

CITY OF LANCASTER
WATER POLLUTION CONTROL DEPARTMENT

MICHAEL NIXON • *Superintendent*
PAUL MENZ • *Assistant Superintendent*

800 LAWRENCE STREET

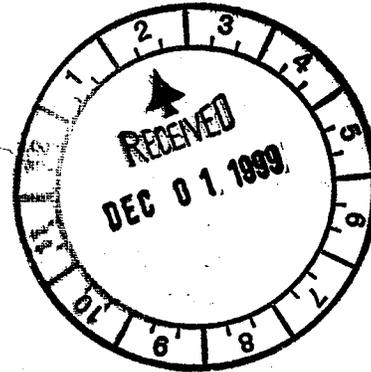
(740) 687-6664

FAX (740) 687-6667

LANCASTER, OHIO 43130-9401

December 1, 1999

Mr. Jan Rice
Division of Surface Water
Central District Office
Ohio EPA
3232 Alum Creek Drive
Columbus, OH 43207



RE: City of Lancaster
NPDES Permit 4PD00001*HD
Combined Sewer System Characterization Report

Dear Mr. Rice:

We are pleased to submit two copies of the City of Lancaster Combined Sewer System Characterization. This report was developed to satisfy the requirements of Part I, C – Schedule of Compliance, Paragraph 5.B. of the City's NPDES Permit.

We believe you will find the report satisfactory. Should you have any questions regarding the report, please feel free to contact me at (740) 687-6664 or Mr. Tom Bulcher of Malcolm Pirnie, Inc. at (614) 888-4953.

Sincerely,

Handwritten signature of Michael B. Nixon in cursive.

Michael B. Nixon
Superintendent

jln

Enclosures

C: Mr. L. Kent Huston, City Engineer
Mr. Tom Bulcher, Malcolm Pirnie, Inc.

"Insuring Your Right to Clean Water . . . Now and in the Future"



**CITY OF
LANCASTER, OHIO**

**WATER POLLUTION CONTROL
DEPARTMENT**

**COMBINED SEWER SYSTEM
CHARACTERIZATION REPORT**

NOVEMBER 1999

**MALCOLM
PIRNIE**



INDEPENDENT ENVIRONMENTAL ENGINEERS, SCIENTISTS & CONSULTANTS

Lancaster, Ohio
Water Pollution Control Department
Combined Sewer System Characterization Report

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1.0 EXECUTIVE SUMMARY

1.1 PURPOSE

As part of the Schedule of Compliance in the City of Lancaster's 1997 National Pollution Discharge Elimination System (NPDES) permit, a *Combined Sewer System Characterization Report* must be completed and submitted to the Ohio EPA by December 1, 1999. This report will characterize the Lancaster wastewater collection system and the combined sewer overflows (CSOs) to the Hocking River and its tributaries. A copy of the City's NPDES permit is included in Appendix I for reference.

1.2 SCOPE

The scope of this report is to characterize the City of Lancaster's wastewater collection system and combined sewer overflows. System characterization is required by the NPDES Permit Schedule of Compliance for the Lancaster Water Pollution Control Facility (WPCF). The objectives of the characterization report are as follows:

- Develop an understanding of the collection system and how it responds to a variety of rain events.
- Identify separate sewered areas tributary to combined sewer overflows and determine their impacts on CSOs.
- Identify sources of toxic and hazardous pollutants within the combined sewer system and estimate loads entering the system.
- Quantify and characterize the combined sewer overflow (CSO) discharged to the Hocking River and its tributaries during rain events.
- Support development of the Long Term Control Plan.

This process is based on the Ohio EPA's March 1995 Combined Sewer Overflow Strategy.

1.3 DATA COLLECTION

In order to characterize and understand the wastewater collection system and the combined sewer overflows (CSOs), various data collection activities were completed. Data was collected from multiple sources that are summarized below. A complete discussion of these activities is provided in Chapter 3.

1.3.1 Sewer Map and Atlas

An electronic version of the City Sewer Map and Atlas was developed. This provided a current, updatable, and readily available map for City personnel to use for operation and maintenance of the entire collection system. To develop the Sewer Map and Atlas, sewer system information such as sewer diameters, slopes, elevations, and collection areas were researched from drawings in the City Engineer's office. Locations of sewers, connections and questionable or incomplete records were field verified where possible.

A copy of the City Sewer Map, Figure 1-1, is provided at the end of the report for reference. Figure 1-1 shows collection system drainage areas, interceptor sewers, sanitary sewers, storm sewers, combined sewers, siphons, pump stations, combined sewer overflow structures and the Hocking River and its tributaries.

1.3.2 Monitoring Plan

A requirement of Lancaster's NPDES permit, which has previously been fulfilled, is the development of a monitoring plan. The purpose of the monitoring plan is to provide sufficient data to support the various CSO activities required by the NPDES permit Schedule of Compliance, including this characterization report. The *Wastewater Collection System Monitoring Plan* was prepared and submitted to the Ohio EPA as part of the *Combined Sewer System Operational Plan* dated March 1998. A copy of the monitoring plan is included in Appendix B for reference.

The monitoring plan outlined the following data collection activities:

- Measurement of baseline flow, wet weather flow, and combined sewer overflows.
- Collection and analysis of samples from selected CSO locations.
- Measurement of rainfall in the study area.

A schematic of the collection system showing CSO monitoring points is shown on Figure 3-3.

1.3.3 CSO Activation

All CSOs within the City were monitored to determine the frequency of activation. To measure CSO activity, a wooden block was strategically located in each CSO structure, tethered with a string for retrieval. After rain events, each CSO was monitored by observing and recording the position of the wooden block. If the block moved, the CSO had activated. This data documented the size and type of rain event that causes overflows and in general how the combined sewer system responds to rainfall. This data is summarized in Chapter 3.

1.3.4 Basement Flooding Questionnaire

A questionnaire was distributed to City residents to identify areas where basement flooding occurs, how often basement flooding occurs, and probable causes of the basement flooding. The surveys were distributed to residents with their monthly utility bill. The responses from the surveys that were returned were compiled in a database for evaluation. This data is summarized in Chapter 3.

1.3.5 Floatable Materials Survey

A survey of floatable materials discharged from the combined sewer system to receiving streams during wet weather was performed. The survey evaluated and characterized material discharged from both CSOs and storm sewers. Conclusions from the survey are discussed in Chapter 3.

1.3.6 Collection System Model

To better understand the existing operation of the combined sewer system and the impacts of future projects, the City of Lancaster developed a computer model of their wastewater collection system. Sewer information collected to develop the sewer map and atlas was also used to develop the sewer network in the model. The sewer flow data and rainfall information were collected in accordance with the monitoring plan and were used to develop and calibrate the model. The model is discussed in more detail in Chapter 4.

1.4 CONCLUSIONS

Data collection, field sampling and computer modeling were used to characterize flow in the Lancaster combined sewer wastewater collection system and combined sewer overflows to the Hocking River and its tributaries. The conclusions from the characterization effort are summarized below according to the four criteria included in the Ohio EPA's Combined Sewer Overflow Strategy:

Collection System Understanding

- From field investigations, it was found that a rainfall of 0.10-inches will typically activate at least one CSO in the system. CSO 1019 is the most active while CSO 1035 appears inactive.
- The most active CSOs in the Lancaster system (as determined by frequency of activation predicted by the Lancaster collection system model) are:

<u>Stream</u>	<u>CSO</u>
• Baldwin Run	1019
• Feters Run	1029
• Hocking River	1005, 1011, 1013, 1016, 1027, 1031 and 1033

Note: CSO 1005 has recently been permanently closed.

- Deposition occurs in several areas in the combined sewer system. The most significant location is a 1,400-foot length of a 27-inch interceptor. This section has been cleaned recently.

- Flow metering and computer model development defined complex hydraulic conditions which occur within the collection system, such as surcharging and backwater.
- Through flow metering and computer model development, it was found that the response of the collection system to rainfall, including frequency of activation and volume of overflow, is dependent on the precipitation volume, the rainfall duration, and pre-existing conditions. These conditions were successfully included in the Lancaster collection system model.
- CSOs 1010, 1022 and 1024 are prone to inflow from either the receiving stream or the receiving storm sewer. Inflow was identified at an abandoned siphon near Locust Street and the Baldwin Run and from a leaking bulkhead in a manhole near S.R. 793 and Tarhe Run. CSO 1010 has subsequently been permanently closed and the abandoned siphon and leaking bulkhead have been repaired.
- Areas of flooded basements exist. These are summarized in Section 3.5. Residents report that flooded basements occur for a variety of reasons including clean water (storm water) sources and sanitary/combined sewage sources.

Impact of Separate Sewered Areas

- Separate Sewers have minimal impact on CSO discharge as evidenced by the following:
 - Sanitary sewer service areas discharge to the Lancaster interceptor sewers and do not discharge into other combined service areas.
 - Many sanitary service areas discharge to pump stations which regulate flow to the interceptors. This causes storage in the sanitary areas and minimizes the impact on CSOs.
 - Computer modeling demonstrates that an increase in sanitary sewer flow causes a disproportionately small increase in CSO volume.
 - CSOs that could be impacted by separate sewer flows (CSOs 1004, 1006 and 1034) do not overflow for 90% of storms during a typical year. Thus, sanitary sewers have no impact on CSO volumes for 90% of annual storm events.

Toxic and Hazardous Material Sources and Loads

- Lancaster combined sewer overflows are not toxic and hazardous based on the results of annual Priority Pollutant scans of Lancaster wastewater and sampling of aquatic life in Lancaster receiving streams.
- Lancaster combined sewer overflows contain low concentrations of heavy metals. The amount of heavy metals in the combined sewer system has been decreasing over the past fifteen years. This is due primarily to the successful Lancaster Industrial Pretreatment Program. Evidence to support this conclusion includes:
 - Industrial discharge flows to the collection system have decreased approximately 43% since 1977.
 - There are only four industries directly upstream of combined sewer overflow structures which are capable of discharging industrial pollutants. Those industries are listed in Figure 5-9.
 - The sludge produced by the WPCF contains low enough concentrations of heavy metals that it could qualify as a Class A high quality sludge.

Quantity and Characteristics of Combined Sewer Overflows

- Field sampling showed that the floatable material discharged from the CSOs is similar to the material discharged from storm sewers.
- Lancaster CSOs exhibit a typical "first flush" pollutant concentration pattern. The concentrations of pollutants at the beginning of the overflow event are generally higher than the concentrations of pollutants near the end of the overflow event. Pollutant concentrations decrease significantly after the first 30 minutes of overflow and are not significant enough to cause water quality violations in the receiving stream during wet weather conditions.
- The Lancaster CSO system discharges approximately 111 million gallons of combined sewage during wet weather in a typical year and conveys for treatment approximately 588 million gallons of combined sewage during wet weather. Thus, the Lancaster wastewater system treats more than 80% of the combined sewage collected during wet weather.
- Approximately 45% of the total annual CSO volume is discharged from CSO 1019.

++ END OF EXECUTIVE SUMMARY ++

2

2.0 SEWER SYSTEM DESCRIPTION

2.1 BACKGROUND

The City of Lancaster, Ohio owns and operates the Lancaster Water Pollution Control Facility (WPCF). The WPCF is located adjacent to the Hocking River in the City of Lancaster, approximately 1.5 miles southeast of the City's downtown area. The City's wastewater collection system has a service area of approximately 17 square miles and a population of approximately 36,600 (1995 Housing Plan) is served by the system. The wastewater collection system conveys residential, commercial, and industrial flows to the WPCF. Significant features of the collection system, including sewers, siphons, pump stations, combined sewer overflow (CSO) structures and wastewater collection service areas are shown on Figure 1-1 at the end of this report for reference. Each type of sewer and sewer system component in the Lancaster wastewater collection system is also described in Sections 2.2 through 2.8 of this chapter.

The oldest sections of the City's wastewater collection system have been in existence since the early 1900s. These sewers are classified as "combined sewers" since they were designed to carry both sanitary flow and stormwater flow in the same pipe. These sewers were designed to discharge excess flow (greater than the system's capacity) to the local receiving stream through the CSOs. Over the years, the City's wastewater collection system has been modified and expanded. These modifications include the addition of separate sanitary sewer areas, interceptor sewers, and separation of storm flow from sanitary flow in some combined sewer areas. Today, the City's wastewater collection system totals over 170 miles of sanitary and combined sewers with diameters between 6 and 60 inches. The total length of each type of these sewers and their relative age is shown in Figure 2-1. The sewers are constructed of many different types of materials including brick, clay, concrete, and cast iron.

The City's combined sewer system transports sanitary sewage and stormwater collected during rain events to the WPCF. During wet weather, flows greater than the sewer capacity are discharged to receiving streams through CSO structures. The City's 1997 National Pollutant Discharge Elimination System (NPDES) Permit identified thirty-one (31) separate CSO locations that can discharge excess flow from the combined sewer collection system. Of these CSOs, one discharges to the Fetters Run, five discharge to the Baldwin Run, and twenty-five (25) discharge to the Hocking River.

2.2 INTERCEPTOR SEWERS

For purposes of this report, interceptor sewers are defined as large diameter sewers that collect and transport wastewater to the WPCF. Flows are conveyed to the WPCF through three main interceptors. The three main interceptors are known by their nominal diameter and general service area: 36-inch East (Baldwin Run), 27-inch West, and 36-inch West. The 36-inch East interceptor generally parallels the Baldwin Run as shown on Figure 1-1. The 27-inch West and 36-inch West interceptors generally follow the Hocking River as shown on Figure 1-1. All three interceptors connect to two 48-inch sewers entering the WPCF. A summary of the interceptors and large diameter sewers is listed in Figure 2-2. Figure 2-2 summarizes sewer length, slope, roughness coefficient, and maximum capacity. The collection area for each of these interceptors is discussed in the following sections. Figures showing plans and elevations of the siphon structures and the CSO structures are attached as Appendix A.

2.2.1 Interceptor Sewer Service Areas

The 36-inch East Interceptor collects flow from six areas. Two 24-inch sewers known as the Fetters Run Sewer and the Ewing Run Sewer join at the at the upstream end of the 36-inch East interceptor. The collection area for the 36-inch East interceptor is the eastern portion of the City (areas 2, 3, 5A, 5B, 6 and 7) as shown on Figure 1-1. A schematic of the interceptor sewers and tributary service areas is also provided on Figure 3-3 and a description of each area is provided in Section 2.5. Before entering the WPCF, flow from

the 36-inch East Interceptor combines with flow from a 30-inch sanitary sewer and the underflow from a 60-inch combined sewer. This convergence is near the southeast corner of Mary Burnham Park and the CSX Railroad. From this point, the 48-inch East Interceptor continues to the WPCF site. For a short distance on the WPCF site, the 48-inch diverges into a 42-inch sewer and an 18-inch sewer before recombining into a 48-inch line. The 48-inch line discharges to the WPCF.

The 27-inch West Interceptor collects both wastewater and stormwater flows from thirteen subsystems in the south-central area of the City. These subsystems service areas 10, 11, 14, 15, 16, 17, 18, 19, 20, 21A, 21B, 22, and 23 which are shown on Figure 1-1 and described in Section 2.5. Flows enter the 27-inch interceptor through sanitary and combined sewers ranging in size from 8 to 15 inches in diameter. The Wheeling Street Pump Station discharges into the 27-inch West Interceptor. This pump station is discussed in Section 2.6.

The 36-inch West Interceptor follows the Hocking River west and then north from the WPCF as shown on Figure 1-1. The 36-inch West Interceptor collects both sanitary and combined flows from twelve areas in the southwestern, west, north, and northwest areas of the City. These subsystems serve areas 12A, 12B, 13, 24, 25, 26, 27, 28, 29, 30, 31, and 32 which are shown on Figure 1-1 and described in Section 2.5. Two pump stations, the YMCA Pump Station and the South Broad Street Pump Station, discharge flow into the 36-inch West Interceptor. These pump stations are discussed in Section 2.6.

Wastewater flow in the 27-inch West and 36-inch West Interceptors are interconnected at five locations where they parallel each other on the north and east banks of the Hocking River.

These locations are:

- ▶ West of the CSX Railroad Bridge over the Hocking River, east of Maple Street.
- ▶ West of High Street and Canal Street.
- ▶ Near the intersection of the alley south of Lincoln Street and Whiley Avenue, on Whiley Avenue.

- ▶ Northwest of Walnut Street and Whiley Avenue, on Whiley Avenue.
- ▶ East of the Wheeling Street Pump Station.

As the interceptors approach the WPCF, their sizes change. The 36-inch increases to a 42-inch sewer near the CSX Railroad and the Hocking River. The 27-inch and 42-inch join at the WPCF perimeter. A 48-inch sewer conveys wastewater from this point to the WPCF.

2.3 COMBINED SEWER SERVICE AREAS

The combined sewer service areas are primarily located in the central portion of the City. However, some combined sewers are located in the east and north areas of the City. Seventeen areas contribute combined flow to the interceptors. The seventeen combined sewer service areas are 3, 4, 5A, 8, 9, 11, 14, 15, 16, 17, 19, 20, 21, 22, 23, 24, and 26. Each of these collection areas is shown geographically on Figure 1-1 and schematically on Figure 3-3. A description of each area is provided in Section 2.5.

Typically, combined sewers were designed to convey sanitary sewage plus stormwater up to a certain amount to the WPCF, with excess flows being discharged to a nearby stream. Thus, during wet weather, the Lancaster combined sewer system is designed to relieve flow greater than the sanitary sewer capacity to the Hocking River, Baldwin Run and Feters Run. The location of all CSOs within the system is shown on Figure 1-1 and listed in Section 2.8 for reference. A drawing of each CSO is also provided in Appendix A.

2.4 SEPARATE SEWER SERVICE AREAS

The City of Lancaster also has many areas serviced by separate sewer systems. Separate sewer systems are designed with sanitary sewers for sewage flow and storm sewers for stormwater. Sanitary sewers transport wastewater to the WPCF and storm sewers transport stormwater to local streams. The sanitary sewer service areas surround the central portion of the City, which is served primarily by combined sewers. The service areas with

sanitary sewers are 1, 2, 5B, 10, 12, 13, 18, 25, and 27 to 32. These areas are shown geographically on Figure 1-1 and schematically on Figure 3-3. Each area is described in Section 2.5. The wastewater from these areas flows to the 36-inch East, 27-inch West and the 36-inch West Interceptors and then to the WPCF.

2.5 SEWER COLLECTION AREAS

The City of Lancaster Wastewater Collection System provides service to thirty-nine (39) service areas within the City. Figure 1-1 shows the boundaries for each of the wastewater collection system service areas. A brief description of each area is provided below:

2.5.1 Area 1

Area 1 is located in the southeastern portion of the City. Flow from this area is collected and transported to a 30-inch sewer. This sewer extends eastward parallel to the CSX Railroad tracks and serves industrial and residential users. The 30-inch sewer connects to the 36-inch East Interceptor southeast of Mary Burnham Park and the CSX Railroad. The facilities in this area include three pump stations (East Main Pump Station, Commerce Street Pump Station and Lawrence Street Pump Station) and one siphon. Individual characteristics of the pump stations and the siphon are described in Sections 2.6 and 2.7 respectively.

2.5.2 Area 2

Area 2 is located in the southeastern area of the City north of Area 1. This area is composed primarily of residential customers and separated sewers. Wastewater from this area flows to the 36-inch East Interceptor. The approximate boundary of Area 2 is the CSX Railroad, Chestnut Street, Marietta Road, and Baldwin Avenue.

2.5.3 Area 3

The combined sewer serving this area collects flow from the eastern portion of the City and discharges to the 36-inch East Interceptor at the northeast corner of Mary Burnham Park. This residential and commercial area is approximately bounded by Chestnut Street, Brooks Alley, Main Street, Fulkerson Avenue, Livingston Avenue, Mulberry Street, and Baldwin Avenue. CSO 1024 is located in the upper reaches this area near Wheeling Street and Livingston Avenue. The combined flow from the entire area passes through the structure at CSO 1020 before entering the interceptor. CSO 1020 is located at the intersection of Brooks Alley and Chestnut Street. Any flow greater than the capacity of the 15-inch sanitary sewer overflows to Baldwin Run.

2.5.4 Area 4

The combined sewer system for Area 4 collects flow from a residential area bounded by Cherry Street, King Street, Main Street, and Eastwood Avenue. Wastewater from the combined sewer system flows through the structure at CSO 1026 and then into the 36-inch East Interceptor at the northeast corner of Mary Burnham Park. CSO 1026 diverts combined sewer overflow to Baldwin Run.

2.5.5 Areas 5A and 5B

The 24-inch Feters Run Sewer extends north from the 36-inch East Interceptor, collecting sanitary and combined flows from this residential area.

Area 5A is served by a 48-inch combined sewer and is bounded by Feters Run, Mt. Pleasant Avenue, King Street, Eastwood Avenue, Sixth Avenue, and Fair Avenue. Before entering the 24-inch Feters Run Sewer, wastewater passes through the structure at CSO 1029 that is located at Sixth Avenue and Boyd Street. Combined sewer overflows are discharged to Feters Run at CSO 1029.

Area 5B is served by a separated sanitary sewer system. Wastewater collected from Area 5B flows directly into the 24-inch Feters Run Sewer. The sewers in area 5B collect flow from the area in the northern part of the City. The approximate boundary for this area is Feters Run, Granville Pike, Fair Avenue, and the City corporation line.

2.5.6 Area 6

Collection Area 6 is located in the north central part of the City and is served by separated sanitary sewers. The approximate service area boundary is Fair Ave, Feters Run, and Sheridan Drive. The collection area also receives flow from a section of Allen Street east of Sheridan Drive. The flow is conveyed in a 12-inch sewer to a 15-inch sewer along the east bank of Baldwin Run. The 15-inch collector sewer then connects to the 36-inch East Interceptor at the northeast corner of Mary Burnham Park.

2.5.7 Area 7

Collection Area 7 is located in the northeast part of the City and is served by separated sanitary sewers. Wastewater from this area is conveyed to the 36-inch East (Baldwin Run) Interceptor through the 24-inch Ewing Run Sewer. The Ewing Run Sewer extends to the northeast collecting sanitary flows from this residential area.

2.5.8 Areas 8A, 8B, 8C, 8D and 8E

Areas 8A, 8B, 8C, 8D and 8E are served by combined sewers. The 60-inch combined sewer entering the northwest corner of Mary Burnham Park collects flow from this central area of the City which is composed of residential and commercial users. The 60-inch combined sewer has a service area bounded by High Street, Chestnut Street, Eastwood Avenue, Sixth Avenue, Mt. Pleasant Avenue, and Rising Park. The structure at CSO 1019, which is located at the southeastern corner of Mary Burnham Park, diverts combined sewer overflows during wet weather to Baldwin Run. Dry weather flow is normally conveyed through the structure at CSO 1019 to an 18-inch sewer before entering the 48-inch East Interceptor. This combined sewer area also has three additional CSOs (1023, 1031 and 1032) that relieve the combined sewer system upstream from CSO 1019.

Area 8A is approximately bounded by Chestnut Street, Wyandotte Street, and the alley north of Main Street. This service area is composed of residential and commercial users. CSOs 1031 and 1032 are located within this collection area.

Wastewater from Area 8B is collected and conveyed through a 24-inch combined sewer to the 60-inch combined sewer. The collection area is composed of residential and commercial users. The approximate service area boundary is Chestnut Street, Mt. Pleasant Avenue, Sixth Avenue, Wyandotte Street, and two blocks east and west of Madison Avenue.

The approximate collection area for Area 8C is bounded by Wheeling Street, Maple Street, Frederick Street, Mt. Pleasant Avenue, Sixth Avenue, and two blocks east of Mt. Pleasant Avenue. The sewers in this area collect stormwater and wastewater from residential and commercial users.

The approximate boundary for Area 8D is High Street, Allen Street, Maple Street, Wheeling Street, Chestnut Street, and Mt. Pleasant Avenue. The flow in this area is generated by residential and commercial users.

Area 8E is the northern most collection subarea for Area 8. Flows in this area are mainly residential. The approximate area boundary is Allen Street, the City corporation line, and Rising Park. CSO 1023 is located in this area at the third manhole north of Fair Avenue on High Street.

2.5.9 Area 9

Flow collected from this south-central area of the City discharges to a 24-inch combined sewer at the intersection of Wyandotte Street and Lawrence Street. The 24-inch sewer transports flow to the 48-inch West Interceptor located northwest of the WPCF. This residential service area is approximately bounded by Lawrence Street, Mt. Pleasant Avenue, Chestnut Street, and Cherry Street.

2.5.10 Area 10

Area 10 is served by separated sanitary sewers and is located in the south-central part of the City. This area is composed of residential users and its approximate service area is bounded by the Hocking River, the City corporation line, and Tarhe Run. The flow from Area 10 is conveyed to the 27-inch West Interceptor through a 12-inch sanitary line and a two-barrel siphon. CSO 1006 is part of the siphon structure.

2.5.11 Area 11

Wastewater from this south-central area of the City is collected in an 18-inch combined sewer that discharges to the 27-inch West Interceptor. The area is composed of residential, commercial, and industrial customers. This service area is bounded by Lawrence Street, Mt. Pleasant Avenue, Main Street, and Pearl Avenue. Before entering the 27-inch West Interceptor, wastewater passes through the structure at CSO 1005 that is located east of the CSX Railroad along the north bank of the Hocking River. CSO 1030, at the intersection of Walnut Street and Maple Street, also relieves this combined system.

2.5.12 Areas 12A and 12B

Areas 12A and 12B are served by separated sanitary sewers. The 24-inch sewer in Area 12 collects sanitary flow from the southern portion of the City. The 24-inch sewer extends south from a 30-inch sanitary sewer at the South Broad Street Pump Station to the intersection of Hamburg Road and BIS Road (S.R. 793). Sanitary flows are collected from residential and industrial areas through sewers that range in size from 6 to 12 inches in diameter and are pumped to the 36-inch West Interceptor through the Broad Street Pump Station. The approximate service area boundary for Area 12A is Memorial Drive, Lewis Avenue, Lane Street, the City corporation line, and Hunter Avenue, minus Area 12B. The approximate service area boundary for area 12B is Spring Street, South Broad Street, Mt. Ida Avenue, Hunter Avenue, and the City corporation line.

2.5.13 Area 13

Area 13 is served by separated sanitary sewers. A 30-inch sewer collects residential wastewater from the southwestern portion of the City. This sewer extends westward from the Broad Street Pump Station along the CSX Railroad until it reduces in size to a 24-inch sewer (Area 32) at Hunter Avenue. The approximate collection system area boundary is the Hocking River, CSX Railroad, the City corporation line, Hunter Avenue, and Lewis Avenue. Flows from this area are pumped to the 36-inch West Interceptor through the South Broad Street Pump Station.

2.5.14 Area 14

Flow collected from this south-central area of the City is discharged to the 27-inch West Interceptor. This residential and commercial area is bounded by South Columbus Street, High Street, Chestnut Street, and South Broad Street. CSO 1007 (structures CSO 7A through 7D) is located in this area.

2.5.14 Area 15

Wastewater from this southern portion of the downtown area is discharged to a 27-inch combined sewer that in turn discharges to the 27-inch West Interceptor. This commercial and industrial service area is bounded by Memorial Drive, Main Street, Front Street, High Street, and South Broad Street. Wastewater entering the interceptor passes through the structure at CSO 1027. CSO 1027, at the intersection of Walnut Street and Whiley Avenue, directs combined sewer overflows to the Hocking River during wet weather.

2.5.16 Area 16

Wastewater from this southern portion of the downtown area is discharged to a 24-inch combined sewer that in turn discharges to the 27-inch West Interceptor. This commercial area is bounded by Main Street, High Street, Wheeling Street, and the Hocking River. The combined sewer from this area pass through the structure at CSO 1008, located

at Lincoln Avenue and the Hocking River, before entering the interceptor. Wet weather flows greater than the capacity of the 10-inch sewer connecting the combined sewer to the interceptor overflow into the Hocking River.

2.5.17 Area 17

Collection Area 17 is located in the southwestern area of the City west of the Hocking River. Combined flow from this area is discharged to the Wheeling Street Pump Station through a 36-inch combined sewer and then is pumped to the 27-inch West Interceptor. The approximate boundary for Area 17 is the CSX Railroad, Lincoln Avenue, Hocking River, and Wheeling Street.

2.5.18 Area 18

Area 18 is served by separated sanitary sewers and is located in the southwestern area of the City. Sanitary flow from this area is transported to the 27-inch West Interceptor through 8 inch collector sewers. The approximate boundary of this area is Memorial Drive, Hocking River, Lincoln Avenue, and South Broad Street.

2.5.19 Area 19

The combined sewer serving this area collects flow from part of the downtown area and discharges to the 27-inch West Interceptor. This commercial and residential area is bounded by the Hocking River, Wheeling Street, High Street, and the alley north of Mulberry Street. Wastewater passes through the structure at CSO 1009, which is located at Memorial Drive and Mulberry Street, before entering the interceptor. CSO 1018, which is in the upstream portion of this area at North Broad Street and Mulberry Street, relieves to a 12-inch storm sewer.

2.5.20 Area 20

The combined sewer serving this area collects flow from part of the downtown area and discharges to the 27-inch West Interceptor. This commercial area is bounded by the Hocking River, High Street, and the alleys to the north and south of Union Street. The flow

from this area passes through a 12-inch sewer at the structure at CSO 1011 before entering a 16-inch interceptor. The 16-inch interceptor discharges to the 27-inch West Interceptor. CSO 1011 is located at Memorial Drive and Union Street.

2.5.21 Areas 21 A and 21B

Area 21 is located in the west-central area of the City. Areas 21A and 21B collect stormwater plus sanitary flow from residential, industrial, and commercial users.

The approximate boundary for Area 21A is the CSX Railroad, Wheeling Street, Hocking River, Union Street, Washington Avenue, Eighth Avenue, and Pierce Avenue. Wastewater from Area 21A is conveyed through a 18-inch combined sewer to the Wheeling Street Pump Station. CSOs 1028 and 1021 relieve combined sewage to the Hocking River from this area during storm events.

The approximate boundary for Area 21B is the Hocking River, Union Street, Eighth Avenue, Slocum Street and Harrison Avenue. Wastewater from Area 21B is conveyed through an 18-inch combined sewer to the Wheeling Street Pump Station. Wastewater passes through the structure at CSO 1010 prior to discharging to the pump station. CSO 1010 has been plugged and abandoned.

2.5.22 Area 22

The combined sewer serving this area collects flow from the northern portion of the downtown area and discharges to the 27-inch West Interceptor. This commercial area is bounded by the Hocking River, High Street, and the alleys to the north and south of Fifth Avenue. Before entering a 15-inch interceptor, the flow from this area passes through the structure at CSO 1012 that is located at Memorial Drive and Fifth Avenue. The 15-inch interceptor discharges to the 27-inch West Interceptor. CSO 1017, which is in the upstream portion of this area at North Broad Street and Fifth Avenue, relieves to a 24-inch storm sewer.

2.5.23 Area 23

The combined sewer serving this area collects flow from the northern portion of the downtown area and discharges to the 27-inch West Interceptor. This commercial area is bounded by the Hocking River, High Street, and the alleys to the north and south of Sixth Avenue. Before entering the interceptor, the flow from this area passes through a 10-inch sewer at the structure at CSO 1013 that is located at Memorial Drive and Sixth Avenue. Wastewater from the 10-inch sewer is discharged to a 15-inch interceptor which discharges to the 27-inch West interceptor. CSO 1016, which is in the upstream portion of this area at North Broad Street and Sixth Avenue, relieves to a 36-inch storm sewer.

2.5.24 Area 24

This residential and commercial area is bounded by North Broad Street, Sixth Avenue, Arnold Avenue, Fair Avenue, and the Hocking River in the north-central area of the City. Wastewater from the combined sewer system passes through the structure at CSO 1014 that is located west of Allen Street and Memorial Drive. At CSO 1014, a 12-inch sewer connects the combined sewer area to the YMCA Pump Station.

2.5.25 Area 25

Area 25 is served by separated sanitary sewers and is located in the western portion of the City. It is bounded by the CSX Railroad, Graylock Street, Meda Avenue, Pierce Avenue, Eighth Avenue, Harrison Avenue, Union Street, Washington Avenue, Seventh Avenue, and Slocum Street. The wastewater from this area is conveyed by gravity to the YMCA Pump Station through a 36-inch interceptor. The wastewater is pumped through an 18-inch force main to the 36-inch West Interceptor by the YMCA Pump Station.

2.5.26 Area 26

A 30-inch combined sewer collects flow from Area 26, which is in the north central part of the City. This residential, commercial, and industrial area is approximately bounded by the Hocking River, the City corporation line, High Street, Allen Street, and Fair Avenue.

Combined flows from this area pass through the structure at CSO 1033 and eventually reaches the YMCA Pump Station. CSO 1033 is located on Park Street west of Memorial Drive.

Three additional CSOs are located in this combined sewer area. CSO 1015 is located east of North Broad Street on Fair Avenue, CSO 1022 is located at the intersection of Wilson Avenue and Columbus Street, and CSO 1035 is located east of Park Street and Columbus Street. These three CSOs are located in the upstream portion of the area and relieved to storm sewers which discharge to the Hocking River through an 84-inch line.

2.5.27 Area 27

Area 27 is served by separated sanitary sewers. Wastewater in Area 27 is conveyed by gravity to the YMCA Pump Station through a 36-inch interceptor. The approximate collection system area boundary is the Hocking River, Ohio Avenue, Beacon Street, and Meda Avenue. Flows in this area are generated from residential and commercial users.

2.5.28 Area 28

Area 28 is served by separated sanitary sewers. An 18-inch sewer collects sanitary flows from this northwestern area of the City and discharges to the 30-inch Northwest Annexation Sewer described below for Area 29. This 18-inch sewer conveys residential sanitary flows from collector sewers ranging in size from 8 to 15 inches in diameter. The approximate collection area boundary for Area 28 is the City corporation line, Memorial Drive, Arlington Avenue, and Graf Street. The Whittier Street Pump Station is located within Area 28. The City plans to abandon the Whittier Street Pump Station in the near future and replace it with a gravity line under Memorial Drive.

2.5.29 Area 29

Area 29 is served by separated sanitary sewers. A 30-inch sewer (the 1992 Northwest Annexation Sewer) extends north and then west collecting wastewater from the northwest area of the City near the River Valley Mall. This collection area is composed of residential,

commercial, and industrial users. The 30-inch sewer receives flows from 18-inch and 24-inch sewers (Areas 28, 30 and 31). The 18-inch sewer from Area 28 joins the 30-inch sewer near Hocking Street and Harrison Avenue. The 24-inch sewer from Areas 30 and 31 joins the 30-inch sewer northwest of the Hocking River and Pierce Avenue. These flows are eventually pumped to the 36-inch West interceptor by the YMCA Pump Station.

2.5.30 Area 30

Area 30 is served by separated sanitary sewers. The wastewater from Area 30 is collected from residential and industrial users. The approximate collection area boundary for Area 30 is the City corporation line, CSX Railroad, and West Fair Avenue. Flow from this area is conveyed by an 18-inch sewer to the 24-inch sewer described in Area 29 near Zimmer Street and the Hocking River.

2.5.31 Area 31

Area 31 is served by separated sanitary sewers. The primary sewer in Area 31 is a 24-inch sewer that connects to the 30-inch sewer (Area 29) near the Hocking River and Pierce Avenue. This sewer drains the western area of the City and collects flow from residential, commercial, and industrial users. The approximate collection area boundary for Area 31 is the City corporation line, CSX Railroad, West Main Street, Mulberry Street, and Ohio Avenue.

2.5.32 Area 32

Area 32 is served by separated sanitary sewers. A 24-inch sewer extends north from Hunter Avenue and the CSX Railroad to Hunters Run where the sewer changes direction and proceeds southwest. This sewer collects residential, commercial, and industrial sanitary flows from the southwestern area of the City. Area 32 is bounded by the CSX Railroad on two sides, the City corporation line, West Main Street, Mulberry Street, and Busby Avenue. The wastewater collected from Area 32 flows by gravity to the South Broad Street Pump Station where it is pumped to the 36-inch West Interceptor.

2.6 PUMP STATIONS

The City currently operates and maintains eight pump stations. Each pump station is described below and summarized in Figure 2-3.

2.6.1 YMCA Pump Station

The YMCA Pump Station is located west of the intersection of Allen Street and Memorial Drive behind the YMCA. This station pumps sanitary flows from the northwest and combined flows from the north and north-central areas (Areas 24, 25, 26, 27, 28, 29, 30, and 31) through an 18-inch force main to the 36-inch West Interceptor. With the largest of the four pumps out of service, the pump station has a firm pumping capacity of 7,000 gpm.

2.6.2 South Broad Street Pump Station

The South Broad Street Pump Station is located east of Memorial Drive and Lewis Avenue. This station pumps sanitary flows from the southern and the southwestern areas of the City (Areas 12A, 12B, 13, and 32) through a 10-inch force main to the 36-inch West Interceptor sewer. This pump station has a firm pumping capacity of 2,000 gpm (with one pump out of service).

2.6.3 Whittier Street Pump Station

The Whittier Street Pump Station is located in Area 28 in the northwest area of the City at the intersection of Schorway Drive and Whittier Street. This station pumps sanitary flows from the northwestern area of the City through a 3-inch force main to a 10-inch sanitary sewer in Area 28. The 10-inch sewer conveys the flow to an 18-inch sewer which discharges to the 30-inch Northwest Annexation Sewer and is subsequently pumped through the YMCA Pump Station. This station has a firm pumping capacity of 125 gpm (with one pump out of service). The City plans to abandon this station in the near future by replacing it with a gravity sewer under Memorial Drive.

2.6.4 Wheeling Street Pump Station

The Wheeling Street Pump Station is located in the alley south of Wheeling Street and east of George Street next to the Hocking River. This station pumps combined flows from the west areas of the City (Areas 17, 21A, and 21B) through an 8-inch force main to the 27-inch West Interceptor. With one pump out of service, the pump station has a firm pumping capacity of 1,800 gpm.

2.6.5 East Main Street Pump Station

The East Main Street Pump Station is located in Area 1 south of the CSX Railroad near Homestead Court. This station pumps sanitary flows from the eastern area of the City to a 30-inch sewer through a 10-inch force main. The 30-inch sewer discharges to the 36-inch East Interceptor. The East Main Pump Station has a firm capacity of 1,600 gpm (with one pump out of service).

2.6.6 Fogg Drive (Stonegate) Pump Station

The Fogg Drive (Stonegate) Pump Station is located in Area 2 at Fogg Drive and Ashwood Court. This station pumps residential flow from the northeastern area of the City through a 4-inch force main. The force main connects to an 8-inch sewer which flows into the 24-inch Ewing Run Sewer and then to the 36-inch East Interceptor. The Fogg Drive (Stonegate) Pump Station has a firm pumping capacity of 135 gpm (with one pump out of service).

2.6.7 Commerce Street Pump Station

The Commerce Street Pump Station is located in Area 1 on Commerce Street west of Quarry Road. This station pumps flow from the southeastern area of the City through an 8-inch force main to a 24-inch sanitary sewer that conveys flow to the East Main Street Pump Station. The Commerce Street Pump Station has a firm capacity of 410 gpm (with one pump out of service).

2.6.8 Lawrence Street Pump Station

The Lawrence Street Pump Station is located in Area 1 on Lawrence Street west of Ewing Street. This station primarily serves the City of Lancaster Sanitation Department maintenance and service facility which was recently expanded. The Lawrence Street Pump Station has a firm capacity of 98 gpm (with one pump out of service). It discharges to the 48-inch East Interceptor near the Lawrence Street bridge over the Baldwin Run via a 4-inch poly vinyl chloride (PVC) force main.

2.7 SIPHONS

There are three siphons in the Lancaster Wastewater Collection System which convey wastewater under streams and rivers. A sketch showing the location of each structure and plan and section drawings of each siphon is included in Appendix A. Each siphon location and configuration is described below.

2.7.1 Southeast of Mary Burnham Park

The siphon structure southeast of Mary Burnham Park conveys wastewater from the 30-inch sewer in Area 1 under Baldwin Run. This siphon has three barrels (8-inch, 12-inch and 18-inch) that cross under the stream.

2.7.2 West of WPCF

This siphon is located west of the intersection of the CSX Railroad and the Hocking River. Wastewater flowing through this siphon is collected from Area 10 in the southern portion of the City and conveyed to the siphon through a 12-inch sanitary line. The siphon has two 8-inch barrels under the Hocking River. This siphon also has an overflow that diverts flow to the river if the siphon becomes blocked or if downstream flows exceed sewer capacity. This overflow is located on the south bank of the Hocking River and numbered CSO 1006. Thus, CSO 1006 acts as both a CSO and a Facility Protection Device (FPD) for the siphon.

2.7.3 Lincoln Avenue

The Lincoln Avenue siphon is located near the intersection of Lincoln Avenue and Hunter Avenue. It conveys wastewater from the east side to the west side of Hunters Run in Area 32. The siphon consists two 8-inch barrels under Hunters Run. This siphon also has a FPD that diverts flow to the river if the siphon becomes obstructed.

2.8 COMBINED SEWER OVERFLOWS

Combined sewer overflow structures are located throughout the City of Lancaster's combined sewer system to relieve excess storm flow and to prevent surcharging and flooding during wet weather. The City's 1997 NPDES permit identified thirty-one (31) CSOs within the wastewater collection system. Drawings for each CSO are included in Appendix A. Each CSO is listed in Figure 2-4 which also identifies whether the CSO was included in the 1990 NPDES Permit or if it was identified as part of the wastewater collection system characterization effort and added to the 1997 permit.

As shown in the Figure 2-4, CSO 1006 acts as both a CSO and a facility protection device (FPD). This overflow is located on a siphon and typically overflows when the capacity of the downstream interceptor is exceeded due to high flow during wet weather. Activation of this CSO also prevents flow from entering basements of homes located upstream.

Figure 2-4 also shows that CSOs 1005 and 1010 have been abandoned. CSO 1005 was one of the most active CSOs in the Lancaster system. However its location and design made it difficult to maintain and prone to dry weather overflows. It was abandoned in 1999. CSO 1010 was abandoned by the City in 1998. CSO 1010 was prone to river backflow and rarely reached its overflow elevation. Before abandoning these CSOs, the City plugged the overflows and observed and monitored the depth of flow in the sewers during wet weather. It does not appear at this time that closing these CSOs will cause excessive surcharging of the combined sewer system or basement flooding. However, should problems develop, the

City will have to address the flow that was previously handled by these structures. For purposes of this report, both CSOs will be assumed to be operational until their final status is confirmed.

+ + END OF CHAPTER 2.0 + +

+ + FIGURES FOLLOW + +

**FIGURE 2-1
CITY OF LANCASTER, OHIO
WASTEWATER COLLECTION SYSTEM SEWER SUMMARY**

AGE / SIZE	SEPARATE SANITARY SEWERS (Feet)											Total
	6 inch	8 inch	10 inch	12 inch	15 inch	18 inch	21 inch	24 inch	>24 inch			
<10 yrs	0	70,870	3,276	7,232	1,254	9,489	0	169	4,796		97,086	
≥10 and <20 yrs	177	100,787	5,794	4,397	4,154	8,599	9,643	2,519	3,408		139,478	
≥20 and <40 yrs	1,364	138,078	11,999	2,593	5,275	7,056	10,268	2,615	22,395		201,643	
≥40 yrs	7,484	243,919	29,227	10,251	8,132	16,249	6,289	1,600	47,947		371,098	
Subtotal	9,025	553,654	50,296	24,473	18,815	41,393	26,200	6,903	78,546		809,305	
AGE / SIZE	COMBINED SANITARY SEWERS (Feet)											Total
	6 inch	8 inch	10 inch	12 inch	15 inch	18 inch	21 inch	24 inch	>24 inch			
<10 yrs	0	0	0	0	0	21	0	0	0	0	21	
≥10 and <20 yrs	0	0	0	0	0	2	0	0	0	0	2	
≥20 and <40 yrs	0	585	0	505	0	0	0	0	0	0	1,090	
≥40 yrs	0	9,130	3,675	8,125	17,805	10,440	6,245	15,075	16,455		86,950	
Subtotal	0	9,715	3,675	8,630	17,805	10,463	6,245	15,075	16,455		88,063	
TOTAL	9,025	563,369	53,971	33,103	36,620	51,856	32,445	21,978	95,001		897,368	
inch-diameter miles	10.3	853.6	102.2	75.2	104.0	176.8	129.0	99.9	539.8		2,090.8	

NOTE: 1. The average sewer size for those lines greater than 24 inches in diameter is assumed to be 30 inches.
 2. Table information obtained from Water Pollution Control Department and is current through 09/29/99.

FIGURE 2-2
INTERCEPTOR SYSTEM SUMMARY

<u>Description</u> ⁺	<u>Location</u>	<u>Length</u> <u>(feet)</u>	<u>Overall</u> <u>Slope</u> <u>(ft./ft.)</u>	<u>Roughness</u> <u>Coefficient</u> <u>(n)*</u>	<u>Full Pipe</u> <u>Capacity</u> <u>(cfs/mgd)</u>
<u>East and Northeast Areas</u>					
Baldwin Run Interceptor Sewer (Dwg. 65-3)					
48" East	Mary Burnham Park to WPCF	240	0.000292	0.018	17.72/11.46
Baldwin Run Interceptor Sewer (Dwg. 65-3)					
36" East	From beginning of Baldwin Run to SE corner Mary Burnham Park	290	0.00031	0.018	8.50/5.49
Baldwin Run Interceptor, Ewing Run Trunk Sewer, Ewing Trunk (Dwgs. 65-3, 69-3, 1976)					
24" Ewing	Valley Forge and Ewing Run to the beginning of Baldwin Run	5,600	0.00357	0.014	12.60/8.15
Baldwin Run Interceptor, Fetters Run Interceptor (Dwgs. 65-3, 66-2)					
24" Fetters	N. of Stone Run Ct. and Fetters Run to the beginning of Baldwin Run	1,800	0.00363	0.014	12.70/8.22
60" East	From Wheeling & Maple to SE Corner Mary Burnham Park	200	0.00219	0.02	79.10/57.13
Sanitary Sewer East to Industrial Park (Dwgs. 65-1, 65-2)					
30" East	Along CSX RR to Mary Burnham Park	530	0.00151	0.014	14.85/9.58

* - Roughness coefficient used in City of Lancaster Sewer System Computer Model.

+ - Dwg. Number refers to Record Drawings located in City Engineer's Office.

FIGURE 2-2
INTERCEPTOR SYSTEM SUMMARY (Continued)

<u>Description</u> ⁺	<u>Location</u>	<u>Length</u> <u>(feet)</u>	<u>Overall</u> <u>Slope</u> <u>(ft./ft.)</u>	<u>Roughness</u> <u>Coefficient</u> <u>(n)*</u>	<u>Full Pipe</u> <u>Capacity</u> <u>(cfs/mgd)</u>
<u>South and Southwest Areas</u>					
Utica Reese Trunk Sewer (Dwgs. 69-1, 69-2)					
24" West	From Hamburg Road. and S.R. 793 to Broad St. Pump Station	540	0.00417	0.014	13.63/8.81
Utica Reese Trunk Sewer and Hunters Run (Dwgs. 69-1, 70-1)					
30"	From CSX RR and Hunter Ave. to Broad St. Pump Station	2350	0.0026	0.014	19.48/12.59
<u>West, Central and Northwest Areas</u>					
Hunters Run Trunk Sewer (Dwg. 70-1)					
24" West	From Lincoln Ave. and Hunters Run to 30" sewer	510	0.00165	0.014	8.57/5.54
Hocking River Trunk Sewer (Dwg. 67-1)					
48" West	From CSX RR. to WPCF	340	0.000235	0.018	15.90/10.28
Hocking River Trunk Sewer (Dwg. 67-1)					
42" West	From CSX RR. to Maple St. and Hocking River	670	0.000328	0.018	13.17/8.51
Pre 1940's Trunk Sewers (Dwg. A-4)					
27" West	From Wheat St. and Hocking River to 48" West Trunk	220	0.000409	0.018	4.54/2.93
Hocking River Trunk Sewer (Dwg. 67-1)					
36" West	From Park St. and Hocking River to 42" West Trunk	730	0.000164	0.016	6.95/4.49

* - Roughness coefficient used in City of Lancaster Sewer System Computer Model.

+ - Dwg. Number refers to Record Drawings located in City Engineer's Office.

FIGURE 2-2
INTERCEPTOR SYSTEM SUMMARY (Continued)

<u>Description</u> ⁺	<u>Location</u>	<u>Length</u> <u>(feet)</u>	<u>Overall</u> <u>Slope</u> <u>(ft./ft.)</u>	<u>Roughness</u> <u>Coefficient</u> <u>(n)*</u>	<u>Full Pipe</u> <u>Capacity</u> <u>(cfs/mgd)</u>
<u>West, Central and Northwest Areas (Continued)</u>					
Hocking River Trunk Sewer (Dwg. 68-2)					
24" West	From W. Fair and Shasta Dr. to 30" sewer	470	0.000575	0.014	5.06/3.27
1992 NE Annexation Sanitary Sewer Extension (Ety Road and River Valley Complex)					
30" West	From Columbus Road. to 36" West interceptor	770	0.000481	0.014	8.38/5.42

*- Roughness coefficient used in City of Lancaster Sewer System Computer Model.

+ - Dwg. Number refers to Record Drawings located in City Engineer's Office.

**FIGURE 2-3
PUMP STATION SUMMARY**

Pump Station	Pump Number	Ground Elevation (Feet)	Wet Well Elevation (Feet)	Discharge Elevation (Feet)	Pump Capacity (gpm)	TDH (Feet)	Pump On (Feet)	Pump Off - Pump Falling (Feet)	Pump Off - Pump Rising (Feet)
YMCA	1	816.5	790.17	804.5	1,300	52	794.67	793.17	796.17
	2	816.5	790.17	804.5	2,200	53	796.17	794.17	NA
	3	816.5	790.17	804.5	3,500	70	797.17	795.67	NA
	4	816.5	790.17	804.5	3,500	70	797.17	795.67	NA
South Broad Street	1	815.0	787.33	800.17	1,000	40	791.83	791.33	NA
	2	815.0	787.33	800.17	1,000	40	793.33	790.33	NA
	3	815.0	787.33	800.17	1,000	40	793.33	790.33	NA
Whittier Street	1	844.5	828.00	840.00	125	40	831.00	829.00	NA
	2	844.5	828.00	840.00	125	40	834.00	829.00	NA
Wheeling Street	1	818.0	798.49	806.82	900	21	802.99	801.49	NA
	2	818.0	798.49	806.82	900	21	804.99	800.49	NA
	3	818.0	798.49	806.82	900	21	804.99	800.49	NA
East Main Street	1	826.5	802.00	815.00	800	33	807.00	806.00	NA
	2	826.5	802.00	815.00	800	33	809.00	805.00	NA
	3	826.5	802.00	815.00	800	33	809.00	805.00	NA
Fogg Drive (Stonegate)	1	909.5	887.00	905.00	135	73	889.80	888.00	NA
	2	909.5	887.00	905.00	135	73	891.00	888.00	NA
Street	1	826.2	815.00	823.50	410	15	817.50	815.50	NA
	2	826.2	815.00	823.50	410	15	819.00	815.50	NA
Lawrence Street	1	810±	793.00	801.6	98	26	795.00	794.00	NA
	2	810±	793.00	801.6	98	26	796.00	794.00	NA

FIGURE 2-4
COMBINED SEWER OVERFLOW STATUS

<u>CSO</u>	<u>Location</u>	<u>Included in 1990 Permit</u>	<u>Notes</u>
1004	West Perimeter of WPCF	Yes	
1005	CSX RR and Hocking R. N. Bank	Yes	Abandoned 1999
1006	CSX RR and Hocking R. S. Bank	Yes	Also siphon FPD
1007	South Broad Street Chestnut - S. Columbus	Yes	
1008	Lincoln Avenue and Hocking River	Yes	
1009	Mulberry Street and Memorial Drive	Yes	
1010	Mulberry Street and Hocking Street	Yes	Abandoned 1998
1011	Union Street and Memorial Drive	Yes	
1012	Fifth Street and Memorial Drive	Yes	
1013	Sixth Avenue and Memorial Drive	Yes	
1014	Allen Street and Memorial Drive	Yes	
1015	North Broad Street and Fair Avenue	Yes	
1016	Sixth Avenue and North Broad Street	Yes	
1017	Fifth Street and North Broad Street	Yes	
1018	North Broad Street and Mulberry Street	Yes	
1019	SE Corner of Mary Burnham Park	Yes	
1020	Chestnut Street and Brooks Avenue	Yes	
1021	Union Street and Garfield Avenue	Yes	
1022	Columbus Street and Wilson Avenue	Yes	
1023	High Street North of Fair Avenue	Yes	
1024	Wheeling Street and Livingston Avenue	Yes	
1025	Fetters Run North of Frederick	Yes	Abandoned, not in permit
1026	NE Corner of Mary Burnham Park	No	Added to 1997 Permit
1027	Walnut Street and Whiley Avenue	No	Added to 1997 Permit
1028	Sixth Avenue and Pierce Avenue	No	Added to 1997 Permit
1029	Sixth Avenue and Boyd Avenue	No	Added to 1997 Permit
1030	Walnut Street and Maple Street	No	Added to 1997 Permit
1031	Wheeling Street and Maple Street	No	Added to 1997 Permit
1032	Alley North of Main Street and Maple Street	No	Added to 1997 Permit
1033	Park Street and Memorial Drive	No	Added to 1997 Permit
1034	Baldwin Run and Lawrence Street	No	Added to 1997 Permit
1035	E. of Park and Columbus	No	Added to 1997 Permit

3

3.0 DATA COLLECTION AND EVALUATION

3.1 INTRODUCTION

In order to characterize the collection system and understand how the system responds to different rainfall events, a variety of data collection activities were performed. These activities included:

1. Development of a computerized sewer system base map and atlas
2. Development of a Monitoring Plan to:
 - a. Monitor sewer flow (dry and wet weather periods).
 - b. Collect and analyze samples from combined sewer overflows.
 - c. Collect and analyze rainfall data.
3. Evaluation of combined sewer overflow activation.
4. Assessment of basement flooding areas.
5. Sampling of CSOs for floatable material.
6. Development of a Stormwater Management Model (SWMM).

This chapter describes the data collection activities and summarizes the collection system characteristics that were observed.

3.2 SEWER SYSTEM BASE MAP AND ATLAS

The City recognized it needed to update its wastewater collection system base map from a hanging wall map to an electronic, computer - based format. The new computer generated base map enables the City to quickly update the map with ongoing wastewater collection system improvements or modifications. Figure 1-1 at the end of this report is a copy of the City's new base map.

The City of Lancaster also decided to replace its sewer atlas. The sewer atlas is a large scale version (1-inch equals 400 feet) of the base map broken into thirty-nine (39) 11-inch x 17-inch sheets for ease of handling. The larger scale of the sewer atlas facilitates its use by Lancaster maintenance personnel when investigating complaints or researching problems within the collection system.

The collection of data for the development of the new wastewater collection system base map and the new sewer atlas began in the fall of 1995. Data collection consisted of researching sewer record drawings for pipe data such as slope, diameter, invert elevations, and ground elevations. Information such as pump station construction, sewer locations, siphon construction, and CSO configurations were also researched from record drawings at the City Engineer's Office.

In addition to researching existing records, field inspections were performed to verify sewer connections, sizes, elevations and locations. Field inspections also provided additional sewer system insight. For example, field inspections identified a 1,400 foot section of the 27-inch West Interceptor that was full of sediment and grit. Ten additional CSO locations and one abandoned CSO location were also identified.

3.3 MONITORING PLAN

A Monitoring Plan was developed to outline the flow monitoring and combined sewer overflow sampling activities. The Monitoring Plan was submitted to the Ohio EPA as Appendix H of the *Combined Sewer System Operational Plan* on March 31, 1998. The Monitoring Plan is included in Appendix B of this report for reference. The measured flow data, rainfall information and CSO sample data collected as outlined in the Monitoring Plan were used to develop the following:

- ▶ The City of Lancaster Combined Sewer System Operational Plan (submitted to Ohio EPA in March 1998).
- ▶ The Combined Sewer System Characterization Report (This report, due to Ohio EPA by December 1, 1999).
- ▶ A computer-based hydraulic model of the City's wastewater collection system (See Chapter 4 of this report).
- ▶ The City of Lancaster Combined Sewer System Long Term Control Plan (due to Ohio EPA by June 1, 2000).

3.3.1 Flow Monitoring Data

To develop a computer model that represents the wastewater collection system under typical conditions, an understanding of the flow rates within the system during both dry and wet weather was required. Dry weather flows (DWFs) measured baseline flow (wastewater) normally present in the sewer system. Wet weather flows (WWFs) were measured to model the system's response (increased flow) to rain events. These flows were used to calibrate the collection system computer model to actual rain events.

The flow rates were measured using a portable flow data acquisition system (Flo-tote®) manufactured by Marsh-McBirney, Inc. The Flo-tote® system uses velocity and water surface level data to calculate the flow rates at selected time increments. The system can measure a wide range of flow regimes and can be configured for both full pipe (pressure) and open channel (gravity) flow applications. The system consists of the following components:

- ▶ Sensor with mounting band
- ▶ Flow meter
- ▶ Portable computer
- ▶ Computer software

To measure flow, a sensor is installed at the bottom of each pipe being monitored. It is held in place with a mounting band. The sensor measures velocity and level of the fluid flowing through the pipe to enable calculation of a corresponding flowrate. A portable computer with Flo-tote® software is used to program the site specific monitoring parameters for each flow meter. After the flow monitoring is completed at each location, the data collected at the flow meter is uploaded to the computer using the Flo-tote® software. The software is then used to analyze the data, calculate flow rates and print various data reports.

Dry Weather Flow Monitoring

Baseline flow measurements were made during periods of dry weather to determine the typical wastewater flow patterns in the sewer system. In the fall of 1995, the City's three Marsh-McBirney Flo-totes® were used to monitor dry weather flows (DWFs) in twenty-seven (27) different locations. Additional baseline flow measurements were recorded between March and December 1996. A listing of all of the monitoring locations is provided in Figures 3-1 and 3-2. A schematic of the monitoring locations is shown in Figure 3-3.

Wet Weather Flow Monitoring

The wet weather flow (WWF) rates were measured during and immediately following rainfall events. In the spring of 1996, ten Marsh-McBirney Flo-totes® were rented in addition to the City's five Flo-totes® (the City purchased two additional meters during the winter). A total of 77 locations were monitored. At 7 locations, flow meters were installed a second time to obtain additional data. Between March 16 and May 31, 1996, 53 new locations and 2 repeat locations were monitored. Using only the City's five Flo-totes®, an additional 29 new locations and 5 repeat locations were monitored between June and December 1996 to further quantify flows within the collection system.

Utilizing the 15 flow meters, data was collected at the 77 locations during ten monitoring periods. At the end of each monitoring period, each flow monitor was moved to a new location. For the first three monitoring periods, 15 flow meters were utilized. For the fourth monitoring period, ten flow meters were utilized. Five flow meters were utilized for the remainder of the monitoring periods. A list of all monitoring locations is provided in Figure 3-2. A schematic of the monitoring locations is provided in Figure 3-3.

For model calibration purposes, the WWF monitoring objective for each monitoring location was to monitor wastewater flowrates before, during, and after three rain events. Ideally, rainfalls exceeding 0.5 inches with varying intensities and duration were desired. However, due to the variability of the weather, any rainfall that created an overflow was considered acceptable for use as one of the rainfall events.

Flow monitoring during the spring and summer of 1996 quantified rainfall related flows within the wastewater collection system and overflowing through CSO structures. The monitoring also identified areas of apparent excessive inflow and infiltration (I/I). Two identified sources of inflow include an old siphon near Locust Street and Baldwin Run and a stubbed sewer near Tarhe Run and S.R. 793. The flow monitoring also identified CSO locations that allow river and/or stormwater to enter the sewer system. These CSOs are 1010, 1022 and 1024.

3.3.2 Combined Sewer Overflow Sample Data

In order to characterize the flow discharged to receiving streams by the combined sewer system, several CSOs were sampled during wet weather. CSOs were selected based on frequency of activation and volume of discharge. The sampling program occurred simultaneously with flow monitoring activities. The following CSO locations were sampled:

<u>Stream</u>	<u>CSO</u>
▶ Baldwin Run	1019, 1026
▶ Fetters Run	1029
▶ Hocking River	1004, 1012, 1013, 1014, 1027, 1031, 1033

Flow-activated automatic samplers were installed at the selected CSO locations to collect CSO discharge samples for analysis. The collected samples were analyzed by lab personnel at the Water Pollution Control Facility (WPCF) for the following parameters:

- ▶ 5-day Carbonaceous Biochemical Oxygen Demand (CBOD₅)
- ▶ Suspended Solids (SS)
- ▶ Total Kjeldahl Nitrogen (TKN)
- ▶ Cadmium (Cd)
- ▶ Lead (Pb)
- ▶ Copper (Cu)
- ▶ Zinc (Zn)

A list of the sampled CSOs, associated rainfall, and the number of samples collected is provided in Figure 3-4. The data collected from these CSOs was used to identify the concentrations of pollutants typically discharged to the receiving streams during rainfall events.

During an overflow event, an initial sample was taken immediately when the overflow began. The flow was then sampled at 15 minutes intervals for the duration of the overflow or for six hours, whichever came first. All samples collected during the first hour and one sample from each of the remaining hours were analyzed. These samples provided a measure of the pollution concentrations in the combined sewer overflow.

A summary of the collected data is tabulated in Appendix C. In order to characterize Lancaster's CSOs, the data in Appendix C was averaged for all CSOs and plotted versus time. The results of this analysis are shown in Figures 3-5A and 3-5B. Figures 3-5A and 3-5B demonstrate that a significant decrease in pollutant concentrations occurs between the start of the overflow event (the initial sample) to the end of the overflow event (the final sample). This phenomenon occurs in many combined sewer systems and is known as the "first flush."

The "first flush" occurs because debris and other sewage materials settle and deposit throughout the collection system during dry weather when the wastewater flowrates and resultant velocities are low. When wet weather occurs, the increased flowrates and velocities resuspend much of this material. Once the material is resuspended and flushed through the system, the concentration of pollutants begins to decrease. The continued addition of relatively clean infiltration and inflow further reduces the pollutant concentrations at the CSOs to below typical wastewater pollutant concentration levels.

3.3.3 Rain Data

To measure precipitation events, two temporary rain gages and one permanent rain gage were installed around the City. In addition, the City had an existing rain gage at the Water Treatment Plant. The temporary rain gages were placed at the State Highway Patrol Office in the northwest area of the City and the water reservoir in the northeast area of the City. In the southwest area of the City, a permanent rain gage was installed on top of Digester Control Building No. 2 at the WPCF.

The rain data collected during the Monitoring Plan is summarized by wet weather monitoring period in Figure 3-6. Since the rain data from the two temporary rain gages correlated with the rain data from the gauge at the WPCF, the rain data from the Water Treatment Plant was not used.

3.4 COMBINED SEWER OVERFLOW ACTIVATION

As discussed in Section 2.8, the City's 1997 NPDES permit identified thirty-one combined sewer overflows (CSOs) that can discharge flow to the Hocking River and its tributaries during rain events. One CSO discharges to Fetters Run, five CSOs discharge to Baldwin Run, and twenty-five CSOs discharge to the Hocking River. In order to gain a better understanding of how the combined sewer system operates and to assist in calibration of the wastewater collection system computer model, each CSO was monitored to determine its frequency of activation during rain events.

CSO activation was monitored by placing a wooden block in the discharge line of each CSO. Each block was tied to a string which was secured to the CSO structure. The blocks were strategically placed such that occurrence of an overflow would cause them to move. After a rainfall event(s), each CSO was checked and the location of the block observed and recorded. If an overflow had occurred, the block was reset. The CSO activation observations are summarized in Figure 3-6.

As indicated in Figure 3-6, different CSOs are activated by different rain events. This is due to the wide range of parameters affecting CSO activation. These include the rainfall intensity, rainfall duration, and rainfall volume. In general, a rainfall of 0.10 inches usually results in at least one overflow. During the monitoring period of March 16 through November 20, 1996, there were 33 rain events greater than 0.10 inches for which the blocks were checked. The following CSOs were observed to activate more than twenty times:

<u>Stream</u>	<u>CSO</u>
▶ Baldwin Run	1019, 1026
▶ Fetters Run	1029
▶ Hocking River	1008, 1009, 1011, 1012, 1013, 1014, 1015, 1016, 1027, 1031, 1033

CSO 1019 appears to be the most active while no activations were recorded at CSO 1035.

The data in Figure 3-6 was used to establish general trends, e.g., which CSOs activated with the greatest frequency. Due to the frequency of some of the rain events, it was not possible to check each CSO after each rain event. Therefore, when more than one rain event occurred between block checks, if a block moved, it could not be determined which event (s) caused the blocks to move. In addition, at some CSOs, placement of the blocks were difficult due to the physical configuration of the structure and determination of the actual occurrence of an overflow was judgmental. Therefore, the data in Figure 3-6 provided only a general qualitative check of the collection system model. As discussed in Chapter 5, the calibrated collection system model provides a more definitive analysis of CSO discharge frequency.

3.5 BASEMENT FLOODING QUESTIONNAIRE

A basement flooding questionnaire was sent to each resident along with their monthly utility bill in February 1996. The purpose of the questionnaire was to identify areas within the City where basement flooding occurs, how often basement flooding occurs, and probable causes of basement flooding. A copy of the questionnaire is attached in Appendix D.

The survey identified the following combined sewer areas as having numerous homes with flooded basements:

- ▶ Fair, Lake and Allen Streets.
- ▶ High Street and King Avenue.
- ▶ Fifth Avenue and Broad Street.
- ▶ Madison Avenue - South of Sixth Avenue.
- ▶ Chestnut Street.
- ▶ West Main Street and George Street (Wheeling Street Pump Station).

The results of this survey were used to identify where the most significant problems are located. However, due to the nature of the survey and the randomness of the responses, the survey only provided an overview of basement flooding. The collection system computer model confirmed the potential for basement flooding in the above identified areas based on the resultant hydraulic grade in the combined sewers during selected storm events.

3.6 CSO SAMPLING FOR SOLID AND FLOATABLE MATERIAL

As part of the National CSO Policy, one of the Nine Minimum Controls requires the “control of solid and floatable material.” To determine the type and extent of floatables discharging from the combined sewer system, a sampling program was completed between May 27 and June 15, 1996. Floatable material was collected from both CSO and stormwater outfall locations for two rain events.

Copatrawl® nets with a ½-inch opening were used to collect the floatable material. Manufacturer’s data for Copatrawl® nets is attached in Appendix E. Individual Copatrawl® nets were attached to three combined sewer outfalls and two storm sewer outfalls. A typical installation of a Copatrawl® net is shown in Figure 3-7. After each rain event, the Copatrawl® nets were removed from each of the headwall locations and taken to the WPCF for evaluation. The evaluation consisted of photographing, identifying, and quantifying the

collected floatable material. A data summary of the collected material is presented in Figure 3-8.

As indicated in Figure 3-8, the collected material from the 0.13 inch rain event on June 6, 1996 consisted primarily of yard waste (i.e., grass clippings and leaves). The material collected from the 1.48 inch rain event on June 14, 1996 consisted primarily of gravel. Figures 3-9 and 3-10 are pictures of the material collected from both the combined sewers and the storm sewers for the June 6 and June 14 rainfalls respectively. In both instances, the material collected from the CSO discharges did not differ significantly from the material collected from the storm sewer discharges.

3.7 STORM WATER MANAGEMENT MODEL (SWMM)

In order to better understand its operation, the City developed a computer model of the wastewater collection system. The model was used to characterize the sewer system and evaluate the hydraulic capacity of the system during dry weather and wet weather. The model can also be used as a tool for predicting and evaluating how the sewer system would respond to sewer system expansion as a result of future development. Development of the model is discussed in Chapter 4. The results of model simulations for typical yearly storms are discussed in Chapter 5.

++END OF CHAPTER 3.0++

++ FIGURES FOLLOW ++

FIGURE 3-1

**COMBINED SEWER SYSTEM CHARACTERIZATION REPORT
1995 FLOW MONITORING LOCATIONS - DRY WEATHER**

DATE	MONITOR NUMBER	LOCATION	ATLAS SHEET NO.	PIPE SIZE
9/26/95	49	Lake and Edgemont	F-6	30"
	23	Miller Park (S. of 5th)	F-6	15"
	32	E. of Canal and High	H-6	27"
10/10/95	1	NE Corner of Mary Burnham Park	G-7	10"
	37	W. of Park and Memorial (33)	F-5	15"
	44	Hocking and Harrison	F-5	30"
10/18/95	50	Locust and Baldwin Run	G-7	15"
	15	Fulkerson and CSX RR	G-7	30"
	20	Walnut and Memorial	G-6	27"
10/24/95	43	8 th and Slocum	F-5	10"
	39	Thomas N. of Main	G-5	36"
	78	Cherry and Sheridan	F-7	12"
10/31/95	48	Hocking and Beacon	F-5	10"
	42	East End of Carpenter	H-6	12"
	13	N. of Brooks and Chestnut	G-7	15"
11/7/95	8	E. of King and Cherry	G-7	24"
	9	Behind Kroger	G-7	24"
	12	Della and Chestnut	G-7	15"
11/14/95	62	Mulberry and George	G-5	15"
	63	Union and George	G-5	18"
	31	E. of Canal and High	H-6	36"
12/5/95	45	Pershing and Arlington	E-5	18"
	3	NE of Chestnut and Mt. Pleasant	G-6	24"
	16	Lawrence and Wheat	G-6	18"
12/15/95	79	6th & Pierce	F-5	12"
	63	Union and George	G-5	18"
	7	SE Corner of Mary Burnham Park	G-7	18"

FIGURE 3-2

**COMBINED SEWER SYSTEM CHARACTERIZATION REPORT
1996 FLOW MONITORING LOCATIONS - WET & DRY WEATHER
(Sheet 1 of 3)**

PERIOD	DATE	NUMBER	LOCATION	ATLAS SHEET NO.	PIPE SIZE
1	3/18/96	1	NE Corner of Mary Burnham Park	G-7	10"
		2	S of Main and W of Baldwin Run	G-7	27"
		3	NE of Chestnut and Mt. Pleasant	G-6	24"
		4	Mulberry E of Maple	G-6	24"
		5	Maple and Mulberry	G-6	48"
		6	SE Corner of Mary Burnham Park	G-7	60"
		7	SE Corner of Mary Burnham Park	G-7	18"
		8	E of King and Cherry	G-7	24"
		9	Behind Kroger	G-7	24"
		10	W of Fetters Run and 6th	F-7	48"
		11	E of Fetters Run and 6th	F-7	8"
		12	Della and Chestnut	G-7	15"
		13	N of Brooks and Chestnut	G-7	15"
		14	W of Brooks and Chestnut	G-7	15"
		15	Fulkerson and CSX RR	G-7	30"
2	4/17/96	16	Lawrence and Wheat	G-6	18"
		17	CSO 1004	G-6	27"
		18	CSO 1005	G-6	18"
		19	Walnut and Whiley CSO	G-6	27"
		20	Walnut and Memorial	G-6	27"
		21	S of Union and Memorial	G-6	16"
		22	E of Union and Memorial	G-6	30"
		23	Miller Park (S of 5th)	F-6	15"
		24	5th and Forest Rose	F-6	36"
		25	6th and Forest Rose	F-6	20"
		26	S of 6th and Memorial	F-6	15"
		27	Lewis and South Broad (24")	H-6	24"
		28	Lewis and Whiley (30")	H-6	30"
		29	Witte and Center	G-5	24"
		30	Hubert and W of South Broad	H-6	12"

FIGURE 3-2

COMBINED SEWER SYSTEM CHARACTERIZATION REPORT
 1996 FLOW MONITORING LOCATIONS - WET & DRY WEATHER
 (Sheet 2 of 3)

PERIOD	DATE	NUMBER	LOCATION	ATLAS SHEET NO.	PIPE SIZE
3	5/1/96	31	E of Canal and High	H-6	36"
		32	E of Canal and High	H-6	27"
		33	S of 8th and Hocking	F-5	36"
		34	Allen and Memorial	F-6	18"
		35	Influent to YMCA Pump Station	F-5	12"
		36	Allen and Memorial	F-5	12"
		37	W of Park and 33	F-5	10"
		38	W of Park and 33	F-5	30"
		39	Thomas N of Main	G-5	36"
		40	Hocking and Wheeling	G-5	18"
		41	High and Canal	H-6	10"
		42	E end of Carpenter	H-6	12"
		43	8th and Slocum	F-5	10"
		17	CSO 1004	G-6	42"
		18	CSO 1005	G-6	18"
4	5/14/96	44	Hocking and Harrison	F-5	30"
		45	Pershing and Arlington	E-5	18"
		46	Zimmer and Meda	F-5	24"
		47	Ety Road	E-4	18"
		48	Hocking and Beacon	F-5	10"
		49	Lake and Edgemont	F-6	30"
		50	Locust and Baldwin Run	G-7	15"
		51	Locust and Baldwin Run	G-7	15"
		52	Wheeling and Fulkerson	G-7	12"
		53	NE Wheeling and Livingston	G-7	12"
5	6/3/96	54	CSO 1031 (Wheeling & Maple)	G-6	42"
		55	N of CSO 1030	G-6	15"
		56	S of CSO 1030	G-6	15"
		58	E of CSO 1032	G-6	15"
		57	W of CSO 1032	G-6	15"

FIGURE 3-2

**COMBINED SEWER SYSTEM CHARACTERIZATION REPORT
1996 FLOW MONITORING LOCATIONS - WET & DRY WEATHER
(Sheet 3 of 3)**

PERIOD	DATE	NUMBER	LOCATION	ATLAS SHEET NO.	PIPE SIZE
6	6/13/96	59	CSO 1010	G-5	24"
		60	CSO 1021 Upstream	G-5	24"
		61	CSO 1021 Downstream	G-5	24"
		62	Mulberry and George	G-5	15"
		63	Union and George	G-5	18"
7	7/26/96	27	S Broad and Lewis	H-6	24"
		64	3rd S of Eyman	H-6	12"
		65	Hubert E of 2nd	H-6	8"
		30	Hubert W of 2nd	H-6	12"
		66	2nd N of Elm	H-6	24"
8	9/10/96	28	Lewis and Whiley	H-6	30"
		67	Lewis and Hunter	H-5	12"
		29	Witte N of CSX RR	G-5	24"
		68	Cedar Hill and Pierce	G-5	12"
		69	Chestnut and Baker	G-5	24"
9	10/7/96	67	Lewis and Hunter	H-5	12"
		70	Hubert W of Hunter	H-5	8"
		71	Hunter and Reese	H-5	8"
		72	CSO 1017 (N. Broad/Sixth)	F-6	36"
		73	CSO 1018 (N. Broad/Mulberry)	G-6	12"
10	11/20/96	74	N Broad N of 6th	F-6	36"
		75	N Broad S of 6th	F-6	24"
		76	CSO 8 Upstream	G-5	24"
		77	CSO 8 Downstream	G-5	10"

Figure 3-4

**Combined Sewer Characterization Report
Overflow Sampling Record**

Location	Date	Rainfall (in)	Start Time (1)	Remarks	Laboratory ID #
CSO 1019	03/25/1996	~0.1	NA	Sample not analyzed because sample was removed from manhole after 48 hour hold time.	NA
	04/01/1996	~0.5	10:31	Samples analyzed from bottles 1, 2, 3, 4, 7,10, 13, 17 and 21.	455
	04/04/1996	~0.25	NA	Sampler inhibited by debris on pickup tube.	NA
	04/15/1996	~0.65	15:37	Samples analyzed from bottles 1, 2, 3, 4, 5, 9, 13	531
CSO 1013	04/22/1996	~0.25	19:30	Samples analyzed from bottles 2, 3, 4, 5, 8 and 10. Bottles 1, 6,7 and 9 were empty.	569
	04/23/1996	~0.5	NA	Samples were collected from bottles 10, 11, and 12 Samples were not analyzed since "first" flush was not collected.	NA
	04/26/1996	~0.2	15:15	Samples analyzed from bottles 1 to 9 except 5 and 6 which did not contain liquid.	596
	04/28/1996	~0.25	17:30	Samples analyzed from bottles 1,2,3,4,5,9 and 13. Samples collected through bottle 15.	606
	04/29/1996	~1.5		Sample analyzed from bottle 1. No other samples collected. Flow collection tube became disconnected and went downstream.	618
CSO 1012	04/22/1996	~0.25	NA	No sample collected. Sample tube not in overflow stream.	NA
	04/23/1996	~0.5	NA	No sample collected. Sample tube not in overflow stream.	NA
	04/26/1996	~0.2	NA	No sample collected. Sample tube not in overflow stream.	NA
	04/28/1996	~0.25	NA	No sample collected. Sample tube not in overflow stream.	NA
	04/29/1996	~1.5		Sample analyzed from bottle 2. No other samples collected. Sample tube not in overflow stream.	617

(1) Samples collected from an Isco sampler at 15 minute increments after start of overflow event

Figure 3-4
Combined Sewer Characterization Report
Overflow Sampling Record
(Continued)

Location	Date	Rainfall (in)	Start Time (1)	Remarks	Laboratory ID #
CSO 1014	05/04/1996	~0.6		Sample collected in bottles 1 to 8 Sample analyzed from bottles 1 to 7	646
	05/08/1996	~0.2	21:25	Sample collected in bottles 1 to 6. Analyzed samples 1 to 4	694
CSO 1033	05/04/1996	~0.6		Sample collected in bottles 1 to 8 Sample analyzed from bottles 1 - 8	647
	05/08/1996	~0.2	21:25	Sample collected in bottles 1 to 6	695
CSO 1031	06/03/1996	~0.35	19:16	Sample collected in bottles 1, 2, 3, 4, 11, 12 All samples analyzed.	833
	06/07/1996	~0.38	18:29	Sample collected in bottles 1 - 7 Analyzed bottles 1 - 5	860
CSO 1029	6/14/96	1.46	15:30	Sample collected in bottle 1 & 2 and analyz Pick up tube became disconnected and sample collection stopped after 1 bottle.	903
	6/18/96	0.09	19:41	Sample collected in bottles 1 - 4. Analyzed sample from bottles 1 - 4.	929
	06/30/1996	0.25		Sample collected in bottles Analyzed bottles	
CSO 1004	07/30/1996	0.081	13:15	Sample collected in bottles 1, 5, 6, 7, 9 - 13 Analyzed sample from bottles 1, 5, 6, 7, 9, 13 Volume of overflow was 250,000 gallons	1197
CSO 1026	08/24/1996		6:45	Sample collected in bottle 1 and analyzed.	1448
CSO 1027	9/26/96	0.09	11:18	Sample collected in 2 bottles. Samples wer analyzed for metals only. (small quantity collected and checking for industry impact)	1834
	9/27/96	1.57	22:37	Sample collected in 4 bottles. Samples wer analyzed for metals only. (small quantity collected and checking for industry impact)	1837
	10/9/96	0.49		Sample collected in 2 bottles. Samples wer analyzed from bottles 1 & 2.	1837
CSO 1016	11/21/1996	0.05	11:21	Sample collected in bottles 2 - 8 Sampler not checked after rain event due to small rainfall.	

(1) Samples collected from an Isco sampler at 15 minute increments after start of overflow event

Figure 3-5A
Lancaster CSO Pollutant Concentrations
Average of CSO Samples Collected April 1996 - October 1996

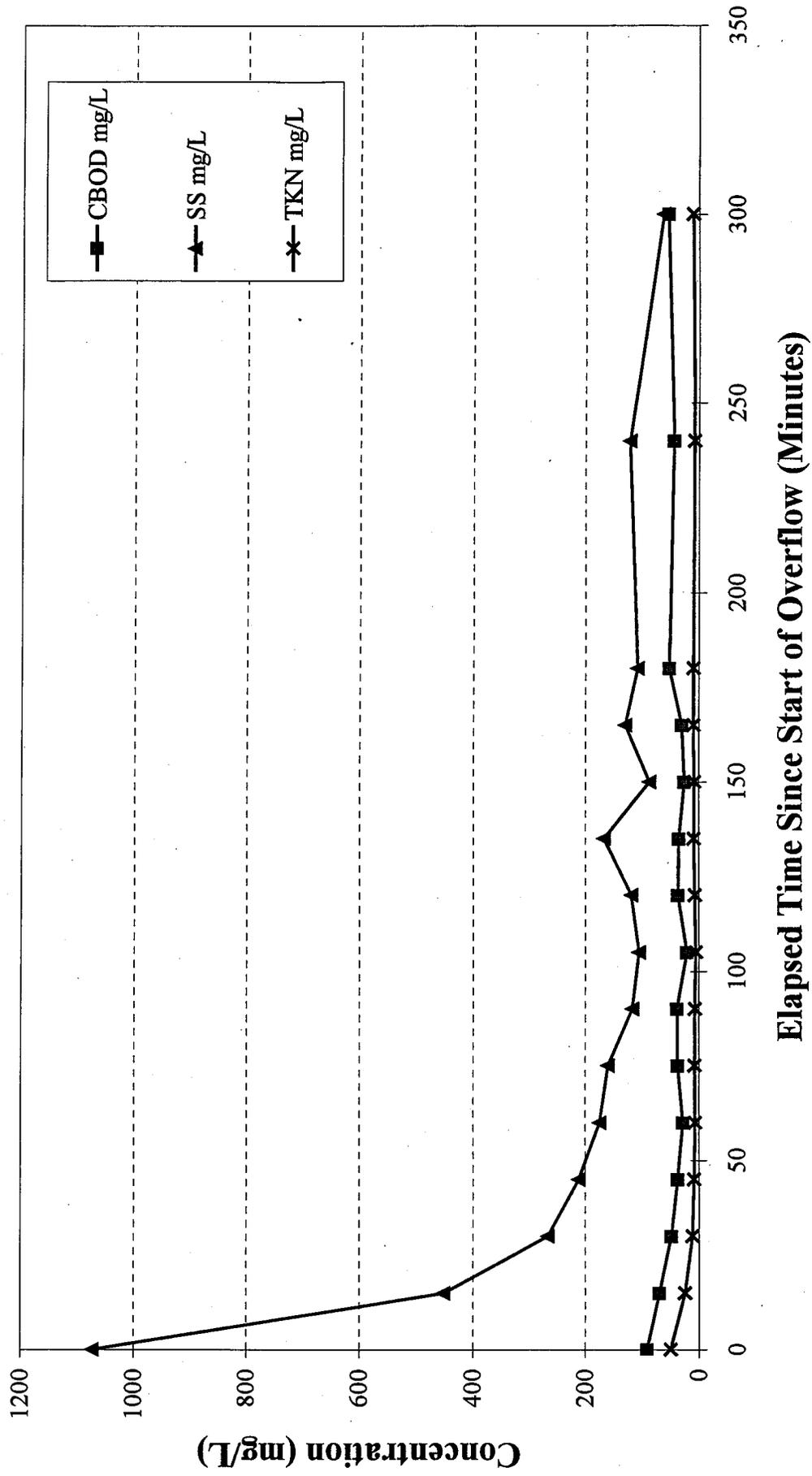
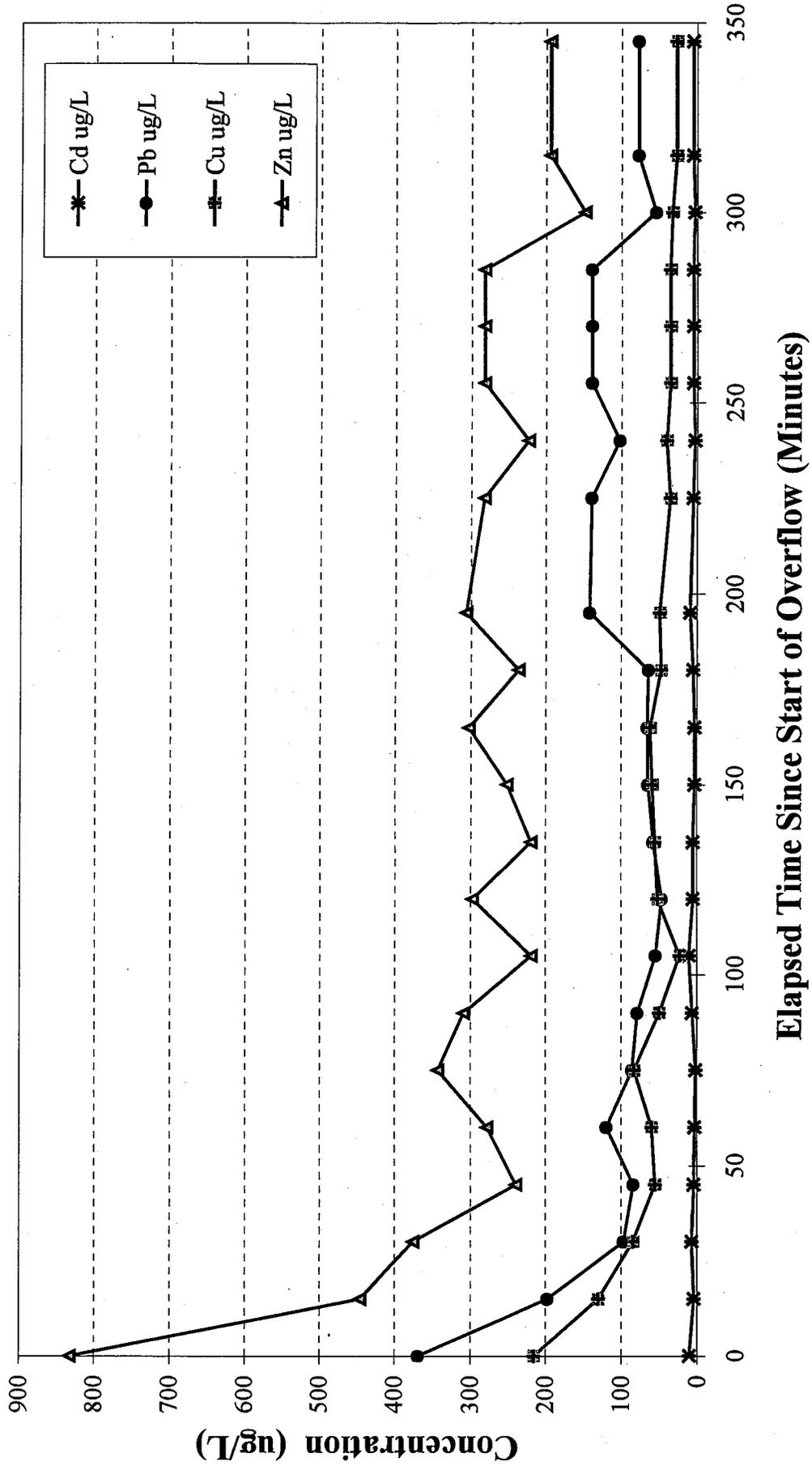


Figure 3-5B
Lancaster CSO - Pollutant Concentrations
Average of CSO Samples Collected April 1996 - October 1996



**Figure 3-6
Lancaster CSO Overflow Activation Observations March - November 1996**

CSO No.	CSO Location	Monitoring Period 1																Verified Overflow Events						
		Premonitoring								Rain Date									Rain 3/16 - 4/15					
		3/16	3/19	3/20	3/21	3/23	3/25	3/31	4/1	4/4	4/13	4/15	3/16	3/19	3/20	3/21	3/23			3/25	3/31	4/1	4/4	4/13
	Water Storage Tank Rain Gage	0.16	1.10																0.51	0.25	0.02	0.68	2.84	Rain Events Selected = 3
	Highway Patrol Rain Gage	0.15	1.08		Rain/snow														0.42	0.26	0.05	0.61	2.65	
	WPCD Rain Gage	0.12	1.07	0.49	0.26	0.00	0.03	0.02	0.56	0.24	NA	0.56	0.24	NA	NA	2.79								
1004	West Perimeter of WWTP	(1)	(1)	(1)														Yes	No	No		Yes		2
1005	N. Bank IN & OH RR and Hocking River	(1)	(1)	(1)														Yes	Yes	Yes		Yes		3
1006	S. Bank IN & OH RR and Hocking River (19)	(1)	(1)	(1)														Yes	No	No		No		1
1007	S. Broad (Chestnut thru S. Columbus) (2)	(1)	(1)	(1)														(2)	(2)	(2)		(2)		3
1008	Lincoln and Hocking River	(1)	(1)	(1)														No	No	No		Yes		1
1009	Mulberry and Memorial	(1)	(1)	(1)														Yes	Yes	Yes		Yes		3
1010	Mulberry and Hocking	(1)	(1)	(1)														No (3)	No (3)	No (3)		No (3)		0
1011	Union and Memorial	(1)	(1)	(1)														Yes	Yes	Yes		Yes		3
1012	5th and Memorial	(1)	(1)	(1)														Yes	Yes	Yes		Yes		3
1013	6th and Memorial	(1)	(1)	(1)														Yes	Yes	Yes		No		2
1014	Allen and Memorial	(1)	(1)	(1)														No	No	No		Yes		1
1015	N. Broad and Fair	(1)	(1)	(1)														Yes	No	No		Yes		2
1016	6th and N. Broad	(1)	(1)	(1)														Yes	Yes	Yes		Yes		3
1017	5th and N. Broad	(1)	(1)	(1)														No	No	No		No		0
1018	N. Broad and Mulberry	(1)	(1)	(1)														Yes	No	No		(6)		1
1019	SE Corner Mary Burnham Park	(1)	(1)	(1)														Yes	Yes	Yes		Yes		4
1020	Chestnut and Brooks	(1)	(1)	(1)														(4)	No	No		(4)		0
1021	Union and Garfield	(1)	(1)	(1)														No	No	No		Yes		1
1022	Columbus and Wilson	(1)	(1)	(1)														No	No	No		Yes		1
1023	High N. of Fair	(1)	(1)	(1)														No	No	No		No		0
1024	Wheeling and Livingston	(1)	(1)	(1)														(5)	No	No		(6)		0
1026	NE Corner Mary Burnham Park	(1)	(1)	(1)														Yes	Yes	Yes		Yes		3
1027	Walnut and Whiteley	(1)	(1)	(1)														Yes	(6)	(6)		Yes		2
1028	6th and Pierce	(1)	(1)	(1)														No	No	No		No		0
1029	6th and Boyd	(1)	(1)	(1)														Yes	Yes	Yes		Yes		3
1030	Walnut and Maple	(1)	(1)	(1)														No	No	No		No		0
1031	Wheeling and Maple	(1)	(1)	(1)														Yes	Yes	Yes		Yes		3
1032	Maple and Alley N. of Main	(1)	(1)	(1)														No	No	No		Yes		1
1033	Park and Memorial	(1)	(1)	(1)														Yes	No	No		Yes		2
1034	Baldwin Run and Lawrence	(1)	(1)	(1)																		Yes		1
1035	E. of Park and Columbus	(1)	(1)	(1)														No	No	No		No		0
	Lincoln and Hunters Run (19)	(1)	(1)	(1)														No	No	No		No		0
1037	Wildwood and Pershing (Closed)	(1)	(1)	(1)														No	No	No		No		0
Total Overflows per Rain Event		(1)	(1)	(1)														1	16	10		20		49

**Figure 3-6
Lancaster CSO Overflow Activation Observations March - November 1996**

CSO No.	CSO Location	Monitoring Period 2													Verified Overflow Events
		Rain Date													
		4/19	4/20	4/22	4/23	4/26	4/28	4/29	4/30	5/1	5/3(9)	Rain 4/19 - 5/3			
	Water Storage Tank Rain Gage	0.05	0.20	0.26	0.54	0.19	0.26	1.44	0.51	0.30	NA	3.75	Rain Events Selected =		
	Highway Patrol Rain Gage	0.00	0.22	0.29	0.47	0.24	0.24	1.85	0.57	0.24	NA	4.12	2		
	WPCD Rain Gage	NA	0.23	0.28	0.53	0.19	0.23	1.35	0.53	0.35	NA	3.69			
1004	West Perimeter of WWTP	(7)	(7)	Yes		(8)	(8)	(8)	(8)	(8)	Yes		2		
1005	N. Bank IN & OH RR and Hocking River	(7)	(7)	Yes		(8)	(8)	(8)	(8)	(8)	Yes		2		
1006	S. Bank IN & OH RR and Hocking River (19)	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	Yes		1		
1007	S. Broad (Chestnut thru S. Columbus) (2)	(7)	(7)	(1)		(8)	(8)	(8)	(8)	(8)	Yes		1		
1008	Lincoln and Hocking River	(7)	(7)	Yes		(8)	(8)	(8)	(8)	(8)	No		1		
1009	Mulberry and Memorial	(7)	(7)	Yes		(8)	(8)	(8)	(8)	(8)	Yes		2		
1010	Mulberry and Hocking	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	No (3)		0		
1011	Union and Memorial	(7)	(7)	Yes		(8)	(8)	(8)	(8)	(8)	No		1		
1012	5th and Memorial	(7)	(7)	Yes		(8)	(8)	(8)	(8)	(8)	Yes		2		
1013	6th and Memorial	(7)	(7)	Yes		(8)	(8)	(8)	(8)	(8)	(10)		2		
1014	Allen and Memorial	(7)	(7)	Yes		(8)	(8)	(8)	(8)	(8)	Yes		2		
1015	N. Broad and Fair	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	Yes		1		
1016	6th and N. Broad	(7)	(7)	Yes		(8)	(8)	(8)	(8)	(8)	Yes		2		
1017	5th and N. Broad	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	No		0		
1018	N. Broad and Mulberry	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	Yes		1		
1019	SE Corner Mary Burnham Park	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	Yes		1		
1020	Chestnut and Brooks	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	(6)		0		
1021	Union and Garfield	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	No		0		
1022	Columbus and Wilson	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	Yes		1		
1023	High N. of Fair	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	No		0		
1024	Wheeling and Livingston	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	(6)		0		
1026	NE Corner Mary Burnham Park	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	Yes		1		
1027	Walnut and Whiley	(7)	(7)	Yes		(8)	(8)	(8)	(8)	(8)	Yes		2		
1028	6th and Pierce	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	No		0		
1029	6th and Boyd	(7)	(7)	Yes		(8)	(8)	(8)	(8)	(8)	(10)		2		
1030	Walnut and Maple	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	Yes		1		
1031	Wheeling and Maple	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	Yes		1		
1032	Maple and Alley N. of Main	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	Yes		1		
1033	Park and Memorial	(7)	(7)	Yes		(8)	(8)	(8)	(8)	(8)	Yes		2		
1034	Baldwin Run and Lawrence	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	Yes		1		
1035	E. of Park and Columbus	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	No		0		
	Lincoln and Hunters Run (19)	(7)	(7)	Yes		(8)	(8)	(8)	(8)	(8)	No		1		
1037	Wildwood and Pershing (Closed)	(7)	(7)	No		(8)	(8)	(8)	(8)	(8)	No		0		
Total Overflows per Rain Event		(7)	(7)	13		(8)	(8)	(8)	(8)	(8)	21		34		

**Figure 3-6
Lancaster CSO Overflow Activation Observations March - November 1996**

CSO No.	CSO Location	Monitoring Period 3											Verified Overflow Events
		Rain Date											
		5/4	5/5	5/6(9)	5/7	5/8	5/9	5/9(9)	5/10	5/11(9)	Rain 5/4 - 5/11	Rain Events Selected =	
	Water Storage Tank Rain Gage	0.97	0.00	NA	0.00	0.00	0.00	NA	0.00	0.00	1.00	3	
	Highway Patrol Rain Gage	0.89	0.20	NA	0.20	0.69	0.09	NA	0.34	0.61	7.00	3	
	WPCD Rain Gage	1.08	0.32	NA	0.11	0.20	0.39	NA	0.35	1.00	7.00	3	
1004	West Perimeter of WWTP			Yes				Yes		Yes		3	
1005	N. Bank IN & OH RR and Hocking River			Yes				Yes		Yes		3	
1006	S. Bank IN & OH RR and Hocking River (19)			No				No		No		0	
1007	S. Broad (Chestnut thru S. Columbus) (2)			(2)				(2)		Yes		3	
1008	Lincoln and Hocking River			Yes				(6)		(10)		2	
1009	Mulberry and Memorial			Yes				Yes		Yes		3	
1010	Mulberry and Hocking			No (3)				Yes(3)		(3)(6)		1	
1011	Union and Memorial			Yes				Yes		(10)		3	
1012	5th and Memorial			Yes				Yes		(10)		3	
1013	6th and Memorial			(10)				Yes		(10)		3	
1014	Allen and Memorial			Yes				Yes		Yes		3	
1015	N. Broad and Fair			Yes				Yes		Yes		3	
1016	6th and N. Broad			(6)				Yes		Yes		2	
1017	5th and N. Broad			No				No		No		0	
1018	N. Broad and Mulberry			No				Yes		Yes		2	
1019	SE Corner Mary Burnham Park			Yes				Yes		Yes		3	
1020	Chestnut and Brooks			No				(6)		Yes		1	
1021	Union and Garfield			No				No		No		0	
1022	Columbus and Wilson			Yes				Yes		Yes		3	
1023	High N. of Fair			Yes				No		No		1	
1024	Wheeling and Livingston			No				No		(6)		0	
1026	NE Corner Mary Burnham Park			Yes				Yes		(6)		2	
1027	Walnut and Whiley			Yes				Yes		(10)		3	
1028	6th and Pierce			No				No		No		0	
1029	6th and Boyd			Yes				Yes		(6)		2	
1030	Walnut and Maple			No				No		Yes		1	
1031	Wheeling and Maple			Yes				Yes		(10)		3	
1032	Maple and Alley N. of Main			No				No		Yes		1	
1033	Park and Memorial			Yes				Yes		Yes		3	
1034	Baldwin Run and Lawrence			Yes				No		No		1	
1035	E. of Park and Columbus			No				No		No		0	
	Lincoln and Hunters Run (19)			No				No		No		0	
1037	Wildwood and Pershing (Closed)			No				No		No		0	
Total Overflows per Rain Event				19				19		20		58	

**Figure 3-6
Lancaster CSO Overflow Activation Observations March - November 1996**

CSO No.	CSO Location	Monitoring Period 4											Verified Overflow Events		
		Rain Date													
		5/15	5/16	5/17(9)	5/21	5/23	5/27	5/28(9)	5/28-29	Rain 5/15 - 5/29		Rain Events Selected =			
	Water Storage Tank Rain Gage	0.00	0.23	NA	0.07	0.13	0.77	NA	1.07				2.27	2	4
	Highway Patrol Rain Gage	1.05	0.15	NA	0.06	0.12	0.83	NA	1.16				3.37	3	4
	WPCD Rain Gage	1.27	0.20	NA	0.05	0.18	1.09	NA	1.27				4.06	4	4
1004	West Perimeter of WWTP			Yes	No				Yes					3	
1005	N. Bank IN & OH RR and Hocking River			(10)	No				Yes					3	
1006	S. Bank IN & OH RR and Hocking River (19)			No	No				No					1	
1007	S. Broad (Chestnut thru S. Columbus) (2)			Yes	(2)				Yes					4	
1008	Lincoln and Hocking River			Yes	No				Yes					3	
1009	Mulberry and Memorial			Yes	No				Yes					3	
1010	Mulberry and Hocking			(3)(6)	No				No (3)					1	
1011	Union and Memorial			Yes	No				Yes					3	
1012	5th and Memorial			Yes	Yes				Yes					4	
1013	6th and Memorial			Yes	Yes				Yes					4	
1014	Allen and Memorial			Yes	No				Yes					3	
1015	N. Broad and Fair			No	No				Yes					2	
1016	6th and N. Broad			Yes	No				Yes					3	
1017	5th and N. Broad			No	No				No					1	
1018	N. Broad and Mulberry			(6)	No				(6)					1	
1019	SE Corner Mary Burnham Park			Yes	Yes				Yes					4	
1020	Chestnut and Brooks			(6)	No				Yes					1	
1021	Union and Garfield			No	No				No					1	
1022	Columbus and Wilson			No	No				(6)					0	
1023	High N. of Fair			No	No				Yes					2	
1024	Wheeling and Livingston			No	No				(6)					1	
1026	NE Corner Mary Burnham Park			Yes	Yes				Yes					3	
1027	Walnut and Whitley			Yes	No				Yes					3	
1028	6th and Pierce			No	No				Yes					2	
1029	6th and Boyd			Yes	No				Yes					3	
1030	Walnut and Maple			No	No				Yes					2	
1031	Wheeling and Maple			Yes	No				Yes					3	
1032	Maple and Alley N. of Main			No	No				Yes					2	
1033	Park and Memorial			Yes	No				Yes					2	
1034	Baldwin Run and Lawrence			Yes	No				Yes					3	
1035	E. of Park and Columbus			No	No				No					0	
	Lincoln and Hunters Run (19)			No	No				No					0	
1037	Wildwood and Pershing (Closed)			No	No				No					1	
Total Overflows per Rain Event				17	5			23	27					72	

**Figure 3-6
Lancaster CSO Overflow Activation Observations March - November 1996**

CSO No.	CSO Location	Monitoring Period 5														Verified Overflow Events	
		Rain Date															
		6/2	6/3	6/4	6/6-7	6/7	6/8	6/9	6/10	6/11(9)	6/11	6/12	Rain 6/2 - 6/12	Rain Events Selected =			
	Water Storage Tank Rain Gage	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Highway Patrol Rain Gage	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	WPCD Rain Gage	0.52	0.34	0.13	0.95	0.36	0.23	0.25	0.02								3.11
	West Perimeter of WWTP	(8)	Check Plant Data														
1004	N. Bank IN & OH RR and Hocking River	(8)	(11)	(11)	(11, 12)									(14)	Yes		1
1005	S. Bank IN & OH RR and Hocking River (19)	(8)	Yes	No	Yes									(14)	No		2
1006	S. Broad (Chestnut thru S. Columbus) (2)	(8)	(2)	No	Yes									(14)	Yes		3
1007	Lincoln and Hocking River	(8)	Yes	No	(12)									(14)	Yes		2
1008	Mulberry and Memorial	(8)	(11)	(11)	(11, 12)									(14)	Yes		1
1009	Mulberry and Hocking	(8)	No	No	(6)									(14)	No		0
1010	Union and Memorial	(8)	(11)	(11)	(11, 12)									(14)	Yes		1
1011	5th and Memorial	(8)	(11)	(11)	(11, 12)									(14)	Yes		1
1012	6th and Memorial	(8)	(11)	(11)	(11, 12)									(14)	Yes		1
1013	Allen and Memorial	(8)	Yes	Yes	Yes									(14)	Yes		4
1014	N. Broad and Fair	(8)	No	No	Yes									Yes	Yes		3
1015	6th and N. Broad	(8)	Yes	Yes	Yes									Yes	Yes		5
1016	5th and N. Broad	(8)	No	No	No									No	No		0
1017	N. Broad and Mulberry	(8)	No	No	Yes									Yes	(6)		2
1018	SE Corner Mary Burnham Park	(8)	Yes	Yes	Yes									Yes	Yes		5
1019	Chestnut and Brooks	(8)	No	No	Yes									No	No		1
1020	Union and Garfield	(8)	No	No	Yes									(14)	No		1
1021	Columbus and Wilson	(8)	No	Yes	(11, 12)									(14)	(6)		1
1022	High N. of Fair	(8)	No	No	No									No	No		0
1023	Wheeling and Livingston	(8)	No	No	(6)									Yes	No		1
1024	NE Corner Mary Burnham Park	(8)	Yes	No	Yes									Yes	Yes		4
1025	Walnut and Whiley	(8)	(11)	(11)	(11, 12)									(14)	(11, 12)		0
1026	6th and Pierce	(8)	No	No	Yes									(14)	Yes		2
1027	6th and Boyd	(8)	Yes	Yes	Yes									Yes	Yes		5
1028	Walnut and Maple	(8)	No	No	Yes									(14)	Yes		2
1029	Wheeling and Maple	(8)	Yes	Yes	Yes									(14)	Yes		2
1030	Maple and Alley N. of Main	(8)	Yes	Yes	Yes									(14)	Yes		4
1031	Park and Memorial	(8)	No	No	Yes									(14)	Yes		2
1032	Baldwin Run and Lawrence	(8)	No	No	No									(14)	Yes		4
1033	E. of Park and Columbus	(8)	No	No	No									(14)	No		0
1034	Lincoln and Hunters Run (19)	(8)	No	No	No									(14)	No		0
1035	Wildwood and Pershing (Closed)	(8)	No	No	No									(14)	No		0
1037		(8)	No	No	No									(14)	No		0
	Total Overflows per Rain Event		10	7	16									7	18		58

**Figure 3-6
Lancaster CSO Overflow Activation Observations March - November 1996**

CSO No.	CSO Location	Monitoring Period 6						Monitoring Period 7			Verified Overflow Events	Rain 7/22 - 9/10	Verified Overflow Events Selected =			
		Rain Date						Rain Date								
		6/14	6/30	7/15	7/18	7/22	6/13 - 7/22	7/30	8/8	8/24				9/6		
	Water Storage Tank Rain Gage	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Highway Patrol Rain Gage	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	WPCD Rain Gage	1.46	0.27	0.71	2.01	0.71	5.16	0.81	0.10	0.20	0.77	1.88	0.77	1.88	0.77	1.88
1004	West Perimeter of WWTP	Check plant data	Check plant data	Check plant data	Check plant data	Check plant data	Check plant data	Check plant data	Check plant data	Check plant data	Check plant data	Check plant data	Check plant data	Check plant data	Check plant data	Check plant data
1005	N. Bank IN & OH RR and Hocking River	Yes	Yes	Yes	Yes	Yes	(16)	Yes	(17)	(18)	Yes	(17)	Yes	(17)	Yes	(17)
1006	S. Bank IN & OH RR and Hocking River (19)	Yes	No	No	Yes	(11,16)	(16)	Yes	(17)	No	No	(17)	Yes	(17)	No	No
1007	S. Broad (Chestnut thru S. Columbus) (2)	Yes	(2)	Yes	Yes	(2)	(2)	Yes	(17)	Yes	No	(17)	Yes	(17)	No	No
1008	Lincoln and Hocking River	Yes	Yes	Yes	Yes	Yes (11)	Yes (11)	Yes	(17)	Yes	Yes	(17)	Yes	(17)	Yes	Yes
1009	Mulberry and Memorial	(6)	Yes	Yes	Yes (11)	Yes (11)	Yes (11)	Yes	(17)	Yes	Yes	(17)	Yes	(17)	Yes	Yes
1010	Mulberry and Hocking	Yes	No	No	(6)	No	No	Yes	(17)	No	No	(17)	Yes	(17)	No	No
1011	Union and Memorial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	(17)	Yes	Yes	(17)	Yes	(17)	Yes	Yes
1012	5th and Memorial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	(17)	Yes	Yes	(17)	Yes	(17)	Yes	Yes
1013	6th and Memorial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	(17)	Yes	Yes	(17)	Yes	(17)	Yes	Yes
1014	Allen and Memorial	Yes	(6)	Yes	Yes	Yes	Yes	Yes	(17)	Yes	Yes	(17)	Yes	(17)	Yes	Yes
1015	N. Broad and Fair	Yes	Yes	Yes	Yes	Yes	Yes	Yes	(17)	No	No	(17)	Yes	(17)	No	No
1016	6th and N. Broad	Yes	Yes	Yes	Yes	Yes	Yes	Yes	(17)	No	No	(17)	Yes	(17)	No	No
1017	5th and N. Broad	Yes	Yes	Yes	Yes	Yes	Yes	Yes	(17)	No	No	(17)	Yes	(17)	No	No
1018	N. Broad and Mulberry	Yes	(6)	Yes (15)	Yes	Yes	Yes	Yes	(17)	No	No	(17)	Yes	(17)	No	No
1019	SE Corner Mary Burnham Park	Yes	Yes (15)	Yes (15)	Yes	Yes (15)	Yes (15)	Yes	(17)	No	No	(17)	Yes	(17)	No	No
1020	Chestnut and Brooks	Yes	(6)	No	Yes	No	No	Yes	(17)	Yes	Yes	(17)	Yes	(17)	No	No
1021	Union and Garfield	Yes	No	Yes (15)	No	No	No	Yes	(17)	No	No	(17)	Yes	(17)	No	No
1022	Columbus and Wilson	(6)	(6)	(6)	No	No	No	Yes	(17)	No	No	(17)	Yes	(17)	No	No
1023	High N. of Fair	Yes	No	No	No	No	No	No	(17)	No	No	(17)	Yes	(17)	No	No
1024	Wheeling and Livingston	Yes	(6)	Yes	Yes	(6)	(6)	Yes	(17)	No	No	(17)	Yes	(17)	No	No
1026	NE Corner Mary Burnham Park	Yes	Yes	Yes	Yes	Yes	Yes	Yes	(17)	Yes	Yes	(17)	Yes	(17)	Yes	Yes
1027	Walnut and Whiley	Yes	(6)	Yes	Yes	(6)	(6)	Yes	(17)	Yes	Yes	(17)	Yes	(17)	Yes	Yes
1028	6th and Pierce	Yes	No	No	Yes	Yes	Yes	Yes	(17)	No	No	(17)	Yes	(17)	No	No
1029	6th and Boyd	Yes	(11,12)	Yes	Yes	Yes	Yes	Yes	(17)	No	No	(17)	Yes	(17)	No	No
1030	Walnut and Maple	Yes	(6)	(6)	(6)	No	No	Yes	(17)	Yes	Yes	(17)	Yes	(17)	Yes	Yes
1031	Wheeling and Maple	Yes	Yes	(6)	Yes	Yes	Yes	Yes	(17)	No	No	(17)	Yes	(17)	No	No
1032	Maple and Alley N. of Main	Yes	(6)	(6)	(6)	(6)	(6)	Yes	(17)	Yes	Yes	(17)	Yes	(17)	Yes	Yes
1033	Park and Memorial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	(17)	No	No	(17)	Yes	(17)	Yes	Yes
1034	Baldwin Run and Lawrence	Yes	No	Yes	Yes	Yes	Yes	Yes	(17)	Yes	Yes	(17)	Yes	(17)	Yes	Yes
1035	E. of Park and Columbus	(6)	No	No	No	No	No	No	(17)	No	No	(17)	No	(17)	No	No
	Lincoln and Hunters Run (19)	No	No	No	No	No	(16)	No	(17)	No	No	(17)	No	(17)	No	No
1037	Wildwood and Pershing (Closed)	(6)	No	No	(6)	No	No	No	(17)	No	No	(17)	No	(17)	No	No
Total Overflows per Rain Event		27	13	15	22	15	92	19	5	9	10	43	10	43	10	43

**Figure 3-6
Lancaster CSO Overflow Activation Observations March - November 1996**

CSO No.	CSO Location	Monitoring Period 8					Monitoring Period 9			Verified Overflow Events	Rain 9/10-9/28	Verified Overflow Events	Rain 9/10-11/20	Total Overflow Events
		Rain Date					Rain Date							
		9/13	9/16	9/21	9/28	9/28	10/9	10/18	11/6					
	Water Storage Tank Rain Gage	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Highway Patrol Rain Gage	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	WPCD Rain Gage	0.13	1.15	0.25	1.57	3.10	0.49	0.67	0.24	1.08	2.48	2.48	2.48	2.48
1004	West Perimeter of WWTP	No	No		Yes		Yes							
1005	N. Bank IN & OH RR and Hocking River	No			Yes		Yes		Yes					
1006	S. Bank IN & OH RR and Hocking River (19)	No	No		Yes		Yes		No					
1007	S. Broad (Chestnut thru S. Columbus) (2)	No	No		Yes		Yes		Yes					
1008	Lincoln and Hocking River	Yes	Yes	Yes	Yes		Yes		No					
1009	Mulberry and Memorial		Yes	Yes	Yes		Yes		No					
1010	Mulberry and Hocking		No		(6)				No					
1011	Union and Memorial		Yes	Yes	Yes		Yes		Yes					
1012	5th and Memorial		Yes	Yes	Yes		Yes		Yes					
1013	6th and Memorial		Yes	Yes	Yes		Yes		Yes					
1014	Allen and Memorial		Yes	Yes	Yes		Yes		Yes					
1015	N. Broad and Fair	No	No	Yes	Yes		Yes		No					
1016	6th and N. Broad		Yes	Yes	Yes		Yes		Yes					
1017	5th and N. Broad		No	No	No		No		(7)	(7)				
1018	N. Broad and Mulberry		Yes	Yes	(6)		Yes		(7)	(7)				
1019	SE Corner Mary Burnham Park	Yes	Yes	Yes	Yes		Yes		Yes					
1020	Chestnut and Brooks	No	Yes		No		No		No					
1021	Union and Garfield	No	No	No	Yes		Yes		Yes					
1022	Columbus and Wilson	No	Yes	No	Yes		Yes		Yes					
1023	High N. of Fair		No		No		No		No					
1024	Wheeling and Livingston	No	No	No	(6)				No					
1026	NE Corner Mary Burnham Park	No	Yes	Yes	Yes		Yes		Yes	(11,12)				
1027	Walnut and Whiley	Yes	Yes	Yes	Yes		Yes		Yes					
1028	6th and Pierce		No		Yes		Yes		No					
1029	6th and Boyd	No	Yes	Yes	Yes		Yes		Yes					
1030	Walnut and Maple		No		No		No		No					
1031	Wheeling and Maple		Yes	Yes	Yes		Yes		Yes	(11,12)				
1032	Maple and Alley N. of Main		Yes	Yes	(6)		No		No					
1033	Park and Memorial		Yes	Yes	Yes		Yes		Yes					
1034	Baldwin Run and Lawrence	No							No					
1035	E. of Park and Columbus		No		No		No		No					
	Lincoln and Hunters Run (19)	No	No	No	No		Yes		No					
1037	Wildwood and Pershing (Closed)	No	No	No	No		No		No					
	Total Overflows per Rain Event	3	17	14	21	55	18	10	13	41	502			

Figure 3-6
Lancaster CSO Overflow Activation Observations March - November 1996

Notes

1. Overflows were not checked because of flow meter installation.
2. Sanitary sewer connects to storm sewer in a series of 4 manholes.
3. Flap gate at headwall is buried with mud and cannot open.
4. Wet material on string possibly preventing block from moving.
5. Wet
6. Block is in Sanitary Pipe
7. Blocks were not reset prior to rain event due to meters being moved.
8. Could not reset blocks due to rain and current overflowing situations.
9. Blocks were checked after more than 1 rain event
10. Currently overflowing and could not reset block.
11. No block in manhole.
12. Replaced block
13. Blank space indicates overflows were not checked.
14. Block was not checked because of start of rain.
15. Preparing headwall for attachment of floodgate and could not see overflow block.
16. No flow visible from CSO headwall.
17. Block not checked
18. Weir plate is leaking
19. Acts as a Facility/Property Protection Device

Figure 3-7

**Lancaster CSO
Typical Installation of Floatable Collection System**

Installation of a Copatrawl® Net at CSO 1013 on June 13, 1996



**Figure 3-8
Lancaster CSO
Summary of Collected Floatable Material**

Location	Date	Rainfall		Volume Collected Gallons	Material Description	Remarks
		Inches	Hours			
CSO 1027 Walnut and Hocking River 27" Combined Sewer	5/27	1.09	30	0	None	Collection bag was split open but attached to headwall and laying in river when retrieved.
	5/29	1.27	10			
Canal at the End of High 18" Storm Sewer	6/6/96	0.13	0.25	4	98% Yard Waste - leaves, grass clippings 1% Plastic - straws, cup lids 1% Paper - Cigarette Butts	Collection bag was in water when retrieved.
Wheeling and Hocking River 24" Storm Sewer	6/6/96	0.13	0.25	1	35% Yard Waste - leaves, grass clippings 65% Plastic - straws, cup lids Paper - Cigarette Butts	Collection bag was not in water when retrieved.
CSO 1013 6th and Hocking River 24" Combined Sewer	6/6/96	0.13	0.25	5.5	85% Yard Waste - leaves, grass clippings 15% Plastic - straws, cup lids Paper - Cigarette Butts 1 rag	Collection bag was in water when retrieved.
CSO 1026 NE Corner of Mary Burnham Park 27" Combined Sewer	6/6/96	0.13	0.25	10	95% Yard Waste - leaves, grass clippings 5% Human Waste Plastic - straws, cup lids, comb Paper - Cigarette Butts	Collection bag was in water when retrieved.

**Figure 3-8
Lancaster CSO
Summary of Collected Floatable Material
(Continued)**

Canal at the End of High 18" Storm Sewer	6/14	1.48	1.5	~12	90% Gravel, stone, asphalt 10% Aluminum and plastic cans Plastic - straws, cup lids Paper - Cigarette Butts	Collection bag was setting in mud on headwall floor when retrieved.
Wheeling and Hocking River 24" Storm Sewer	6/14	1.48	1.5	~7	70% Gravel, stone, asphalt 30% Aluminum and plastic cans, grass Plastic - straws, cup lids Paper - Cigarette Butts	Collection bag was not in water when retrieved.
CSO 1013 6th and Hocking River 24" Combined Sewer	6/14	1.48	1.5	~10	95% Gravel, stone, asphalt 5% Grass, cigarette butts	Collection bag was split open but attached to headwall and and laying in river when retrieved.
CSO 1026 NE Corner of Mary Burnham Park 27" Combined Sewer	6/14	1.48	1.5	0	Some cigarette butts and Styrofoam	Collection bag was split open but attached to headwall and and laying in river when retrieved.

Figure 3-9

Lancaster CSO Floatable Material Collected on June 6, 1996

Floatable material collected from a storm line located on the north bank of the Hocking River at Canal St. and High St. on June 6, 1996.



Floatable material collected from the discharge CSO 1026 located on the west bank of Baldwin Run at the north end of Mary Burnham Park on June 6, 1996.



Figure 3-10

Lancaster CSO Floatable Material Collected on June 14, 1996

Floatable material collected from a storm line located on the east bank of the Hocking River at Wheeling St. on June 14, 1996.



Floatable material collected from the discharge from CSO 1013 located on the east bank of the Hocking River on 6th St. on June 14, 1996 (only gravel was visible due to the net failure).



4

4.0 COLLECTION SYSTEM MODELING

4.1 INTRODUCTION

The Lancaster wastewater collection system model will be used to characterize the sewer system. The characterization will estimate the sewer system's hydraulic capacity during dry weather and wet weather and estimate the quantity of flow and pollutants discharged from the system through its CSO structures. The model can also be used as a tool for estimating the impact future development will have on the Lancaster sewer.

The EPA developed the Storm Water Management Model (SWMM) in 1969. Over the past two decades, modifications and changes have been made to increase model capabilities and user friendliness. XP-Software Inc. developed a graphical version of the original SWMM program that allows graphical representation of the sewer system and graphical output. For this project, the City purchased XP-SWMM Version 1.33 (upgraded to Version 2.2).

The XP-SWMM program has three different components (layers) used for data input. The type of output desired from the model determines which layer(s) are used for data input. The three layers are described below in the order in which they would be used in the model.

- ▶ The RUNOFF layer generates surface runoff, pollutant concentrations, and subsurface runoff based on land topography, land use, soil conditions, and impervious area. The runoff flows and pollutants are generally based on antecedent conditions and actual or simulated precipitation hydrographs.
- ▶ The TRANSPORT layer routes flows and pollutants through open channels or closed pipes of a sewer system using information from either the RUNOFF layer or user defined information in the TRANSPORT layer. Dry weather flow (DWF) and infiltration into a sewer may be optionally generated using TRANSPORT. Pollutant concentration simulations (routing pollutant concentrations through the collection system) is available in TRANSPORT.
- ▶ The EXTRAN layer routes complex flow conditions such as surcharging, backwater, and interconnected networks through open or closed conduits of a sewer system. Flows generated by the RUNOFF and TRANSPORT layers

can be used in EXTRAN. Dry weather flow in the sewer may be generated from the TRANSPORT layer or optionally generated using EXTRAN. The ability to route pollutant concentrations through the collection system is not available in EXTRAN.

The City of Lancaster collection system model has been constructed using the RUNOFF and EXTRAN layers. This allows the City to route wet weather flows through the open channels and closed pipes of the wastewater collection system and evaluate complex hydraulic situations such as backwater and interconnected sewer networks.

4.2 MODEL CONSTRUCTION

Modeling urban runoff for a wastewater collection system requires various input data. In order for flows to be modeled, the sewer network must be constructed from record drawings showing pipe sizes, invert elevations, and ground elevations. Pump station, siphon, and CSO configurations must also be researched and built into the model. Next, dry weather flow (DWF) data is measured in the system and entered into the EXTRAN layer. To produce runoff for combined sewer areas, the drainage area, imperviousness, slope, catchment width, and infiltration are determined and defined in the RUNOFF layer. Once the structure of the model is established, the model can be calibrated using rainfall data from local rain gages and flows measured during dry and wet weather by flow meters installed in key sewer manholes.

4.2.1 EXTRAN Layer Construction

After the various pipe information was collected from the City Engineers's office, the combined and sanitary sewer data were entered into the EXTRAN layer of the model. The model was constructed for combined and sanitary sewers greater than or equal to 12 inches in diameter. These sewers represent the City's main wastewater collection system and reduce the number of conduits and nodes required by the model. However, some sewers less than 12-inches in diameter were included where necessary to create a working model. For example, small diameter sewers (less than 12-inches) were necessary in the model to allow the input of DWF in upstream branches of many drainage areas.

Industrial flows were also entered into the EXTRAN layer. The major industrial flows entered into the model were taken from the City's Industrial Pretreatment Program (IPP). Specific industries and their flowrates are listed below.

<u>Industry</u>	<u>Flowrate</u>
Akrosil	0.0212 mgd
Anchor Hocking Plant #1	0.2864 mgd
Baily Corporation	0.0199 mgd
Conn's Potato Chips	0.0108 mgd
Diamond Power	0.0067 mgd
Fairfield Medical Center	0.0961 mgd
Lancaster Electro Plating #1	0.0705 mgd
Lancaster Electro Plating #2	0.1313 mgd
Lancaster Glass	0.0314 mgd
Premier Auto Glass	0.1208 mgd
Ralston Foods	0.0901 mgd
RUS	0.0402 mgd
Sonoco Products	0.1506 mgd

The DWF within the system was calculated using the base flow data collected during the fall of 1995 and the spring of 1996. Before the base flow could be entered into the model, the measured residential/commercial DWF (baseflow - industrial) was proportionally divided to represent flows in branches of the wastewater collection system upstream of a given flow monitoring location. Using the City plat drawings, an average flow per parcel was developed for each of the monitored areas. The per parcel flow was then multiplied by the appropriate number of parcels within the branch to calculate the appropriate residential/commercial DWF for sewer system branches upstream of the monitoring point.

Precipitation data was also entered into the EXTRAN layer of the model. Actual precipitation measurements were entered into a global database and used for model calibration.

4.2.2 RUNOFF Layer Construction

Using topographical information from USGS maps and ground elevation data from sewer records, the runoff area, catchment width, and slope for each of the combined sewer subareas were determined and entered into the RUNOFF layer of the model. The catchment width and slope were calculated based on the configuration of the drainage area. An impervious percentage was assigned to each of the catchment areas based on the type of land use. In addition, soil infiltration factors were assigned to each catchment area based on the type of soil.

4.3 MODEL CALIBRATION

Model calibration is the process of adjusting model variables such that the model results represent actual measured data for a given event. Calibrating the model for several storm events provides assurance of the model's ability to predict actual conditions. At least two rain events were used for model calibration. When possible, storms with varying intensities, durations and rainfall totals were used. However, due to model complexity and the empirical formulas used to calculate flows within the system, calibration to a particular storm event may not represent all rain events.

Data used to calibrate the model consisted of:

- ▶ Measured peak flow rates at monitoring locations
- ▶ Measured total flow volumes at monitoring locations
- ▶ Measured CSO volumes at monitoring locations
- ▶ Measured depth of flow at monitoring locations

The measured data was compared with values calculated by the model. In order for the model calibration to be acceptable, the calibrated values had to be within 20%± of the actual measured values. When all model values could not be brought within 20%± of measured values, the model was calibrated so that at least the total volumes were satisfactory. For purposes of the characterization report, total volumes (including CSO volumes) were considered more important than peak flow rates.

The model calibration procedure is outlined in the following section for both dry and wet weather flow calibration.

4.3.1 Dry Weather Flow Calibration

Dry weather flow calibration verifies that the data entered into the model is producing the correct DWF at monitored locations. Once all of the residential/commercial DWF, industrial flow, and sewer characteristics were entered into the EXTRAN layer of the model, an EXTRAN layer simulation was run to generate flows and perform the hydraulic calculations. The results from this simulation were then compared with monitored data.

Little calibration is required for DWFs since they are based on the field measured flows and parameters in the model have little impact on the DWFs. In addition to verifying that the DWF is correct, this calibration step can be used to find incorrect input data values. These data values include ground elevations, sewer diameters, and sewer invert elevations.

4.3.2 Wet Weather Flow Calibration

The following calibration procedure was followed for each major drainage area that was flow monitored. A schematic of drainage areas and flow monitor locations is shown in Figure 3-3.

Calibration of the RUNOFF Layer

After the various runoff input values discussed in Section 4.2.2 were determined and entered into the model, an initial simulation for each individual area was performed using a rainfall event recorded during the monitoring period. The runoff volume from the initial simulation was compared with actual measured increased flow volume (WWF minus DWF) in the sewer system. If the volumes were not within the calibration goal of 20%±, runoff variables were adjusted and the simulation rerun. This process continued until the model output was within 20%± of the field measured values.

Calibration of the EXTRAN Layer

Once runoff variables were calibrated for a given storm, the data from the RUNOFF layer was entered into the EXTRAN layer through an interface file. These RUNOFF flows were then combined with the industrial and residential/commercial DWFs to determine the total flow in the collection system. Actual peak flow rates at meter locations were compared to the model output. If a slight difference existed between the meter data and the modeled data, the pipe roughness coefficient in the EXTRAN layer was adjusted. If the calibration values were substantially different, the variables in the RUNOFF layer were readjusted until a simulation for the RUNOFF and EXTRAN layers provided results that were within 20%± of the actual values.

After an area was calibrated for a particular rainfall event, a second rainfall event was chosen for the same area and a simulation performed. Again, simulated runoff volumes and measured Wet Weather Flow (WWF) volumes were compared. If the simulated volumes were not within the calibration goal, runoff variables were adjusted. After acceptable RUNOFF values were reached, the values were interfaced into EXTRAN and a simulation performed. The peak flow rate values were compared and variables adjusted until calibration goals were achieved.

An example of this procedure is provided in Figures 4-1 and 4-2. The model was calibrated for Drainage Area 5A using flow data collected from two storms:

04/04/96 - 0.24 inches in 5.75 hours

04/15/96 - 0.68 inches in 3 hours.

These storms varied sufficiently in length and intensity to calibrate the model. After many iterations, the model was calibrated to the values shown. The calibration process placed greater emphasis on matching measured volumes, followed next by matching peak flows and then matching measured depths.

After many simulations, final calibration variables were determined for each area. When a model simulation is performed, these variables generate the total flow volumes and peak flow rates for the selected rainfall simulation. Once each individual subarea was calibrated (similar to Figures 4-1 and 4-2), the subarea models were combined to create one overall model of the Lancaster wastewater collection system. Since the entire wastewater collection system model terminates at the Water Pollution Control Facility (WPCF), wet weather flow data from the WPCF was compared to modeled flows at the WPCF for a calibration of the entire Lancaster model.

4.4 CONTINUED MODEL DEVELOPMENT

The City's model is calibrated to represent the flow conditions that existed in the sewer system during the periods of wet and dry weather flow monitoring (fall of 1995 through the fall of 1996). In order for the model to continue to represent the sewer system, it must be updated to reflect collection system changes. These changes include updating the DWF to reflect the addition of flow from outlying areas, CSO removals, I/I removal, pump station rehabilitation and the addition of new sewer systems. Model calibration of a wastewater collection system is an ongoing process of using measured flow and precipitation data to predict flows within the system.

+ +END OF CHAPTER 4.0 + +
+ + FIGURES FOLLOW + +

FIGURE 4-1 TYPICAL MODEL CALIBRATION

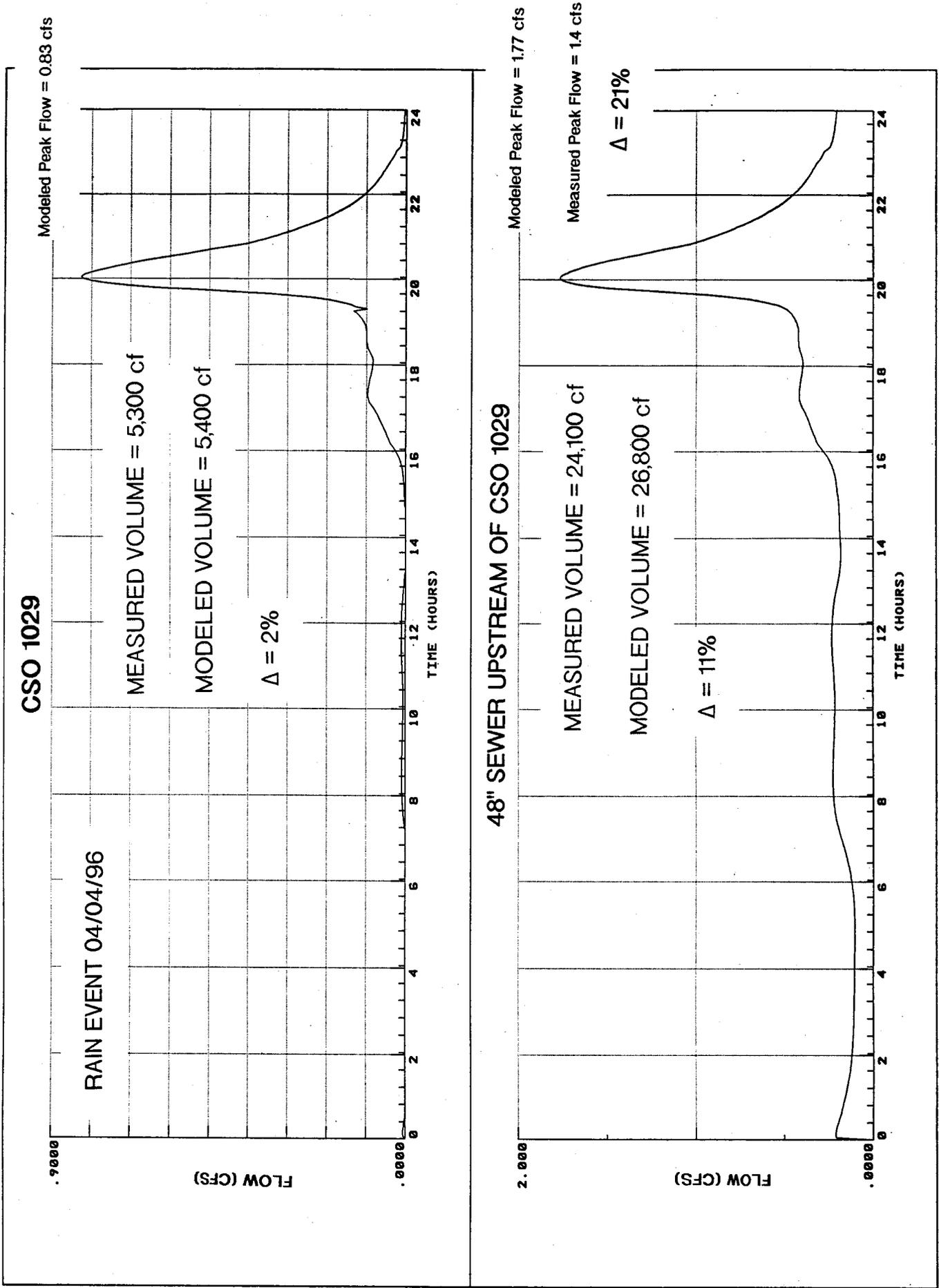
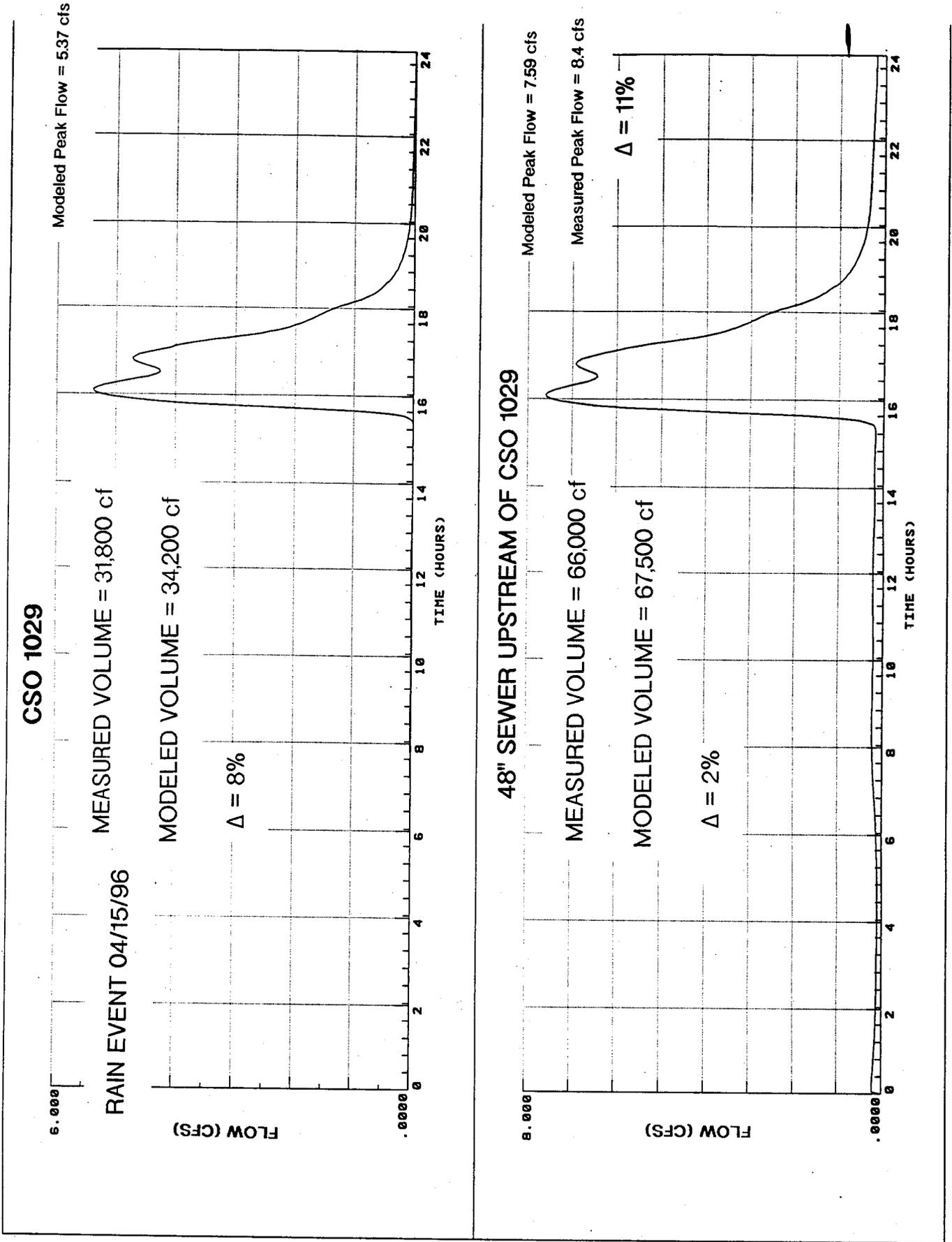


FIGURE 4-2 TYPICAL MODEL CALIBRATION



5

5.0 SYSTEM CHARACTERIZATION

5.1 INTRODUCTION

Characterization of the City of Lancaster's Combined Sewer System is required by the City's National Pollutant Discharge Elimination System (NPDES) permit.

The five objectives of sewer system characterization are:

- ▶ Develop an understanding of the collection system and how it responds to a variety of rain events.
- ▶ Identify separate sewer areas tributary to combined sewer overflows and determine their impacts on CSOs.
- ▶ Identify sources of toxic and hazardous pollutants within the combined sewer system.
- ▶ Quantify and characterize the combined sewer overflow (CSO) discharged to the Hocking River and its tributaries during rain events.
- ▶ Support the development of the Long Term Control Plan.

Each of these objectives is evaluated as part of this Combined Sewer System Characterization Report.

5.2 COLLECTION SYSTEM UNDERSTANDING

The development of the Lancaster Combined Sewer System Characterization Report has increased the City's knowledge of the overall wastewater collection system and how it responds to rainfall events.

5.2.1 Collection System Knowledge

The most significant improvements in the City's knowledge of its sanitary and combined sewer system are the developments of a new wastewater collection system base map, sewer atlas, and computer model of the City's wastewater collection system. These are powerful tools that the City can use to operate and maintain its system.

The wastewater collection system base map updated the City's existing map. Recent housing developments were added and combined and sanitary drainage areas were defined. The base map was produced in an electronic format in use by the City (AutoCAD) to allow future updates by the City when required.

The sewer atlas replaced the City's existing sewer atlas. The existing atlas was a paper-based collection of sewer maps that had to be updated manually by individual collection system supervisors. The sewer atlas is created from the same computer file as the base map thus it is automatically updated when the base map is updated.

Information shown on the new base map and atlas include:

- ▶ Street Right-of-Ways and Names
- ▶ Streams and Rivers
- ▶ Sewer Type (Sanitary, Combined and Storm)
- ▶ Sewer Alignments
- ▶ Sewer Diameters
- ▶ Service Areas and Designations
- ▶ Curb Inlet and Catch Basin Locations
- ▶ Pump Stations
- ▶ CSO Structure locations, CSO number, headwall locations and floodgate locations
- ▶ Siphon Locations and Sizes

The wastewater collection system computer model was developed using the XP-SWMM software. This model estimates the flow in the wastewater collection system during and after rain events and the volume of flow that will be discharged from CSOs. The City can also use the model to plan for future developments and analyze the impact, if any, future developments will have on the wastewater collection system.

The efforts necessary to develop these tools included a significant amount of field work. The field work included installing flow meters and samplers, investigating sewer structure configurations, and determining manhole elevations (invert, ground and weir). This field work also increased the City's knowledge of its wastewater collection system. The following conditions within the collection system were identified during of the field work:

- ▶ A 1,400 foot section of a 27" combined sewer full of sediment and grit (This has been cleaned)
- ▶ An inflow source from an old siphon at the end of Locust Street near Baldwin Run (This has been repaired)
- ▶ An inflow source in the South Broad Street Area near Tarhe Run and S.R. 793 (This has been repaired)
- ▶ Ten additional CSOs (These have been included in the most recent permit)
- ▶ An abandoned CSO (This has been removed from the most recent permit)

The City also identified areas of basement flooding by distributing approximately 13,000 questionnaires to all City residents with the monthly utility bill. This effort is summarized in Chapter 3.

5.2.2 Collection System Rainfall Response

The collection system model was used to estimate the response of the wastewater collection system to different rainfall events. To estimate the response of the wastewater collection system to rainfall events, the following procedure was followed:

- 1) The average yearly precipitation was determined for the Lancaster area from six years (May 1990 through October 1996) of historical rainfall records. The annual precipitation was further broken down into four typical storms.
- 2) The modeled CSO volume resulting from each typical storm was combined with typical CSO pollutant concentrations to estimate the pollutant load discharged to the receiving streams through the CSOs for each typical storm.
- 3) The modeled CSO volume and pollutant load from each typical storm were multiplied by the annual storm frequency to estimate the annual CSO volume and pollutant loads discharged to the Hocking River and its tributaries. This data is summarized in Section 5.5.

Precipitation Analysis

Using rainfall data from May 1990 through October 1996, the average yearly precipitation was determined to be approximately 34 inches. The rainfall data was divided into four categories to develop typical storms for the Lancaster area. A summary of the average precipitation, frequency, and duration for each of the typical storms is shown in the table below. The rainfall data for the entire period is included in Appendix F. Hydrographs of these four typical storms are shown on Figures 5-1 through 5-4.

Lancaster CSO

Precipitation Summary

Storm Size (inches)	Events Per Year	Average Total (inches)	Ave. Duration (hours)	Total Rainfall (inches)
0 - 0.5	62.00	0.21	2.3	13.02
>0.5 - 1.0	12.48	0.74	6.9	9.24
>1.0 - 1.5	5.22	1.28	8.4	6.68
>1.5	2.87	1.85	8.6	5.31
Annual Total	----	----	----	34.25

CSO Volumes and Pollutant Loads

The typical storm events determined by the precipitation analysis were entered into the collection system model. As discussed in Chapter 4, the model was calibrated using flow data (correlated to rainfall) collected from 77 monitoring points throughout the collection system. The model was run to estimate the CSO volume discharged to the Hocking River and its tributaries for each typical storm. The model was also used to develop a CSO hydrograph (overflow rate vs. time) for each type of storm.

As discussed in Chapter 3, typical CSO pollutant concentrations been developed from CSO sampling completed in 1996 (see Figures 3-5A and 3-5B). The CSO hydrographs, which were developed through utilization of the collection system model, were combined with the typical CSO pollutant concentrations to calculate the pounds of pollutants

discharged during each rain event. Each model simulation is described below. Figures 5-5 through 5-8 summarize the CSO discharge volume and loads for each typical storm. Figure 5-10 summarizes the total annual CSO discharge volume and loads for Lancaster combined sewer system.

Simulation No. 1 (Typical Storm 0.1 to 0.5-inches)

For Simulation No. 1, a typical storm of 0.21 inches with a duration of 2.3 hours was used. As shown in Figure 5-5, the total CSO volume discharged to the Hocking River and its tributaries during this type of storm was estimated to be 311,000 gallons. The corresponding volumes from the nine CSOs activated are also shown in Figure 5-5. The hydrographs (flow vs. time) developed through utilization of the model are included in Appendix G for reference.

Using the CSO hydrographs shown in Appendix G and typical CSO pollutant concentrations (Figures 3-5A and 3-5B), the quantity of pollutants discharged for this type of rain event was calculated. The pollutant load discharged to the Hocking River and its tributaries for this type rain event is summarized in Figure 5-5. The calculations for these loadings are included Appendix H for reference.

Simulation No. 2 (Typical Storm 0.5 to 1.0-inches)

For Simulation No. 2, a 0.74 inch rain event with a 6.9 hour duration was used. As shown in Figure 5-6, the total CSO volume discharged to the Hocking River and its tributaries during this type of storm was estimated to be 2,034,000 gallons. Discharge volumes for the eleven CSOs activated are also shown in Figure 5-6. The hydrographs (flow vs. time) developed through utilization of the model for this storm are included in Appendix G for reference.

The CSO hydrographs shown in Appendix G and the typical CSO pollutant concentrations were used to calculate the pollutant loadings discharged to the Hocking River and its tributaries for this type of storm. The CSO pollutant loadings for this type rain event are summarized in Figure 5-6. Calculations for these loadings are included in Appendix H for reference.

Simulation No. 3 (Typical Storm 1.0 to 1.5-inches)

For Simulation No. 3, a typical storm of 1.28 inches with a duration of 8.4 hours was used. During this type of storm, the model predicted nineteen CSOs would activate and discharge a total of 6,301,000 gallons to the Hocking River and its tributaries. A summary of the discharge from individual CSOs is shown in Figure 5-7. The CSO hydrographs developed through utilization of the model are included in Appendix G for reference.

The CSO hydrographs and typical CSO pollutant concentrations were used to estimate the CSO pollutant loadings for this type of storm. The pollutant loadings for this type of storm are summarized in Figure 5-7. Calculations for each of the pollutant loadings is included in Appendix H for reference.

Simulation No. 4 (Typical Storm > 1.5-inches)

For Simulation No. 4, a 1.85 inch rain event with an 8.6 hour duration was used. As shown in Figure 5-8, the model predicted that this type of rain event would activate twenty CSOs and discharge 11,774,000 gallons to the Hocking River and its tributaries. A summary of the discharge volumes from individual CSOs is also shown in Figure 5-8. CSO hydrographs developed through utilization of the model for this type of storm are included in Appendix G for reference.

The CSO hydrographs and typical CSO pollutant concentrations were used to estimate the CSO pollutant loadings for this type of storm. The pollutant loadings for this type of storm are summarized in Figure 5-8. Calculations for each of the pollutant loadings is included in Appendix H for reference.

5.3 SEPARATE SEWER SYSTEM IMPACTS

5.3.1 Separate Sewer System Development

The Lancaster wastewater collection system was constructed over many years. Combined sewers were constructed in the central and older portion of the City. As the City grew, interceptor sewers were extended to the outer areas of the system to collect wastewater from new developments. These developments were constructed using separated sanitary sewers.

A schematic of the collection system delineating individual drainage basins (both sanitary and combined) and the main interceptors is shown in Figure 3-3. A general description of the collection system is provided in Chapter 2. Figure 3-3 shows that the separated sanitary sewer service areas discharge directly to the interceptors and not into combined service areas. This minimizes the potential impact of the separated sanitary sewer areas on the combined areas.

The minimal impact of separated sewers on CSOs is a result of the development sequence of the Lancaster wastewater collection system. The 27-inch West and 15-inch East Interceptors were installed around 1938 to collect dry weather sewage from the combined areas and transport it for treatment to the Water Pollution Control Facility. Wet weather flows which could not be handled by the system were discharged to receiving streams through the CSO structures. By 1961, the original interceptors were overloaded during wet weather due primarily to City growth. The 36-inch West and 36-inch East Interceptors were constructed in the early 1960s to serve the newer, upstream, separated sanitary sewer areas and to relieve the older, overloaded, trunk sewers. In order to maximize the hydraulic and storage capacity of the system, the new and old interceptors were interconnected at several locations.

Another characteristic of the Lancaster wastewater collection system that minimizes the impact of separated sanitary sewer areas are the pump stations within the system. Figure

3-3 shows that most of the separated sanitary sewer areas are upstream of pump stations. As the stations reach their capacity, they tend to dampen peaks and regulate flow to the interceptors, forcing storage in the upstream system. This is especially true on the west side where all separated sewer areas, except Area 18, are upstream of pump stations.

The only portions of the combined sewer system directly impacted by the sanitary system are the combined sewer overflow structures near the Water Pollution Control Facility (WPCF). These include CSO 1034 (located on the east side of the WPCF) and CSOs 1004 and 1006 (located on the west side of the WPCF). The other CSO near the WPCF, CSO 1005, is in the process of being abandoned. All captured sanitary flow and stormwater remaining in the collection system pass through these structures prior to being treated by the WPCF. Based on a review of the impact of rain events it was found that 90% of storms (in a "typical" year) do not cause overflows at CSOs 1004, 1006 and 1034. Therefore, the separated sanitary sewer flows have no impact on CSO discharge volumes for 90% of Lancaster storm events.

5.3.2 Sanitary Sewer Extension Evaluation

As part of the City's Combined Sewer Overflow Long Term Control Plan (to be completed June 2000), a sanitary sewer extension evaluation is being performed. The purpose of the evaluation is to look at the impact of new sanitary sewer flows on combined sewer overflow volumes. However, the results can also be used to draw conclusions with regard to the impact of existing separate sanitary flows on the combined sewer system. Below are some preliminary conclusions from the evaluation:

- ▶ When the anticipated increase in flow due to development over the next 20 years is added to the system (approximately 3.2 MGD), the annual CSO volumes would increase by only 26 MG/year. A volume equal to only 10% of the additional sanitary flow would be discharged as CSO during wet weather. The remainder of the additional sanitary flow would be captured by the collection system and treated at the Water Pollution Control Facility.

- ▶ As anticipated, because of the configuration of the interceptors, only CSOs 1004, 1006 and 1034 showed significant impact as a result of the additional sanitary flows.

The impact of separated sanitary sewers will be evaluated more thoroughly as part of Lancaster's Combined Sewer System Long Term Control Plan (LTCP). The LTCP will include the final sanitary sewer extension study. This study will present a plan to allow for addition of sanitary sewer flow from new developments without increasing CSO discharges above current volumes. The plan will include existing and future (if necessary) CSO reduction projects to facilitate growth without increasing CSO volume.

5.4 TOXIC AND HAZARDOUS POLLUTANTS

5.4.1 General

For purposes of this report, the phrase, "toxic and hazardous" is not intended to imply that pollutants in the Lancaster wastewater collection system were sampled, analyzed, and reviewed for toxic and hazardous implications under existing state or Federal laws, regulations and policies. Such a review is beyond the scope of this report and the intent of the Ohio EPA's CSO Strategy. Historical sampling data and stream surveys and new CSO sampling data are used in this report to determine if Lancaster CSOs have toxic and hazardous impacts on local receiving streams. Such impacts would be indicated by impaired aquatic life in the streams. Other indicators of the potential presence of toxic and hazardous materials are the priority pollutant scans performed annually on the influent wastewater to the WPCF.

5.4.2 Priority Pollutant Scans

As part of the permit approval process, the Ohio EPA requires the City of Lancaster to perform a priority pollutant scan on the WPCF influent, effluent and sludge. The intent of the scans is to identify substances that are harmful to the treatment plant processes or to the environment. Pollutants that enter the plant are identified in the influent sample. The effluent and sludge samples are analyzed to measure the pollutants released to the

environment. The priority pollutant scans samples are analyzed for (13) heavy metals, (28) volatile organic compounds, (46) base neutral compounds, (11) acids and (26) pesticides.

Based on a review of the reports from 1993 through 1997, it was found that there were very few samples with measurable amounts of volatile compounds, acids, base neutral compounds or pesticides. Various heavy metals were present in minor concentrations during all sample years. These reports are reviewed by the Ohio EPA. The only pollutant of concern recently identified by the Ohio EPA is Bis (2-ethylhexyl) phthalate. As a result, the Ohio EPA required the City to include effluent sampling for this compound in their quarterly sampling program. However, the industry that was a primary source of this pollutant has since discontinued its use. As a result, this pollutant is no longer detected in the City's wastewater. If this trend continues, the agency has stated that they will remove it from the City's NPDES sampling requirement.

The Ohio EPA's review of the priority pollutant scans has not found toxic or hazardous pollutant concentrations in the City of Lancaster wastewater. Since combined sewer overflows are essentially plant influent wastewater diluted with rainwater, it can be concluded that Lancaster CSOs are also not toxic or hazardous. Thus, sampling for toxic and hazardous materials was not required for the characterization report. However, since heavy metals are present in dilute concentrations, several were sampled as part of the overflow characterization process.

5.4.3 Pollutant Sources and Loads in the Combined Sewer System

The City currently has 21 industrial users that discharge a daily flow of approximately 1.1 million gallons. An analysis of the industrial users showed only four discharge to the combined sewer system directly upstream of a combined sewer overflow structure. These users are listed below:

<u>INDUSTRY</u>	<u>DOWNSTREAM CSO</u>
▶ Anchor Hocking 1	1010, 1021
▶ Conn's Potato Chips	1005*
▶ Lancaster Glass	1027
▶ National Meter Inc.	1020, 1024

* - CSO 1005 is in the process of being abandoned.

The discharge of pollutants to the Lancaster combined sewer system from these industries is summarized in Figure 5-9. Although five CSOs are located downstream of these industries, proportional quantities of all flow in the Lancaster Wastewater Collection Sewer system can be discharged through CSOs 1004, 1006 and 1034 due to their location on the system interceptors. The discharge of pollutants from the entire system is discussed in the following sections.

5.4.4 Pollutants Discharged from the Combined Sewer System

In 1977, 36% of the base flow to the Lancaster Water Pollution Control Facility was contributed by industrial users. By 1997, this percentage had dropped to 20%. This decrease was due to the combined impact of the closing of Lancaster-area industries and the implementation of the Industrial Pretreatment Program in 1985. This decrease also represents a significant reduction in the discharge of pollutants from industrial users through combined sewer overflows.

A measure of industrial discharge activity is the concentration of metals in the sludge produced at the WPCF. Figures 5-12 and 5-13 show that annual average WPCF sludge metals concentrations have decreased significantly since 1986. It can be assumed that there has also been a corresponding reduction in the discharge of heavy metals from Lancaster CSOs.

As discussed above, heavy metals were the pollutants typically detected in the priority pollutant scans. The collection system model was used to estimate the quantity of heavy metals discharged from CSOs. The heavy metals cadmium, lead, copper and zinc were selected to characterize the discharge to the Hocking River and its tributaries. The estimated quantity of heavy metals discharged to the Hocking River and its tributaries during a typical year is shown in Figure 5-10. The bases of the calculations for these loadings are discussed in Section 5.2.

The low concentrations of metals in the Lancaster Wastewater Collection system and the minimal impacts on the receiving streams are due primarily to the success of the City of Lancaster Industrial Pretreatment Program and the minimization of CSOs.

5.4.5 Aquatic Life Surveys

For purposes of this report, the final measure of the toxic or hazardous impacts of Lancaster CSOs, is the quality of the aquatic life in the receiving streams. Aquatic life in the Lancaster receiving streams has been steadily improving as documented by the Ohio EPA's studies of the Hocking River and its tributaries in 1982, 1990 and 1995. The 1995 study concluded that there were no impacts from chemical pollutants. An additional aquatic life survey performed by the City of Lancaster for its Combined Sewer Overflow Long Term Control Plan (due June 2000) confirmed the Ohio EPA's findings. Based on the 1997 survey, it was found that habitat modifications and a dry weather overflow were the most significant impacts on aquatic life. This study will be discussed in more detail in the Long Term Control Plan.

5.4.6 Conclusions

The following is a summary of finding that confirm that the Lancaster wastewater collection system CSOs are not toxic or hazardous.

- ▶ Ohio EPA's review of priority pollutant scans has not resulted in identification of any pollutants of concern or action items to be implemented by the City of Lancaster.

- ▶ Industrial discharge to the collection system has decreased approximately 43% since 1977.
- ▶ Concentrations of heavy metals in sludge produced at the Lancaster WPCF have decreased due to the Industrial Pretreatment Program and a reduction in industrial flows. The sludge produced by the WPCF contains low enough concentrations of heavy metals that it could qualify as a Class A high quality sludge.
- ▶ Aquatic life in the Hocking River and tributaries do not show impacts from chemical pollutants. (*Biological and Water Quality Study of the Upper Hocking River and Selected Tributaries, December 31, 1997, State of Ohio Environmental Protection Agency, pages 8-9*).

5.5 CSO DISCHARGE CHARACTERIZATION

5.5.1 General

The City of Lancaster's wastewater collection system is typical of urban combined systems in several ways:

- ▶ CSO activation is dependent on several interrelated variables including storm intensity, storm duration, and total precipitation. A rainfall event of 0.10-inches will typically activate at least one CSO in the system.
- ▶ Lancaster CSOs exhibit a "first flush" effect. Based on sampling of the CSO discharges during storm events it was found that samples collected at the start of the overflow had higher pollutant concentrations than samples collected at the end of the overflow. Neither pollutant concentrations nor loadings appeared to have a significant impact on receiving streams.
- ▶ The floatable material discharged from CSOs is similar to the material discharged through storm sewers.

5.5.2 Annual CSO Activation

As discussed in Section 5.2, four typical storms were developed for the Sewer System Characterization in order to simulate annual rainfall in the Lancaster area. The four storms were developed based on an analysis of actual Lancaster rainfall records in which only rain events greater than 0.1-inches were included. These typical storms were entered into the XP-

SWMM computer model of the wastewater collection system (Simulations 1-4) to estimate the annual frequency of activation of the CSOs. The frequency of activation for each CSO for the four typical storms is summarized in Figure 5-11. The most active CSOs are listed below:

	<u>STREAM</u>	<u>CSO</u>
▶	Baldwin Run	1019
▶	Fetters Run	1029
▶	Hocking River	1005*, 1011, 1013, 1016, 1027, 1031 and 1033

* CSO 1005 is in the process of being abandoned.

5.5.3 Annual CSO Volume

The model of the wastewater collection system was used to estimate the annual CSO volume and the annual volume of captured combined sewage resulting from rain events. Using simulation output data from the four typical storms, as discussed in Section 5.2.2., the annual CSO discharge to the Hocking River and its tributaries is estimated to be 111 million gallons. By comparison, the Lancaster sewer system model estimates that the Water Pollution Control Facility annually treats over 588 million gallons of combined sewage during wet weather.

5.5.4 Annual CSO Pollutant Loadings

The estimated total annual pollutant loadings discharged through the combined sewer overflows to the Hocking River and its tributaries are presented in Figure 5-10. To determine the total annual quantity of CBOD₅, SS, TKN, Cd, Pb, Cu, and Zn discharged to the Hocking River and its tributaries, the individual storm loadings were converted to yearly loadings. Using the number of events per year for each storm (see the table in Section 5.2.2.) and the pollutants discharged for typical rain events (Figures 5-5 through 5-8), the total pounds of pollutants discharged to the Hocking River and its tributaries in a year were calculated. As can be seen from Figure 5-10, CSO 1019 is responsible for more than 45% of the entire CSO volume discharged to the Hocking River and its tributaries.

5.6 LONG TERM CONTROL PLAN

As part of the City of Lancaster's NPDES permit, an evaluation of the sanitary sewer extensions of the combined sewer system is required for the Long Term Control Plan. The findings of this characterization report and the computer model of the collection system will be used to develop the Long Term Control Plan and evaluate the potential effects that future development will have on the existing combined sewer system.

++ END OF CHAPTER 5.0 ++

++ FIGURES FOLLOW ++

Figure 5-1
Typical Annual Storm #1 (0.21 inches in 2.3 hours)

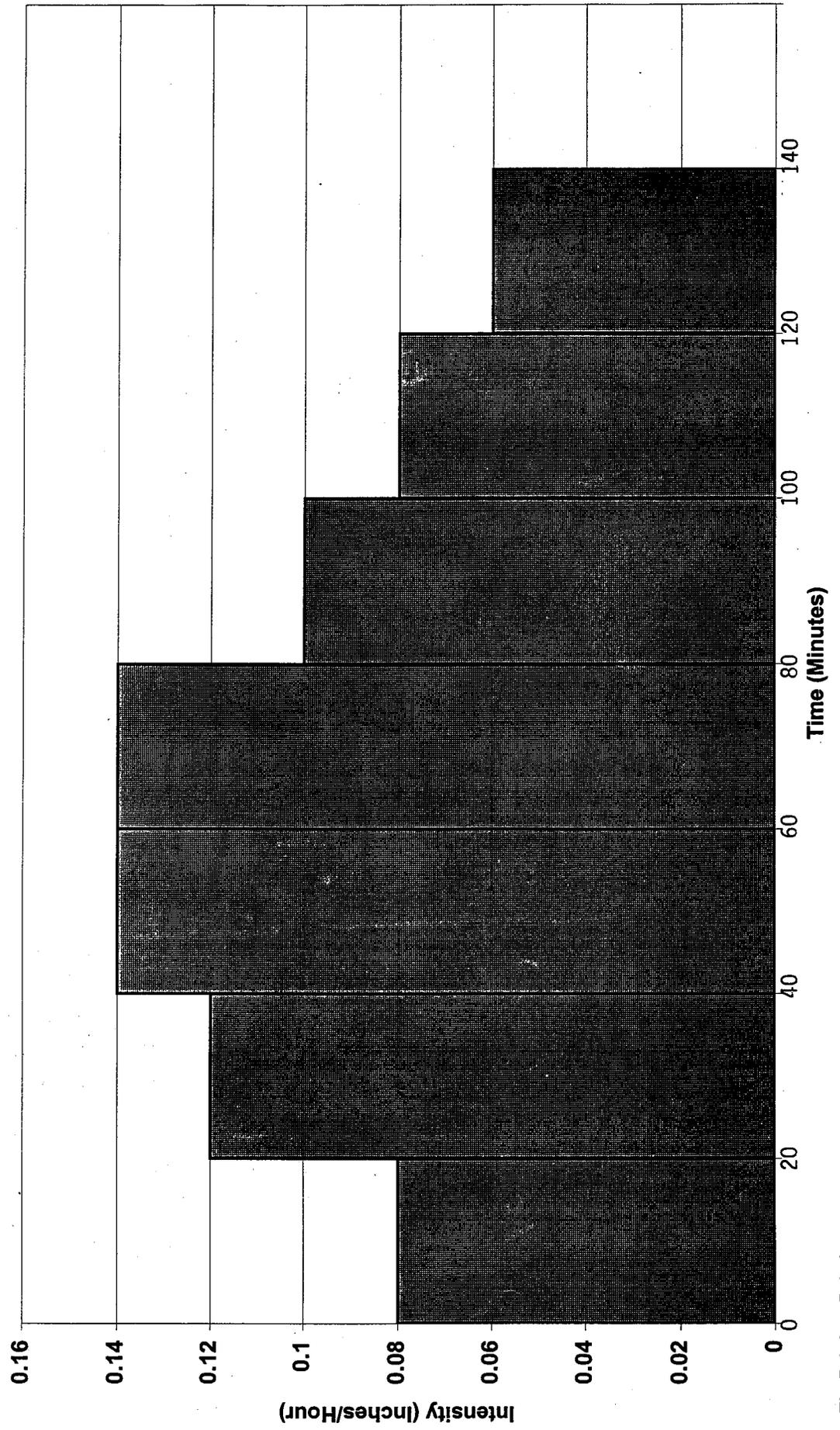


Figure 5-2
Typical Annual Storm #2 (0.74 Inches in 6.9 Hours)

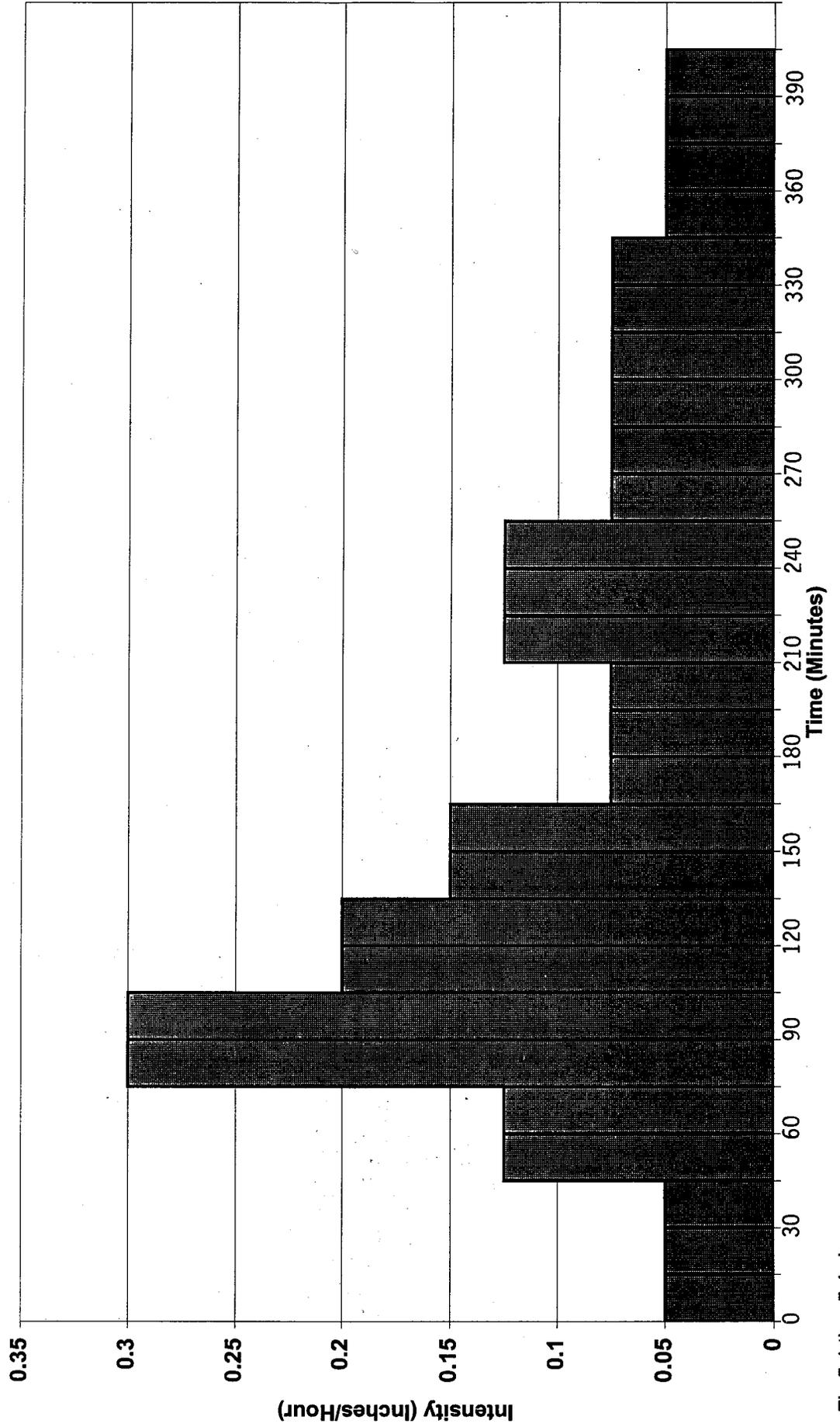
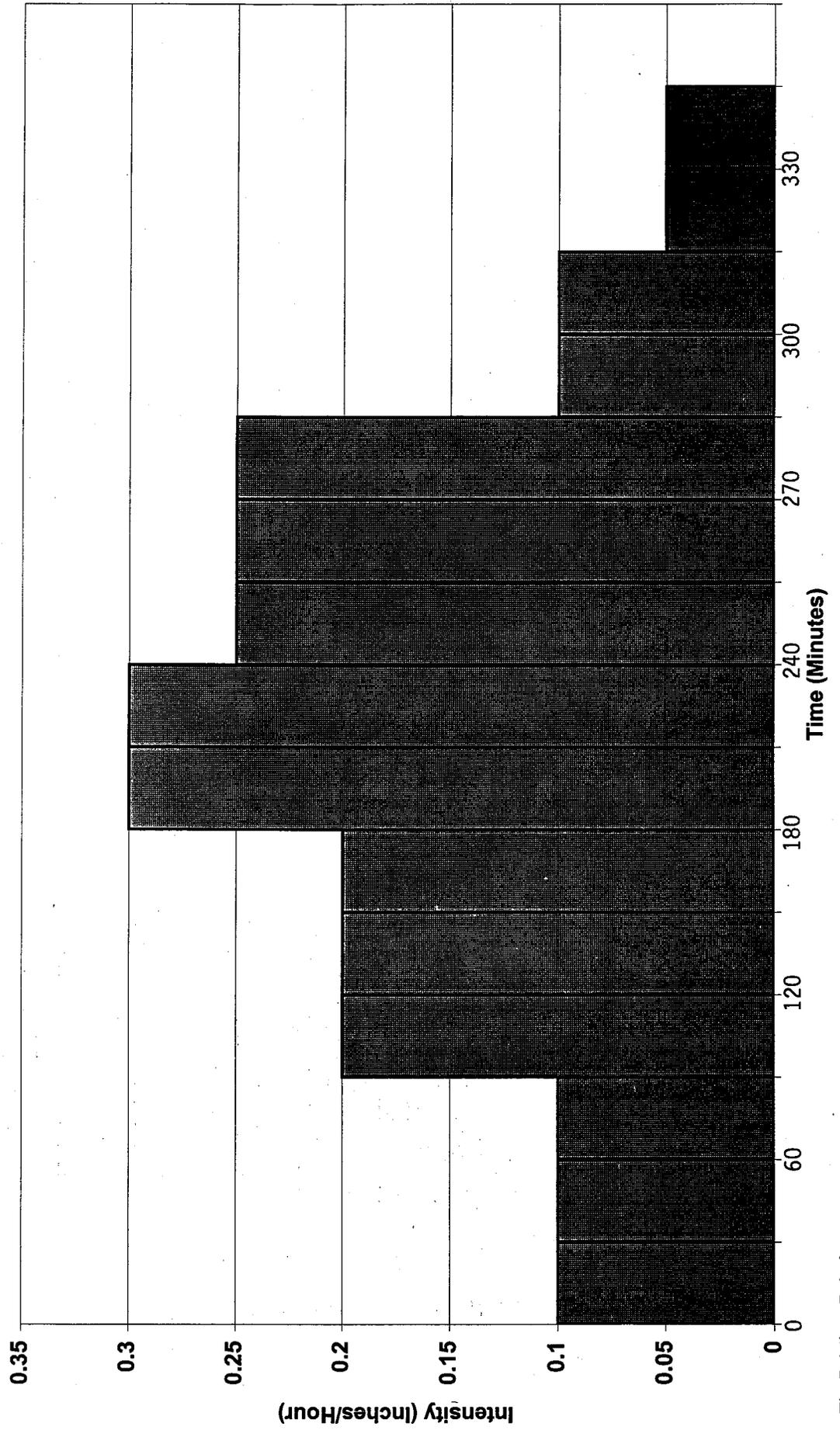


Figure 5-3
Typical Annual Storm #3 (1.28 Inches in 8.4 Hours)



**Figure 5-4
 Typical Annual Storm #4 (1.85 Inches in 8.6 Hours)**

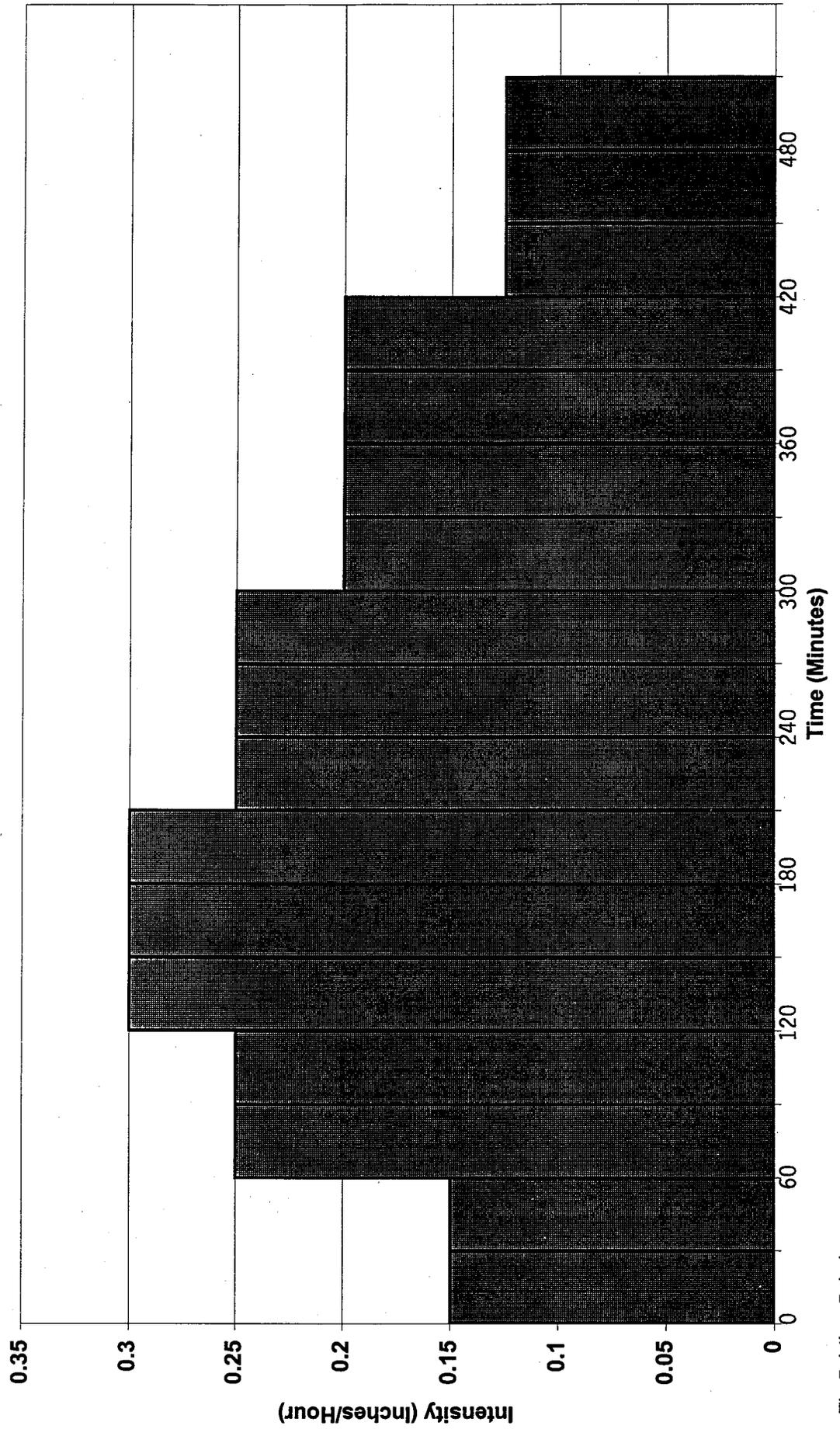


Figure 5-5
Lancaster Combined Sewer System Characterization Report
Combined Sewer Overflow Discharge for Typical Storm 0.1 to 0.5 Inches
Simulation No. 1 Summary - 0.21 inches / 2.3 Hour Duration Storm

CSO No.	Location	Volume (Gal)	CBOD (lbs)	SS (lbs)	TKN (lbs)	Cu (lbs)	Cd (lbs)	Pb (lbs)	Zn (lbs)
1004	West Perimeter of WWTP	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1005	N. Bank CSX RR and Hocking River	17,588	5.0	21.9	1.1	0.01	0.00	0.01	0.04
1006	S. Bank CSX RR and Hocking River	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1007	S. Broad and S. Columbus	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1008	Lincoln and Hocking River	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1009	Mulberry and Memorial	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1010	Mulberry and Hocking	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1011	Union and Memorial	208	0.1	0.4	0.0	0.00	0.00	0.00	0.00
1012	5th and Memorial	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1013	6th and Memorial	49	0.0	0.1	0.0	0.00	0.00	0.00	0.00
1014	Allen and Memorial	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1015	N. Broad and Fair	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1016	6th and N. Broad	17	0.0	0.1	0.0	0.00	0.00	0.00	0.00
1017	5th and N. Broad	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1018	N. Broad and Mulberry	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1019	SE Corner Mary Burnham Park	258,587	75.5	367.0	17.3	0.13	0.01	0.18	0.63
1020	Chestnut and Brooks	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1021	Union and Garfield	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1022	Columbus and Wilson	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1023	High N. of Fair	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1024	Wheeling and Livingston	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1026	NE Corner Mary Burnham Park	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1027	Walnut and Whitley	1,263	0.3	1.5	0.1	0.00	0.00	0.00	0.00
1028	6th and Pierce	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1029	6th and Boyd	13,178	3.7	16.9	0.8	0.01	0.00	0.01	0.03
1030	Walnut and Maple	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1031	Wheeling and Maple	20,105	6.5	36.3	1.6	0.01	0.00	0.02	0.05
1032	Maple and Alley N. of Main	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1033	Park and Memorial	11	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1034	Baldwin Run and Lawrence	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1035	E. of Park and Columbus	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
Total Simulation No.1		311,007	91.2	444.1	20.9	0.16	0.01	0.22	0.76
Total Baldwin Run		258,587	75.5	367.0	17.3	0.13	0.01	0.18	0.63
Total Fetters Run		13,178	3.7	16.9	0.8	0.01	0.00	0.01	0.03
Total Hocking River		39,241	11.95	60.25	2.80	0.02	0.00	0.03	0.10

Note: Rainfall events developed from actual data collected during the period of January 1990 thru October 1997.

Figure 5-6
Lancaster Combined Sewer System Characterization Report
Combined Sewer Overflow Discharge for Typical Storm 0.5 to 1.0 Inches
Simulation No. 2 Summary - 0.74 inches / 6.9 Hour Duration Storm

CSO No.	Location	Volume (Gal)	CBOD (lbs)	SS (lbs)	TKN (lbs)	Cu (lbs)	Cd (lbs)	Pb (lbs)	Zn (lbs)
1004	West Perimeter of WWTP	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1005	N. Bank CSX RR and Hoeking River	528,714	199.5	425.4	39.6	0.17	0.02	0.40	1.06
1006	S. Bank CSX RR and Hoeking River	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1007	S. Broad and S. Columbus	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1008	Lincoln and Hoeking River	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1009	Mulberry and Memorial	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1010	Mulberry and Hoeking	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1011	Union and Memorial	3,136	1.1	2.9	0.2	0.00	0.00	0.00	0.01
1012	5th and Memorial	20,626	7.1	19.4	1.5	0.01	0.00	0.02	0.05
1013	6th and Memorial	6,415	2.3	6.1	0.5	0.00	0.00	0.01	0.01
1014	Allen and Memorial	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1015	N. Broad and Fair	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1016	6th and N. Broad	12,036	3.9	12.7	0.9	0.01	0.00	0.01	0.03
1017	5th and N. Broad	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1018	N. Broad and Mulberry	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1019	SE Corner Mary Burnham Park	1,069,168	353.7	1,103.3	73.1	0.43	0.04	0.79	2.36
1020	Chestnut and Brooks	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1021	Union and Garfield	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1022	Columbus and Wilson	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1023	High N. of Fair	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1024	Wheeling and Livingston	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1026	NE Corner Mary Burnham Park	33,886	14.1	53.0	3.3	0.02	0.00	0.04	0.09
1027	Walnut and Whitley	41,396	13.1	44.7	2.7	0.02	0.00	0.03	0.09
1028	6th and Pierce	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1029	6th and Boyd	163,195	52.4	183.7	10.9	0.07	0.01	0.12	0.37
1030	Walnut and Maple	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1031	Wheeling and Maple	127,451	40.5	159.0	8.7	0.06	0.01	0.10	0.30
1032	Maple and Alley N. of Main	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1033	Park and Memorial	28,465	8.7	37.7	1.9	0.01	0.00	0.02	0.07
1034	Baldwin Run and Lawrence	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1035	E. of Park and Columbus	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
Total Simulation No. 2		2,034,487	696.2	2,047.9	143.4	0.79	0.08	1.54	4.44
Total Baldwin Run		1,103,054	367.7	1156.3	76.5	0.44	0.04	0.83	2.45
Total Fetters Run		163,195	52.4	183.7	10.9	0.07	0.01	0.12	0.37
Total Hoeking River		768,238	276.1	707.9	56.0	0.28	0.03	0.58	1.62

Note: Rainfall events developed from actual data collected during the period of January 1990 thru October 1997.

Figure 5-7
Lancaster Combined Sewer System Characterization Report
Combined Sewer Overflow Discharge for Typical Storm 1.0 to 1.5 Inches
Simulation No. 3 Summary - 1.28 inches / 8.4 hour Storm Duration

CSO No.	Location	Volume (Gal)	CBOD (lbs)	SS (lbs)	TKN (lbs)	Cu (lbs)	Cd (lbs)	Pb (lbs)	Zn (lbs)
1004	West Perimeter of WWTP	530,140	158.3	670.1	35.7	0.25	0.02	0.37	1.26
1005	N. Bank CSX RR and Hocking River	1,337,470	535.0	921.9	104.2	0.39	0.06	0.96	2.49
1006	S. Bank CSX RR and Hocking River	250,105	83.1	294.7	18.2	0.11	0.01	0.20	0.58
1007	S. Broad and S. Columbus	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1008	Lincoln and Hocking River	196,884	58.7	219.4	13.1	0.09	0.01	0.13	0.45
1009	Mulberry and Memorial	4,584	1.4	7.9	0.3	0.00	0.00	0.00	0.01
1010	Mulberry and Hocking	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1011	Union and Memorial	2,118	0.7	2.0	0.2	0.00	0.00	0.00	0.00
1012	5th and Memorial	349,665	109.6	342.5	23.4	0.14	0.02	0.25	0.78
1013	6th and Memorial	24,629	7.7	23.6	1.6	0.01	0.00	0.02	0.05
1014	Allen and Memorial	1,222	0.4	2.4	0.1	0.00	0.00	0.00	0.00
1015	N. Broad and Fair	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1016	6th and N. Broad	81,836	26.1	79.0	5.6	0.03	0.00	0.06	0.18
1017	5th and N. Broad	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1018	N. Broad and Mulberry	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1019	SE Corner Mary Burnham Park	2,187,277	818.9	1,839.3	163.1	0.74	0.09	1.75	4.52
1020	Chestnut and Brooks	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1021	Union and Garfield	2,612	0.8	4.7	0.2	0.00	0.00	0.00	0.01
1022	Columbus and Wilson	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1023	High N. of Fair	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1024	Wheeling and Livingston	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1026	NE Corner Mary Burnham Park	259,155	84.9	253.9	18.2	0.10	0.01	0.19	0.57
1027	Walnut and Whiley	115,764	41.0	101.6	8.3	0.04	0.00	0.09	0.25
1028	6th and Pierce	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1029	6th and Boyd	422,376	149.8	372.2	30.3	0.15	0.02	0.34	0.91
1030	Walnut and Maple	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1031	Wheeling and Maple	331,885	121.1	292.8	24.4	0.12	0.01	0.27	0.71
1032	Maple and Alley N. of Main	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1033	Park and Memorial	184,673	58.2	189.4	12.4	0.08	0.01	0.13	0.42
1034	Baldwin Run and Lawrence	18,605	6.1	35.7	1.5	0.01	0.00	0.02	0.05
1035	E. of Park and Columbus	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
Total Simulation No. 3		6,301,001	2,261.9	5,653.1	460.9	2.25	0.26	4.80	13.26
Total Baldwin Run		2,465,037	909.9	2,129.0	182.8	0.85	0.10	1.96	5.14
Total Fetters Run		422,376	149.8	372.2	30.3	0.15	0.02	0.34	0.91
Total Hocking River		3,413,589	1,202.2	3,152.0	247.8	1.25	0.14	2.50	7.20

Note: Rainfall events developed from actual data collected during the period of January 1990 thru October 1997.

**Figure 5-8
Lancaster Combined Sewer System Characterization Report
Combined Sewer Overflow Discharge for Typical Storm > 1.5 Inches
Simulation No. 4 Summary - 1.85 inches / 8.6 Hour Duration Storm**

CSO No.	Location	Volume (Gal)	CBOD (lbs)	SS (lbs)	TKN (lbs)	Cu (lbs)	Cd (lbs)	Pb (lbs)	Zn (lbs)
1004	West Perimeter of WWTP	1,934,143	697.7	1,764.3	141.6	0.69	0.08	1.51	4.10
1005	N. Bank CSX RR and Hocking River	2,047,325	840.4	1,309.2	162.2	0.55	0.09	1.42	3.67
1006	S. Bank CSX RR and Hocking River	497,843	187.4	445.4	38.1	0.17	0.02	0.38	1.02
1007	S. Broad and S. Columbus	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1008	Lincoln and Hocking River	592,799	216.3	513.0	43.6	0.21	0.02	0.46	1.24
1009	Mulberry and Memorial	5,327	1.7	8.5	0.4	0.00	0.00	0.00	0.01
1010	Mulberry and Hocking	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1011	Union and Memorial	2,667	0.8	2.8	0.2	0.00	0.00	0.00	0.01
1012	5th and Memorial	669,460	260.3	501.4	51.5	0.21	0.03	0.52	1.32
1013	6th and Memorial	48,523	18.4	36.5	3.7	0.02	0.00	0.03	0.09
1014	Allen and Memorial	1,711	0.5	2.8	0.1	0.00	0.00	0.00	0.00
1015	N. Broad and Fair	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1016	6th and N. Broad	144,765	52.3	118.7	10.6	0.05	0.01	0.11	0.30
1017	5th and N. Broad	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1018	N. Broad and Mulberry	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1019	SE Corner Mary Burnham Park	3,440,355	998.4	2,744.1	260.0	1.11	0.14	2.56	6.84
1020	Chestnut and Brooks	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1021	Union and Garfield	4,305	1.4	6.8	0.3	0.00	0.00	0.00	0.01
1022	Columbus and Wilson	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1023	High N. of Fair	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1024	Wheeling and Livingston	1	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1026	NE Corner Mary Burnham Park	481,820	175.1	411.1	35.6	0.16	0.02	0.36	0.99
1027	Walnut and Whitley	185,532	69.4	145.4	13.8	0.06	0.01	0.14	0.37
1028	6th and Pierce	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1029	6th and Boyd	652,829	236.6	553.0	47.4	0.22	0.03	0.50	1.36
1030	Walnut and Maple	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1031	Wheeling and Maple	517,536	190.2	439.4	38.4	0.18	0.02	0.39	1.06
1032	Maple and Alley N. of Main	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
1033	Park and Memorial	308,273	107.1	285.7	21.9	0.11	0.01	0.23	0.66
1034	Baldwin Run and Lawrence	238,851	81.3	247.3	17.1	0.10	0.01	0.19	0.54
1035	E. of Park and Columbus	0	0.0	0.0	0.0	0.00	0.00	0.00	0.00
Total Simulation No. 4		11,774,065	4,135.3	9,535.4	886.6	3.86	0.49	8.79	23.60
Total Baldwin Run		4,161,027	1254.8	3402.5	312.7	1.37	0.17	3.11	8.37
Total Feters Run		652,829	236.6	553.0	47.4	0.22	0.03	0.50	1.36
Total Hocking River		6,960,210	2643.9	5579.9	526.4	2.26	0.29	5.19	13.87

Note: Rainfall events developed from actual data collected during the period of January 1990 thru October 1997.

**FIGURE 5-9
COMBINED SEWER SYSTEM CHARACTERIZATION REPORT
INDUSTRIAL POLLUTANTS - SOURCES AND LOADS**

Industry	Flow (MGD)	Cadmium		Chromium		Copper		Lead		Nickel		Zinc	
		mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day
Anchor Hocking Glass Plant 1	0.2954	0.0061 (1)	0.015	0.161	0.3966	0.049	0.1207	0.061	0.1503	0.104	0.2562	0.048	0.1183
Lancaster Glass Corporation	0.0606	0.0064 (1)	0.0032	0.05 (1)	0.0253	0.04	0.0202	0.044	0.0222	0.02 (1)	0.0101	0.089	0.0450
National Meter Inc.	0.0031	0.0073	0.0002	0.064	0.0017	0.511	0.0132	0.097	0.0025	0.06	0.0016	0.824	0.0213
Conn's Potato Chips	0.0125	0.007	0.0007	0.0475	0.0050	0.1988	0.0207	0.05	0.0052	0.033	0.0034	0.177	0.0185

Note: Values in Figure 5-9 are 1998 Averages
(1) Measured Values For These Parameters are Below Detection Limits.
Detection Limits Are Shown

**Figure 5-10
Lancaster Combined Sewer System Characterization Report
Typical Annual CSO Discharge**

CSO No.	Location	Volume (Gal)	CBOD (lbs)	SS (lbs)	TKN (lbs)	Cu (lbs)	Cd (lbs)	Pb (lbs)	Zn (lbs)
1004	West Perimeter of WWTP	8,318,318	2,829	8,570	593	3.3	0.3	6.3	18.3
1005	N. Bank CSX RR and Hocking River	20,556,829	8,007	15,249	1,574	6.3	0.8	14.8	39.4
1006	S. Bank CSX RR and Hocking River	2,734,356	972	2,819	205	1.1	0.1	2.1	6.0
1007	S. Broad and S. Columbus	0	0	0	0	0.0	0.0	0.0	0.0
1008	Lincoln and Hocking River	2,729,070	927	2,620	193	1.0	0.1	2.0	5.9
1009	Mulberry and Memorial	39,221	12	66	3	0.0	0.0	0.0	0.1
1010	Mulberry and Hocking	0	0	0	0	0.0	0.0	0.0	0.0
1011	Union and Memorial	70,817	23	77	5	0.0	0.0	0.0	0.2
1012	5th and Memorial	4,004,422	1,408	3,471	289	1.4	0.2	3.0	8.5
1013	6th and Memorial	351,031	122	312	25	0.1	0.0	0.3	0.7
1014	Allen and Memorial	11,291	4	20	1	0.0	0.0	0.0	0.0
1015	N. Broad and Fair	0	0	0	0	0.0	0.0	0.0	0.0
1016	6th and N. Broad	994,150	336	918	70	0.4	0.0	0.7	2.1
1017	5th and N. Broad	0	0	0	0	0.0	0.0	0.0	0.0
1018	N. Broad and Mulberry	0	0	0	0	0.0	0.0	0.0	0.0
1019	SE Corner Mary Burnham Park	50,688,428	16,242	54,034	3,585	20.4	2.0	37.8	111.8
1020	Chestnut and Brooks	0	0	0	0	0.0	0.0	0.0	0.0
1021	Union and Garfield	25,992	8	44	2	0.0	0.0	0.0	0.1
1022	Columbus and Wilson	0	0	0	0	0.0	0.0	0.0	0.0
1023	High N. of Fair	0	0	0	0	0.0	0.0	0.0	0.0
1024	Wheeling and Livingston	3	0	0	0	0.0	0.0	0.0	0.0
1026	NE Corner Mary Burnham Park	3,159,179	1,122	3,170	239	1.2	0.1	2.5	6.9
1027	Walnut and Whiteley	1,732,519	599	1,601	122	0.6	0.1	1.3	3.7
1028	6th and Pierce	0	0	0	0	0.0	0.0	0.0	0.0
1029	6th and Boyd	6,935,407	2,345	6,874	480	2.7	0.3	5.3	15.3
1030	Walnut and Maple	0	0	0	0	0.0	0.0	0.0	0.0
1031	Wheeling and Maple	6,057,401	2,088	7,028	444	2.6	0.2	4.8	13.7
1032	Maple and Alley N. of Main	0	0	0	0	0.0	0.0	0.0	0.0
1033	Park and Memorial	2,205,236	720	2,283	152	0.9	0.1	1.6	4.9
1034	Baldwin Run and Lawrence	782,621	265	897	57	0.3	0.0	0.6	1.8
1035	E. of Park and Columbus	0	0	0	0	0.0	0.0	0.0	0.0
	Annual Total	111,396,291	38,030	110,054	8,040	42.4	4.6	83.3	239.6
	Total Baldwin Run	54,630,231	17,629.4	58,100.9	3,881.3	22.0	2.2	40.9	120.6
	Total Fetters Run	6,935,407	2,345.4	6,874.1	480.4	2.7	0.3	5.3	15.3
	Total Hocking River	49,830,653	18,055.6	45,078.9	3,678.3	17.8	2.1	37.1	103.7

Note: Rainfall events developed from actual data collected during the period of January 1990 thru October 1997.
 0.21 inch storm in 2.3 hours - 62 events per year
 1.28 inch storm in 8.4 hours - 5.22 events per year
 0.74 inch storm in 6.9 hours - 12.5 events per year
 1.85 inch storm in 8.6 hours - 2.87 events per year

Figure 5-11
Lancaster Combined Sewer System Characterization Report
Estimated Yearly Overflow Events

CSO No.	Location	Annual Estimated Overflow Events By Storm				Total Events Per Year
		0.21 inch Rainfall	0.75 inch Rainfall	1.22 inch Rainfall	1.85 inch Rainfall	
1004	West Perimeter of WWTP	0	0	5	3	8
1005	N. Bank CSX RR and Hocking River	62	13	5	3	83
1006	S. Bank CSX RR and Hocking River	0	0	5	3	8
1007	S. Broad and S. Columbus	0	0	0	0	0
1008	Lincoln and Hocking River	0	0	5	3	8
1009	Mulberry and Memorial	0	0	5	3	8
1010	Mulberry and Hocking	0	0	0	0	0
1011	Union and Memorial	62	13	5	3	83
1012	5th and Memorial	0	13	5	3	21
1013	6th and Memorial	62	13	5	3	83
1014	Allen and Memorial	0	0	5	3	8
1015	N. Broad and Fair	0	0	0	0	0
1016	6th and N. Broad	62	13	5	3	83
1017	5th and N. Broad	0	0	0	0	0
1018	N. Broad and Mulberry	0	0	0	0	0
1019	SE Corner Mary Burnham Park	62	13	5	3	83
1020	Chestnut and Brooks	0	0	0	0	0
1021	Union and Garfield	0	0	5	3	8
1022	Columbus and Wilson	0	0	0	0	0
1023	High N. of Fair	0	0	0	0	0
1024	Wheeling and Livingston	0	0	0	3	3
1026	NE Corner Mary Burnham Park	0	13	5	3	21
1027	Walnut and Whiley	62	13	5	3	83
1028	6th and Pierce	0	0	0	0	0
1029	6th and Boyd	62	13	5	3	83
1030	Walnut and Maple	0	0	0	0	0
1031	Wheeling and Maple	62	13	5	3	83
1032	Maple and Alley N. of Main	0	0	0	0	0
1033	Park and Memorial	62	13	5	3	83
1034	Baldwin Run and Lawrence	0	0	5	3	8
1035	E. of Park and Columbus	0	0	0	0	0

Note: Rainfall events developed from actual data collected during the period of January 1990 thru October 1997.

Typical Annual Storm Distribution Used in Analysis

- 0.21 inch storm in 2.3 hours - 62 events per year
- 0.74 inch storm in 6.9 hours - 12.5 events per year
- 1.28 inch storm in 8.4 hours - 5.22 events per year
- 1.85 inch storm in 8.6 hours - 2.87 events per year

Figure 5-12
Lancaster OH Water Pollution Control Facilities
Annual Average Sludge Metals Concentrations

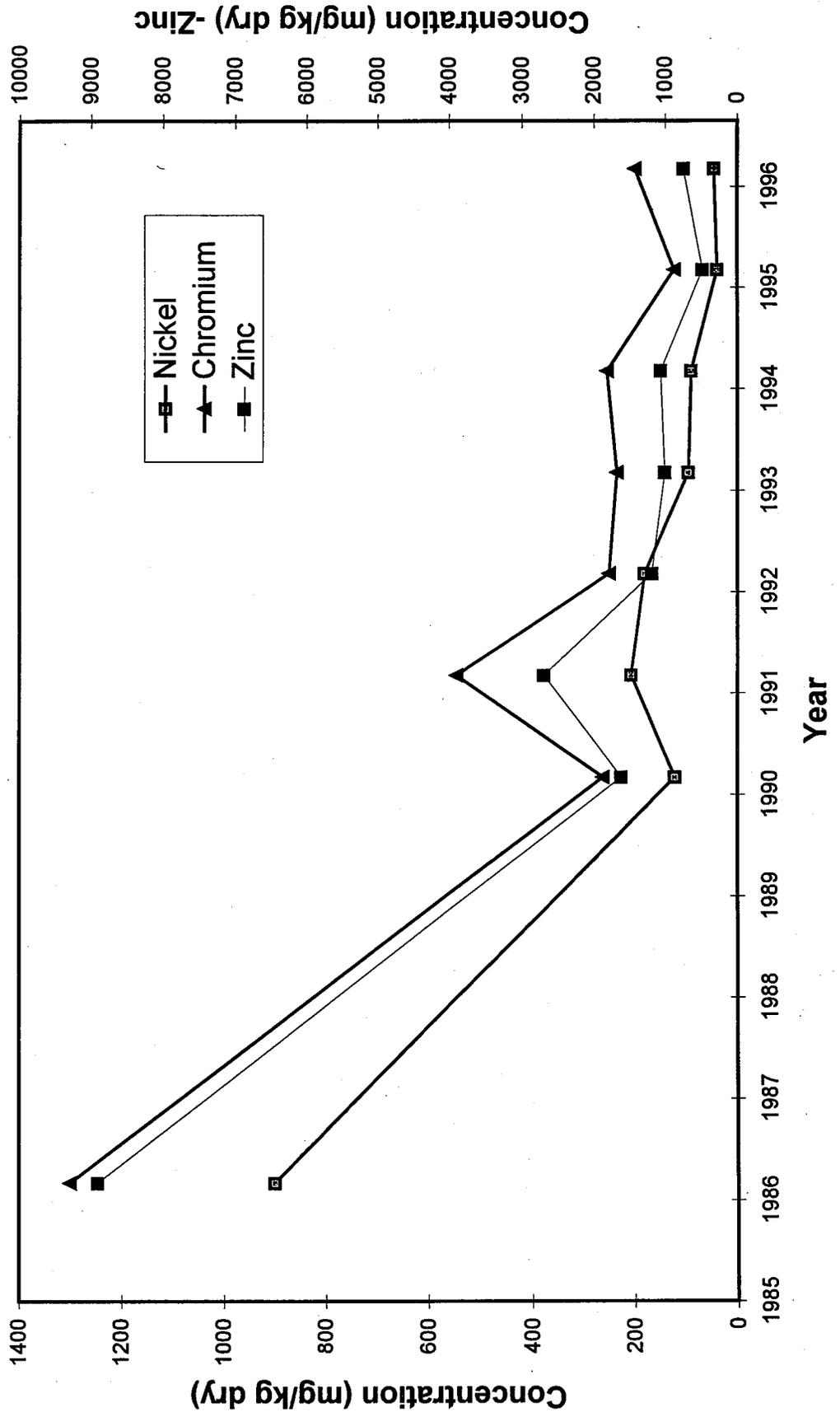


Figure 5-13
Lancaster OH Water Pollution Control Facilities
Annual Average Sludge Metals Concentrations

