2 Section Two – Current Conditions

2.1 Introduction

Understanding the current baseline condition of the collection system and local waterways provides a basis for understanding sources of pollution and for comparing the benefits of potential CSO controls. This section describes the current capacity and condition of the existing wastewater collection system, including the combined sewer system (CSS), and the wastewater treatment plant (WWTP). This chapter also discusses the current water quality in the Wabash River and the impacts of the City's CSOs on the river based on available data collected since 1991. These data indicate that *E. coli* is the only pollutant of concern.

The City submitted a Stream Reach Characterization and Evaluation Report (SRCER) in 1999 as part of the development of its first Long Term Control Plan (LTCP) that described current river quality conditions. This section summarizes the SRCER's conclusions and updates the information presented in the SRCER by extending the data analyses through 2009 and includes activities that have been conducted since the first SRCER was submitted. For example, the City conducted flow monitoring in the combined collection system in 2005 to better characterize the system and to have a robust dataset for calibrating and validating the CSS model (discussed in Section 3). The City also conducted an extensive Wet Weather Sampling Program in 2007 to characterize water quality in the Wabash River during periods when their CSOs are actively discharging to use in calibrating and validating their detailed river model (presented in Section 4). These datasets serve as a baseline for comparing the benefits of potential CSO controls.

The following sections describe the current conditions of major elements of the combined sewer system in and around the City of Terre Haute.

2.2 Wabash River Watershed

Thirty miles after its starting point in Grand Lake, Ohio, the Wabash River enters Indiana, where it drains two-thirds of Indiana's 92 counties. It flows over 475 miles before it enters the Ohio River below Mount Vernon, Indiana and is the longest free-flowing river east of the Mississippi River (Figure 2.2-1). The total Wabash River watershed is 32,959 square miles with numerous streams and creeks flowing into the river. Much of Indiana's farmland drains into the Wabash River (www.indianaoutfitters.com).

Throughout the Wabash River Watershed, the major land uses are agriculture and urbanization (commercial, industrial, and residential land areas). Several cities have grown along the banks of the Wabash River, including Vincennes, Terre Haute, Lafayette, and Logansport. Major tributaries to the Wabash River include major population centers of Kokomo (Wildcat Creek), and Marion (Mississinewa River) as well as Indianapolis, Anderson, and Muncie (White River). The total population for the Wabash River Watershed is approximately 1,250,000 (U.S. Census Bureau, 2010). This total does not include the population along the White River, which drains into the Wabash River in the lower portion of its watershed.

Most of the Wabash River basin lies in the geologic area known as the Tipton Till Plain. This area, characterized by flat to gently rolling surfaces, till (a mixture of sand, silt, clay, and boulders), and covered bedrock, comprises the landscape for a large portion of the Upper Wabash River watershed. A small portion of the Upper Wabash River watershed lies in the Northern Moraine and Lake Region, which is mainly hilly with many lakes and large depressions formed from glacial retreat (Indiana Geology Today website). The Middle and Lower Wabash River watersheds are located in the areas known as the Wabash Lowland, the Mitchell Plain, and the Crawford Upland. The Wabash Lowland consists of relatively nonresistant siltstone and shale of the Pennsylvanian age, which occurred approximately 310 million years ago. The Mitchell Plain geological division is distinguished by its sinkholes and underlain cave systems developed in the Mississippian age limestone bedrock, which occurred approximately 345 million years ago. Alternating layers of limestone, shale, and sandstone of late Mississippian age and some sandstone of the Pennsylvanian age forms the Crawford Upland. The geology of both the Pennsylvanian age and Mississippian age are part of the Paleozoic Era. (Smith, 2001.)

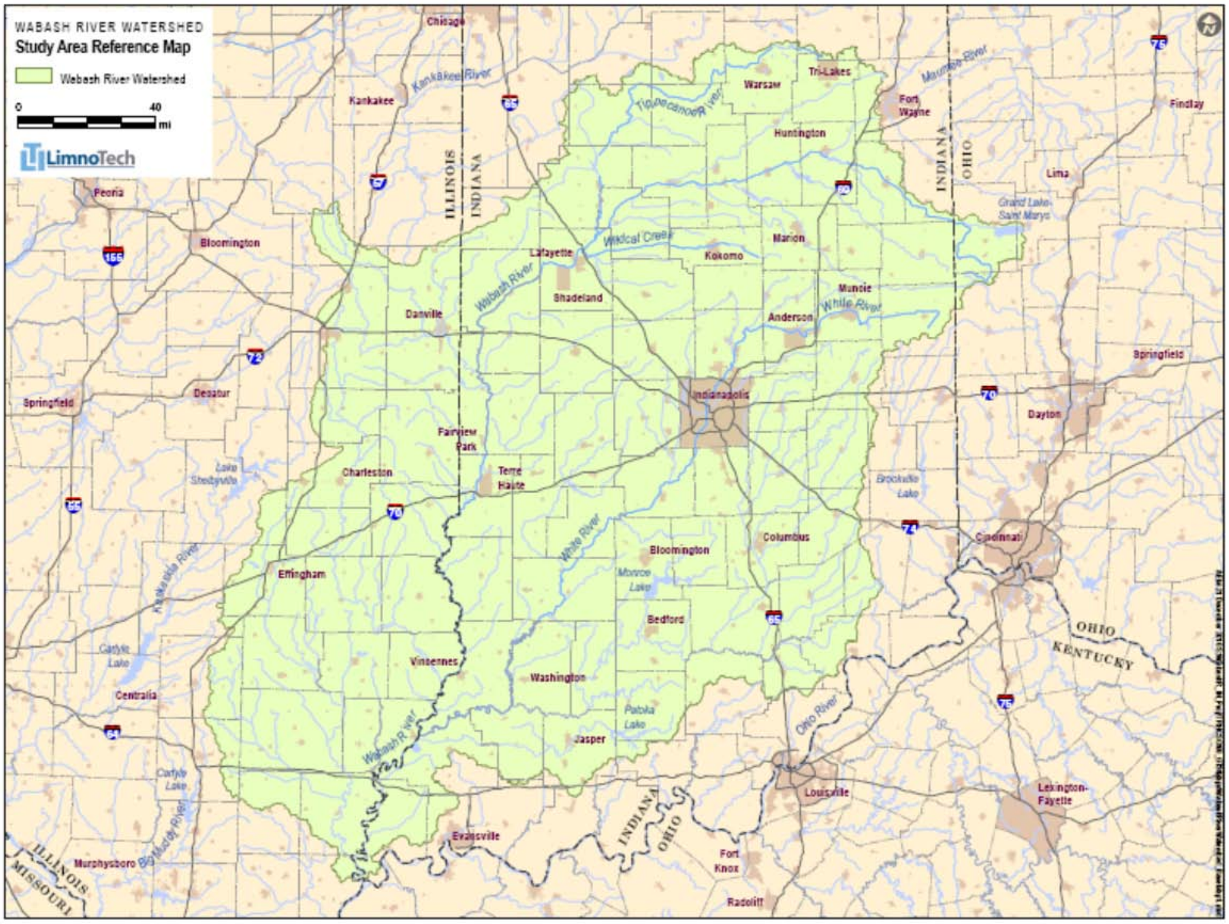


Figure 2.2-1. Wabash River Watershed.

The river has historically had a robust and diverse aquatic life. During a 2001 fish survey of the Wabash River conducted by the Indiana Department of Natural Resources Fish and Wildlife Service, 82 species and two hybrids of fish were collected from 15 different families. The most dominant species present, as reported by the Indiana Department of Natural Resources (IDNR), were common carp, channel catfish, flathead catfish, freshwater drum, golden redhorse, gizzard shad, shortnose gar, quillback, blue sucker, and river carpsucker (http://www.state.in.us/isdh/dataandstats/fish/fish_99/watershed.htm).

More recently, Asian carp have been found in the Wabash River (IDNR 2010b). Asian carp (comprising the species of bighead, black, grass and silver carps) are found across much of the Mississippi River Basin (Kolar et al. 2005, Figures 2.2-2A and 2.2-2B). Asian carp were first detected in Indiana in 1996 in the southwest corner of the state (IDNR 2010a). Subsequent surveys from Indiana Department of Natural Resources (IDNR) have found bighead carp and silver carp to be in low abundances across the Wabash River system, but the recent surveys suggest an upstream expansion to Huntington, Salamonie, and Mississenewa lakes in the upper portion of the Wabash River watershed. As recently as 2008, IDNR surveyed over 105-miles of the Wabash River, and found that Asian carp abundances appeared low at that time (IDNR 2010b). Anecdotal evidence suggests that Asian carp are quite abundant in the Wabash River, however, scientific quantification of local abundance is lacking for locations like Terre Haute, Indiana so their local influence is uncertain at this time.

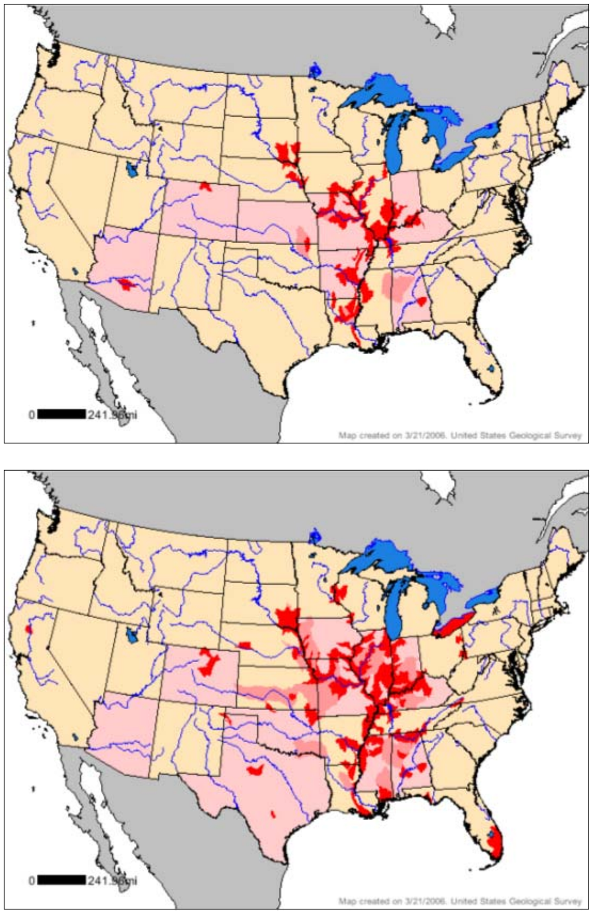


Figure 2.2-2A (top). Silver carp distribution in 2006 (from USFWS 2006). Figure 2.2-2B (bottom). Bighead carp distribution in 2006 (USFWS 2006).

Detailed risk assessments for Asian carp are being completed across their potential range in North America (USFWS 2006). Known risks include rapid range expansion and population increases, resulting in decreases in abundances of native aquatic fauna (USFWS 2006). Research summaries on specific Asian carp affects, such as that of Kolar et al. (2005) suggest that the primary negative ecosystem effects that Bighead and Silver carps have on ecosystems into which they invade is trophic alteration. Kolar et al. (2005) also documents lesser but important adverse changes to habitats, water quality, individual species and disease transmission within invaded and introduced systems.

Within Indiana, Dr. Reuben Goforth (Purdue University) has expressed a concern over Asian carp impacts on native fishes in the Wabash River stating their numbers appear to be increasing but additional surveys are still needed to verify the rate (Goforth 2010a). Dr. Goforth stated that these invasives are removing the plankton that serves as the food base for this ecosystem and for species like gizzard shad and skipjack herring (Goforth 2010b). Shad and herring serve as the main foods for large predators like catfish, bass and walleye, and although it is hard to tell if their presence has had a negative effect on the system as of yet, the trajectory could mean a significant impact on the overall fish community (Goforth 2010b). Again, local information on abundances and impacts for areas like Terre Haute are lacking but their presence in the Wabash suggests that adverse effects on the aquatic community are likely.

2.2.1 Terre Haute River Basin

The City of Terre Haute, Indiana is located approximately 220 miles upstream of the Wabash River's confluence with the Ohio River in the center of Vigo County in west-central Indiana (Figure 2.2-1). The upstream portion of the watershed draining to the Terre Haute reach is approximately 12,263 square miles. The City itself is approximately 31 square miles in size and serves a population of approximately 57,259, based on a 2006 estimate from the U.S. Census Bureau. Population has been declining slightly based on the change in population from 2000, when it was 59, 614 (U.S. Census Bureau, 2010). The City has 10 CSO outfalls and a 48 million gallons per day (MGD) WWTP that discharge to the main stem of the Wabash River (Figure 2.2-3).

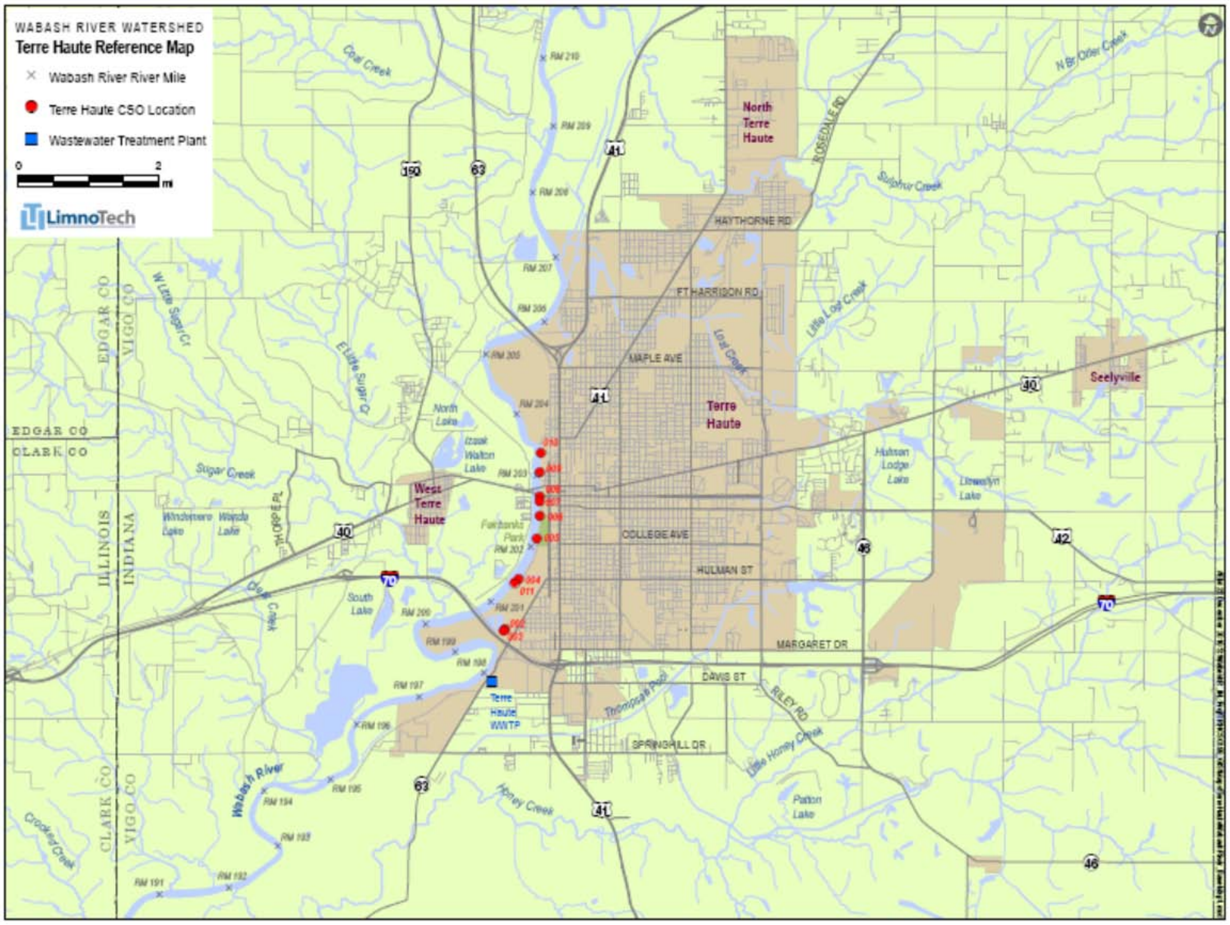


Figure 2.2-3. Wabash River Watershed Features Near the City of Terre Haute

The dominant land use in the Terre Haute metro area is industrial but the watershed upstream is largely agricultural and forested (NLCD, 2001). Several CSO communities are located upstream, including the larger communities of Lafayette, West Lafayette, and Kokomo. All of these Cities are implementing Long Term Control Plans to address their combined overflows.

The City of Terre Haute is home to Indiana State University, whose campus is contained completely within the combined sewer service area, and the Rose Hulman Institute of Technology (located east of the City limits). Outside of these campus areas, land use is largely commercial and industrial in the historical downtown area and becomes increasingly residential away from downtown (Figure 2.2-3). The City has numerous parks and recreation areas and of particular note is Fairbanks Park, a large park located along the Wabash River near downtown (see Figure 2.2-3 and 2.2-4).

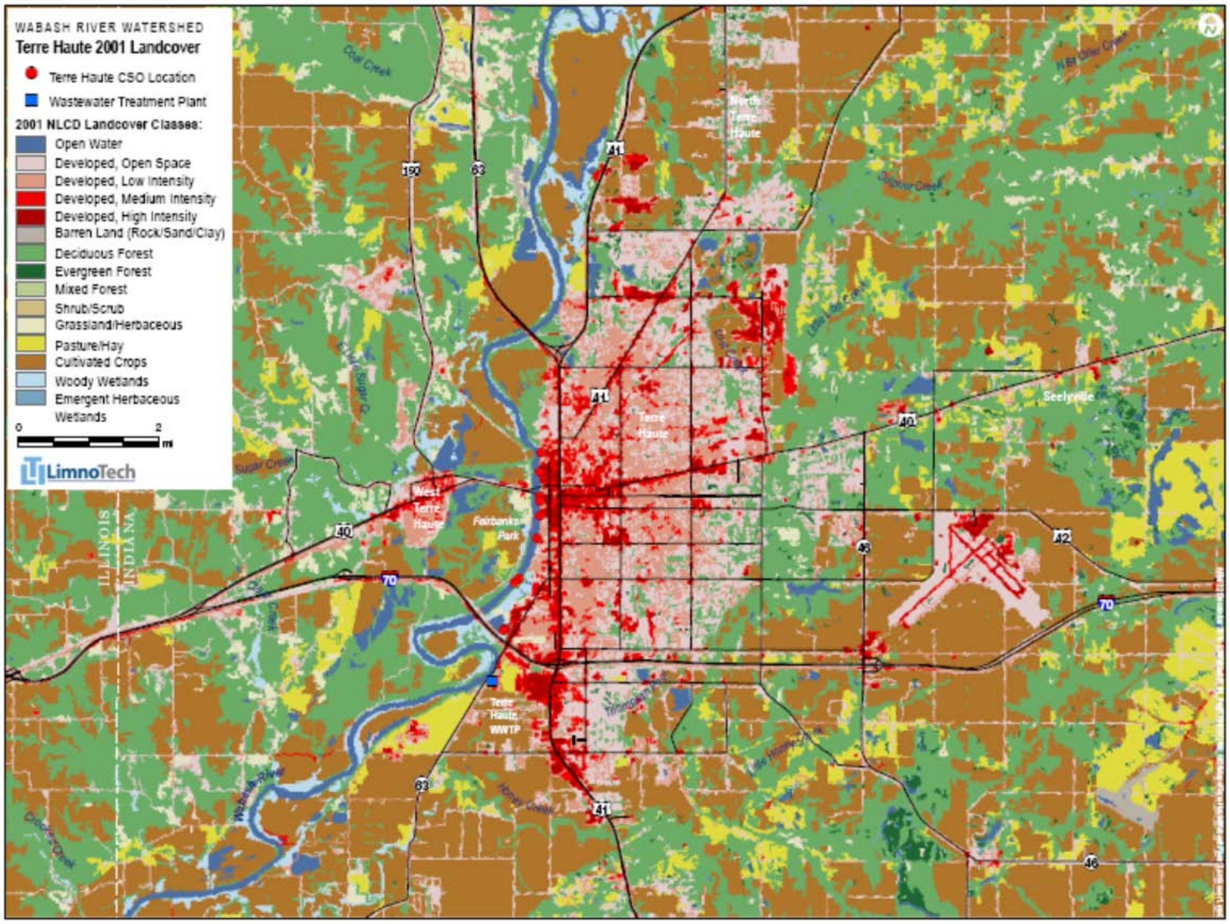


Figure 2.2-4. Land Cover in the Wabash River Watershed Near the City of Terre Haute.

The U.S. Geological Survey (USGS) has maintained a gage in the Wabash River in Terre Haute since 1927. Water Resources Data from the U.S. Geological Survey (USGS) indicate that the mean annual flow in the Wabash River at their gage in Terre Haute is 11,410 cubic feet per second (cfs) and the median flow (50th percentile) is 6,620 cfs, based on daily records from 1928-2009.

There are several small tributaries to the Wabash River that flow through or near Terre Haute. They are Sugar Creek, Otter Creek, Honey Creek, and Lost Creek (Figure 2.2-3). Storm water discharges in Terre Haute flow into these tributaries and consequently can affect the water quality of the Wabash River. The City does not have any CSO discharges to the tributaries.

The water quality of the Wabash River in Terre Haute is impacted by CSOs, urban storm water and agricultural runoff and upstream pollution sources. IDEM's 2008 303(d) List of Impaired Water

Bodies has the Wabash River listed as impaired by E. coli and nutrients as well as fish consumption advisories for PCB and Mercury contamination (IDEM, 2008). The nearby tributaries of Sulphur Creek and Sugar Creek are also on the 2008 303(d) list. Sulphur Creek is also listed for mercury and PCB fish consumption advisories and E. coli as well as pH, total dissolved solids and sulphate while Sugar Creek is listed for impaired biotic communities. None of these tributaries receive discharges from the City's CSOs.

2.3 CSS Description

2.3.1 Combined Sewer System Description

The City's Sanitary District includes significant rural and urban areas outside of the City so the City's waste water treatment plant (WWTP) not only treats wastewater for Terre Haute but also for the Town of Seelyville, which is located to the east of Terre Haute and has a population of 1,117 (U.S. Census Bureau, 2009 Population Estimates) and significant nearby unincorporated developed and undeveloped areas. In 1965, the City constructed the main interceptor, main lift station and primary wastewater treatment plant to convey dry weather and a portion of wet weather wastewater flows to the WWTP. Both combined and separated sewers convey wastewater to the main interceptor sewer, which flows to the WWTP.

The combined sewer area is centrally located in the older, central and northern sections of the City and covers approximately 5,100 acres. Many of the combined sewer trunk lines (of brick construction), which discharged directly into the Wabash River prior to the construction of the main interceptor, were installed in the late 1800's and early 1900's. Ten CSO outfalls are located in the combined sewer area and one outfall is located at the WWTP.

2.3.2 Combined Sewer Service Areas

Figure 2.3-1 shows the boundaries of each of the seven CSO service areas, some of which contain more than one outfall. The areas and corresponding outfalls are designated from north to south, as the Spruce, Chestnut, Ohio, Walnut, Oak and Crawford, Hulman and Idaho, and Turner basins. The service areas receive sanitary flow from both combined and separated sewers. Table 2.2-1 shows the combined and separated areas in each service area. The following sections describe each of the individual CSO basins.

Table 2.2-1
City of Terre Haute CSO Service Areas

CSO Service Area	CSO Service Area Names	Combined Area (acres)	Separated Area (acres)	Total (acres)
010	Spruce St.	1,262.6	5,877.0	7,139.6
009	Chestnut St.	321.9	7.3	329.2
008	Ohio St.	87.0	7.6	94.6
007	Walnut St.	1,079.5	2,890.0	3,969.5
005/006	Oak/Crawford St.	271.1	36.0	307.1
004/011	Hulman/Idaho St.	1,502.6	1,079.0	2,581.6
003	Turner St.	613.8	2,086.0	2,699.8
TOTAL		5,138.4	11,982.9	17,121.3

2.3.2.1 Spruce Street

The Spruce Street service area (CSO-010) is the most northern service area in Terre Haute's combined sewer area and is served by the 108-inch Spruce Street trunk sewer. It has approximately 1,260 acres of combined sewers. The land use in the area consists mostly of residential with some commercial areas including the expanding Union Hospital campus and a small portion of Indiana State University. The trunk line, which extends northeast on Lafayette Avenue, receives sanitary flows from the separated area to the north of the basin. Flows are conveyed through the trunk sewer to a 36-inch throttle pipe diversion structure that diverts dry weather flows to the interceptor sewer. The throttle pipe defines the beginning of the main interceptor sewer.

2.3.2.2 Chestnut Street

The Chestnut Street service area (CSO-009) is located directly south of the Spruce Street service area and is served by a 66-inch trunk sewer that flows from the old Canal Sewer. It has approximately 320 acres of combined sewers and the land use in the area consists mostly of Indiana State University.

2.3.2.3 Ohio Street

The Ohio Street service area (CSO-008) is located between the Chestnut Street and Walnut Street service areas and is served by the 42-inch Ohio Street trunk sewer. This area serves most of the downtown area therefore; the land use is mostly commercial with some industry and a small portion of the Indiana State University campus area. The outfall for this basin lies in Fairbanks Park.

2.3.2.4 Walnut Street

The Walnut Street service area (CSO-007) is located immediately south of the Ohio Street service area. It has approximately 1,080 acres of combined sewers. The land use is mostly residential with some commercial areas. The separated area to the east of this service area includes the Town of Seelyville. Areas east of this basin (including the Seelyville interceptor) have recently been separated and diverted to the south side lift station via the Thompson Ditch interceptor. The Walnut Street CSO outfall structure is located in Fairbanks Park.

2.3.2.5 Oak and Crawford Streets

The Oak (CSO-006) and Crawford Streets (CSO-005) service area is located south of the Walnut Street service area. The combined basin area has approximately 270 acres of combined sewers. The area serves mostly residential and commercial areas. Although each area has a trunk sewer that conveys combined sewage to the interceptor sewer, there is a cross connection between the two sewers on Second Street from Oak Street to Crawford Street. Therefore, the Crawford Street trunk sewer is a relief sewer for the Oak Street trunk sewer. The outfalls for these service areas are located in Fairbanks Park.

2.3.2.6 Hulman and Idaho Streets

The Hulman Street (CSO-004) and Idaho Street (CSO-011) service area is the largest area in the City with a total combined area of approximately 1,500 acres. The basin is served by the 114-inch Hulman Street trunk sewer and the 96-inch Idaho Street trunk sewer. The land use is mostly residential with some commercial and industrial areas. The Idaho Street trunk sewer is referred to as the Central Relief Sewer because the two trunk lines contain several cross connections. The two trunk lines also collect sanitary flow from the separated area to the east of 25th Street and conveys it to the main interceptor sewer. The outfalls are interconnected just upstream of each diversion structure.

2.3.2.7 Turner Street

The Turner Street service area (CSO-003) is the southernmost combined sewer service area and is served by 84-inch trunk sewer. It has approximately 610 acres of combined sewers. The land use is mostly residential with some commercial along the Margaret Avenue corridor. The trunk sewer picks up sanitary flows from the separated areas to the east and south of the CSO basin and then conveys all flow to the main lift station. The overflow outlets to a ditch just southeast of the main lift station, which extends south and west around an existing basin.

2.3.2.8 Main Lift Station

The Main Lift Station overflow (CSO-002) is an interceptor relief overflow that is activated when the capacity of the main lift station is exceeded and the interceptor sewer is surcharged. There is a gate at the main lift station wet well that can be opened prior to the Lift Station being flooded out. Currently there are automatic controls on this gate that the City personnel can override to maximize the flow to the treatment plant.

2.3.3 Trunk Sewer & Interceptor Network

The City of Terre Haute has nine major trunk sewers that flow to the west towards the Wabash River, as described in the previous section. The main interceptor sewer along the river intercepts all of the flows from the trunk sewers and conveys flow to the main lift station. The trunk sewer diameters range from 42-inches to 132-inches. Figure 2.3-2A through 2.3-2C shows the major trunk sewers and the interceptor sewer. The figure shows diameters and capacities of the sewers from the collection system model runs during wet weather conditions.

The concrete main interceptor sewer runs along the east bank of the Wabash River to intercept wastewater flows from the trunk sewers that originally flowed directly into the river. The interceptor sewer conveys this flow to the 48 MGD Main Lift Station where it is then pumped to the Wastewater Treatment Plant.

The concrete interceptor sewer starts at the north end of the combined sewer area at Spruce Street. The 36-inch throttle pipe from the Spruce Street diversion structure begins the interceptor sewer. The interceptor sewer consists of several large diameter sewers to convey the wastewater to the main lift station. It begins as a 36-inch pipe and then immediately increases to 48-inch just south of Spruce Street. It then increases to a 54-inch sewer just south of Ohio Street and increases again to a

60-inch sewer at Oak Street. Lastly, it increases to a 66-inch sewer at Idaho Street and proceeds to the main lift station. The interceptor is constructed in a 100 foot easement and contains sections with little or no cover.

Wastewater from each of Terre Haute's combined sewer service areas discharge to a diversion structure. During dry weather, all of the flow is diverted through the throttle pipes into the main interceptor sewer for conveyance to the wastewater treatment facility. During large storms, excessive flows enter the diversion structure, overtop the elevation of a weir and overflow into the Wabash River through the outfall pipe. The CSS has nine diversion structures and ten outfalls. The diversion structures vary in design. The diversion structures at Hulman and Idaho Streets are located at the interceptor whereas the other seven diversion structures divert dry weather flow through a throttle pipe to the interceptor. A flap gate is located on each outfall pipe, except the outfall at the main lift station and the WWTP, to prevent river water from entering the system. Table 2.2-2 describes each CSO diversion structure. Drawings and photographs of each diversion structure are shown in Terre Haute's *Combined Sewer Operational Plan* (2006). Currently, City personnel inspect the outfalls during and after every rain event in accordance with their Operational Plan.

Table 2.2-2
CSO Diversion Structure Descriptions

CSO Diversion Structure	CSO Diversion Structure Location	CSO Diversion Structure Description	Outfall Pipe Size (1)	Throttle Pipe Size	Influent Pipe Invert Elevation (ft.)	Height of Weir (ft.)	Outfall Pipe Submerged
010	Spruce St.	108" trunk sewer from Spruce St. enters weir chamber and is diverted into a 36" throttle pipe which is the start of the interceptor	108"	36"	468.92	3.88	no
009	Chestnut St.	66" trunk sewer conveys flows from the Canal Sewer and flow that is diverted over the weir at Lafayette St. and Spruce St. into a weir chamber that is located near Third St. The flow is diverted into a 30" throttle pipe into the 48" interceptor	96"	30"	469.11	2.54	partially
008	Ohio St.	42" trunk sewer from Ohio St. enters weir chamber and is diverted into an 8" throttle pipe and then into a 15" throttle pipe to the 54" interceptor	42"	8" - 15"	468.25	3.18	partially
007	Walnut St.	96" trunk sewer from Walnut St. enters weir chamber and is diverted into an 18" throttle pipe to the 54" interceptor	96"	18"	463.92	4.25	no
006	Oak St.	54" trunk sewer form Oak St. enters weir chamber and is diverted into an 8" throttle pipe to the 60" interceptor. Some flow from Oak St. flows to the Crawford St. outfall from a cross connection on Second St.	54"	8"	469.5	1.5	yes
005	Crawford St.	63" trunk sewer from Crawford St. enters weir chamber and is diverted into a 12" throttle pipe to the 60" interceptor	66"	12"	471.08	2.81	yes

004	Hulman St.	114" trunk line on Hulman St. coveys flow from Hulman St. and flow relieved from Idaho St. through the 84" cross connection at Prairieton Rd. Flow enters the diversion structure and is diverted to the 60" interceptor through a 56" X 64" orifice	96"	orifice opening 56" X 64"	459.18	2.61	no
011	Idaho St.	96" trunk line on Idaho St. enters the diversion structure and is diverted to the 66" interceptor through a 65" X 72" orifice	96"	orifice opening 65" X 72"	458.75	3.92	no
003	Turner St.	84" trunk sewer from Turner St. enters weir chamber and is diverted into a 20" throttle pipe to the 66" interceptor which flows into the Main Lift Station which is then pumped to the WWTP	84"	20"	459.47	4.25	no
002	Main Lift Station	The flow enters the wet well of the main lift station and when the capacity of the lift station is reached, the flow goes over a weir and out the outfall.	48"	N/A	N/A	Elevation = 461.0	no

2.3.4 Wastewater Treatment Plant Facilities

The wastewater treatment plant in Terre Haute, located along the Wabash River, east of SR 63 and south of Interstate 70 was originally constructed and put into operation in 1963 as a primary treatment facility. New facilities at that time included: pretreatment and primary treatment facilities, chlorination and digestion facilities, the administration/control building and the main lift station. In 1971, it was expanded to include secondary treatment. Additional sludge handling and dewatering/storage facilities and fine-bubble diffusers were added in 1989. The two flow equalization basins were added in 1990 and the main lift station was upgraded with new screening in 1997. A summary of the process capacities described in the following sections are included in Table 2.3-3. The schematic of the existing processes is shown in Figure 2.3-3.

The existing NPDES permit (Permit No. IN 0025607) indicates that the WWTP is rated for a design average daily flow of 24 MGD. A copy of the current NPDES permit is included in

Appendix 1-1. The effluent discharge limits contained in the permit are shown in Table 2.3-4. The mass loading limits presented are based on a peak wet weather flow of 48 MGD. A summary of the current plant flow loadings is included in Table 2.3-5.

Table 2.3-3
Wastewater Treatment Facility Capacities

Facility	No. of Units	Unit Size	Design Peak Capacity (MGD)	Actual Peak Capacity (MGD)
Main Lift Station	4	4 @ 11,100 GPM	56	48
		(1 is a standby)		
Preliminary Treatment				
- Aerated Grit Tanks	2	40'x16'-2"x14'-4"SWD	48	48
- Comminutors	3	36"	48	48(1)
- Pre-Aeration Tanks	4	68'x16'x12'-8"SWD	48	48
Primary Treatment				
- Primary Clarifier	12	139'x16'x10'-1"SWD	48	48(2)
Secondary Treatment				
- Aeration Tanks	4	3 passes each @	36	31(3)
		108'-8"x30'x15'-1"SWD		
- Secondary Clarifiers	4	100' Diam. 12'SWD	36	31(3)
- Chlorine Contact Tank	1	66,840 cu. Ft. volume	48	48
- Dechlorination Tank	1	3,570 cu. Ft. volume	48	48
Equalization Tanks	2	5.2 Mgal Volume		

(1) One channel does not receive grinding to maintain this peak capacity
(2) Based on NPDE permit and 1,800 gpd/sf
(3) Based on previous operational experience

Table 2.3-4
Terre Haute WWTP - NPDES Discharge Limits

Parameter	Quantity or Loading				Quality or Concentration		
	Monthly Average	Weekly Average	Units		Monthly Average	Weekly Average	Units
BOD$_5$	10014	16022	lbs/day		25	40	mg/L
TSS	12017	18025	lbs/day		30	45	mg/L
Interim NH$_3$-N							
Summer	2003	3004	lbs/day		5	7.5	mg/L
Winter	6008	9013	lbs/day		15	22.5	mg/L
Final NH$_3$-N							
Summer	1843	2764	lbs/day		4.6	6.9	mg/L
Winter	2604	3925	lbs/day		6.5	9.8	mg/L

Parameter	Quality or Concentration			
	Daily Minimum	Daily Maximum	Monthly Average	Units
pH	6	9	---	s.u.
Total Residual Chlorine Final Effluent	---	0.04	0.02	mg/L
E. Coli	---	235	125	colonies/100 ml

Table 2.3-5
WWTF Influent and Effluent Loadings
June 2008 through June 2010

Month	Avg. Flow MGD	Max. Day MGD	Raw BOD mg/l	Raw TSS mg/l	Raw NH4 mg/l	Final BOD mg/l	Final TSS mg/l	Final NH4 mg/l
June '08	19.2833	42	75	122	10.03	9.7	33.9	0.5357
July	15.2387	20.6	98	114	13.28	5.9	16.7	0.2929
August	9.7129	13	139	127	18.66	5.4	5.9	0.259
September	10.9467	19.6	141	131	19.09	Missing Data		
October	8.73548	14.4	157	135	22.62	4.8	9.8	0.502
November	8.22	12.7	165	136	24.18	4.6	7.9	0.8693
December	10.8194	21.4	155	144	21.21	8.6	28.4	0.6235
January '09	9.16129	11.1	177	144	23.61	4.9	14.3	0.8465
February	11.3036	28.9	171	170	18.78	20.6	68.9	1.445
March	8.97419	15.4	165	154	21.09	9.3	23.1	0.3648
April	13.45	22.5	151	131	17.53	14.6	26.9	0.7887
May	13.0065	20.1	113	132	15.68	8.6	17.4	0.5513
June	13.4333	19.1	124	130	16.79	5.2	11.7	0.2997
July	13.9613	19.5	126	147	17.32	3.2	6.7	0.2687
August	10.3387	16.9	143	130	19	3.7	7.4	0.241
September	10.45	15.1	168	147	24.31	4.7	11.9	0.51
October	11.4484	20.6	162	160	21.45	4.3	8.8	0.2894
November	9.34333	15.2	184	150	25.25	3.6	10.6	0.272
December	12.8548	20.5	180	136	23.42	7.8	16	0.4748

Month	Avg. Flow MGD	Max. Day MGD	Raw BOD mg/l	Raw TSS mg/l	Raw NH4 mg/l	Final BOD mg/l	Final TSS mg/l	Final NH4 mg/l
January '10	15.8161	28.4	179	163	24.2	4.5	14.7	0.1535
February	17.9393	23.3	181	145	24.43	6.8	24.5	0.2054
March	10.8484	26.9	184	176	22.84	10.4	24.8	0.4694
April	10.937	17.7	174	183	22.28	8.4	22.1	0.3693
May	11.142	16.1	165	161	20.34	4.6	9.5	0.1352
June	13.02	20.3	117	147	14.36	4.4	9.1	0.3583

	Avg. Flow MGD	Max. Day MGD	Raw BOD mg/l	Raw TSS mg/l	Raw NH4 mg/l	Final BOD mg/l	Final TSS mg/l	Final NH4 mg/l
Combined Average	12.01539	20.052	151.76	144.6	20.07	7.025	17.9583	0.463558

2.3.4.1 Main Lift Station

The Main Lift Station consists of two buildings connected at an upper level. The first building houses the influent screening facilities. The original bar screens were designed to handle 60 Million Gallons Per Day (MGD). The improvement project of 1997 replaced the mechanically operated screens with similar type equipment and rated capacity. The second building houses the four raw sewage pumps and controls. The station was originally designed to pump 40 MGD with three vertical shaft pumps operating. In 1997, the pumps were changed to dry-pit submersibles and designed to pump 48 MGD to the wastewater treatment plant with three pumps operating. The force main to the plant is 48-inches. At the average daily flow of 12 MGD, the velocity in the force main is approximately 1.5 feet per second (fps). To prevent solids from settling out in the pipe, a velocity of 2-3 fps is required. The buildup of solids in the pipe can and has caused problems at the headworks of the plant when a surge of flow from a rain storm flushes the solids through the pipes. The buildup of the solids in the grit chamber lowers the holding capacity and sends more solids to the primary clarifiers to be removed when pumping sludge.

The wastewater treatment plant also receives wastewater from the following lift stations:

- Southside Lift Station (which has a self cleaning bar screen),
- Honey Creek Mall Lift Station, and
- Penitentiary Lift Station.

The current average dry weather flow from these three lift stations is estimated to be 1.5 MGD, with a peak of 5.0 MGD. Unlike the main lift station, these lift stations serve areas with separate sanitary sewers. There are sub-basins within those separate sewer areas however that have peak flows due primarily to inflow/infiltration during rain events that act similar to combined sewers. All flow from the four lift stations discharge into the preliminary treatment facility.

2.3.4.2 Preliminary Treatment

The original preliminary treatment processes, sometimes referred to as the headworks, was constructed in 1963. It consists of 2 aerated grit tanks, 3 comminutors/grinders in channels downstream of the grit tanks and 4 pre-aeration tanks. The facilities were originally designed with a treatment capacity rating of 48 MGD. The grit was removed from the aerated grit tank with a clamshell bucket which is now inoperable. The only improvement project to these facilities over the years replaced two comminutors with channel type grinders. Previous studies have indicated that the capacity for the preliminary treatment is limited to 40 MGD because of hydraulic problems with the comminutors/grinders (Terre Haute CSO Operational Plan - 2006). It has been estimated that present facilities only remove a small portion of the grit. The remaining grit passing through these facilities acts to degrade downstream equipment, create odors and make sludge handling more difficult.

These preliminary treatment facilities were part of the original construction and were up to date for the 1960's. The operational and maintenance difficulties and age of the units have made the preliminary treatment an inefficient process that affects the overall performance of the entire treatment facility. The upgrade of these facilities would significantly reduce problems in this area as well as the treatment performance and cost of the entire wastewater treatment plant.

2.3.4.3 Primary Treatment

The primary clarifiers were part of the original 1963 construction. They were designed to treat wastewater flow of 48 MGD. There are four clarifier tanks with three channels per tank. The clarifiers' longitudinal collectors act to move sludge to one end and cross collectors move sludge at the end of the channels to a common hopper for wasting. The effluent channel from the primary clarifiers was altered with a side channel weir in 1990 to discharge to the flow equalization (EQ) basins during high flow periods. This discharge to the EQ basins presently occurs at 24 MGD. The south end of the effluent channel has a sluice gate which is opened manually to act as a bypass when the EQ tanks are full and the flow rate exceeds the secondary treatment capacity.

2.3.4.4 Administration and Control Building

The existing administration and control building was constructed in 1963. It is a two level brick building located near the entrance gate. The building contains various process equipment and control components, insufficient storage areas and personnel lockers in addition to the management and staff offices. It is undersized for current and future needs and approaching 40 years in age. The current location on the site is in a position relatively distant from most plant operational and maintenance activities. There is not sufficient parking. A properly programmed and designed facility to meet all the current and projected staff needs is desirable. It has served its useful life.

2.3.4.5 Secondary Treatment

The secondary treatment plant consists of aeration tanks and secondary clarifiers that were built in 1971. It is rated for 24 MGD. The four aeration tanks are comprised of three passes each and can be operated in step feed mode. There are four 100' diameter circular secondary clarifiers with 12' side water depth. The plant staff has operated these clarifiers up to the equivalent of 36 MGD during field testing and believes a higher rate is possible if flow splitting and piping improvements are constructed. Flow distribution between the aeration tanks and the clarifiers is not balanced. Better flow splitting facilities would help to balance out flows to all tanks and thereby increase performance and efficiency.

The discharge from the clarifiers is disinfected by utilizing gas chlorination and dechlorination with sulphur dioxide. The wastewater is only disinfected during the recreation season (April-October) in accordance with the NPDES Permit. The disinfection system is sized for 48 MGD.

2.3.4.6 Biosolids

The original plant was constructed with anaerobic digesters and storage of liquid digested biosolids in lagoons. In 1989, new belt presses and dewatered biosolids storage facilities were constructed to allow disposal of liquid and/or dewatered biosolids. Recently, the anaerobic digesters were converted to aerobic units. Most biosolids processes and equipment with the exception of the digesters are in a deteriorated condition.

2.3.4.7 Flow Equalization Basins

The two earthen, lined flow equalization basins were constructed in 1990 and have a total volume of 5.2 Million gallons. The equalization basins receive primary effluent on flows greater than 24 MGD. Once the basins are full, approximately 24 MGD of flow continues to be sent to secondary treatment and the balance is bypassed from the primary effluent channel to the chlorine contact tank. When raw sewage flows subside, sewage from the basins can be pumped back into pre-aeration tanks. The bypass weir in the primary clarifier effluent channel could be adjusted or replaced to increase the amount of flow sent to secondary treatment before discharge occurs to the basins.

2.3.4.8 WWTF Expansion – Phase I

Given the age and condition of the existing treatment facility, a preliminary engineering report (PER) was completed for the entire facility in 2008/09 during the latter stages of the CSO LTCP process. The PER recommended significant upgrades for the facility to address antiquated equipment and processes, operational issues, hydraulic/organic capacity and to have the ability to meet future regulatory requirements. The improvements recommended were estimated at $130 million and were proposed to be completed in 3 phases over 5 – 6 years.

Phase I of the improvements to the treatment facility consist of a new Headworks facility which initiated construction in late 2010. As a result, this new facility shall be considered part of the existing facility with respect to the CSO LTCP, and the Phase II and III work considered as future improvements and will be discussed later in the report. A summary of the new headworks facility is as follows:

The new headworks facility will be constructed east of the existing aerobic digesters. New influent piping will convey all influent flows from the existing preliminary treatment structure to the new facility site. Three 24 MGD fine screens will be followed by two 30 MGD Pista grit removal systems. The third fine screen will be redundant and a by-pass channel will be provided between the two grit removal tanks to meet firm peak wet weather capacity. The entire preliminary treatment facility will be enclosed with ozone odor control equipment. Influent flow metering and sampling facilities will be installed upstream of the influent screening. A flow division structure will initially be installed downstream of the headworks structure to split flow to the primary tanks. The new headworks facility will have a capacity of 48 MGD.

2.3.4.9 Summary

In general, while the wastewater treatment plant has adequate capacity for the present dry weather flows, there are many areas that are significantly depreciated, inefficient and are beyond the useful life cycle. The recommended and planned improvements proposed as phases II and III of the overall facility rehabilitation will be discussed later in the report.

2.3.5 Implementation of Nine Minimum Controls

Various options were investigated to determine the options applicable to implementation of the Nine Minimum Controls in Terre Haute's combined sewer system. Each of these options is summarized in Table 2.2-5 below.

Table 2.2-5
Options for Implementation of Nine Minimum Controls

Control	Pros	Cons	Implemented by City
Netting Devices	Lower capital cost than other floatable control equipment, easy to operate and maintain, and detains high percentage of floatable material until net becomes full.	Cost of replacing and maintaining the nets, frequent maintenance/disposal costs, poor performance for high flows, maintenance difficult for CSO's in remote locations.	No
Manually Cleaned Bar Screens	Easy to install and less costly than other mechanical type screening equipment and easier to retrofit into existing structures	Frequency of cleaning required to prevent clogging and typical bar spacing greater than most mechanical systems allows smaller floatable materials to pass through.	Yes
Mechanically Cleaned Weir-Mounted Screens	Controls floatable material directly at the weir in the diversion structures with a higher percentage of capture.	Maintenance and cleaning can be difficult due to the design of the diversion structure containing the weir	No
Overflow Screen with Automatic Backwash	High capture of floatable material, and ease of maintenance as screen floatable material backwashed to interceptor	Cost of installation and operation and difficult to install or retrofit in existing overflows without construction of new overflow diversion structure	No
Baffles Mounted in Regulator	Low cost method of decreasing velocity of CSO flows to encourage capture of floatables in the existing interceptors	Additional headloss in the combined sewer can affect upstream flow levels and effectiveness of floatable control/capture is limited the amount of material captured and directed into the interceptor	Yes
Street Sweeping	Typically already a maintenance task completed by Cities and thus low cost of implementation. Captures most floatable material on streets which are swept	Cost of maintenance, only removes larger floatable materials and grit which accumulates on the streets, and frequency of sweeping and ability to sweep all areas in a CSO basin have a direct affect on effectiveness	Yes
Catch Basin Cleansing	No capital costs required and floatable material and other accumulated solids which affect combined sewer flows are removed prior to entry into the sewer system.	Cost of maintenance, and removal of material from catch basins can increase the flow of stormwater into the combined sewer system thus increasing the potential for CSO's and consequently floatable material.	Yes

Control	Pros	Cons	Implemented by City
Public Education	Low cost option which encourages the public to prevent CSO's and introduction of floatable materials at the source	Not often effective or measurable in regards to CSO and floatable material control	Yes
Maximization of flow through the plant	Typically low capital cost to utilize existing systems to convey maximum amount of flow to WWTF which in turn should limit the amount of floatables entering receiving waters by reduction of CSO's in the system.	Can affect WWTF operations by exceeding process capacities which can affect discharge quality and allow floatables to be discharged at the WWTF. Also, may require costly plant expansion to be effective in treating additional CSO flows.	Yes
Public Notification Program	Low cost action which encourages the public to be proactive in measures which will limit floatable materials from entering the CSO system	Effectiveness is dependent upon the public's willingness to take measures suggested in the program to limit floatable materials from entering CSO system	Yes

The City is currently implementing all of the Nine Minimum Controls except for Floatable controls which are addressed in the LTCP.

2.4 Receiving Stream Water Quality

In 1999, the City of Terre Haute submitted its Stream Reach Characterization and Evaluation Report (SRCER) to characterize conditions within the CSO receiving stream, the Wabash River. The City conducted a river sampling program to measure *E. coli*, Total Suspended Solids (TSS), Biological Oxygen Demand (BOD), and various metals in summer 1999. Although many of the bacteria data had results of "not in range" or "too numerous to count", qualitatively, the data were sufficient to identify *E. coli* as the only pollutant of concern in the river in the 1999 SRCER. This section summarizes the SRCER's conclusions and updates the information presented in the SRCER by extending the data analyses to 2009.

2.4.1 Receiving Stream Water Quality Data Sources

2.4.1.1 Historical Water Quality Data

Several Agencies have monitored water quality in the Wabash River, most notably the Indiana Department of Environmental Management (IDEM), but also U.S. EPA, ORSANCO and USGS. Monitoring the Wabash River near the City of Terre Haute is difficult because there are no safe bridges to sample from and sampling by boat is both expensive and time-consuming. Many of the agencies have focused their water quality surveying on sections of the Wabash River outside of the Terre Haute area.

IDEM monitored water quality, including *E. coli*, for several years in the 1990s and again in 2009 in the Terre Haute area. They also collected many more samples in the 1990s and 2000s at a location approximately 25 miles downstream of the City. The data from this location were compiled but were not used in any analyses because this location's distance from the City likely does not capture impacts on the river in the City.

The City, as noted above, has also conducted sampling in the Wabash River to supplement the paucity of data collected by other agencies in the local area. As part of the original CSO LTCP development, the City conducted another river sampling program from September 2001 through November 2001 to measure *E. coli* and dissolved oxygen (D.O.) primarily to inform the calibration of the river model used for the 2002 LTCP. Unlike the 1999 Sampling Program, nearly all of the *E. coli* data were quantified within the counting range of the analysis. Once the City embarked on the update to the LTCP in 2007, a more extensive Wet Weather Sampling Program was designed and conducted in Fall 2007, as described in the next section.

2.4.1.2 City of Terre Haute Wet Weather Sampling Program

The updated Wet Weather Sampling Program was conducted by LimnoTech in Fall 2007 for the City of Terre Haute and consisted of collecting water samples from the Wabash River, selected combined sewer overflows, and tributaries that receive storm water for *E. coli* analysis (Figure 2.4-1). This is the most detailed water quality sampling conducted in this portion of the Wabash River. Six rounds of river sampling and two rounds of source sampling were conducted over a 72-hour period during three discrete storm events with varying characteristics (City of Terre Haute Sampling Plan, July 2007). The results from the wet weather sampling were used to characterize impacts of the City's CSOs on river quality by monitoring the amount of *E. coli* found in the river over the course of the storm event.

LimnoTech mobilized on four separate occasions between August and October, 2007, and gathered data for three wet-weather events and one dry period. Temporal, spatial and statistical analyses were used to assess the river data by event, location and hour of sampling. Major findings from the river sampling program include:

- The City's CSOs impact water quality in the Wabash River but impacts tend to last less than a day;
- Local precipitation conditions do not significantly alter in-stream pollutant loads originating upstream of the City;
- Upstream sources do not impact the City until one or two days after the local storm event; and,
- The magnitude of the impact from the City's CSOs on the river water quality is positively correlated with the magnitude of the rainfall.

The goal of the source sampling program was to identify representative concentrations for estimating *E. coli* loadings from the City's CSOs and storm water. Major findings from the source sampling program include:

- No first flush effect was evident in the source sampling data;
- The data from CSO-009 was significantly different from the data from the other CSOs;
- An event mean (representative) concentration of 210,000 cfu/100 ml was determined from the data for CSO-009 while an event mean concentration of 675,000 cfu/100 ml was determined from the data for the remaining CSOs (CSO-007, CSO-006, and CSO-004);
- An event mean concentration of 5,000 cfu/100 ml was determined from the storm water data; and,
- The data from the CSO and storm water sites are consistent with values in the literature and at other Indiana CSO communities.

More detail on the storm event characteristics and associated data are described in Appendix 2-1.

2.4.2 Effects of CSOs on Water Quality

The analyses presented in this section include analysis of water quality parameters relevant to the designated uses of the Wabash River: recreation use and supporting aquatic life. Specifically, *E. coli* data were used to assess impacts to recreation use. Aquatic life use was assessed by evaluating available dissolved oxygen, metals and total suspended solids data.

Chemical data, which are snapshots of in-stream conditions in space and time, can be segregated into "wet" and "dry" categories so that distinctions in water quality attributed to wet weather sources, such as CSOs, can be identified, if such distinctions exist. For this analysis, data were characterized as "wet" if the monitoring was conducted on or the day after a local rainfall event of at least 0.10 inches. Otherwise the data were characterized as "dry". It should be noted that these characterizations were based on local conditions only. Given the large size of the upstream watershed (Figure 2.2-1), it is possible that upstream wet weather source loads may reach the Terre Haute area during local dry weather conditions. Nevertheless, the local condition is used as the basis for segregating the data because the purpose of this analysis is to discern water quality impacts, if any, from the City's CSOs, which are dependent on local rainfall.

2.4.2.1 E. coli

The State of Indiana has designated all surface waters to support full-body contact recreation at all times, during both dry and wet weather. As noted in Chapter 1, Indiana's recreation standards require that no sample in a 30-day period can exceed an *E. coli* bacteria criterion of 235 Coliform forming units (cfu) per 100 ml sample from April through October. If at least five samples are taken over a period of 30 days, a geometric mean of the samples cannot exceed a value of 125 *E. coli* colonies per 100 ml. *E. coli* is an organism found in the intestines of many warm-blooded animals and is used as an indicator of untreated human sewage.

This section analyzes bacteriological conditions in the Wabash River during both dry and wet weather, based upon data collected by IDEM and the City between 1991 and 2009 (including 2007 Wet Weather Sampling Program). The data indicate that the Wabash River occasionally exceeds the State's water quality standards and these exceedances occur more frequently during wet weather, suggesting that CSOs and other wet weather sources are contributing *E. coli* loads to the river.

Figure 2.4-2 presents a box-and-whisker analysis of *E. coli* levels during wet and dry conditions in the Wabash River. Data were aggregated into categories corresponding to the location relative to the City. Samples collected between river miles 220 and 216.85, which are upstream of the City's CSO area, were grouped together into the "Upstream" category. Samples collected between river miles 216.75 and 211.85 correspond to the portion of the river adjacent to the downtown CSO area and are categorized as "City". Samples collected below river mile 211.85 and river mile 207 were categorized as "Downstream". In this figure, the "box" corresponds to the 25th and 75th percentile concentrations. The line in the middle of the figure corresponds to the median concentration. The "whiskers" correspond to the 5th and 95th concentrations measured since 1990. Indiana's single sample maximum water quality standard criterion (235 cfu/100 ml) is also shown as a red line on the figure.

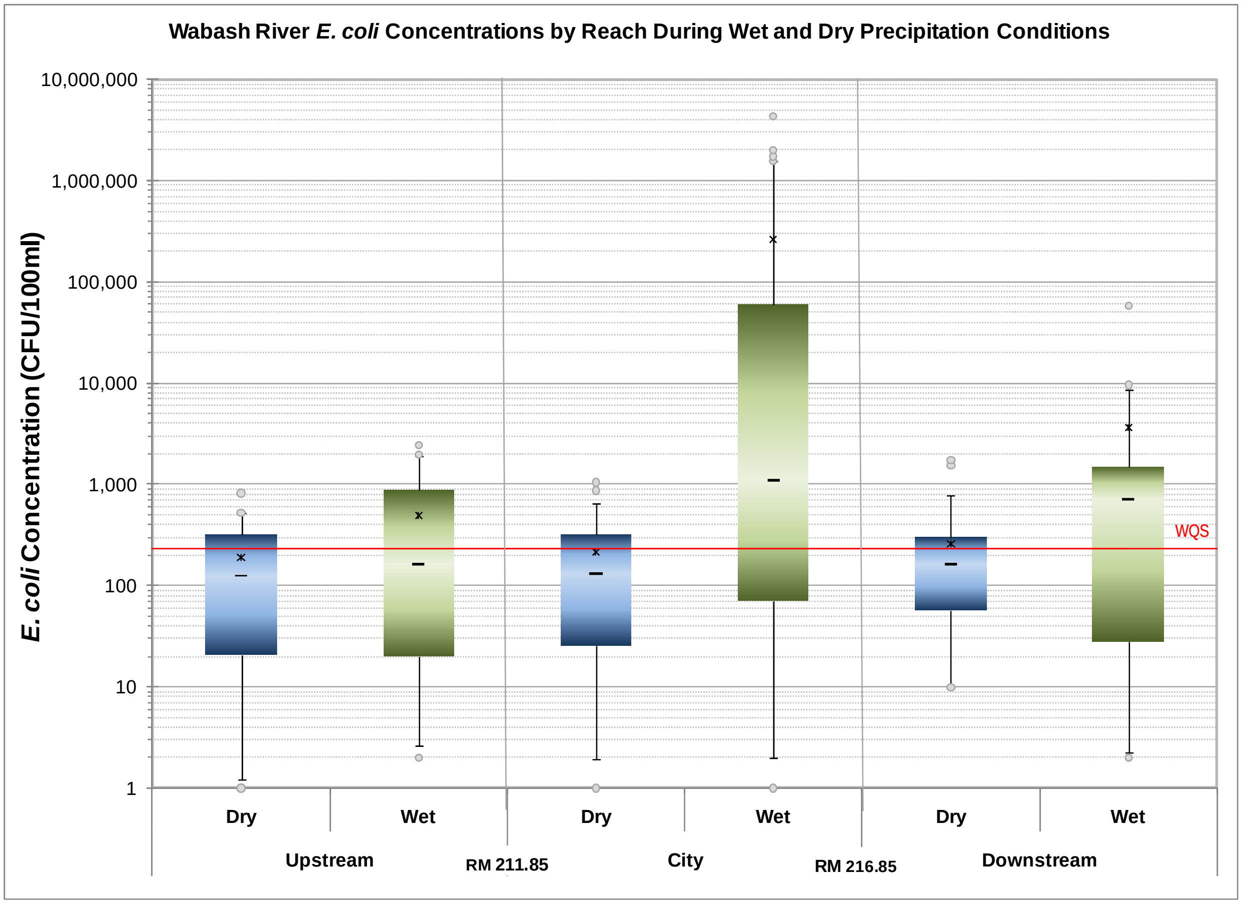


Figure 2.4-2. Box-and-whisker plot of wet and dry E. coli data in the Wabash River.

A comparison of the "boxes" (concentrations between the 25th and 75th percentiles) in these figures illustrate that wet weather concentrations tend to be higher than dry weather concentrations at all locations. This suggests that wet weather sources of bacteria are important. Further, the wet weather concentrations in the City tend to be higher than upstream wet weather concentrations. This suggests that local CSOs are important factors in local water quality. However, as the top of the "boxes" and the upper "whiskers" indicate, concentrations during both dry and wet weather exceed the single sample maximum water quality standard. This suggests that dry weather and/or upstream sources can be significant in the watershed. To date, dry weather sources have not been identified, although commonly discussed sources include failing septic systems, wildlife, agriculture (livestock with stream access), and storm sewer cross connections. Based on the watershed characteristics (land cover, census data), all of these sources are likely to be potential sources contributing to the occasional high dry weather observations.

The Wabash River meets *E. coli* water quality standards (single sample maximum) approximately 60% of the time as it enters the Terre Haute area. Compliance is approximately 55% of the time within the City and 45% downstream of the City. Compliance tends to be worse during wet weather than dry weather in and downstream of the City. Table 2.4-1 presents a tabular comparison of water quality standard compliance during wet and dry periods (single sample maximum criterion of 235 cfu/100 ml). Because there were no 30-day periods with at least five samples, compliance with the State's 30-day geometric mean criterion (125 cfu/100 ml) could not be analyzed. The trend in compliance also indicates that wet weather sources in the City, such as CSOs, are factors affecting compliance with the State's *E. coli* water quality standards.

Table 2.4-1
Frequency of E. coli Single Sample Maximum Water Quality Standard Compliance During Wet and Dry Periods

Reach	River Mile Extent	Number of Observations		Percent of Observations < 235 cfu/100 ml	
		Dry	Wet	Dry	Wet
Upstream	220.00 - 216.85	18	23	61%	61%
City	216.85 - 211.85	40	83	68%	35%
Downstream	211.85 - 207.00	38	25	63%	32%

2.4.2.2 Dissolved Oxygen

Dissolved oxygen (DO) concentration provides a reasonable indicator of impacts to aquatic life due to oxygen-depleting pollutants. Monitoring data for DO are available for the Wabash River from the early 1990s through 2009. The State of Indiana has developed numeric criteria for dissolved oxygen in their water quality standards to protect aquatic life (IWPCB, 2010). These criteria are a daily average concentration of 5.0 mg/L (to protect chronic exposure to oxygen-demanding pollutants) and a minimum concentration of 4.0 mg/L (to protect acute exposure).

Figure 2.4-3 presents a box-and-whisker analysis of dissolved oxygen levels during wet and dry conditions in the Wabash River. Data were aggregated into categories corresponding to the location relative to the City. Samples collected between river miles 220 and 216.85, which is upstream of the City's CSO area, were grouped together into the "Upstream" category. Samples collected between river miles 216.75 and 211.85 correspond to the portion of the river adjacent to the downtown area and are categorized as "City". Samples collected below river mile 211.85 and river mile 207 were categorized as "Downstream". In this figure, the "box" corresponds to the 25th and 75th percentile concentrations. The line in the middle of the figure corresponds to the median concentration. The "whiskers" correspond to the 5th and 95th concentrations measured since 1990. Indiana's acute water quality standard criterion (4 mg/L) is also shown as a red line on the figure.

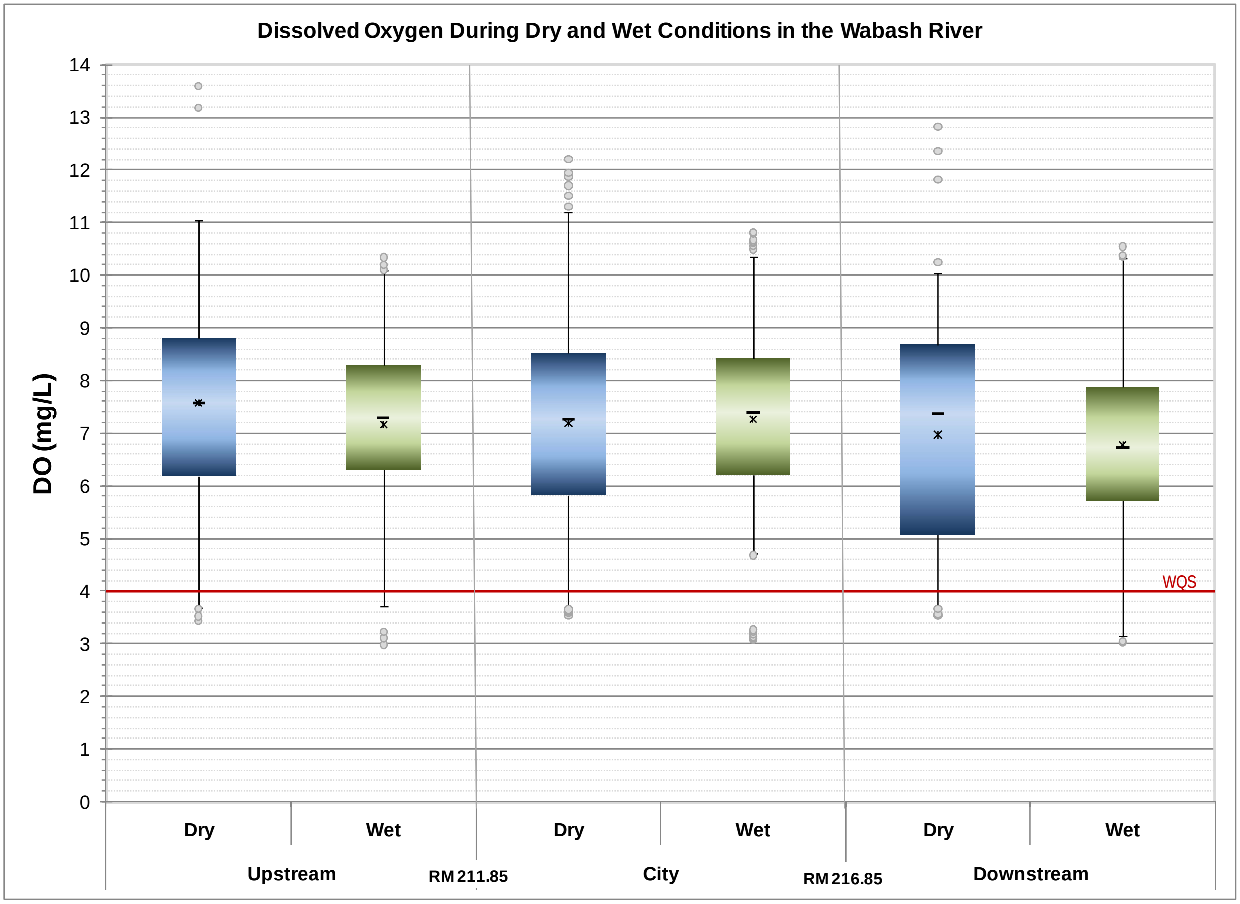


Figure 2.4-3. Box-and-whisker plot of wet and dry dissolved oxygen data in the Wabash River.

A comparison of the "boxes" (concentrations between the 25th and 75th percentiles) in these figures illustrate that dry and wet weather concentrations are not similar in all reaches. This suggests that wet weather sources of oxygen-depleting materials are not significant. Further, the wet weather concentrations in and downstream of the City are similar to upstream wet weather concentrations, suggesting that local CSOs are not important factors affecting dissolved oxygen. However, as the bottom of the "boxes" and the lower "whiskers" indicate, concentrations during both dry and wet weather exceed the acute minimum water quality standard criterion (4 mg/L). This suggests that other sources are significant but these have not been identified.

The Wabash River meets dissolved oxygen water quality standards (acute criterion of 4 mg/L) approximately 90% of the time as it enters the Terre Haute area. Compliance is also approximately 90% of the time within the City and 85% downstream of the City. Compliance tends to be worse during dry weather than wet weather in all reaches. Table 2.4-2 presents a tabular comparison of water quality standard compliance during wet and dry periods (both acute and chronic criteria).

Table 2.4-2
Frequency of Dissolved Oxygen Water Quality Standard Compliance During Wet and Dry Periods

Reach	River Mile Extent	Number of Observations		Compliance with Chronic Criterion (>5 mg/L)		Compliance with Acute Criterion (>4 mg/L)	
		Dry	Wet	Dry	Wet	Dry	Wet
Upstream	220.00 - 216.85	53	47	83%	91%	85%	94%
City	216.85 - 211.85	108	136	83%	90%	84%	96%
Downstream	211.85 - 207.00	76	59	76%	90%	79%	90%

2.4.2.3 Metals

Limited data are available for pollutants with potentially toxic effects on aquatic life, such as metals. Table 2.4-3 shows the results of metals data in the three reaches (Upstream, City and Downstream) of the local Wabash River area (insufficient data were available to evaluate the data on the basis of "wet" vs. "dry"). In general, heavy metals are not prevalent in the water column of the river, as shown by the high percent of non-detected results in this table. Copper and nickel are most frequently detected, although their frequency of detection is not significantly higher in the City compared to upstream locations, suggesting that the sources of these metals are distributed throughout the watershed. There were no exceedances of the acute or chronic criteria for any of the metals. Given the low levels of metals, it is unlikely that any are impairing water quality since the overwhelming majority are below detection limit. This conclusion is reinforced by the fact that the state has not listed this reach of the Wabash River as impaired by metals in their 305(b) reports (see Section 2.2.1.1).

Table 2.4-3
Summary of Heavy Metals Data by Reach Measured in the Wabash River Near the City of Terre Haute

	Number of Observations			Percent of Non-Detects		
Metal	Upstream	City	Downstream	Upstream	City	Downstream
Arsenic	6	3	6	100%	100%	100%
Cadmium	6	3	6	100%	100%	100%
Chromium	6	3	6	67%	67%	67%
Copper	6	3	6	33%	33%	50%
Nickel	6	3	6	0%	33%	0%
Lead	6	3	6	67%	67%	67%
Selenium	6	3	6	100%	100%	100%
Zinc	6	3	6	67%	67%	67%

2.4.2.4 Total Suspended Solids

Suspended solids in a water body can depress dissolved oxygen levels, block sunlight needed by aquatic plants and smother organisms that live in the stream bed. Sediment layers that build up in a water body can change its natural flow. After wet weather events, streams and rivers can carry significant quantities of suspended solid matter that have entered the waterway from both urban and rural runoff. Indiana does not have any numeric criteria for total suspended solids.

Figure 2.4-4 presents a box-and-whisker analysis of total suspended solids (TSS) levels during wet and dry conditions in the Wabash River. Data were aggregated into categories corresponding to the location relative to the City. Samples collected between river miles 220 and 216.85, which is upstream of the City's CSO area, were grouped together into the "Upstream" category. Samples collected between river miles 216.75 and 211.85 correspond to the portion of the river adjacent to the downtown area and are categorized as "City". Samples collected below river mile 211.85 and river mile 207 were categorized as "Downstream". In this figure, the "box" corresponds to the 25th and 75th percentile concentrations. The line in the middle of the figure corresponds to the median concentration. The "whiskers" correspond to the 5th and 95th concentrations measured since 1990.

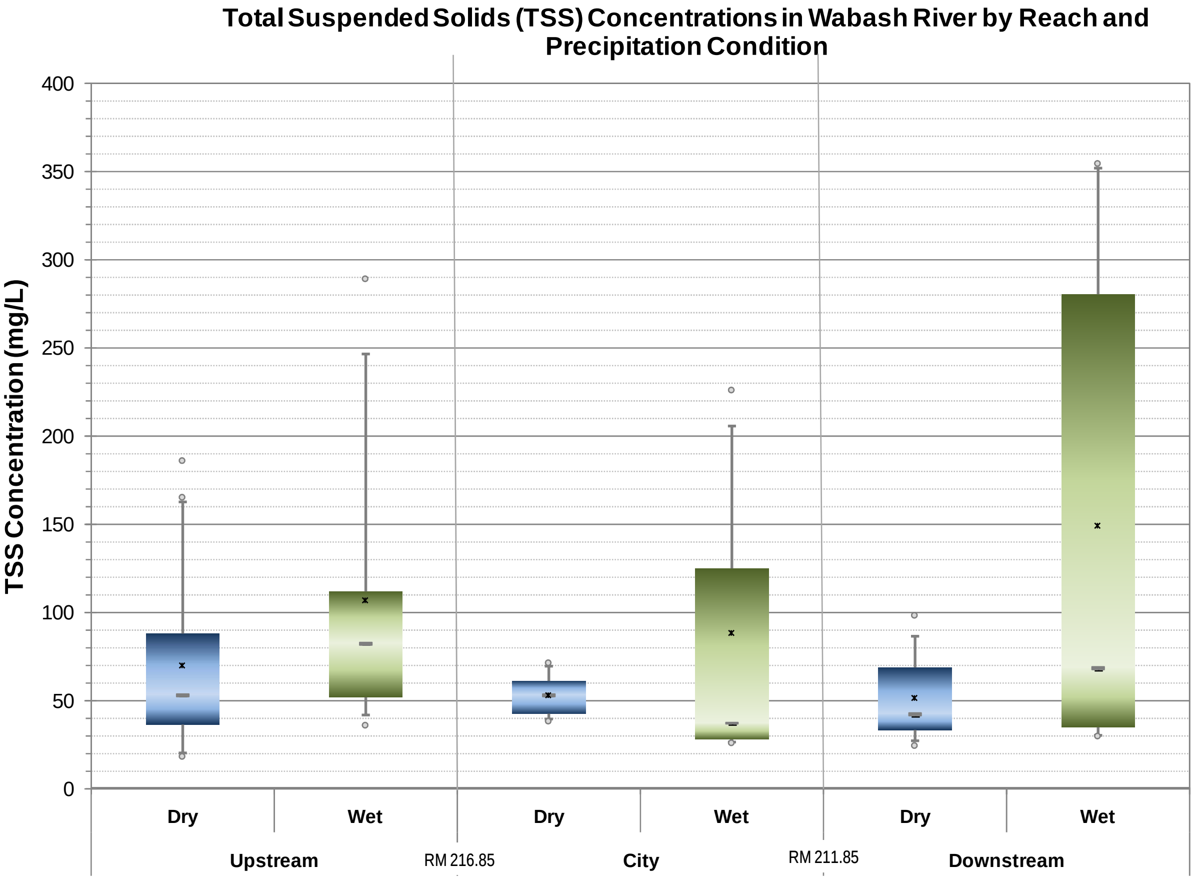


Figure 2.4-4. Box-and-whisker plot of wet and dry total suspended solids (TSS) data in the Wabash River.

Results of the box-and-whisker plot show that wet weather concentrations tend to be higher than dry weather concentrations, indicating that wet weather sources and resuspension of in-stream sediment are potentially important. The plot also shows that wet weather concentrations tend to increase as one moves downstream, though the reason for this is not clear. It is likely that other, non-CSO sources are contributing solids to the river during wet weather. However, the TSS data are somewhat limited (e.g. there were only 12 observations in the City reach) so the spatial differences may be due to the limited data rather than the result of pollutant loads.

2.4.2.5 Conclusions

Data collected by the City of Terre Haute and IDEM indicate that the Wabash River near Terre Haute is impacted by elevated bacteria concentrations. While the City's CSOs have been identified as a source of bacteria, analyses of the available data show that state water quality standards are exceeded in both dry and wet weather and that exceedances are observed in portions of the watershed that do not receive any CSO discharges. These results suggest that there are multiple sources loading bacteria to the rivers. CSO discharges in wet weather appear to have no impact on either the dissolved oxygen or total suspended solids parameters of the receiving streams. In addition, the streams do not appear to be under any conditions of stress due to biodegradable organics or heavy metals.

The data analyses presented in this section that include data collected since the first SRCER and LTCP were submitted provide additional confirmation that *E. coli* is the only pollutant of concern with respect to CSO discharges and that it is the appropriate water quality parameter to evaluate the benefits of CSO control.

2.5 Sensitive Areas

2.5.1 Consideration of Sensitive Areas

USEPA and Indiana CSO Control Strategies require that communities identify any "sensitive areas" along the CSO stream segments, or further downstream. Any area meeting one or more of the "sensitive" criteria must be given the highest priority for CSO discharge elimination, reduction or control. The USEPA CSO Policy lists the following criteria: :

- Habitat for threatened or endangered species,
- Primary Contact Recreational Areas such as swimming and water skiing areas,
- Drinking Water Source Waters, and
- Outstanding State Resource Waters or Outstanding Natural Resource Waters.

The City conducted a sensitive area analysis as one of their first steps in the development of the 2002 LTCP. This section presents the findings from that investigation.

Several agencies were contacted to determine if "sensitive areas" exist in the Terre Haute area. Responses were received from United States Department of the Interior Fish and Wildlife Service, and the Indiana Department of Natural Resources. The "Outstanding Rivers List for Indiana" as compiled by the Natural Resources Commission was also reviewed.

2.5.1.1 Habitat for Threatened or Endangered Species

Based on the letters received from the contacted agencies, the Wabash River has suitable habitat for the federally endangered Indiana bat, the ring pink mussel, the tubercled-blossom pearlymussel, the white-warty back pearlymussel and the bald eagle. After receipt of the agency letters, the city's consultant contacted the agency experts.

- Brant Fisher of IDNR confirmed on January 2, 2002 that the endangered mussels listed have not been found in Indiana for many years and are considered expatriated. Mussel surveys that have been completed for IDNR have confirmed this finding.
- Forest Clark with U.S. Fish & Wildlife discussed the endangered species on January 7, 2002. His past survey information indicated that there are no federally endangered mussels found alive in the Wabash River stream section. He also indicated that a bald eagle's nest has been observed in northwestern Vigo County (though not on the banks of the river itself).

2.5.1.2 Primary Contact Recreational Areas

The Wabash River can frequently have a velocity greater than 2.5 feet per second which is considered dangerous. The City and its Parks Department have posted "NO SWIMMING" signs at several locations. Boat access to the river is available at Fairbanks Park, which has a public boat ramp.

A stream survey was conducted by boat during the Fall of 2001 for visual confirmation that primary contact recreational activities were occurring in the Wabash River. No contact activities were noted. The stream banks are generally very steep and overgrown, which makes access difficult. It was noted that several areas had narrow footpaths to the riverbank, which appeared to allow access for fishing. Stair steps down to the river edge also exist in several locations. All of the steps are for wastewater staff to access and maintain the CSO's except for one across the river from CSO-007. These conditions have been witnessed by numerous individuals involved with the creation of the plan. In summary, no primary contact recreational activities were observed.

2.5.1.3 Drinking Water Source Waters

The Wabash River is not the source of any water supplies in the area. The City of Terre Haute is served by Indiana-American Water Company, which utilizes a well field north of the northern most CSO. The interceptor for the northern most CSO in Terre Haute is partially in the 5 year Time of Travel (TOT) boundary for the city wells. This is depicted on Figure 2.4-1. The city will study the interceptor for exfiltration in the future. The Town of West Terre Haute and Marion Heights Conservancy District own and operate well fields within one mile of the Wabash River.

2.5.1.4 Outstanding State Resource Waters

The Wabash River is not an Outstanding State Resource Water (327 IAC 2-1-2).

2.5.2 Sensitive Area Assessment

As a part of the planning process to create the 2002 LTCP, information regarding sensitive areas was presented to the Citizen Advisory Committee. Several items were noted during the discussions:

- The Wabash River is dangerous because of the rapid currents, channels in the river bottom and difficult access.
- There are only a few areas that are known to be frequented for fishing and camping (these are noted in Figure 2.4-1).
- Convenient access to the river's edge is only possible at Fairbanks Park because of the boat dock.

2.5.3 Identification of Areas to be Further considered

Although no sensitive areas were identified, the City and Citizens Advisory Committee considered whether some areas of the City should be prioritized with respect to CSO control. The consensus of the Citizen Advisory Committee and City staff was that Fairbanks Park, a prominent City park on the banks of the Wabash that has several CSO outfalls within its area, should be given priority for protection by reducing or eliminating the CSOs discharging to the river from the outfalls located in the park.

2.6 Historical Rainfall Analysis

This subsection discusses the analysis of the 50 years of rainfall data used to develop the typical design storms used for the collection system computer model.

2.6.1 Fifty-Year Data Analysis

Historical hourly precipitation records were obtained from the National Climatic Data Center. Rainfall data for Terre Haute was only available from 1948 to 1954. This seven-year period was compared to the same seven-year period of rainfall data from Indianapolis and was found to have similar rainfall patterns. Therefore, 51 years (1948 – 1998) of rainfall data from Indianapolis was used for Terre Haute's historical rainfall analysis.

The 51 years of hourly precipitation data was imported in XP-SWMM for preliminary analysis. During the analysis, the criterion of a dry period of six hours between storms was used. XP-SWMM's output file included rainfall statistics by year, which included duration, intensity, volume and the number of months of data per year. XP-SWMM's output file also included rainfall statistics by month and ranked return periods for duration, intensity and volume.

2.6.2 Design Storms

The rainfall data from the original XP-SWMM output file was sorted by depth of rain to determine rainfall ranges for the design storms as shown in Table 2.6-1. The 50% Huff Curve Ordinates table for Indianapolis (Burke, p. 2-5) was used to develop the hourly distribution of rainfall for each rainfall range. The rainfall hyetograph (bar graph of rainfall amount versus time) for each rainfall range is shown on Figure 2.6-1. The data for the rainfall hyetographs for each design storm, shown in Table 2.6.2, was used to define the duration, the average total rainfall, the maximum one-hour intensity, and the number of hours into the storm the peak occurred. These storm parameters are shown in Table 2.6-1. The typical storm hyetographs were used as input to the XP-SWMM model to estimate the overflow volume for each CSO structure for each design storm. In addition to using the Huff Curve analysis, a rainfall frequency curve was created from the 51 years of historical rainfall data. From this curve the percentage of occurrence for each storm was determined and is shown in Table 2.6-1. The approximate return periods for each storm were determined from *Rainfall Frequency Atlas of the Midwest* (1992) and are also shown in Table 2.6-1.

Table 2.6-1
Characteristics of Selected Storms

Range	Duration of Storm (Hour)	Average Total Rainfall for Storm (T.R.) (inch)	Maximum One-Hour Intensity (M.I.) (inch/hour)	Number of Hours Into Storm Peak Occurs	M.I./T.R.	T.R./ Duration (inch/hour)	Rainfall Range (inches)	Occurrence %	Approximate Return Period (2)
A	2	0.023	0.016		0.696	0.011	0.010 - 0.050	31.62%	---
B	7	0.242	0.121	3	0.500	0.033	0.051 - 0.150	19.48%	---
C	8	0.367	0.18	3	0.490	0.046	0.150 - 0.370	18.94%	---
D	9	0.486	0.22	3	0.453	0.051	0.371 - 0.650	13.94%	15 days
E	12	0.818	0.332	4	0.406	0.068	0.651 - 1.000	7.65%	30 days
F	15	1.212	0.451	9	0.372	0.083	1.001 - 1.500	4.68%	60 days
G	19	2.043	0.676	11	0.331	0.107	1.501 - 3.399	3.42%	1 year
H	23	3.888	1.146	14	0.295	0.168	3.400 - 5.290	0.25%	6 years
I (3)	21	5.32	1.24	12	0.233	0.253	5.300 & Larger	0.02%	80 years

Table 2.6-2
Rainfall Hyetograph Data

	Rain, inches							
Hours	Storm B	Storm C	Storm D	Storm E	Storm F	Storm G	Storm H	Storm I
1	0.020	0.020	0.023	0.020	0.020	0.026	0.066	0.230
2	0.040	0.050	0.064	0.061	0.040	0.026	0.066	0.000
3	0.121	0.180	0.220	0.081	0.020	0.076	0.066	0.000
4	0.030	0.060	0.064	0.332	0.020	0.026	0.066	0.000
5	0.020	0.030	0.064	0.100	0.040	0.026	0.066	0.000
6	0.010	0.020	0.013	0.081	0.040	0.076	0.066	0.010
7	0.001	0.005	0.033	0.041	0.080	0.026	0.066	0.080
8		0.002	0.003	0.041	0.120	0.076	0.066	0.190
9			0.004	0.020	0.451	0.076	0.066	0.150
10				0.020	0.140	0.176	0.166	0.090
11				0.001	0.100	0.676	0.216	0.050
12				0.020	0.060	0.226	0.266	0.090
13					0.040	0.176	0.266	0.760
14					0.020	0.126	1.146	1.240
15					0.020	0.076	0.316	0.620
16						0.076	0.266	0.620
17						0.026	0.216	0.100
18						0.026	0.116	0.240
19						0.026	0.116	0.400
20							0.066	0.370
21							0.016	0.080
22							0.066	
23							0.066	
24								
Total Rainfall	0.242	0.367	0.486	0.818	1.211	2.044	3.898	5.320
Max. Intensity	0.121	0.180	0.220	0.332	0.451	0.676	1.146	1.240

In addition, a Design Storm event resulting in 4 overflows per year was developed and accepted by IDEM for use in preliminary sizing of alternatives.

2.6.3 Typical Year Rainfall

The City of Terre Haute proposed to use a continuous modeling approach for the alternative evaluations using rainfall data from 1978 for sizing controls, then evaluating the performance of the alternatives using 1978 rainfall and stream flow conditions.

The documentation of the selection of the typical year period of 1978 is detailed in Appendix 2-2, "Typical" Period Analysis for the City of Terre Haute."

2.7 Summary

Current conditions in the City of Terre Haute and the Wabash River can be summarized in the following bullets:

1. The City has *10* CSOs discharging to the Wabash River. No CSOs discharge to local tributaries.
2. Although the City's collection system and WWTP reflect the age of this historic river community, the City has been investing in upgrades to their system, including implementation of NMCs to limit CSO overflows.
3. The Wabash River is a very large watershed. Over 12,000 sq mi. have drained to the Wabash River by the time it passes through the City of Terre Haute. Upstream sources can affect water quality in the vicinity of the City
4. The City has invested significant resources in understanding the effects of their CSOs on in-stream water quality and has determined (in combination with IDEM data) that *E. coli* is the only pollutant of concern from the City's CSOs. CSOs do not impact DO, TSS, or metals.
5. The Citizens Advisory Committee has identified Fairbanks Park, which has four CSOs located in it, as an area for reducing or eliminating CSO discharges.
6. The year 1978 has a typical year of rainfall and was used to evaluate benefits of control alternatives (presented in Section 6). Design storms were developed from rainfall data in Indianapolis and were used to size the CSO controls evaluated in the control alternatives.

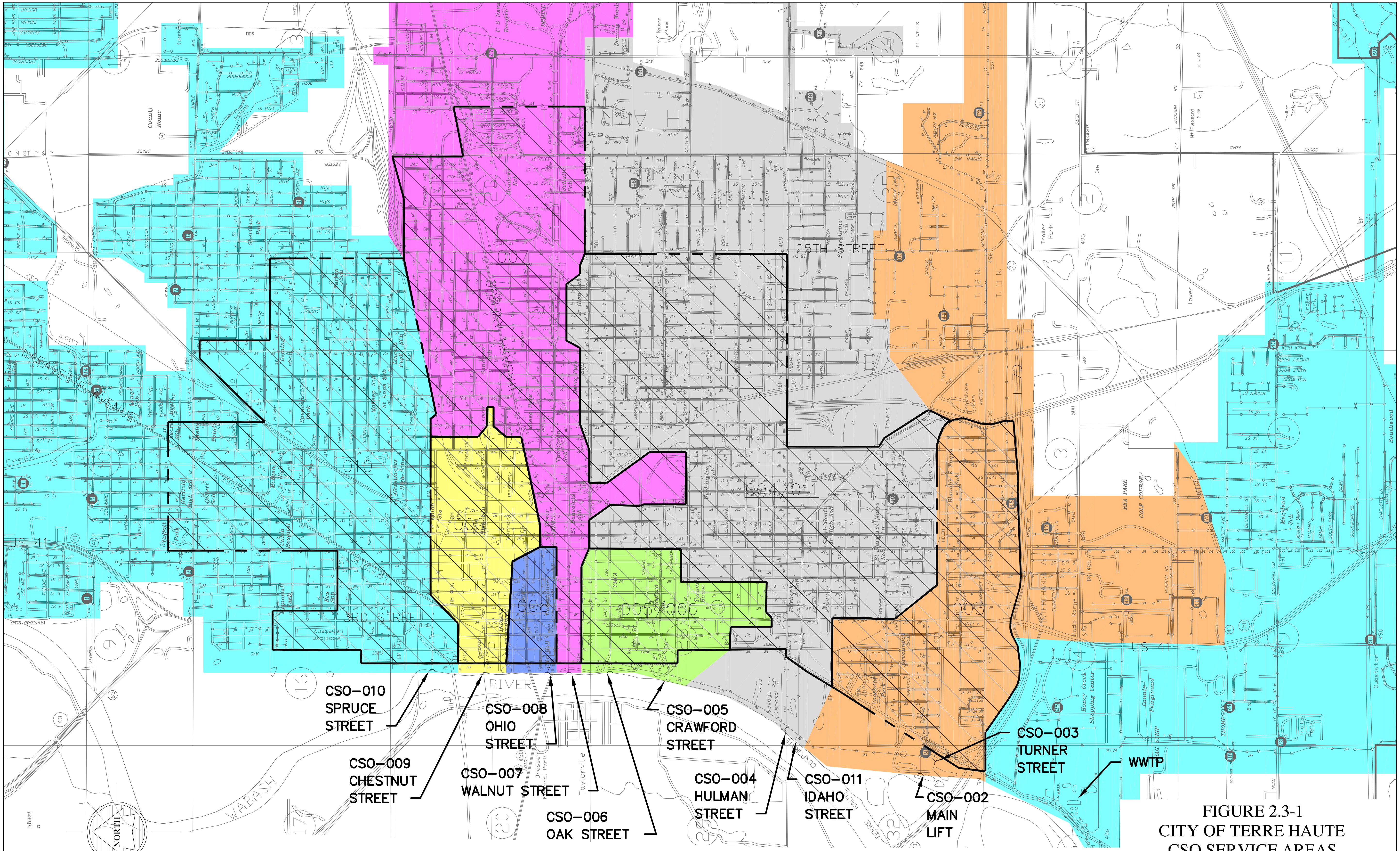


FIGURE 2.3-1
CITY OF TERRE HAUTE
CSO SERVICE AREAS

HANNUM, WAGLE & CLINE
engineering

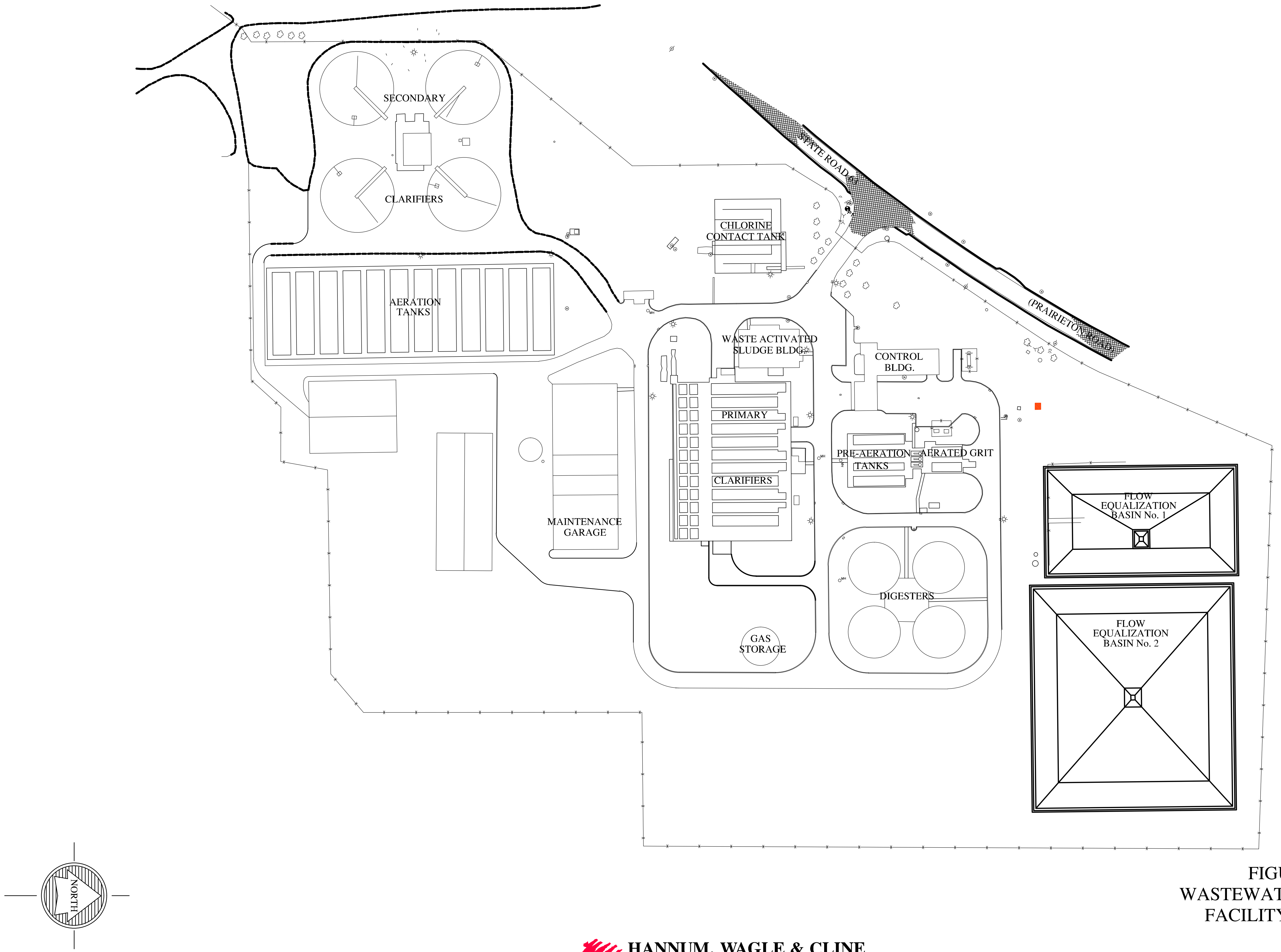
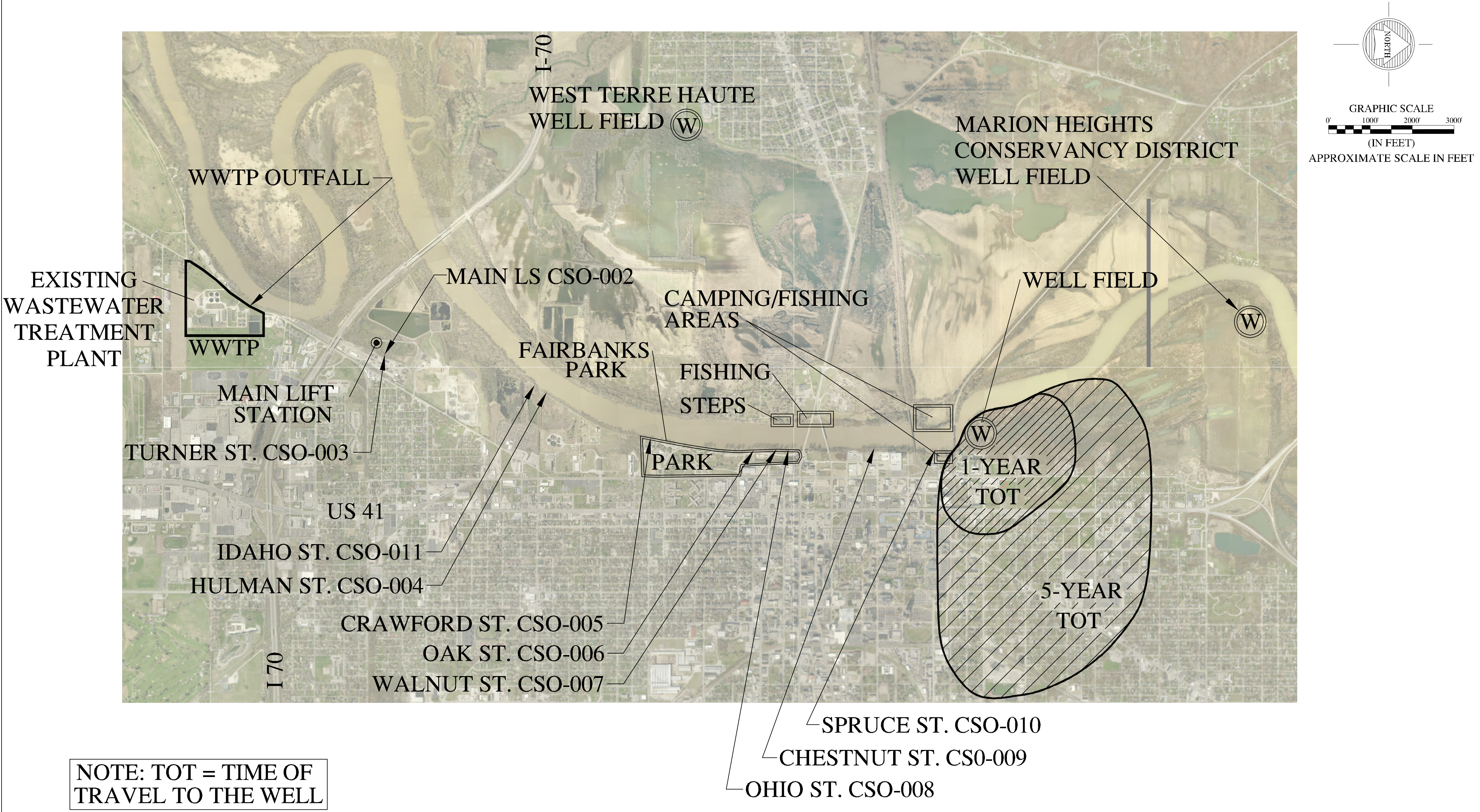


FIGURE 2.3-3
WASTEWATER TREATMENT
FACILITY SCHEMATIC

HANNUM, WAGLE & CLINE
engineering

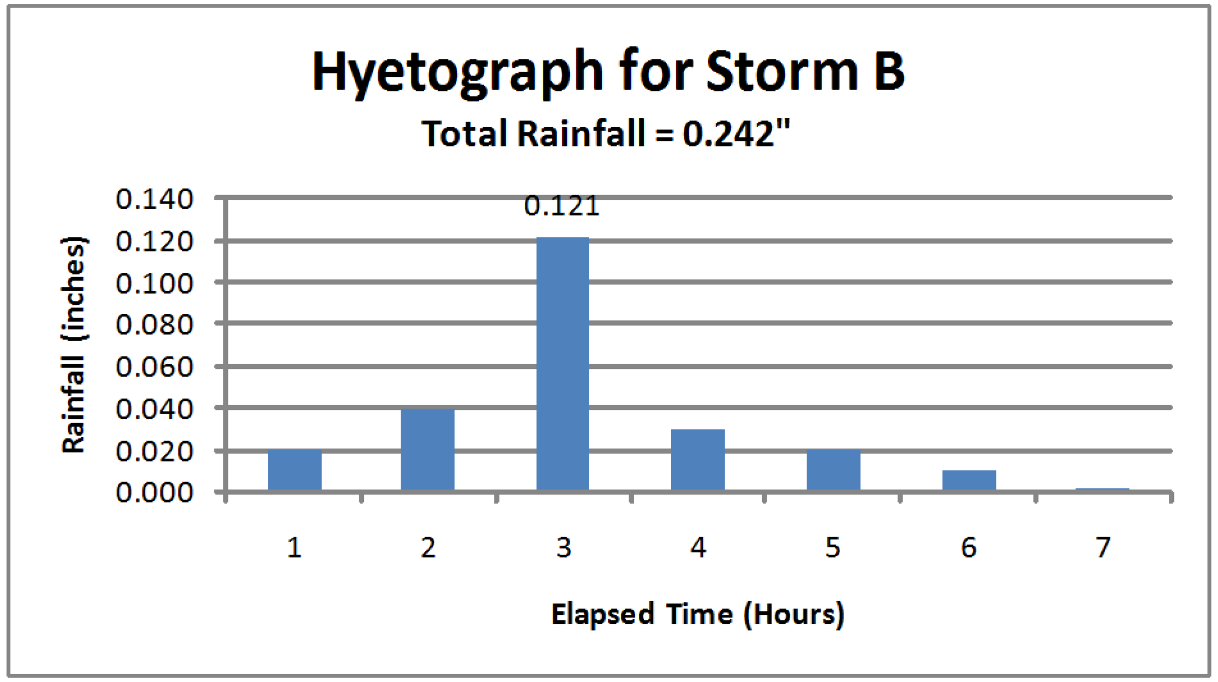


NOTE: TOT = TIME OF
TRAVEL TO THE WELL

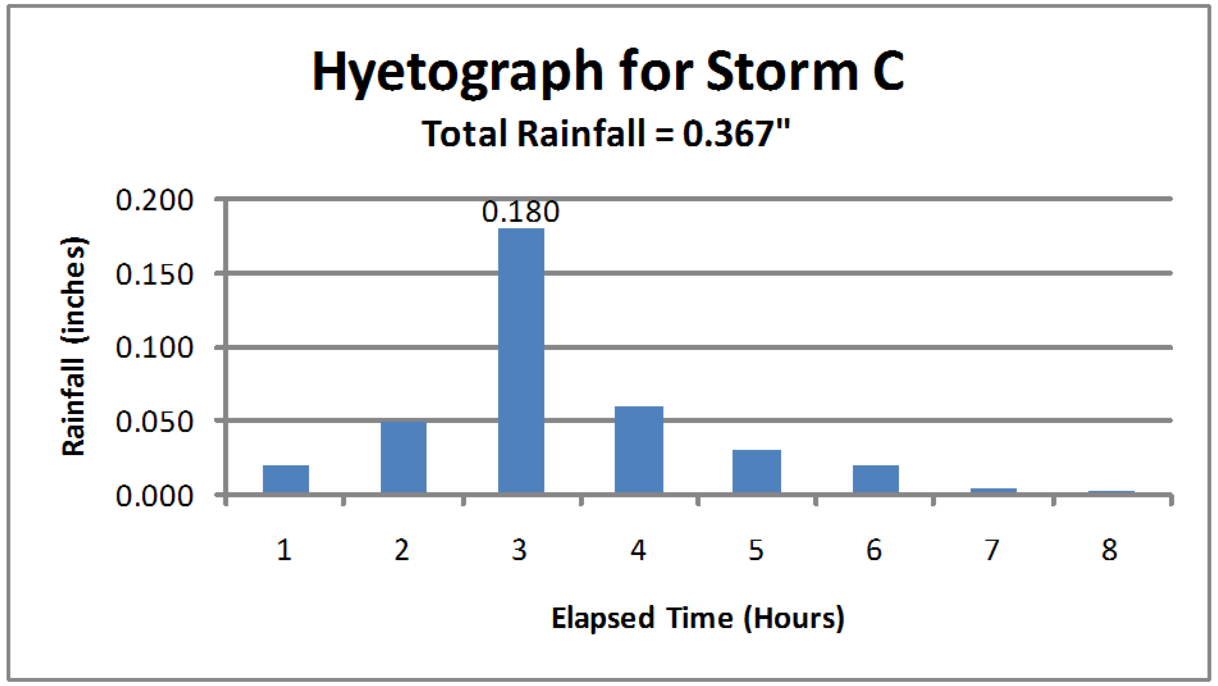
HANNUM, WAGLE & CLINE
engineering

SPECIAL CONCERN AREAS

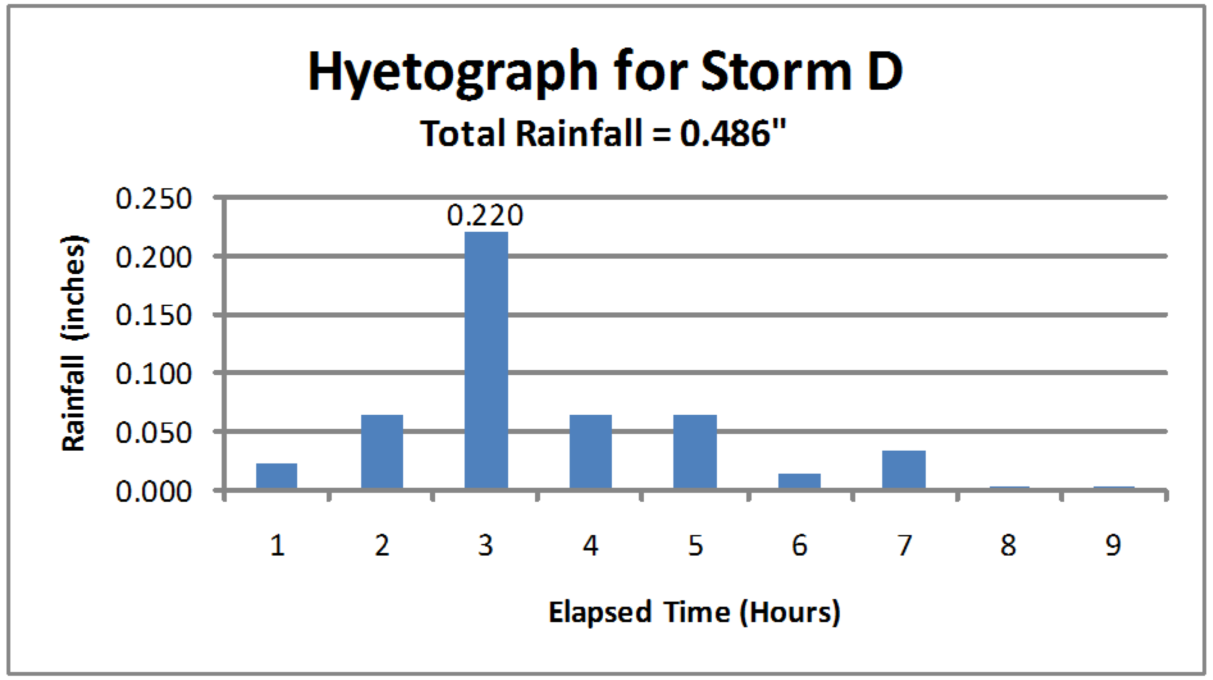
CITY OF TERRE HAUTE
COMBINED SEWER OVERFLOW
LONG TERM CONTROL PLAN
FIGURE 2.4–1


Hyetograph for Storm B

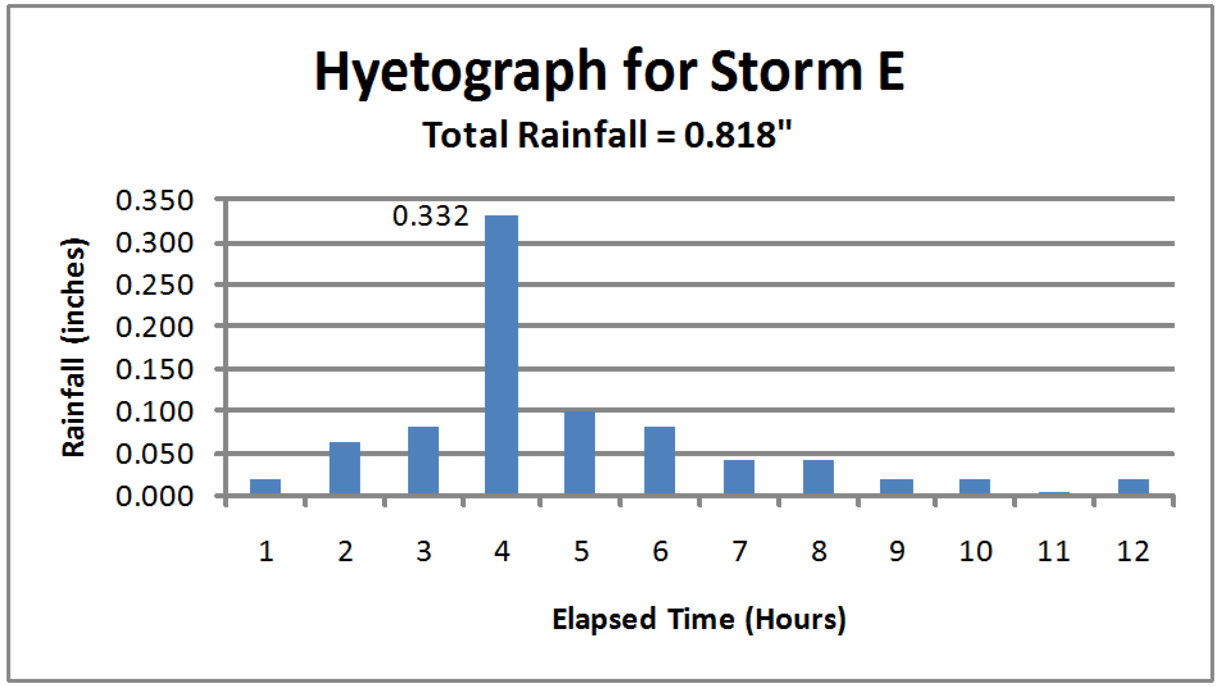
Total Rainfall = 0.242"


Hyetograph for Storm C

Total Rainfall = 0.367"

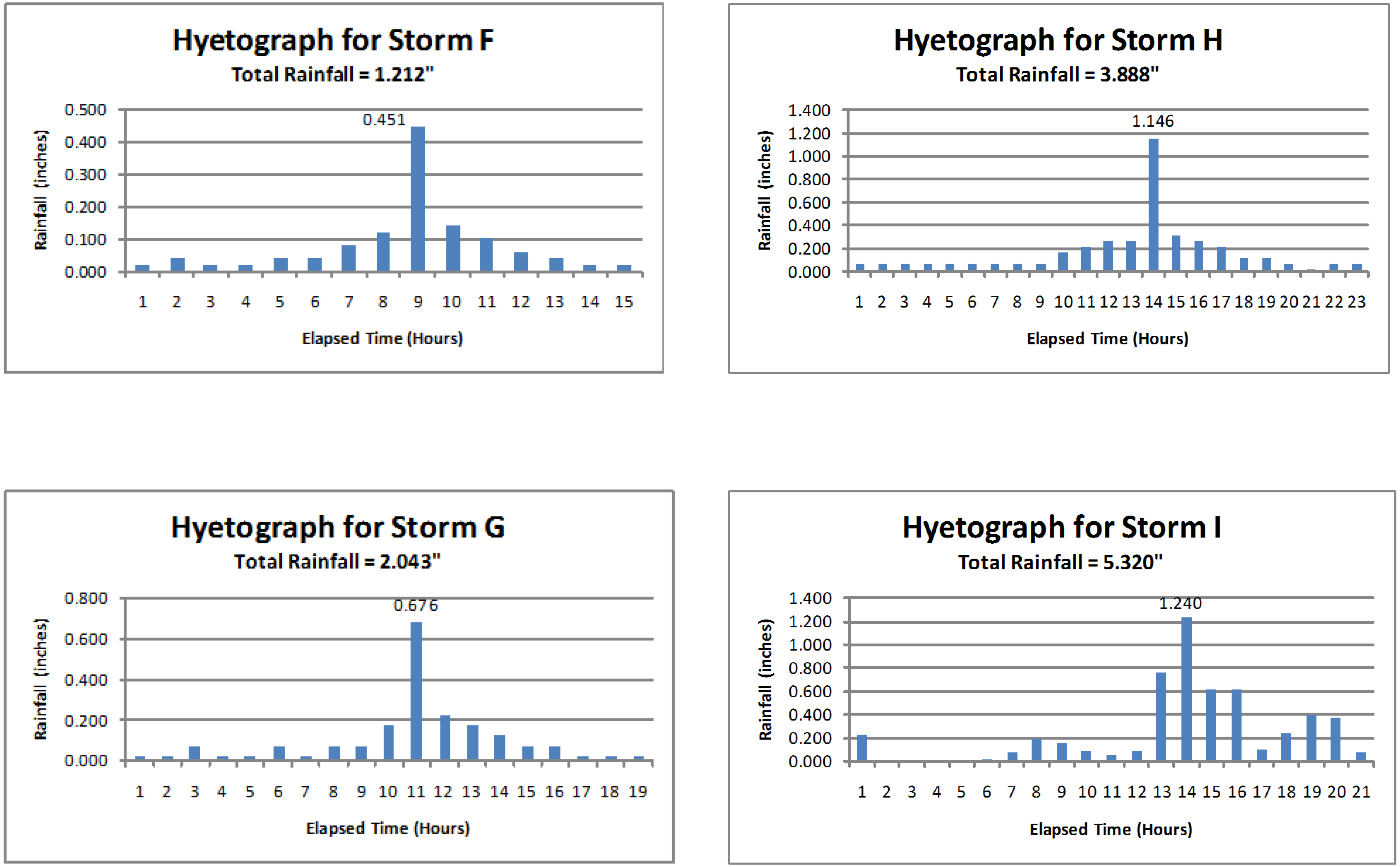

Hyetograph for Storm D

Total Rainfall = 0.486"


Hyetograph for Storm E

Total Rainfall = 0.818"

FIGURE 2.6-1A
CITY OF TERRE HAUTE
COMBINED SEWER OVERFLOW
LONG TERM CONTROL PLAN



Hyetograph for Storm F

Total Rainfall = 1.212"

Hyetograph for Storm H

Total Rainfall = 3.888"

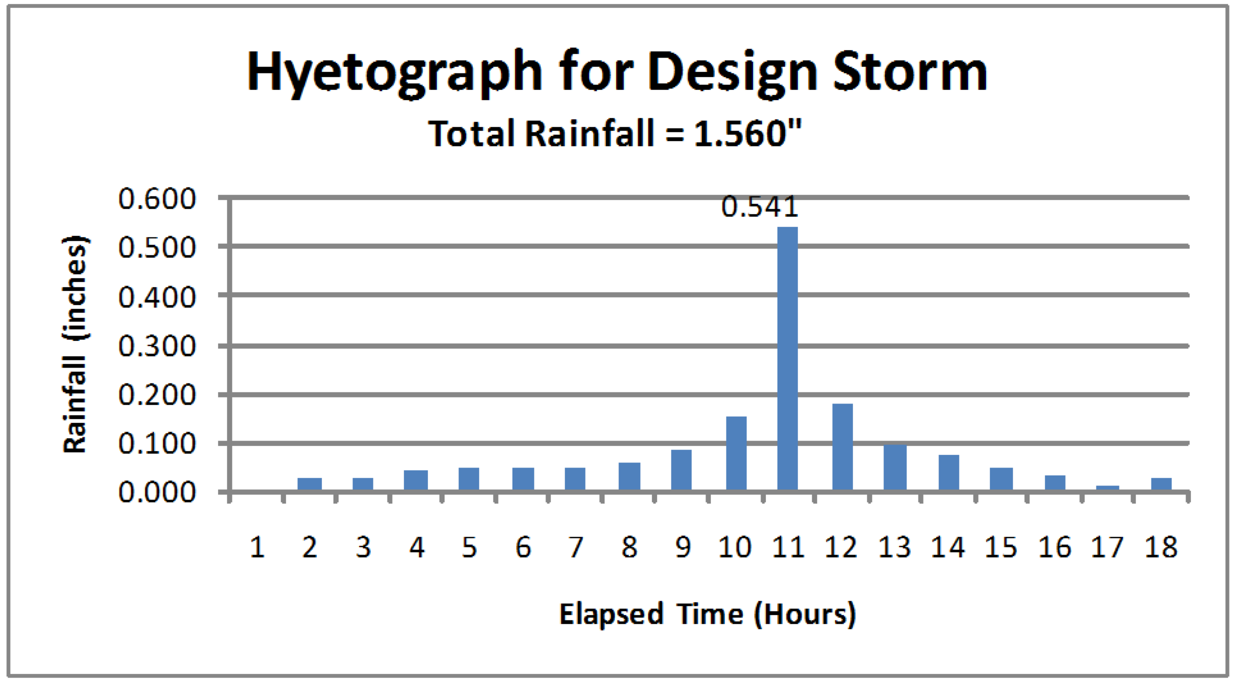
Hyetograph for Storm G

Total Rainfall = 2.043"

Hyetograph for Storm I

Total Rainfall = 5.320"

FIGURE 2.6-1B
CITY OF TERRE HAUTE
COMBINED SEWER OVERFLOW
LONG TERM CONTROL PLAN


Hyetograph for Design Storm

Total Rainfall = 1.560"

FIGURE 2.6-1C
CITY OF TERRE HAUTE
COMBINED SEWER OVERFLOW
LONG TERM CONTROL PLAN

HANNUM, WAGLE & CLINE
engineering