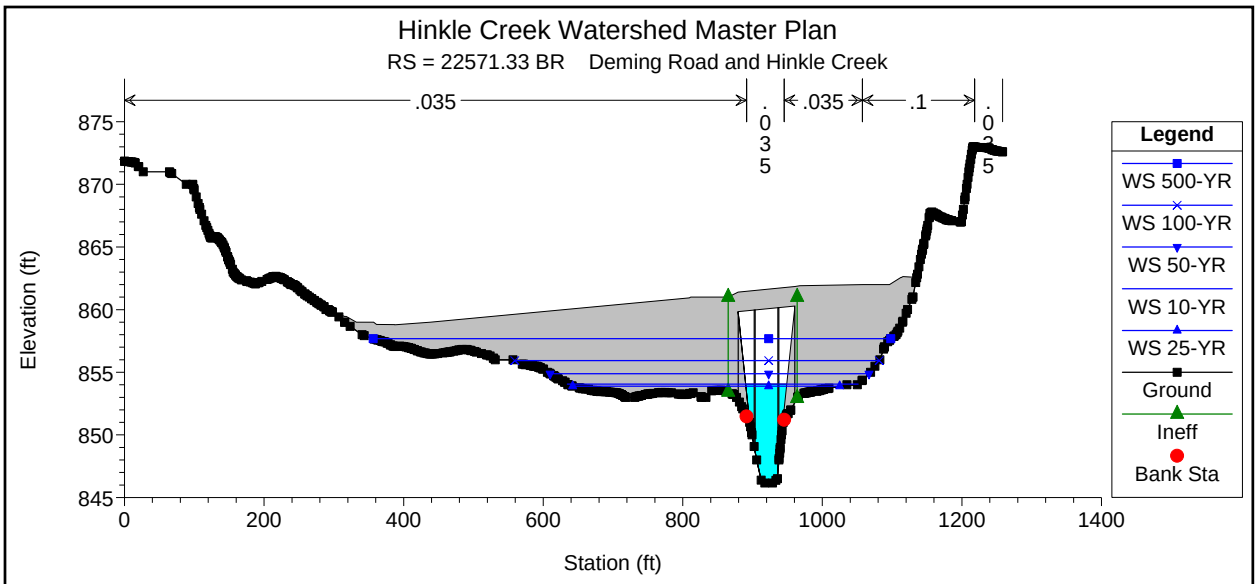
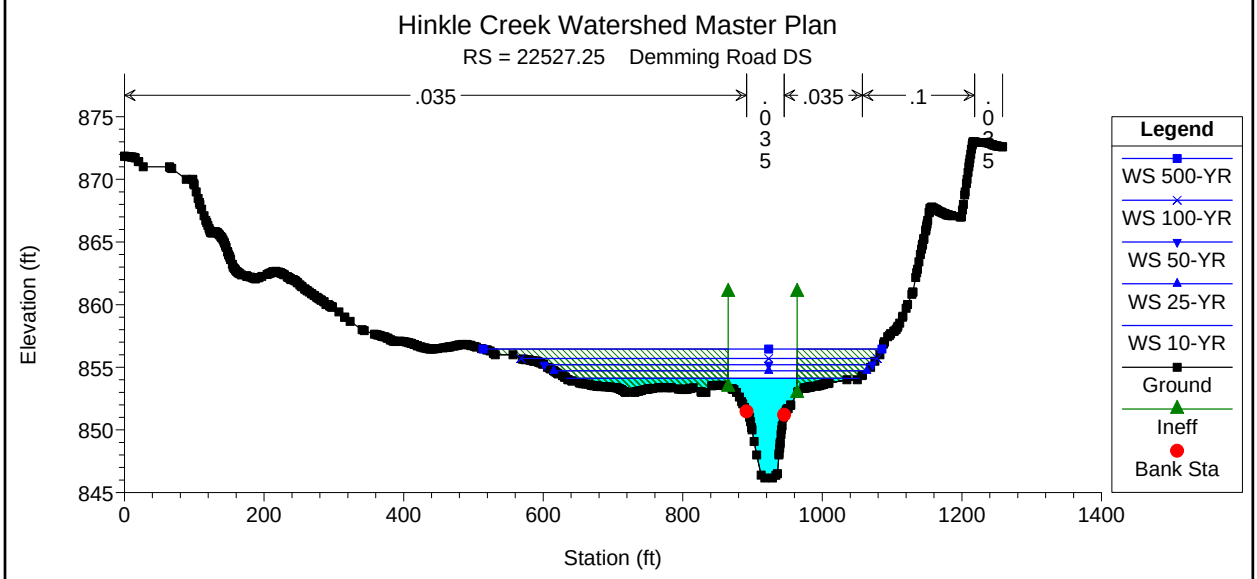
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 22605.55
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 22571.33 BR Deming Road and Hinkle Creek
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 22571.33 BR Deming Road and Hinkle Creek
.035
.035
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 10-YR
WS 25-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 22527.25 Demming Road DS
.035
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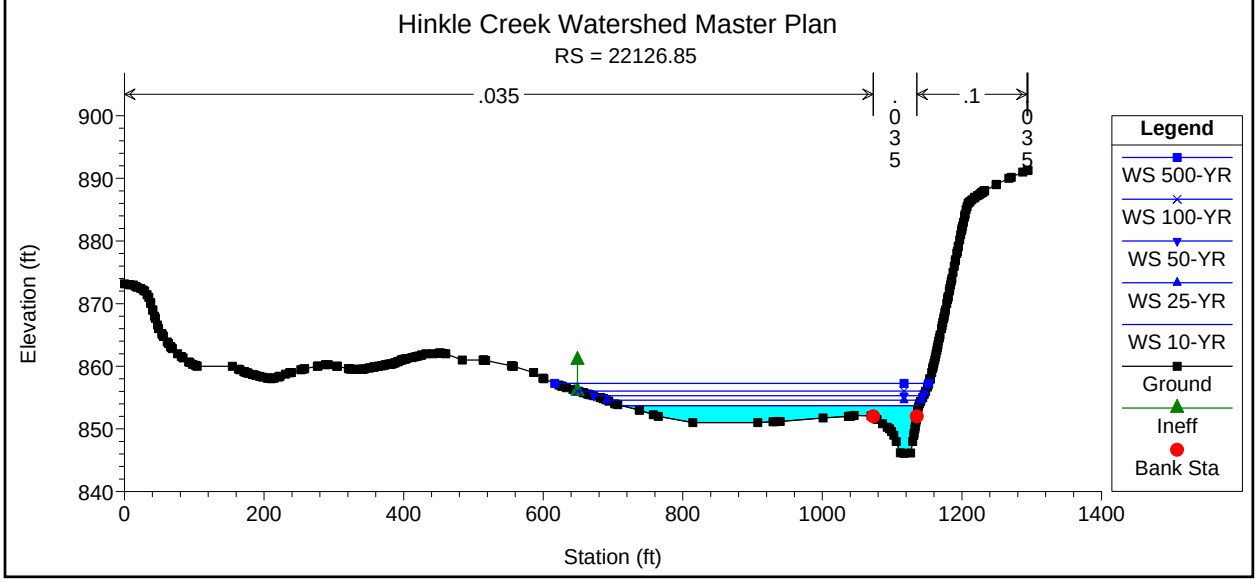
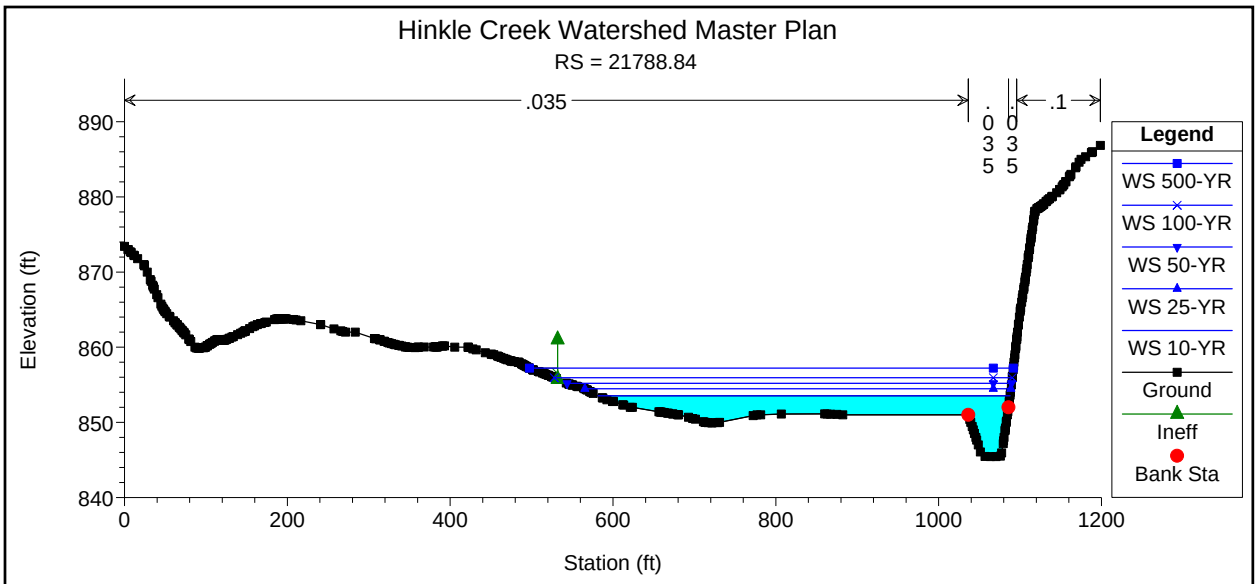
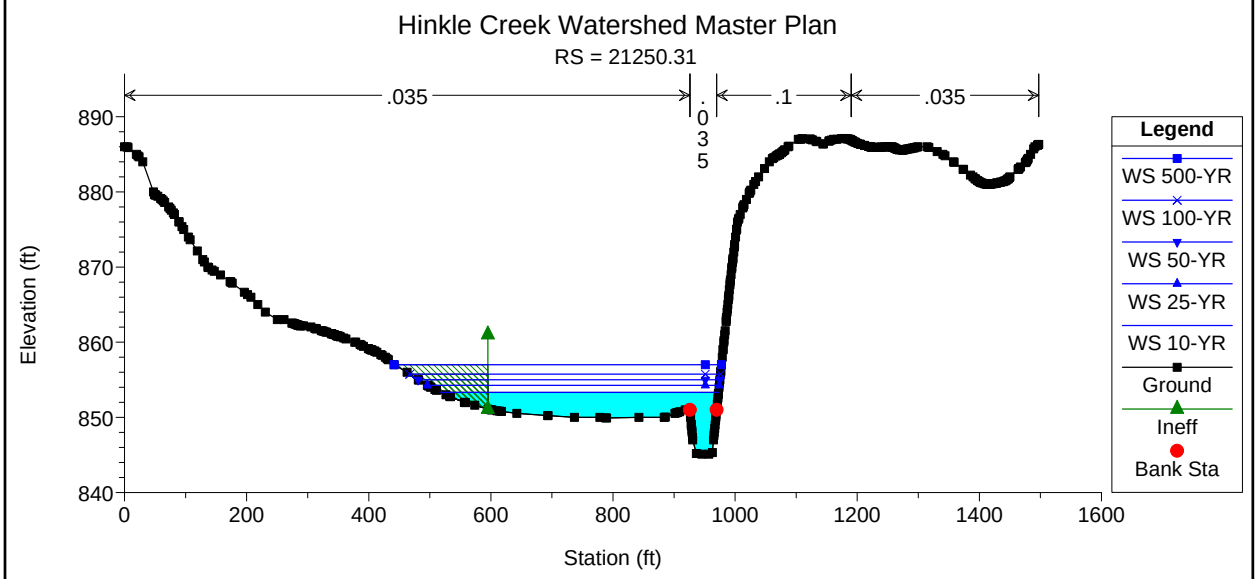
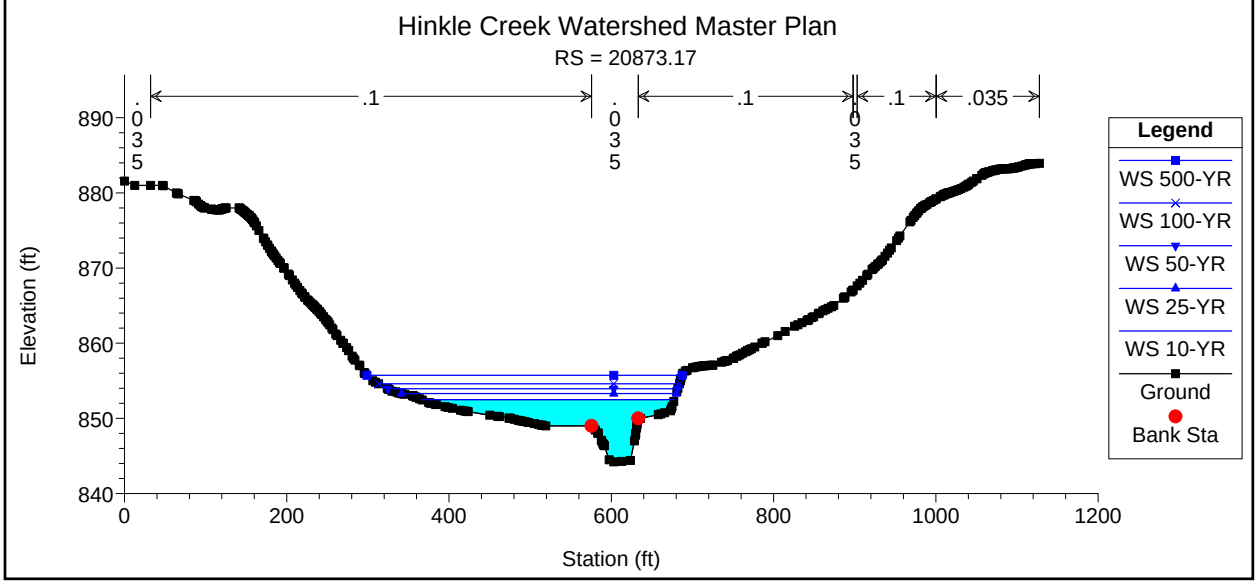
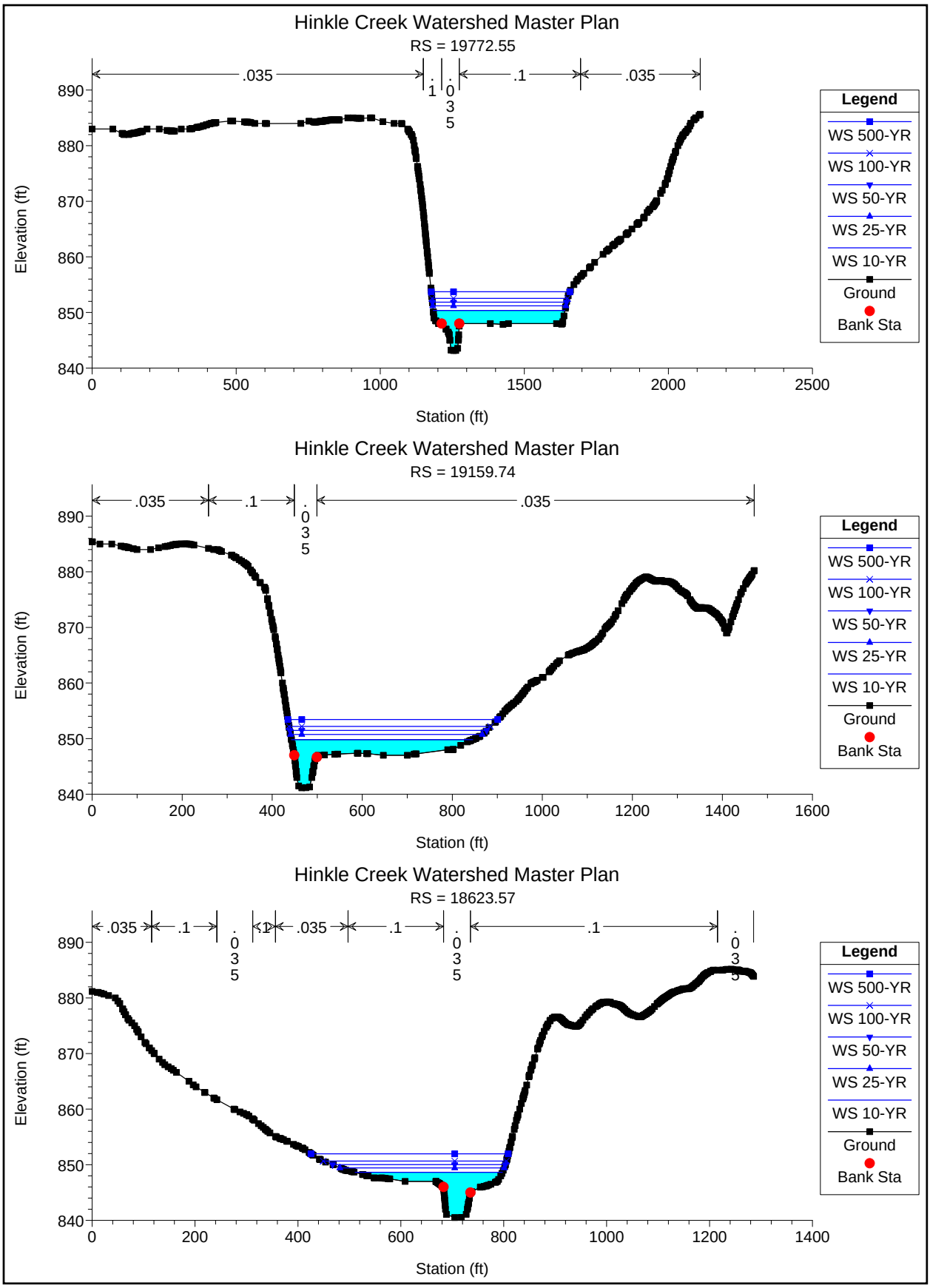
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 22126.85
.035
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 21788.84
.035
.035
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 21250.31
.035
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 20873.17
.035
.1
.035
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 19772.55
.035
.1
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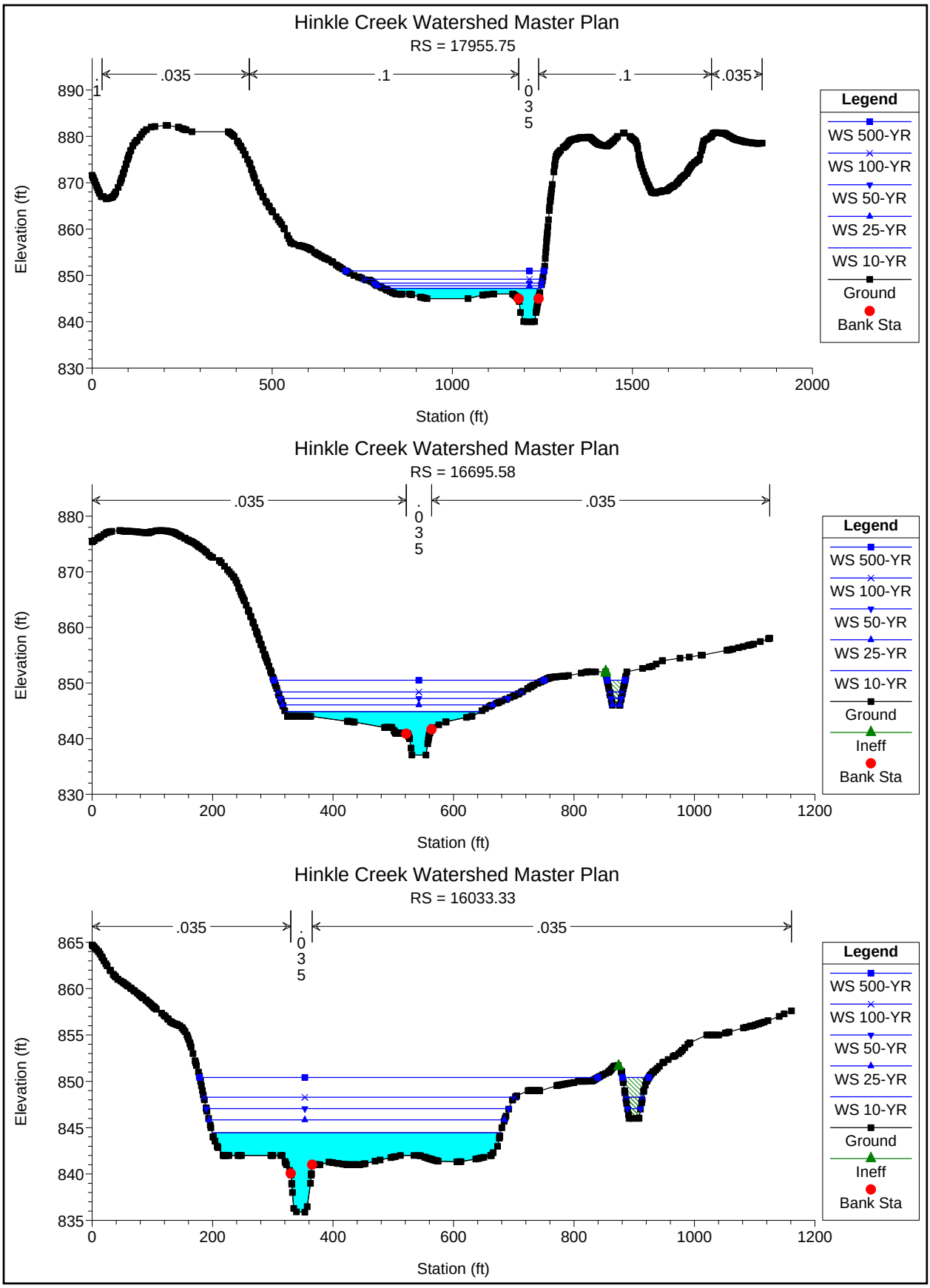
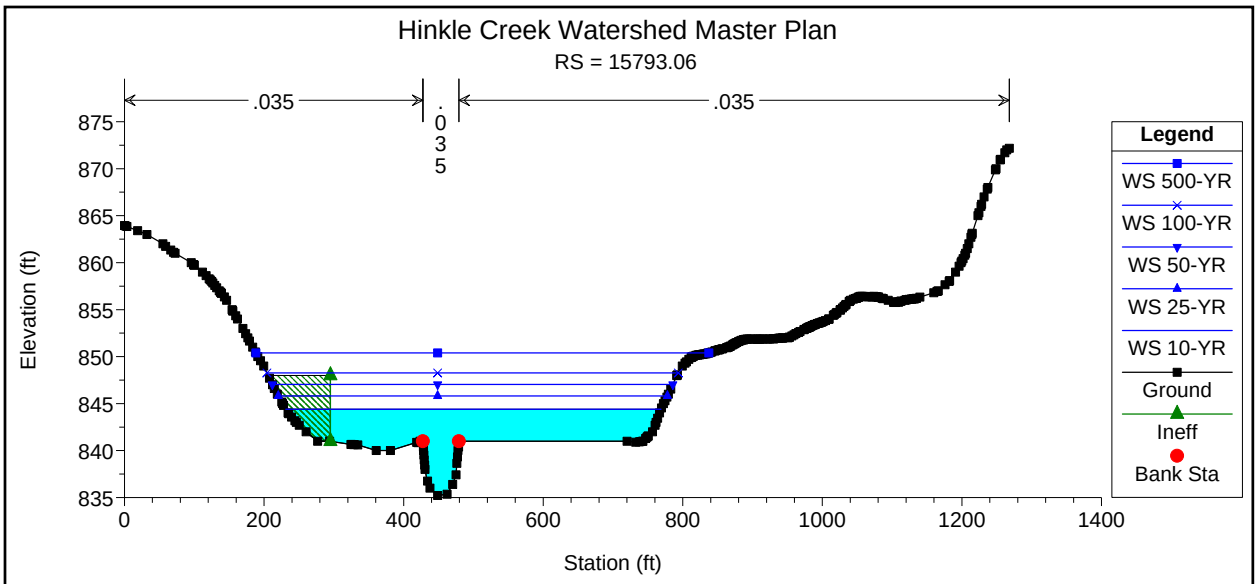
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 19159.74
.035
.1
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 18623.57
.035
.1
.035
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 17955.75
.1
.035
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 16695.58
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 16033.33
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 15793.06
.035
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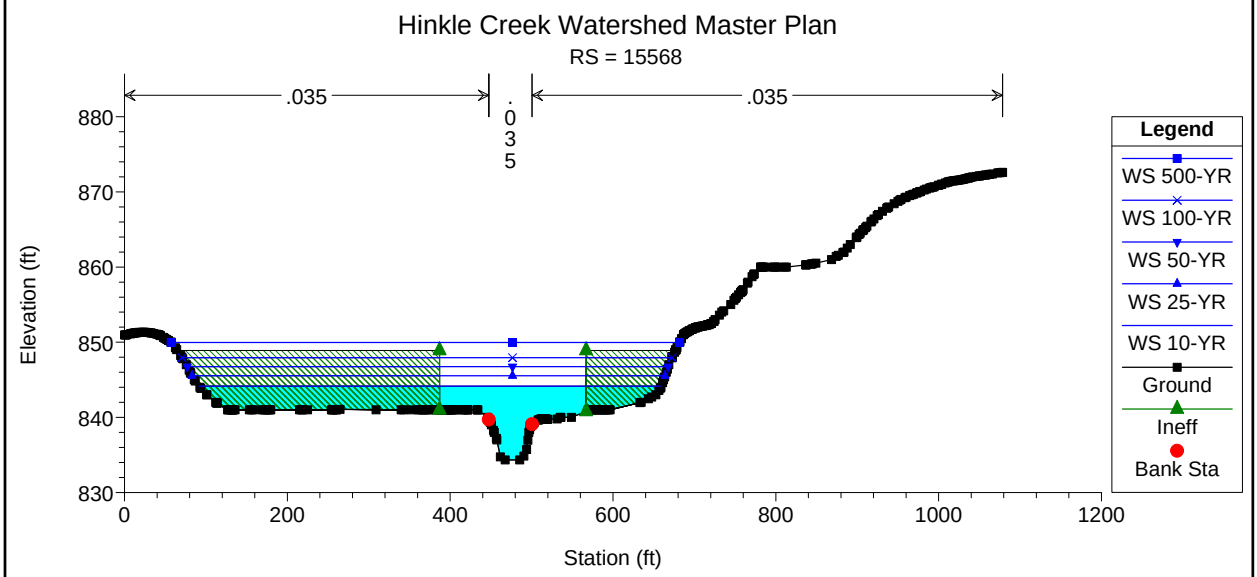
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 15568
.035
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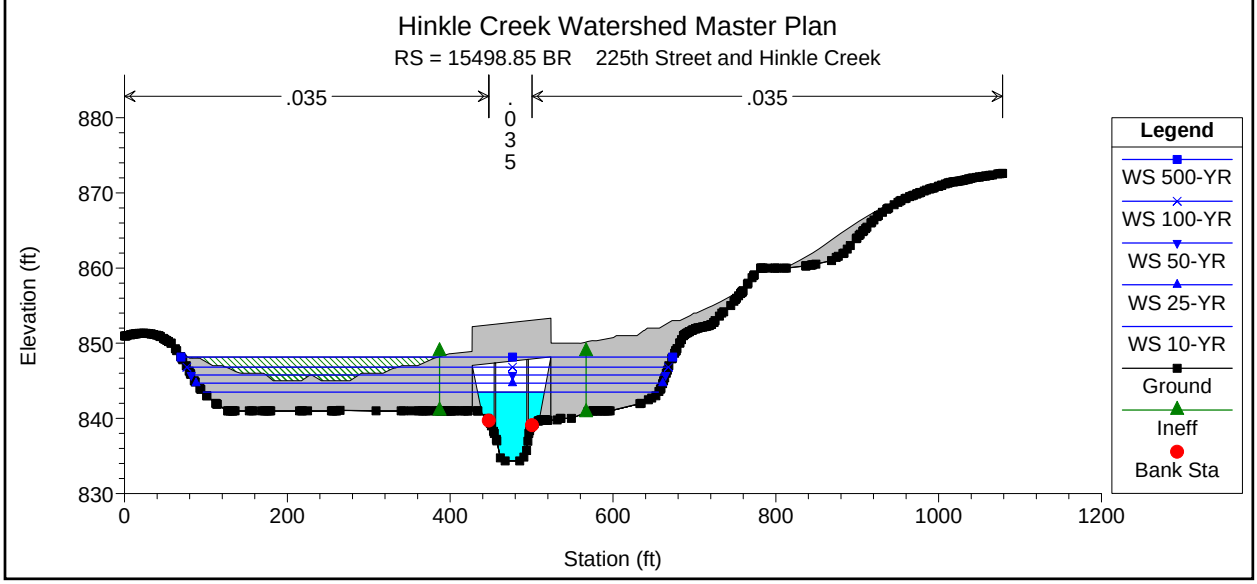
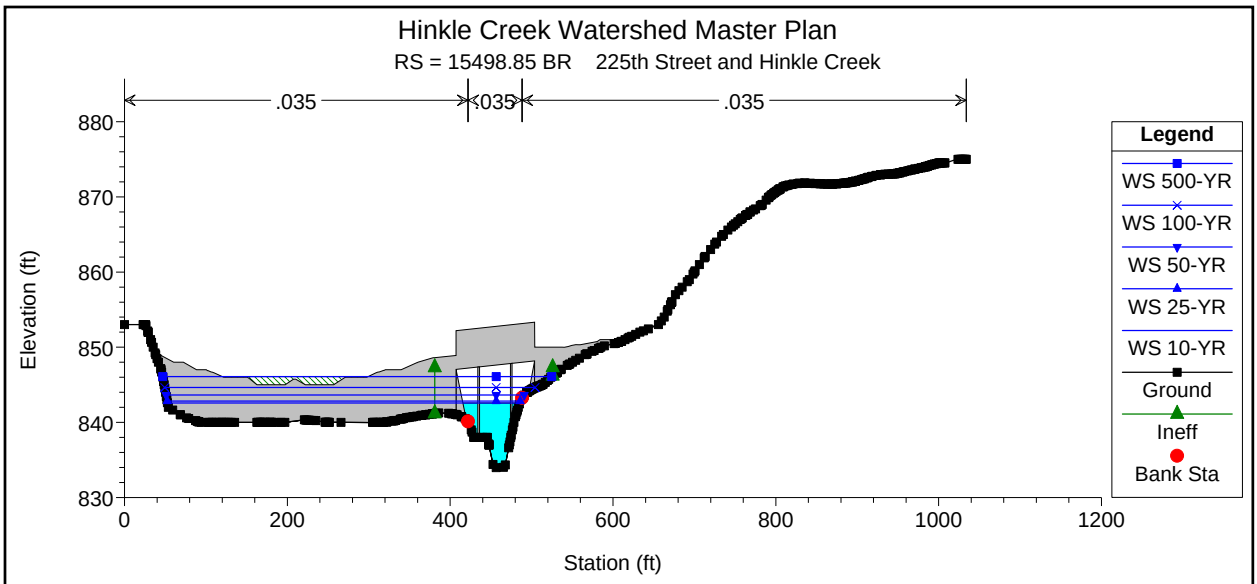
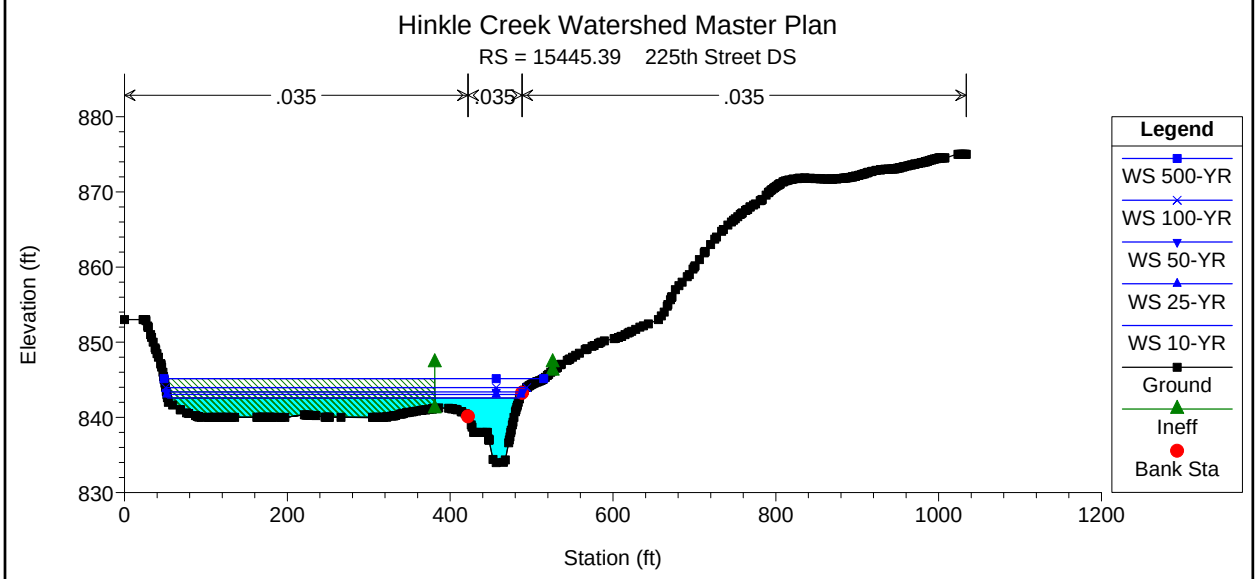
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 15498.85 BR 225th Street and Hinkle Creek
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 15498.85 BR 225th Street and Hinkle Creek
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 15445.39 225th Street DS
.035
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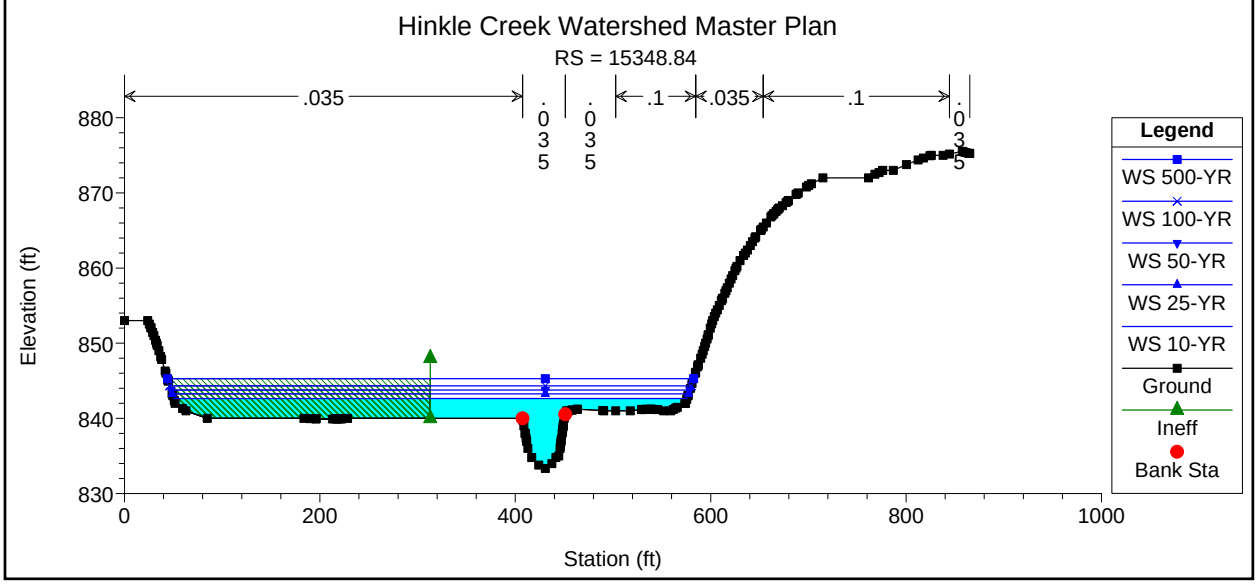
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 15348.84
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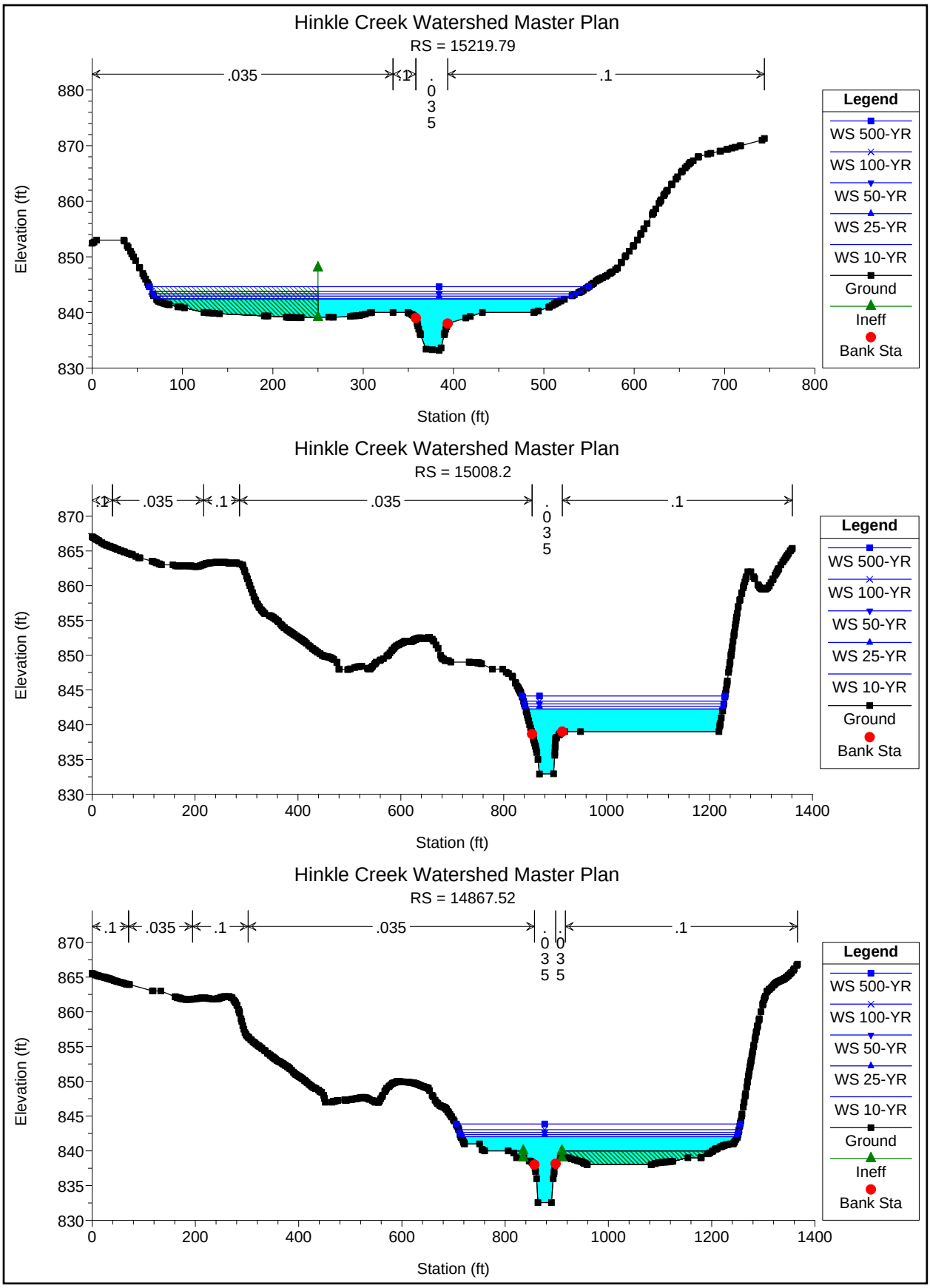
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 15219.79
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.1
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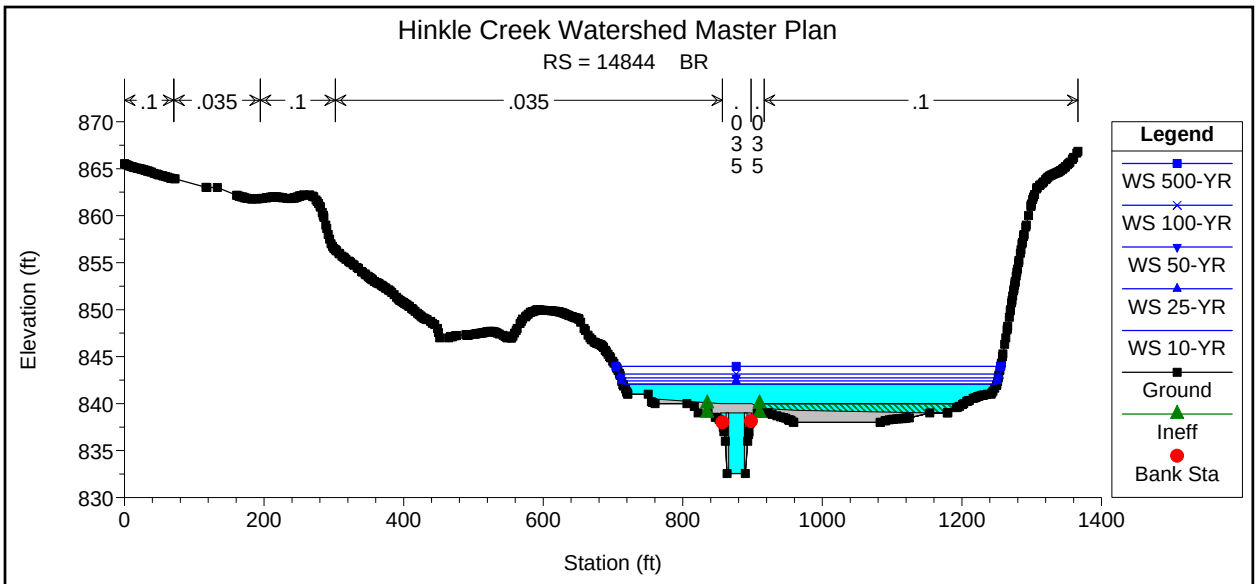
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 15008.2
.1
.035
.1
.035
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 14867.52
.1
.035
.1
.035
.035
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 14844 BR
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.035
.1
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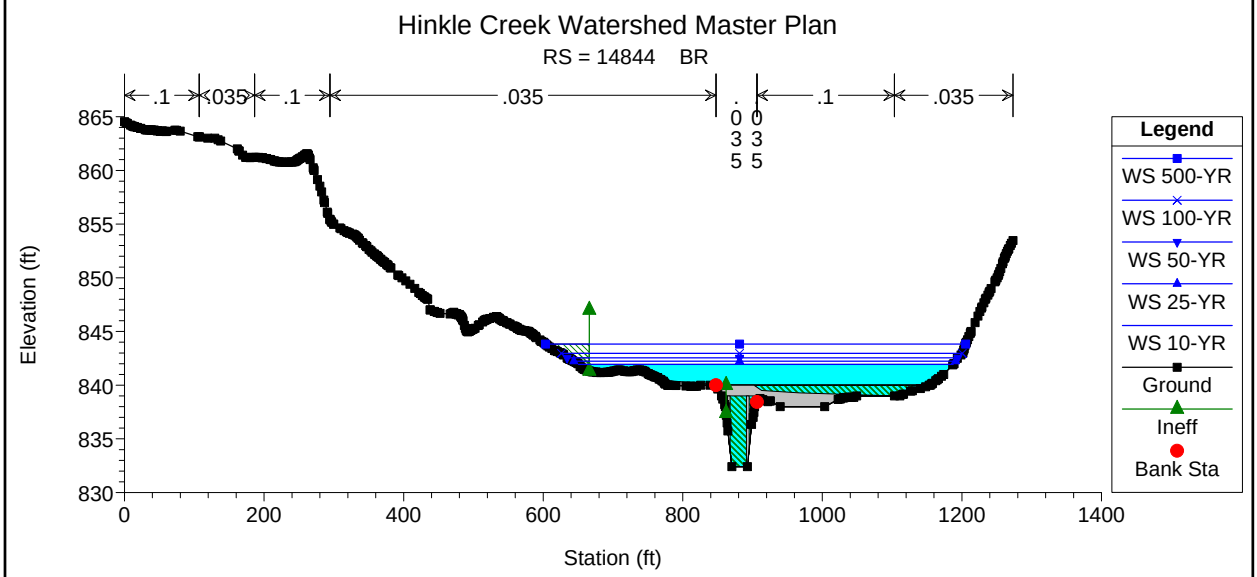
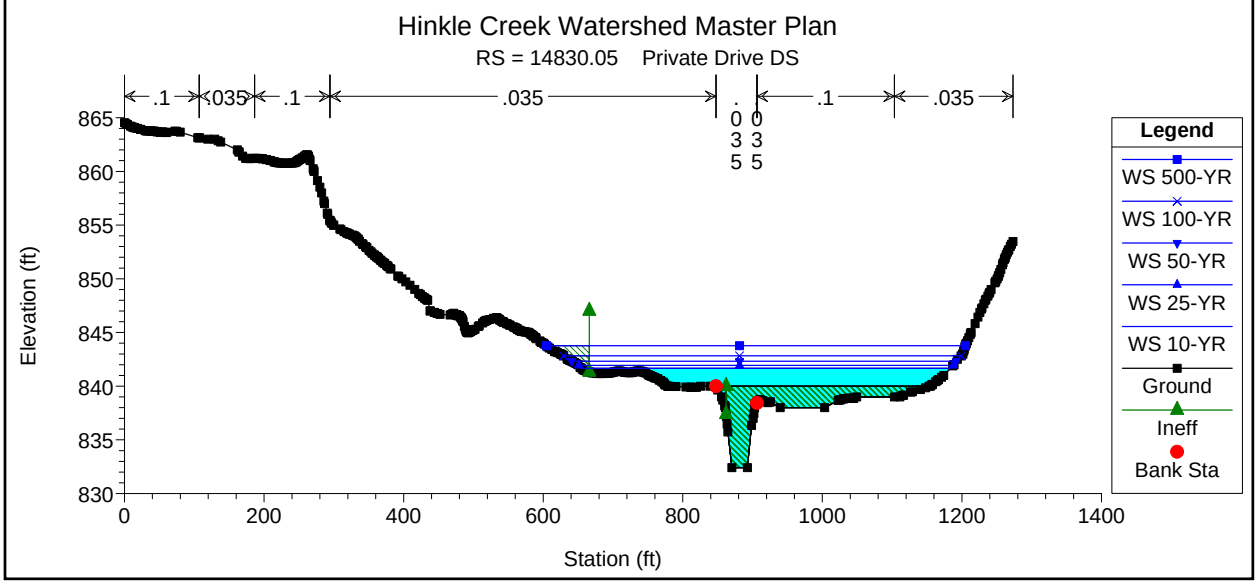
.035
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 14844 BR
.1
.035
.1
.035
.035
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 14830.05 Private Drive DS
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.035
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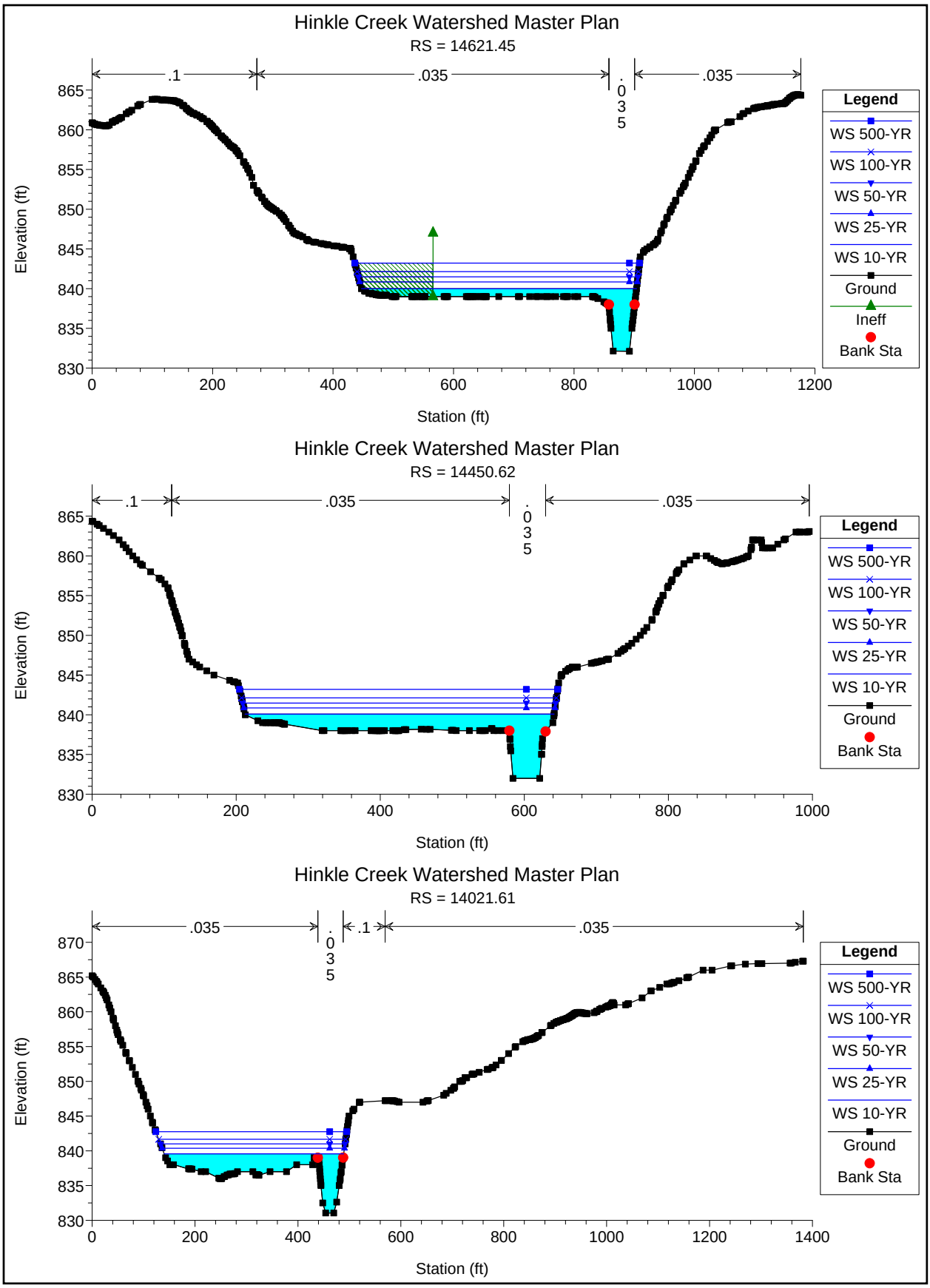
.035
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 14621.45
.1
.035
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Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 14450.62
.1
.035
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 14021.61
.035
.035
.1
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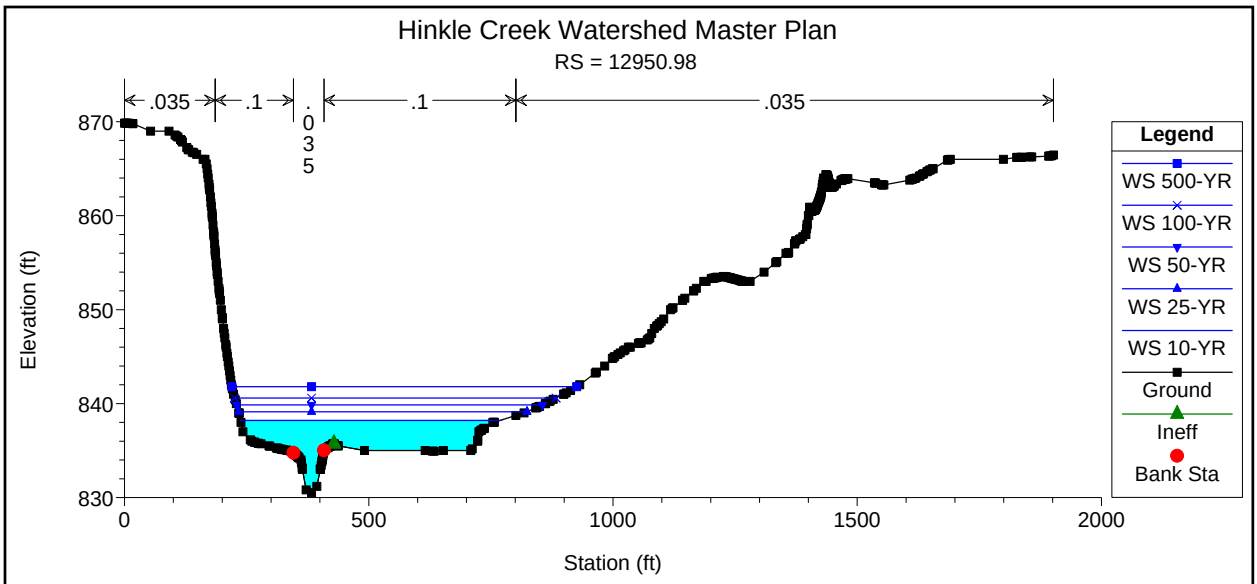
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 12950.98
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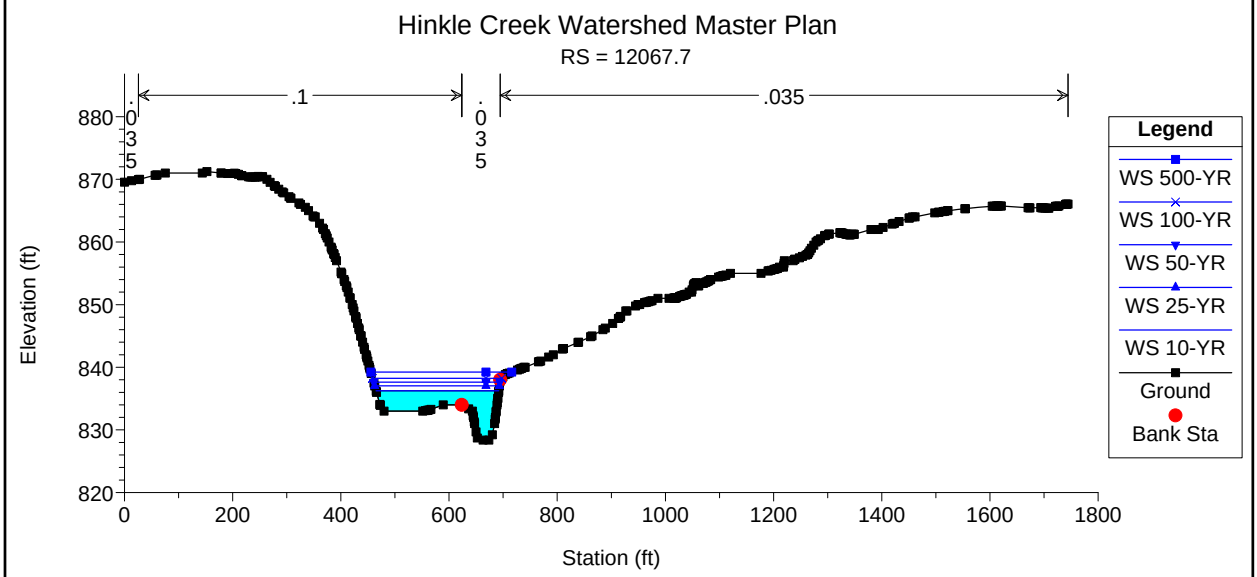
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 12067.7
.035
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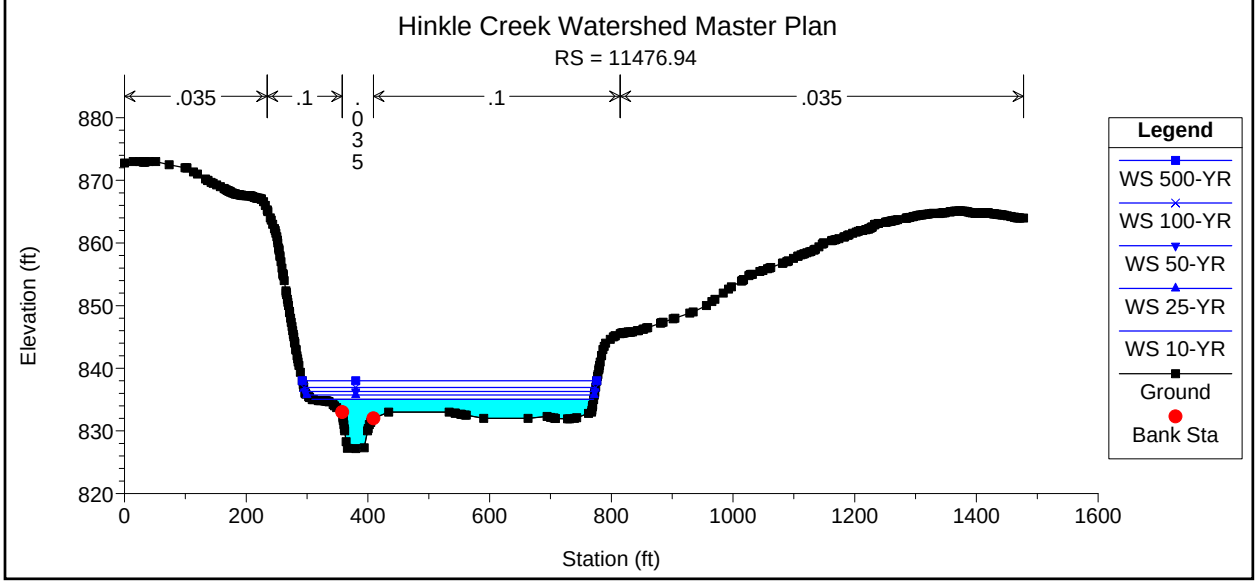
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 11476.94
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.035
.1
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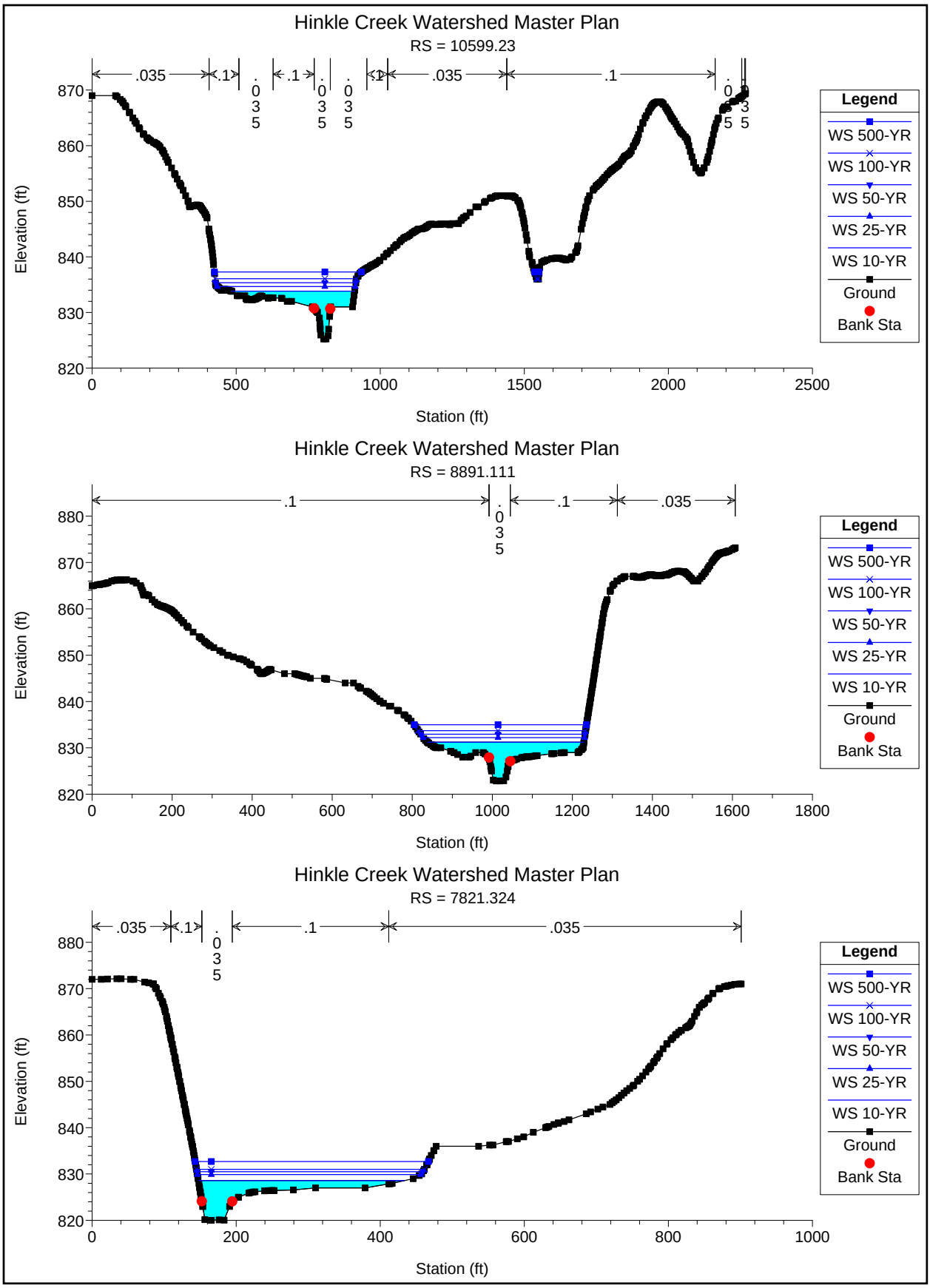
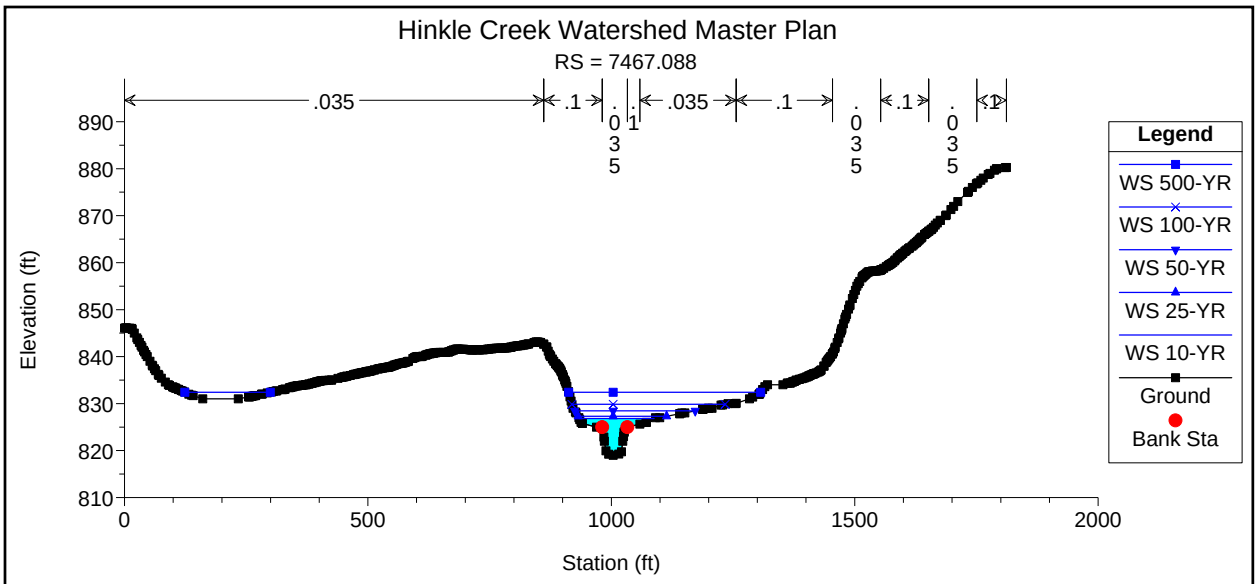
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 10599.23
.035
.1
.035
.1
.035
.1
.035
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 8891.111
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 7821.324
.035
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 7467.088
.035
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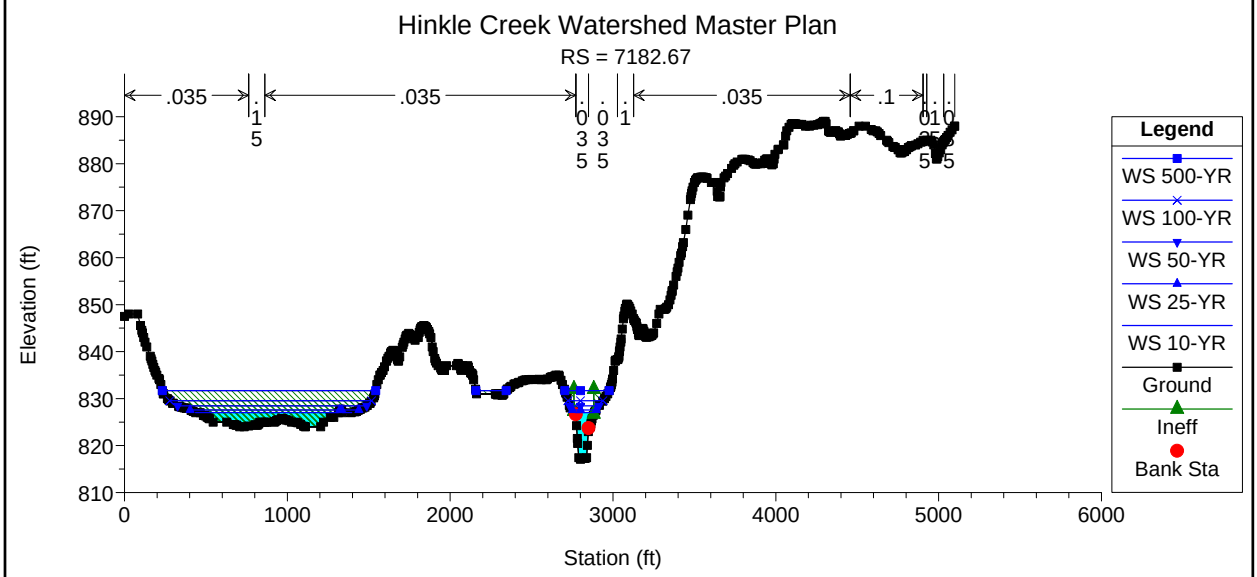
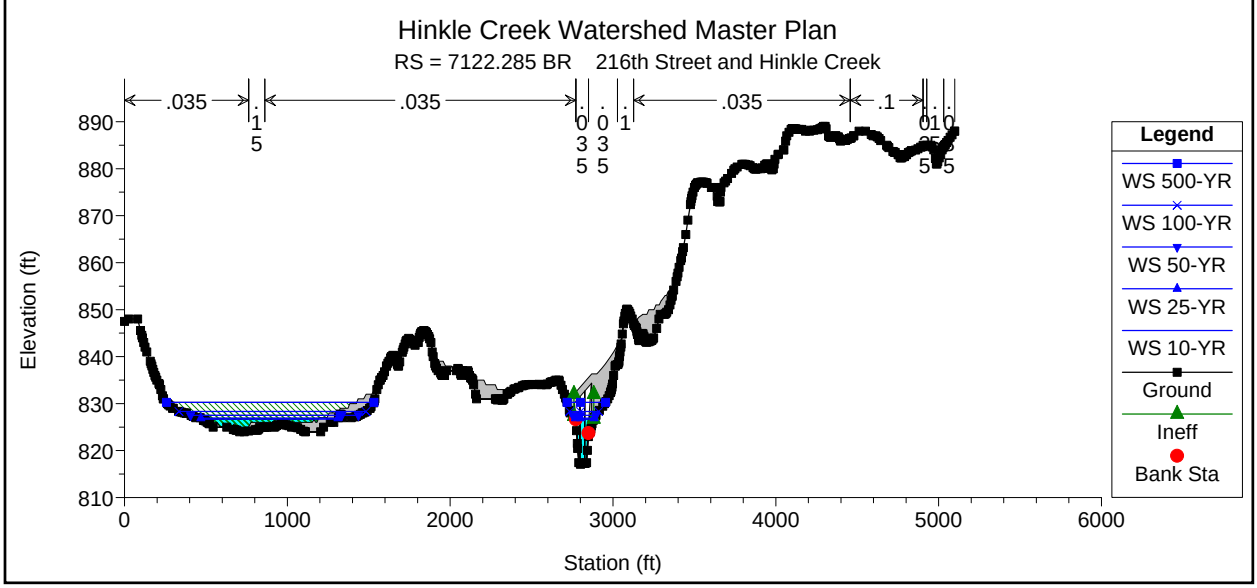
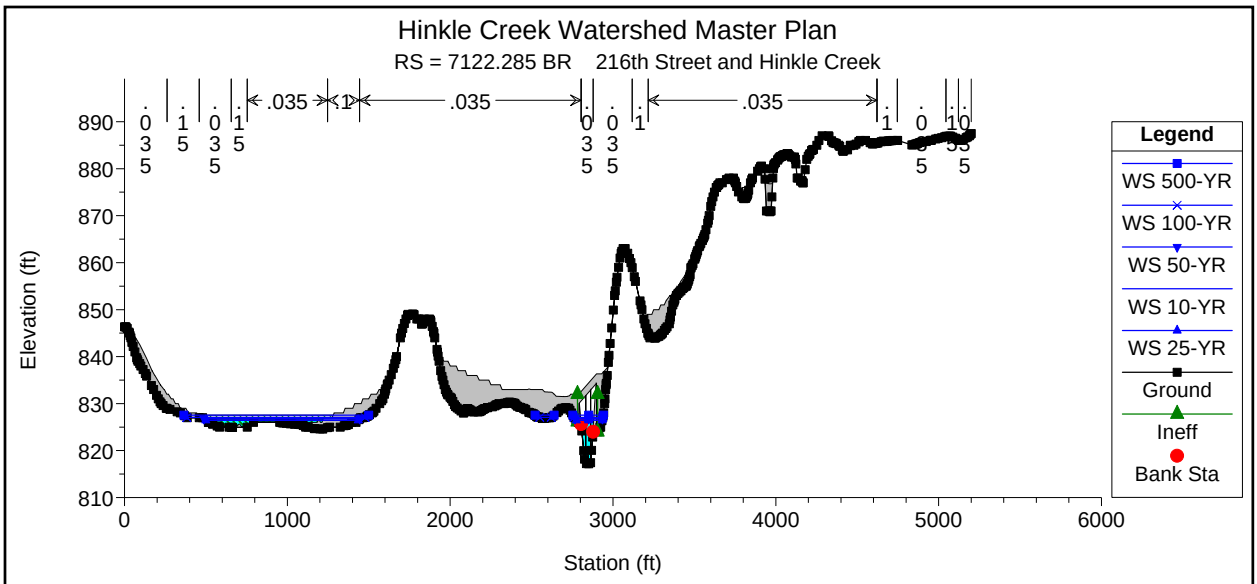
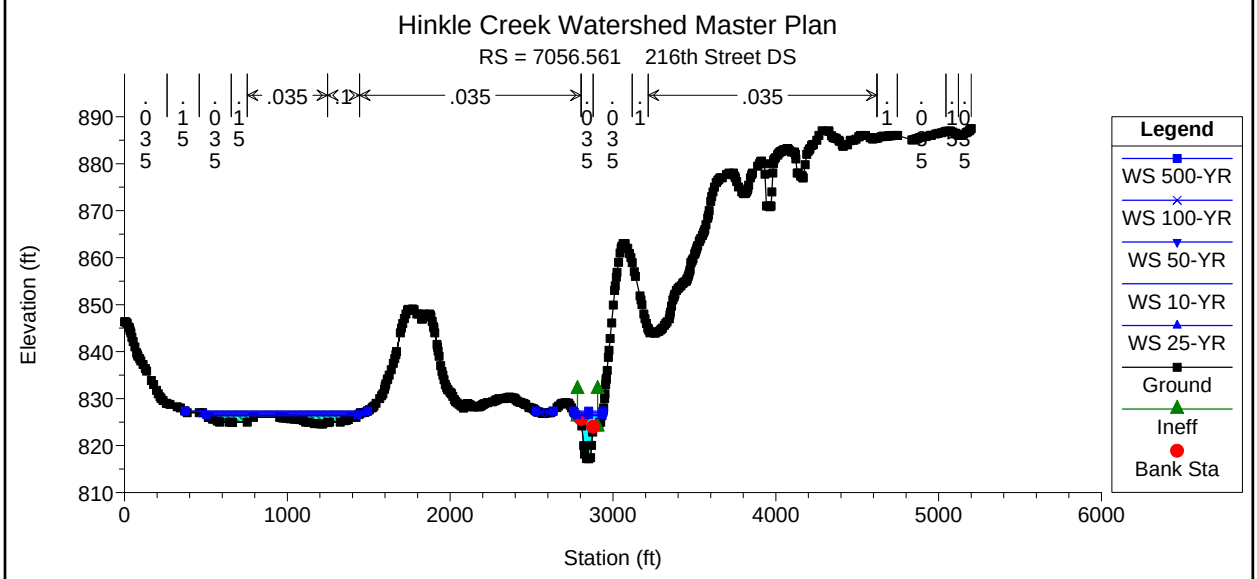
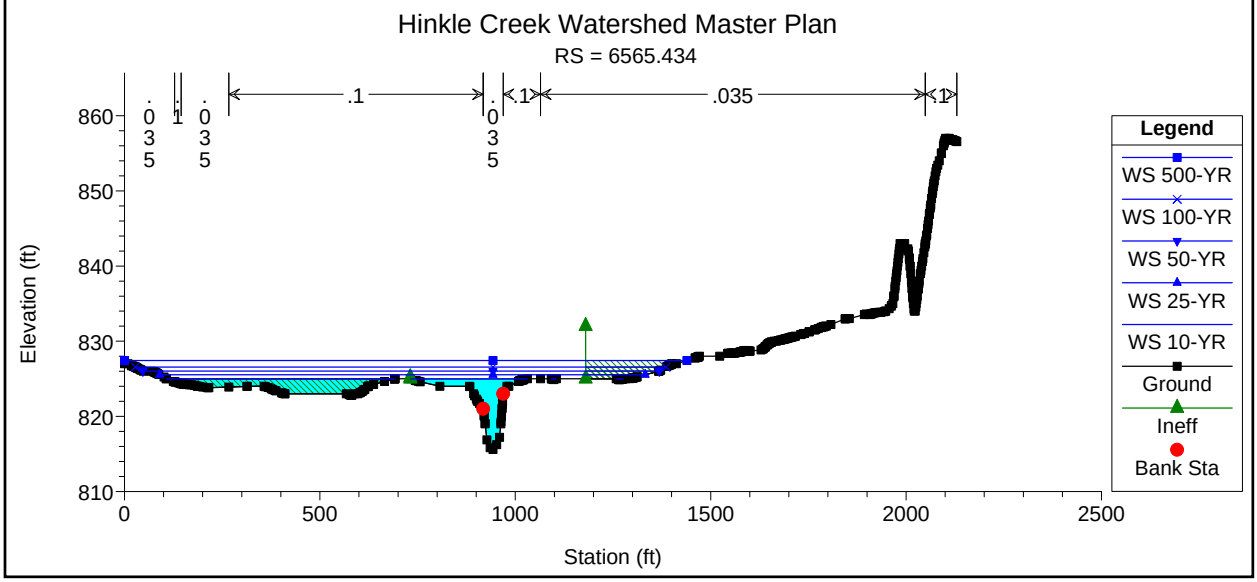
.035
.1
.1
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta

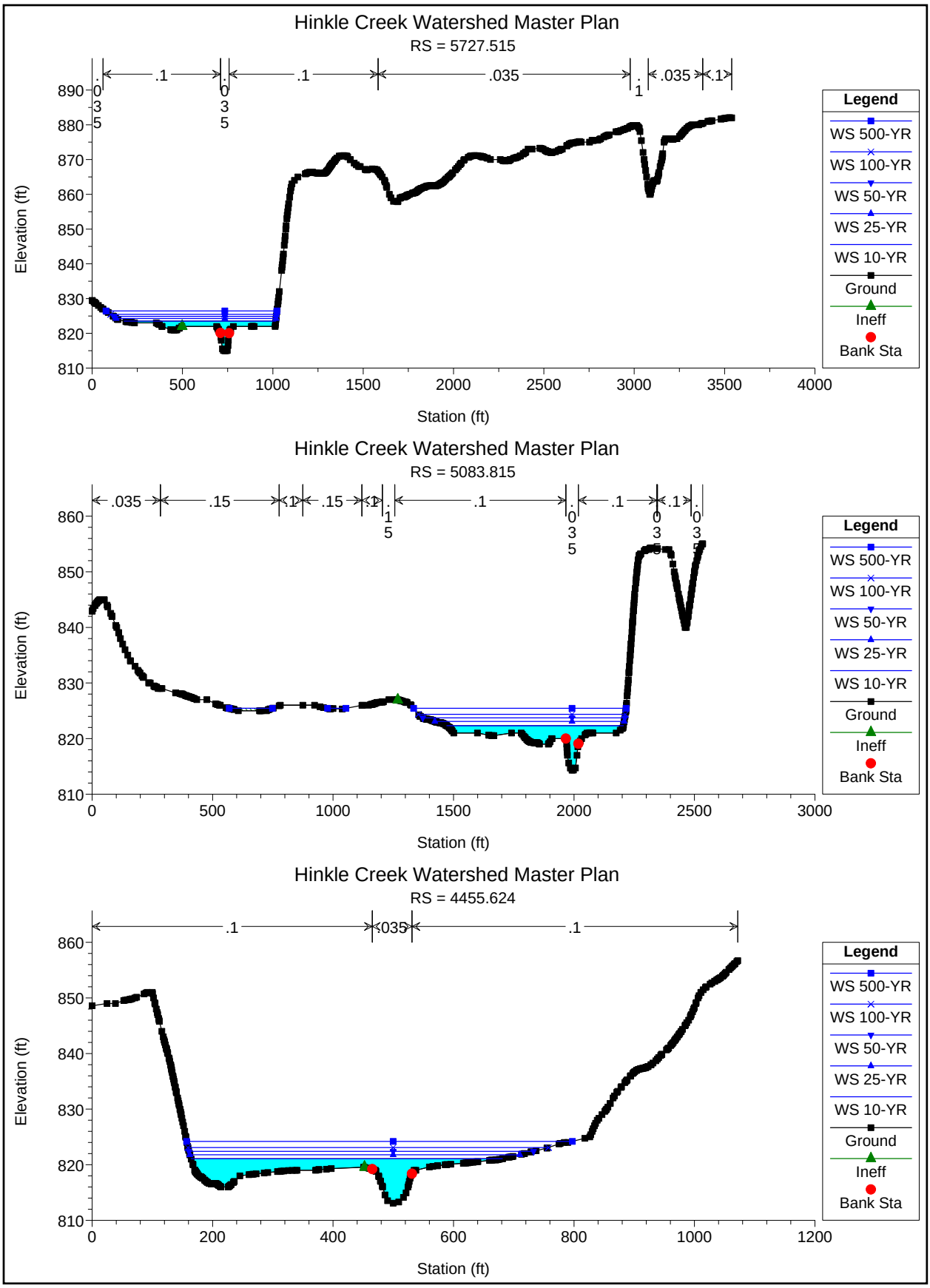

Hinkle Creek Watershed Master Plan
RS = 7182.67
.035
.035
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

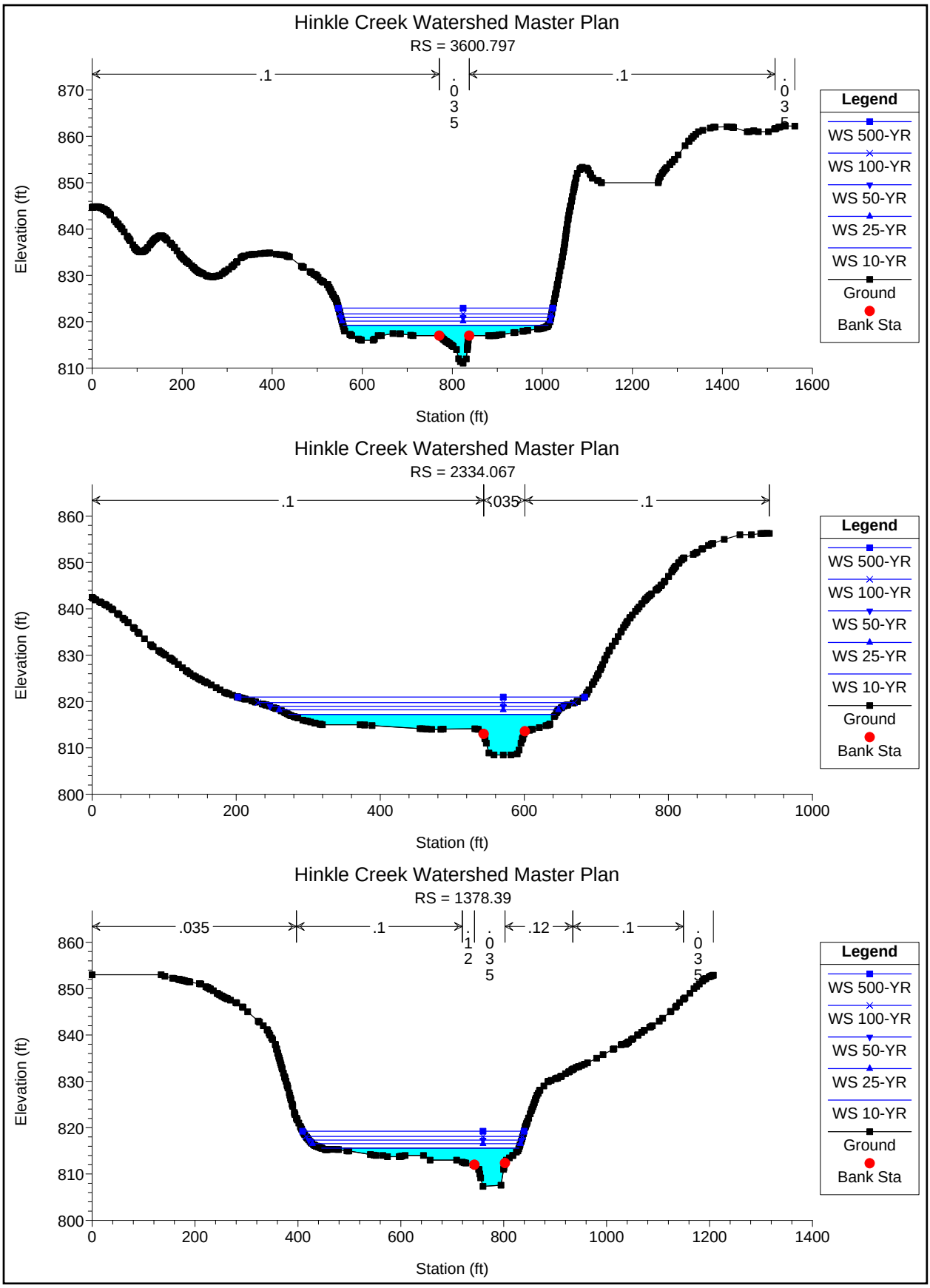

Hinkle Creek Watershed Master Plan
RS = 7122.285 BR 216th Street and Hinkle Creek
.035
.035
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

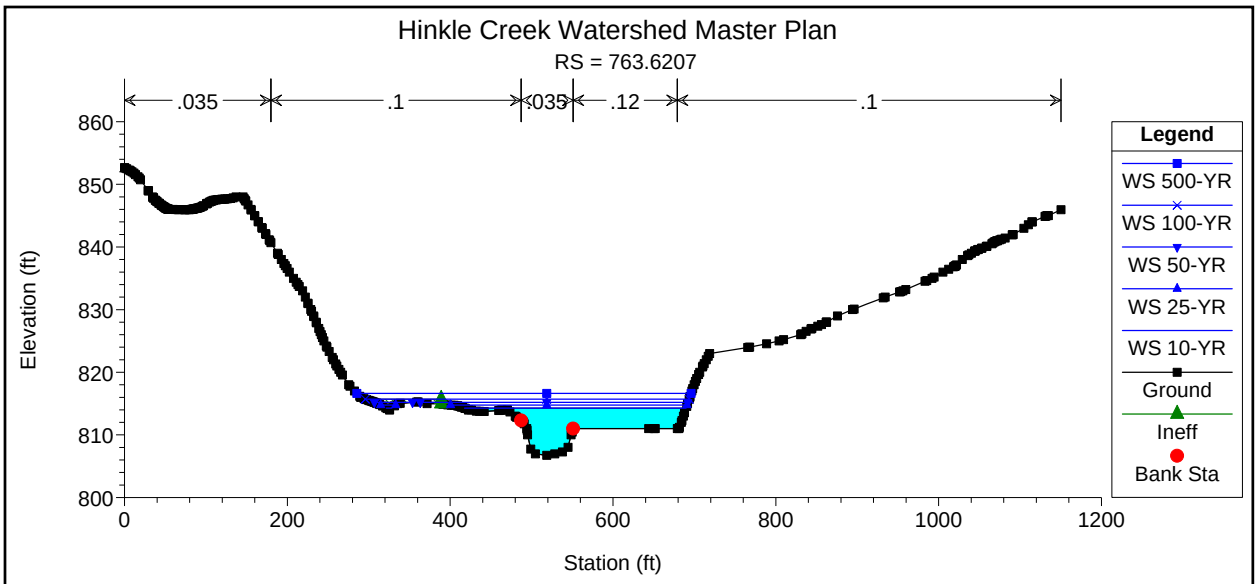

Hinkle Creek Watershed Master Plan
RS = 7122.285 BR 216th Street and Hinkle Creek
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 10-YR
WS 25-YR
Ground
Ineff
Bank Sta

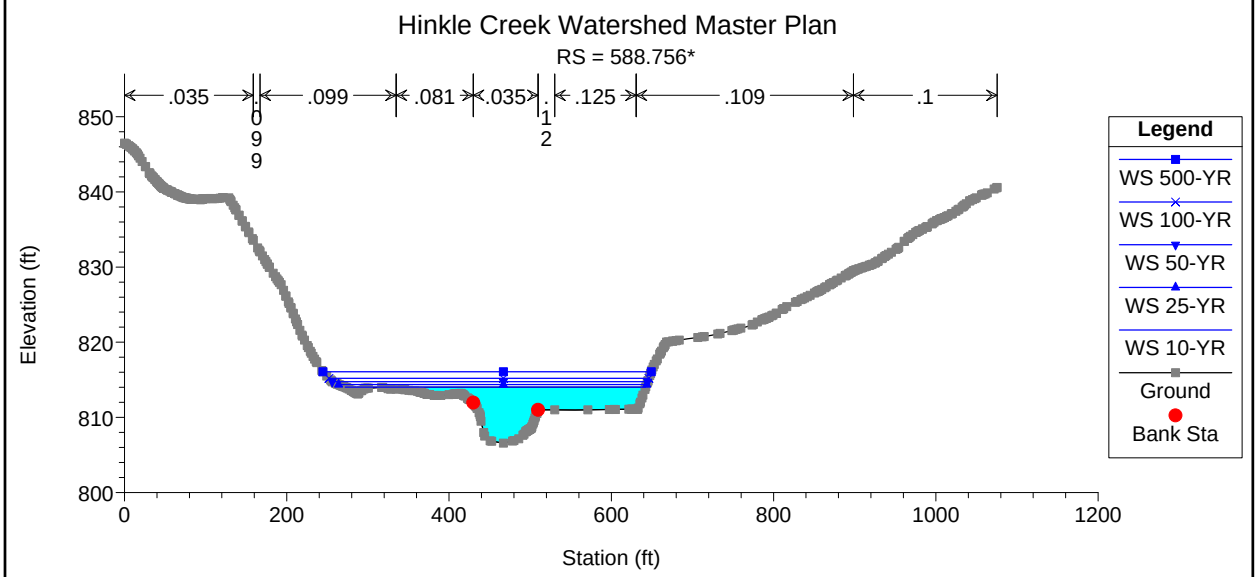

Hinkle Creek Watershed Master Plan
RS = 7056.561 216th Street DS
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 10-YR
WS 25-YR
Ground
Ineff
Bank Sta

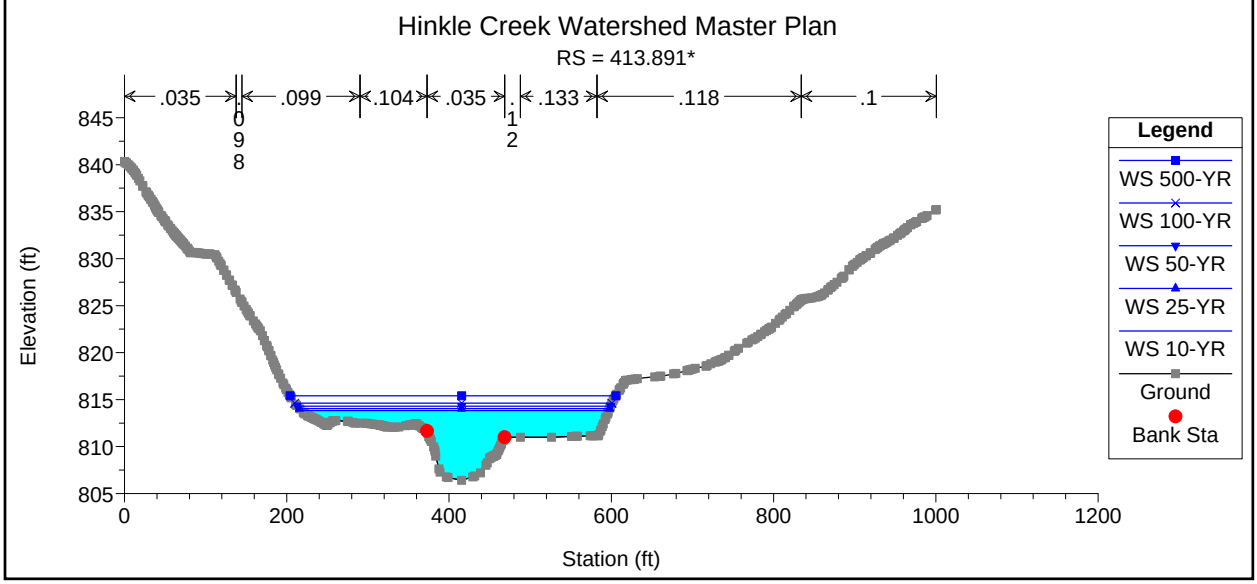

Hinkle Creek Watershed Master Plan
RS = 6565.434
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

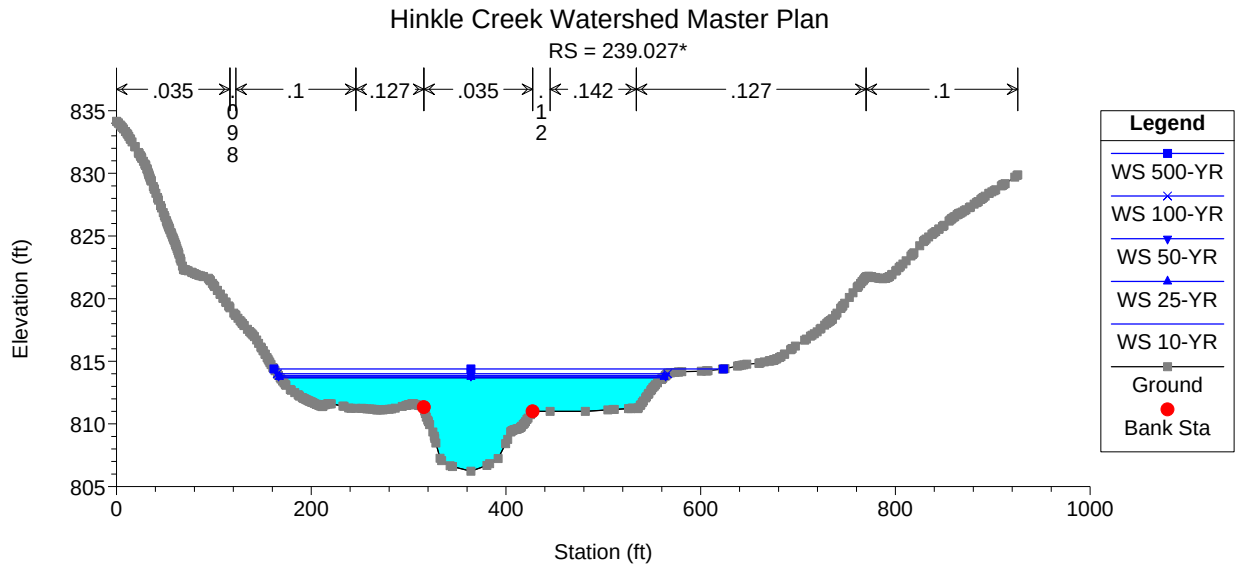

Hinkle Creek Watershed Master Plan
RS = 5727.515
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 5083.815
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 4455.624
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta

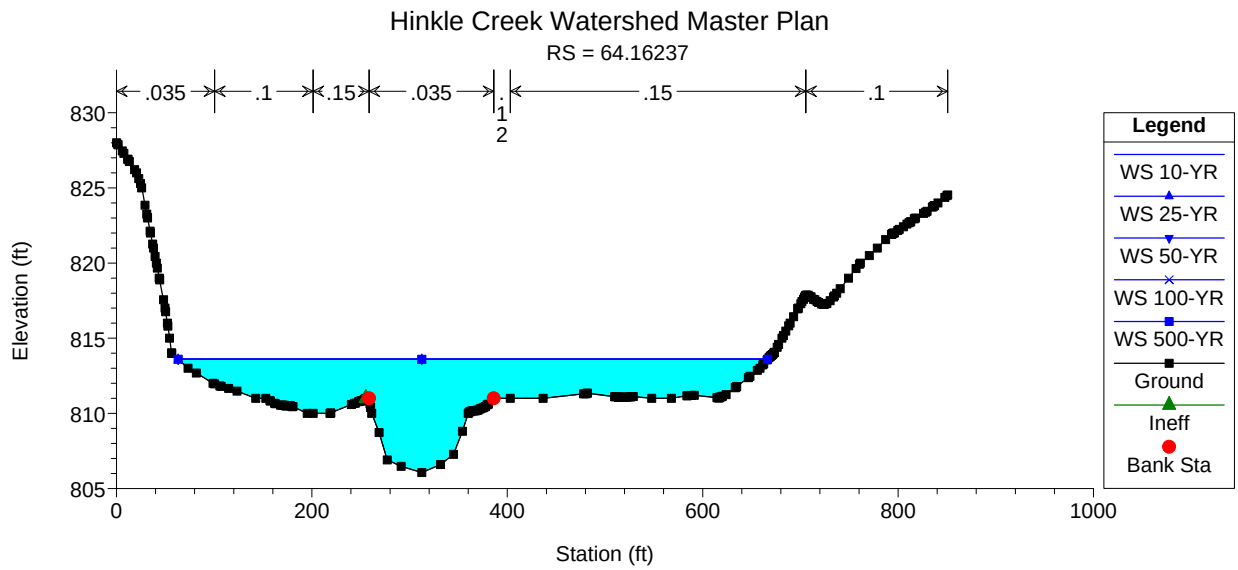

Hinkle Creek Watershed Master Plan
RS = 3600.797
.1
.035
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 2334.067
.1
.035
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta
Hinkle Creek Watershed Master Plan
RS = 1378.39
.035
.1
.12
.035
.12
.1
.035
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 763.6207
.035
.1
.035
.12
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Ineff
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 588.756*
.035
.099
.081
.035
.125
.109
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 413.891*
.035
.099
.104
.035
.133
.118
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 239.027*
.035
.1
.127
.035
.142
.127
.1
Elevation (ft)
Station (ft)
Legend
WS 500-YR
WS 100-YR
WS 50-YR
WS 25-YR
WS 10-YR
Ground
Bank Sta


Hinkle Creek Watershed Master Plan
RS = 64.16237
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.1
.15
.035
.15
.1
Elevation (ft)
Station (ft)
Legend
WS 10-YR
WS 25-YR
WS 50-YR
WS 100-YR
WS 500-YR
Ground
Ineff
Bank Sta

Isaac Jones Drain

HEC-RAS Modeling Output Files

HEC-RAS Plan: Revised IDNR River: Jones Ditch Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	4.554	100yr	1196.30	898.54	906.00	905.84	906.85	0.008081	8.59	296.54	160.79	0.63
1	4.554	FW	1196.30	898.54	906.01	905.73	907.13	0.009644	9.39	215.32	81.00	0.69
1	4.554	10yr	524.10	898.54	904.28	903.28	905.03	0.008833	7.08	87.32	42.18	0.62
1	4.554	50yr	986.00	898.54	905.53	905.53	906.48	0.009113	8.61	222.09	152.88	0.66
1	4.554	500yr	1658.20	898.54	906.83		907.58	0.006938	8.70	433.30	168.11	0.60
1	4.521	100yr	1196.30	897.49	905.18	904.33	905.70	0.004488	7.37	374.69	134.65	0.50
1	4.521	FW	1196.30	897.49	905.26	904.19	905.82	0.004570	7.50	332.04	95.00	0.50
1	4.521	10yr	524.10	897.49	903.17	901.91	903.75	0.005707	6.58	134.65	88.67	0.53
1	4.521	50yr	986.00	897.49	904.65	903.90	905.20	0.004820	7.24	304.85	129.29	0.51
1	4.521	500yr	1658.20	897.49	905.88	904.93	906.49	0.005015	8.32	470.90	141.24	0.54
1	4.392	100yr	1196.30	893.39	899.70	899.64	900.93	0.012621	10.40	240.43	124.23	0.80
1	4.392	FW	1196.30	893.39	899.85	899.71	901.08	0.011956	10.30	207.80	72.00	0.78
1	4.392	10yr	524.10	893.39	898.60	897.82	899.25	0.007809	6.98	126.05	90.87	0.61
1	4.392	50yr	986.00	893.39	899.43	899.34	900.47	0.011037	9.38	208.74	110.41	0.74
1	4.392	500yr	1658.20	893.39	900.57	900.57	901.70	0.010888	10.70	370.44	168.18	0.76
1	4.325	100yr	1196.30	891.28	897.95	897.18	898.27	0.004281	5.82	477.14	242.62	0.47
1	4.325	FW	1196.30	891.28	897.98	897.21	898.36	0.004647	6.09	408.33	171.00	0.49
1	4.325	10yr	524.10	891.28	896.58	895.58	896.93	0.005248	5.14	187.51	189.21	0.49
1	4.325	50yr	986.00	891.28	897.58	896.96	897.91	0.004492	5.65	392.15	226.32	0.47
1	4.325	500yr	1658.20	891.28	898.53	897.64	898.87	0.004367	6.34	622.93	259.72	0.48
1	4.202	100yr	1196.30	887.38	893.76		894.60	0.008178	8.67	249.94	100.49	0.66
1	4.202	FW	1196.30	887.38	893.90		894.69	0.007361	8.37	225.34	60.00	0.63
1	4.202	10yr	524.10	887.38	891.99		892.62	0.008859	6.89	110.98	60.66	0.65
1	4.202	50yr	986.00	887.38	893.28		894.08	0.008440	8.28	204.97	87.72	0.66
1	4.202	500yr	1658.20	887.38	895.04		895.74	0.005757	8.41	414.11	158.01	0.58
1	4.152	100yr	1196.30	885.79	893.71		893.84	0.000951	3.35	599.50	222.00	0.24
1	4.152	FW	1196.30	885.79	893.74		893.90	0.001124	3.65	457.67	113.00	0.26
1	4.152	10yr	524.10	885.79	891.46		891.62	0.001682	3.29	199.80	111.98	0.29
1	4.152	50yr	986.00	885.79	893.14		893.27	0.001096	3.37	475.81	205.77	0.25
1	4.152	500yr	1658.20	885.79	895.10		895.19	0.000624	3.11	935.55	262.15	0.20
1	4.105	100yr	1196.30	884.79	891.93	891.00	893.02	0.009554	8.55	153.14	171.47	0.68
1	4.105	FW	1196.30	884.79	891.96	891.00	893.03	0.009323	8.48	154.74	50.24	0.68
1	4.105	10yr	524.10	884.79	889.78	889.17	890.54	0.013401	6.96	75.31	27.24	0.74
1	4.105	50yr	986.00	884.79	891.41	890.48	892.41	0.009933	8.09	127.44	102.67	0.68
1	4.105	500yr	1658.20	884.79	893.91	892.23	894.68	0.004609	7.46	254.58	266.01	0.50
1	4.101		Bridge									
1	4.082	100yr	1196.30	884.45	890.28	890.23	891.60	0.011669	9.89	160.37	173.87	0.79
1	4.082	FW	1196.30	884.45	890.23	890.22	891.61	0.012268	10.07	157.33	60.40	0.81
1	4.082	10yr	524.10	884.45	888.54	888.13	889.41	0.012474	7.62	75.78	33.22	0.76
1	4.082	50yr	986.00	884.45	889.84	889.81	891.09	0.012018	9.42	134.20	118.06	0.79
1	4.082	500yr	1658.20	884.45	891.07	890.95	892.57	0.011511	10.85	209.54	221.76	0.80
1	4.05	100yr	1196.30	883.18	888.86		889.77	0.007787	8.91	246.15	106.63	0.68
1	4.05	FW	1196.30	883.18	889.00		889.79	0.006648	8.38	256.44	94.34	0.63
1	4.05	10yr	524.10	883.18	887.58		887.98	0.004455	5.63	141.67	63.90	0.49
1	4.05	50yr	986.00	883.18	888.53		889.31	0.006975	8.09	213.52	92.84	0.63
1	4.05	500yr	1658.20	883.18	889.48	889.08	890.63	0.009070	10.34	325.50	155.31	0.74
1	3.993	100yr	1196.30	880.93	886.88	886.88	887.48	0.006333	7.70	383.04	410.14	0.58
1	3.993	FW	1196.30	880.93	886.99	886.98	887.67	0.006687	8.02	335.05	230.09	0.60
1	3.993	10yr	524.10	880.93	885.60	884.49	886.28	0.006974	6.75	91.06	36.49	0.59
1	3.993	50yr	986.00	880.93	886.70	886.70	887.26	0.005791	7.20	328.62	392.93	0.55
1	3.993	500yr	1658.20	880.93	887.19	887.19	887.87	0.007579	8.74	475.82	447.17	0.64
1	3.917	100yr	1196.30	877.94	883.80	883.53	883.94	0.005341	4.61	648.48	627.95	0.47
1	3.917	FW	1196.30	877.94	883.90	883.85	884.24	0.009716	6.27	434.84	401.53	0.64
1	3.917	10yr	524.10	877.94	882.87	882.68	883.17	0.007784	5.21	210.77	264.05	0.55
1	3.917	50yr	986.00	877.94	883.62	883.28	883.78	0.005500	4.62	550.05	611.79	0.47
1	3.917	500yr	1658.20	877.94	884.10	883.70	884.23	0.005458	4.77	826.64	741.10	0.48
1	3.851	100yr	1196.30	875.38	882.16	881.70	882.30	0.004267	4.54	543.24	818.09	0.41
1	3.851	FW	1196.30	875.38	882.27	881.70	882.38	0.003150	3.97	605.07	568.50	0.35
1	3.851	10yr	524.10	875.38	881.70	881.24	881.78	0.002160	2.97	333.76	563.50	0.28
1	3.851	50yr	986.00	875.38	882.05	881.59	882.19	0.003935	4.28	482.96	799.40	0.39
1	3.851	500yr	1658.20	875.38	882.41	882.00	882.56	0.004384	4.79	687.16	869.68	0.42
1	3.85		Culvert									
1	3.842	100yr	1196.30	875.38	882.14	881.56	882.17	0.001503	2.70	997.13	1031.64	0.20
1	3.842	FW	1196.30	875.38	882.24	881.56	882.30	0.002029	3.14	759.06	650.17	0.23

HEC-RAS Plan: Revised IDNR River: Jones Ditch Reach: 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	3.842	10yr	524.10	875.38	881.50	881.10	881.58	0.002238	3.24	344.89	659.04	0.24
1	3.842	50yr	986.00	875.38	881.97	881.43	882.04	0.002777	3.65	583.28	960.80	0.27
1	3.842	500yr	1658.20	875.38	882.43	881.68	882.46	0.001314	2.54	1298.51	1056.94	0.19
1	3.828	100yr	1603.60	874.79	882.05	881.20	882.11	0.001532	3.08	1015.56	1074.49	0.27
1	3.828	FW	1603.60	874.79	882.18	881.23	882.24	0.001400	3.00	1017.11	698.99	0.26
1	3.828	10yr	708.90	874.79	881.47	879.58	881.51	0.000899	2.24	622.68	819.88	0.20
1	3.828	50yr	1322.40	874.79	881.91	881.06	881.97	0.001336	2.84	915.07	1021.82	0.25
1	3.828	500yr	2213.40	874.79	882.33	881.41	882.40	0.001687	3.37	1223.55	1101.28	0.28
1	3.769	100yr	1603.60	872.38	881.93	879.81	881.94	0.000220	1.43	2075.64	1088.27	0.10
1	3.769	FW	1603.60	872.38	882.00	879.97	882.02	0.000347	1.80	1520.18	722.11	0.13
1	3.769	10yr	708.90	872.38	881.42	877.58	881.42	0.000098	0.90	1471.03	1025.82	0.07
1	3.769	50yr	1322.40	872.38	881.81	879.87	881.82	0.000189	1.31	1800.22	1072.96	0.09
1	3.769	500yr	2213.40	872.38	882.16	880.41	882.18	0.000312	1.74	2334.40	1299.30	0.12
1	3.763		Bridge									
1	3.746	100yr	1603.60	872.62	878.45	878.45	880.49	0.021808	11.46	139.88	650.71	1.00
1	3.746	FW	1603.60	872.62	878.45	878.45	880.49	0.021849	11.47	139.79	539.72	1.00
1	3.746	10yr	708.90	872.62	878.11	876.37	878.58	0.005432	5.53	128.31	505.98	0.49
1	3.746	50yr	1322.40	872.62	878.03	877.88	879.75	0.019972	10.51	125.82	491.11	0.95
1	3.746	500yr	2213.40	872.62	879.81	879.81	881.90	0.017754	11.64	196.38	1316.03	0.92
1	3.638	100yr	1603.60	871.51	877.00		877.10	0.001915	3.76	882.52	1442.65	0.32
1	3.638	FW	1603.60	871.51	877.09		877.17	0.001333	3.18	862.85	530.00	0.27
1	3.638	10yr	708.90	871.51	875.58		875.76	0.004542	4.44	288.55	1174.12	0.46
1	3.638	50yr	1322.40	871.51	876.65		876.74	0.001764	3.41	710.32	1356.45	0.30
1	3.638	500yr	2213.40	871.51	880.33		880.33	0.000026	0.64	5966.03	1604.67	0.04
1	3.52	100yr	1603.60	870.30	876.57		876.59	0.000436	2.21	2216.55	1137.03	0.16
1	3.52	FW	1603.60	870.30	876.71		876.73	0.000415	2.19	1743.43	551.00	0.16
1	3.52	10yr	708.90	870.30	874.90		874.93	0.000593	2.07	803.49	773.09	0.18
1	3.52	50yr	1322.40	870.30	876.01		876.04	0.000759	2.72	1586.20	1107.75	0.21
1	3.52	500yr	2213.40	870.30	880.31		880.32	0.000027	0.76	6785.36	1283.25	0.04
1	3.44	100yr	1603.60	869.48	876.36	873.98	876.38	0.000420	2.05	2136.40	1081.71	0.15
1	3.44	FW	1603.60	869.48	876.44	873.98	876.49	0.000784	2.83	1259.95	412.63	0.21
1	3.44	10yr	708.90	869.48	874.16	873.57	874.38	0.004054	4.64	365.68	944.13	0.43
1	3.44	50yr	1322.40	869.48	875.58	873.98	875.63	0.001081	2.99	1311.70	1041.47	0.23
1	3.44	500yr	2213.40	869.48	880.30	874.79	880.30	0.000024	0.69	6822.33	1378.04	0.04
1	3.284	100yr	1603.60	867.88	876.23	872.38	876.24	0.000102	1.12	3207.75	1183.37	0.08
1	3.284	FW	1603.60	867.88	876.27	872.38	876.28	0.000126	1.25	2247.88	479.00	0.09
1	3.284	10yr	708.90	867.88	873.19	872.00	873.22	0.000704	1.92	783.97	1053.40	0.18
1	3.284	50yr	1322.40	867.88	875.25	872.25	875.27	0.000256	1.59	2059.77	1151.22	0.12
1	3.284	500yr	2213.40	867.88	880.29	872.63	880.29	0.000010	0.48	8183.29	1257.76	0.03
1	3.187	100yr	1603.60	866.88	876.19		876.20	0.000055	0.97	3301.56	932.72	0.06
1	3.187	FW	1603.60	866.88	876.22		876.23	0.000067	1.07	2459.65	491.00	0.07
1	3.187	10yr	708.90	866.88	872.92		872.94	0.000364	1.78	872.25	830.68	0.14
1	3.187	50yr	1322.40	866.88	875.17		875.17	0.000108	1.24	2355.68	909.11	0.08
1	3.187	500yr	2213.40	866.88	880.29		880.29	0.000009	0.50	7249.59	991.90	0.02
1	3.022	100yr	1603.60	865.19	875.47	871.58	875.92	0.002608	5.46	327.43	593.82	0.37
1	3.022	FW	1603.60	865.19	875.47	871.58	875.92	0.002604	5.46	327.76	90.01	0.37
1	3.022	10yr	708.90	865.19	871.64	869.20	872.06	0.004149	5.21	136.10	30.82	0.44
1	3.022	50yr	1322.40	865.19	874.24	870.94	874.75	0.003763	5.72	234.66	173.61	0.43
1	3.022	500yr	2213.40	865.19	880.07	872.80	880.22	0.000511	3.44	811.44	1396.20	0.18
1	3.012		Bridge									
1	2.976	100yr	1603.60	865.08	871.60		872.58	0.005993	8.65	249.43	474.85	0.61
1	2.976	FW	1603.60	865.08	871.69		872.63	0.005643	8.48	256.18	74.12	0.59
1	2.976	10yr	708.90	865.08	870.12		870.57	0.003587	5.60	148.63	50.16	0.45
1	2.976	50yr	1322.40	865.08	871.15		872.02	0.005653	8.00	216.88	441.61	0.58
1	2.976	500yr	2213.40	865.08	872.52		873.70	0.006305	9.73	321.17	1052.99	0.64
1	2.91	100yr	1745.10	864.54	871.86	868.38	871.88	0.000244	1.58	1719.65	1031.50	0.11
1	2.91	FW	1745.10	864.54	871.94	868.37	871.96	0.000229	1.54	1755.53	486.00	0.11
1	2.91	10yr	781.20	864.54	870.12	867.85	870.14	0.000263	1.31	972.50	889.13	0.11
1	2.91	50yr	1439.70	864.54	871.35	868.23	871.37	0.000251	1.51	1502.20	988.34	0.11
1	2.91	500yr	2414.20	864.54	872.89	868.66	872.91	0.000229	1.69	2164.65	1073.24	0.11
1	2.701	100yr	1745.10	862.85	871.55	868.85	871.57	0.000333	2.02	1686.00	683.93	0.14
1	2.701	FW	1745.10	862.85	871.59	868.85	871.63	0.000417	2.27	1288.50	460.00	0.16
1	2.701	10yr	781.20	862.85	869.69	867.83	869.73	0.000589	2.14	651.60	539.98	0.18
1	2.701	50yr	1439.70	862.85	871.01	868.68	871.04	0.000388	2.05	1385.96	669.04	0.15

HEC-RAS Plan: Revised IDNR River: Jones Ditch Reach: 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	2.701	500yr	2414.20	862.85	872.62	869.20	872.65	0.000271	2.01	2385.47	711.88	0.13
1	2.553	100yr	1745.10	861.65	871.34	868.30	871.36	0.000225	1.91	1848.90	548.19	0.12
1	2.553	FW	1745.10	861.65	871.37	868.30	871.40	0.000223	1.91	1723.60	441.00	0.12
1	2.553	10yr	781.20	861.65	869.35	866.28	869.38	0.000348	1.98	835.19	435.72	0.14
1	2.553	50yr	1439.70	861.65	870.77	867.97	870.80	0.000254	1.94	1542.50	533.85	0.12
1	2.553	500yr	2414.20	861.65	872.45	868.65	872.47	0.000187	1.90	2472.66	573.23	0.11
1	2.461	100yr	1745.10	860.90	871.05	868.45	871.15	0.000722	3.37	835.58	622.92	0.21
1	2.461	FW	1745.10	860.90	871.08	868.45	871.19	0.000726	3.38	842.38	198.00	0.21
1	2.461	10yr	781.20	860.90	869.01	865.30	869.11	0.000804	2.94	431.42	533.51	0.21
1	2.461	50yr	1439.70	860.90	870.47	866.91	870.57	0.000745	3.26	721.28	596.45	0.21
1	2.461	500yr	2414.20	860.90	872.17	868.99	872.29	0.000687	3.57	1058.20	670.77	0.21
1	2.448		Bridge									
1	2.429	100yr	1745.10	861.00	870.01	867.56	870.25	0.001472	4.59	515.03	631.59	0.30
1	2.429	FW	1745.10	861.00	870.09	867.55	870.31	0.001405	4.51	522.99	115.00	0.29
1	2.429	10yr	781.20	861.00	868.63	865.37	868.73	0.000789	2.93	367.34	533.90	0.21
1	2.429	50yr	1439.70	861.00	869.63	867.23	869.82	0.001285	4.14	473.83	592.01	0.27
1	2.429	500yr	2414.20	861.00	870.72	868.16	871.05	0.001857	5.48	590.63	657.02	0.34
1	2.343	100yr	1745.10	860.12	869.79		869.83	0.000409	2.44	1664.83	626.74	0.15
1	2.343	FW	1745.10	860.12	869.86		869.90	0.000422	2.49	1486.10	482.00	0.15
1	2.343	10yr	781.20	860.12	868.41		868.45	0.000431	2.22	833.76	566.42	0.15
1	2.343	50yr	1439.70	860.12	869.39		869.43	0.000426	2.41	1417.50	612.19	0.15
1	2.343	500yr	2414.20	860.12	870.52		870.56	0.000407	2.58	2172.34	766.76	0.15
1	2.253	100yr	1745.10	859.21	869.60	866.97	869.64	0.000442	2.52	1860.55	748.35	0.15
1	2.253	FW	1745.10	859.21	869.68	866.98	869.72	0.000388	2.38	1600.91	420.00	0.14
1	2.253	10yr	781.20	859.21	868.26	863.71	868.28	0.000291	1.83	1018.07	482.65	0.12
1	2.253	50yr	1439.70	859.21	869.19	866.63	869.23	0.000484	2.55	1550.99	733.33	0.16
1	2.253	500yr	2414.20	859.21	870.35	867.37	870.38	0.000406	2.55	2424.68	770.95	0.15
1	2.188	100yr	3011.30	858.54	869.31		869.41	0.000803	3.75	1701.70	561.08	0.22
1	2.188	FW	3011.30	858.54	869.39		869.50	0.000817	3.80	1608.97	488.67	0.22
1	2.188	10yr	1376.40	858.54	868.04		868.12	0.000589	2.90	1011.48	527.95	0.19
1	2.188	50yr	2471.70	858.54	868.89		868.99	0.000789	3.60	1469.93	550.82	0.22
1	2.188	500yr	4154.30	858.54	870.04		870.15	0.000850	4.07	2117.60	578.72	0.23
1	2.052	100yr	3011.30	857.16	868.77	866.64	868.88	0.000722	3.99	1827.05	582.97	0.21
1	2.052	FW	3011.30	857.16	868.87	866.64	868.97	0.000691	3.93	1744.42	468.98	0.21
1	2.052	10yr	1376.40	857.16	867.73	862.44	867.79	0.000364	2.65	1249.29	559.98	0.15
1	2.052	50yr	2471.70	857.16	868.37	864.62	868.48	0.000685	3.79	1597.18	574.88	0.21
1	2.052	500yr	4154.30	857.16	869.45	867.29	869.57	0.000810	4.40	2227.65	596.34	0.23
1	1.969	100yr	3011.30	856.31	868.51	866.38	868.59	0.000605	3.31	2118.87	939.69	0.19
1	1.969	FW	3011.30	856.31	868.61	866.38	868.69	0.000604	3.33	1818.99	511.00	0.19
1	1.969	10yr	1376.40	856.31	867.61	862.18	867.65	0.000284	2.12	1415.92	877.08	0.13
1	1.969	50yr	2471.70	856.31	868.11	864.38	868.19	0.000624	3.27	1746.24	918.65	0.19
1	1.969	500yr	4154.30	856.31	869.19	866.83	869.26	0.000599	3.44	2765.85	972.40	0.19
1	1.899	100yr	3011.30	855.59	868.44	864.37	868.46	0.000167	1.76	3158.38	912.36	0.10
1	1.899	FW	3011.30	855.59	868.49	864.37	868.53	0.000294	2.34	2094.85	500.00	0.13
1	1.899	10yr	1376.40	855.59	867.40	861.27	867.50	0.000486	2.78	627.42	862.15	0.17
1	1.899	50yr	2471.70	855.59	868.05	863.73	868.06	0.000157	1.66	2802.79	889.15	0.10
1	1.899	500yr	4154.30	855.59	869.10	866.15	869.13	0.000193	1.98	3777.11	956.41	0.11
1	1.891		Bridge									
1	1.877	100yr	3011.30	855.97	867.56	865.72	867.59	0.000259	2.06	2851.14	834.57	0.12
1	1.877	FW	3011.30	855.97	867.69	865.71	867.73	0.000361	2.45	2200.65	563.00	0.14
1	1.877	10yr	1376.40	855.97	865.47	861.48	865.85	0.002271	5.13	346.50	763.32	0.34
1	1.877	50yr	2471.70	855.97	866.73	863.72	867.28	0.003076	6.65	526.92	807.82	0.40
1	1.877	500yr	4154.30	855.97	868.89	866.61	868.91	0.000183	1.89	3997.89	891.31	0.10
1	1.816	100yr	3011.30	855.89	867.49	864.87	867.51	0.000165	1.76	3130.90	781.88	0.10
1	1.816	FW	3011.30	855.89	867.59	864.88	867.62	0.000230	2.08	2517.81	572.00	0.12
1	1.816	10yr	1376.40	855.89	865.20	861.05	865.30	0.000782	3.21	827.64	734.96	0.20
1	1.816	50yr	2471.70	855.89	866.82	864.64	866.85	0.000193	1.81	2611.22	773.57	0.10
1	1.816	500yr	4154.30	855.89	868.84	865.28	868.86	0.000128	1.68	4195.48	802.03	0.09
1	1.692	100yr	3011.30	855.73	867.40	863.61	867.42	0.000135	1.55	3159.29	674.61	0.09
1	1.692	FW	3011.30	855.73	867.48	863.60	867.50	0.000163	1.71	2702.14	519.00	0.10
1	1.692	10yr	1376.40	855.73	865.03	861.12	865.05	0.000211	1.61	1603.98	635.64	0.10
1	1.692	50yr	2471.70	855.73	866.73	863.51	866.74	0.000145	1.53	2705.78	663.73	0.09
1	1.692	500yr	4154.30	855.73	868.76	863.93	868.78	0.000117	1.57	4094.02	698.48	0.08

HEC-RAS Plan: Revised IDNR River: Jones Ditch Reach: 1 (Continued)

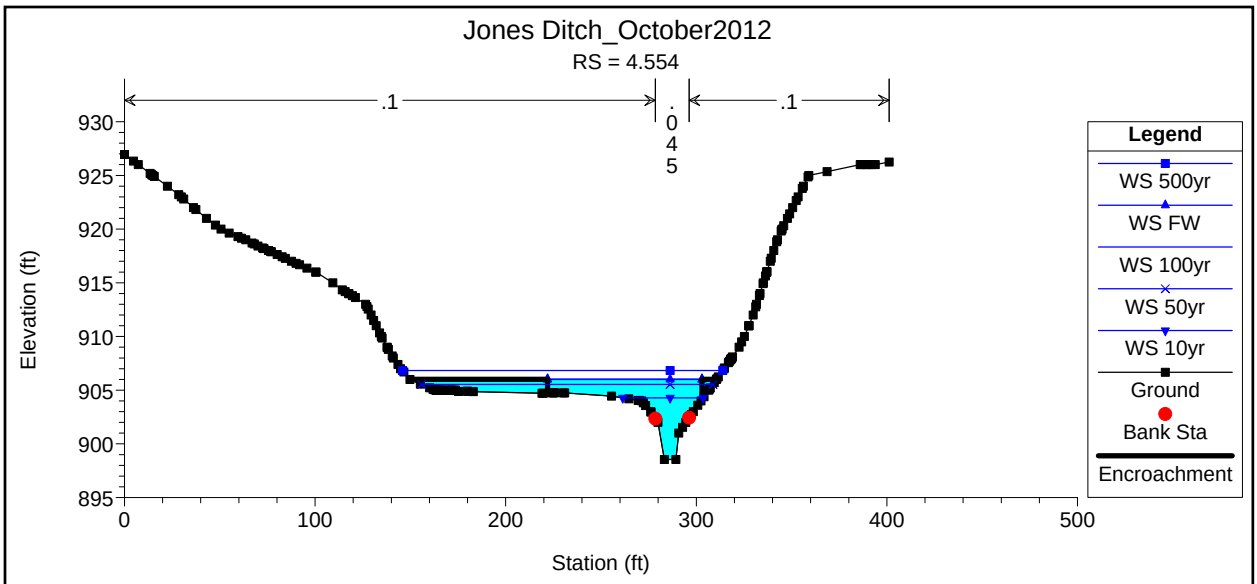
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	1.54	100yr	3011.30	855.53	867.32		867.33	0.000096	1.41	3533.70	687.99	0.08
1	1.54	FW	3011.30	855.53	867.36		867.38	0.000135	1.67	2779.48	474.00	0.09
1	1.54	10yr	1376.40	855.53	864.91		864.92	0.000124	1.33	1929.00	643.48	0.08
1	1.54	50yr	2471.70	855.53	866.63		866.65	0.000100	1.37	3067.87	676.30	0.08
1	1.54	500yr	4154.30	855.53	868.69		868.70	0.000088	1.46	4490.79	708.51	0.08
1	1.486	100yr	3011.30	855.46	867.17	863.26	867.25	0.000469	3.10	1507.77	589.94	0.17
1	1.486	FW	3011.30	855.46	867.22	863.25	867.30	0.000478	3.14	1518.97	252.00	0.17
1	1.486	10yr	1376.40	855.46	864.79	861.69	864.84	0.000446	2.53	906.78	551.79	0.16
1	1.486	50yr	2471.70	855.46	866.50	862.95	866.57	0.000456	2.92	1338.26	582.10	0.17
1	1.486	500yr	4154.30	855.46	868.53	863.77	868.63	0.000472	3.38	1848.93	614.24	0.17
1	1.468		Bridge									
1	1.452	100yr	3011.30	855.01	865.90	863.93	866.52	0.003032	7.12	606.91	492.22	0.42
1	1.452	FW	3011.30	855.01	865.97	863.93	866.58	0.002972	7.08	611.48	123.00	0.42
1	1.452	10yr	1376.40	855.01	864.25	860.30	864.54	0.001726	4.68	404.68	418.74	0.31
1	1.452	50yr	2471.70	855.01	865.50	862.77	866.00	0.002563	6.34	557.21	477.37	0.38
1	1.452	500yr	4154.30	855.01	866.74	864.88	867.57	0.003756	8.41	708.86	524.71	0.47
1	1.408	100yr	3323.40	854.78	865.57	864.13	865.81	0.001791	5.48	1349.74	481.42	0.32
1	1.408	FW	3323.40	854.78	865.64	864.10	865.88	0.001795	5.51	1292.15	374.00	0.32
1	1.408	10yr	1558.10	854.78	863.84	860.62	864.12	0.001916	4.95	655.25	351.13	0.32
1	1.408	50yr	2696.50	854.78	865.17	863.66	865.39	0.001682	5.16	1179.39	463.23	0.30
1	1.408	500yr	4575.10	854.78	866.50	864.75	866.72	0.001670	5.64	1737.31	514.98	0.31
1	1.304	100yr	3323.40	854.23	865.23		865.29	0.000485	2.95	1979.14	527.16	0.17
1	1.304	FW	3323.40	854.23	865.31		865.37	0.000469	2.91	1815.82	400.00	0.16
1	1.304	10yr	1558.10	854.23	863.50		863.56	0.000513	2.67	1113.83	460.40	0.16
1	1.304	50yr	2696.50	854.23	864.87		864.92	0.000426	2.70	1790.21	517.78	0.15
1	1.304	500yr	4575.10	854.23	866.16		866.23	0.000475	3.10	2479.38	548.59	0.17
1	1.168	100yr	3323.40	853.51	864.91		864.96	0.000431	2.71	2000.60	496.23	0.16
1	1.168	FW	3323.40	853.51	864.99		865.05	0.000425	2.71	1897.19	416.00	0.16
1	1.168	10yr	1558.10	853.51	863.16		863.21	0.000448	2.41	1160.74	461.40	0.15
1	1.168	50yr	2696.50	853.51	864.59		864.64	0.000360	2.42	1845.88	492.19	0.14
1	1.168	500yr	4575.10	853.51	865.84		865.90	0.000433	2.89	2466.90	506.45	0.16
1	1.046	100yr	3323.40	852.87	864.63		864.68	0.000411	2.65	1985.94	623.53	0.16
1	1.046	FW	3323.40	852.87	864.73		864.78	0.000381	2.57	2035.91	527.23	0.15
1	1.046	10yr	1558.10	852.87	862.87		862.92	0.000434	2.35	1156.77	459.14	0.15
1	1.046	50yr	2696.50	852.87	864.37		864.41	0.000330	2.32	1861.06	602.15	0.14
1	1.046	500yr	4575.10	852.87	865.55		865.61	0.000427	2.88	2438.87	694.22	0.16
1	0.996	100yr	3323.40	852.60	864.29	862.29	864.47	0.001185	4.70	1966.48	676.28	0.27
1	0.996	FW	3323.40	852.60	864.41	862.30	864.58	0.001104	4.58	1825.08	503.00	0.26
1	0.996	10yr	1558.10	852.60	862.35	858.61	862.67	0.001739	4.89	520.83	496.51	0.31
1	0.996	50yr	2696.50	852.60	864.10	860.81	864.24	0.000906	4.06	1841.88	667.18	0.23
1	0.996	500yr	4575.10	852.60	865.24	863.26	865.40	0.001112	4.85	2624.61	711.88	0.26
1	0.974	100yr	3323.40	852.49	864.23	859.62	864.34	0.000564	3.85	2424.44	621.06	0.20
1	0.974	FW	3323.40	852.49	864.35	859.62	864.46	0.000525	3.75	2326.71	513.00	0.20
1	0.974	10yr	1558.10	852.49	862.34	857.34	862.47	0.000570	3.42	699.50	548.22	0.20
1	0.974	50yr	2696.50	852.49	864.06	859.00	864.14	0.000413	3.26	2321.31	617.29	0.17
1	0.974	500yr	4575.10	852.49	865.16	860.73	865.28	0.000616	4.25	3011.28	640.73	0.22
1	0.972		Bridge									
1	0.953	100yr	3323.40	852.69	863.75	861.86	863.90	0.001033	4.54	1491.47	551.52	0.25
1	0.953	FW	3323.40	852.69	863.81	861.86	863.96	0.001002	4.49	1491.31	418.08	0.25
1	0.953	10yr	1558.10	852.69	861.72	858.56	862.19	0.002381	5.92	351.04	340.11	0.37
1	0.953	50yr	2696.50	852.69	862.92	860.57	863.71	0.003596	8.00	474.81	507.33	0.47
1	0.953	500yr	4575.10	852.69	864.75	862.97	864.92	0.001131	5.07	2052.75	616.60	0.27
1	0.911	100yr	3323.40	852.48	862.90	861.61	863.46	0.003298	7.92	681.62	477.33	0.44
1	0.911	FW	3323.40	852.48	862.99	861.61	863.54	0.003163	7.80	696.51	160.21	0.43
1	0.911	10yr	1558.10	852.48	861.26	858.79	861.64	0.002397	6.00	426.10	342.17	0.36
1	0.911	50yr	2696.50	852.48	862.38	861.19	862.89	0.003063	7.37	600.03	451.71	0.42
1	0.911	500yr	4575.10	852.48	864.65	862.30	864.74	0.000673	3.98	2250.06	562.81	0.20
1	0.835	100yr	3323.40	852.10	862.74		862.81	0.000643	3.09	1815.38	1221.83	0.19
1	0.835	FW	3323.40	852.10	862.78		862.87	0.000714	3.27	1572.79	419.00	0.20
1	0.835	10yr	1558.10	852.10	860.91		860.99	0.000893	3.06	839.30	647.85	0.22
1	0.835	50yr	2696.50	852.10	862.13		862.22	0.000752	3.17	1441.10	1065.19	0.21
1	0.835	500yr	4575.10	852.10	864.50		864.55	0.000321	2.50	2932.69	1385.16	0.14
1	0.716	100yr	3323.40	851.51	862.33		862.39	0.000662	3.26	2274.09	1183.22	0.19
1	0.716	FW	3323.40	851.51	862.32		862.41	0.000713	3.38	1769.45	416.00	0.20

HEC-RAS Plan: Revised IDNR River: Jones Ditch Reach: 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	0.716	10yr	1558.10	851.51	860.29		860.38	0.001018	3.41	936.50	1123.20	0.23
1	0.716	50yr	2696.50	851.51	861.62		861.70	0.000853	3.50	1724.80	1165.56	0.21
1	0.716	500yr	4575.10	851.51	864.32		864.35	0.000280	2.42	3918.18	1226.18	0.13
1	0.562	100yr	3323.40	850.75	861.81		861.89	0.000584	2.99	1731.17	438.07	0.18
1	0.562	FW	3323.40	850.75	861.83		861.89	0.000547	2.79	1681.87	369.00	0.17
1	0.562	10yr	1558.10	850.75	859.53		859.61	0.000884	2.97	843.55	345.46	0.21
1	0.562	50yr	2696.50	850.75	861.00		861.08	0.000689	3.03	1389.57	399.79	0.19
1	0.562	500yr	4575.10	850.75	864.07		864.11	0.000297	2.50	2840.01	544.67	0.14
1	0.408	100yr	3323.40	849.98	861.31		861.39	0.000627	3.28	1893.80	611.36	0.19
1	0.408	FW	3323.40	849.98	861.34		861.42	0.000622	3.27	1907.22	534.13	0.19
1	0.408	10yr	1558.10	849.98	858.56		858.70	0.001416	3.88	684.48	359.35	0.27
1	0.408	50yr	2696.50	849.98	860.35		860.45	0.000854	3.55	1401.41	564.57	0.22
1	0.408	500yr	4575.10	849.98	863.84		863.88	0.000258	2.48	3482.11	776.91	0.13
1	0.309	100yr	3323.40	849.49	861.17	857.07	861.20	0.000211	2.16	3578.02	1026.14	0.12
1	0.309	FW	3323.40	849.49	861.20	857.07	861.23	0.000208	2.15	3524.29	981.00	0.12
1	0.309	10yr	1558.10	849.49	858.22	854.20	858.28	0.000480	2.61	1260.88	658.42	0.17
1	0.309	50yr	2696.50	849.49	860.14	856.58	860.18	0.000308	2.43	2565.50	929.58	0.14
1	0.309	500yr	4575.10	849.49	863.80	857.77	863.81	0.000075	1.50	6372.70	1104.34	0.07
1	0.276	100yr	3323.40	849.33	861.16	857.08	861.17	0.000096	1.47	4698.17	1016.03	0.08
1	0.276	FW	3323.40	849.33	861.19	857.08	861.20	0.000092	1.44	4722.14	996.00	0.08
1	0.276	10yr	1558.10	849.33	858.00	855.62	858.14	0.001048	3.84	657.09	751.83	0.25
1	0.276	50yr	2696.50	849.33	860.13	856.64	860.14	0.000132	1.61	3668.18	976.53	0.09
1	0.276	500yr	4575.10	849.33	863.79	857.79	863.80	0.000044	1.15	7476.25	1093.55	0.06
1	0.267		Bridge									
1	0.251	100yr	3323.40	849.07	861.13	857.53	861.14	0.000105	1.52	4226.90	923.44	0.08
1	0.251	FW	3323.40	849.07	861.16	857.53	861.17	0.000102	1.50	4159.02	841.19	0.08
1	0.251	10yr	1558.10	849.07	857.46	854.71	857.82	0.002272	5.34	398.79	673.66	0.36
1	0.251	50yr	2696.50	849.07	860.03	857.04	860.04	0.000143	1.65	3246.35	858.38	0.09
1	0.251	500yr	4575.10	849.07	863.76	858.32	863.77	0.000051	1.22	6819.05	1039.23	0.06
1	0.231	100yr	3323.40	849.00	861.10	856.72	861.12	0.000179	2.04	3241.13	810.31	0.11
1	0.231	FW	3323.40	849.00	861.13	856.72	861.15	0.000183	2.06	3031.28	679.52	0.11
1	0.231	10yr	1558.10	849.00	857.44	854.15	857.56	0.000913	3.54	721.80	444.06	0.23
1	0.231	50yr	2696.50	849.00	859.99	856.39	860.02	0.000247	2.23	2400.39	708.86	0.12
1	0.231	500yr	4575.10	849.00	863.75	857.24	863.76	0.000085	1.62	5690.18	1003.32	0.08
1	0.153	100yr	3323.40	848.76	861.08	855.01	861.09	0.000047	1.07	5115.79	909.33	0.06
1	0.153	FW	3323.40	848.76	861.11	855.01	861.12	0.000044	1.04	4861.98	743.00	0.05
1	0.153	10yr	1558.10	848.76	857.40	854.24	857.42	0.000154	1.50	1624.00	708.30	0.09
1	0.153	50yr	2696.50	848.76	859.97	854.82	859.97	0.000056	1.10	4122.11	866.59	0.06
1	0.153	500yr	4575.10	848.76	863.74	855.37	863.74	0.000028	0.95	7635.21	1005.15	0.04
1	0.113	100yr	3323.40	848.63	861.05		861.07	0.000085	1.47	4039.39	580.40	0.07
1	0.113	FW	3323.40	848.63	861.08		861.10	0.000090	1.52	3630.88	457.00	0.08
1	0.113	10yr	1558.10	848.63	857.35		857.37	0.000152	1.54	1995.02	521.35	0.09
1	0.113	50yr	2696.50	848.63	859.94		859.95	0.000094	1.45	3400.24	565.06	0.08
1	0.113	500yr	4575.10	848.63	863.72		863.73	0.000060	1.41	5639.24	643.08	0.06
1	0.081	100yr	3323.40	848.53	861.01	854.32	861.04	0.000186	2.24	2761.31	351.41	0.11
1	0.081	FW	3323.40	848.53	861.03	854.32	861.07	0.000202	2.34	2458.07	277.00	0.12
1	0.081	10yr	1558.10	848.53	857.30	853.44	857.33	0.000247	2.02	1505.62	325.36	0.12
1	0.081	50yr	2696.50	848.53	859.89	854.05	859.92	0.000193	2.14	2373.36	344.14	0.11
1	0.081	500yr	4575.10	848.53	863.68	854.79	863.71	0.000143	2.25	3720.52	367.29	0.10
1	0.03	100yr	6800.00	846.80	858.79	855.99	860.47	0.006252	10.42	652.90	75.63	0.62
1	0.03	FW	6800.00	846.80	858.79	855.99	860.48	0.006235	10.41	653.39	75.58	0.62
1	0.03	10yr	3400.00	846.80	855.88	852.92	856.77	0.004465	7.59	447.77	65.35	0.51
1	0.03	50yr	5700.00	846.80	857.89	855.10	859.36	0.005904	9.71	586.76	72.47	0.60
1	0.03	500yr	9100.00	846.80	862.76	857.64	863.41	0.002164	7.24	2222.30	814.00	0.38
1	0.025		Bridge									
1	0.02	100yr	6800.00	846.80	857.80		859.94	0.008675	11.72	580.06	72.15	0.73
1	0.02	FW	6800.00	846.80	857.82		859.95	0.008582	11.69	581.52	71.82	0.72
1	0.02	10yr	3400.00	846.80	855.53		856.52	0.005165	8.00	425.13	64.12	0.55
1	0.02	50yr	5700.00	846.80	857.15		858.92	0.007686	10.68	533.65	69.84	0.68
1	0.02	500yr	9100.00	846.80	858.67	857.64	861.77	0.011643	14.14	643.73	75.20	0.85
1	0.01	100yr	6800.00	846.80	858.00	855.40	859.43	0.005231	9.66	750.38	138.00	0.58
1	0.01	FW	6800.00	846.80	858.00	855.40	859.49	0.005373	9.79	696.36	83.00	0.59
1	0.01	10yr	3400.00	846.80	855.60	852.64	856.32	0.003927	6.83	498.00	79.88	0.48
1	0.01	50yr	5700.00	846.80	857.30	854.62	858.52	0.004986	8.90	660.64	118.40	0.56

HEC-RAS Plan: Revised IDNR River: Jones Ditch Reach: 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	0.01	500yr	9100.00	846.80	859.00	856.92	860.93	0.006210	11.34	902.38	166.00	0.65


Jones Ditch_October2012
RS = 4.554
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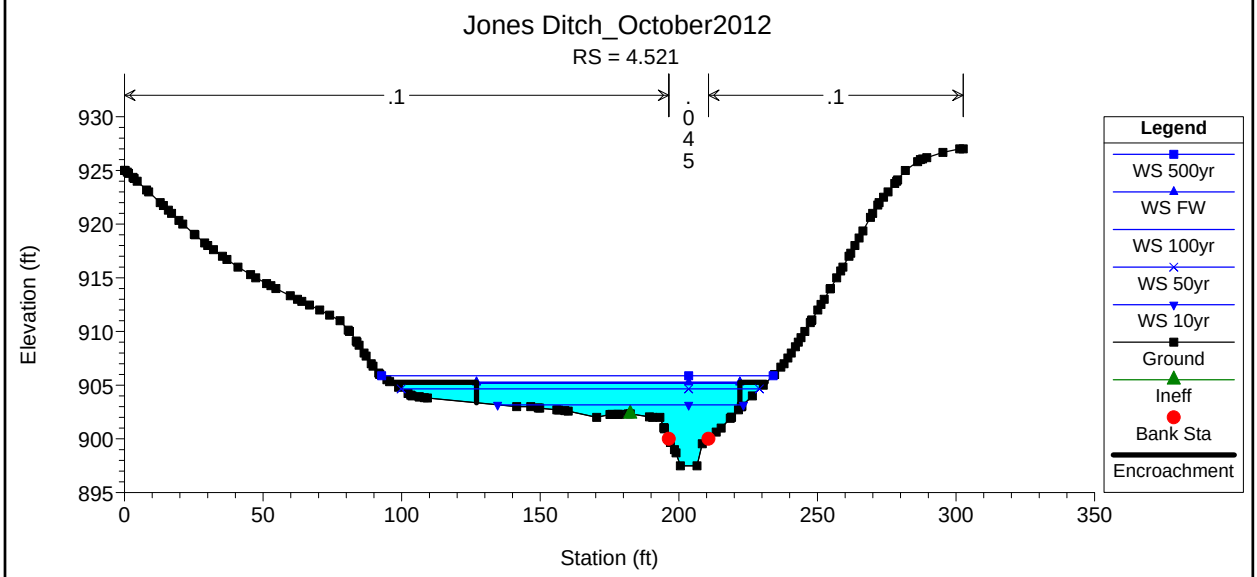
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment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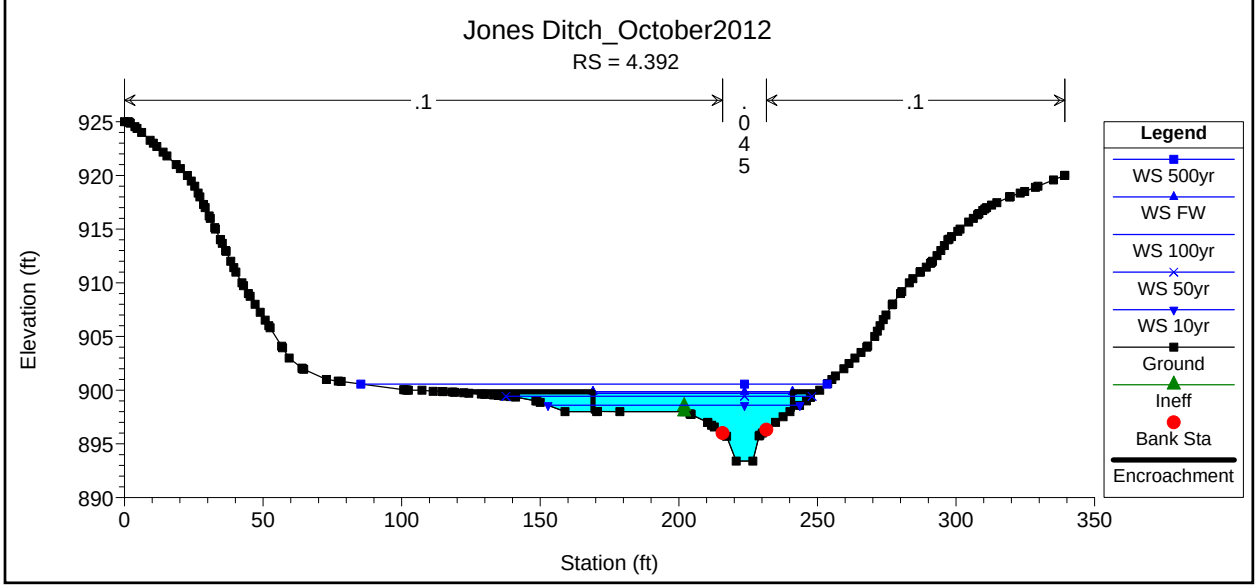
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment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.1
.045
.1
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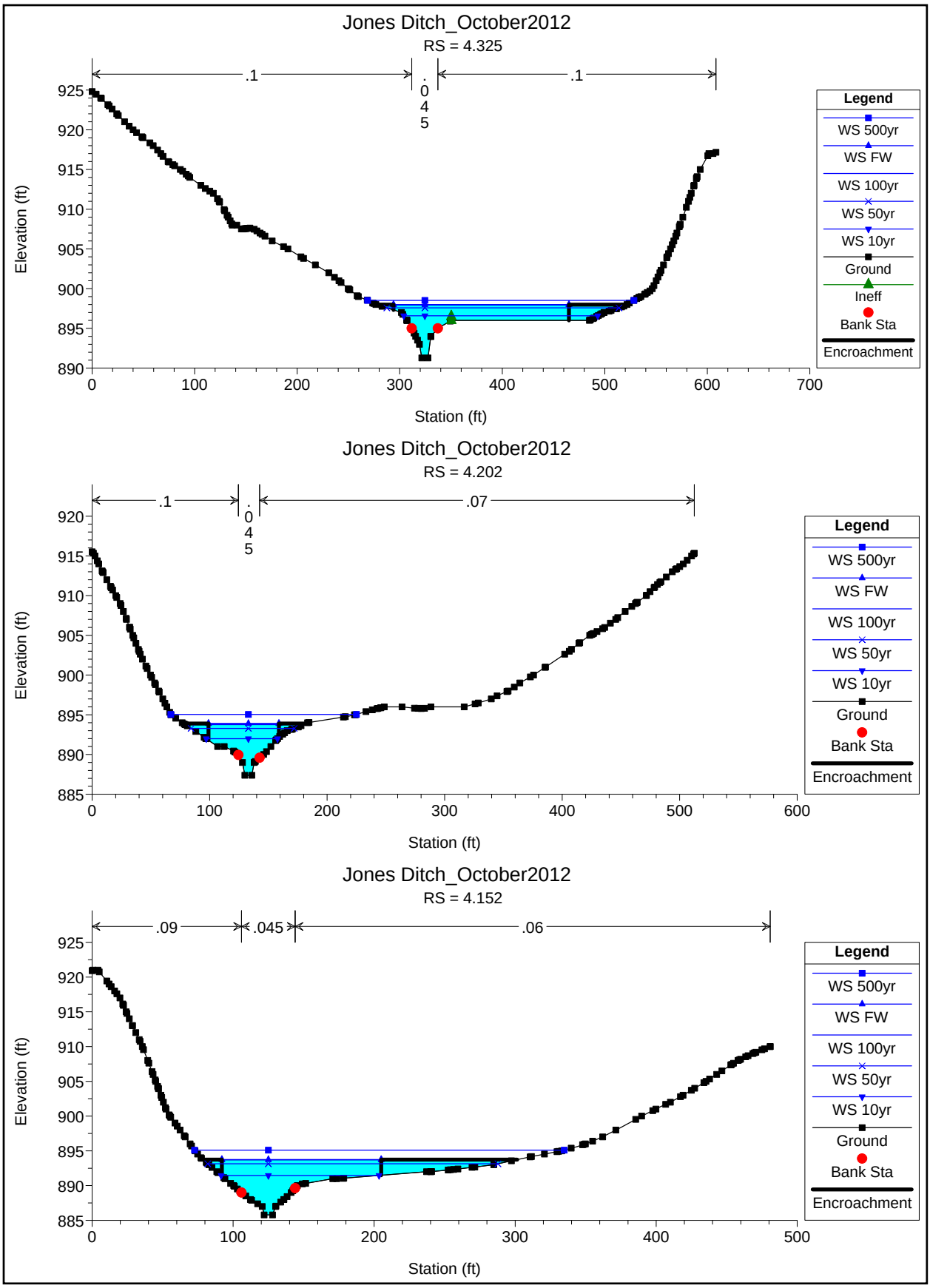
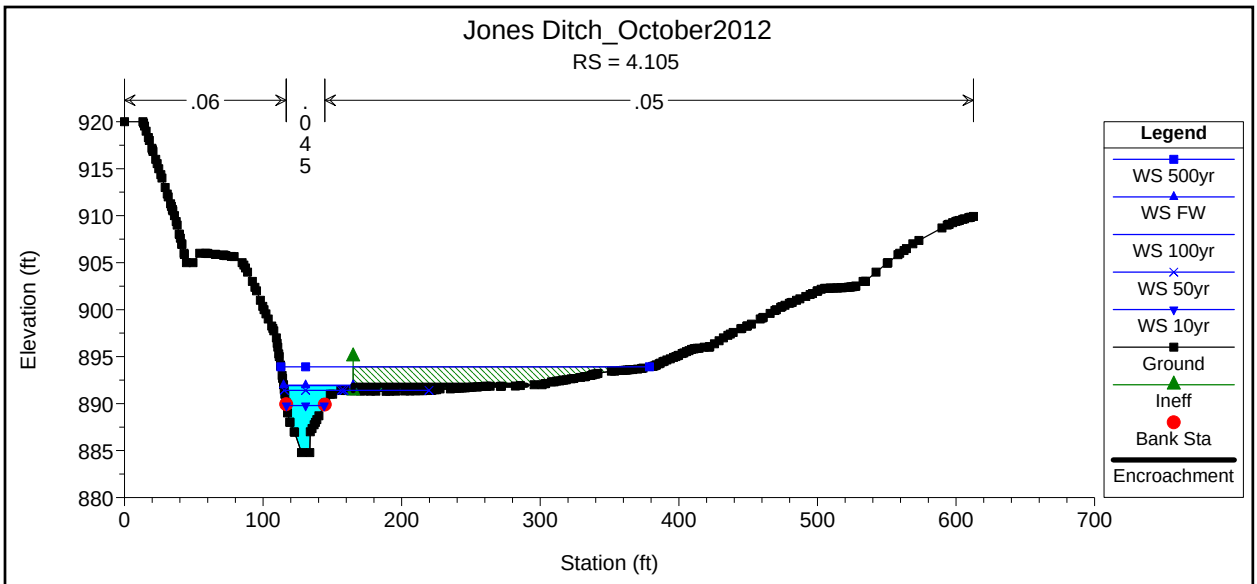
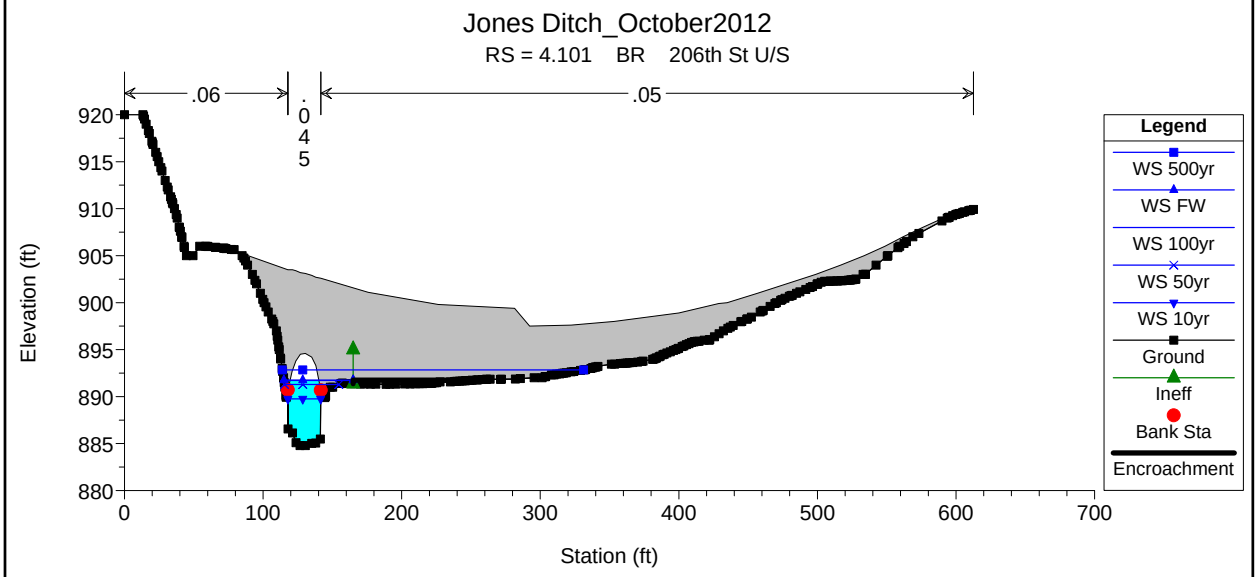
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment


Jones Ditch_October2012
RS = 4.325
.1
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 4.202
.1
.045
.07
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 4.152
.09
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment


Jones Ditch_October2012
RS = 4.105
.06
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment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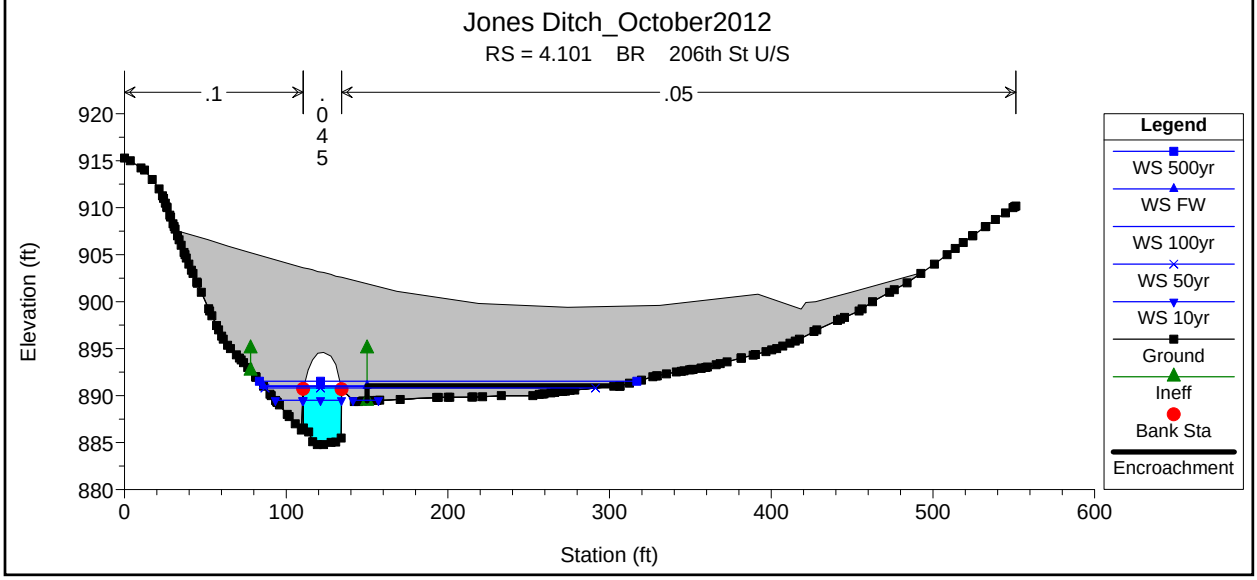
.06
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment


Jones Ditch_October2012
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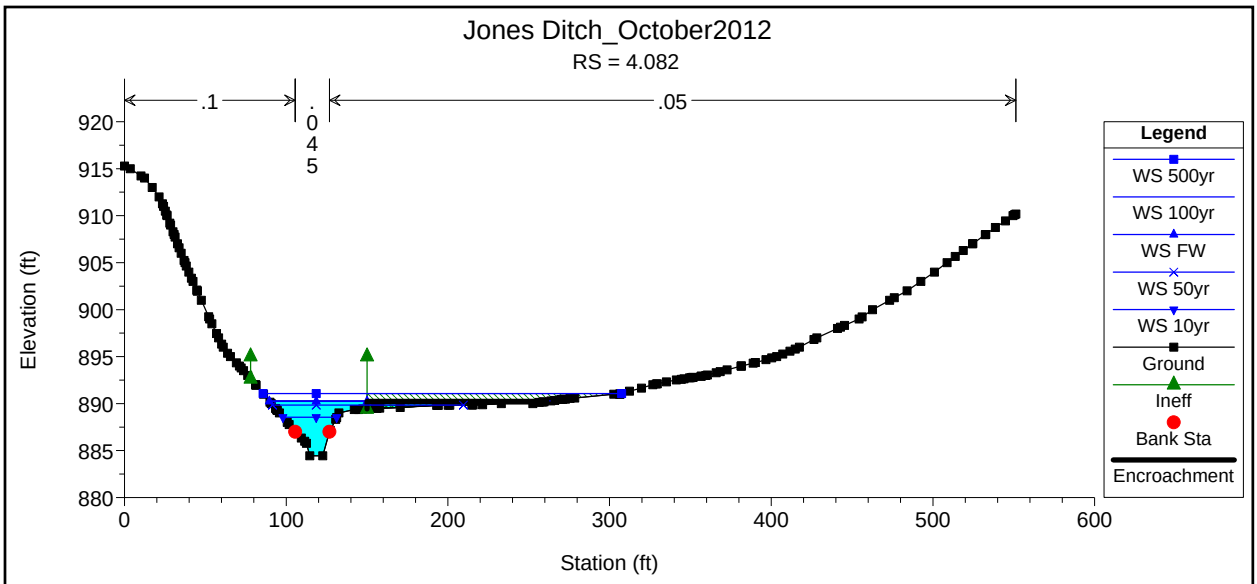
.1
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment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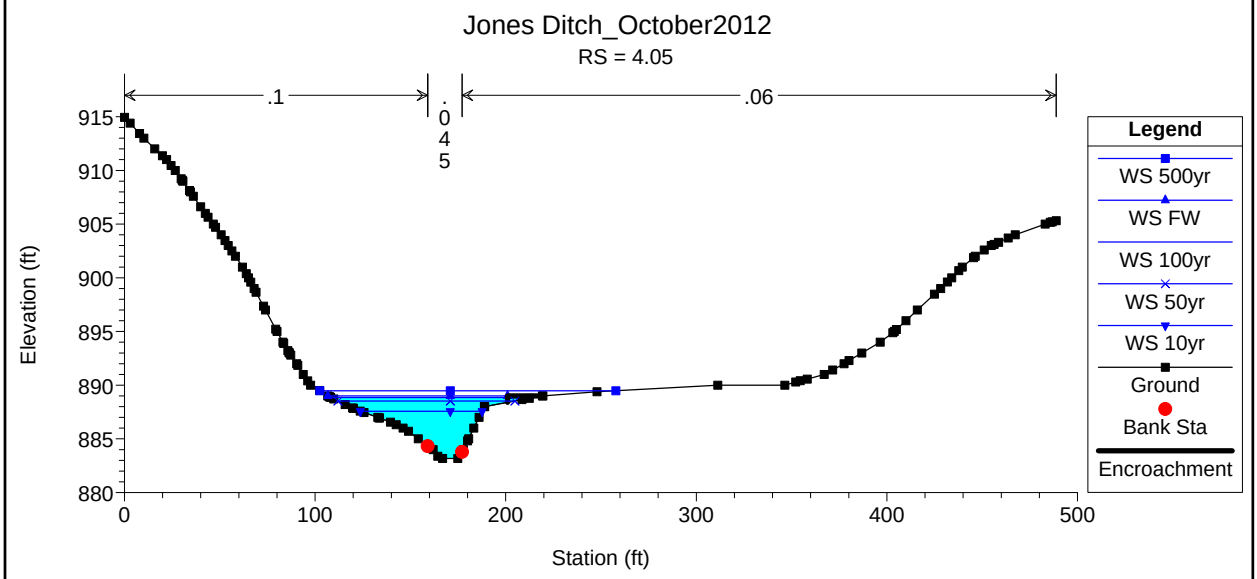
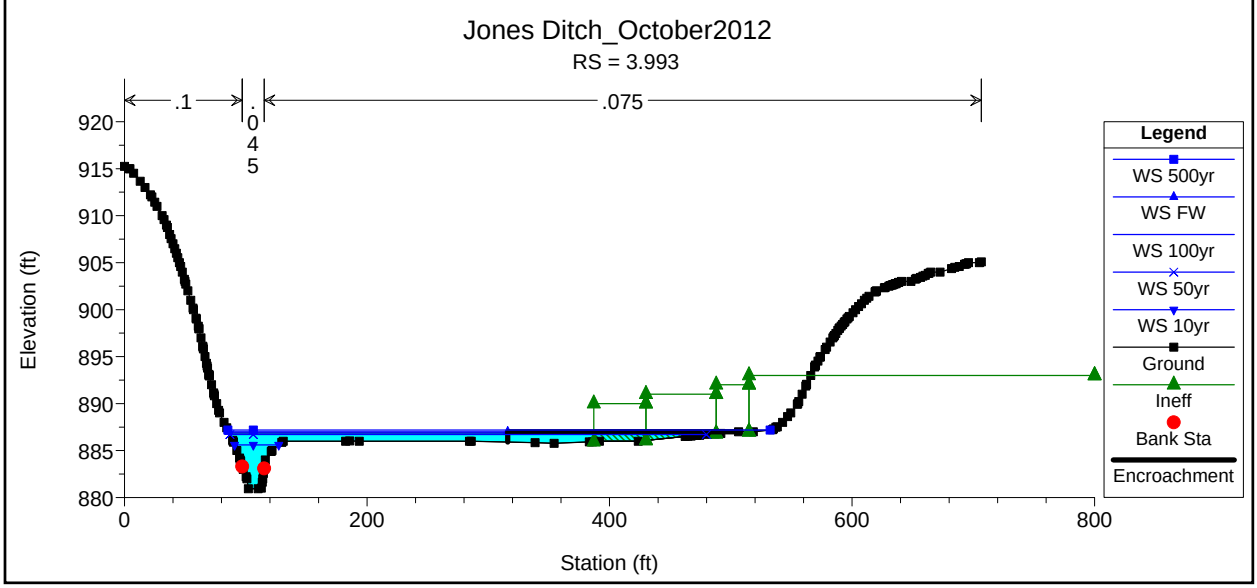
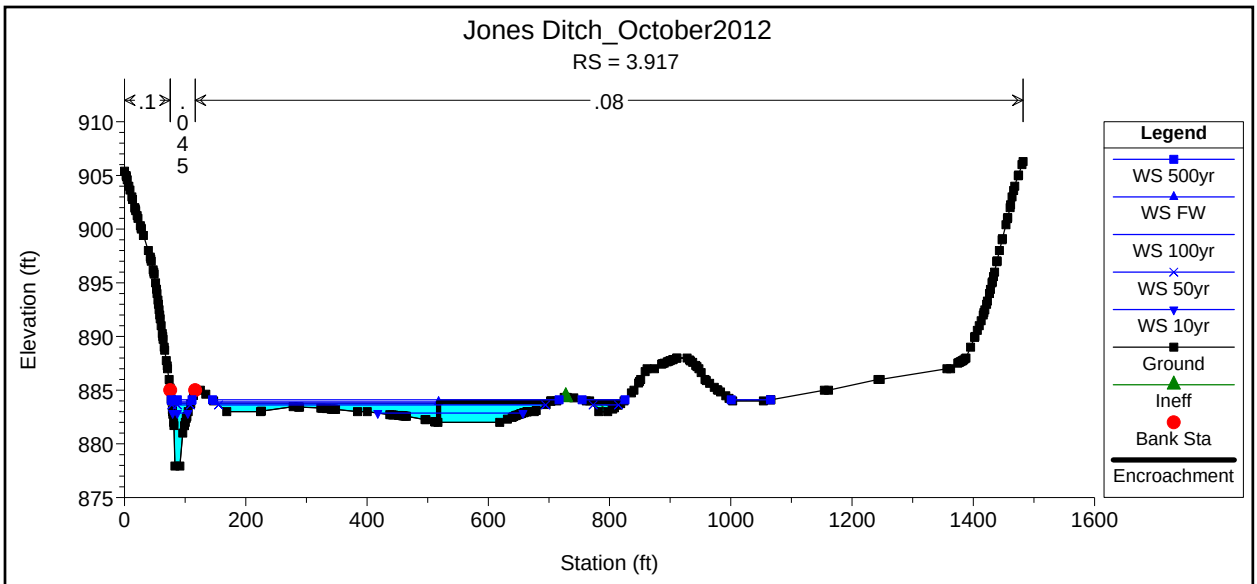
RS = 4.082
.1
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS 100yr
WS FW
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment


Jones Ditch_October2012
RS = 4.05
.1
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment


Jones Ditch_October2012
RS = 3.993
.1
.045
.075
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment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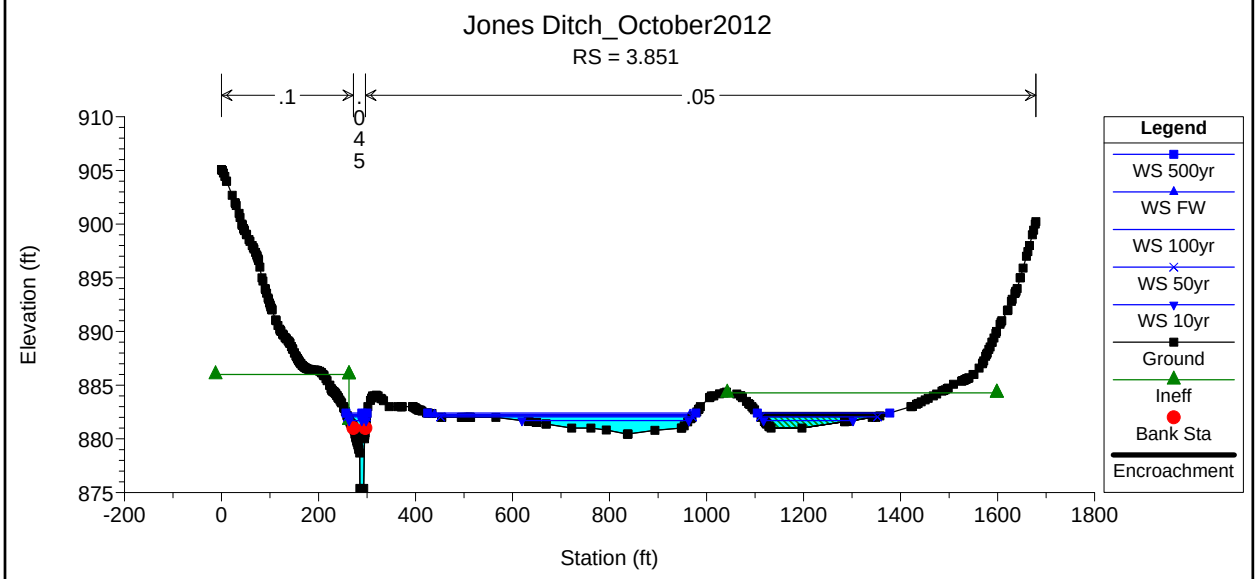
.1
.045
.08
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment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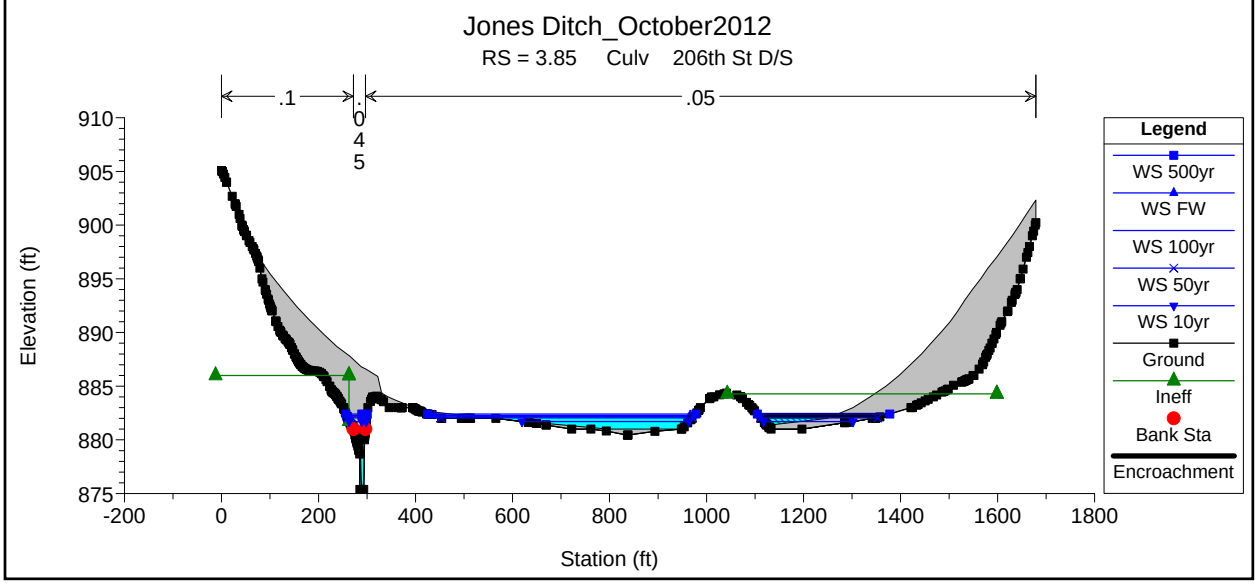
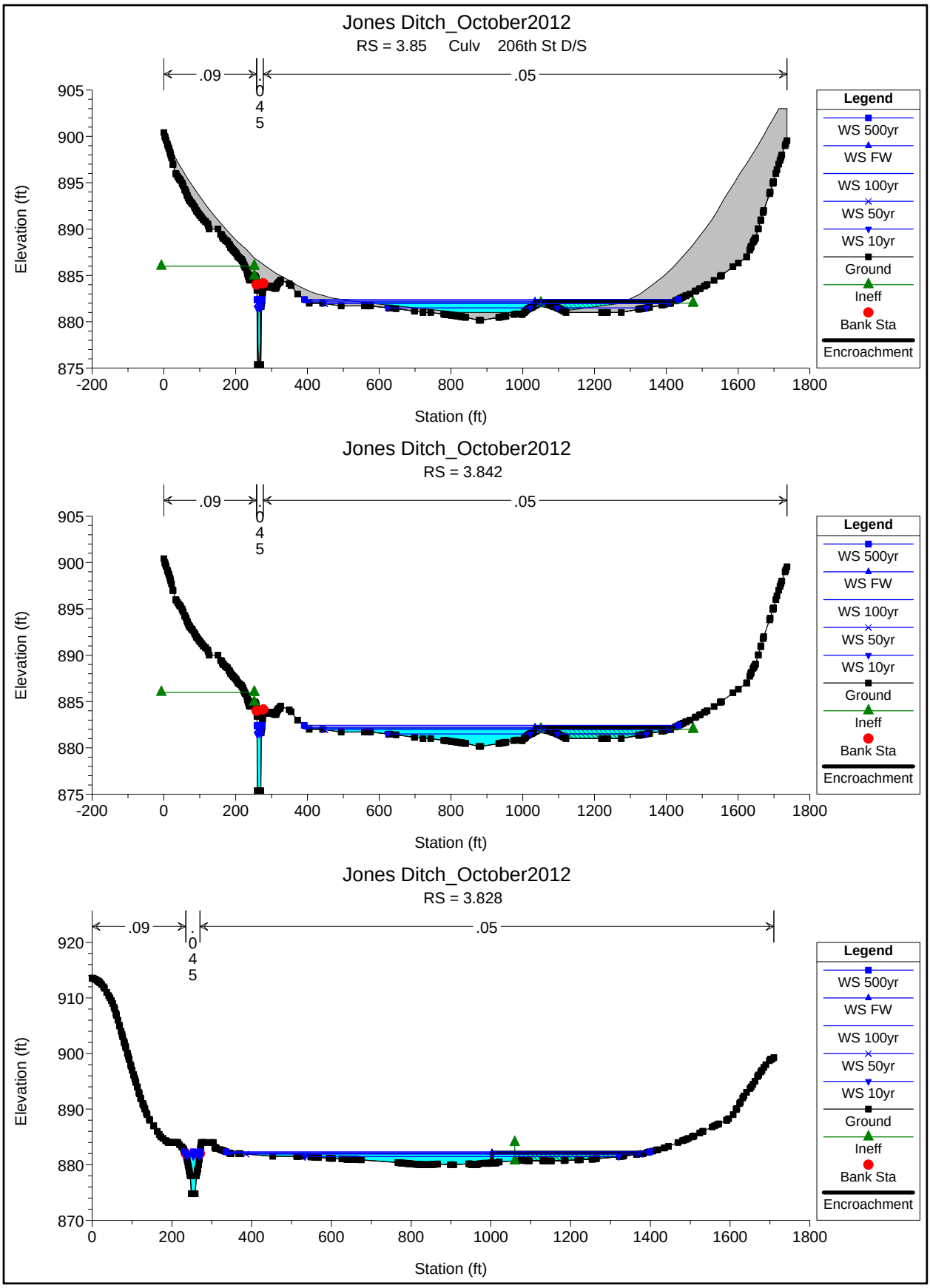
RS = 3.851
.1
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment


Jones Ditch_October2012
RS = 3.85 Culv 206th St D/S
.1
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment


Jones Ditch_October2012
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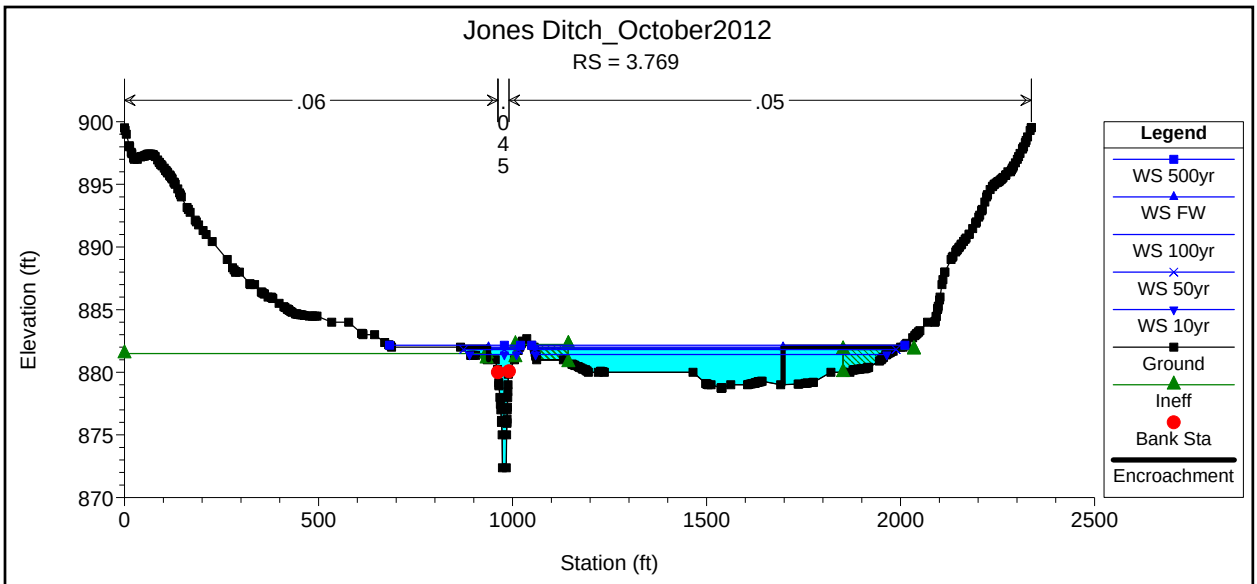
.09
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 3.842
.09
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 3.828
.09
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment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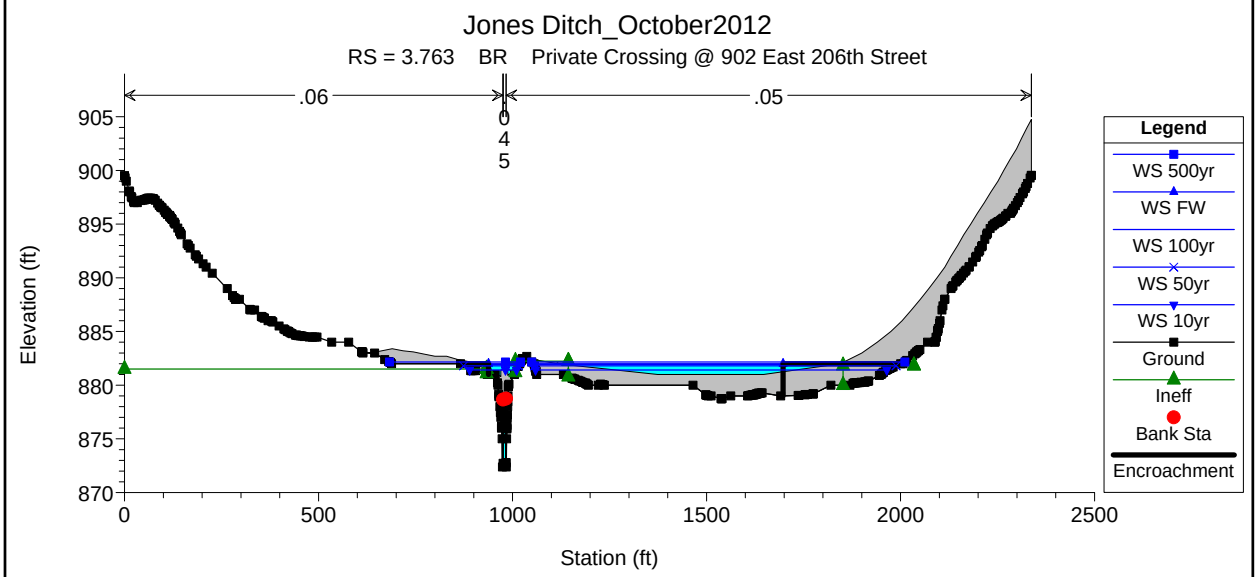
RS = 3.769
.06
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment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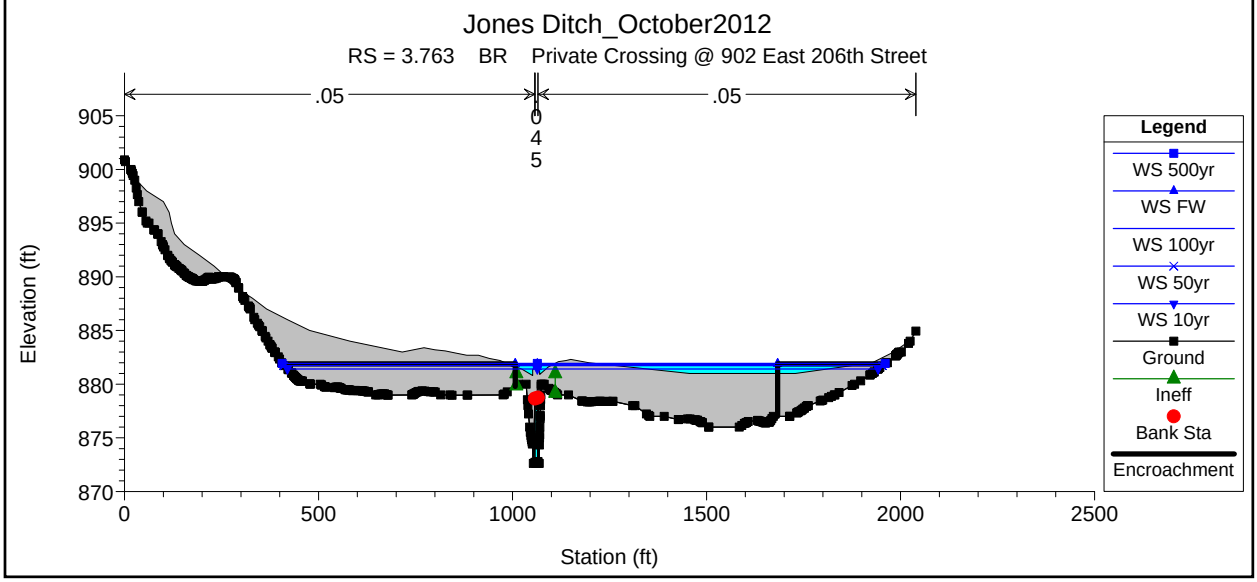
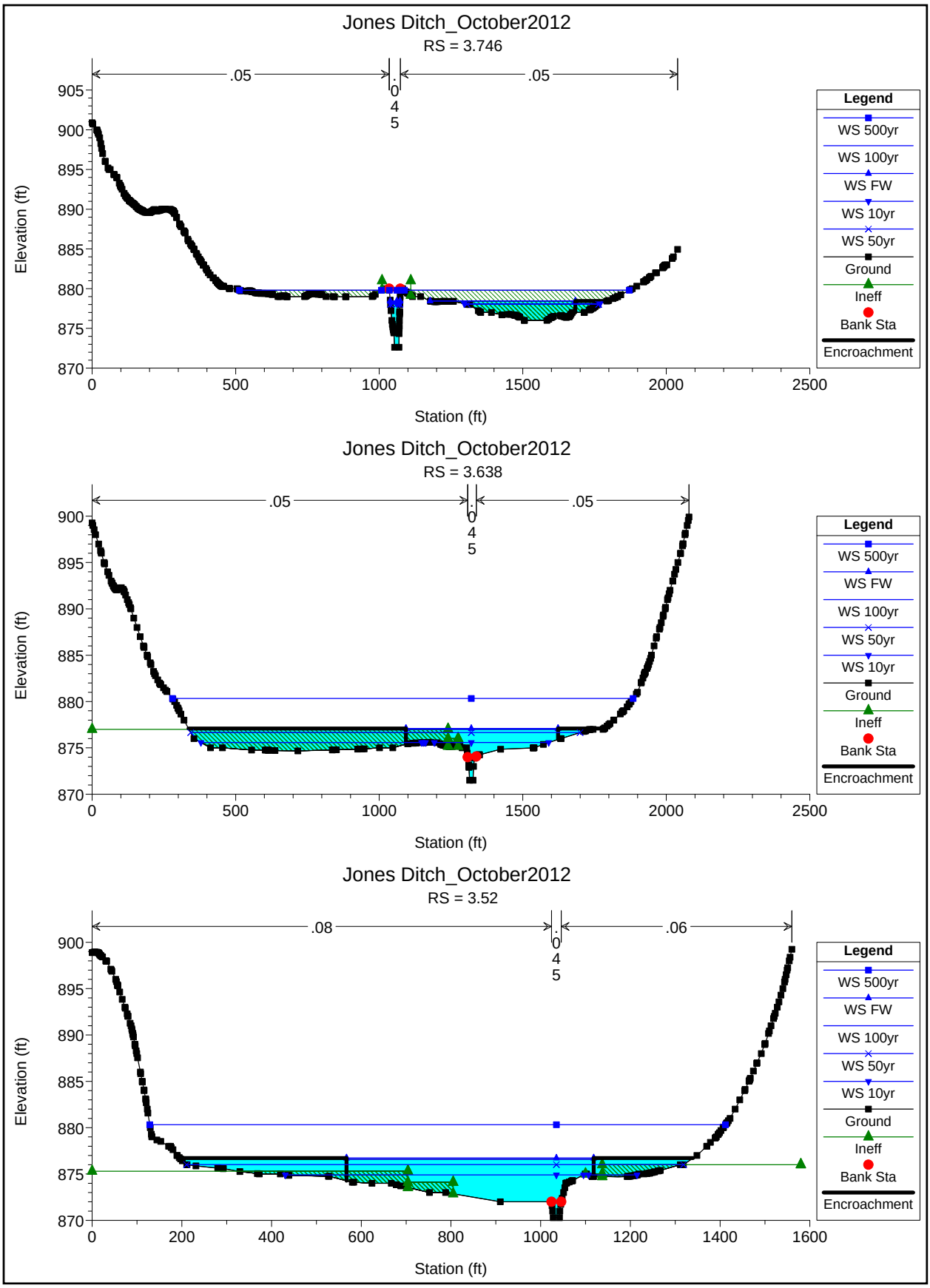
RS = 3.763 BR Private Crossing @ 902 East 206th Street
.06
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment


Jones Ditch_October2012
RS = 3.763 BR Private Crossing @ 902 East 206th Street
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment


Jones Ditch_October2012
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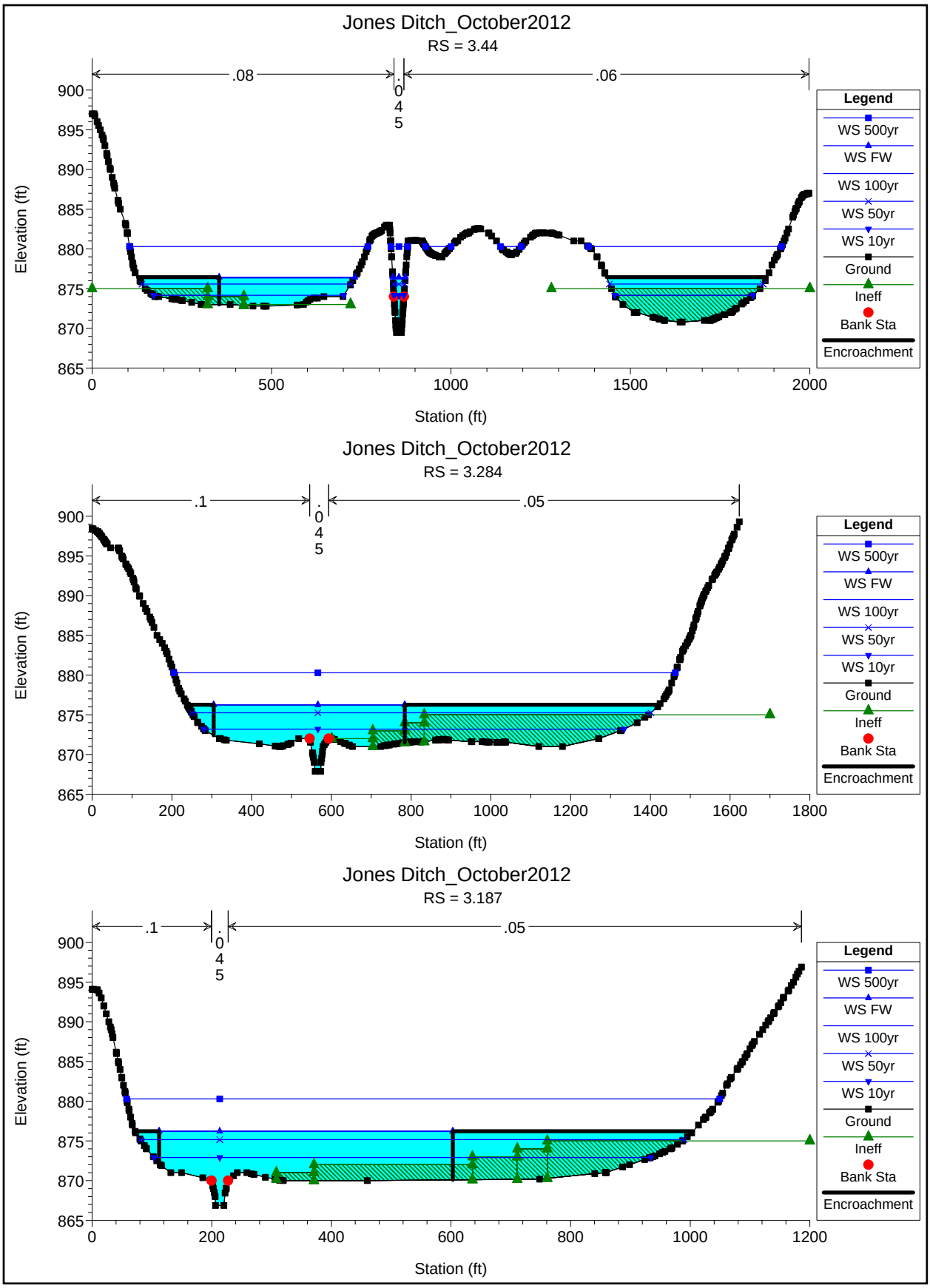
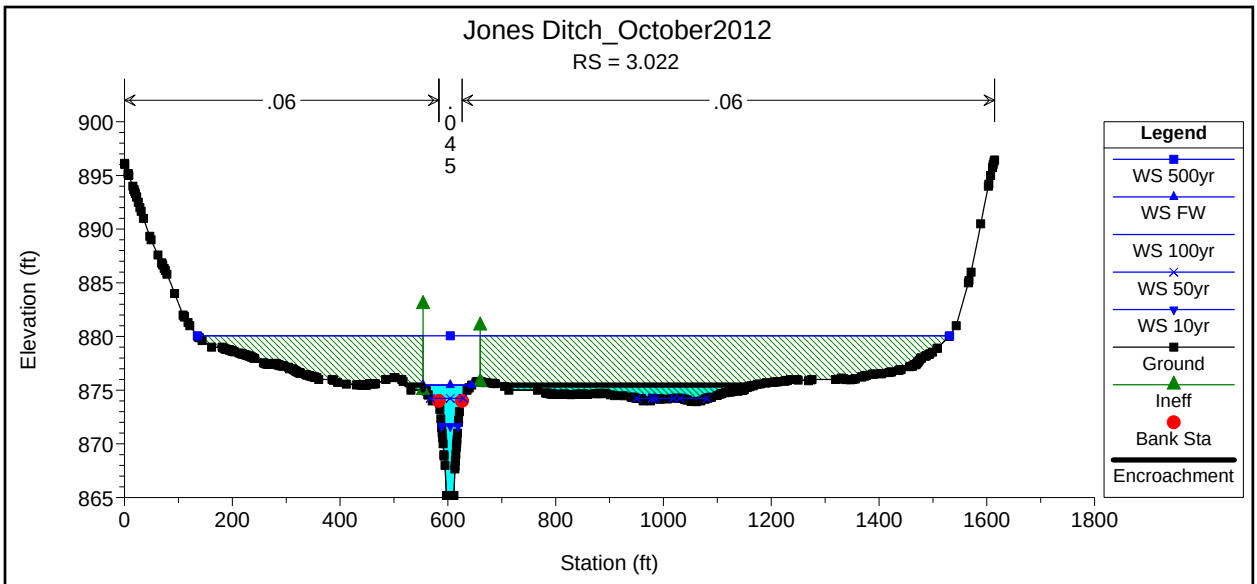
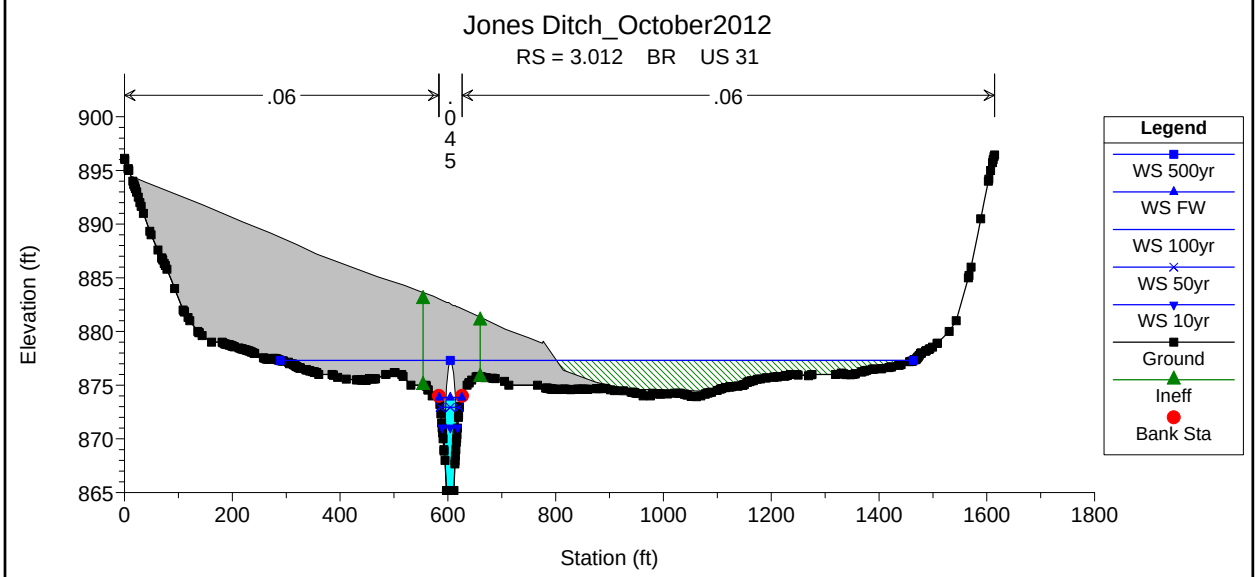
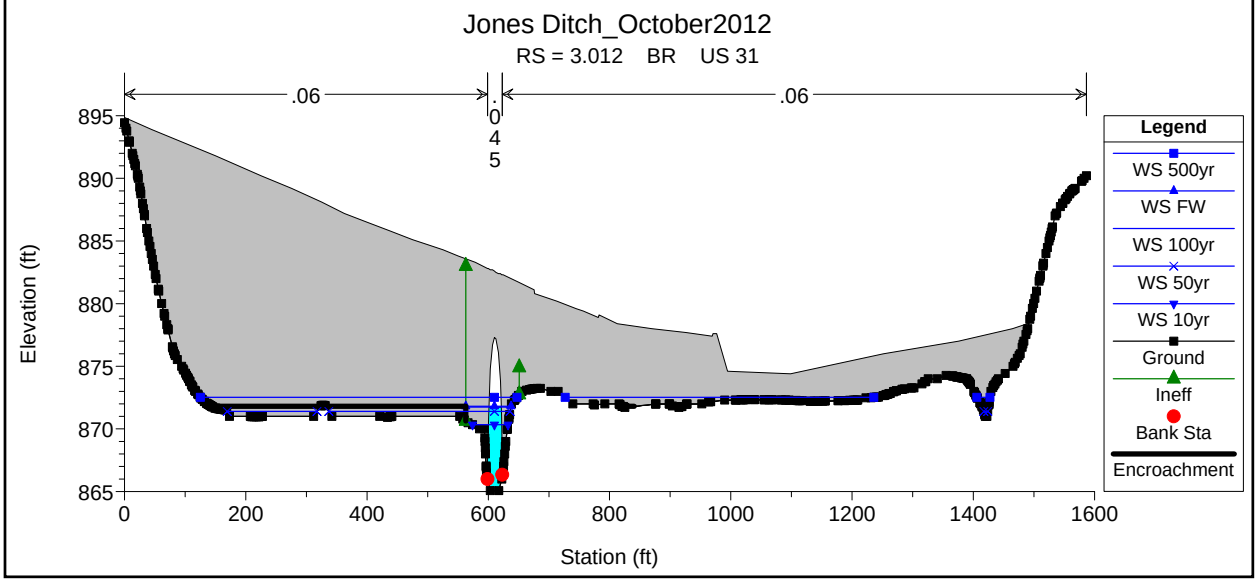
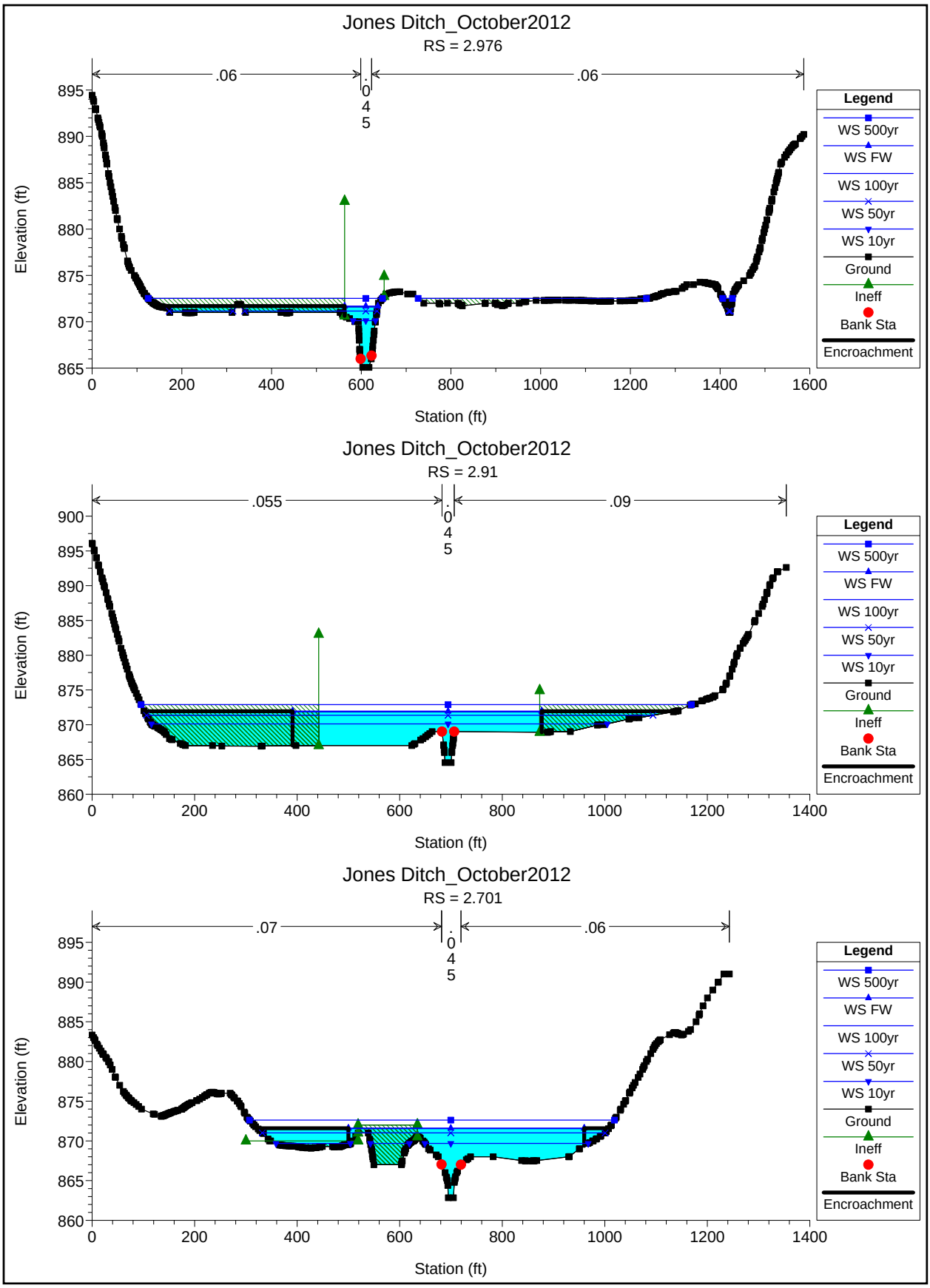
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS 100yr
WS FW
WS 10yr
WS 50yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 3.638
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 3.52
.08
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

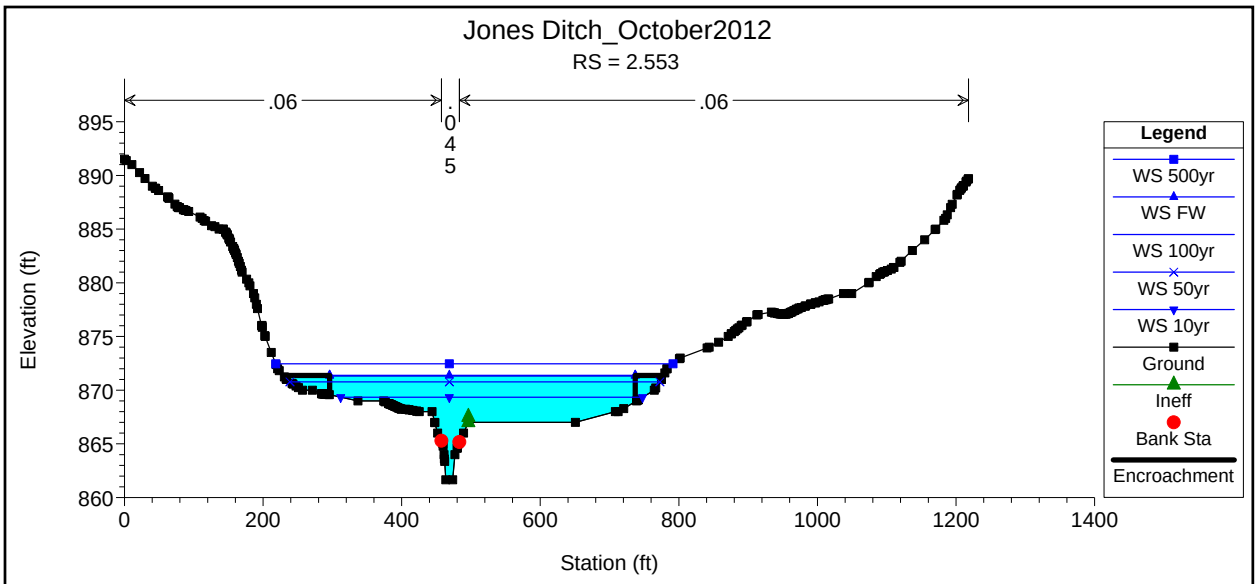

Jones Ditch_October2012
RS = 3.44
.08
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 3.284
.1
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 3.187
.1
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

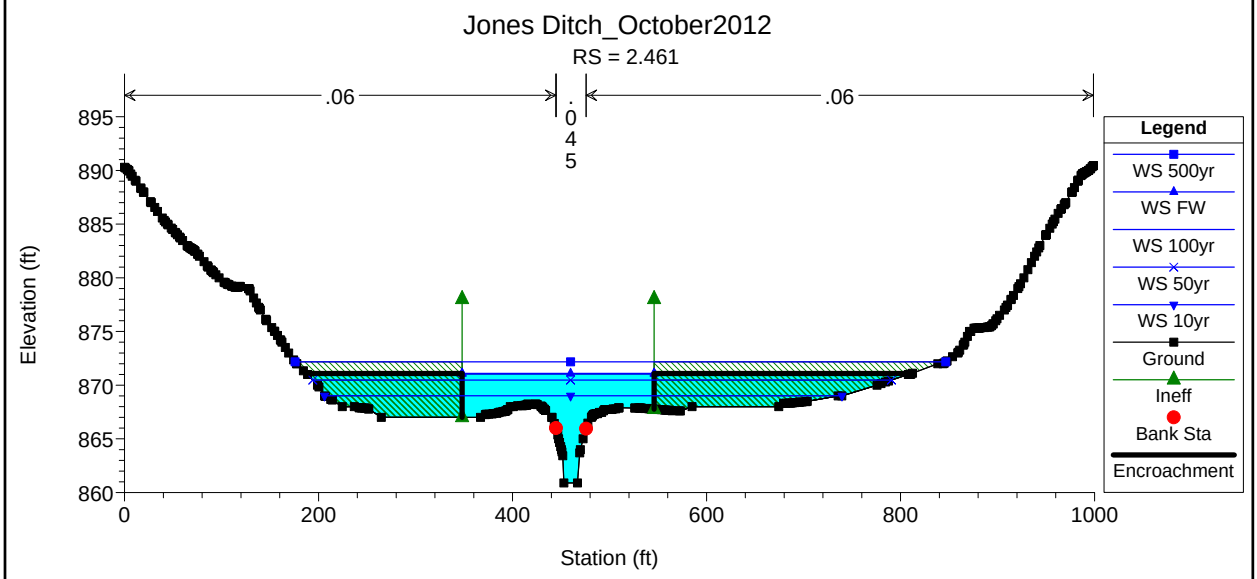

Jones Ditch_October2012
RS = 3.022
.06
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

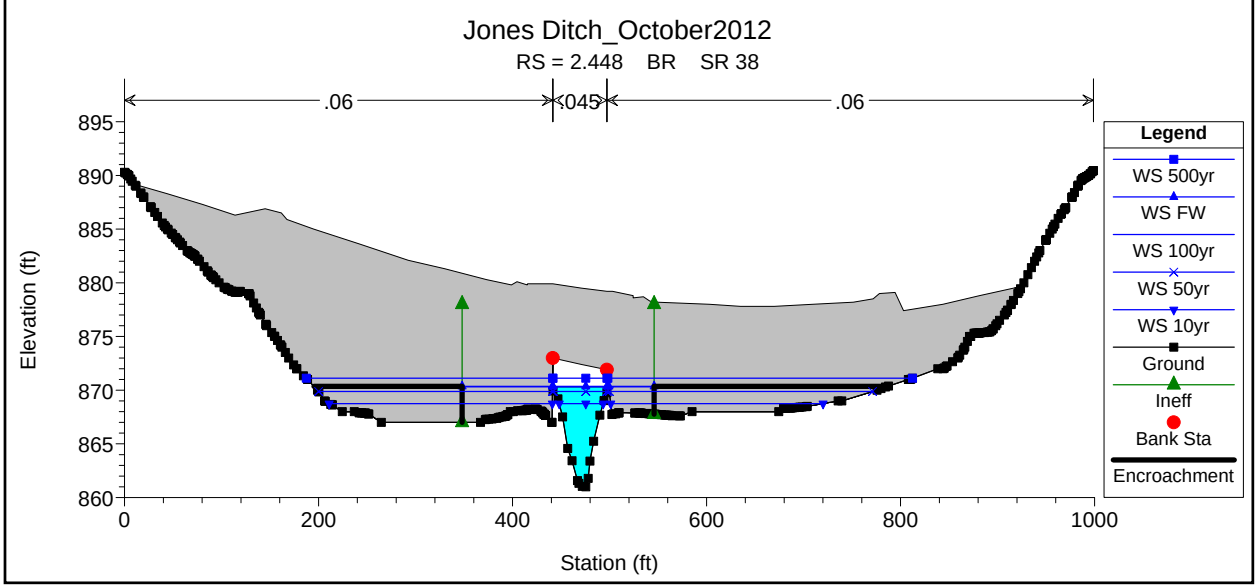

Jones Ditch_October2012
RS = 3.012 BR US 31
.06
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta

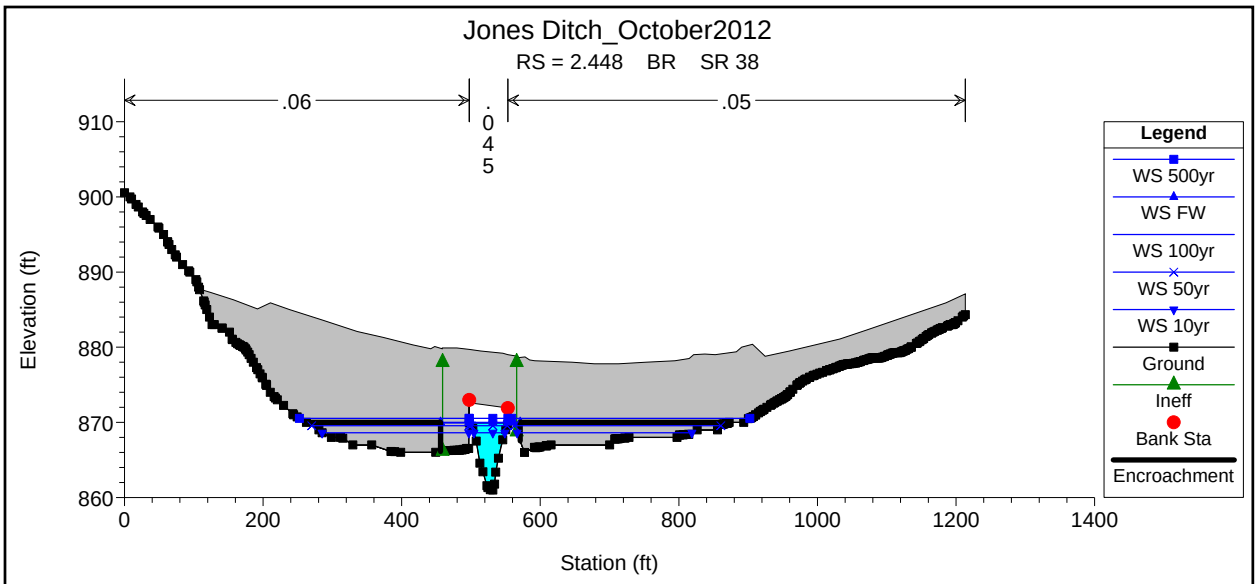

Jones Ditch_October2012
RS = 3.012 BR US 31
.06
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

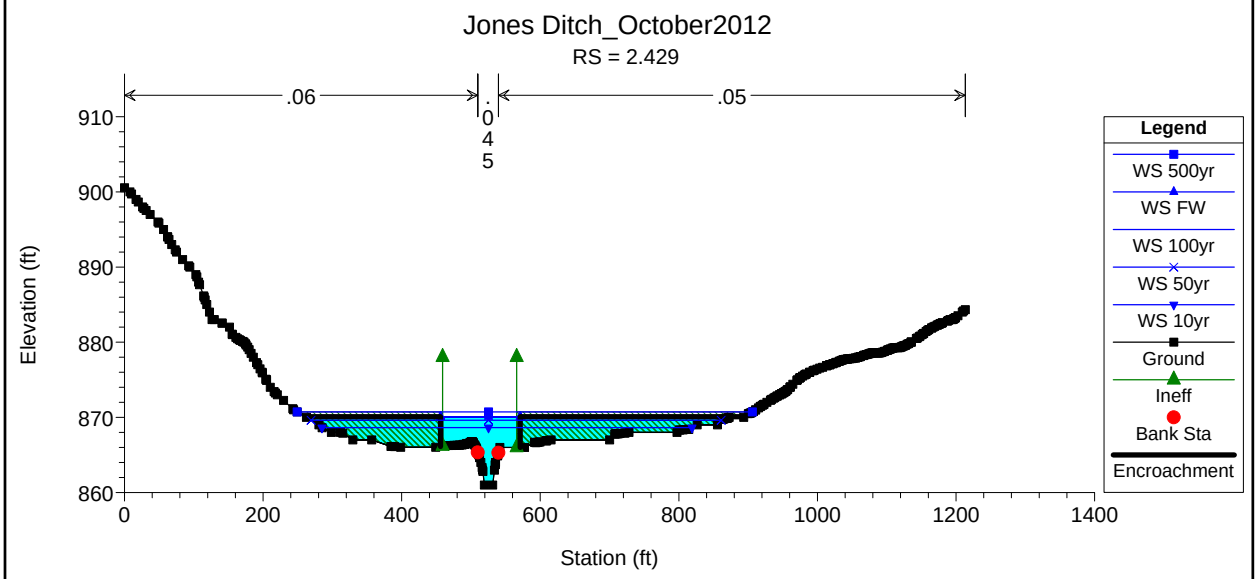

Jones Ditch_October2012
RS = 2.976
.06
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 2.91
.055
.045
.09
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 2.701
.07
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

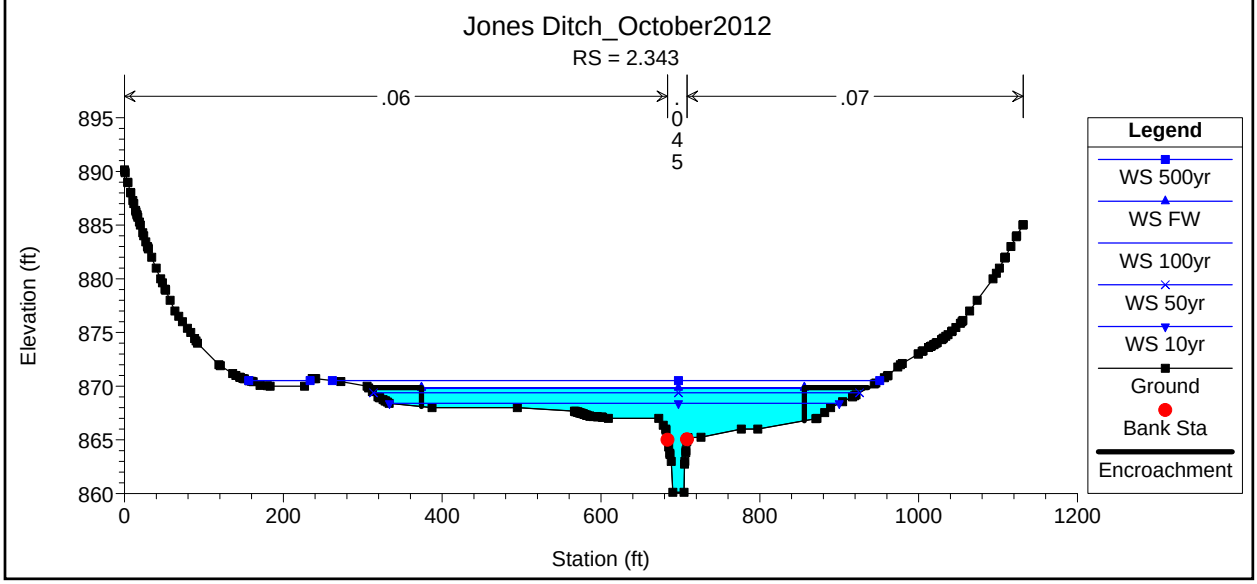

Jones Ditch_October2012
RS = 2.553
.06
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

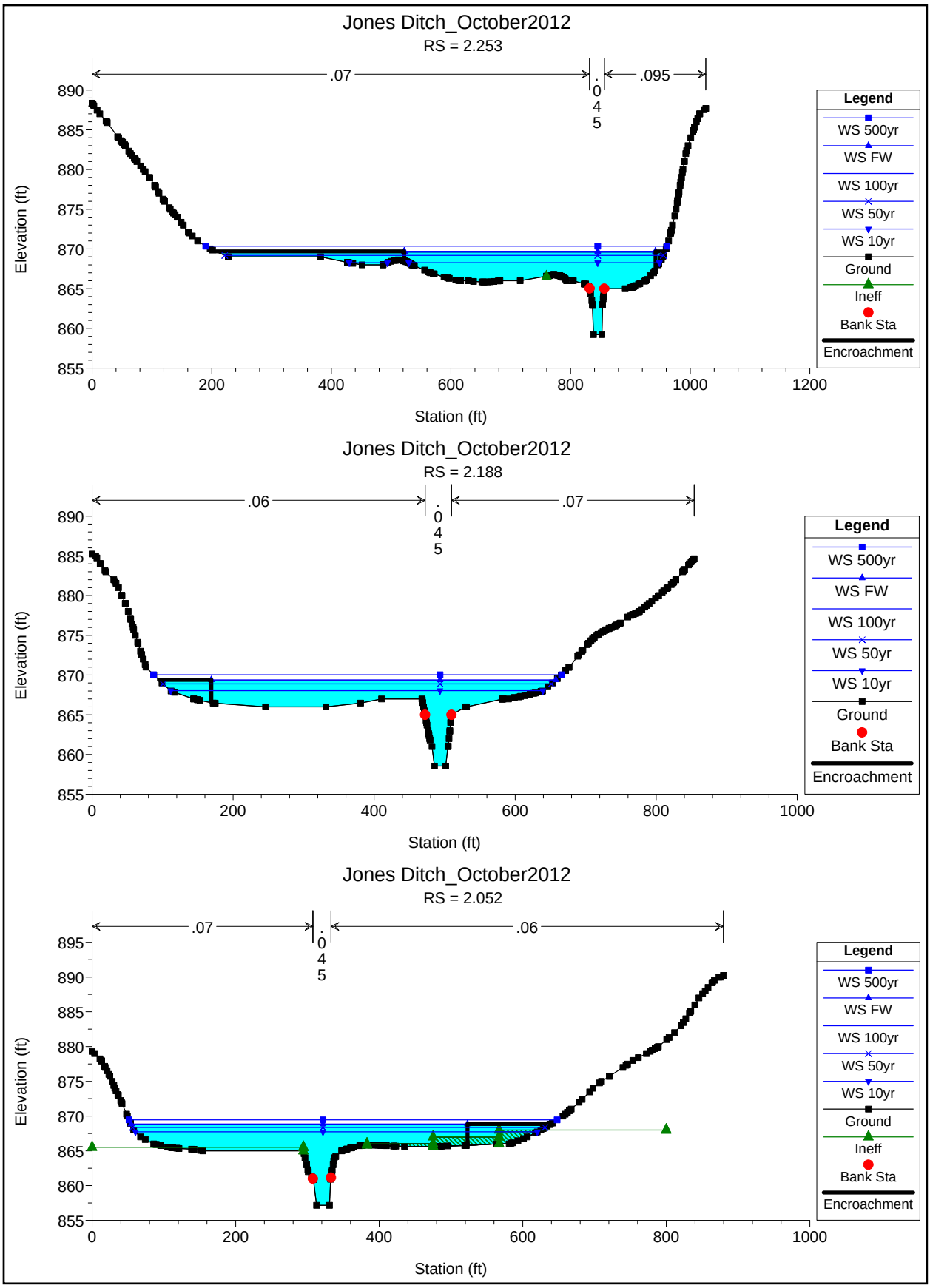

Jones Ditch_October2012
RS = 2.461
.06
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

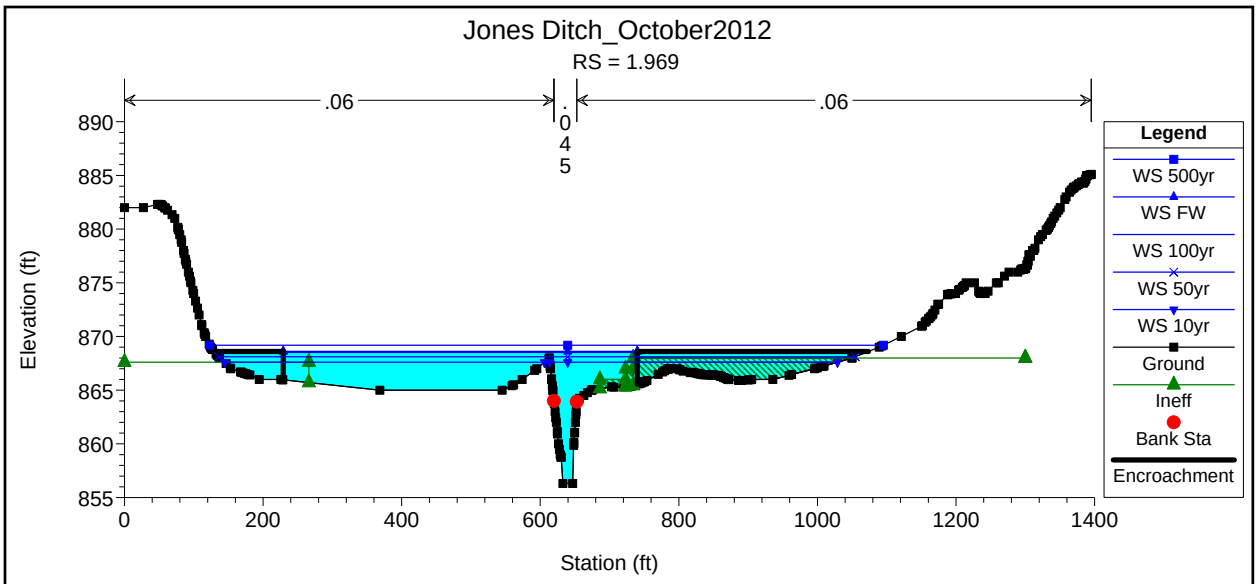

Jones Ditch_October2012
RS = 2.448 BR SR 38
.06
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

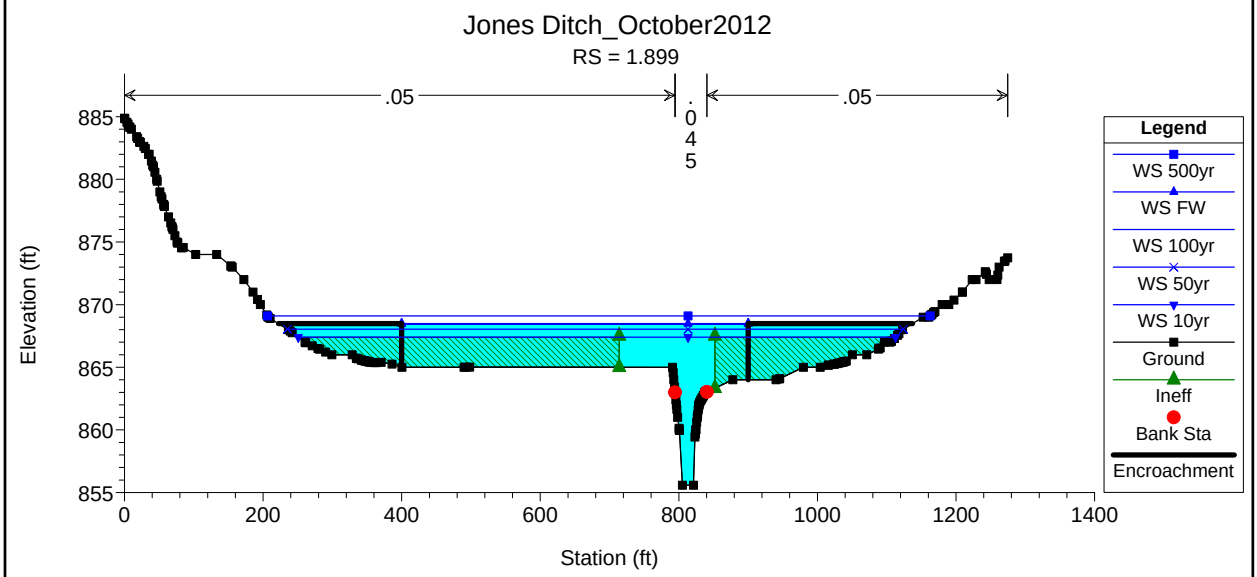

Jones Ditch_October2012
RS = 2.448 BR SR 38
.06
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

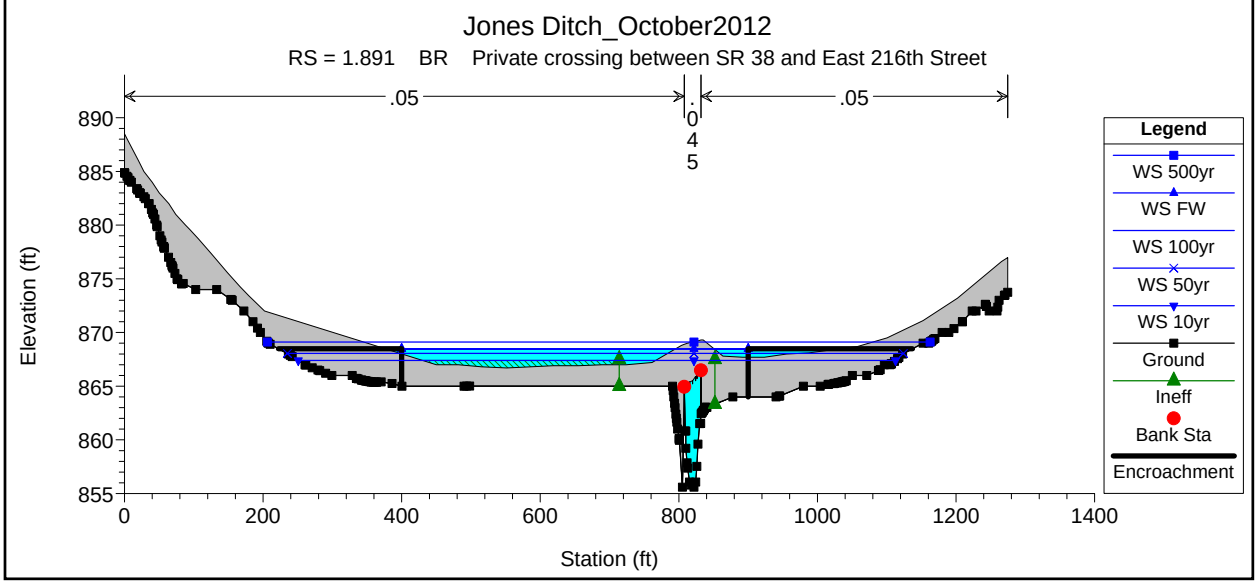

Jones Ditch_October2012
RS = 2.429
.06
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

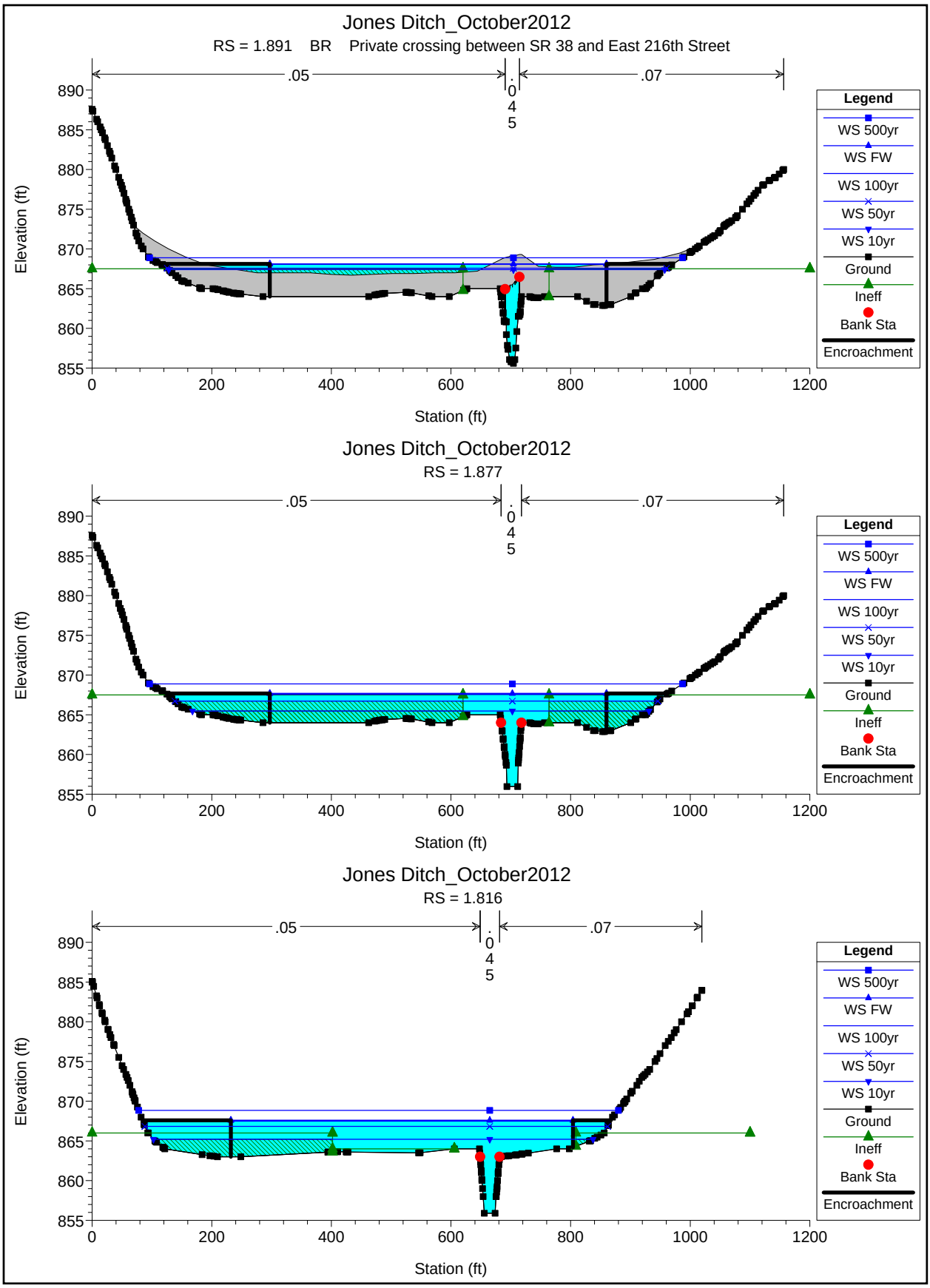

Jones Ditch_October2012
RS = 2.343
.06
.045
.07
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment

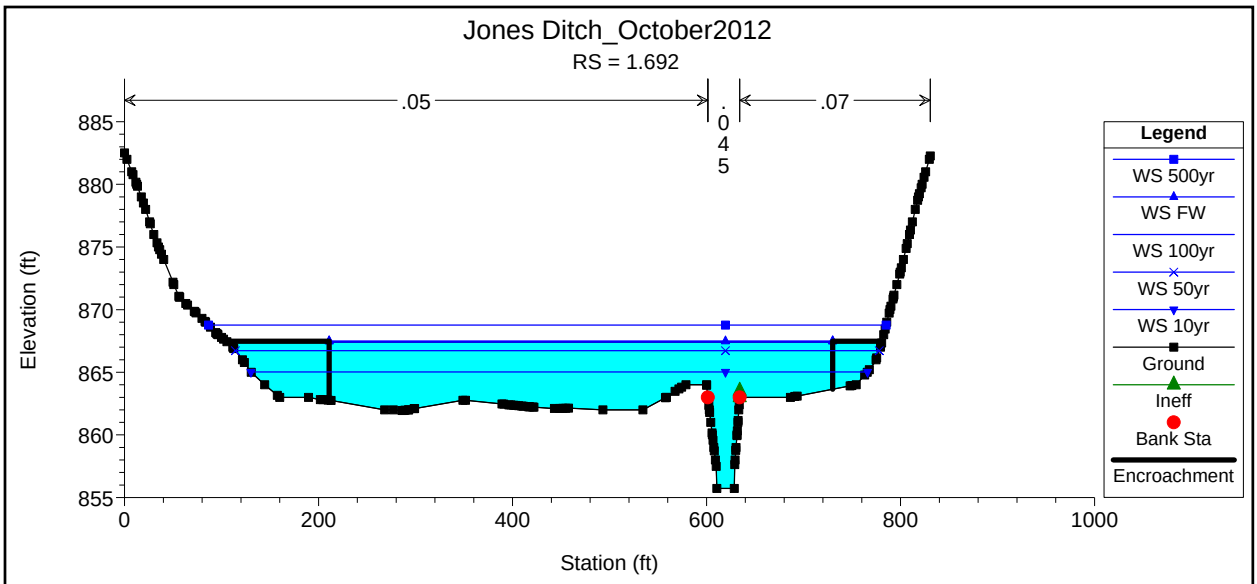

Jones Ditch_October2012
RS = 2.253
.07
.045
.095
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 2.188
.06
.045
.07
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 2.052
.07
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

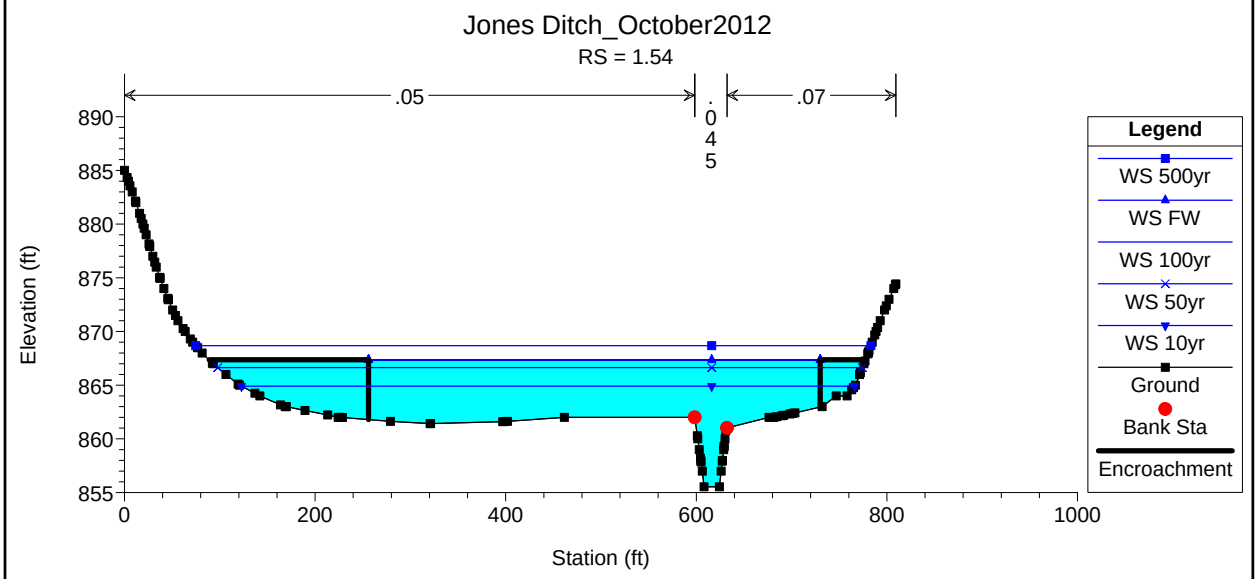

Jones Ditch_October2012
RS = 1.969
.06
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

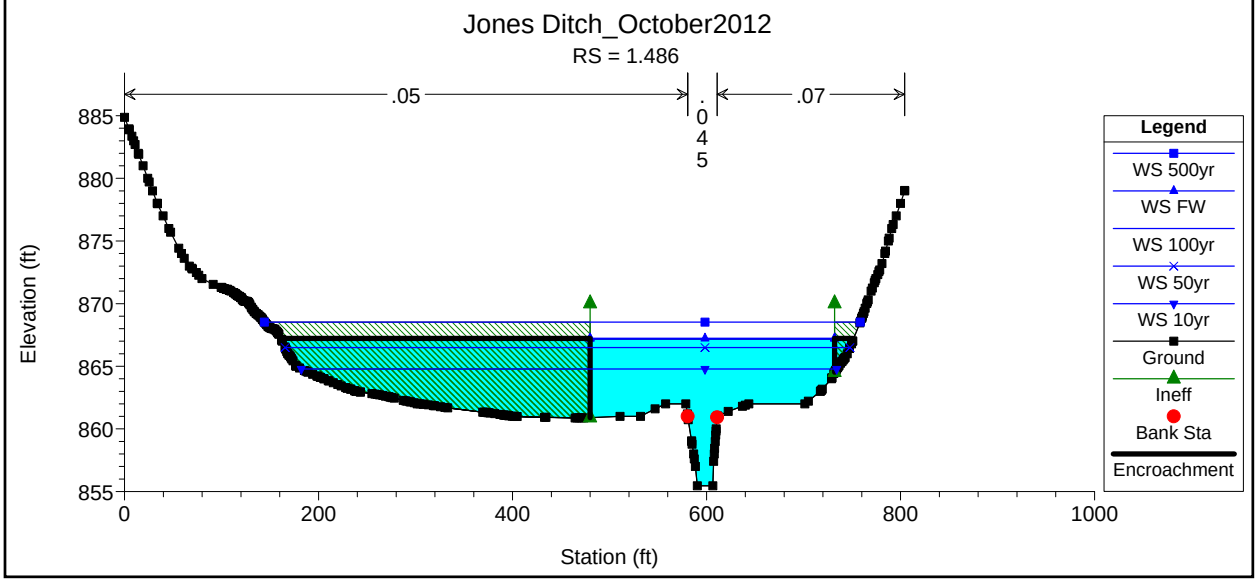

Jones Ditch_October2012
RS = 1.899
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

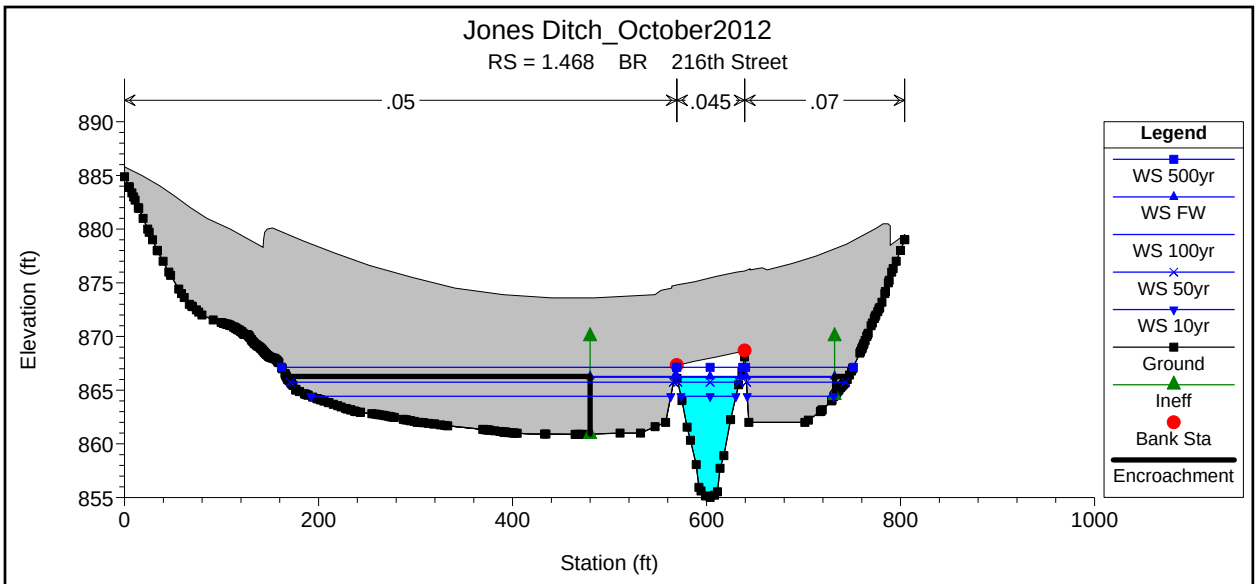

Jones Ditch_October2012
RS = 1.891 BR Private crossing between SR 38 and East 216th Street
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

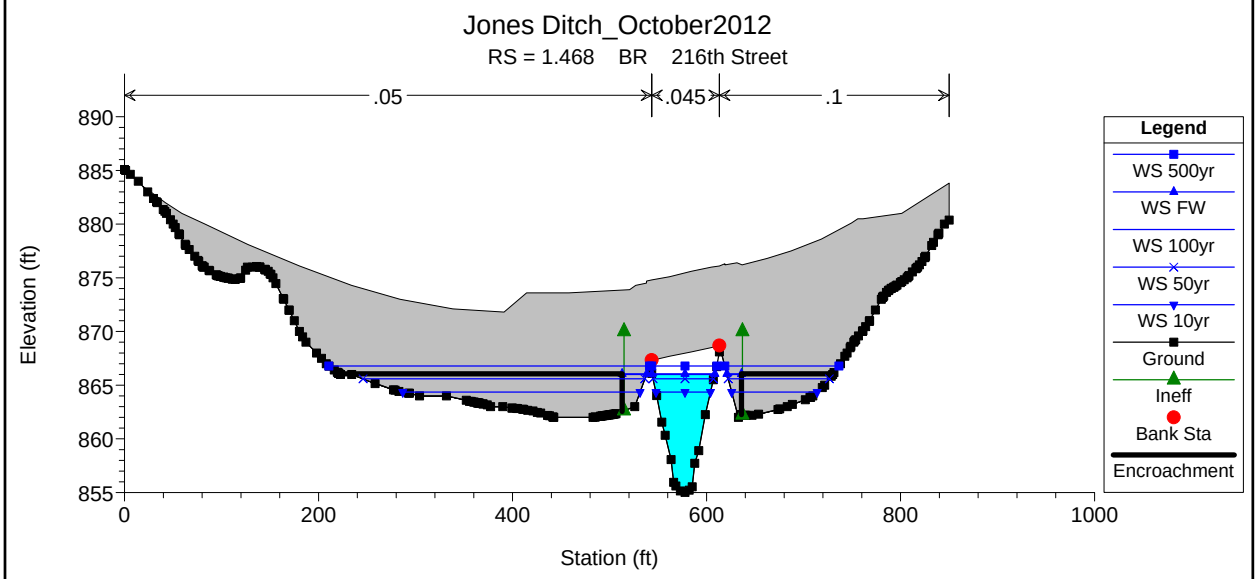

Jones Ditch_October2012
RS = 1.891 BR Private crossing between SR 38 and East 216th Street
.05
.045
.07
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 1.877
.05
.045
.07
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 1.816
.05
.045
.07
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

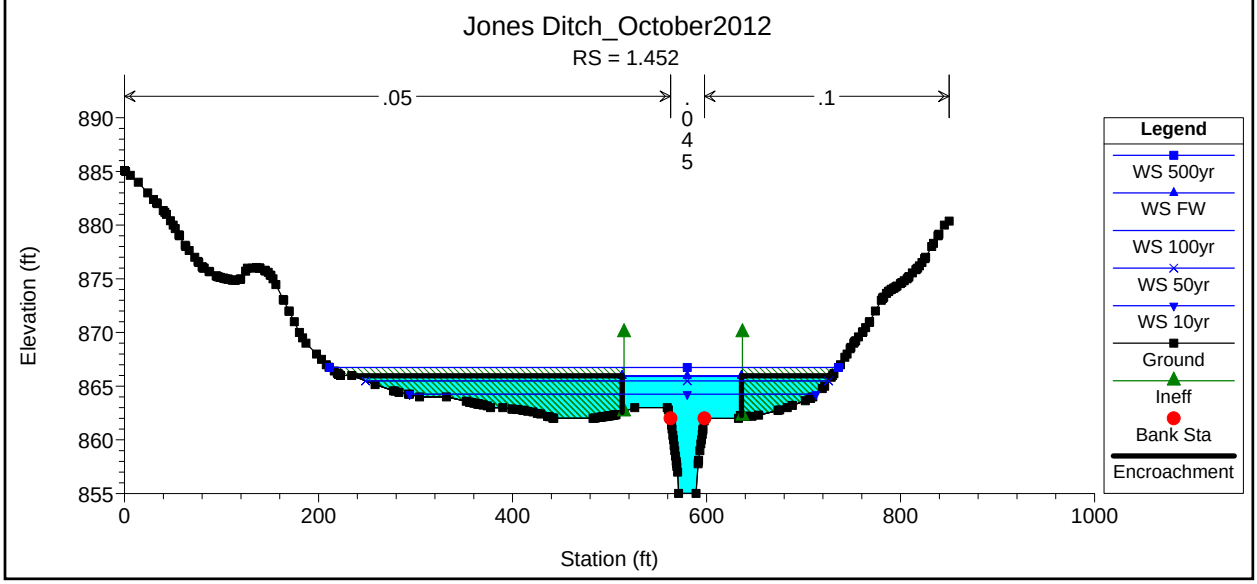

Jones Ditch_October2012
RS = 1.692
.05
.045
.07
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

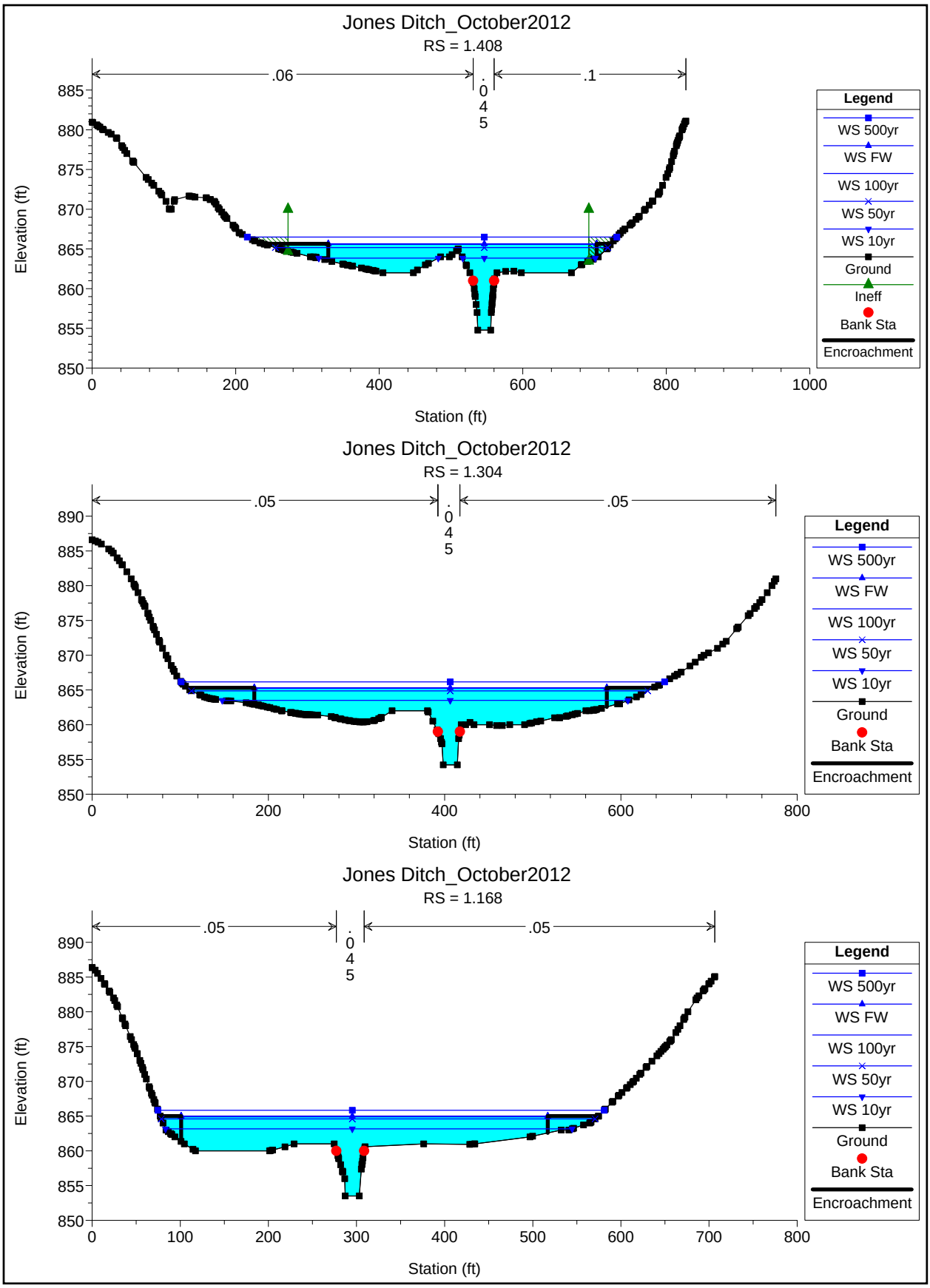

Jones Ditch_October2012
RS = 1.54
.05
.045
.07
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment

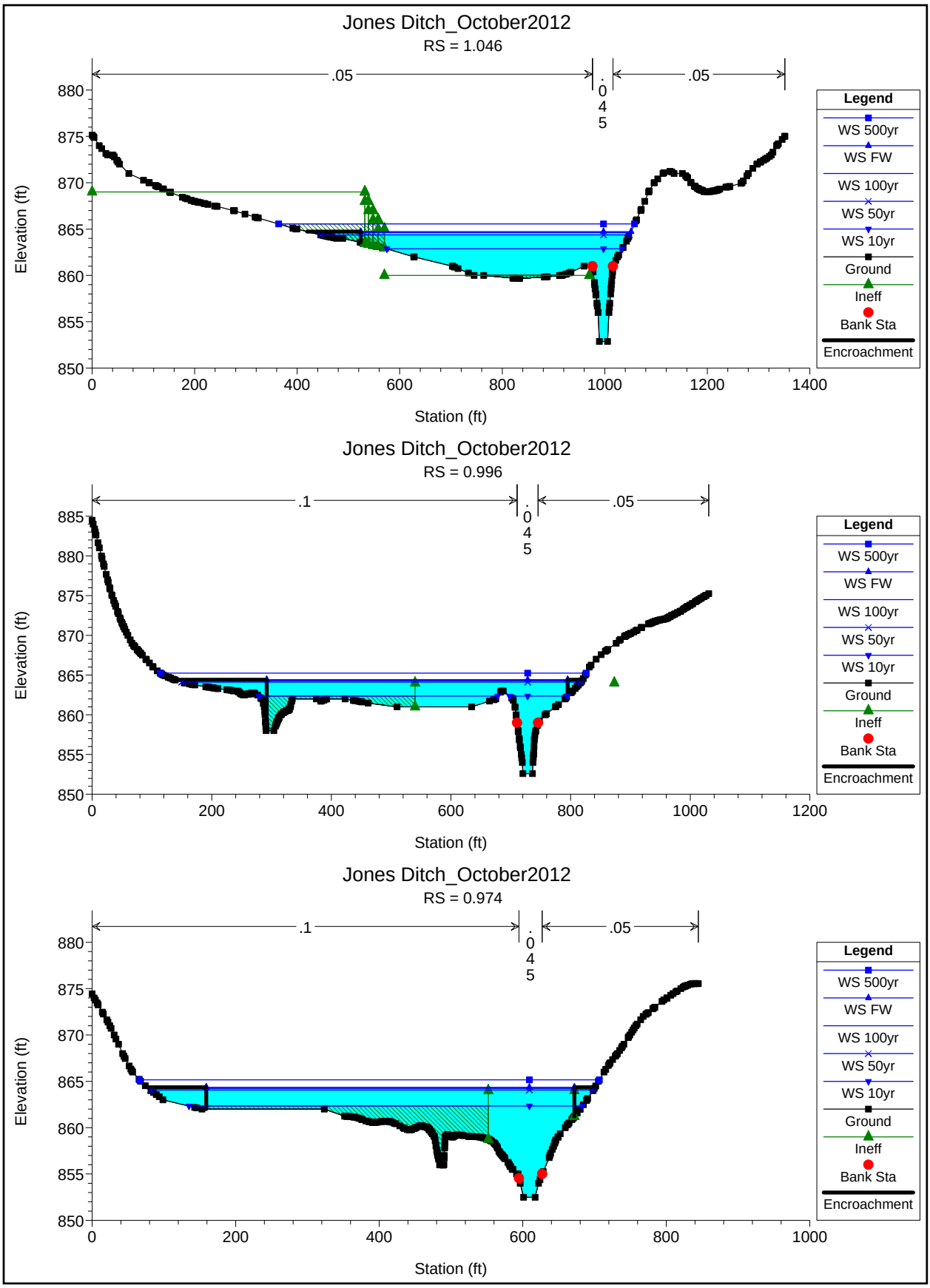

Jones Ditch_October2012
RS = 1.486
.05
.045
.07
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

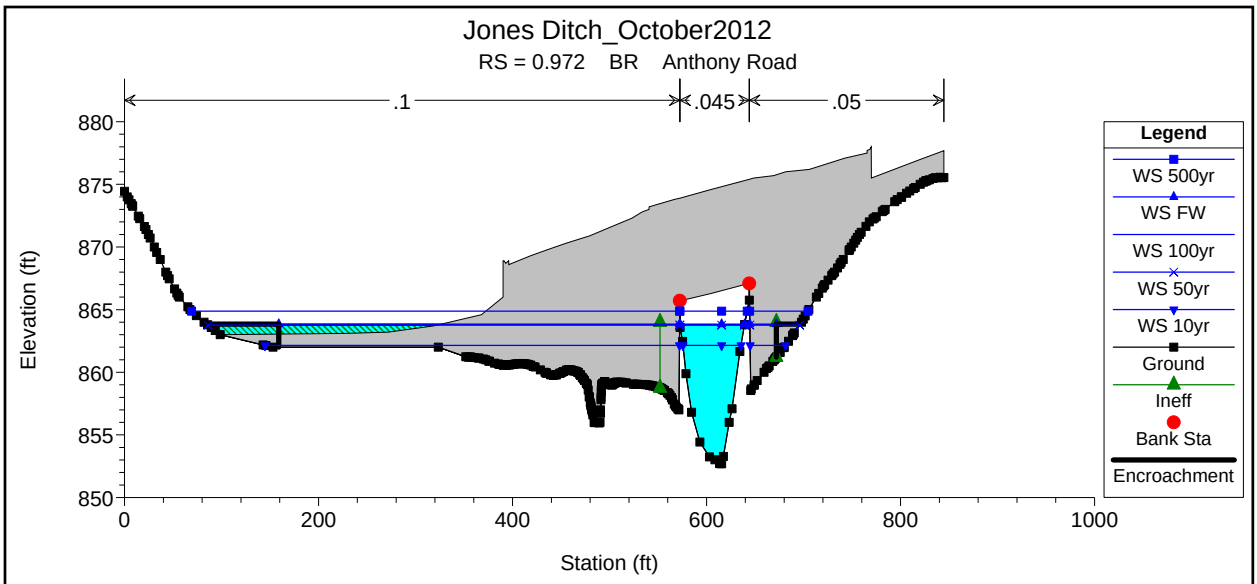

Jones Ditch_October2012
RS = 1.468 BR 216th Street
.05
.045
.07
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

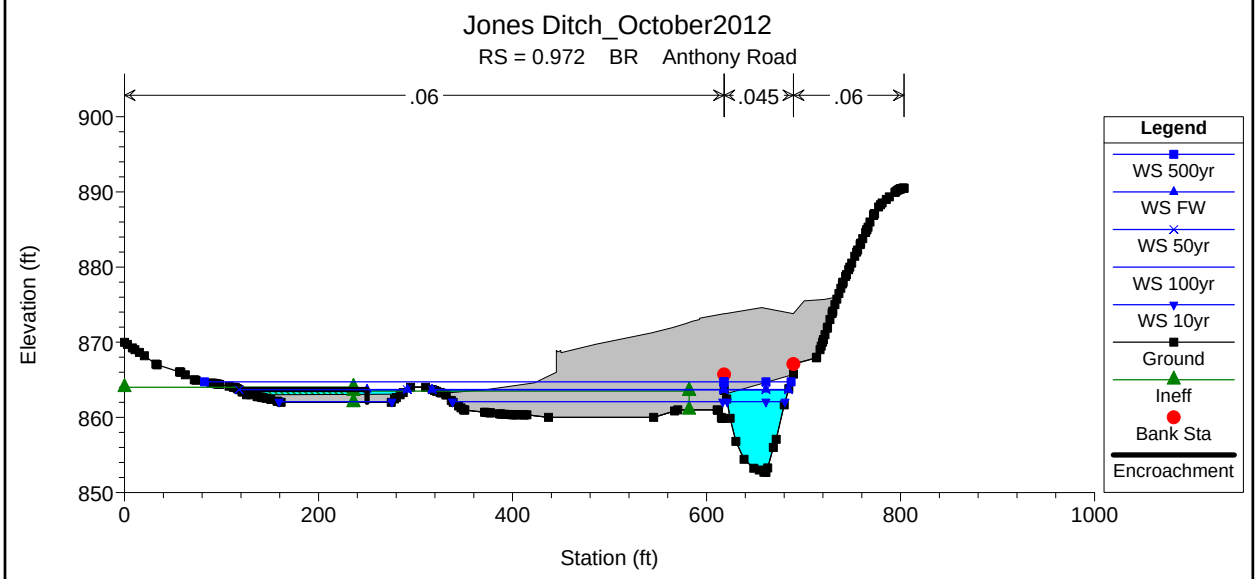

Jones Ditch_October2012
RS = 1.468 BR 216th Street
.05
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

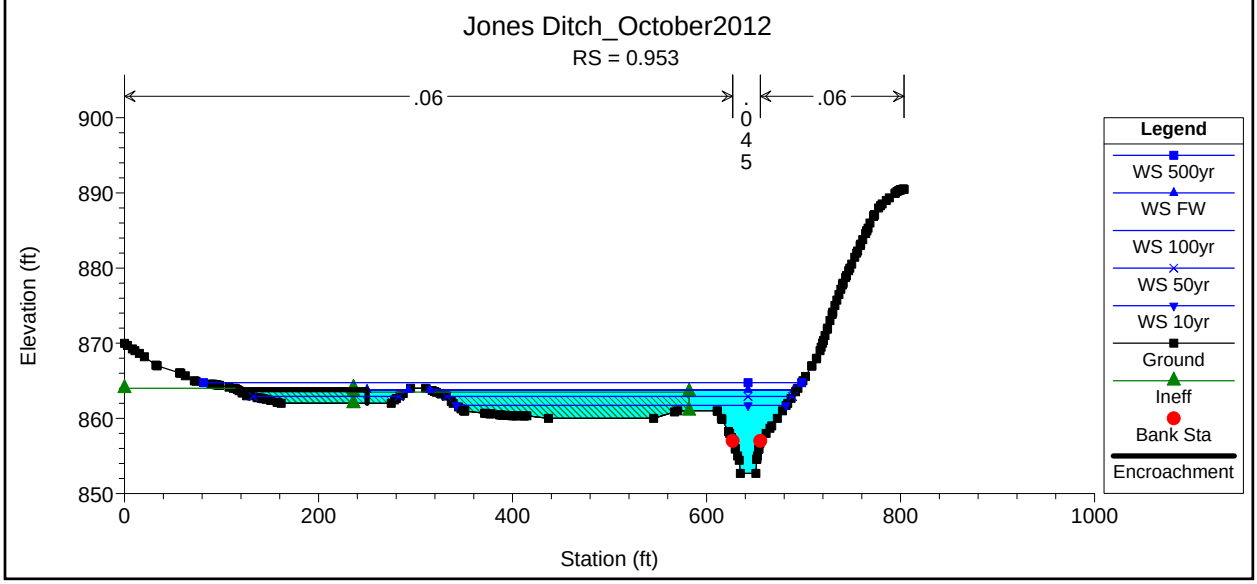

Jones Ditch_October2012
RS = 1.452
.05
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

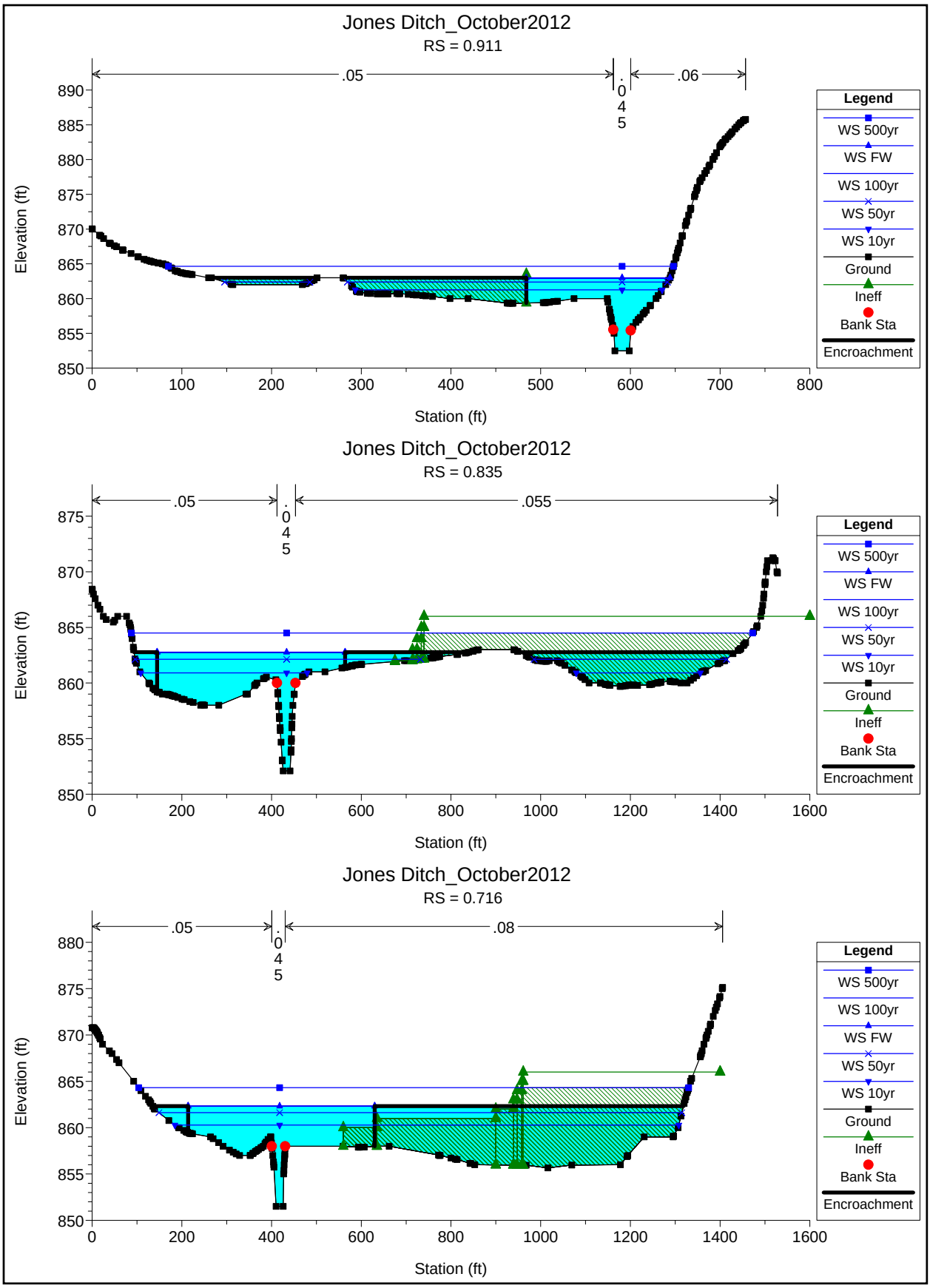

Jones Ditch_October2012
RS = 1.408
.06
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 1.304
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 1.168
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment

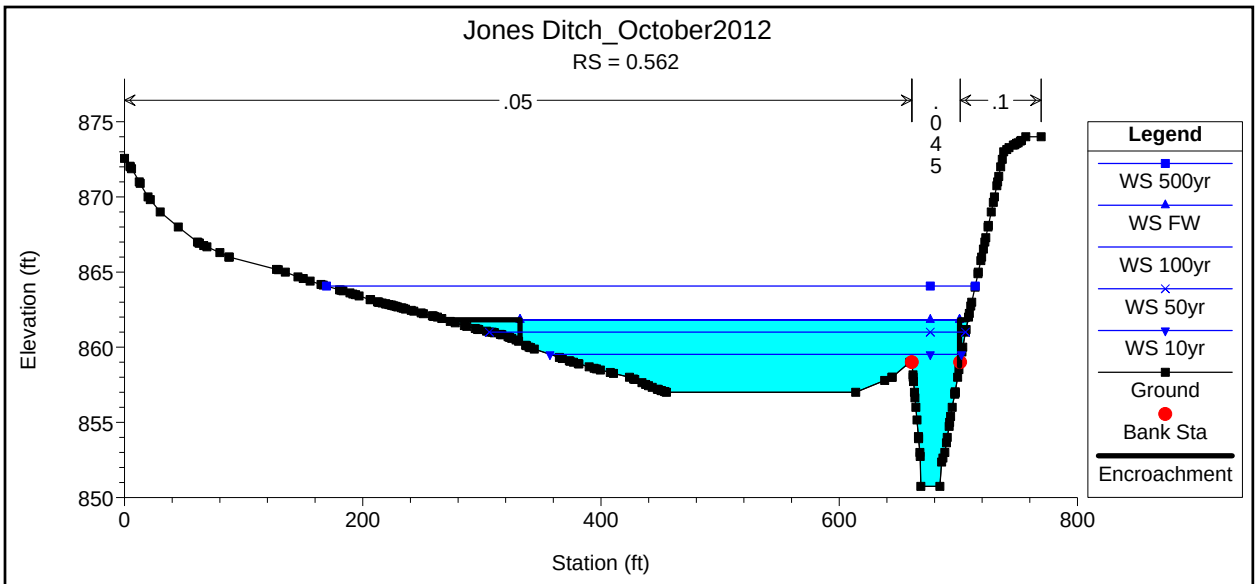

Jones Ditch_October2012
RS = 1.046
.05
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 0.996
.1
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 0.974
.1
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

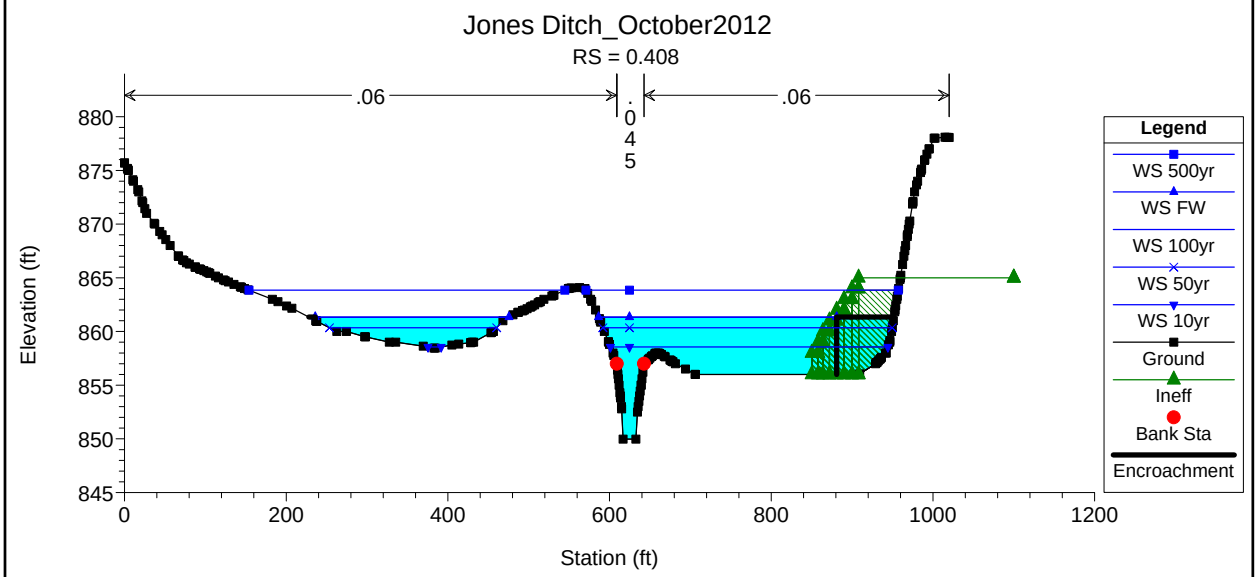

Jones Ditch_October2012
RS = 0.972 BR Anthony Road
.1
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

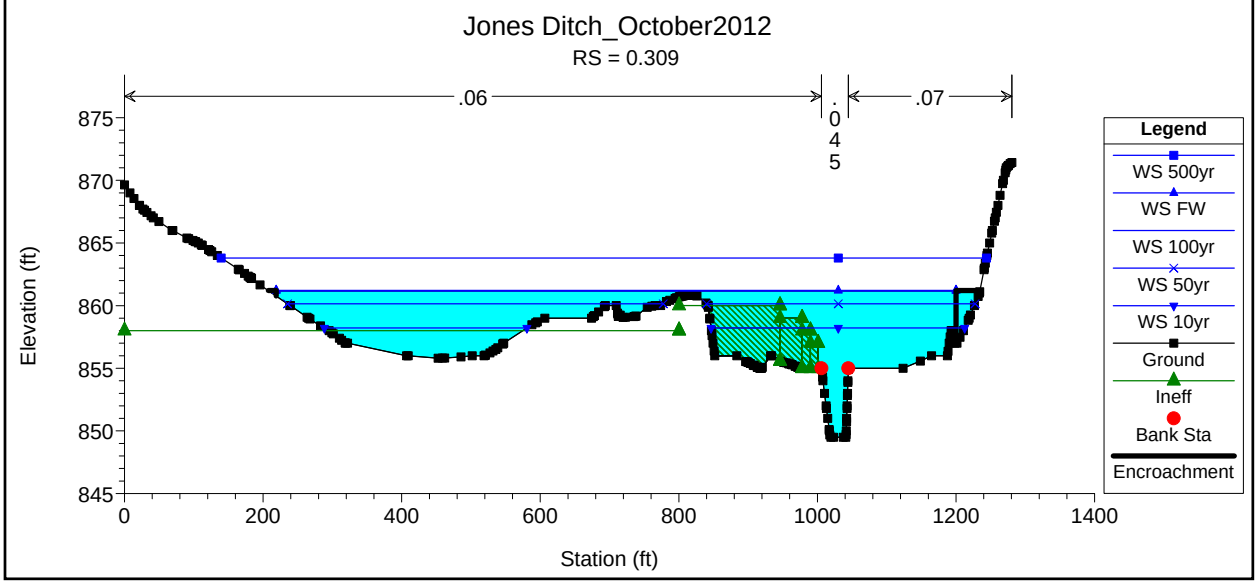

Jones Ditch_October2012
RS = 0.972 BR Anthony Road
.06
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 50yr
WS 100yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

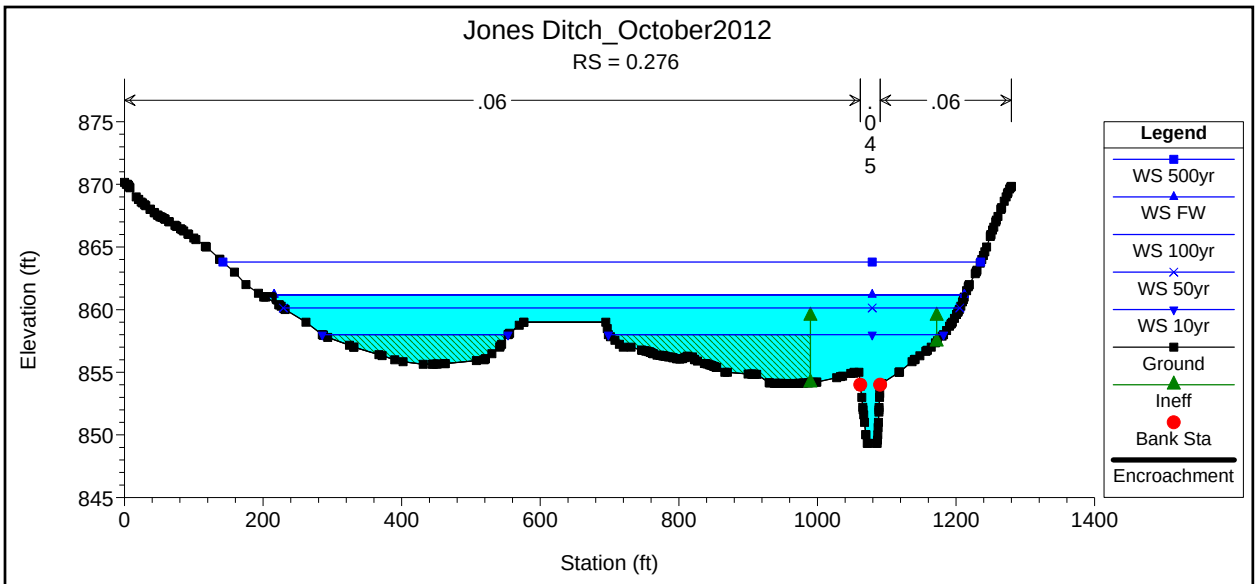

Jones Ditch_October2012
RS = 0.953
.06
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

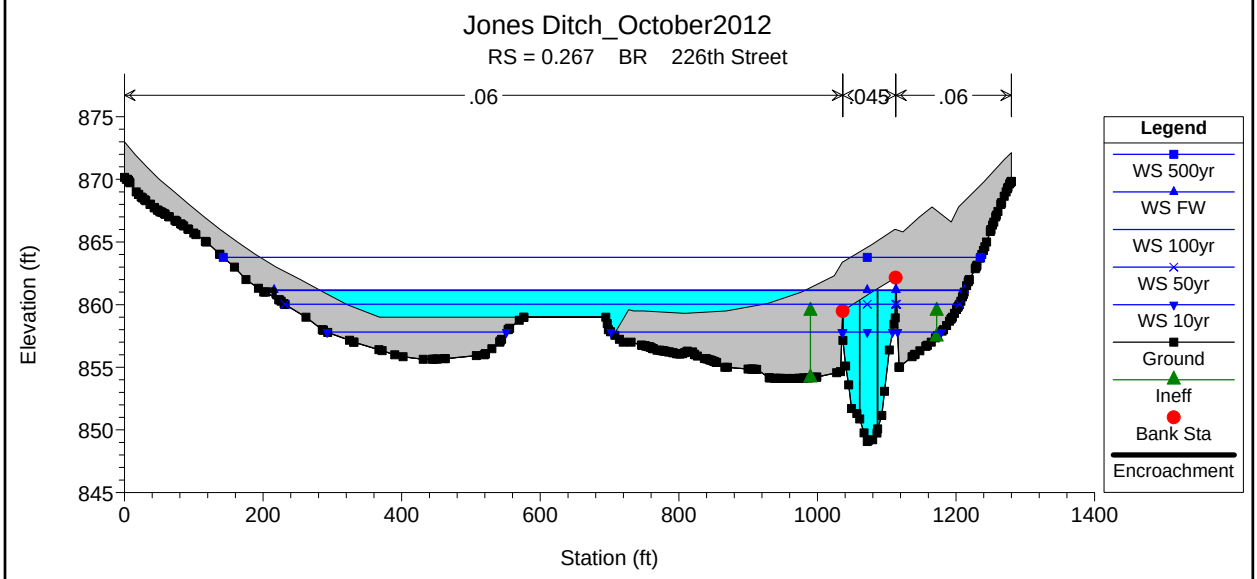

Jones Ditch_October2012
RS = 0.911
.05
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 0.835
.05
.045
.055
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 0.716
.05
.045
.08
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS 100yr
WS FW
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

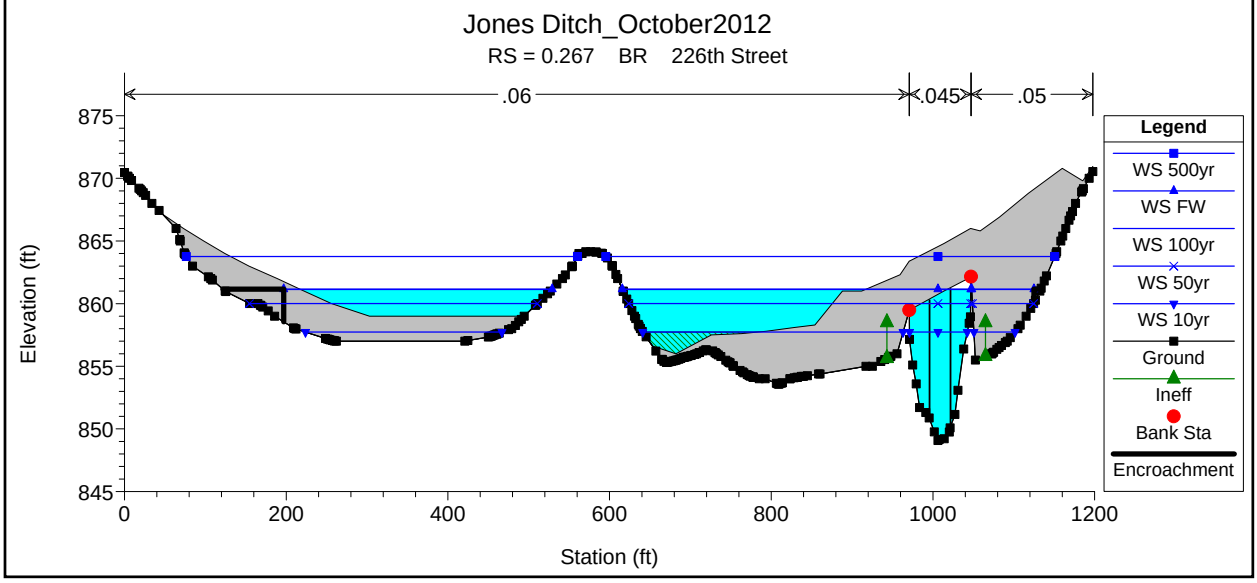

Jones Ditch_October2012
RS = 0.562
.05
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment

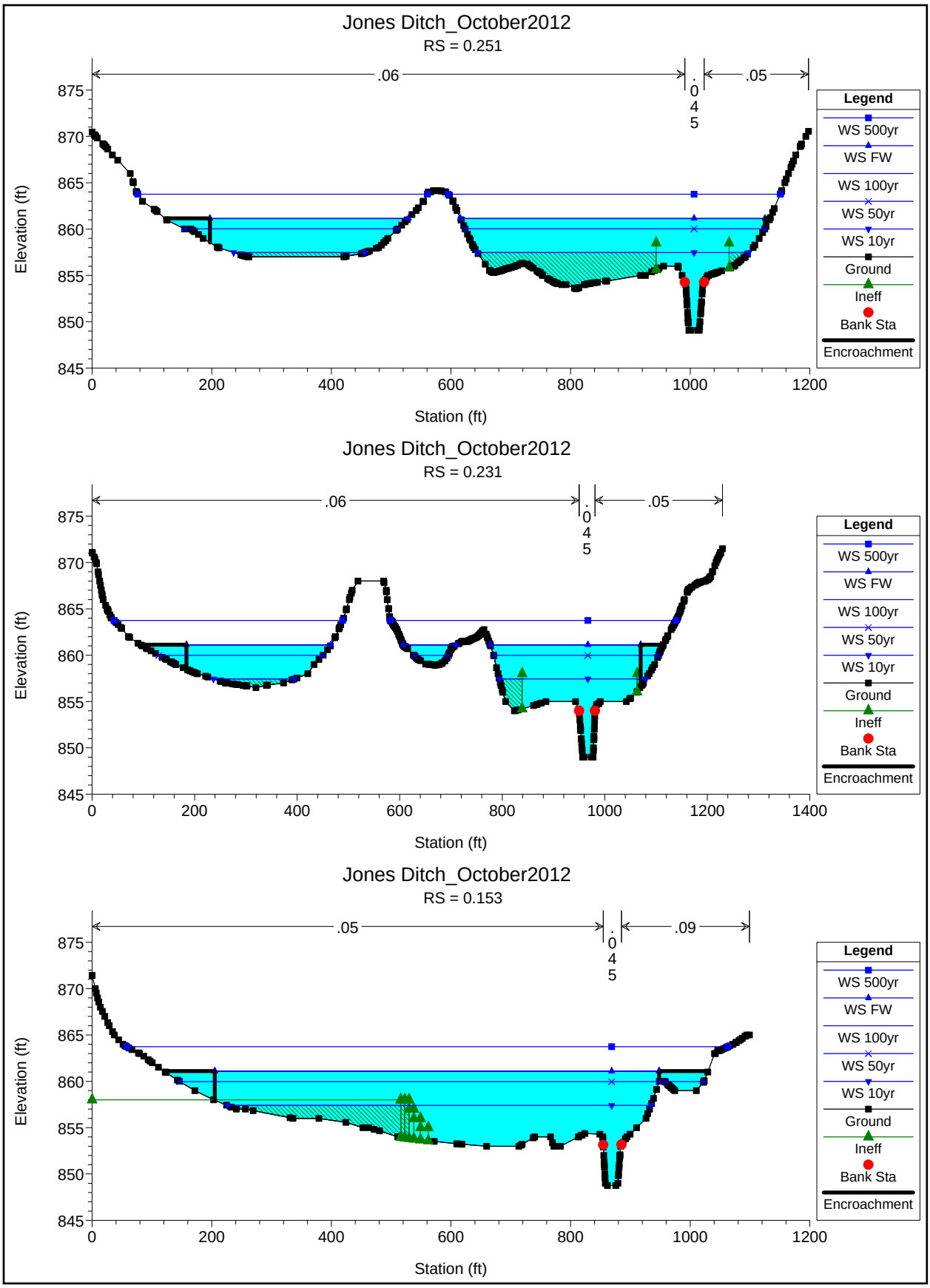

Jones Ditch_October2012
RS = 0.408
.06
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

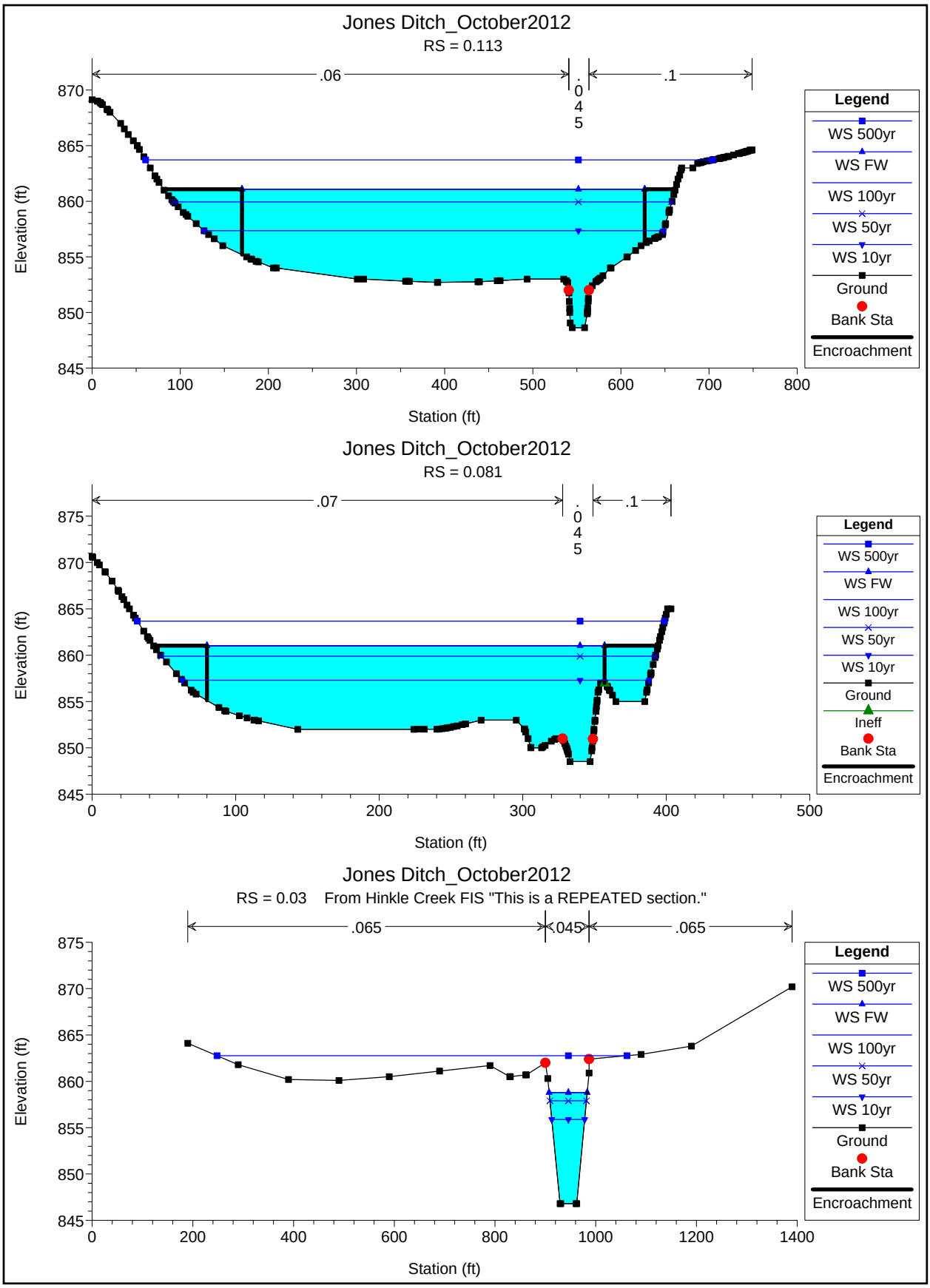

Jones Ditch_October2012
RS = 0.309
.06
.045
.07
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

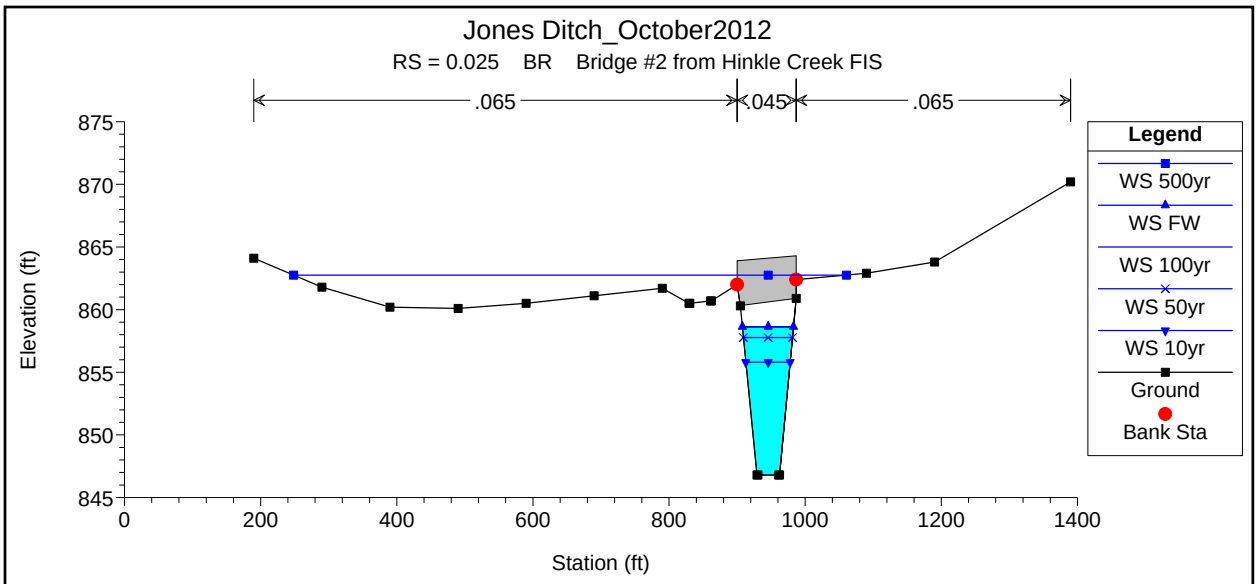

Jones Ditch_October2012
RS = 0.276
.06
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

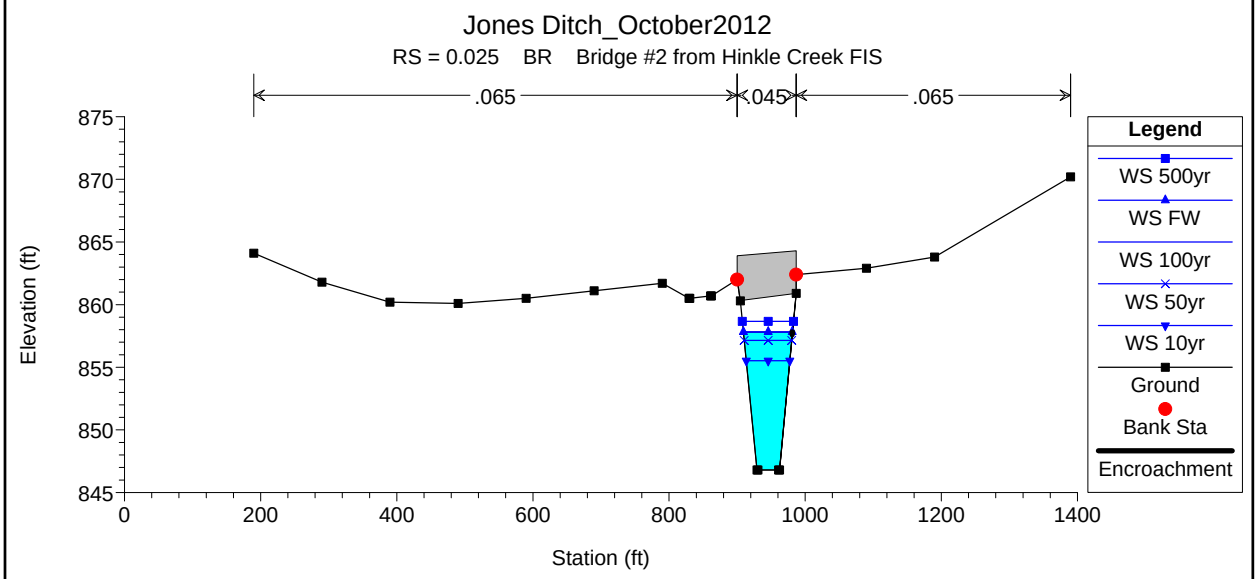

Jones Ditch_October2012
RS = 0.267 BR 226th Street
.06
.045
.06
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

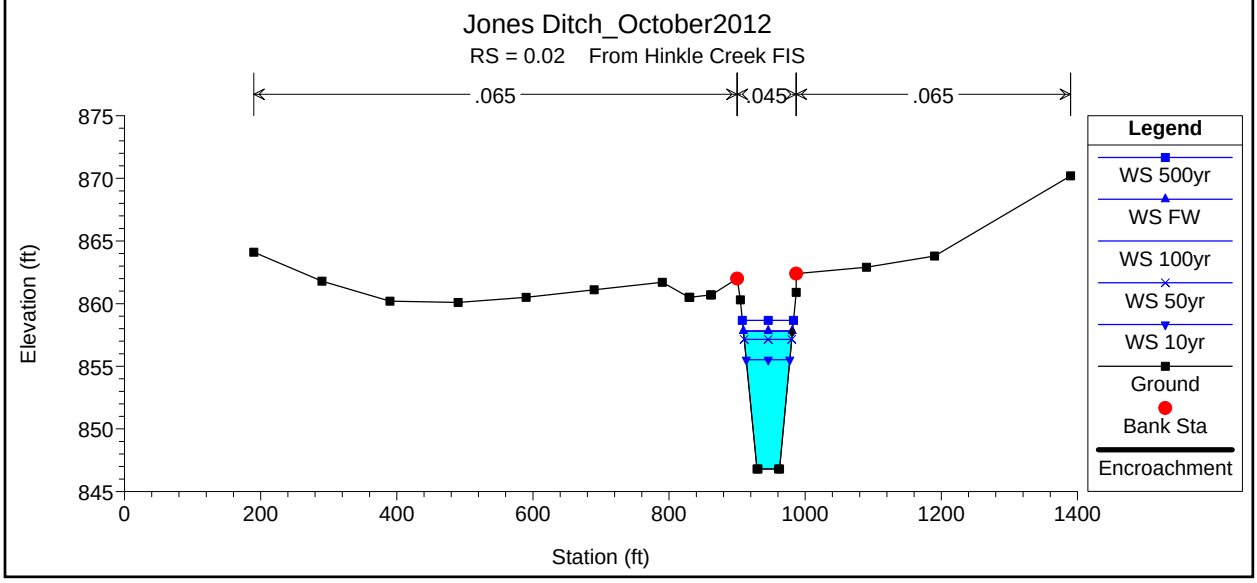

Jones Ditch_October2012
RS = 0.267 BR 226th Street
.06
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment

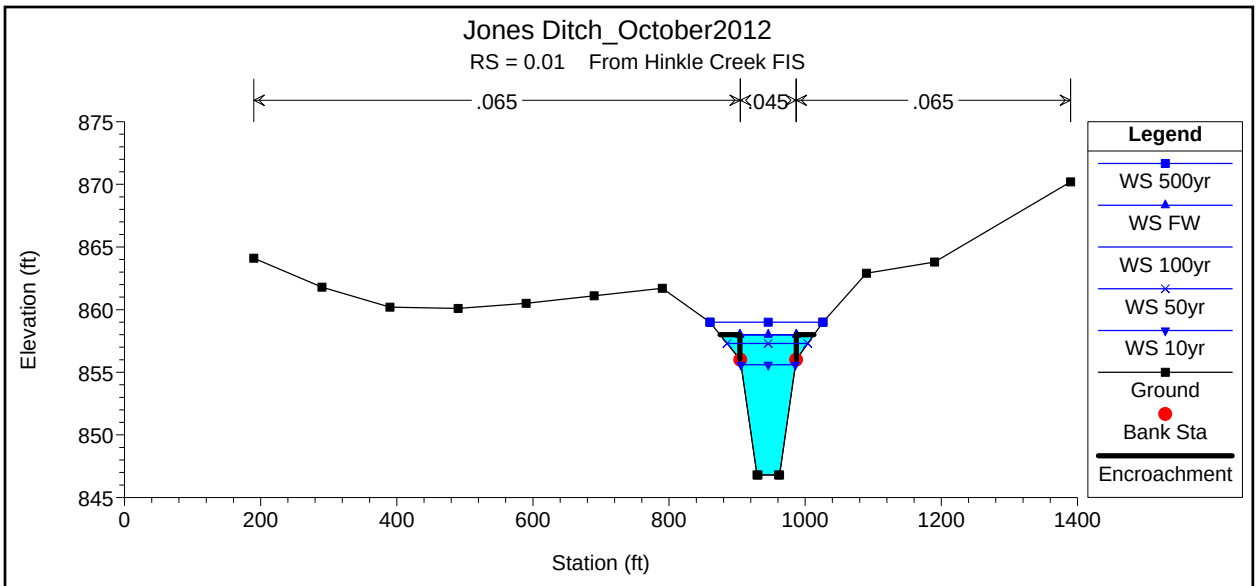

Jones Ditch_October2012
RS = 0.251
.06
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 0.231
.06
.045
.05
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 0.153
.05
.045
.09
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment


Jones Ditch_October2012
RS = 0.113
.06
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 0.081
.07
.045
.1
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Ineff
Bank Sta
Encroachment
Jones Ditch_October2012
RS = 0.03 From Hinkle Creek FIS "This is a REPEATED section."
.065
.045
.065
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment


Jones Ditch_October2012
RS = 0.025 BR Bridge #2 from Hinkle Creek FIS
.065
.045
.065
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta


Jones Ditch_October2012
RS = 0.025 BR Bridge #2 from Hinkle Creek FIS
.065
.045
.065
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment


Jones Ditch_October2012
RS = 0.02 From Hinkle Creek FIS
.065
.045
.065
Elevation (ft)
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment


Jones Ditch_October2012
RS = 0.01 From Hinkle Creek FIS
.065
.045
.065
Elevation (ft)
875
870
865
860
855
850
845
0
200
400
600
800
1000
1200
1400
Station (ft)
Legend
WS 500yr
WS FW
WS 100yr
WS 50yr
WS 10yr
Ground
Bank Sta
Encroachment

APPENDIX E FLOODWAY DATA TABLE, FLOOD PROFILE, AND FLOODMAPPING

FLOODING SOURCE		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Hinkle Creek								
A	2334	2253	2253.14	7.2	819.8	819.8	819.9	0.0
B	3601	2249	2248.97	7.2	821.7	821.7	821.8	0.1
C	5728	3173	3173.23	7.3	825.5	825.5	825.6	0.1
D	7467	1164	1163.75	9.9	829.8	829.8	829.9	0.1
E	11477	2188	2187.69	8.0	836.9	836.9	837	0.1
F	15568	1606	1606.11	4.9	848.0	848.0	848.1	0.1
G	18624	1406	1406.14	9.5	850.7	850.7	850.8	0.1
H	22637	5461	5460.89	1.7	860.6	860.6	860.7	0.1
I	25786	1376	1375.85	12.2	861.0	861.0	861.1	0.1
J	28172	2363	2363.37	3.8	867.1	867.1	867.2	0.1
K	30363	735	735.15	3.7	872.5	872.5	872.6	0.1
L	31559	1003	1002.69	5.5	873.5	873.5	873.6	0.1
M	33764	714	713.8	6.0	880.9	880.9	881	0.1
N	39706	475	474.54	1.7	897.4	897.4	897.5	0.1
O	41898	276	275.63	3.9	900.5	900.5	900.6	0.1
Q	43842	204	204.01	3.7	903.1	903.1	903.2	0.1

[1]Feet above confluence with Morse Reservoir

TABLE 1

HAMILTON COUNTY, IN AND INCORPORATED AREAS

FLOODWAY DATA

HINKLE CREEK

FLOODING SOURCE		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER-SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Jones Ditch								
A	597	457	3631	1.5	861.1	861.1	861.1	0.0
B	1,220	680	3031	2.1	861.1	861.1	861.1	0.0
C	2,967	369	1682	2.8	861.8	861.8	861.8	0.0
D	6,167	416	1897	2.7	864.9	864.9	865.0	0.1
E	8,131	474	2779	1.7	867.3	867.3	867.4	0.1
F	8,934	519	2702	1.7	867.4	867.4	867.5	0.1
G	11,553	489	1609	3.8	869.3	869.3	869.4	0.1
H	11,896	420	1601	2.4	869.6	869.6	869.7	0.1
I	12,371	482	1486	2.5	869.8	869.8	869.9	0.1
J	13,480	441	1724	1.9	871.3	871.3	871.4	0.1
K	21,083	230	335	8.0	886.9	886.9	887.0	0.1
L	21,384	94	256	8.4	888.9	888.9	889.0	0.1
M	22,187	60	225	8.4	893.8	893.8	893.9	0.1

[1]Feet above confluence with Hinkle Creek

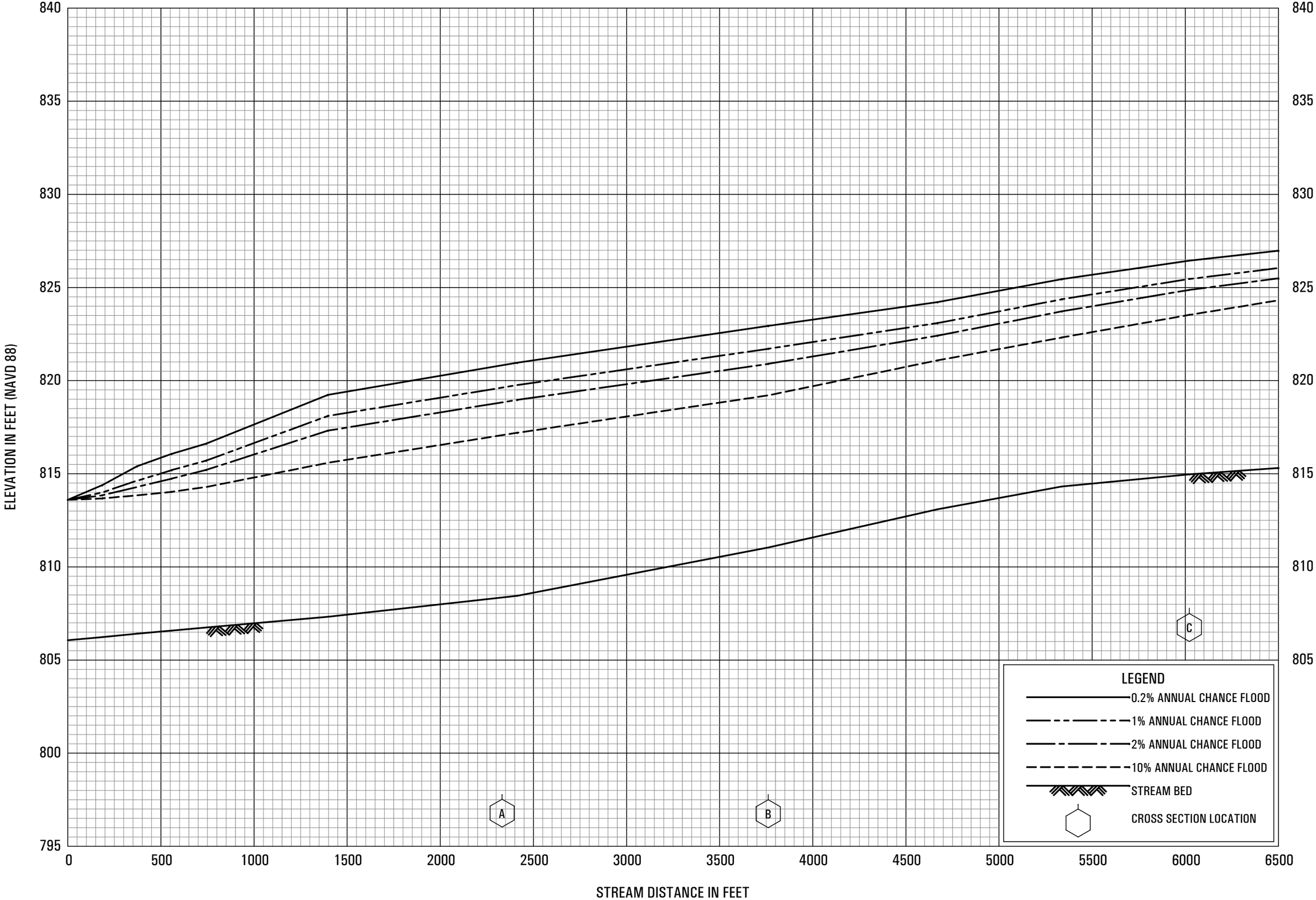
TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

HAMILTON COUNTY, IN AND INCORPORATED AREAS

FLOODWAY DATA

JONES DITCH

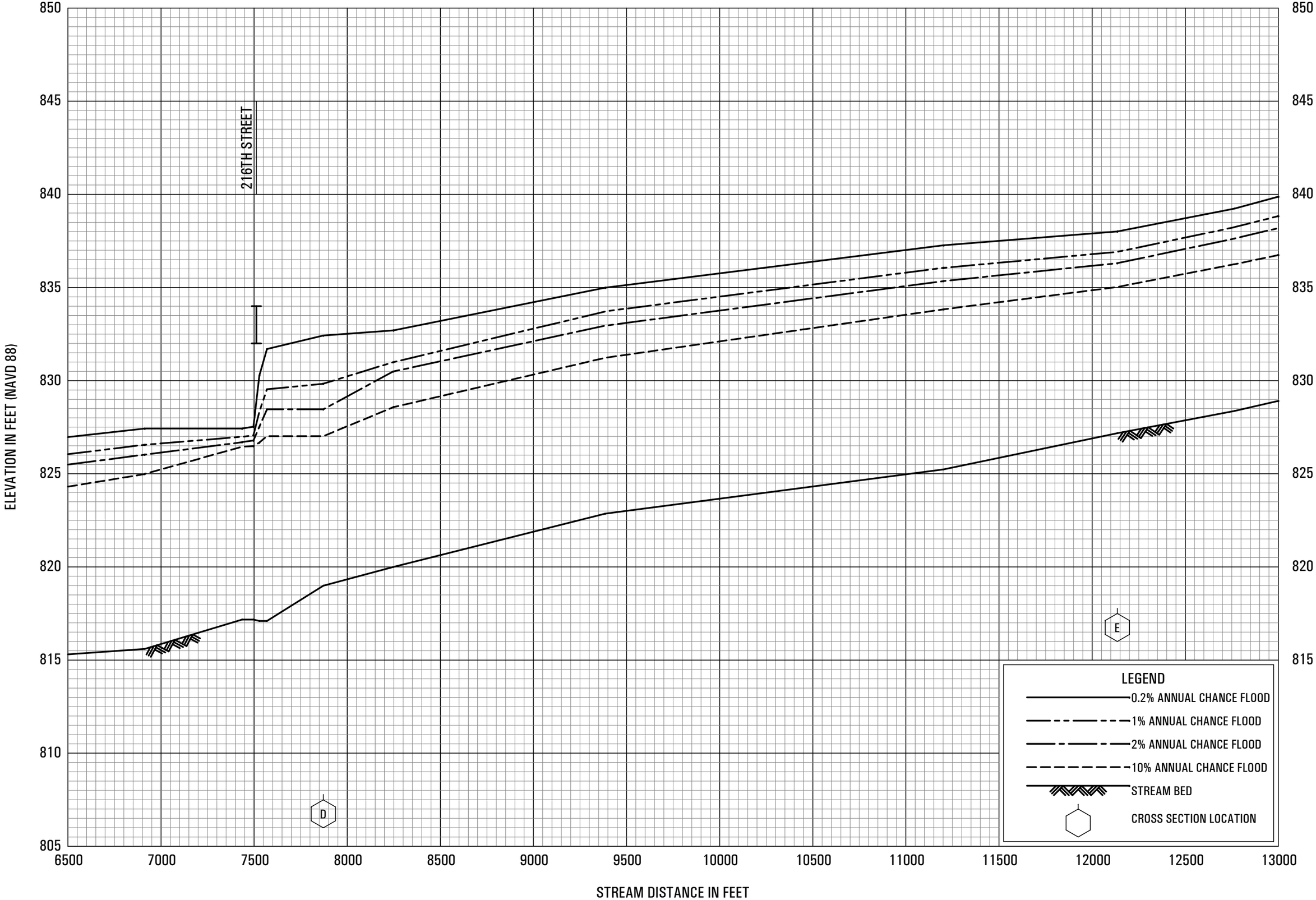


FLOOD PROFILES

HINKLE CREEK

HAMILTON COUNTY, IN
AND INCORPORATED AREAS

01P

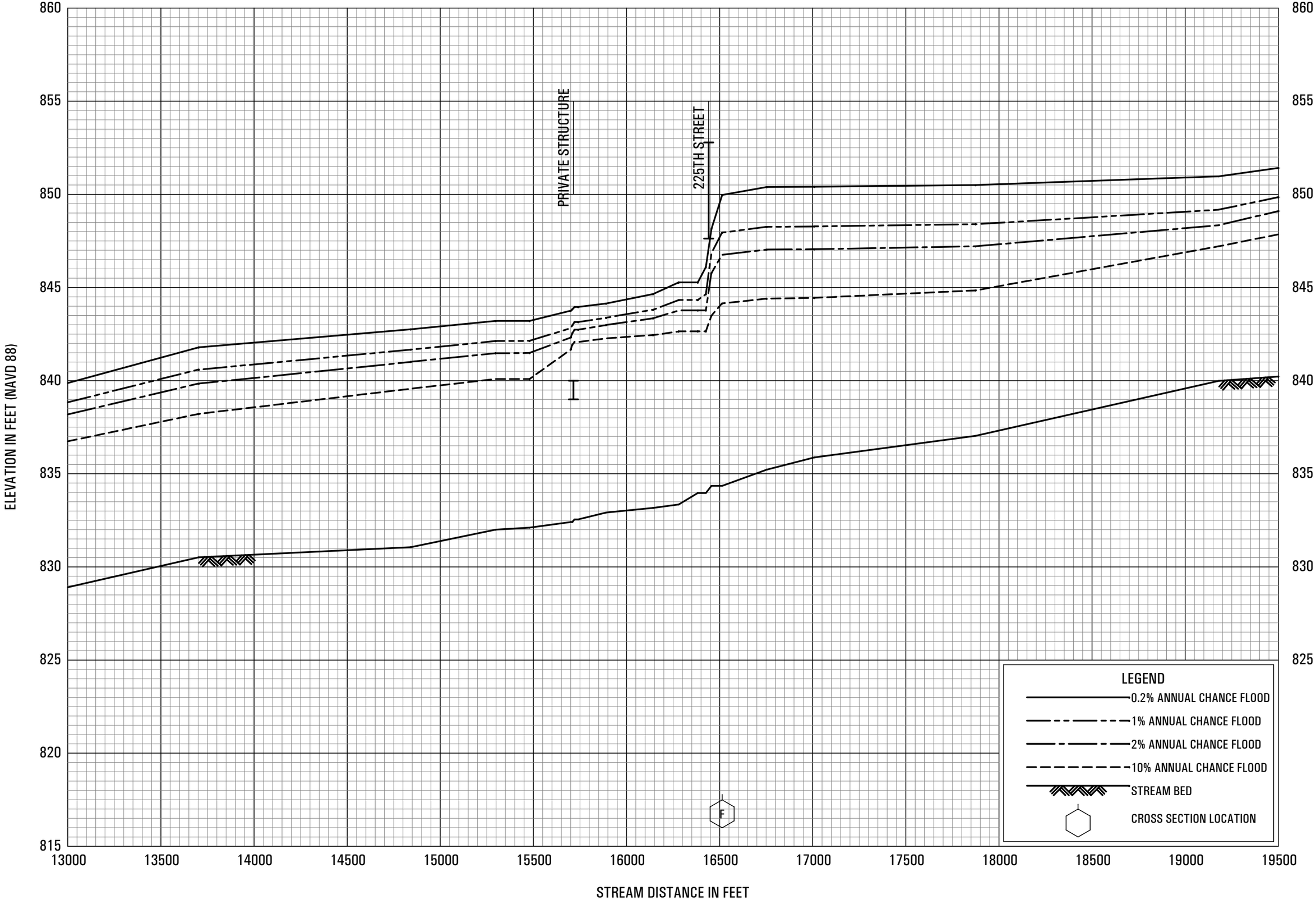


FLOOD PROFILES

HINKLE CREEK

HAMILTON COUNTY, IN
AND INCORPORATED AREAS

02P

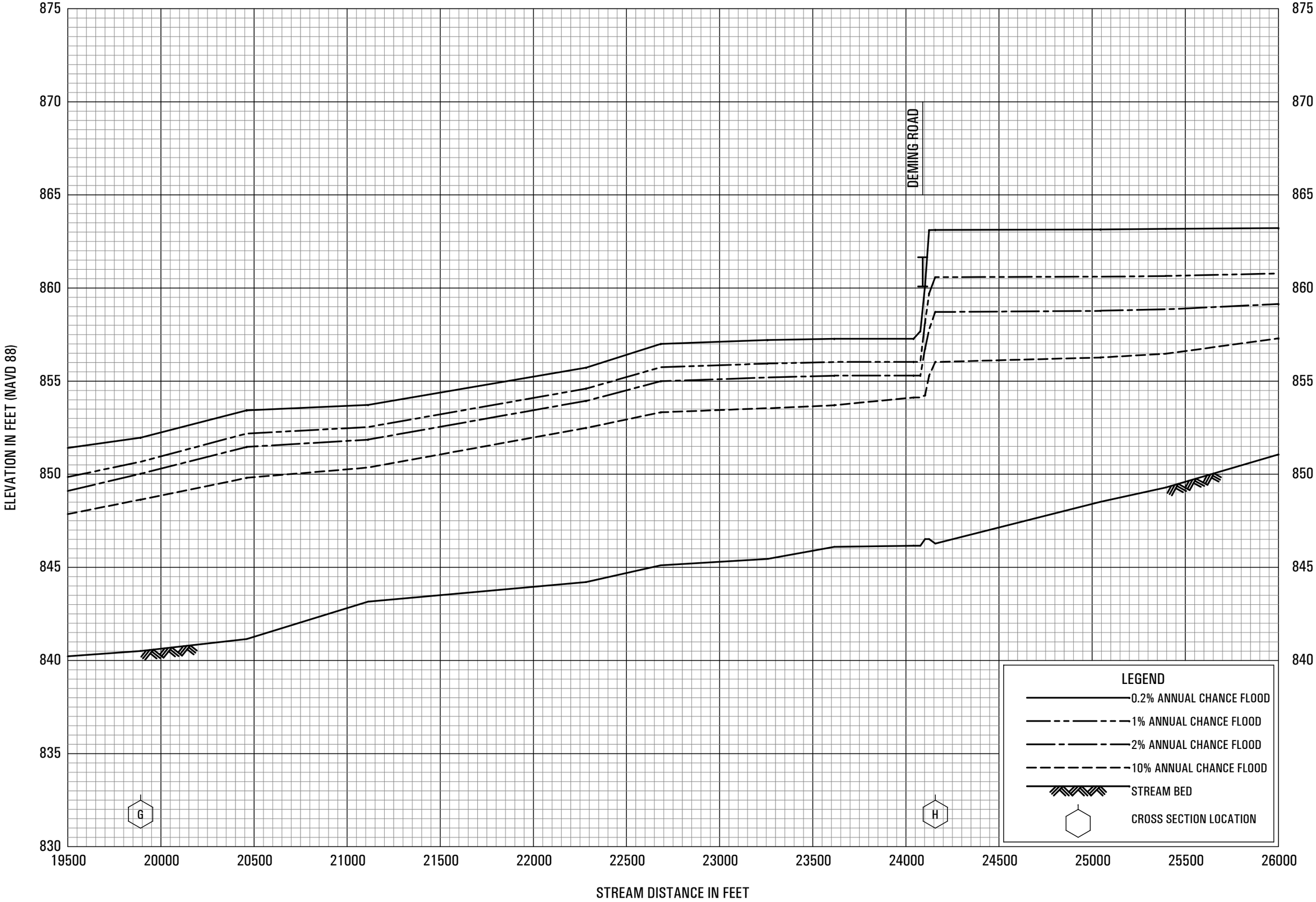


FLOOD PROFILES

HINKLE CREEK

HAMILTON COUNTY, IN
AND INCORPORATED AREAS

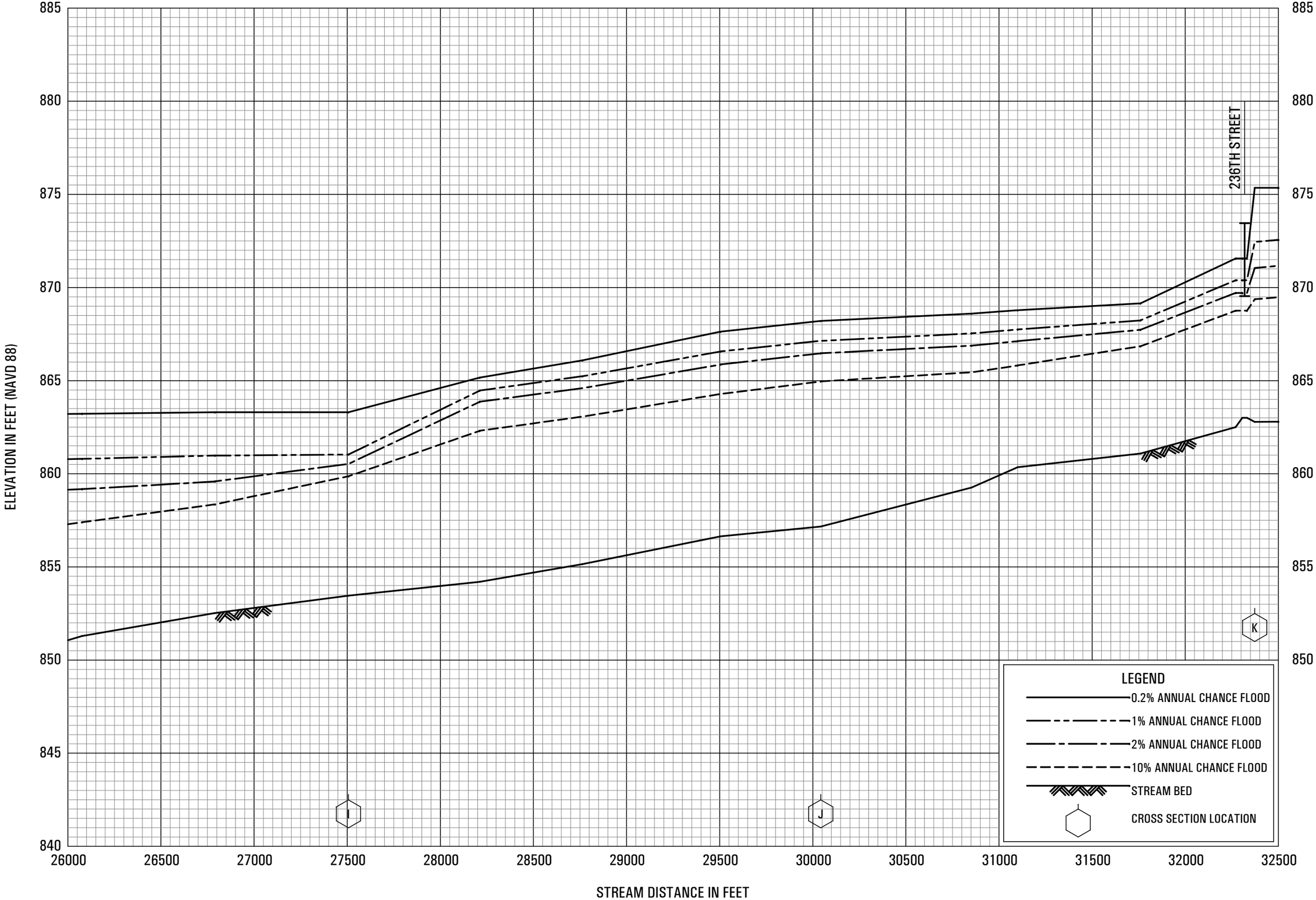
03P



FLOOD PROFILES

HINKLE CREEK

HAMILTON COUNTY, IN
AND INCORPORATED AREAS

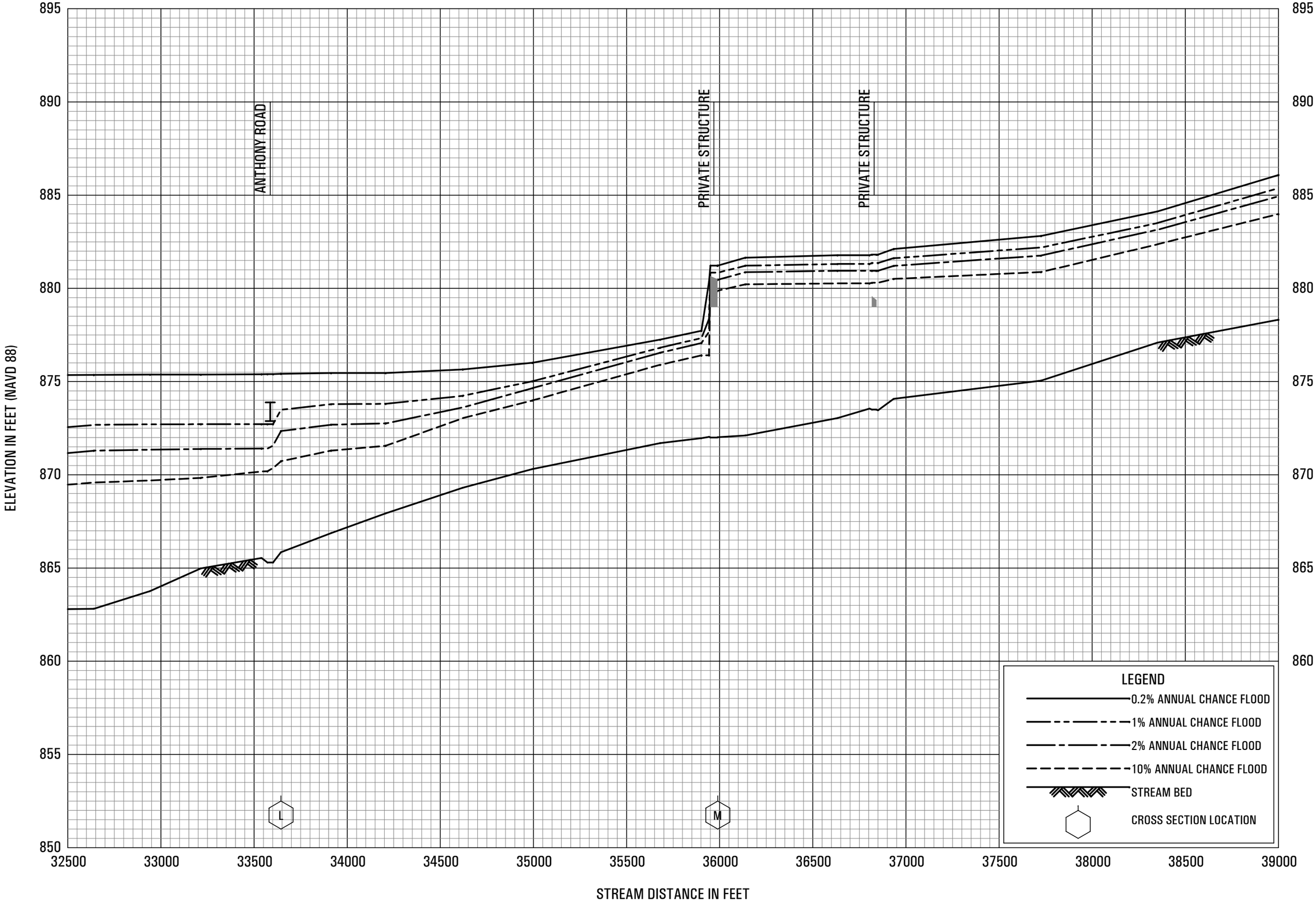


FLOOD PROFILES

HINKLE CREEK

HAMILTON COUNTY, IN
AND INCORPORATED AREAS

05P

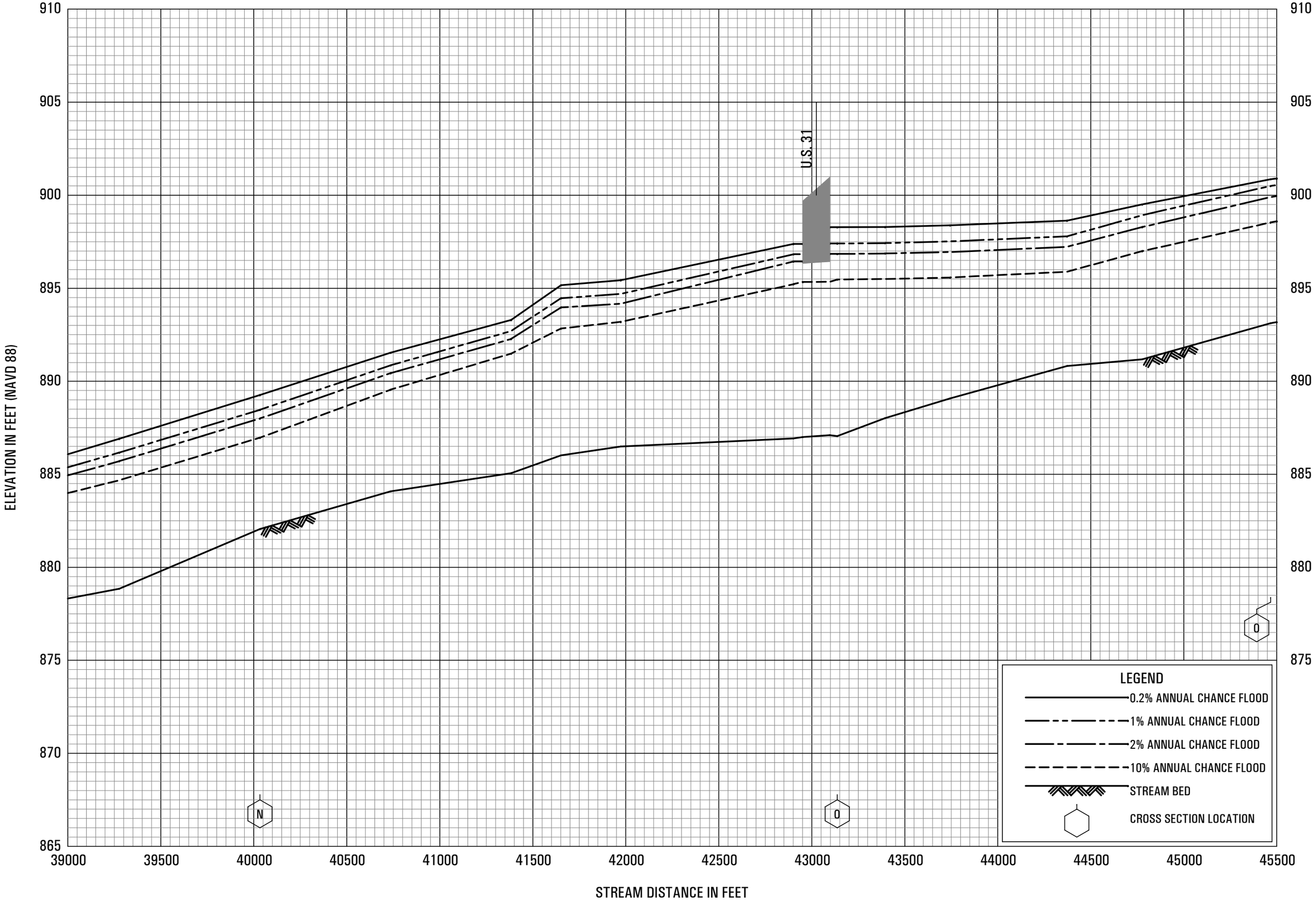


FLOOD PROFILES

HINKLE CREEK

HAMILTON COUNTY, IN
AND INCORPORATED AREAS

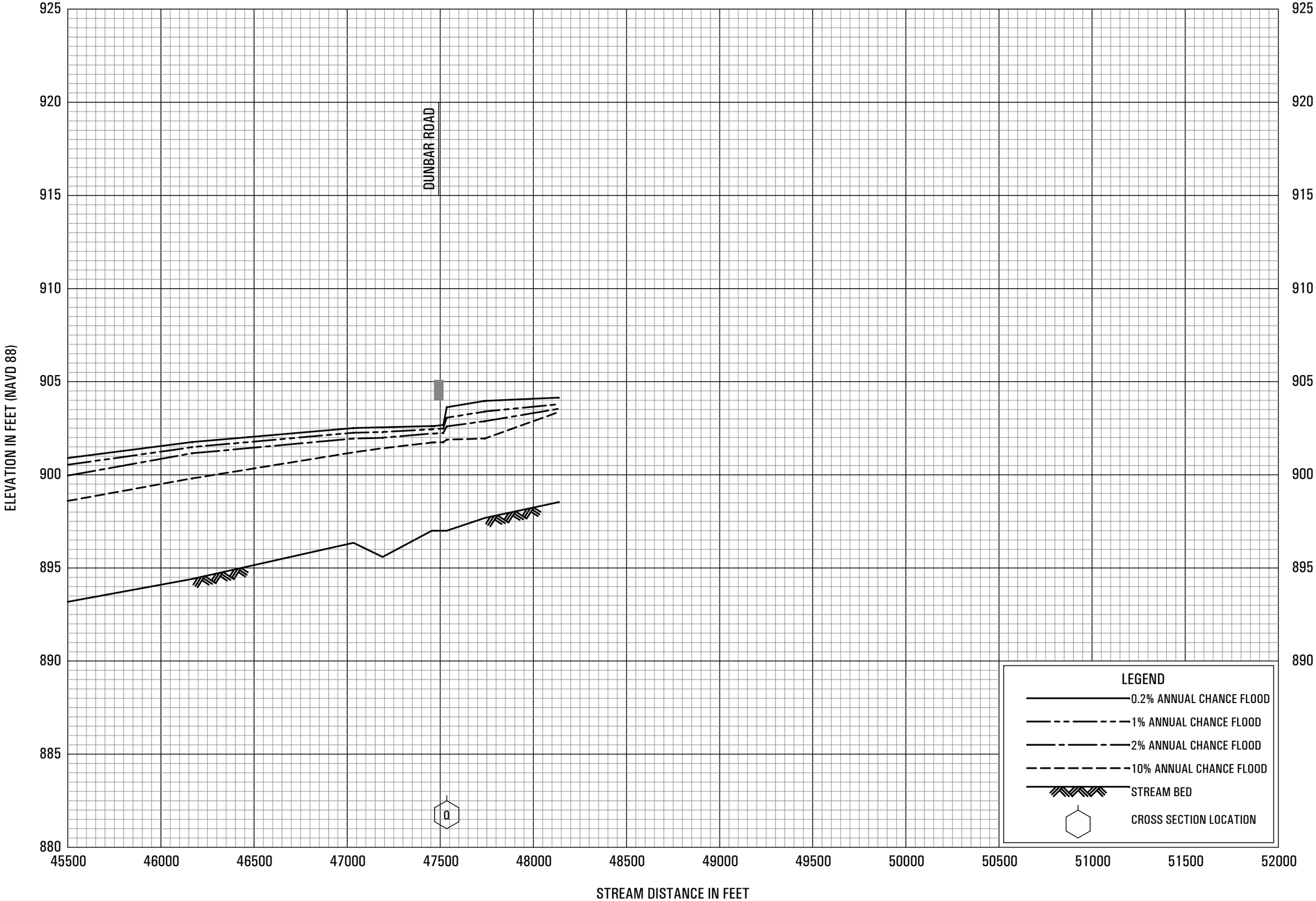
06P



FLOOD PROFILES

HINKLE CREEK

HAMILTON COUNTY, IN
AND INCORPORATED AREAS

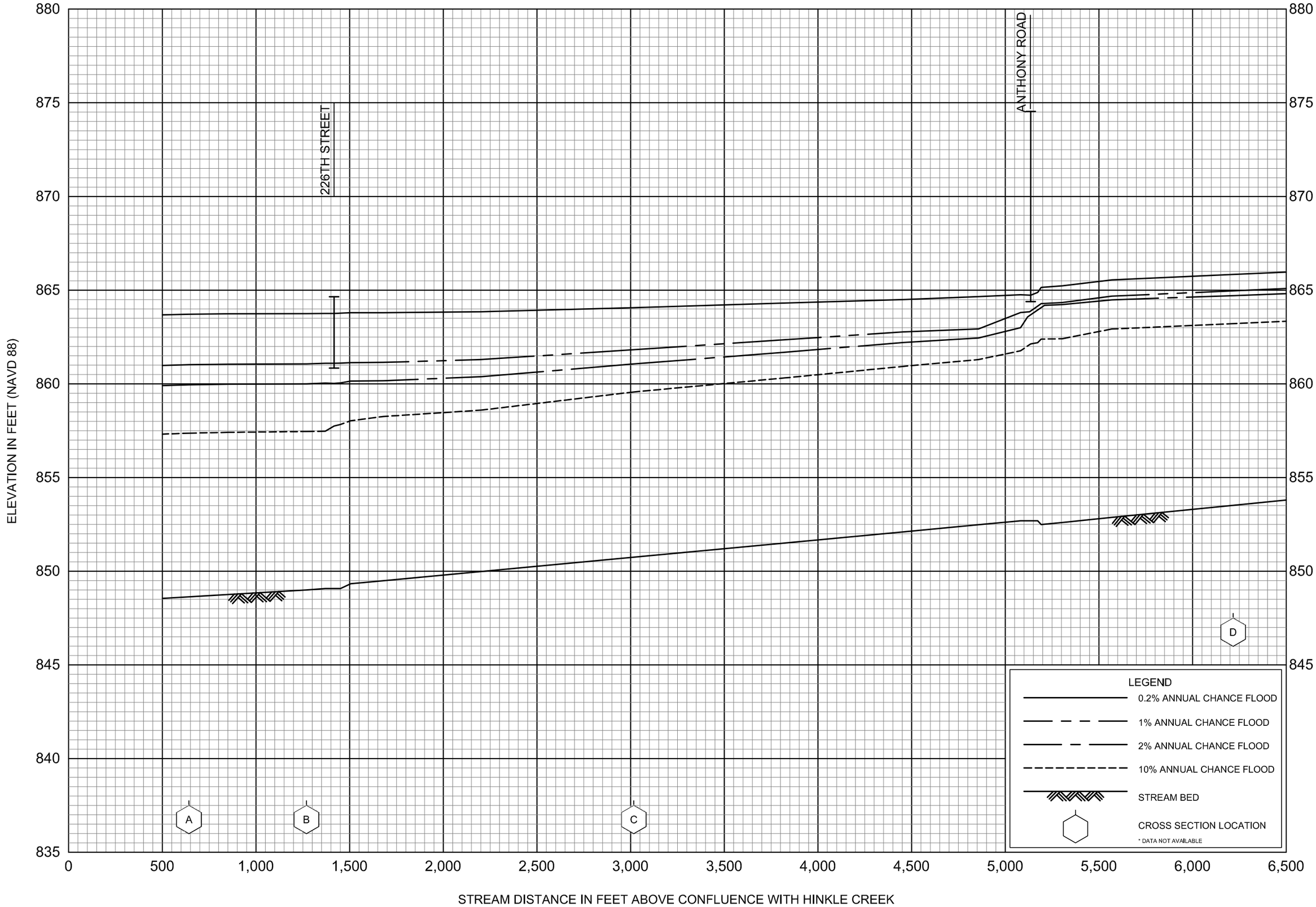


FLOOD PROFILES

HINKLE CREEK

HAMILTON COUNTY, IN
AND INCORPORATED AREAS

08P



FLOOD PROFILES

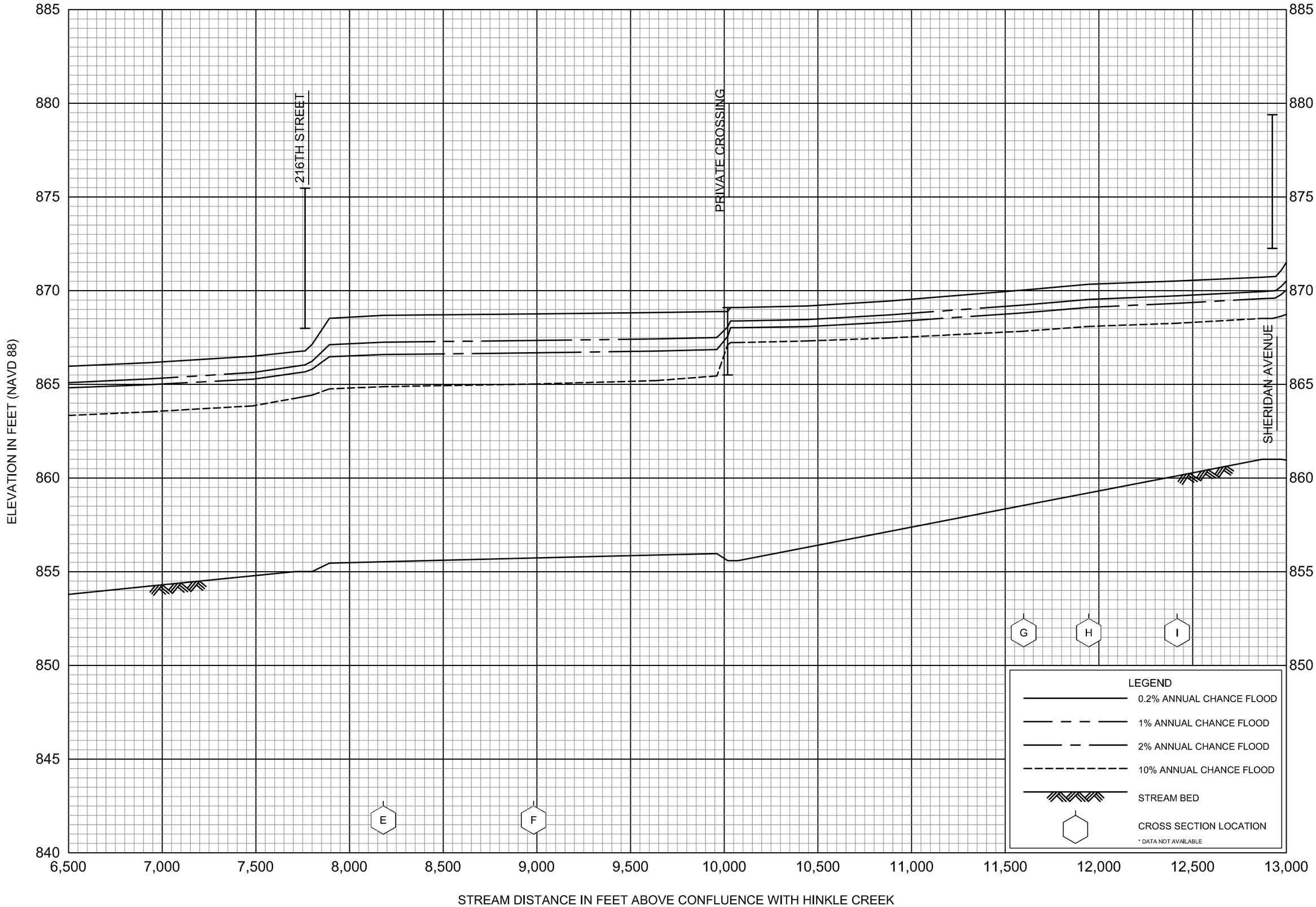
JONES DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

HAMILTON COUNTY, IN

AND INCORPORATED AREAS

09P



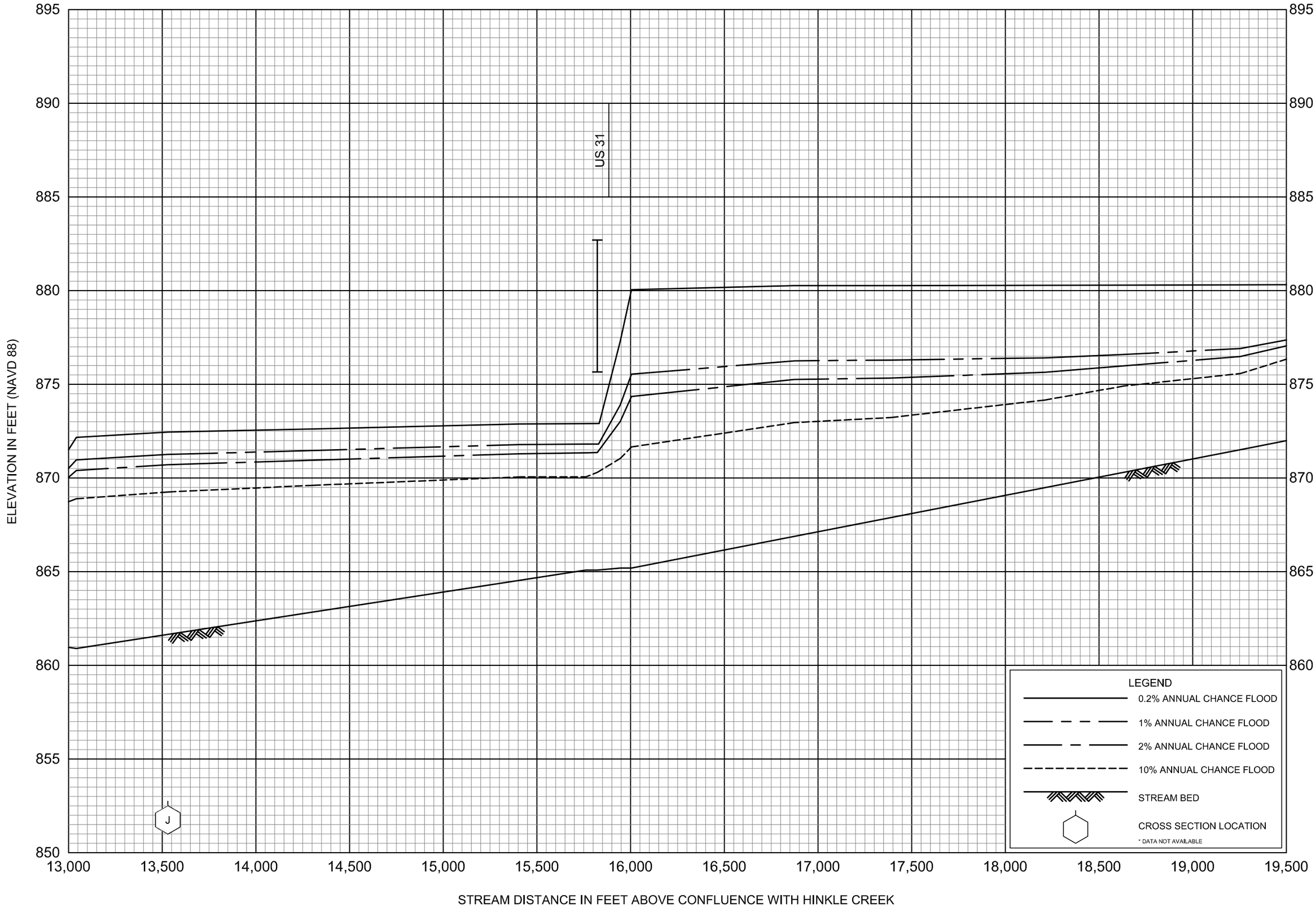
FLOOD PROFILES

JONES DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

HAMILTON COUNTY, IN

AND INCORPORATED AREAS



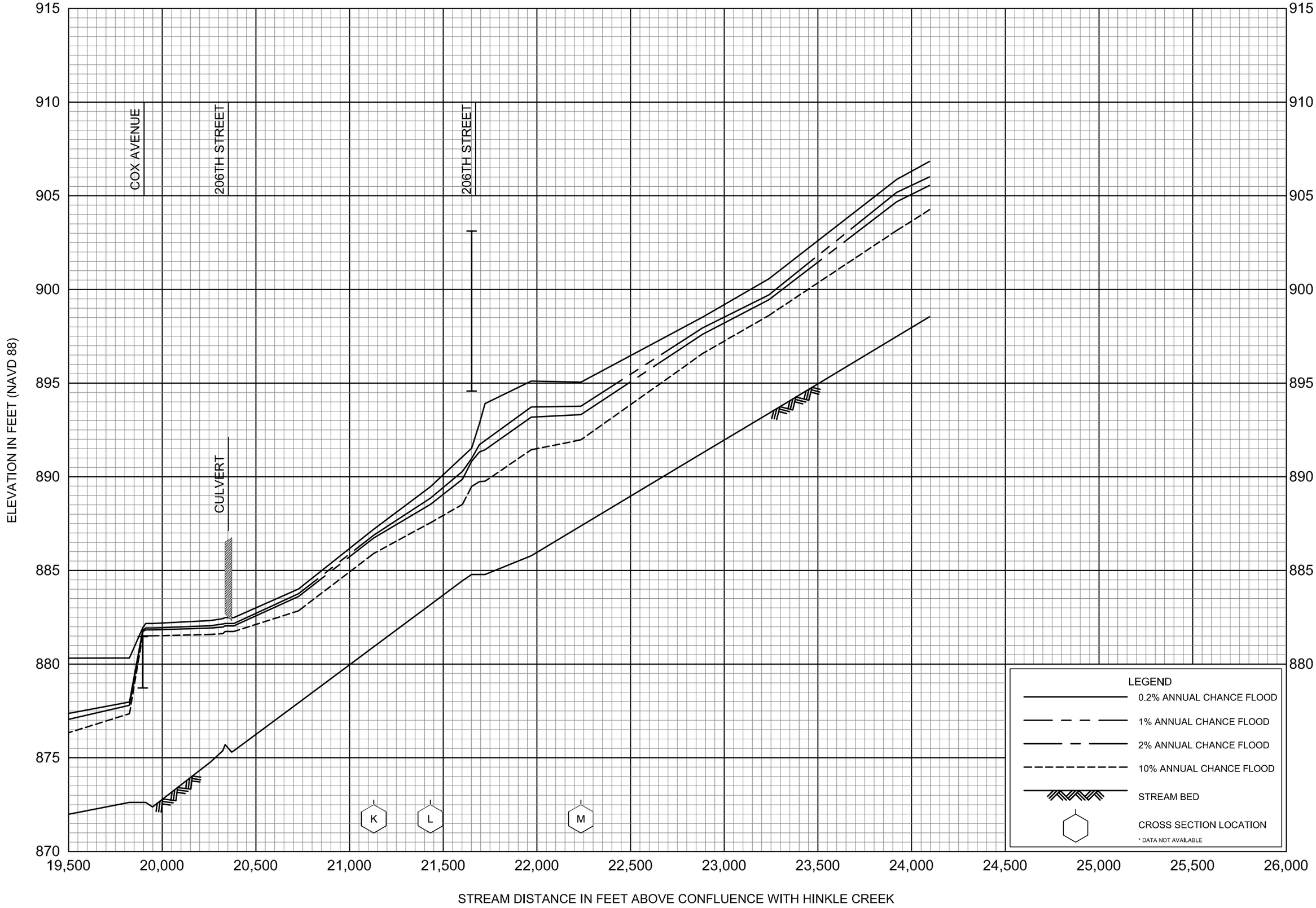
FLOOD PROFILES

JONES DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

HAMILTON COUNTY, IN

AND INCORPORATED AREAS



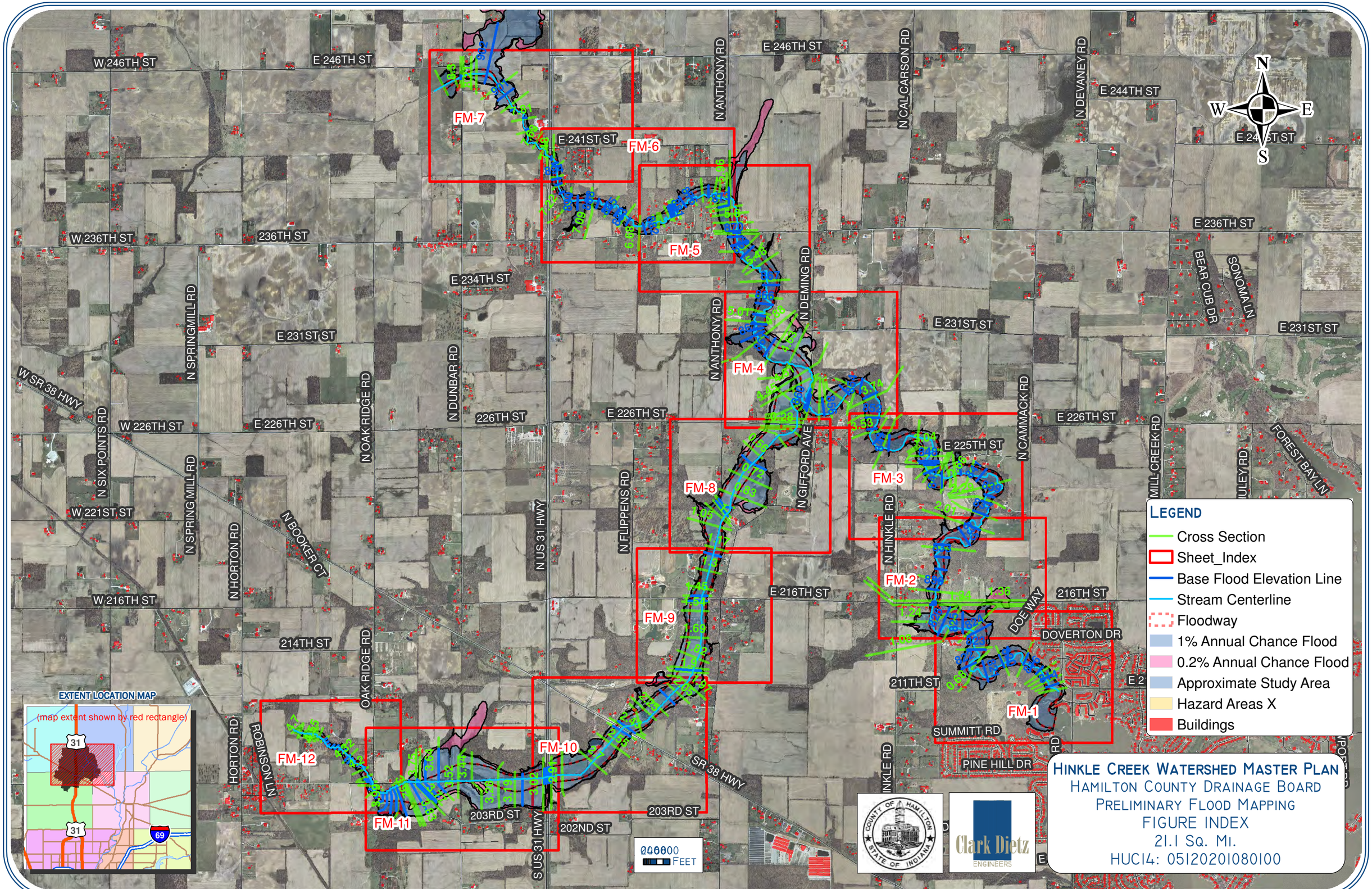
FLOOD PROFILES

JONES DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

HAMILTON COUNTY, IN

AND INCORPORATED AREAS



HINKLE CREEK WATERSHED MASTER PLAN

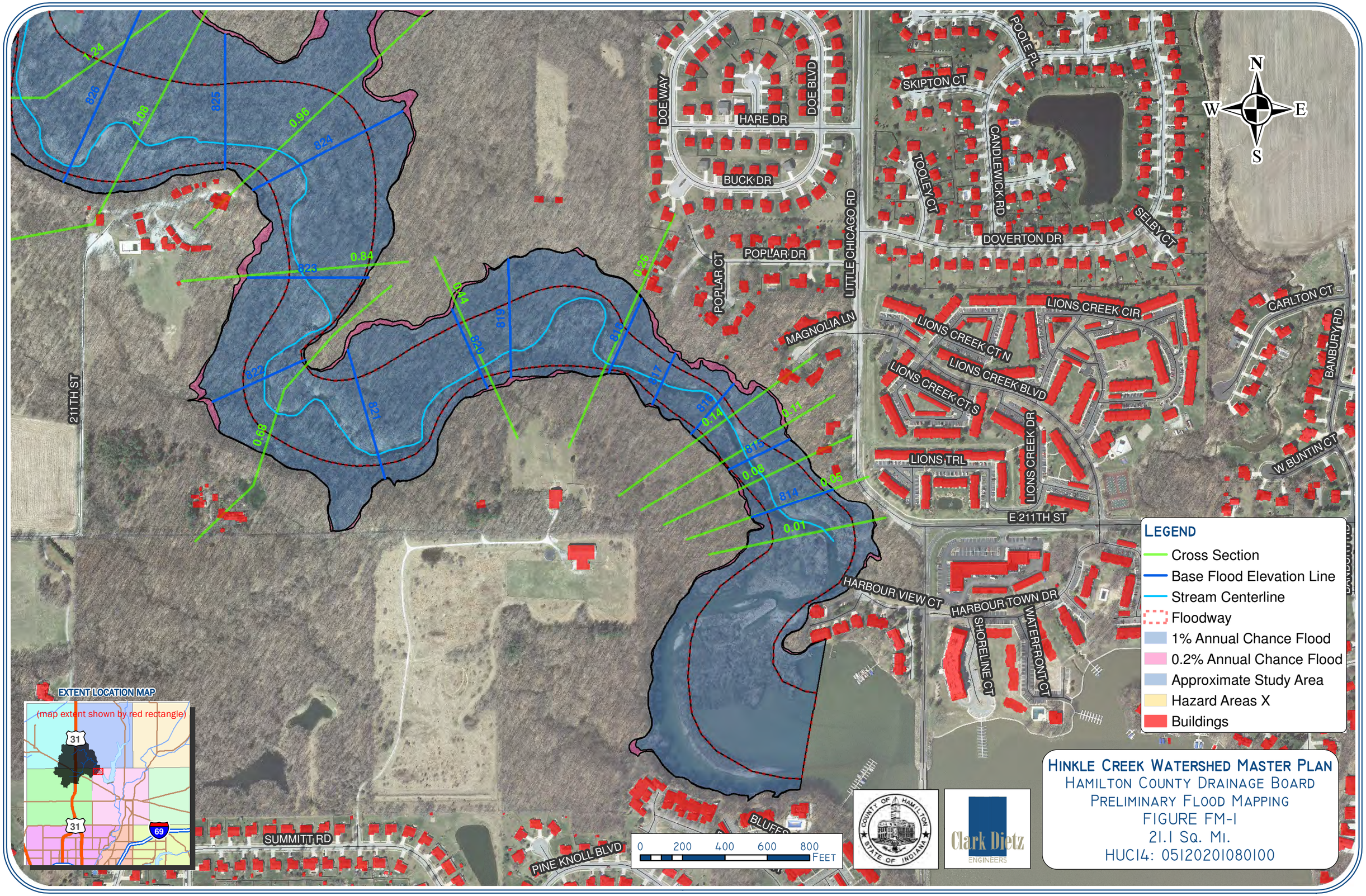
HAMILTON COUNTY DRAINAGE BOARD

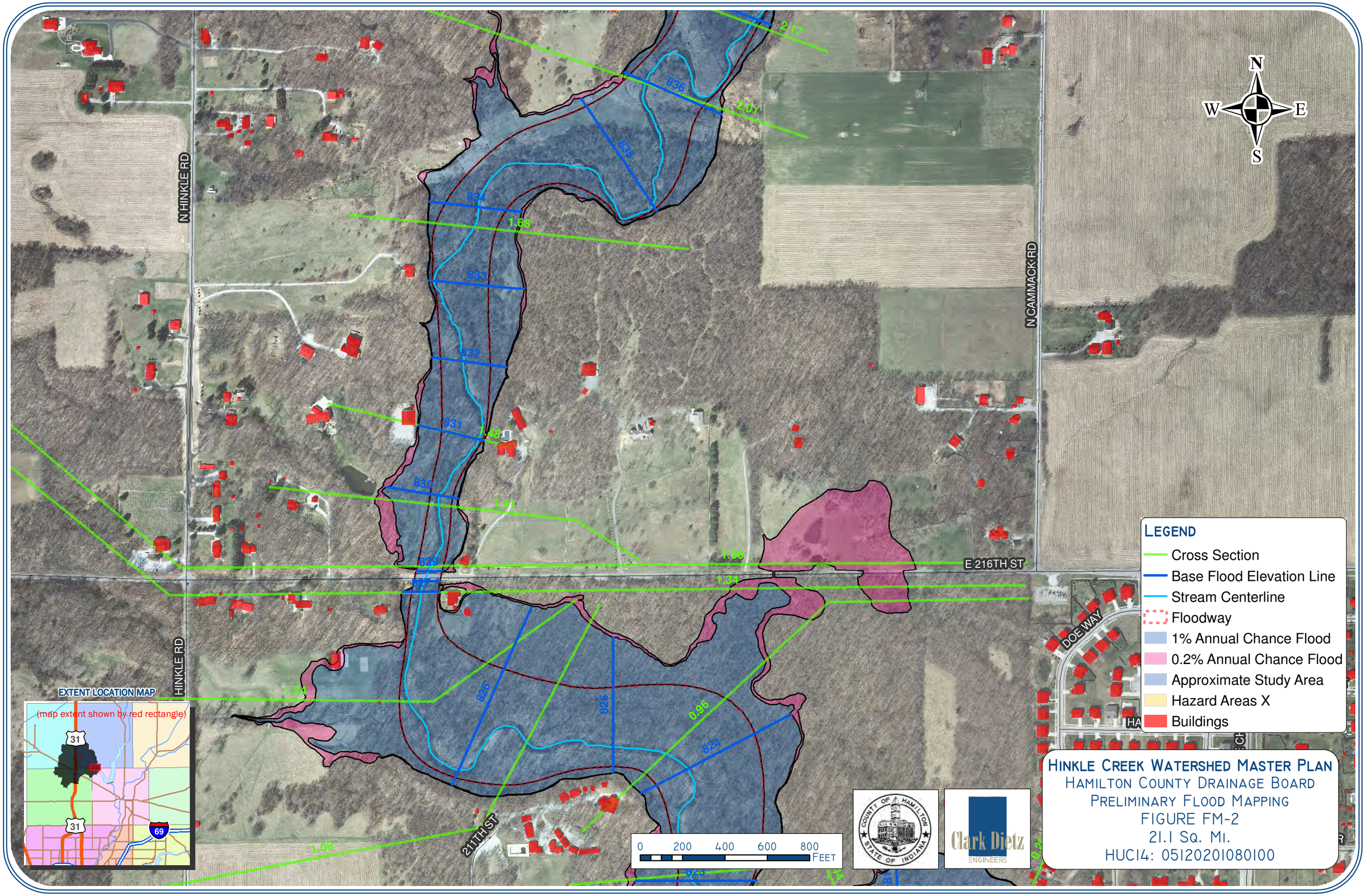
PRELIMINARY FLOOD MAPPING

FIGURE INDEX

21.1 SQ. MI.

HUC14: 05120201080100


N
S
E
W
DOE WAY
DOE BLVD
HARE DR
BUCK DR
POPLAR DR
POPLAR CT
LITTLE CHICAGO RD
SKIPTON CT
POOLE PL
CANDLEWICK RD
TOOLEY CT
DOVERTON DR
SELBY CT
MAGNOLIA LN
LIONS CREEK CIR
LIONS CREEK CT N
LIONS CREEK BLVD
LIONS CREEK CT S
LIONS CREEK DR
LIONS TRL
CARLTON CT
BANBURY RD
W BUNTIN CT
E 211TH ST
211TH ST
HARBOUR VIEW CT
HARBOUR TOWN DR
SHORELINE CT
WATERFRONT CT
SUMMITT RD
PINE KNOLL BLVD
BLUFF
1.24
1.08
0.96
0.84
0.68
0.44
0.26
0.14
0.11
0.08
0.05
0.01
826
825
824
823
822
821
820
819
818
817
816
815
814
EXTENT LOCATION MAP
(map extent shown by red rectangle)
31
69
0 200 400 600 800 FEET
LEGEND
Cross Section
Base Flood Elevation Line
Stream Centerline
Floodway
1% Annual Chance Flood
0.2% Annual Chance Flood
Approximate Study Area
Hazard Areas X
Buildings
COUNTY OF HAMILTON STATE OF INDIANA
Clark Dietz ENGINEERS
HINKLE CREEK WATERSHED MASTER PLAN
HAMILTON COUNTY DRAINAGE BOARD
PRELIMINARY FLOOD MAPPING
FIGURE FM-1
21.1 SQ. MI.
HUC14: 05120201080100



Hinkle Creek Watershed Master Plan

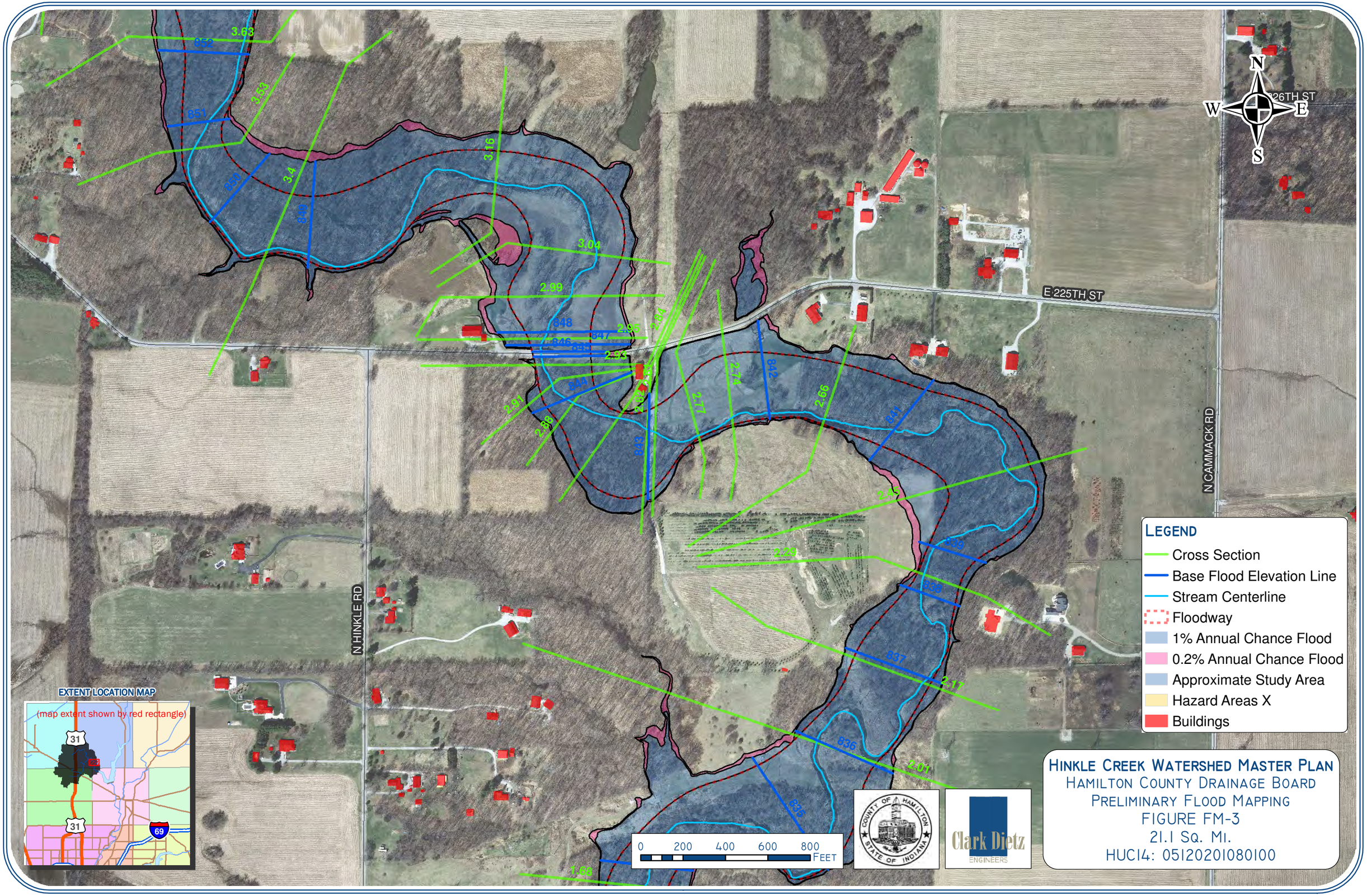
Hamilton County Drainage Board

Preliminary Flood Mapping

Figure FM-2

21.1 Sq. Mi.

HUC14: 05120201080100


N
W
E
S
E 225TH ST
N CAMMACK RD
N HINKLE RD
3.63
852
3.59
851
3.4
850
849
3.16
3.04
2.99
848
847
846
845
2.95
2.54
2.64
844
2.91
2.86
843
2.77
2.74
842
2.66
841
2.45
840
2.39
839
838
837
2.17
836
2.01
835
1.88
EXTENT LOCATION MAP
(map extent shown by red rectangle)
31
22
31
69
0 200 400 600 800
FEET
LEGEND
Cross Section
Base Flood Elevation Line
Stream Centerline
Floodway
1% Annual Chance Flood
0.2% Annual Chance Flood
Approximate Study Area
Hazard Areas X
Buildings
COUNTY OF HAMILTON
STATE OF INDIANA
Clark Dietz
ENGINEERS
HINKLE CREEK WATERSHED MASTER PLAN
HAMILTON COUNTY DRAINAGE BOARD
PRELIMINARY FLOOD MAPPING
FIGURE FM-3
21.1 SQ. MI.
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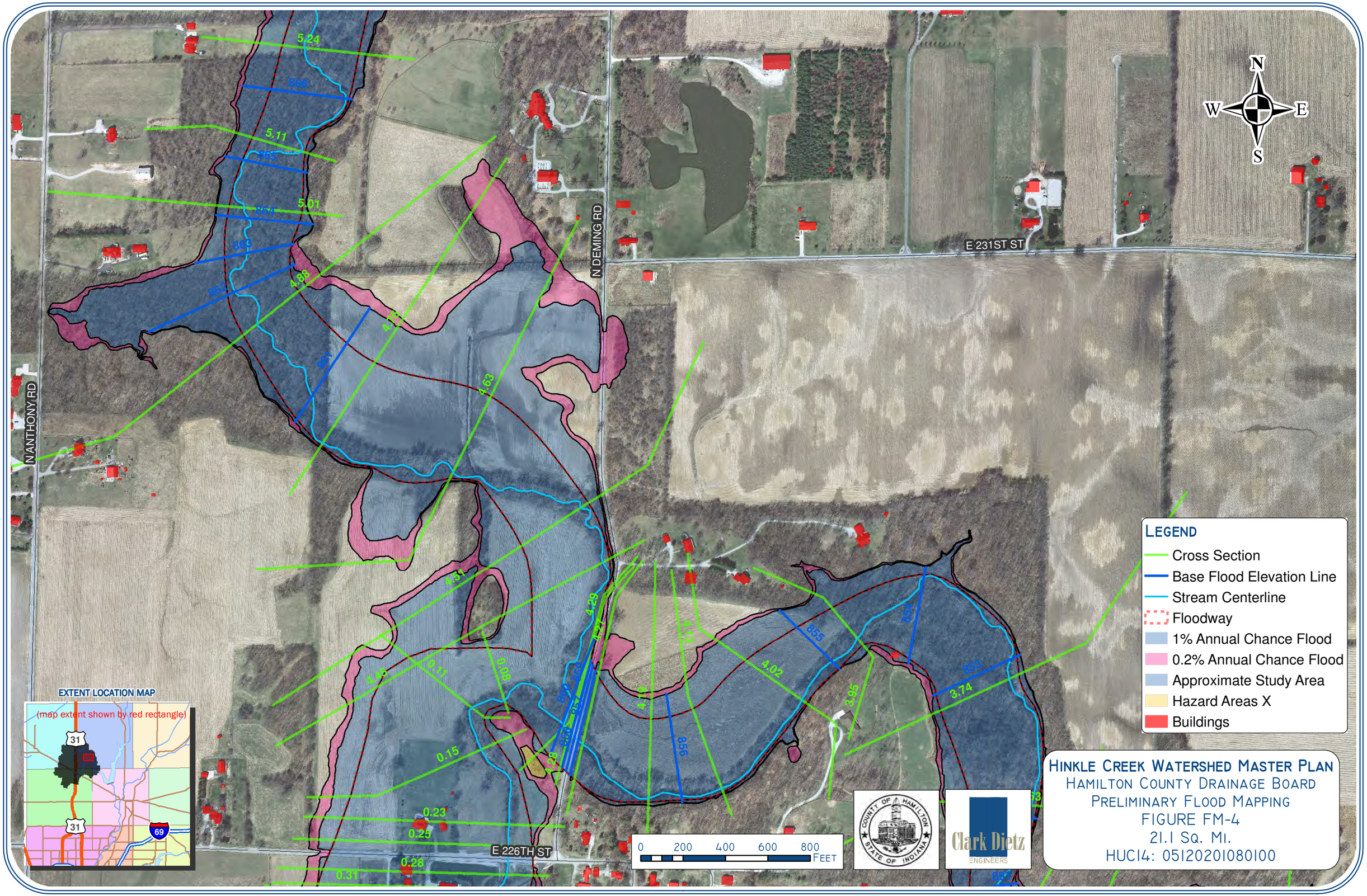
N
W
E
S
N ANTHONY RD
N DEMING RD
E 231ST ST
E 226TH ST
5.24
5.11
5.01
4.88
4.79
4.63
4.51
4.45
0.11
0.00
4.29
4.27
4.13
4.02
3.95
3.74
0.15
0.23
0.25
0.26
0.31
868
865
864
863
862
861
860
859
858
857
856
855
854
853
852
851
EXTENT LOCATION MAP
(map extent shown by red rectangle)
31
22
31
69
0 200 400 600 800
FEET
LEGEND
Cross Section
Base Flood Elevation Line
Stream Centerline
Floodway
1% Annual Chance Flood
0.2% Annual Chance Flood
Approximate Study Area
Hazard Areas X
Buildings
COUNTY OF HAMILTON
STATE OF INDIANA
Clark Dietz
ENGINEERS
HINKLE CREEK WATERSHED MASTER PLAN
HAMILTON COUNTY DRAINAGE BOARD
PRELIMINARY FLOOD MAPPING
FIGURE FM-4
21.1 SQ. MI.
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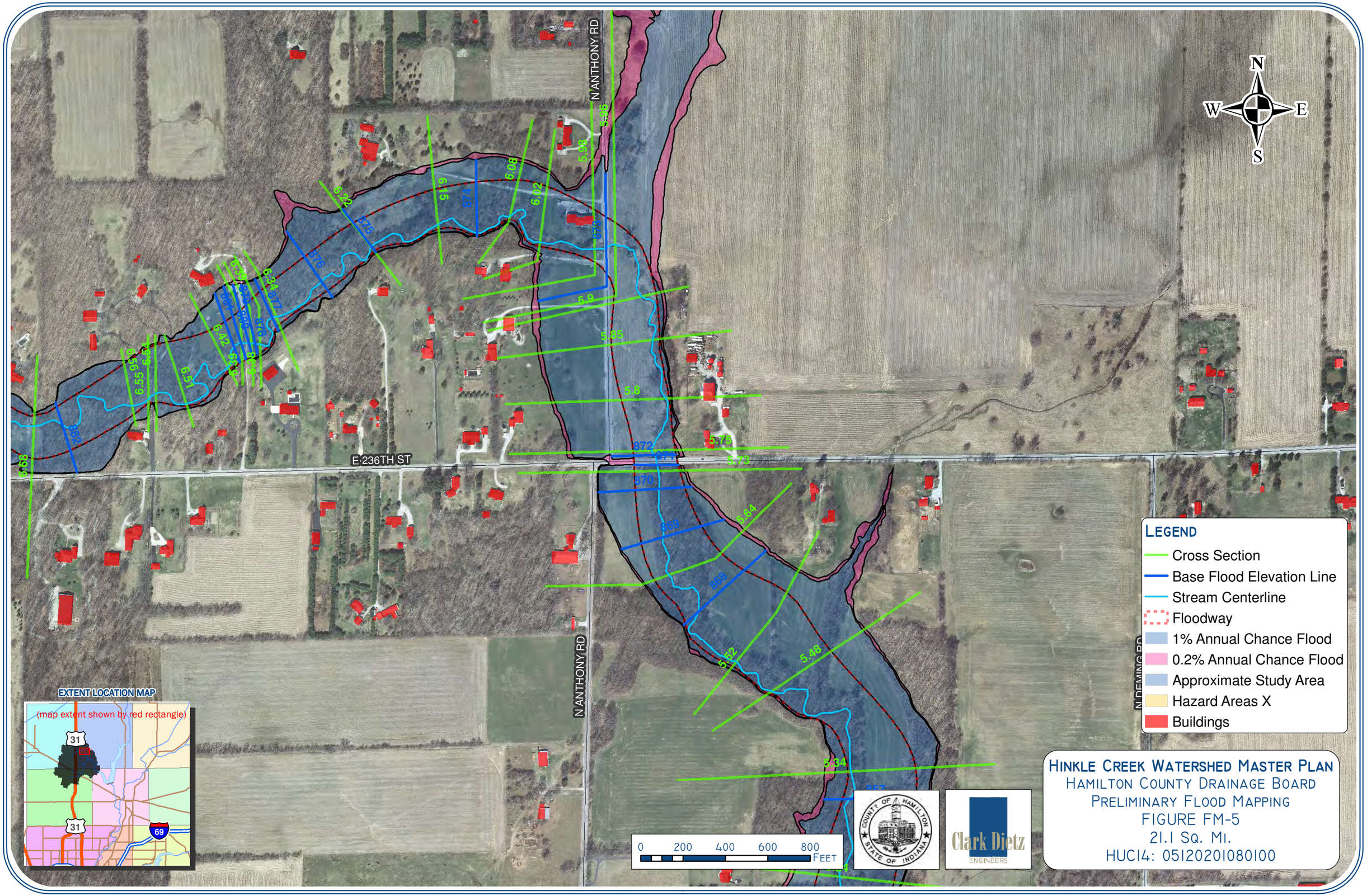
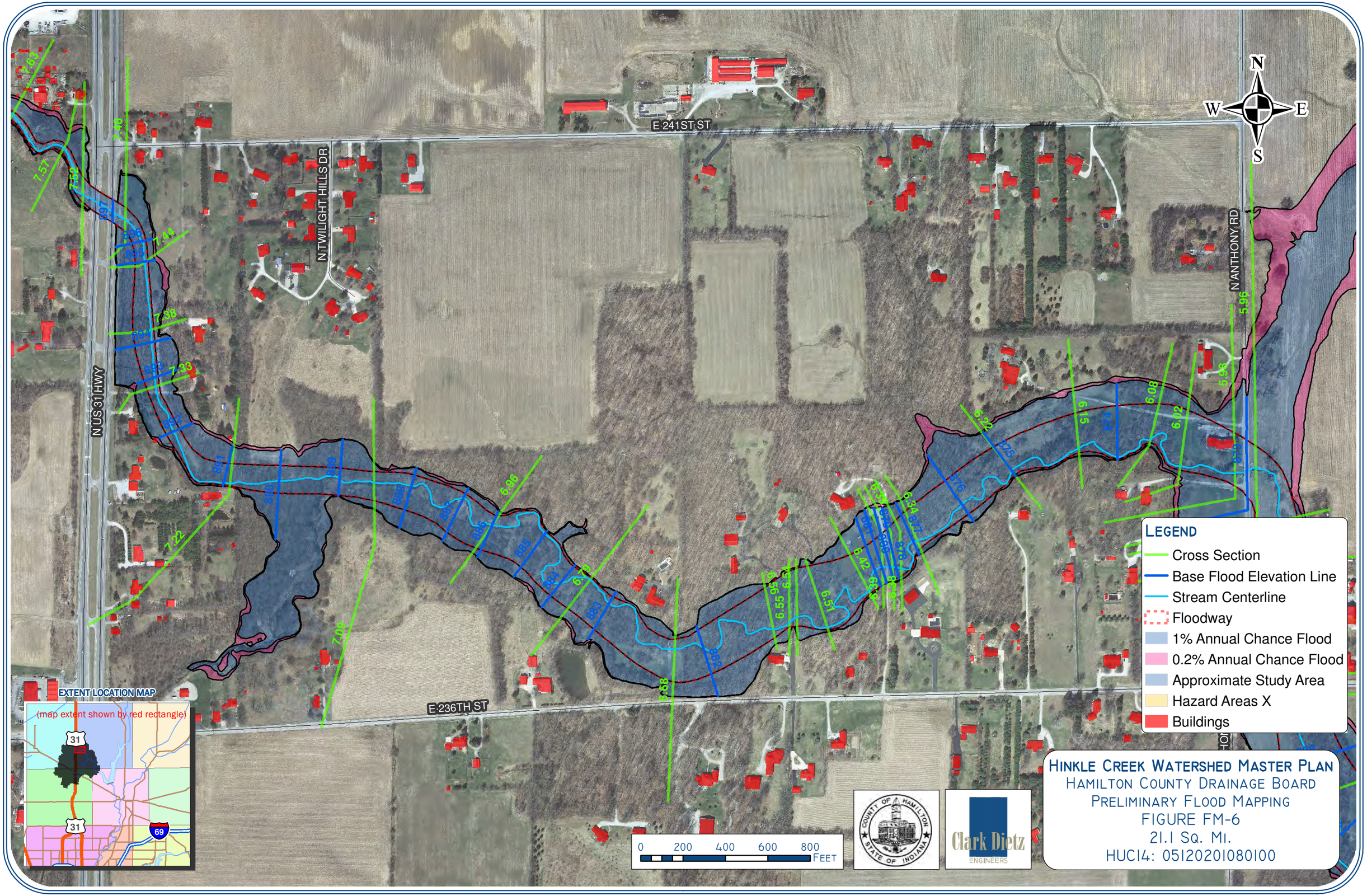

N ANTHONY RD
E 236TH ST
N DEMING RD
N
W
E
S
LEGEND
Cross Section
Base Flood Elevation Line
Stream Centerline
Floodway
1% Annual Chance Flood
0.2% Annual Chance Flood
Approximate Study Area
Hazard Areas X
Buildings
EXTENT LOCATION MAP
(map extent shown by red rectangle)
31
69
0 200 400 600 800 FEET
COUNTY OF HAMILTON STATE OF INDIANA
Clark Dietz ENGINEERS
HINKLE CREEK WATERSHED MASTER PLAN
HAMILTON COUNTY DRAINAGE BOARD
PRELIMINARY FLOOD MAPPING
FIGURE FM-5
21.1 SQ. MI.
HUC14: 05120201080100


E 241ST ST
N TWILIGHT HILLS DR
N US 31 HWY
N ANTHONY RD
E 236TH ST
N
S
E
W
LEGEND
Cross Section
Base Flood Elevation Line
Stream Centerline
Floodway
1% Annual Chance Flood
0.2% Annual Chance Flood
Approximate Study Area
Hazard Areas X
Buildings
EXTENT LOCATION MAP
(map extent shown by red rectangle)
31
69
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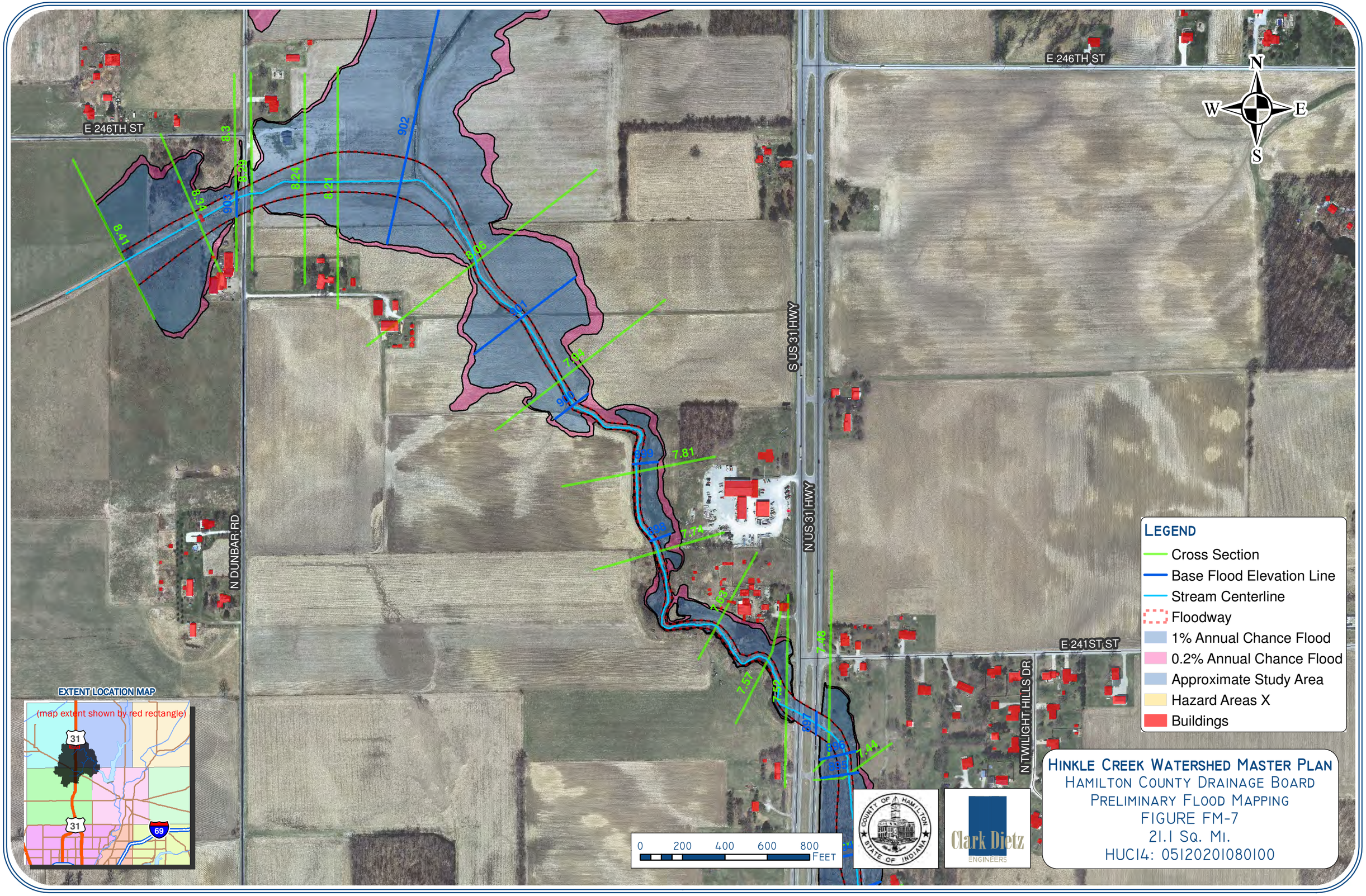
COUNTY OF HAMILTON STATE OF INDIANA
Clark Dietz ENGINEERS
HINKLE CREEK WATERSHED MASTER PLAN
HAMILTON COUNTY DRAINAGE BOARD
PRELIMINARY FLOOD MAPPING
FIGURE FM-6
21.1 SQ. MI.
HUC14: 05120201080100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EXTENT LOCATION MAP
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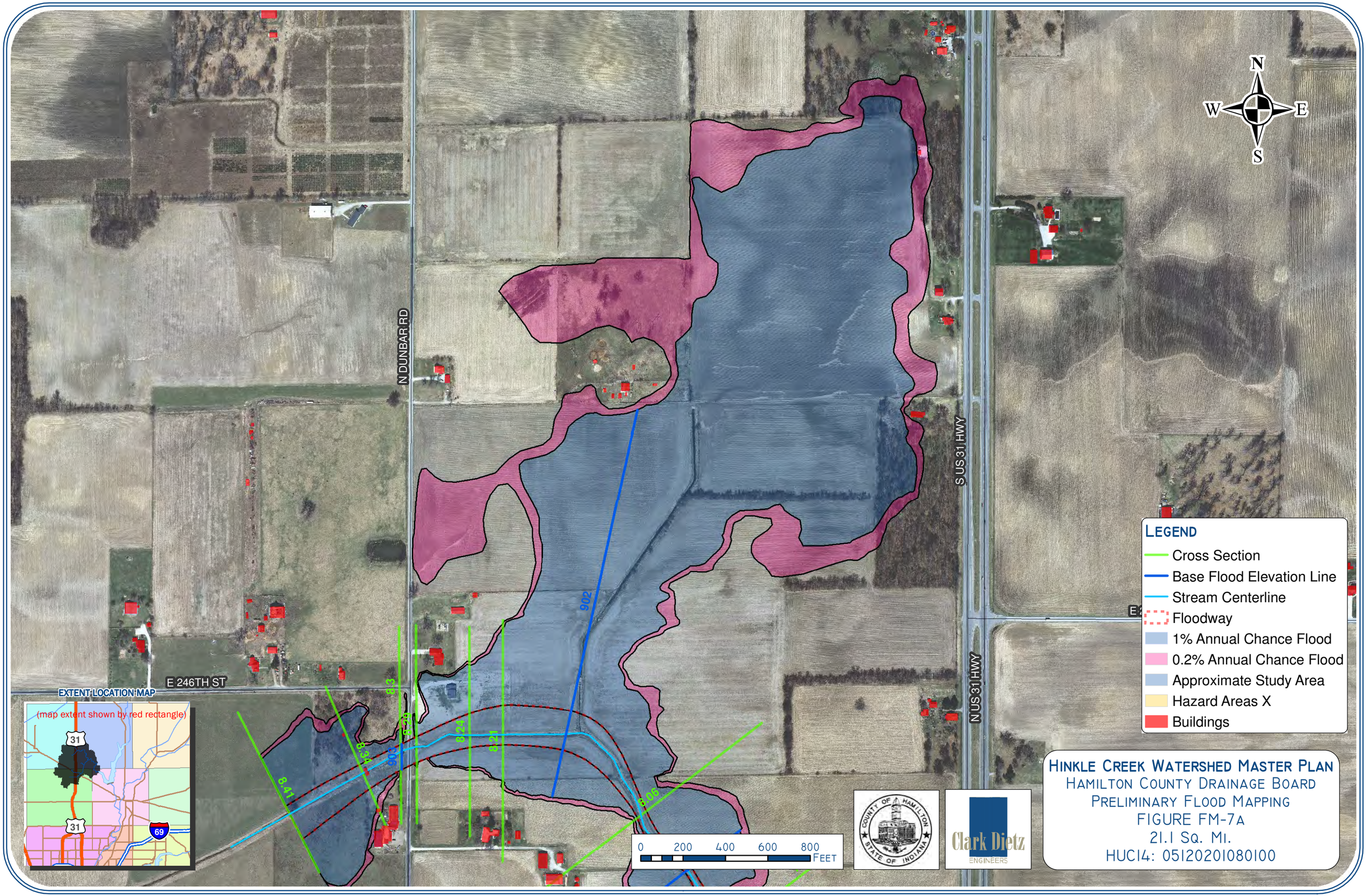
Cross Section
Base Flood Elevation Line
Stream Centerline
Floodway
1% Annual Chance Flood
0.2% Annual Chance Flood
Approximate Study Area
Hazard Areas X
Buildings
COUNTY OF HAMILTON STATE OF INDIANA
Clark Dietz ENGINEERS
HINKLE CREEK WATERSHED MASTER PLAN
HAMILTON COUNTY DRAINAGE BOARD
PRELIMINARY FLOOD MAPPING
FIGURE FM-7
21.1 SQ. MI.
HUC14: 05120201080100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EXTENT LOCATION MAP
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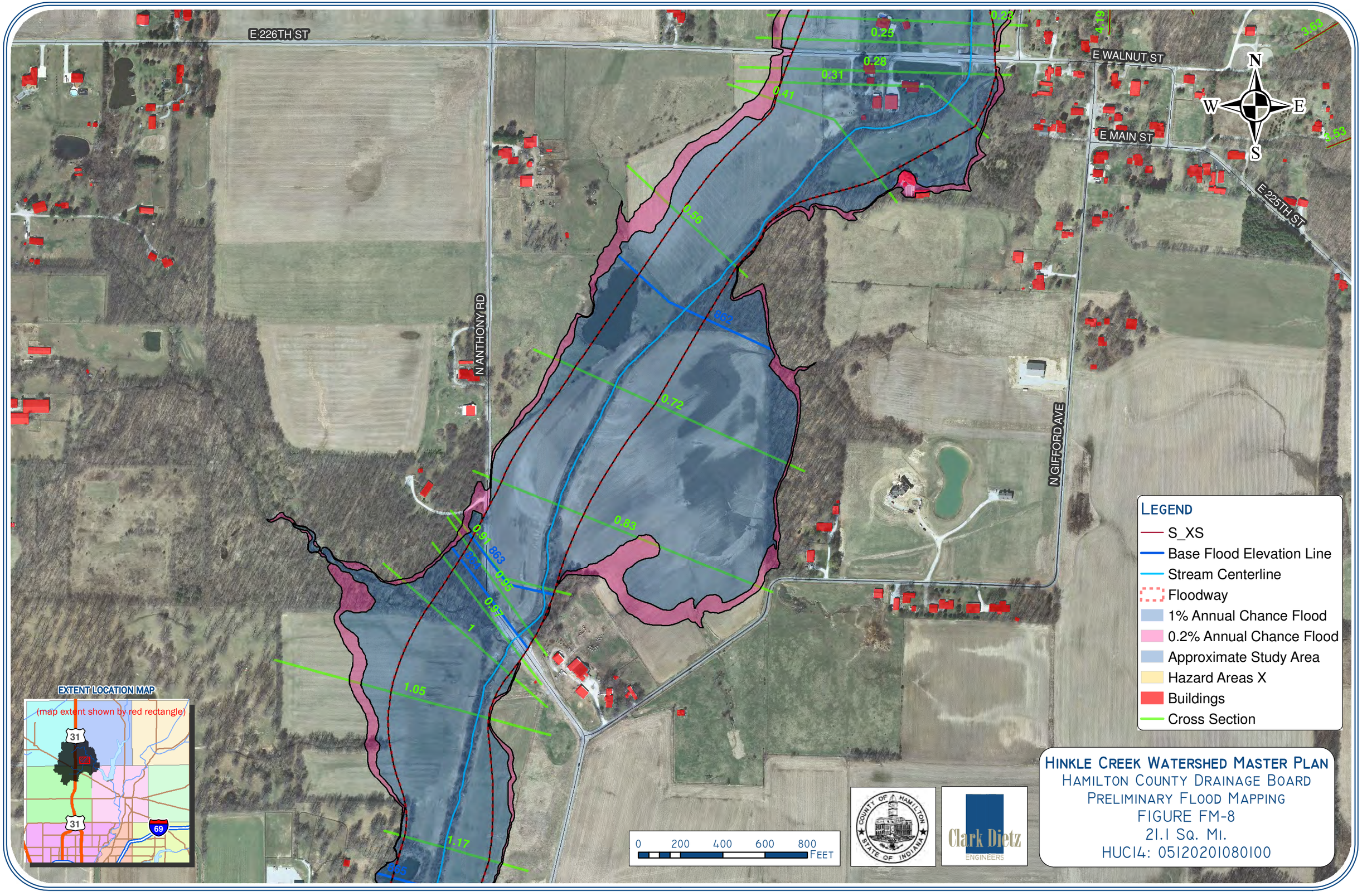
Cross Section
Base Flood Elevation Line
Stream Centerline
Floodway
1% Annual Chance Flood
0.2% Annual Chance Flood
Approximate Study Area
Hazard Areas X
Buildings
COUNTY OF HAMILTON STATE OF INDIANA
Clark Dietz ENGINEERS
HINKLE CREEK WATERSHED MASTER PLAN
HAMILTON COUNTY DRAINAGE BOARD
PRELIMINARY FLOOD MAPPING
FIGURE FM-7A
21.1 SQ. MI.
HUC14: 05120201080100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E WALNUT ST
E MAIN ST
E 225TH ST
N ANTHONY RD
N GIFFORD AVE
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Base Flood Elevation Line
Stream Centerline
Floodway
1% Annual Chance Flood
0.2% Annual Chance Flood
Approximate Study Area
Hazard Areas X
Buildings
Cross Section
EXTENT LOCATION MAP
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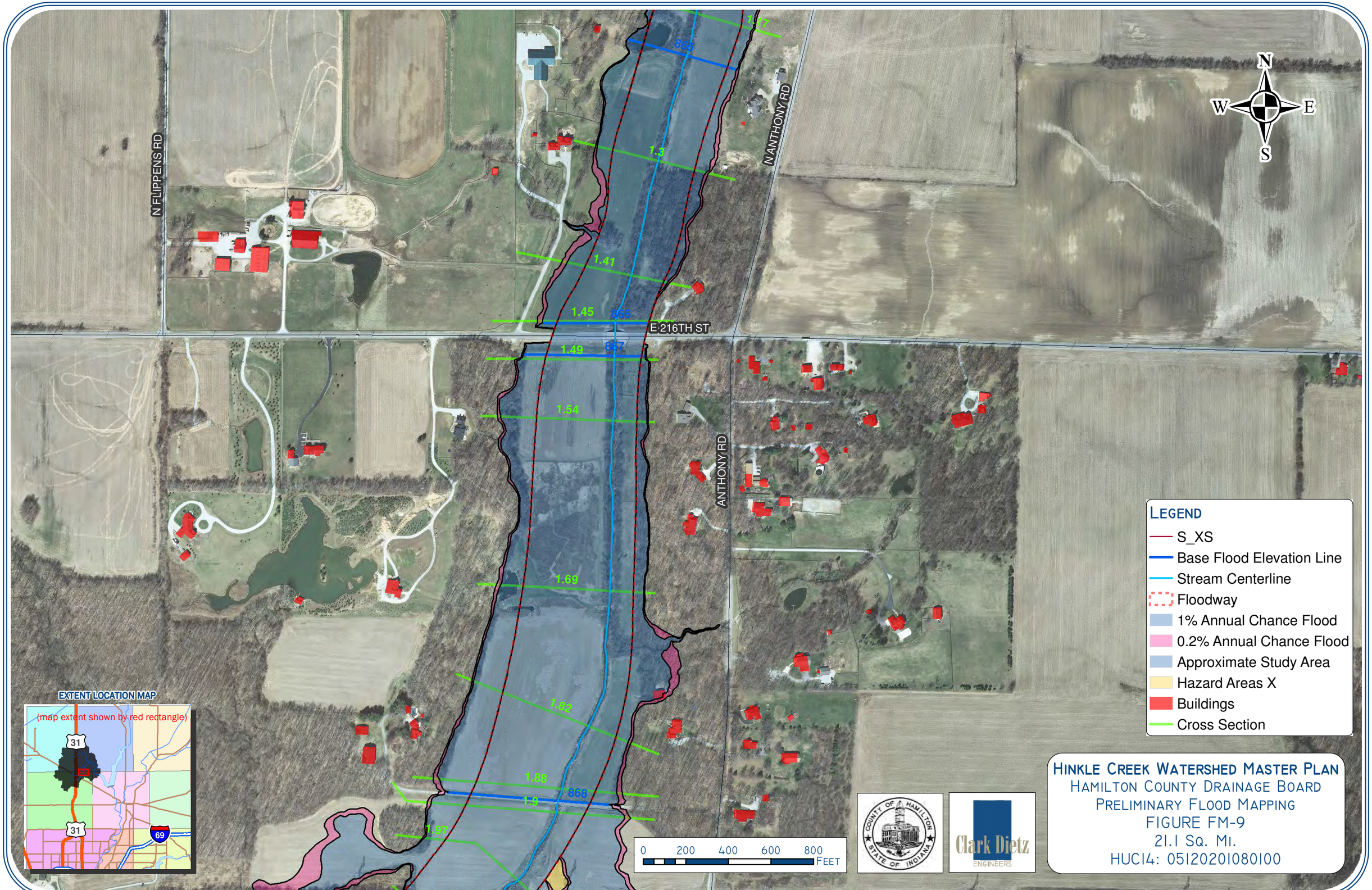
COUNTY OF HAMILTON STATE OF INDIANA
Clark Dietz
ENGINEERS
HINKLE CREEK WATERSHED MASTER PLAN
HAMILTON COUNTY DRAINAGE BOARD
PRELIMINARY FLOOD MAPPING
FIGURE FM-8
21.1 SQ. MI.
HUC14: 05120201080100



HINKLE CREEK WATERSHED MASTER PLAN
HAMILTON COUNTY DRAINAGE BOARD
PRELIMINARY FLOOD MAPPING
FIGURE FM-9
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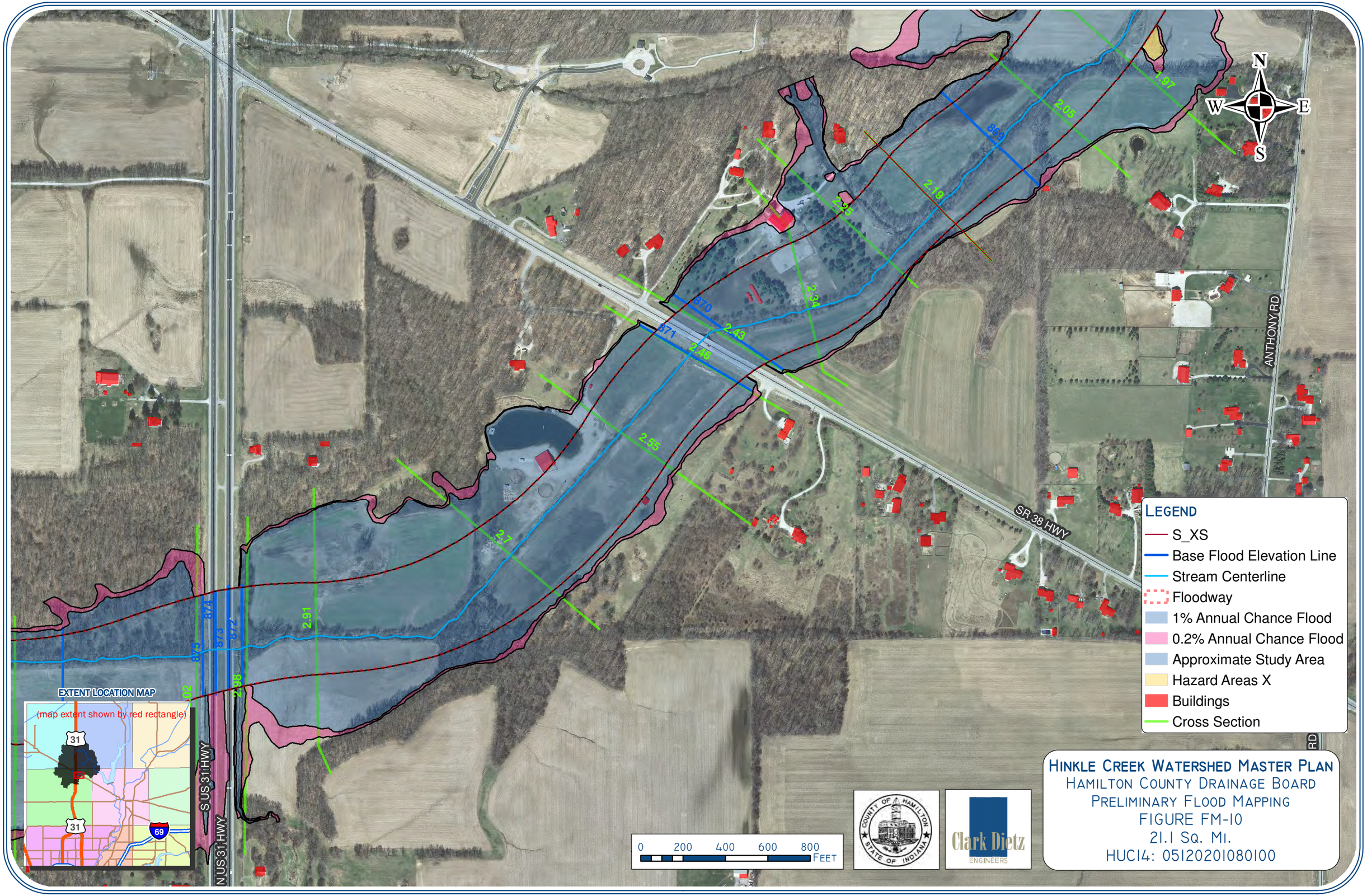
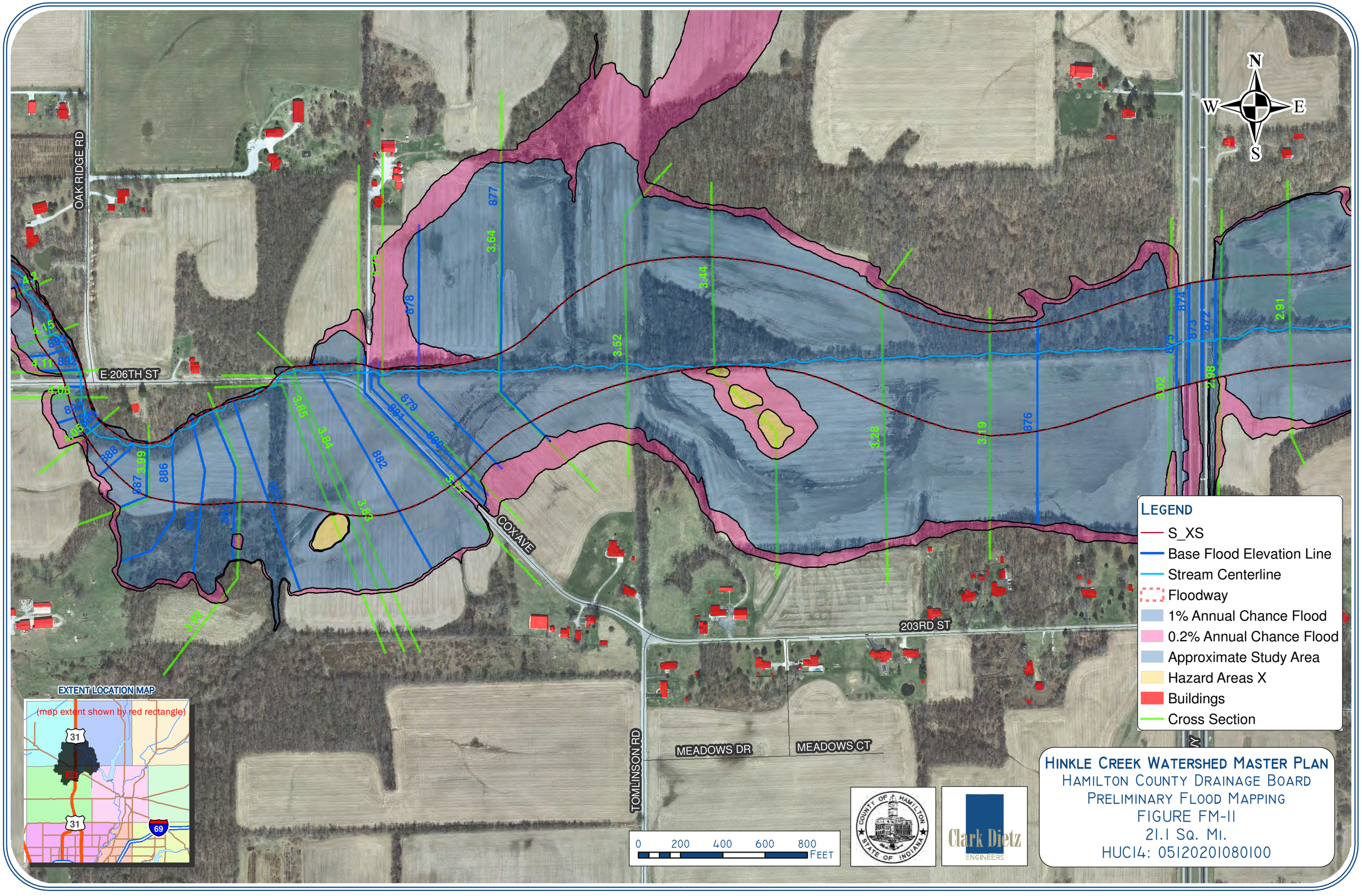
HUC14: 05120201080100



HINKLE CREEK WATERSHED MASTER PLAN
HAMILTON COUNTY DRAINAGE BOARD
PRELIMINARY FLOOD MAPPING
FIGURE FM-10
21.1 SQ. MI.
HUC14: 05120201080100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TOMLINSON RD
MEADOWS DR
MEADOWS CT
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LEGEND
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Base Flood Elevation Line
Stream Centerline
Floodway
1% Annual Chance Flood
0.2% Annual Chance Flood
Approximate Study Area
Hazard Areas X
Buildings
Cross Section
EXTENT LOCATION MAP
(map extent shown by red rectangle)
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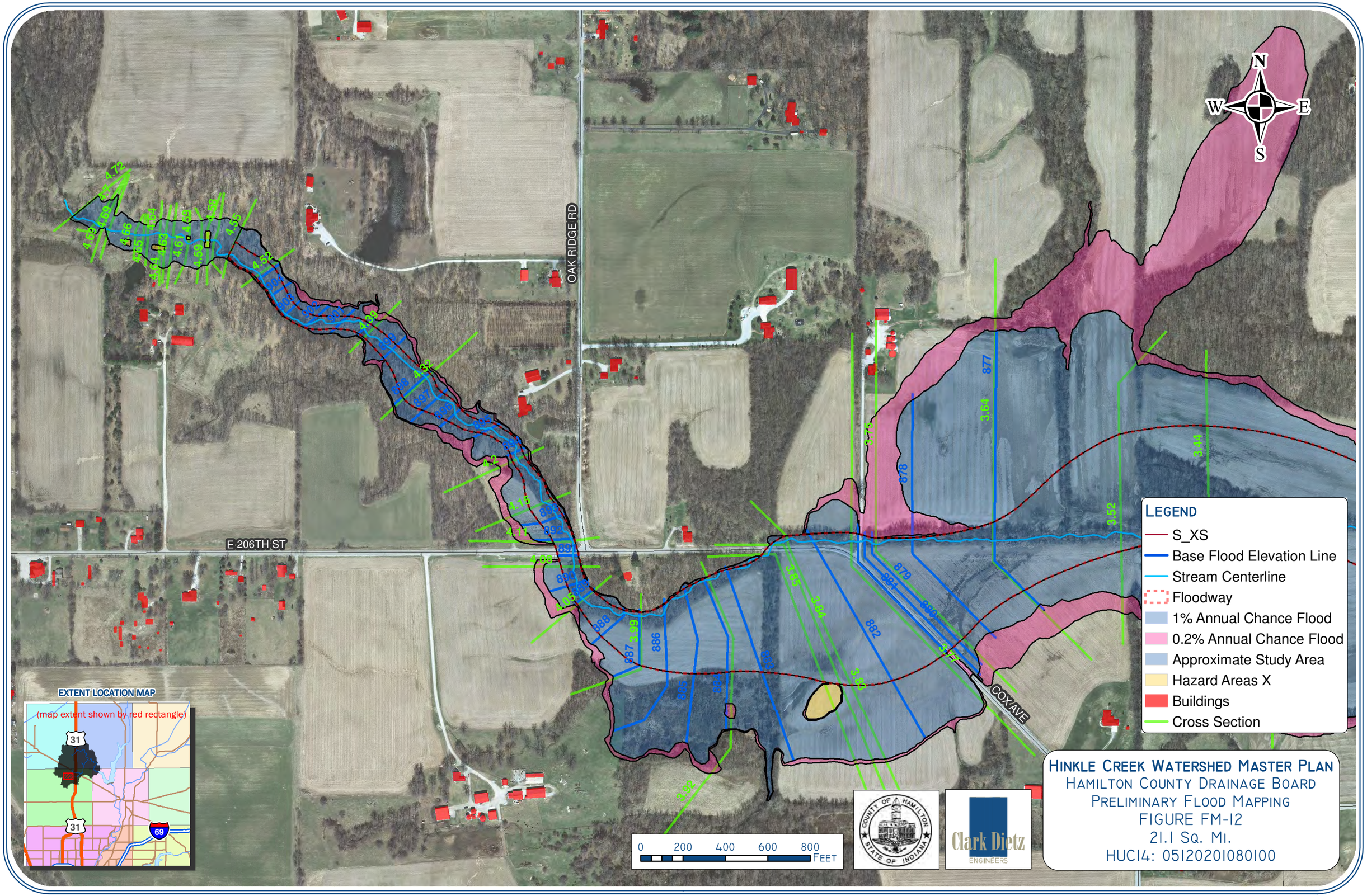
FEET
Clark Dietz
ENGINEERS
HINKLE CREEK WATERSHED MASTER PLAN
HAMILTON COUNTY DRAINAGE BOARD
PRELIMINARY FLOOD MAPPING
FIGURE FM-11
21.1 SQ. MI.
HUC14: 05120201080100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Stream Centerline
Floodway
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0.2% Annual Chance Flood
Approximate Study Area
Hazard Areas X
Buildings
Cross Section
EXTENT LOCATION MAP
(map extent shown by red rectangle)
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COUNTY OF HAMILTON STATE OF INDIANA
Clark Dietz ENGINEERS
HINKLE CREEK WATERSHED MASTER PLAN
HAMILTON COUNTY DRAINAGE BOARD
PRELIMINARY FLOOD MAPPING
FIGURE FM-12
21.1 SQ. MI.
HUC14: 05120201080100

APPENDIX F PUBLIC MEETING NOTES

Hinkle Creek Watershed
Public Meeting Notice

Public Meeting Information

When: **June 27th at 6 pm**

Where: **Deming Masonic Lodge**
22520 Gifford Ave
Deming, Indiana

Meeting Agenda

- **Watershed Basics**
- **Description of the Hinkle Creek Watershed**
- **Project Purpose**
- **Project Scope**
  - **Flooding Issues**
  - **Erosion Issues**
  - **Floodplain Mapping**
  - **Potential Future Problems**
- **Preliminary Findings**

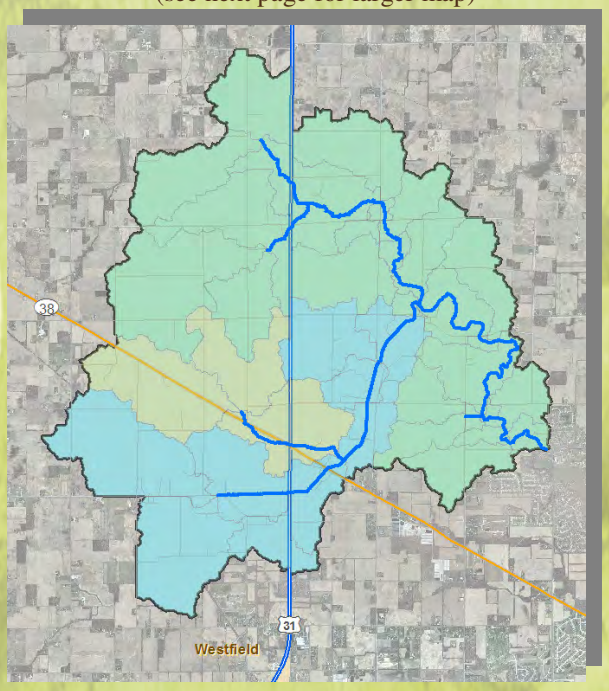
Questions?? Contact:

Sam Robertson, P.E.
Clark Dietz, Inc.
samuel.robertson@clarkdietz.com
(317) 808-3142

or

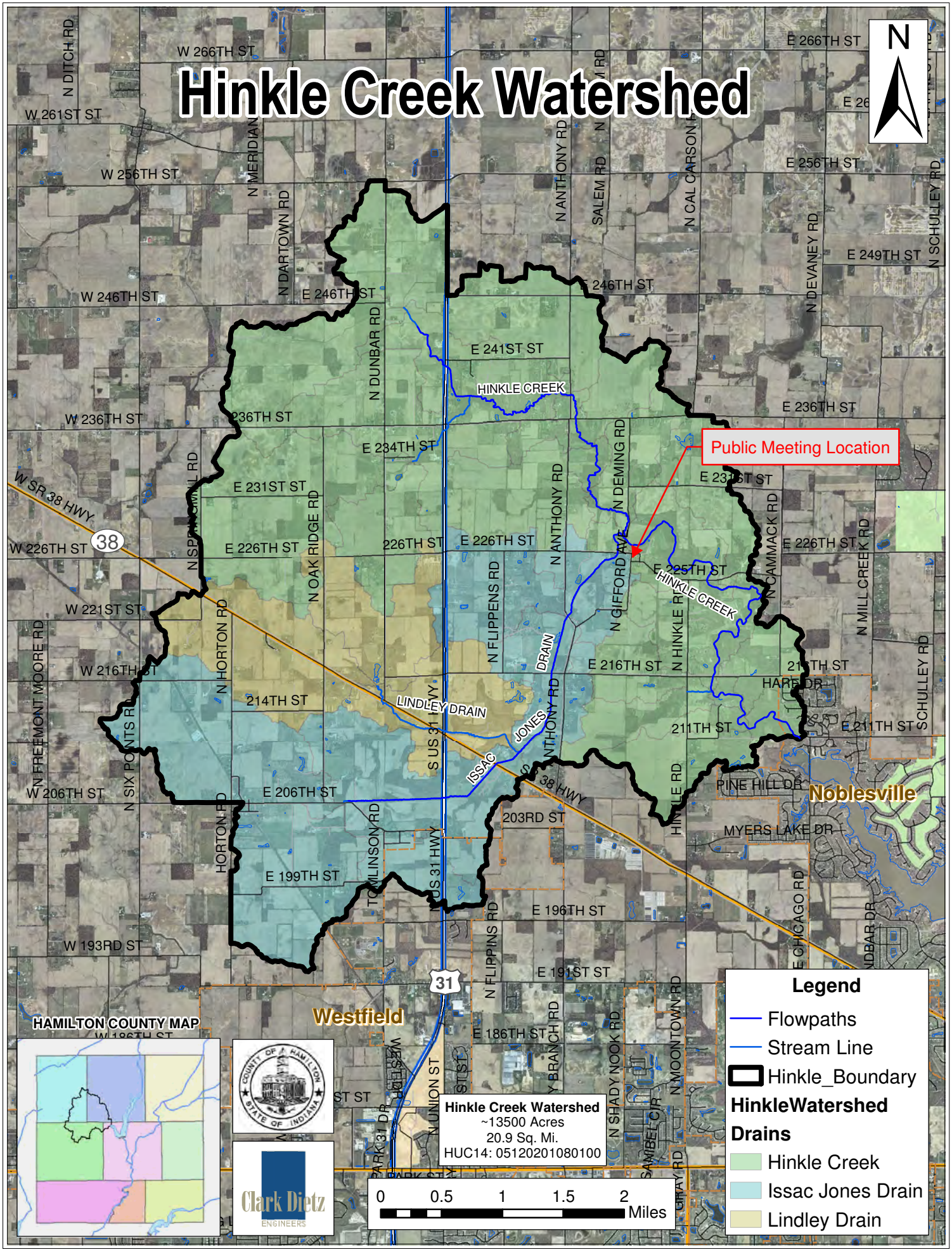
Greg Hoyes
Hamilton County Surveyor's Office
greg.hoyes@hamiltoncounty.in.gov
(317) 776-8495

Hinkle Creek Watershed Map
(see next page for larger map)



Hinkle Creek Watershed Facts

- *20.9 Square Miles*
- *80% Agricultural Land*
- *14% Residential Land*
- *4.5% Commercial/Industrial Land*
- *1.5% Wooded or Pasture Land*


Hinkle Creek Watershed
N
Public Meeting Location
HINKLE CREEK
LINDLEY DRAIN
ISSAC JONES DRAIN
Noblesville
Westfield
HAMILTON COUNTY MAP
Hinkle Creek Watershed
~13500 Acres
20.9 Sq. Mi.
HUC14: 05120201080100
0 0.5 1 1.5 2 Miles
Legend
Flowpaths
Stream Line
Hinkle_Boundary
HinkleWatershed
Drains
Hinkle Creek
Issac Jones Drain
Lindley Drain
Clark Dietz
ENGINEERS

Hinkle Creek Watershed Master Plan

Public Meeting

June 27th, 2012

Sam Robertson, P.E.
(317) 808-3142
samuel.robertson@clarkdietz.com

Jason Steckel
(317) 423-0696
jsteckel@williamscreek.net

Agenda

- Watershed Basics
- Description of the Hinkle Creek Watershed
- Purpose of Study
- Scope of the Project
- Upcoming Project Tasks
- Questions

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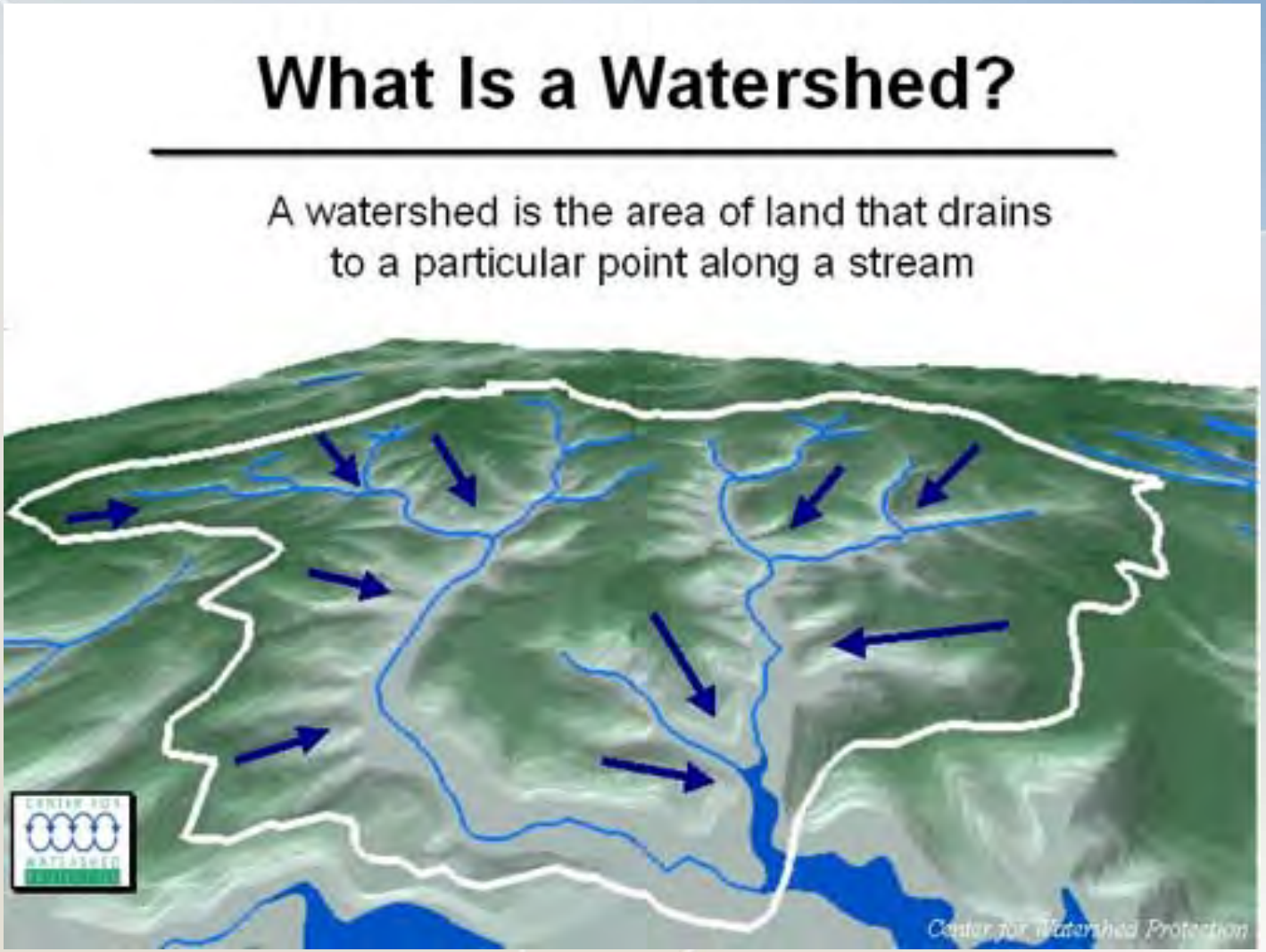
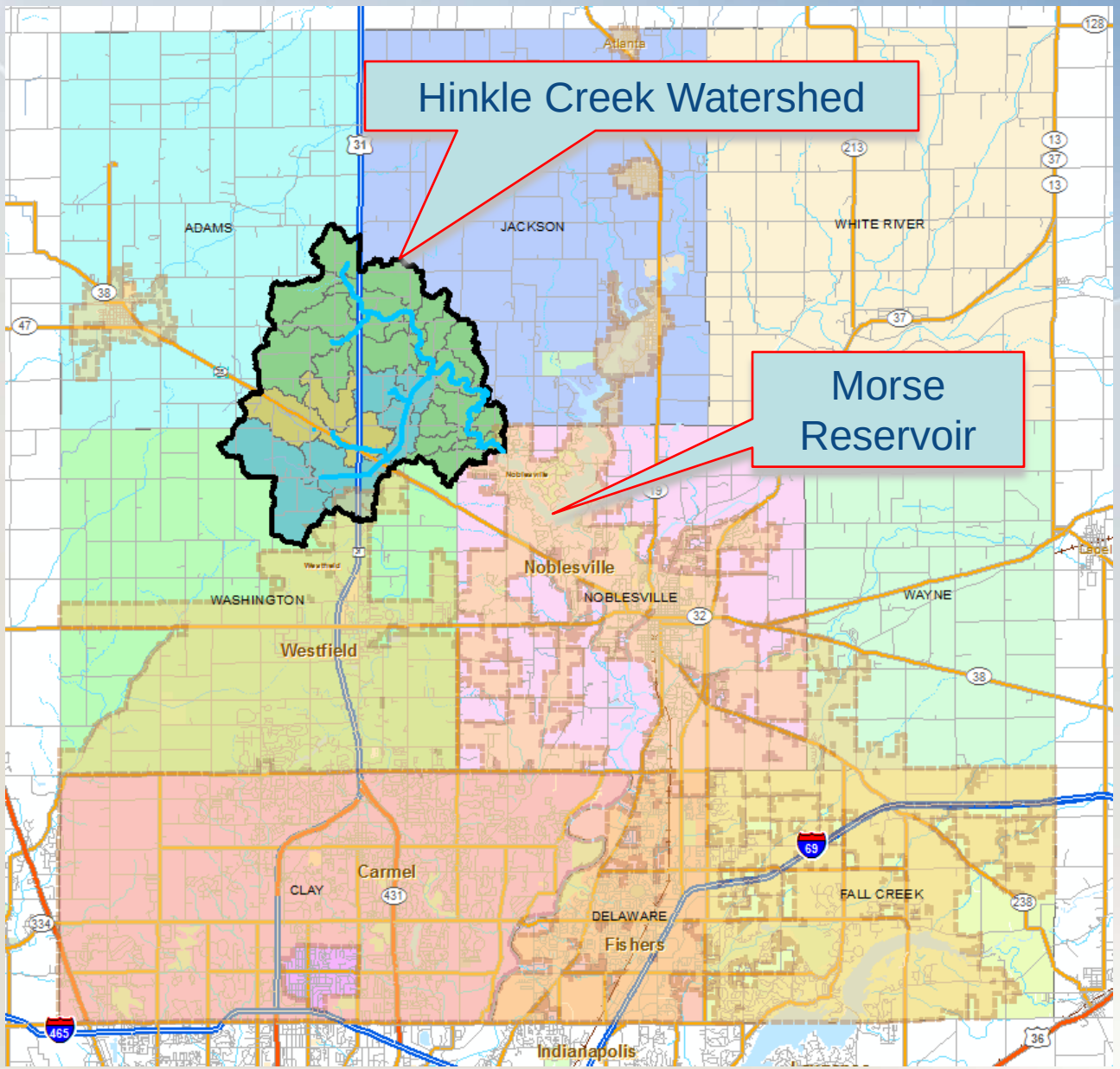
Watershed Basics



Watershed Basics

Hinkle Creek Watershed



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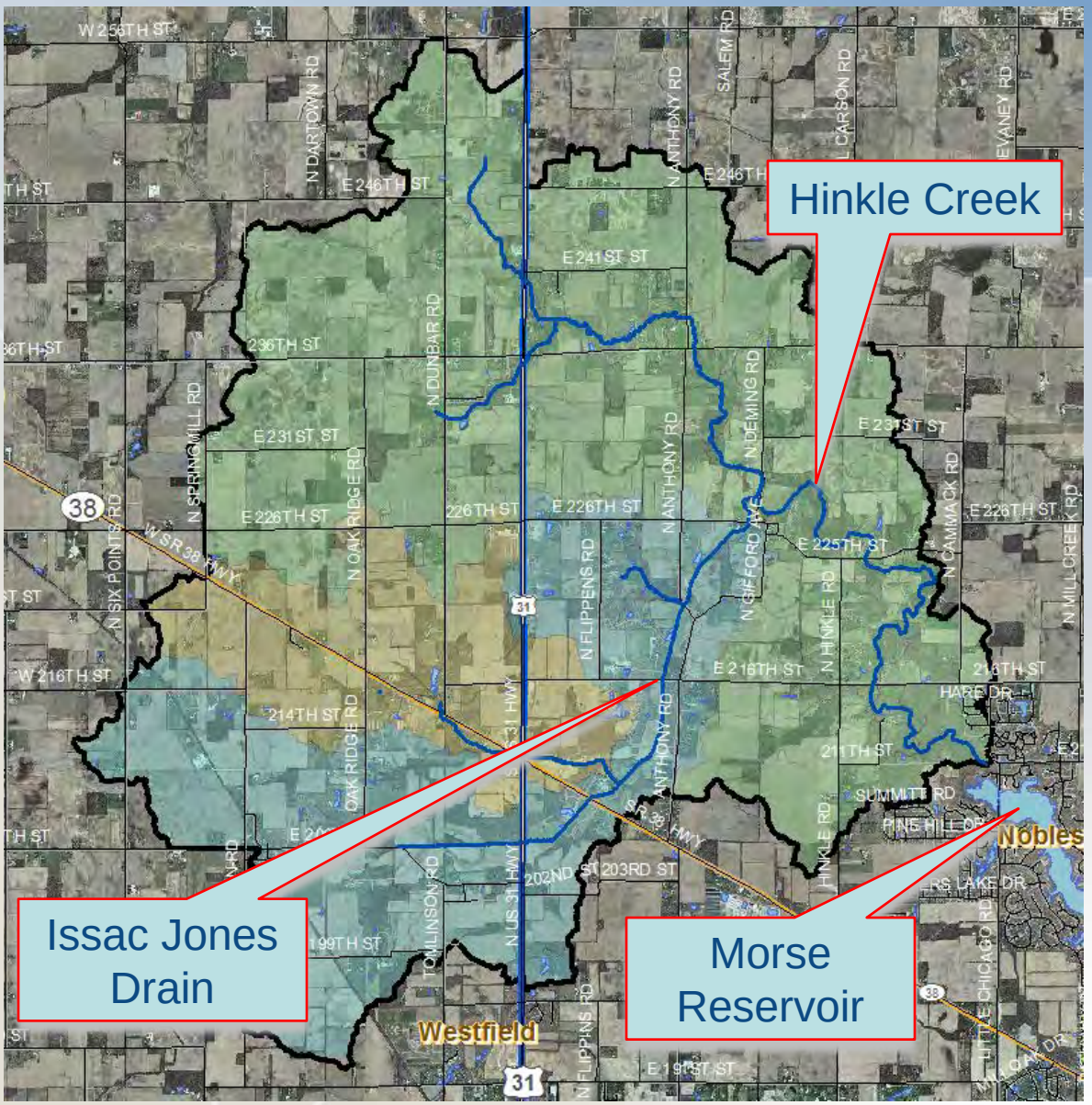
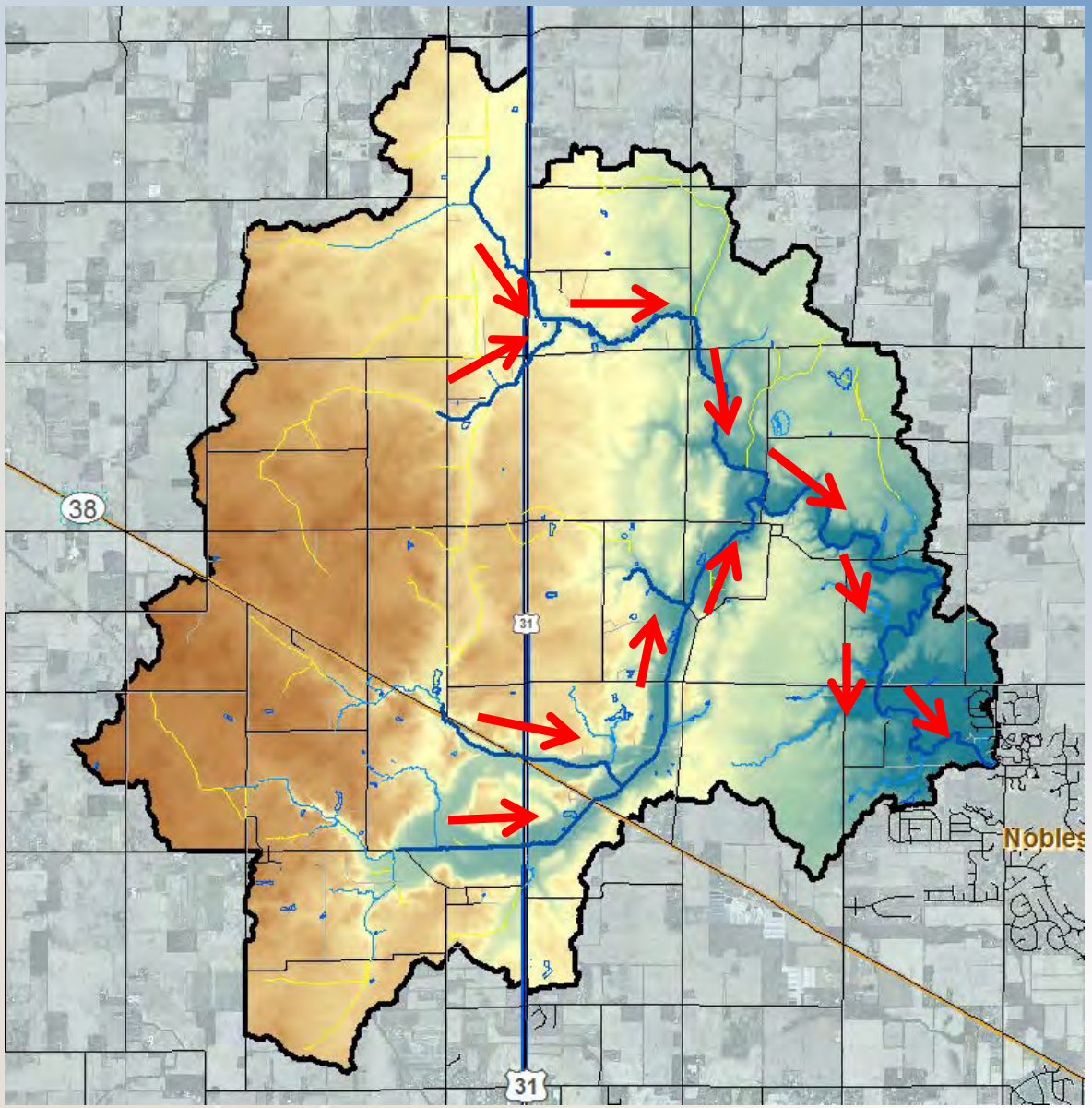
Hinkle Creek Watershed

- 20.9 sq. mi.
- Drains to Morse Reservoir



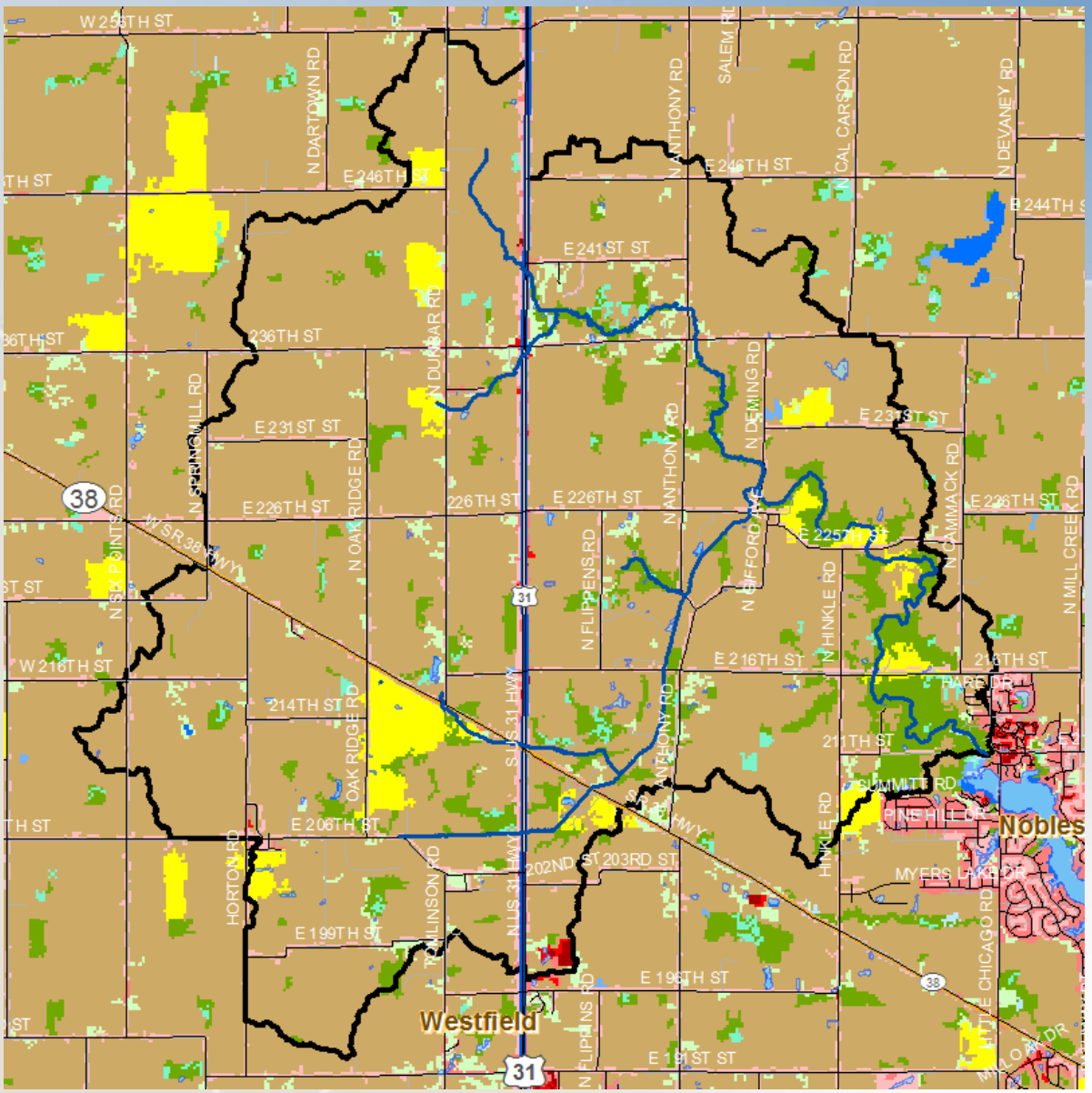
Hinkle Creek Watershed - Topography

- Drains East
- Max. Elev. ~950 feet
- Min. Elev. ~810 feet



Hinkle Creek Watershed – Land use

- *80% Agricultural Land*
- *14% Residential Land*
- *4.5% Commercial/ Industrial Land*
- *1.5% Wooded or Pasture Land*



Source: L-THIA (engineering.purdue.edu/~lthia/)

Purpose of Study

- Address/Identify Existing Stormwater Flooding Problems
- Assess Water Quality and Erosion in Watershed
- Prevent Future Problems as the Watershed Continues to Develop
- Compliance with New Federal Regulations Governing Stormwater Quality.

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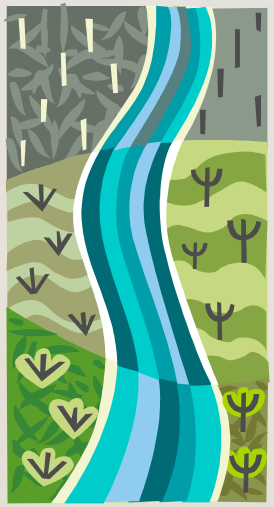
Scope of Project



- Inventory and Problem Identification
- Flood Analysis
- Erosion and Stream Quality
- Recommendations and Alternatives
- Documentation

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Inventory and Problem Identification

- Desktop Review

- Field Visits

- Public Input*
  - Erosion Problem Areas
  - Flooding Problem Areas
  - Other Concerns

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Flood Analysis – Hydrologic Modeling

- Flood Analysis
  - To Identify the Floodplain along Hinkle Creek
- Hydrologic Model (HEC-HMS)
  - To determine flows in a given storm event
- Hydraulic Model (HEC-RAS)
  - To determine flood elevations in given storm event

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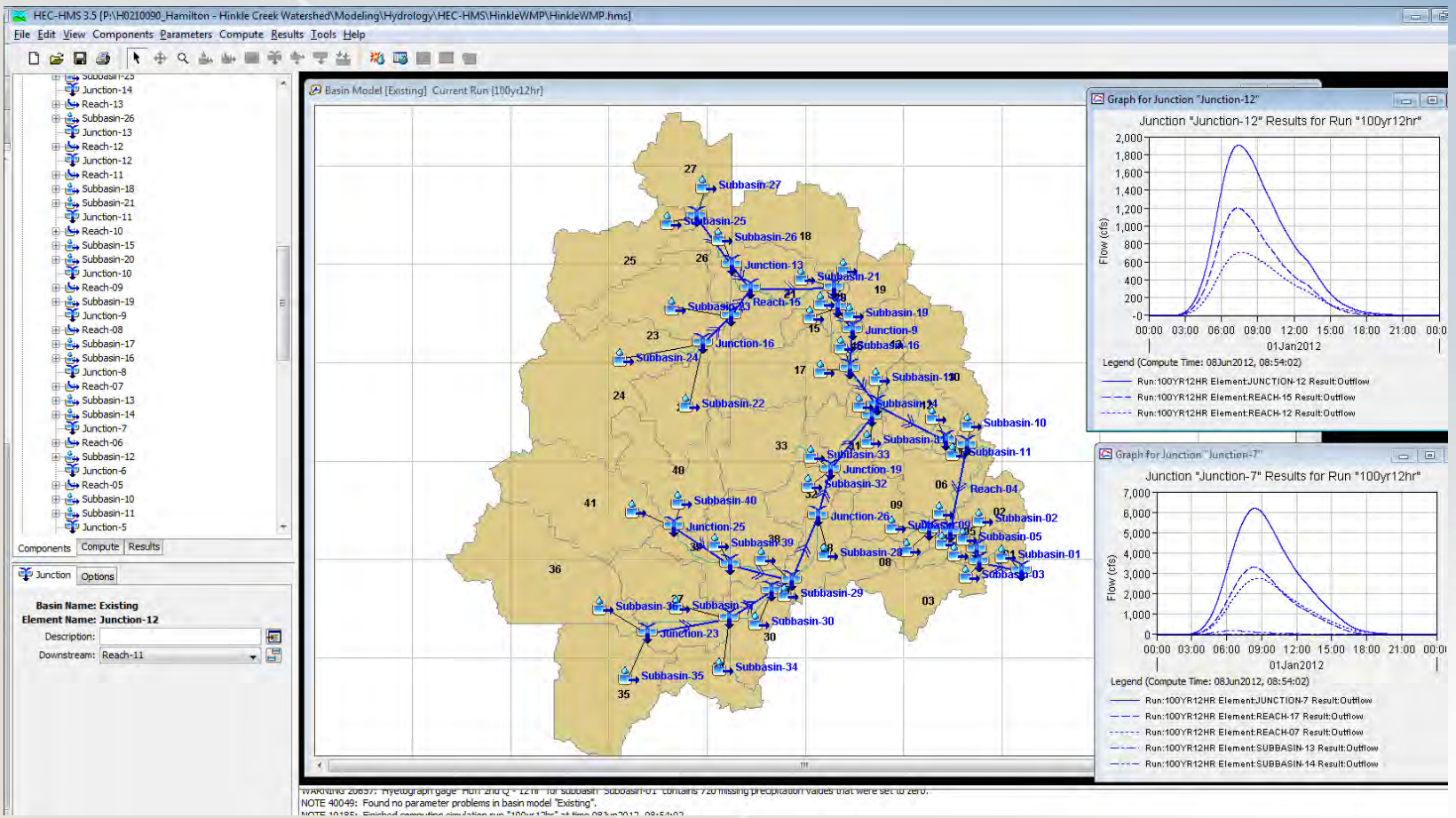
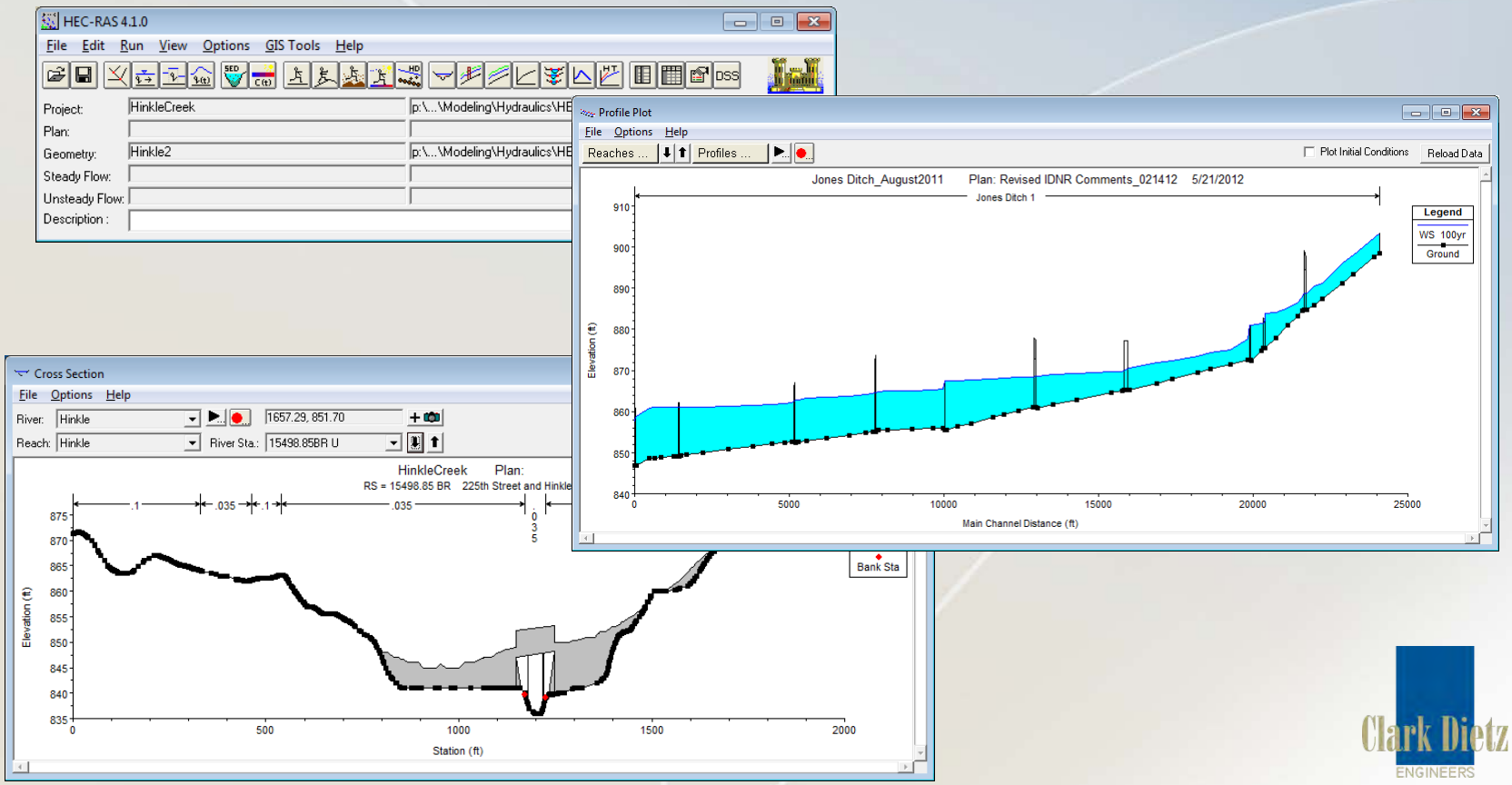
Flood Analysis – Hydrologic Modeling

- Computer Modeling to Determine Stormwater Runoff in Watershed



Flood Analysis – Hydraulic Modeling

- Computer Modeling to Determine Flood Elevations along Stream



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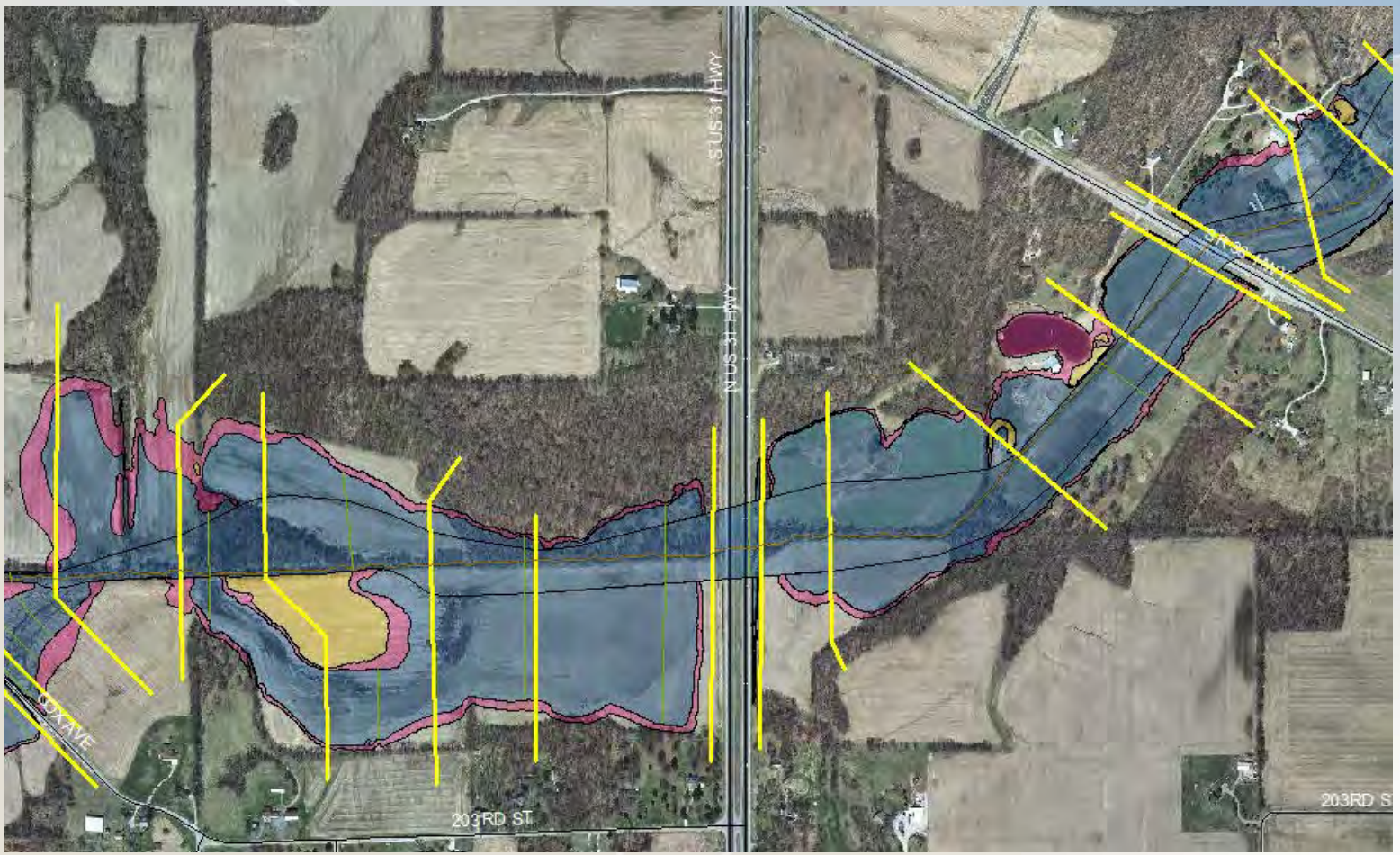
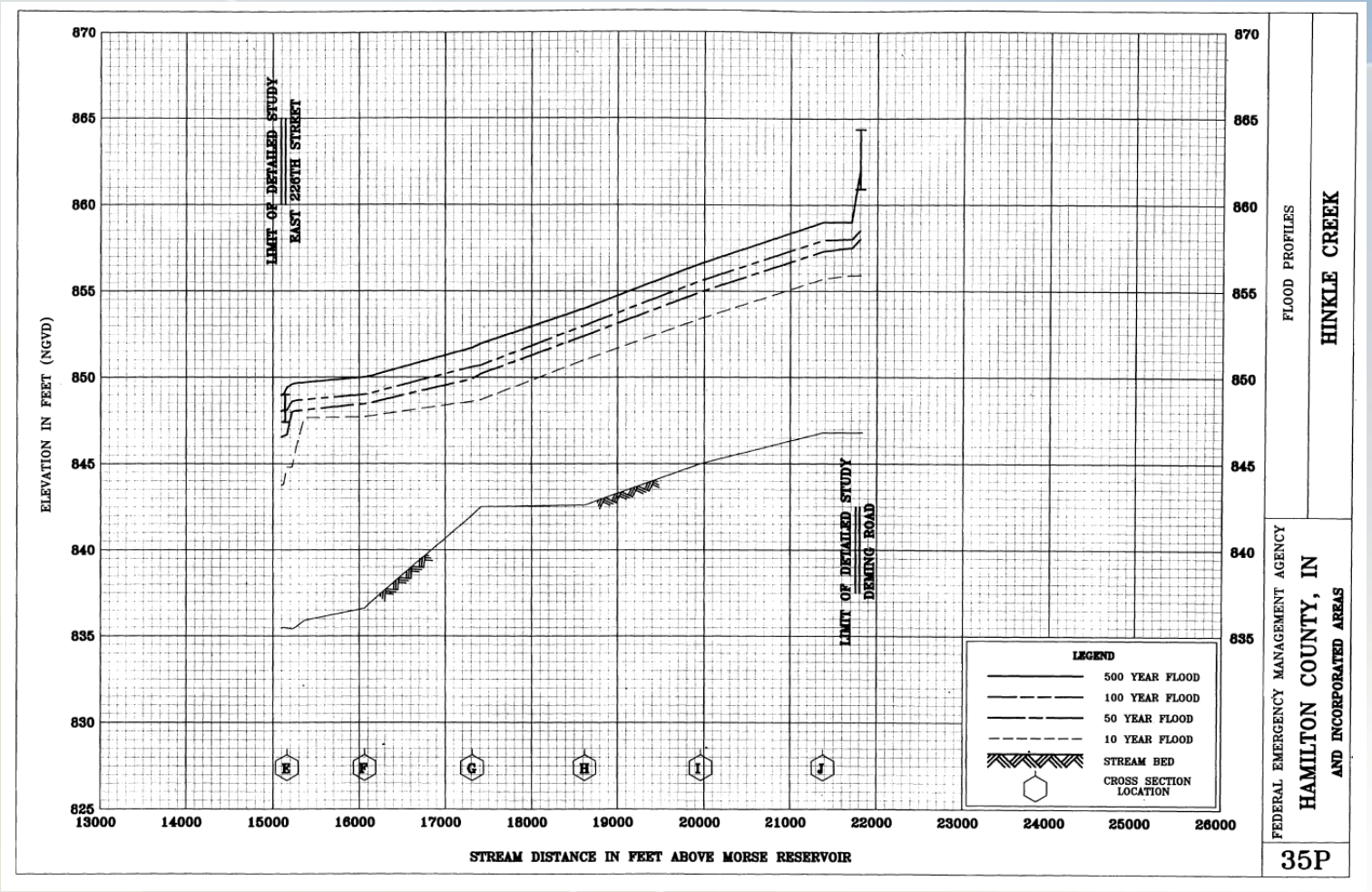
Flood Analysis – Floodplain Mapping

- Delineate Floodplain using Flood Elevations



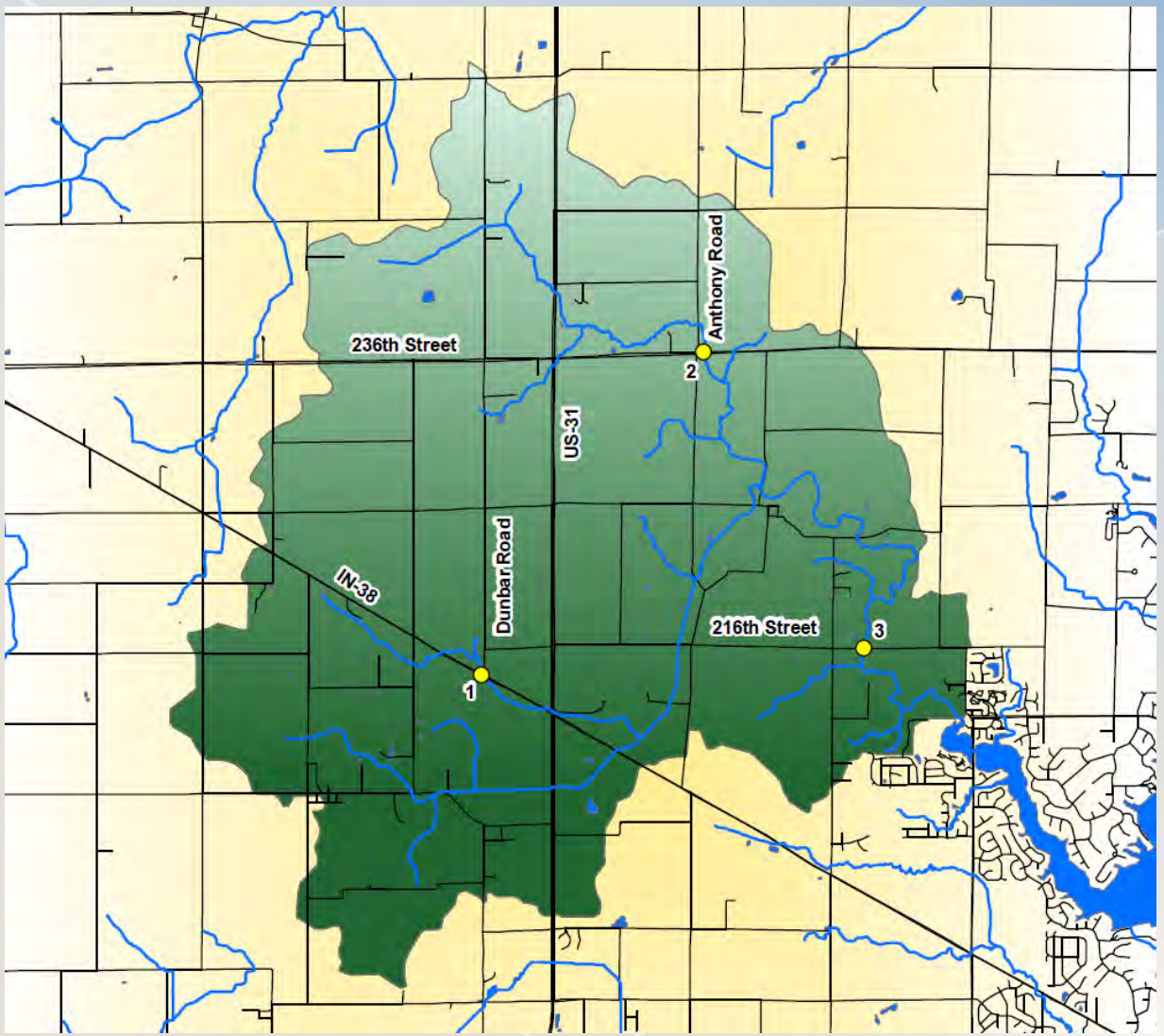
Flood Analysis – Flood Profile

- Delineate Floodplain using Flood Elevations



Water Quality Analysis

- Three Water Quality Sampling Locations



WILLIAMS CREEK CONSULTING

PUBLIC MEETING DISCUSSION

Masonic Lodge
Deming, Indiana
Hinkle Creek Watershed Master Plan

June 27th, 2012 – 6:00 p.m.

Attendees:

See sign in sheet

Public Meeting Question and Answer Session

1. What does the QHEI score mean and what goes into the system?
    a. The Qualitative Habitat Evaluation Index is a standardized method developed by the Ohio EPA to evaluate the ecological integrity of streams. The method calculates a QHEI score for a reach of stream, which corresponds to pre-defined categories of stream quality. Characteristics measured by the QHEI evaluation include channel substrate, in-stream cover, channel morphology (shape), riparian buffer width, pool and riffle quality, and channel gradient (slope).

2. Why are cobbles and buffers better than straight channels with no buffers?
    a. A substrate comprised of a mixture of gravel, sand, cobbles, and boulders will provide a greater diversity of wildlife habitat than a silt and clay bottom. Additionally, eroded silt and clay contributes to total suspended solids (TSS) measurements, reducing water clarity and increasing water temperature. Vegetative buffers adjacent to stream channels serve as a filter to trap and contain sediment and other pollutants, reducing the amount entering the stream channel.

3. Why does the Jones Drain and Lindly Ditch score well on the QHEI score provided it is a hand dug channel?
    a. Although these features may have been excavated, they exhibited characteristics typical of natural channels; i.e. relatively wide buffers, lack of channel erosion, and healthy substrate material. Characteristics typical of excavated channels include little if any channel sinuosity, silt and clay substrates, lack of vegetated buffers between the stream and other human uses, and exposed, non-shaded channels.

4. Did Williams Creek Consulting record the last rainfall prior to the April 13th water quality sampling event?
    a. Williams Creek Consulting did not have the specific date available for the meeting; however, that date was recorded in the field notes. Recollection

was that there had been a measureable rainfall event approximately 2 days prior to the sampling event.

5. What affect has/will the US 31 improvement project have on the watershed?
    a. Potential increase in sediment load during construction.
        i. Sediment should be controlled by erosion control practices. This requirement is known as Rule 5 which requires construction projects to maintain erosion control measures on site.
        ii. INDOT is responsible to following same erosion control regulations as any other construction site.
    b. Potential increase in storm volume due to increase in impervious surface.
        i. A project that increases impervious surface generally requires detention.
        ii. Greg Hoyes believed that there was at least one detention pond in the US 31/SR 38 cloverleaf interchange.

6. What methodology was used in performing the field inspections?
    a. Primarily walking corridors of areas noted during the desktop evaluation.

7. Who maintains the drains?
    a. Individuals are responsible for maintaining conveyance in non-regulated drains.
    b. County Surveyor's office is responsible for reconstruction/maintenance when a budget and schedule is in place.
        i. Until this occurs, the individual is responsible.

8. Who determines if the drain is County regulated?
    a. Up to 1965, it was established by Circuit Court or Commissioners Court of the County.
    b. Since 1965, the county Drainage Board can act on a petition to regulate a drain.
        i. Public notice and remonstrance periods before a drain becomes a regulated drain.

9. Why is vegetation stripped in regulated drains?
    a. Trees/shrubs are removed to improve drainage/conveyance.

10. If County Surveyor conducts maintenance on a regulated drain, will that result in increased runoff or sediment?
    a. Reconstructed areas are constructed with vegetated buffers at that time, so increase in sediment load is not likely.
    b. Farmer is not compensated for crop damage to reconstruct a drain in the drainage easement because the drainage easement allows the County Surveyor to complete work without being required to provide compensation for crop damage.

11. Is there repercussion if an individual damages the regulated drain or if a farmer farms up to the edge of bank of a regulated drain?
    a. Yes. The County has a system in place.
        i. Certified letter to responsible party and they have 10 days to fix the problem.
        ii. If no action, the County may repair the problem and bill the responsible party.
        iii. If no payment, County completes a tax sale to recuperate costs.

12. Is this watershed part of a larger watershed?
    a. Yes. Hinkle Creek watershed contributes to larger watersheds. All of Hamilton County is part of the upper White River watershed. Hamilton County is part of the UWRWA (Upper White River Watershed Alliance).

13. Does the Hinkle Creek watershed have a problem resulting in the need for the current study?
    a. No. This is routine practice to obtain a baseline on the condition of the watershed.
    b. This is particularly helpful for when the watershed characteristic changes (i.e. development) to demonstrate whether the change has affected the watershed or not.
    c. Similar studies have been completed on several other watersheds in the County.
    d. Results of the study to date indicate the need for agricultural conservation practices such as grassed waterways in order to reduce sediment.

14. Are agricultural conservation practices effective in improving water quality?
    a. Yes they can if installed correctly.

15. Can the drainage board force farmers to install filter strips?
    a. Yes, if the drain is regulated. If it is not regulated, this can not be enforced.

Public Meeting Attendance
Hinkle Creek Watershed Master Plan
June 27, 2012 - 6:00 p.m.

Name	Address	Phone or E-mail
Hans Peterson	8900 Keystone Crossing	808-3140 hans.peterson@clarkdietz.com
Sam Robertson	8900 Keystone Xing	808-3142 samuelr@clarkdietz.com
Becky Hoover	Wild Feather Farm	361-5954 rshoover0702@att.net
Rob Stokes	16457 Oak Manor	258-3349 RWSTOKES@COMCAST
KAY DELULLO	WILD FEATHER FARM 2109 S.R. 38 E	258-4663 my4x4haslegs@yahoo.com
Hubert BERRY	22465 ~~Gifford~~ Cicero Ave	984-4476
Hugh Berry	-765-734-1513	
Joe BERRY	43 S. 550 W. Tipton, IN. 46072	
GREG SILCOX		gregsilcox@rocketmail.com
Robert C. O'Rear	4302 E. 236th Cicero 46034	317-984-5466
JIM SCHNEIDER	2460 CAPE HENRY CT. CICERO	JAMES.SCHNEIDER@COMCAST.NET
Roger Goings	117 Edgewater Dr Noblesville	roger306@comcast.net
CINDY SPOLJARIC	16131 Chancellors Ridge Way Westfield	cspoljaric@westfield.in.gov
Rob Snader	336 Harbour Pte Dr W	691-7476
Paul Martz	18506 ~~Grassy~~ Branch Rd. Westfield	
Dale Ostler	355 Harbour Pt. Dr. W Noblesville	DALEROW355@yahoo.com
MIKE McConnell	1340 Lighthouse Pt. Cicero 46034	MCCONNELL36@COMCAST.NET
Steve Decature	20 Bayview "	Steve@Steve decatur.com
Paul Settles	2980 E 236th ST Cicero IN 46034	SettlesJ@Hotmail.Com
Judy Settles	2980 E 236th ST Cicero IN 46034	SettlesJ@Hotmail.Com
Jim & MarySue Riggs	20707 Hinkle Rd, Noblesville	877-2327
DOROTHY CONDER	2844 E 236th ST Cicero	
DAN CONDER	2842 E 236TH ST. CICERO	dconder@hughes.net
Steve Henke	3524 Club Estates Dr, Carmel, IN. 46033	Steve.Henke@HenkeDevelopment.com
Steve Hoover	1614 Woodside Dr. Westfield, IN 46074	stevehoover1@gmail.com

Brian Catt	919 N East St.	bcatt@williamscreek.net
Jason Steckel	"	jsteckel@williamscreek.net