Detroit Water and Sewerage Department

Wastewater Master Plan
Volume 6

Evaluation of Regional SSO Controls

CDM Camp Dresser & McKee

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Detroit Water and Sewerage Department

CS-1314 Wastewater Master Plan Project Team:

Camp Dresser & McKee

CH2M HILL

Hinshon Environmental Consulting

PR Networks, Inc.

Ralph Tyler Companies

Spalding DeDecker Associates, Inc.

SIGMA Associates, Inc.

Tucker, Young, Jackson, Tull, Inc.

Tetra Tech MPS, Inc.

Wade-Trim, Inc.

Detroit Water and Sewerage Department

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Technical Memoranda*

The Following Technical Memoranda were used in the preparation of *Evaluation of Regional SSO Controls*, Volume 6 of the Detroit Water and Sewerage Department's Wastewater Master Plan.

- *Review of Footing Drain Disconnection Projects*
- *Local Alternatives for SSO Control*
- *Summary of Footing Drain Flow Studies*
- *SSO Modeling and Calibration for SSO Case Studies*
- *Regional SSO Control Analyses-Capacity Contraints in the System*
- *Field Data Collection and Water Quality Issues for SSO Control*

*Technical Memoranda are available on the CD that accompanies this report

Executive Summary

1. Introduction and Background

As part of the Detroit Water and Sewerage Department's (DWSD) Wastewater Master Plan (CS-1314), a regional sanitary sewer overflow (SSO) control study was performed. This document is a summary of the work and conclusions of the SSO regional control task.

SSOs are releases of untreated sewage into the environment. Such discharges are illegal in Michigan. SSOs can be related to basement flooding, which has the potential to cause property damage and may present public health concerns. The Michigan Department of Environmental Quality (MDEQ) policy is to identify separate sanitary sewer overflows and take appropriate regulatory action to eliminate them.

In the spring of 2001, the DWSD joined with its wholesale customers in a collaborative process to examine solutions to eliminating the public health and water quality impacts of SSOs in the DWSD service area. This effort began after the DWSD had been approached by several customers seeking additional contract capacity as a potential approach to eliminating SSOs in their collection systems.

The purpose of this regional study is to find a cost-effective solution to the elimination of sanitary sewer overflows from the DWSD service area. This regional study is being performed concurrently with a number of local studies. The results of the local studies are being combined with the regional analysis so that the following alternatives can be evaluated:

- Elimination of the sources of high infiltration/ inflow that cause SSOs;
- Local storage or treatment of SSOs; and
- Regional transmission, storage and treatment of SSOs.

The six local municipalities that served as case studies in the regional analysis are Center Line, Clinton Township, Fraser, Melvindale, Allen Park and Garden City.

2. Approach

This work included four key elements. The first was to collect available data on SSOs to ensure an appropriate forum was in place for customer input. In order to do this, DWSD convened a technical work group representing wholesale customers with SSOs, DWSD staff, the Southeast Michigan Council of Governments (SEMCOG), and Wastewater Master Plan consulting team members. This technical work group has met 15 times during the study to provide direction, review, and facilitate communication among DWSD, its wholesale customers, other treatment providers in the planning area, and regulatory agencies. Furthermore, meetings and presentations with other key stakeholders were held, such as the MDEQ, SEMCOG, and the Wastewater Master Plan technical committee. Meetings with individual communites and their consultants were held as needed to collect information on SSOs in the DWSD service area. This included summarizing reported SSO volumes, causes, and characteristics for the region and case study communities

The second key element was to collect additional data. This included taking water quality samples from the case study community SSOs and receiving waters to compare pollutant loading estimates from other pollution point sources. Also, footing drain flow data was collected from residential homes in order to understand the volume, peak rates, and variabilty of these flows.

The third element was to review local and regional alternatives for SSO control. Local alternatives reviewed include storage and source control (footing drain disconnection). To do this, computer models for each of the case studies were made to evaluate seven different design storms. The Wastewater Masterplan Hydraulic Model was

used to evaluate several different regional management options in order to optimize the use of the regional system. This includes evaluations of current and contract flows from all customers and what additional flow the system can take before creating flooding concerns downstream. Local and regional alternatives were compared using a present worth analysis.

The fourth element was to document this work in a series of technical memoranda and summary report for review and input from the DWSD and its customers.

3 Findings

Overall, a total of 17 DWSD customers have reported 41 million gallons of SSOs to MDEQ in the last two years (July 2000 to July 2002). In the first year, 26 MG was reported; in the second year, 15 MG was reported. By comparison over 33 billion gallons of combined sewer overflows (CSO) were reproted during the same period. A summary of the frequency, volumes, and preceived causes of SSOs in the DWSD serivice area is given in Figure 1 on the following page.

The perceived causes were identified in a survey of the DWSD customers. Based on the regional modeling analysis, it appears excessive flows over the original design capacity is the primary cause. Furthermore, the survey results and field data collection indicate that footing drains connected to the sanitary sewer system appear to be the primary reason for the excessive flows.

Table 1: Summary of Costs for SSO Local and Regional Alternatives (Million $)

	Local Control		Regional Control	
Community	Local Storage	Source Reduction	Alt A	Alt B
Allen Park	24	8 to 31	23	15
Center Line	20	22	15	13
Clinton Twp	32	21	26	NA
Fraser	16+	17+	11	10
Garden City	33	68	NA	NA
Melvindale	22	46	5	2 to 4

A comparison of the local and regional alternative costs is given in Table 1.

In a supplemental policy statement signed in Dec. 2002, the MDEQ offically adopted the 25-year, 24 hour growth (summer) a design event for SSO control. The regional anlaysis found in most cases that the regional system can handle flows to the 10-year, 1-hour design event under growth (summer) conditions. However, design events greater than this could not be reasonably accepted for all areas. Regional costs for the 25-year, 24-hour event were developed for communities where additional regional flows would not potentially cause flooding.

4. Conclusions

The following is a list of conclusions for each of the key components of this study.

4.1 SSO Characteristics in the DWSD System

1. Wet weather SSOs in the DWSD system are not primarily the result of limited transport capacity, but the result of rainfall dependent inflow and infiltration (RDII) in excess of original design expectations.

2. Footing drain inflow is one of the greatest causes of RDII, especially from areas with homes built between the 1950 and 1980.

3. In areas built before 1950 and in sanitary systems originally built as combined systems, sources other than footing drains, such as connected downspouts and unidentified connections missed as part of the disconnection program, play a significant role in the cause of SSOs.

4. The total annual volume of SSOs from the system is very small compared to the annual CSO volume (the total reported SSO volume over the last two years was 0.12 percent of the total re-

Figure 1: Summary of SSO Statistics in the Current DWSD Service Area

7/10/00 to 7/10/02

Wet weather induced SSOs

83	Reported SSOs	**40.7**	Known SSO volume (MG)*
44	SSO points	**35**	Days with SSOs
17	Responsible communities/authorities	**4**	Communities currently under an ACO

With footing drains

17	Entities (100 percent)

Formerly Combined Systems

10	Entities (59 percent)
18.9	Million gallons of volume (46 percent)
56	Occurrences (67 percent)

From Areas Perceived to have . . .

Limited local transport capacity

9	Entities (53 percent)
26	Million gallons of volume (64 percent)
56	Occurrences (67 percent)

Limited interceptor capacity

7	Entities (41 percent)
20.1	Million gallons of volume (49 percent)
56	Occurrences (67 percent)

Limited contract capacity

8	Entities (47 percent)
34.2	Million gallons of volume (84 percent)
62	Occurrences (75 percent)

Excessive inflow and infiltration

11	Entities (65 percent)
22.8	Million gallons of volume (56 percent)
62	Occurrences (75 percent)

Dry weather SSOs

26	Reported SSOs	**0.72**	Known SSO volume (MG)
22	SSO points	**24**	Days with SSOs
12	Communities/authorities reporting a dry-weather SSO		

*12 percent of total SSO volume occurred during events with greater than 4 inches of total rainfall

ported CSO volume).

4.2 Local Alternatives

1. Costs for local storage and footing drain disconnection have been prepared for the full range of SSO control levels identified. Local storage costs are generally more cost-effective than footing drain disconnection for smaller design storms (less than the 25-year, 24-hour storm). However, for larger storms, footing drain disconnections can be more cost-effective. Individual communities will need to evaluate which of these alternatives best suits their needs.

2. The percent contribution from footing drains of total wet weather I/ I can vary significantly between communities (25 to 90 percent).

3. Footing drain disconnection helps provide additional protection for storms larger than the design storm by removing a portion of the total infiltra-

tion and inflow.

4. Footing drain disconnection costs were based on a complete disconnect including a new curb drain installation. Partial disconnection alternatives can also be effective and be as little as one third the cost of a full disconnection.

5. In general, the 25-year, 24-hour growth (summer) design event (the event MDEQ is likely to establish for SSO control) is at the knee of the cost curve for most of the case study communities.

4.3 Regional Alternatives

1. Costs for regional alternatives have been developed for controlling SSOs to a smaller design event (less than 25-year storms). Higher levels of control were found to be unfeasible due to potential flooding issues.

2. Many communities that have not reported SSOs or basement flooding have similar excess RDII, but are at a geographical advantage to enter the regional system over their contract capacity.

3. Even though MDEQ officials have not yet established SSO guidelines, it appears they will accept the 25-year, 24-hour growth (summer) design event as the level of SSO control. However, it is unclear whether CSO displacement will be approved as a long-term solution.

5. Recommendations

Based on the above conclusions it is recommended that Detroit accept flows into the regional system up to an "allowable 10-year, 1-hour flow" for each customer. The "allowable 10-year, 1-hour flow" is the flow generated from a local collection system during the 10-year 1-hour design storm that conforms to criteria for peak hour flow to average daily flow for growth (summer) antecedent conditions and "best practices for system maintenance" developed by the Wastewater Master Plan and endorsed by the Contracts Work Group.

Ultimately, it is expected that following the "best practices for system maintenance" will lead to reducing flows to within a maximum peak flow allowed for the 10-year, 1-hour event. The primary factor in determining this "allowable 10-year, 1-hour flow" for each community is the percentage of homes with connected footing drains. Based on an analysis of the current peak flows from each community a standard of 0.4 cfs/ 1000 to 0.8 cfs/ 1000 is proposed as shown in Figure 2. However, future growth will be held to a stricter standard to be determined by the Contracts Works Group.

Table 2 gives a summary of the current modeled peak rates and the proposed standard rate for each of the DWSD sanitary customers. Based on previous contracts, areas having portions with combined sewers are based on 0.5 cfs/ 1000 people for the combined population.

Local SSO solutions such as storage and footing drain disconnection will be needed for flows over the allowable 10-year, 1-hour flow up to the level of control the MDEQ establishes (most likely the 25-year, 24-hour growth (summer) event). Communities not reporting SSOs but which are over this contract amount will also need to reduce wet weather flows to meet the "allowable 10-year, 1-hour flow."

Details of how this will be implemented and enforced will be determined by the DWSD contract work groups and reported in later WWMP documentation. However, the general recommended framework is summarized in Table 3.

Figure 2: Current 10-yr 1-hr Flows vs. Proposed Upper Limit

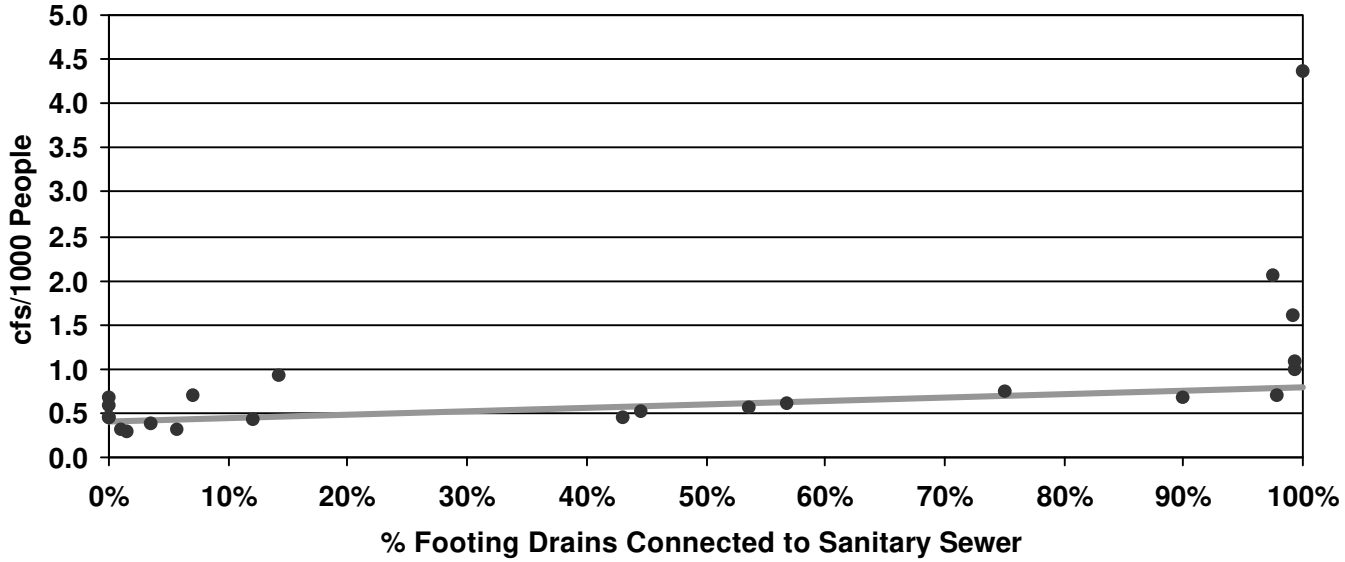


Table 2: Proposed Upper Limit for Contracts

Community	% FDs*	CFS/1000 People**	Proposed Standard Peak Rate (cfs)***
Dearborn (Miller Road PS)	99%	1.09	55.1
Dearborn (Greenfield PS)	99%	1.00	54.0
Oakland County	43%	0.46	184.7
SEMSD-NEWC (WM-S-2)	98%	0.69	181.3
Wayne County (WC-S-1,2,3)	57%	0.62	367.3
Allen Park	100%	4.58	5.3
Center Line	75%	0.75	7.0
Chesterfield	1%	0.32	14.8
Clinton Twp (CT-S-1,3,4)	3%	0.39	21.8
Clinton Twp. (CT-S-2)	45%	0.51	14.5
Farmington	90%	0.67	6.7
Fraser	54%	0.56	10.5
Grosse Pointe Park	97%	2.05	9.8
Harrison Twp (HR-S-1,3)	7%	0.69	9.3
Harrison Twp (HR-S-2)	6%	0.32	2.4
Macomb Twp	0%	0.58	28.8
Melvindale	99%	1.61	9.2
Oakland County	2%	0.30	107.5
Rochester Hills	0%	0.45	7.8
Shelby Twp (SY-S-1)	0%	0.44	4.1
Shelby Twp2 (SY-S-2)	0%	0.67	2.8
Sterling Heights	14%	0.93	63.7
Utica	12%	0.43	2.4

*Based on SEMCOG TAZ data and community supplied information
** CFS/1000 people is based on peak flow from WWMP 10-yr, 1-hr storm model

*** Based on proposed standard rate times residential population plus needs for SIUs and employed population (50 gepd). Areas with portions of combined sewers are based on 0.5 cfs/1000 people for population on the combined areas.

Table 3: Recommended SSO Regional Implementation Plan

Goals:
- Provide cost-effective solutions to eliminate SSOs from the DWSD service area.
- Deal with all customers equitably.
- Manage the regional system optimally and responsibly.
- Comply with state and federal regulations

Program Elements	Details
Regulatory Direction	The MDEQ is developing an SSO guidance document. Although this document has not yet been finalized, the following key elements appear to be consistent with what SSO communities will be required to meet. • Over the first three years, implement the short-term measures outlined in a letter sent by the MDEQ to SSO communities dated 10/23/01. • Develop a long-term plan to eliminate preventable SSOs in 10-20 years. Events over a 25-yr 24-hr design storm during growth (summer) conditions will be considered an "extreme event" and therefore unpreventable.
System and Economic Considerations	The **regional system role** will be to accept customer flows up to the 10-year, 1-hour flow, that the system is generally designed around. It is not possible to accept flows above this from all communities without significant system changes and CSO displacement. The **local system role** is to manage wet weather peak flows to the "allowable 10-year, 1-hour " based on system type and age. It is not cost-effective to use the system to handle to excessive peak flows as this limits the dry weather flow capacity.
DWSD Responsibilities	• Revise and renegotiate contracts based on upper limit of "allowable 10-year, 1-hour flows." • Eliminate regional system bottlenecks that prevent acceptance and conveyance of the 10-year, 1-hour flow. • Work with communities as a technical resource to help advance customer flow management programs
Customer Responsibilities	• Review current allowable 10-year, 1-hour flows. • Implement the "best practices for system maintenance" relevant to system and MDEQ short term measures. • Communities with current peak flow above their "allowable 10-year, 1-hour flow", establish with DWSD a timeframe (eg. 10-20 years) to achieve compliance. • Use local SSO control alternatives for flows above the "allowable 10-year, 1-hour flow" (up to the 25-year, 24-hour unpreventable event). • Continue following ACOs with the MDEQ.

1. Introduction

1.1 Background

The City of Detroit provides regional wastewater collection and treatment services for Detroit and 76 communities in the city's metropolitan area. The regional collection and treatment system serves approximately 3 million people and covers an area of about 904 square miles. Wastewater is treated at the city's wastewater treatment plant located at 9300 W. Jefferson Ave. in Detroit. The Detroit Water and Sewerage Department (DWSD) constructs, finances, operates, and maintains the system-wide wastewater collection and treatment facilities on behalf of the city. Each community owns, operates and maintains its local collection system.

The regional sewer system consists of about 220 square miles of combined sewer service area and more than 580 square miles of separated sanitary sewer service area. Detroit's sewer system is almost all combined and as a result the city does not have any sanitary sewer overflows (SSOs). However, several of the city's wholesale customers do have separate sanitary sewer systems that experience SSOs. These SSOs can be caused by a number of factors, including high wet weather flows due to infiltration and inflow; physical capacity constraints; constraints in achieving contract flow capacities to the DWSD system; and temporary operation and maintenance problems.

SSOs are releases of untreated sewage into the environment. Such discharges are illegal in Michigan. SSOs can be related to basement flooding, which has the potential to cause property damage and may present public health concerns. The Michigan Department of Environmental Quality (MDEQ) policy is to identify separate sanitary sewer overflows and take appropriate regulatory action to eliminate them.

In the spring of 2001, the DWSD joined with its wholesale customers in a collaborative process to examine solutions to eliminating the public health and water quality impacts of SSOs in the DWSD service area. This effort began after the DWSD had been approached by several customers seeking additional contract capacity as a potential approach to eliminating SSOs in their collection systems.

1.2 Purpose of the Regional Analysis of SSO Controls

The purpose of this regional study is to find a cost-effective solution to the elimination of sanitary sewer overflows from the DWSD service area. This regional study is being performed concurrently with a number of local studies. The results of the local studies are being combined with the regional analysis so that the following alternatives can be evaluated:

- Elimination of the sources of high infiltration/ inflow that cause SSOs;
- Local storage or treatment of SSOs; and
- Regional transmission, storage and treatment of SSOs.

The six local municipalities that are serving as case studies in the regional analysis are:

- Center Line
- Clinton Township
- Fraser
- Melvindale
- Allen Park
- Garden City

1.3 Purpose of Report

This document is Volume 6 of the Detroit Water and Sewage Department's Master Plan. Ongoing updates throughout the work were given in a series of interim reports and technical memoranda. A set of the final technical memoranda supporting this work is included in the CD that accompanies this report. Reference to the technical memoranda are made where appropriate in this report. The Master Plan is a comprehensive effort to plan for

wastewater collection and treatment improvements for the next 50 years.

1.4 SSO Technical Work Group and its Objectives

As part of the collaborative approach to this planning effort, the DWSD has convened a technical work group representing wholesale customers with SSOs, DWSD staff, the Southeast Michigan Council of Governments (SEMCOG), and Wastewater Master Plan consulting team members. This technical work group has met 15 times during the study to provide direction, review, and facilitate communication among DWSD, its wholesale customers, other treatment providers in the planning area, and regulatory agencies.

The work group adopted a set of goals and policy statements in May, 2001. These goals and policies include:

Define terms and items related to SSO for common use and understanding.

Every sewer system should be allowed to provide emergency relief points to prevent or mitigate basement flooding in the event of unforeseen emergency conditions or storm events which exceed the capacity of the system.

Future SSO problems should be prevented by requiring Best Management Practices in newly developed areas and by providing adequate transport and treatment capacity for existing sewered areas.

- Immediate action should be taken wherever feasible to reduce infiltration and inflow to the extent such work is cost-effective.
- High-cost SSO control projects should be re-evaluated in the context of a final comprehensive CMOM program including site-specific factors such as water quality impacts, financial capability of the community, etc.
- Coordinate all SSO-related activities with MDEQ and SEMCOG.
- Construction of local SSO storage basins and/ or relief sewers in the context of a comprehensive CMOM program is viable only to the extent that it does not create a problem in the regional system.
- Treatment and discharge of SSOs for extremely infrequent events should be evaluated as an alternative to storage or transport solutions.

2.Causes of SSOs in the DWSD Service Area

2.1 List of Terms

Many key terms related to SSOs are defined differently by various agencies, textbooks, and technical reports. In some cases a single agency may use different definitions. In order to establish a basic understanding among the members of the SSO technical work group and to know how different agencies understand the different terms, a list of authoritative definitions for key terms related to SSOs was compiled. These definitions are listed below with their sources. The most authoritative definition from each agency is used where more than one definition was found from that agency (usually out of the written regulation).

Antecedent moisture: The degree of wetness of the soil at the beginning of a runoff period, frequently expressed as an index determined by summation of weighted daily rainfalls for a period preceding the runoff in question. *William James, University of Guelph Web site*

A high antecedent moisture condition (soil is wet before a rain event) can significantly increase the wet weather response of a sewer as the soil is already saturated, leaving no room for storage. Depending on soil types and system conditions, typically, the first 0.2 to 1 inch of rainfall goes into soil storage if antecedent moisture conditions are low (soil is dry before a rain event). When the antecedent soils conditions are high (due to a previous rain event or snowmelt) the effective rain could be 0.2 to 1 inch higher.

Combined sewer: A combined sewer is a sewer that is designed to carry both sanitary sewage and storm water runoff. *Michigan Department of Environmental Quality (MDEQ)*

A sewer system that carries both sewage and storm water runoff. Normally, its entire flow goes to a waste treatment plant, but during a heavy storm, the volume of water may be so great as to cause overflows of untreated mixtures of storm water and sewage into receiving waters. Storm-water runoff may also carry toxic chemicals from industrial areas or streets into the sewer system. *The U.S. Environmental Protection Agency (EPA)*

Commingle: To combine sanitary sewer flows with combined sewer flows and treating the mix as combined sewage for treatment purposes.

CSO (Combined Sewer Overflow): A discharge from a combined sewer system that occurs in response to rainfall and/ or snowmelt because the carrying capacity of the sewer system is exceeded. These discharges do not receive all treatment that is available and utilized under ordinary dry weather conditions (normally during dry weather conditions the wastewater is transported to a wastewater treatment facility where it receives appropriate treatment prior to discharge). Both the combined sewer overflow structure and the discharge from the structure are referred to as CSOs. *MDEQ*

Decanting: The drawing off (of a liquid) without disturbing the sediment or the lower liquid layers. *Webster's New Collegiate Dictionary*. Should rain events occur closely together and the Detroit Wastewater Treatment Plant is unable to accept all flow, decanting at CSO basins provides an operational option. It enables the top layer of captured flow to be released into the waters of the state after disinfection, providing significant settling time for treatment of flow from subsequent rain events. *Rouge River National Wet Weather Demonstration Project*

Dewatering: The process of draining and/ or pumping water from wastewater equalization/ storage facilities back into the main

sewer lines when there is enough capacity to handle the stored volume. This typically occurs after wet weather I/I from a rain or snowmelt event subsides.

Discharge (also Overflow): Any direct or indirect discharge of any waste, waste effluent, wastewater, pollutant, or any combination thereof into any of the waters of the state or upon the ground. *MDEQ administrative rules wastewater discharge permits October 17, 1973.* This MDEQ definition is the same as an overflow. Note that collection system professionals typically use the term "discharge" to describe the location a flow enters into a pipe that delivers flow to a treatment facility.

Displacement: Sanitary flows taking capacity in a combined system such that an increase in combined sewer overflows occurs, but allowing the sanitary flows to be delivered to publicly owned treatment works. This is also called "preferential treatment." *SSO Technical Work Group*

Downspout: In plumbing, the water conductor from the roof to the storm drain or other means of disposal. *William James, University of Guelph Web Site*

Dry Combined: A combined sewer system with some of the storm sources redirected to a storm sewer system including street drainage, but still having other storm sources such as residential footing drain connections.

Dry Weather Flow: Combination of domestic, industrial and commercial wastes found in sanitary sewers during dry weather not affected by recent or current rain. Base flow is also sometimes used interchangeably with dry weather flow. However, base flow more typically is used to describe dry weather runoff to natural systems such as streams and rivers. *William James University of Guelph Web Site*

Excessive I/I: The amount of infiltration and inflow over the design capacity or 275 gpcd. The amount of infiltration or inflow that can be economically eliminated from a sewer system, as determined in a cost-effective analysis that compares the costs for correcting the infiltration or inflow conditions to the total costs for transportation and treatment of the infiltration or inflow. *Alaska Legal Resource Center*

Extreme event: The EPA does not define "extreme event" but states the following: The existing Clean Water Act prohibition of sanitary sewer overflows that discharge to surface waters is clarified to provide communities with limited protection from enforcement in cases where overflows are caused by factors beyond their reasonable control or severe natural conditions (such as hurricanes, tornados, widespread flooding, earthquakes, tsunamis, and other similar natural conditions), provided there are no feasible alternatives. The proposed standard condition provides several examples of severe natural conditions to clarify that claims should be limited to extreme conditions. The examples listed are not intended to reflect design or performance standards or criteria, but rather are common-sense examples of severe natural conditions. The Agency requests comments on whether these examples clarify the term "severe natural conditions," whether they generally represent technically feasible levels of control, whether they represent a reasonable range of examples relative to the performance of sanitary sewer collection systems, and whether they should be coupled with the "no feasible alternatives" criterion or stand independently. *EPA proposed SSO rule*

The MDEQ is currently reviewing what should be considered as an extreme event for the State of Michigan.

Flow Blending: The practice of routing some portion of peak wet weather influent around bio-

logical treatment units within a wastewater treatment plant and then mixing this flow with the effluent from biological units prior to discharge.

Groundwater: Subsurface water occupying the saturation zone from which wells and springs are fed. In a strict sense the term applies only to water below the water table. Also called phreatic (q.v.) water, plerotic water. *William James, University of Guelph Web site*

Infiltration: Water other than wastewater that enters a sewer system (including sewer service connections and foundation drains) from the ground through such means as defective pipes, pipe joints, connections, or manholes. *EPA Proposed SSO Rule: 40 CFR 35.2005(b)(20)*

Water entering a sewer system, including sewer service connections, from the ground through such means as defective pipes, pipe joints, connections, or manhole walls. *Metcalf & Eddy WW Text 1991*

Inflow: Water other than wastewater that enters a sewer system (including sewer service connections) from sources such as, but not limited to, roof leaders, cellar drains, yard drains, area drains, drains from springs and swampy areas, manhole covers, cross connections between storm sewers and sanitary sewers, catch basins, cooling towers, storm water, surface runoff, street wash waters, or drainage. *EPA Proposed SSO Rule: 40 CFR 35.2005(b)(20)*

Inflow has both a steady and direct component. Steady inflow is water from cellar and foundation drains, cooling water discharges, and drains from springs and swampy areas. This type is steady and therefore measured with infiltration. Direct inflow has a direct storm water runoff connection to the sanitary sewer and causes an almost immediate increase in wastewater flows. This includes roof leaders, yard and area drains, manhole covers, cross connections from storm drains and catch basins, and combined sewers. *Metcalf & Eddy WW Text 1991*

Receiving waters: The surface waters of the state into which an effluent is or may be discharged. *MDEQ administrative rules*

Return frequency: The reciprocal of the annual probability of exceedance of a specific flow value (also known as recurrence interval (q. v.)). In statistical analysis of hydrologic data, with observations equally spaced in time and the interval between two successive observations as unit of time, the reciprocal of one minus the probability of a value equal to or less than a certain value; or, the mean number of such time units necessary in order to obtain once a value equal to or greater than a certain value. For example, when the interval between observations is a year, a return period of 100 years (a frequency of 1/ 100) means that on the average in the long run, an event of this magnitude or greater is expected to occur not more often than once in 100 years. *William James, University of Guelph Web Site*

Sanitary sewer: Underground pipes that carry off only domestic or industrial waste, not storm water. *EPA Web site*

Sewage Backup: One type of residential basement flooding that may originate from hydraulic restrictions, obstructions, sewer or pump station failures, and similar conditions that occur within the public sewer system. They do not include conditions existing within the private service lead or exclusively on private property such as root intrusion into service leads, plugging resulting from attempts to flush large solids, and basement flooding from overland flow or ponding due to inadequate drainage. *MDEQ at the Michigan Water Environment October 24, 2001 Collections System Conference*

Shunting: A shunt channel protects a CSO basin

by directing flows in excess of a basin treatment capacity around the basin. This avoids the potential for negative treatment that can occur if flow through the basin suspends previously settled solids and causes the effluent to be more polluted than the influent. Though the shunted flows do not receive any sedimentation, they are skimmed, screened, and disinfected prior to overflow.

SSO (Sanitary Sewer Overflow): An overflow, spill, release, or diversion of wastewater from a sanitary sewer system. SSOs do not include combined sewer overflows (CSOs) or other discharges from the combined portions of a combined sewer system. SSOs include: (A) Overflows or releases of wastewater that reach waters of the United States; (B) Overflows or releases of wastewater that do not reach waters of the U.S.; (C) Wastewater backups into buildings that are caused by blockages or flow conditions in a sanitary sewer other than a building lateral. Wastewater backups into buildings caused by a blockage or other malfunction of a building lateral that is privately owned are not SSOs. *EPA Proposed SSO Rule: 40 CFR 35.2005(b)(20)*

SSOs are discharges of raw or inadequately treated sewage from municipal separate sanitary sewer systems, which are designed to carry domestic sanitary sewage but not storm water. These overflows may also contain industrial wastewater that is present in the sewer system. When an SSO occurs, raw sewage may be released into basements, city streets, properties, rivers, and streams. *MDEQ Web site*

Storm sewer: A system of pipes (separate from sanitary sewers) that carries water runoff from buildings and land surfaces. *EPA Web site*

Surface Waters of the State: All of the following, but does not include drainage ways and ponds used solely for wastewater conveyance, treatment, or control: (i) The Great Lakes and their connecting waters. (ii) All inland lakes. (iii) Rivers (iv) Streams. (v) Impoundments. (vi) Open drains. (vii) Other surface bodies of water within the confines of the state. *MDEQ administrative rules Water Quality Standards December 13, 1973*

Waters of the State: All waters within the jurisdiction of the state including all of the following: (i) Groundwaters. (ii) Lakes. (iii) Rivers. (iv) Streams. (v) All other watercourses and waters. (vi) The Great Lakes bordering the state. *MDEQ administrative rules, wastewater reporting, April 19, 1991*

Wet sanitary sewer: A sanitary sewer that hydraulically responds to wet weather like a combined system due to the amount of storm water entering the system. This is typically the result of having residential footing drains connected to the sanitary system that can contribute up to 90 percent of total wet weather flows. However, unlike a "dry combined system", they can also be the result of any source of I/ I other than intended direct storm connections, that is significant enough to cause a wet weather response similar to a combined system (eg. Infiltration in joints and cracks) *SSO technical work group*

2.2 Description of Causes and Types of SSOs

According to the United States Environmental Protection Agency (EPA), there are a variety of problems that may cause chronic SSOs. These problems include:

- **Inflow**
- **Infiltration**
- **Undersized Systems** (sewers and pumps too small to carry all of the sewage or peak wet

weather-induced flows in the system)

• **Pipe Failures** (blocked, broken, or cracked pipes, sediment buildup, pipe settling, pipe shifting, etc.)

• **Equipment Failures** (pump failures, power failures)

• **Sewer Service Connections** (discharges occurring at faulty sewer service connections to buildings)

• **Deteriorating Sewer System** (improper installation, improper maintenance)

In the August 2000 report *"Implementing Sanitary Sewer Overflow Corrections: An Action Strategy,"* the Southeast Michigan Council of Governments (SEMCOG) reports that sanitary sewer systems surcharge and sometimes overflow when flows exceed design and system performance standards. Factors that affect systems exceeding performance standards include:

• Footing drains connected directly to sanitary leads

• Sump pumps connected to sanitary leads

• Surface water inflow into manholes in flood-prone areas

• Other sources such as sewer infiltration and storm sewer connections

The SEMCOG task force also reported that not all sanitary sewer overflows are the same. Types of SSOs include:

• Untreated discharges, such as direct discharges from sewer pipes

• Partially treated discharges, such as discharges from retention/ equalization basins

• Periodic fixed-location discharges, such as relief structures constructed as part of the sewer system

• Unique event fixed-location discharges, such as the lowest manhole in a sewer system

• Periodic mobile discharges, such as temporary pumps entering a sewer through a manhole

• Unique event mobile discharges, such as pumping upstream of a blockage to prevent basement backups

These discharges vary significantly in their frequency, magnitude, and impact on water quality. Any reasonable policy for solving SSO problems must reflect these differing impacts on public health and water quality.

To learn more about the sources of inflow and infiltration that can contribute to SSOs, a survey of Planning Area communities was conducted. Communities with sanitary sewer systems were asked to identify which potential I/ I sources they felt were significant. Thirty of 67 communities responded. Of those 67 communities, 18 have reported SSOs to the MDEQ. A summary of the responses and partial results of those responses are shown in Table 2.1.

Table 2.1 shows that 21 of the 25 communities that listed causes for significant inflow and infiltration identified connected residential footing drains as a problem source. This was the most common problem source cited. Twelve communities cited leaky pipes and joints as a significant contributor and 10 communities cited leaky manholes. No other problem was cited more than seven times.

When asked what percentage of residential downspouts, commercial roof drains or residential sump pumps were connected to the sanitary system, 20 or more communities said that five percent or fewer were connected in each category. Four communities said the percentage connected was between five and 10. Farmington and Madison Heights reported higher percentages for commercial roof drains (10-25 percent) while Southfield and Eastpointe reported the same percentages for residential sump pumps. There were no other outliers.

Communities indicated that they arrived at their responses by estimates, rather than inspections at

Table 2.1: Community Inflow/Infiltration Survey

Question asked of each community: Which of the following do you feel are significant sources of inflow and infiltration to your sanitary sewer system?

Community	Connected residential footing drains	Residential sump pump & yard drain connections	Residential downspout connections	Commercial roof drain connections	Improperly connected storm structures	Leaky house lead connections	Leaky manholes	Leaky sewer pipes and joints	High groundwater areas	Leaky or broken water mains
Auburn Hills							●	●		
Bloomfield Township		●				●			●	
Canton Township	●								●	
Clinton Township	●	●				●	●	●		
Eastpointe	●									●
Farmington	●			●						
Farmington Hills	●									
Garden City	●					●		●		
Grosse Pointe	●							●		
Grosse Pointe Shores	●									
Harrison Township	●									
Hazel Park	●				●					
Inkster	●				●	●	●	●		
Lake Orion										
Lenox Township										
Madison Heights	●									
Melvindale	●			●						
Northville	●	●						●	●	
Orchard Lake							●			
Oxford										
Plymouth Township	●					●	●	●	●	
Rochester										
Roseville	●									
Shelby Township							●	●	●	
Southfield	●	●				●	●	●	●	
Sterling Heights	●									
Utica	●						●	●		
Washington Township										
Wayne	●	●	●	●			●	●		
Westland	●					●	●	●		

a 4-to-3 ratio. Not all communities responded to all questions in the survey.

One other potential cause of SSOs not previously mentioned is human operator error.

In reality, there will always be events causing flows greater than a system is designed for. For this reason, it is important to have relief points in systems in order to control overflows to minimize basement flooding, health risks and environmental impacts.

2.3 Description of Construction & Design Standards in Service Area

A number of communities within the DWSD service area were contacted in order to obtain the design and construction standards for residential wastewater plumbing in effect when the majority of homes were constructed. The objectives of this exercise included quantifying the extent to which footing drains are connected to the sanitary systems and providing information needed to select areas within the case study communities that are potential candidates for footing drain disconnection.

In addition to the six case study communities, two other communities were included in the survey. These communities, Farmington Hills and Livonia, were selected as a representative sample of communities in the service area.

In addition to a history of footing drain construction, information regarding residential downspout disconnection ordinances and enforcement was collected from the communities.

A brief summary of the information collected during these interviews is compiled in Table 2.2. In general, downspout disconnect ordinances are in effect and are enforced by inspectors. Furthermore, most footing drain connections constructed prior to new construction bans consist of two basement cleanouts (one for footings, one for sanitary) that combine into a single lead leaving the house.

A comparison was made regarding the contract capacities of first-tier customers. Using the Greater Detroit Regional Sewer System (GDRSS) Phase III Report and the corresponding technical memoranda, the total area, tributary area, and 1998 service population for each first-tier customer was found.

This information, combined with contract capacity criteria, was used to determine the contract capacity per 1,000 people (cfs/ 1,000) and the contract capacity per acre (cfs/ acre) for each first-tier customer. The results are found in Table 2.3.

From the table, it can be seen that there is considerable variability in contract capacities between DWSD customers, ranging from 0.4 to 56 cfs/ 1,000 people. The high contracts values listed for the Grosse Pointe communities were established in order to prevent overflows in that area to protect source water for the water treatment plant. As part of the Wastewater Master Plan, a Contracts Work Group has been established in order to come to an agreement on a more standardized approach to set contract limits. Recommendations from the work done under this task are discussed in Chapter 14.

2.4 Areas with High Dry Weather Inflow and Infiltration

The Greater Detroit Regional Sewer System (GDRSS) flow-metering project (Phase IV of DWSD Contract CS-1249) determined that dry weather I/ I comprises 28 percent of the dry weather flow transported to the DWSD wastewater treatment plant. Figure 2.1 shows the range of DWI/ I across the collection system. The analysis was based on data gathered from November 1997 through October 1999. The GDRSS results indicated that DWI/ I within the City of Detroit and

Table 2.2 Footing Drain Interview Summary

Community	Footing Drain Construction	Downspout Disconnection
Allen Park	Ordinance to disconnect if any basement waterproofing or footing drain work is done.	Ordinance in effect.
Center Line	Originally built as combined system; with footing drains connected. Separated prior to 1950, but footing drains were not disconnected. 1962 ordinance requires footing/foundation drain connection to storm sewer system or rear yard discharge.	Ordinance in effect. Residential and commercial compliance.
Clinton Township	Footing drain connection ban on new construction since 1962. Assumption that all homes with basements, or an estimated 73% of homes, have footing drain connections to sanitary system. Footing drains constructed of vitrified clay pipe. Sump pumps for new homes discharge to backyards.	Township reports that no downspouts are connected to the sanitary system. Ordinance No. 299 prohibits downspout connections. Downspout connections are examined when meters are read. Violations are referred for code enforcement action.
Farmington Hills	System was separate when built. 1969 ordinance banned new construction footing drains to the sanitary system. A few areas have sanitary sewers through backyards. In the early 80s footing drains were connected directly to storm sewers for new construction. Typical footing drain connection on houses built prior to the ban includes two basement cleanouts (one for footings, one for sanitary) that combine into a single lead leaving house.	No direct connection of downspouts to the sanitary system was ever allowed. Some houses have downspouts, which are directed underground, adjacent to foundations. A pilot program was undertaken in the early 1990s to remove disconnected downspouts. Very few were found to need disconnection.
Fraser	32 houses have been selected for a pilot disconnection program. 16 of these houses also have area drains connected to the sanitary sewer.	Ordinance is in effect and enforced. Smoke testing was competed. 2 catch basins and one parking lot drainage system were removed from sanitary system. Storm water system is limited to road drainage.
Garden City	Typical footing drain connection on houses built prior to the ban includes two basement cleanouts (one for footings, one for sanitary) that combine into a single lead leaving house.	Ordinance in effect.
Livonia	Houses built before 1973 had footing drains connected. After 1973 sump pumps required. Leads from sump pumps are directed to storm sewers. Older connections are all vitrified clay. No footings drain disconnections.	Ordinance in place and enforced with a warning when connections are discovered. The city has never investigated flat-roof drainage.
Melvindale	Most houses built in the early 1940s. Last subdivision built between 1955 and 1965. Most houses have basements. Typical footing drain construction for homes built prior to ban includes separate storm and sanitary cleanouts in basements that combine (via a wye) into a single lead.	Disconnection ordinance is in effect with follow-up inspections. Inspections conducted upon sale of houses and have been made for about 22 years. Approximately 10% of houses are sold (and therefore inspected) each year.

Table 2.3: First-Tier Customer Contract Capacity

First-Tier Wholesale Customer	Area [1] (acres)	Tributary [2] Area (acres)	Population [3] Served	Contract [4] Criteria	Contract Capacity Statistics		
					cfs	cfs/1000	cfs/acre
Wayne County							
Rouge Valley	96,767	69,763	508,792	380-cfs	380	0.747	0.005
Dearborn Heights District 2	49	49	257	none	-----	-----	-----
Redford School District 6	80	80	900	none	-----	-----	-----
Northeast Wayne District	21,018	19,762	186,745	127-cfs	127	0.680	0.006
Dearborn	15,615	12,313	86,198	100-cfs[5]	100	1.160	0.008
Melvindale	1,850	1,628	10,862	0.5-cfs/1,000 people	5.43	0.500	0.003
Allen Park	1,590	895	4,213	6-cfs[6]	6	1.424	0.007
Redford Township	58	58	503	unknown	-----	-----	-----
Farmington	1,424	1,288	8,030	6-cfs	6	0.747	0.005
Oakland County							
Evergreen-Farmington	83,090	61,929	254,584	170.0-cfs	170	0.668	0.003
Southeast Oakland	45,527	40,058	304,062	260.0-cfs	260	0.855	0.006
Clinton-Oakland	119,813	53,334	193,434	0.4-cfs/1,000 people	77.37	0.400	0.001
Center Line	1,060	993	8,365	6.5-cfs	6.5	0.777	0.007
Macomb County	103,765	54,895	310,667	0.4-cfs/1,000 people	124.27	0.400	0.002
Harper Woods [8]	1,671	195	1,847	none	-----	-----	-----
Grosse Pointe Farms	1,429	1,419	9,933	554-cfs	554	55.774	0.390
Grosse Pointe	691	685	5,788	192-cfs	192	33.172	0.280
Grosse Pointe Park	1,300	1,295	10,271	84-cfs	84	8.178	0.065
Highland Park	1,906	1,906	18,785	10-year Storm	-----	-----	-----
Hamtramck	1,349	1,349	18,200	63.5-cfs[7]	63.5	3.489	0.047

1. Source: GDRSS Phase III Report

2. Source: GDRSS Phase III Technical Memorandum No. 40, *"Subbasin Delineations and Tributary Area Statistics"*

3. Source: GDRSS Phase III Technical Memorandum No. 40, *"Subbasin Delineations and Tributary Area Statistics"*

4. Source: Wastewater Master Plan Interim Report on Planning Criteria Technical Memorandum *"Recommended Standard Provisions of Wholesale Contracts"***5. 4. 5.** The City of Dearborn has a contract capacity of 0.5-cfs/1,000 people. However, an overall contract limit of 100-cfs, divided evenly between the two pump stations, is commonly used.

6. The City of Allen Park has a contract capacity of 0.4-cfs/1,000 people. However, a contract capacity of 6-cfs has been documented in a previous contract and is commonly used.

7. The City of Hamtramck was found to have a contract capacity of 1,244.5-cfs in a CS-1281 report.

8. For portion of storm flow that goes directly to Detroit system.

that of suburban areas was 42 percent and 15 percent respectively.

The six areas shown in Figure 2.1 having the highest DWI/ I are primarily within the City of Detroit (relatively small portions of some areas extend into Dearborn, Hamtramck, and Highland Park.) DWSD has responded to these findings and is currently preparing a detailed investigation into sources of DWI/ I within the City of Detroit (DWSD Contract CS-1374).

2.5 Footing Drain and Downspout Issues

In the DWSD service area it is suspected that footing drains are a leading contributor to excessive inflow, which can result in wet weather SSOs. Footing drains are constructed around the foundations of homes and other buildings with basements to drain water away from basement walls. This is done in order to keep water from leaking

Figure 2.1: Dry Weather I/I in the DWSD Service Area

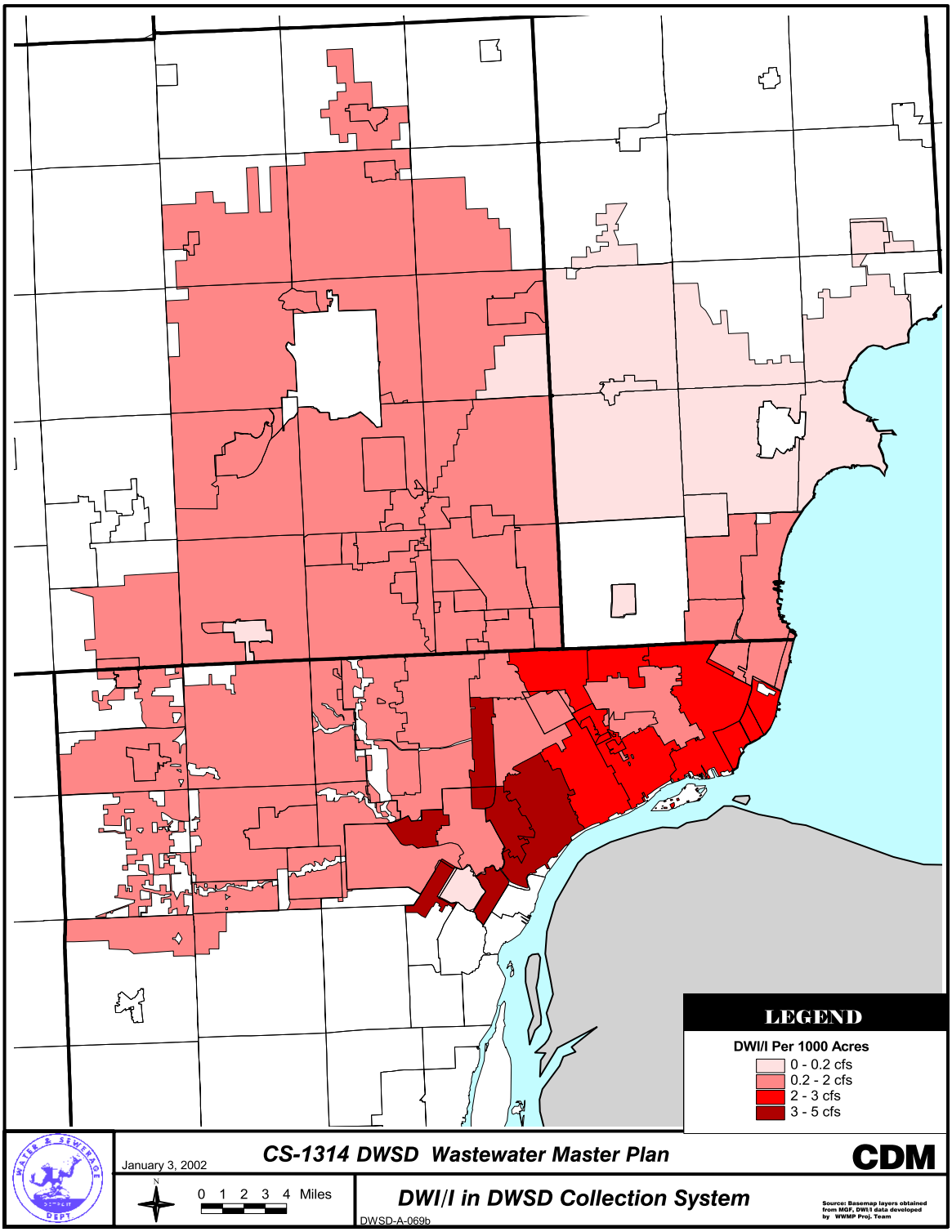
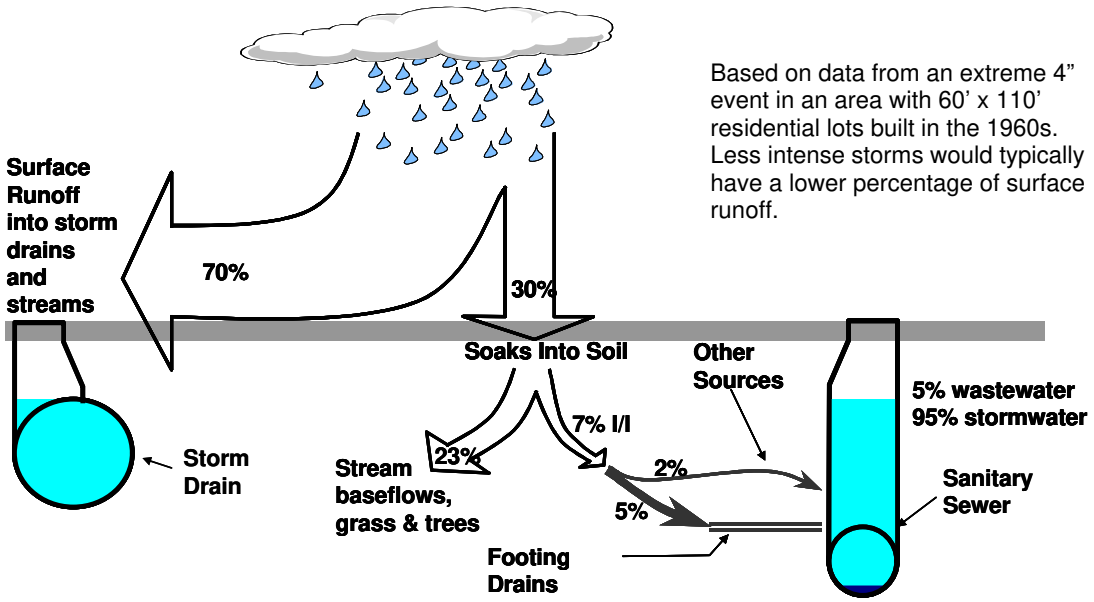


Figure 2.2: Example of Rainwater Flow Pathways



Note: Percentages can vary significantly between locations based on site-specific variables.

through the walls. Water around basement walls can be due to a high groundwater table that may fluctuate seasonally, or due to rainwater that infiltrates into the soil after a rain event. Foundations built in clay with sand backfill can act as a "bathtub," not allowing water to disperse through the clay away from the foundation. Based on a recent study performed by the City of Ann Arbor, Figure 2.2 shows an example of flow pathways for rainwater in a residential area with lots sizes approximately 60' x 110' and built in the 1960s. In this example, five percent of the rainwater enters the sanitary sewer through footing drains. Although this is a small amount relative to the amount that enters the storm sewer system (70 percent), it is a high amount relative to the capacity of the sanitary sewer system. However, these percentages will vary between locations and could be significantly different depending upon site-specific variables such as soil types, topography and construction standards used. The timeframe for rain water entering the sanitary system through footing drains can be as short as five or 10 minutes and as long as 10 days, depending on site and soil conditions.

Historically, the connection of footing drains into sanitary collection systems was common practice in southeast Michigan. Based on inspections and information gathered from local plumbing inspectors, Figure 2.3 shows how a residential footing drain is typically connected into the sanitary sewer system. In this figure the footing drain pipes connect to the house sanitary lead inside the house. There are two cleanouts, one for the sanitary line and one for the footing drain line. In some homes this connection is made outside of the home.

Where combined sewer systems were originally built, all sanitary and storm drainage was directed into a common sewer. As combined collection systems have been separated in some communities in response to CSO regulations, footing drains were not typically disconnected from the sanitary system. This was because the benefits of a complete separation program were not great enough to justify the expense and disruption to private prop-

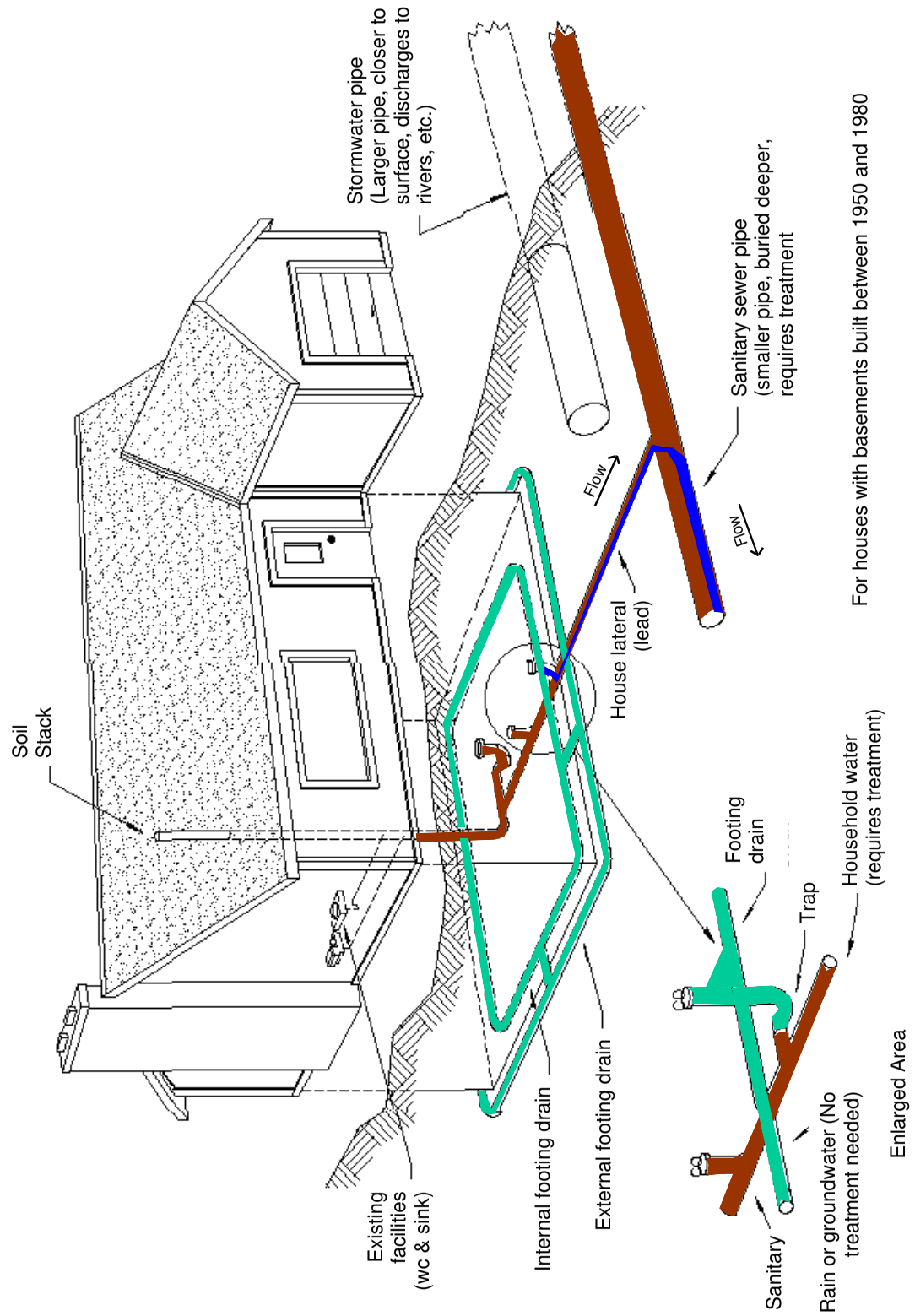


Figure 2.3: Typical Residential Footing Drain Connection

erty required to redirect footing drains to storm water collection systems or into backyards. However, as footing drains' impact on inflow becomes more apparent to many communities, footing drain disconnect programs are becoming more widespread. Footing drain disconnection is consistent with federal pollution prevention.

In order to assess the extent of footing drain connections in the region, a map has been made of areas that have been identified as having a high proportion of residences with footing drains connected to the sanitary system. Areas that were identified as not having footing drains connected to the sanitary systems are also shown. The information to develop this map was based on existing reports and GDRSS project information. Where no data was available, Tier 1 customers were asked to provide it. Figure 2.4 shows footing drain information collected to date.

Over the years, building code requirements have evolved to the point that footing drains cannot be connected to sanitary collection systems for newly constructed buildings. Generally prior to 1973 the connecion of footing drains was allowable under the National Building Code and few communities had local requirements prohibiting connection to the sanitary system. Between 1973 and 1985, the connection of footing drains to sanitary collection systems was prohibited by individual community ordinances, but enforcement of this building code provision was not widespread. In the mid-1980s enforcement became more rigorous and it is believed that most homes built after 1985 do not have footing drains connected to sanitary collection systems.

A map of areas with suspected footing drain connections to the sanitary system was developed using median house age obtained from the 1990 U.S. Census. Figure 2.5 shows the service area divided into census tracks which correspond to different categories as follows:

- **CSO -** Combined Sewer Area where all footing drains are connected to the wastewater collection system (based on GDRSS information not census data.)
- **Before 1973 -** Areas where widespread connection of footing drains to sanitary collection systems is suspected.
- **1973–1985 -** Areas where connection of footing drains to the sanitary collection systems is possible.
- **After 1985 -** Areas where widespread connection to footing drains is not expected.

This figure provides a regional picture of areas with a higher potential for widespread footing drain connections to the sanitary system and which will be subject to more intensive investigations.

Residential and commercial downspouts connected to the sanitary system present another potentially significant contributor to excessive I/ I. Most communities have therefore passed downspout disconnect ordinances. However, they are enforced to varying degrees.

Figure 2.4: Footing Drain Connections in the DWSD Service Area

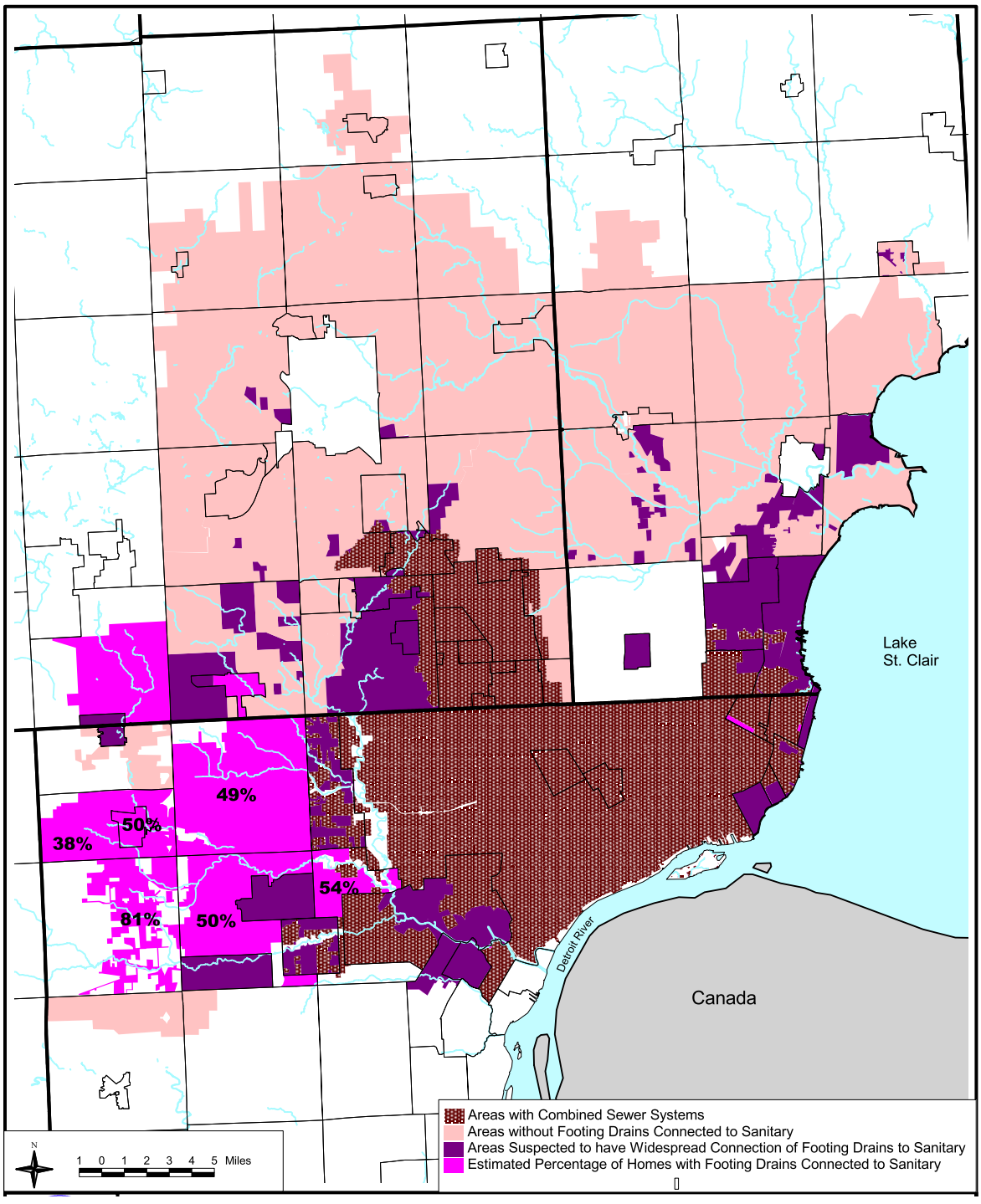
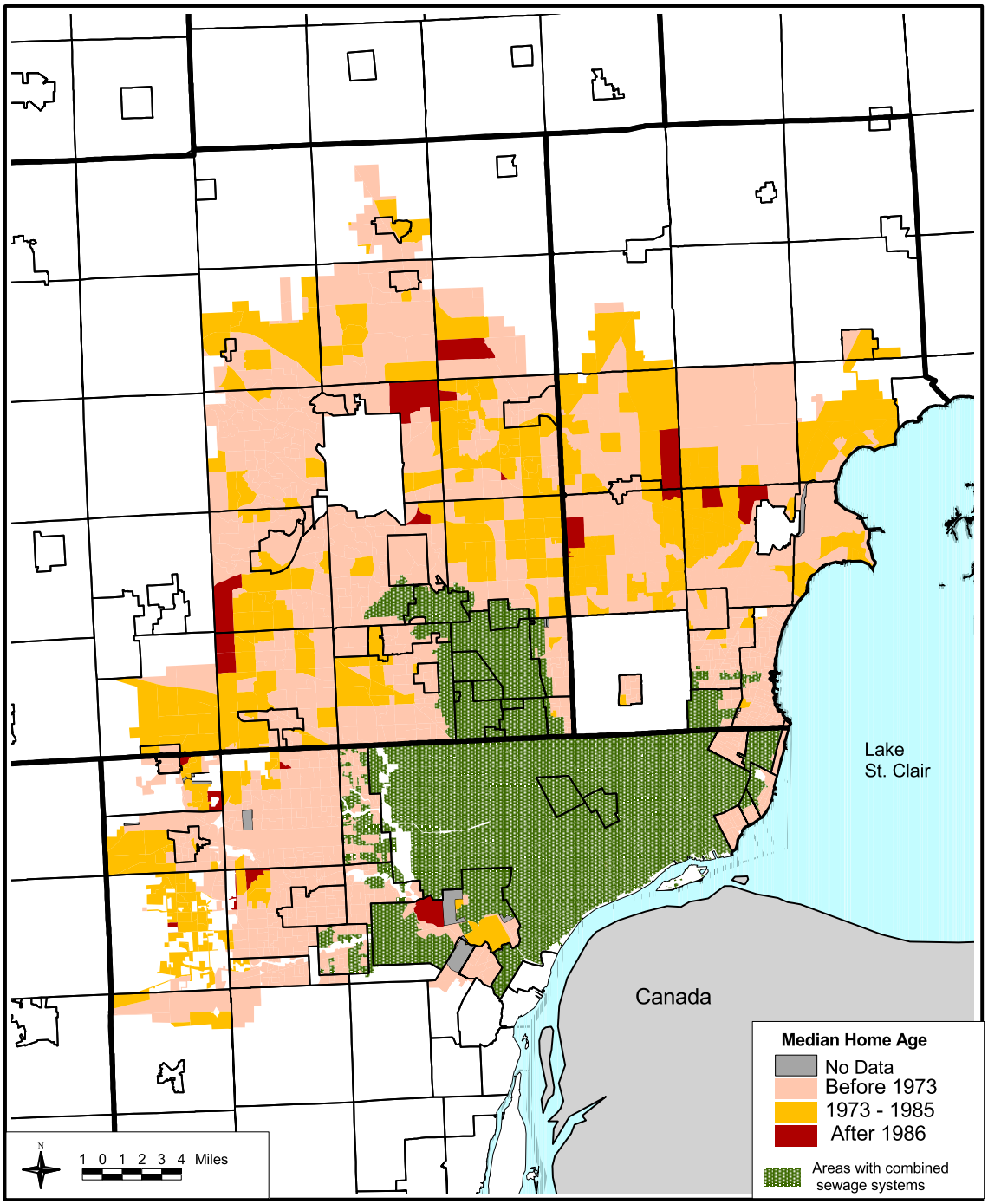


Figure 2.5: Median Home Ages in the DWSD Service Area



3. Characteristics of SSOs in DWSD Service Area

3.1 Recent SSO Events

Since July 1999, Michigan law requires the reporting of sanitary and combined sewer overflow events to the MDEQ and media within 24 hours of the start of the overflow. This information is available at the Michigan Department of Environmental Quality (MDEQ) Web site: http://www.michigan.gov/deq. The data was compiled and analyzed in the following sections.

The most comprehensive SSO data is available starting July 10, 2000, when MDEQ officially adopted its SSO strategy as described in Section 12.1 of this report. Therefore, only data from that date on is summarized here. SSO locations reported to MDEQ during this analysis period are shown in Figure 3.1.

A summary of the SSOs reported to the MDEQ by Detroit Water and Sewerage Department (DWSD) customers between July 10, 2000 and July 10, 2002 is given in Table 3.2. This table includes the responsible entity, the start date of the SSO, the location, and the volume in millions of gallons. Where no volume is given, the amount was not reported. It is important to understand that the reported volumes can be either measured or estimated. Some communities such as Center Line and Clinton Township can give more accurate volumes as they either have a flow meter or pump data. Many other location can only make an estimate based on observation and duration. The details of how each volume was measured or estimated are not known for most of the reported volumes.

Most SSO reports did not include precipitation. In order to obtain the values listed in Table 3.2 the nearest SEMCOG or Midwest Climate Center rain gages were used. These values are estimates because gages were as far away as 10 miles from some events. The amount of rainfall listed is not necessarily the daily total as some events occurred over more than one day. Furthermore, it does not take into consideration antecedent moisture conditions and snowmelt. For example, the average precipitation for the events of Feb. 9, 2001 is only 0.88 inches, but it does not include the 1.3 feet of snowpack reported melted by the Midwest Climate Center. Likewise, the precipitation listed for the SSO events of Sept. 11, 2000 does not include the more than one inch of rain that fell the day before.

Events listed in Table 3.2 were classified as being caused by either a wet or dry weather event. A wet weather event classification indicates that it was caused by I/I due to rainfall and/or snowmelt. All of the dry weather event classifications were attributed to operations and maintenance problems. The final column in the table provides comments related to the event.

According to SEMCOG, 2000 was a wet year with recorded precipitation of six to eight inches above average. Figure 3.2 shows rainfall amounts in southeast Michigan in 2000 and Figure 3.3 shows the year's rainfall deviations from average. For 2001, SEMCOG reports that rainfall totals were on average over 3" less than in 2000, making it closer to an average year for rainfall.

The difference in amount of rainfall between 2000 and 2001 can be seen in the total volumes of wet weather reported wet SSOs. From July 10, 2000 to July 10, 2001, the reported wet weather SSO volume from local systems tributary to the DWSD collection system was 26.1 million gallons (MG). This compares to 14.7 MG the following 12 months. The total reported SSO volume over the two years analyzed under this study is 41.4 MG. The total dry weather reported SSO over the two years is 0.7 MG.

Figure 3.4 gives the total wet weather SSO volume reported for each event and the number of events that began on a given date. Of the 83 SSOs reported, 11 had unknown volumes. Wet weather SSOs occurred on 35 different days over the two-year analysis period. About 23 percent of the volume occurred during a single rain event on Oct. 16, 2001. Eighty two percent of the volume occurred when the average rainfall across the service area was above 1.8" of total rainfall.

Figure 3.5 shows the percent contribution of total SSO volumes for each community. In some cases, SSOs were the result of localized extreme events, exceeding a 100-year return frequency. For some communities, more than 50 percent of total reported SSO volume is due to a greater-than-100-year storm. SSOs from events of this magnitude are unlikely to be prohibited by Michigan law.

Figure 3.6 shows the percent contribution of the number of wet weather SSO discharges from local systems tributary to the DWSD collection system. In cases where communities have more than one SSO location for any given event, the each location is grouped to only count as one occurrence. As seen in Figure 3.7 the total volume reported by each community is not necessarily related to its number of SSO events. Clinton Township reported the second most events (14), but only accounted for about 1.8 percent of SSO volume.

Each of the 17 communities that reported wet weather SSOs was identified as to whether it was a formerly combined system. The communities were also identified as to whether they have footing drains connected to the sanitary sewer system. Then, based on information from reports to the Federal Court, community I/ I surveys, and discussion with each community, they were identified as having any of four general causes for SSOs:

- Lack of local sewer transport capacity
- Lack of interceptor capacity
- Lack of contract capacity
- Excessive I/ I

These categories are not mutually exclusive and represent what the community feels are the sources. Table 3.3 summarizes the information collected.

Table 3.1: WWTP, SSO and CSO Volume Comparison

		Volume (MG)	% of WWTP Flow
WWTP		252,478	100
SSO		26.1	0.01
CSO	Treated	1,753	0.7
	Untreated	19,426	7.6
	Total	21,179	8.4

Comparison period: July 10, 2000–July 10, 2001

Based on the information presented in this section, Figure 3.8 provides a summary of key statistics related to SSOs from DWSD customers for events reported between July 10, 2000 and July 10, 2002. Most notable is that 100 percent of the wet weather SSO volume comes from communities with footing drains connected to the sanitary sewer. Furthermore, 84 percent of the wet weather SSO volume comes from communities that feel they are limited by contract capacity. However, based on the regional analysis detailed in chapter 12, a more likely reason is excess I/ I.

3.2 Comparison of SSOs

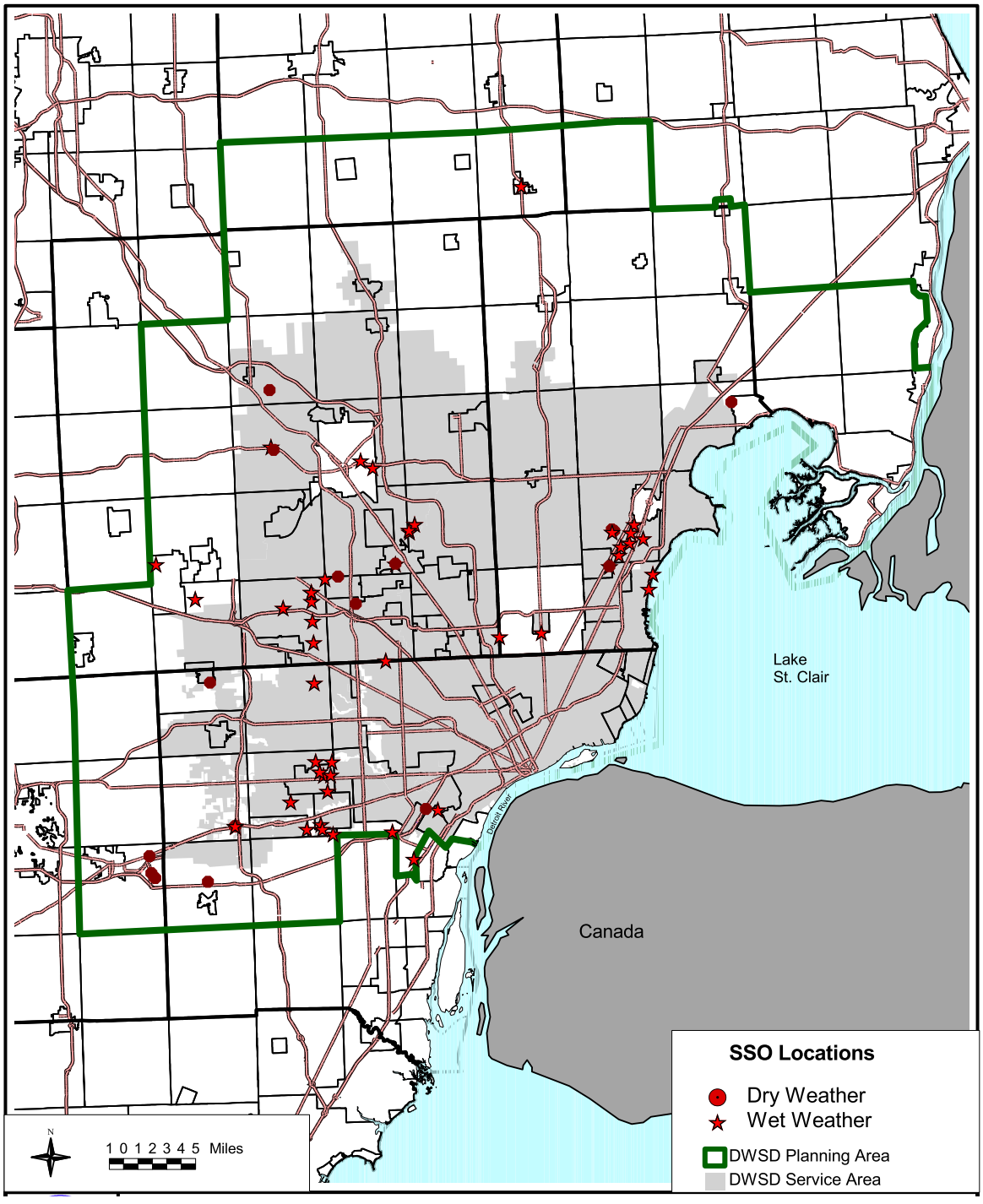
Annual total volumes of wastewater treated at the Detroit Wastewater Treatment Plant, combined sewer overflows and sanitary sewer overflows are compared in Table 3.1. The SSO volume is based on reported volumes to MDEQ from July 10, 2000 to July 10, 2001. The volumes at the treatment plant are based on monthly operations reports provided by the DWSD for the same period. The

DWSD uses a computer model to estimate CSO volumes based on rainfall data. The average annual CSO volume for Detroit was calculated based on model runs from April 1999 to April 2001. CSO volumes from suburban communities were obtained from MDEQ and added to the DWSD average annual volume.

SSO volumes in the service area were 0.01 percent of the volume treated at the Detroit WWTP. The total CSO volume in the service area was 6.2 percent of the volume at the treatment plant.

The relative impact of pollutant loading to the environment due to SSOs, the Detroit Wastewater Treatment Plant and CSOs was investigated by comparing reported pollutant concentrations. The reported concentrations for a number of common pollutants found in wastewater were obtained from a variety of sources and are discussed on chapter 10. Generally, the concentrations found in CSOs and SSOs are lower than those found in dry weather wastewater flows prior to treatment with CSOs and SSOs being generally similar.

Figure 3.1: SSO Locations in the Planning Area



Note: Locations are linked through Wastewater Master Plan GIS to Table 3.2 where locations were reported

Table 3.2: Summary of SSOs in DWSD Service Area

Between 7/10/00 and 7/10/02 for Current DWSD Customers. Source: MDEQ and Communities

Community or Authority	Date	Location	Volume (MG)	Precipitation (inches)	Wet/ Dry	Comment
Birmingham	12/12/00	Hidden Ravine @ Rouge River		1.18	wet	Cleaned sewer
	8/22/01	Hidden Ravine @ Rouge River		0.03	dry	Obstruction: Jet Rodded
Canton	9/27/00	Michigan and Haggerty	0.0045	0	dry	During Maintenance
	6/7/02	Michigan East of Sheldon	0.00005	0	dry	Air release valve failure
Center Line	7/29/00	Center Line Lift Station	2.63331	4.26	wet	Chronic
	8/2/00	Center Line Lift Station	2.93423	1.86	wet	Chronic
	2/9/01	Center Line Lift Station	0.38924	1.16	wet	Chronic; significant snow melt
	2/25/01	Center Line Lift Station	0.09339	1.27	wet	Chronic
	4/6/01	Center Line Lift Station	0.0116	1.05	wet	Chronic
	6/2/01	Center Line Lift Station	0.05518	1.34	wet	Chronic
	10/12/01	Center Line Lift Station	0.0874	0.83	wet	Chronic
	10/16/01	Center Line Lift Station	0.446	1.45	wet	Chronic
	11/30/01	Center Line Lift Station	0.52507	2.51	wet	Chronic
	4/13/02	Center Line Lift Station	0.02335	0.71	wet	Chronic
	5/2/02	Center Line Lift Station	0.39291	0.95	wet	Chronic
Clinton Twp.	7/30/00	Beaconsfield PS#9	0.01164	4.01	wet	Chronic
	7/30/00	Golden and Danbury PS#4	0.00038	4.01	wet	Chronic
	7/30/00	King and Price PS#3	0.0197	4.01	wet	Chronic
	7/30/00	Mulberry and Remick PS#1	0.06282	4.01	wet	Chronic
	7/30/00	North Nunneley PS#2	0.0086	4.01	wet	Chronic
	7/30/00	Rutherford and Griswald PS#6	0.02965	4.01	wet	Chronic
	8/2/00	Beaconsfield PS#9	0.00385	1.78	wet	Chronic
	8/2/00	Golden and Danbury PS#4	0.00586	1.78	wet	Chronic
	8/2/00	King and Price PS#3	0.00178	1.78	wet	Chronic
	8/2/00	Mulberry and Remick PS#1	0.00472	1.78	wet	Chronic
	8/2/00	North Nunneley PS#2	0.01373	1.78	wet	Chronic
	8/2/00	Rutherford and Griswald PS#6	0.01589	1.78	wet	Chronic
	9/11/00	Golden and Danbury PS#4	0.00656	2.39	wet	Chronic
	9/11/00	King and Price PS#3	0.00005	2.39	wet	Chronic
	9/11/00	Mulberry and Remick PS#1	0.00439	2.39	wet	Chronic
	9/11/00	North Nunneley PS#2	0.01904	2.39	wet	Chronic
	9/11/00	Rutherford and Griswald PS#6	0.01225	2.39	wet	Chronic
	2/9/01	Beaconsfield PS#9	0.00179	1.09	wet	Chronic
	2/9/01	King and Price PS#3	0.01608	1.09	wet	Chronic
	2/9/01	Mulberry and Remick PS#1	0.0602	1.09	wet	Chronic
	5/18/01	Private Residence 1	0.252	0.27	dry	Lift station problem; resolved
	5/18/01	Private Residence 2	0.00623	0.27	dry	Plugged sewer; resolved
	8/19/01	Private Residence 2	0.00001	2.44	wet	Not under the ACO
	10/12/01	Beaconsfield PS#9		1.2	wet	Chronic

Community or Authority	Date	Location	Volume (MG)	Precipitation (inches)	Wet/ Dry	Comment
Clinton Twp.	10/16/01	Beaconsfield PS#9	0.00033	1.53	wet	Chronic
	10/16/01	Rutherford and Griswald PS#6		1.53	wet	Chronic
	11/30/01	Beaconsfield PS#9	0.00253	2.9	wet	Chronic
	11/30/01	Golden and Danbury PS#4	0.3138	2.9	wet	Chronic
	11/30/01	Mulberry and Remick PS#1	0.0019	2.9	wet	Chronic
	11/30/01	North Nunneley PS#2	0.00472	2.9	wet	Chronic
	11/30/01	Private Residence 2	0.054	2.9	wet	Not under the ACO
Evergreen/ Farmington	7/30/00	Walnut #1 Pump Station	0.04	2.05	wet	Chronic
	8/2/00	Walnut #1 Pump Station	0.01	0.57	wet	Chronic
	9/10/00	13 Mile and Middlebelt		1.65	wet	Chronic; 041002
	9/10/00	Walnut #1 Pump Station	0.109	1.65	wet	Chronic
	9/11/00	Walnut #1 Pump Station	0.016	3.71	wet	Chronic
	12/24/00	Walnut #1 Pump Station	0.126	0.07	wet	Chronic
	2/9/01	13 Mile and Middlebelt		0.48	wet	MH overflow; FAT 041002
	2/9/01	Eldon Rd between 9 & 10 Mile		0.48	wet	MH overflow; FAT 98103
	2/9/01	MH # WBT 133001		0.48	wet	Plugged Sewers; resolved
	2/9/01	MH # WBT 133002		0.48	wet	Plugged Sewers; resolved
	2/9/01	Walnut #1 Pump Station	3.776	0.48	wet	Chronic
	2/25/01	Walnut #1 Pump Station	0.054	1.25	wet	Chronic
	10/12/01	Walnut #1 Pump Station	0.072	1.15	wet	Chronic
	10/16/01	Evergreen and Eight Mile Roads	4.776	0.46	wet	Only reported once so far
	10/16/01	Walnut #1 Pump Station	2.59	0.46	wet	Chronic
	10/17/01	Walnut #1 Pump Station	0.1546	1.44	wet	Chronic
	11/30/01	Walnut #1 Pump Station	0.464	1.2	wet	Chronic
Farmington Hills	9/10/00	Lincolnshire Pump Station	0.0024	3.06	wet	MH overflow
	10/5/00	Lincolnshire Pump Station		0.32	wet	MH overflow
	2/9/01	12 Mile and Farmington Rd	0.0616	0.48	wet	MH overflow; FAT 039197
	2/9/01	Utley and Middlebelt		0.48	wet	MH overflow; FAT 047103
	10/16/01	13 Mile and Middlebelt		2.52	wet	MH overflow; FAT 041002
Franklin	6/25/01	Cranbrooke & 14 mile	0.0001	0	dry	Force Main; Repaired
Fraser	7/28/00	Beacon Lift Station	2.19315	4.24	wet	Chronic
	8/2/00	Beacon Lift Station	0.67884	1.06	wet	Chronic
	8/6/00	Beacon Lift Station	0.11527	0.78	wet	Chronic
	8/14/00	Beacon Lift Station	0.10509	0	dry	Pump Malfunction
	9/10/00	Beacon Lift Station	0.03649	1.24	wet	Chronic
	9/11/00	Beacon Lift Station	0.87558	1.89	wet	Chronic
	2/9/01	Beacon Lift Station	0.3591	1.25	wet	Chronic
	2/25/01	Beacon Lift Station	0.0519	1.46	wet	Chronic
	4/6/01	Beacon Lift Station	0.04576	0.61	wet	Chronic
	4/9/01	Beacon Lift Station	0.02219	0.63	wet	Chronic

Community or Authority	Date	Location	Volume (MG)	Precipitation (inches)	Wet/ Dry	Comment
Fraser	5/21/01	Beacon Lift Station	0.01256	1	wet	Chronic
	9/9/01	Beacon Lift Station	0.00531	1.45	wet	Chronic
	10/5/01	Beacon Lift Station	0.0247	1.52	wet	Chronic
	10/12/01	Beacon Lift Station	0.14666	1.62	wet	Chronic
	10/16/01	Beacon Lift Station	0.29331	1.46	wet	Chronic
	11/30/01	Beacon Lift Station	0.96866	1.58	wet	Chronic
	4/8/02	Beacon Lift Station	0.00841	0.77	wet	Chronic
	5/5/02	Beacon Lift Station	0.02277	0	dry	Well level sensor replaced
Garden City	9/11/00	Dawson and Garden	0.03125	3.33	wet	Mobil bypass pumping
	9/11/00	Deering and Dawson	0.03125	3.33	wet	Mobil bypass pumping
	9/11/00	Harrison and Kathyrn	0.03125	3.33	wet	Mobil bypass pumping
	9/11/00	Middlebelt and Maplewood	0.03125	3.33	wet	Mobil bypass pumping
	10/26/01	Dawson and Garden	0.0175	0.72	wet	Mobil bypass pumping
	10/26/01	Harrison and Kathyrn	0.0175	0.72	wet	Mobil bypass pumping
Hazel Park	7/30/00	Tucker Street @ Dequindre	0.004	1.64	wet	Chronic: under ACO
	8/2/00	Tucker Street @ Dequindre	0.081	0.93	wet	Chronic: under ACO
	1/30/01	Tucker Street @ Dequindre	0.0023	0.41	wet	Chronic: under ACO
Inkster	9/11/00	29450 Andover Street	0.656	2.14	wet	CSO Basin under schedule of compliance
	2/26/02	3700 John Daly	0.0195	0.19	dry	Pump failure
Livonia	8/2/00	Pickford and Lamar	0.03	0.59	wet	Pumped, chronic
	9/10/00	Pickford and Lamar	0.059	2.47	wet	Pumped, chronic
	2/9/01	Pickford and Lamar	0.0198	1.32	wet	Pumped, chronic
Melvindale	9/11/00	Pumping Station	2.141	3.37	wet	Opened bypass valve
	3/22/01	Greenfield Rd @ I-94		0	dry	Maintenance issue; resolved
Oakland County - Clinton Oakland	10/17/01	Spring Lake Lift Station; 6120 Maybee Road	3E-06	2.52	dry	PS failure: resolved
Southfield	10/13/00	Wildbrook Drive and 12 Mile		0	dry	Plugged sewer; resolved
St. Clair Shores	7/30/00	Jefferson PS @ Lake Boulevard	0.651	1.87	wet	Chronic
	7/30/00	Masonic, Jefferson Overflow PS	0.949	1.87	wet	Chronic
	8/2/00	Jefferson PS @ Lake Boulevard	0.45	1.6	wet	Chronic
	8/2/00	Masonic, Jefferson Overflow PS	0.465	1.6	wet	Chronic
	11/30/01	Masonic, Jefferson Overflow PS	0.514	2.15	wet	Chronic
Troy	7/30/00	Beach and Tarragona	0.125	2	wet	Chronic
	7/30/00	Binbrook and Kent	0.125	2	wet	Chronic
	2/9/01	Adam and Wattles	0.15	1.45	wet	Only reported once to date
	2/9/01	Beach and Tarragona	0.15	1.45	wet	Chronic
	2/9/01	Binbrook and Kent	0.15	1.45	wet	Chronic
	5/21/01	Beach and Tarragona	0.075	2.5	wet	Chronic
	5/21/01	Binbrook and Kent	0.075	2.5	wet	Chronic
	10/16/01	Beach and Tarragona	0.007	1.72	wet	Chronic
	10/16/01	Binbrook and Kent	0.007	1.72	wet	Chronic

Community or Authority	Date	Location	Volume (MG)	Precipitation (inches)	Wet/ Dry	Comment
Van Buren Twp.	4/2/01	50901 Expressway		0	dry	Force Main Break; resolved
Waterford	10/22/00	Beverly Island	0.003	0	dry	Plugged sewer; cleaned
	5/28/01	Private Residence	0.00157	0.63	wet	Debris in sewer; removed
	4/28/02	Herbell Dr. E of Lorberta Lane	0	0.23	dry	Bad seal on force main seal
Wayne	9/11/00	Hayes, N of Annapolis	0.2	3.71	wet	Generator failure; resolved
Westland	9/10/00	August and Louise	0.18	3.71	wet	Chronic
	9/11/00	Annapolis and Middlebelt	0.24	3.71	wet	Only reported once to date
	9/11/00	Cavell and Warren	0.36	3.71	wet	Chronic
	9/11/00	Hanover and Admiral	0.27	3.71	wet	Only reported once to date
	9/12/00	Schuman and Avondale	0.435	3.71	wet	Only reported once to date
	2/9/01	August and Louise	1.2	1.32	wet	Chronic
	10/16/01	August and Louise	1.115	1.92	wet	Chronic
	10/16/01	Cavell and Warren	0.255	1.92	wet	Chronic
	1/1/02	Hanover and Admiral	0.3	0	dry	Loss of power at pump station
	2/1/02	Annapolis and Inkster	1.38	0.78	wet	Loss of power at pump station
WTUA	7/20/00	WWTP	0.00005	0	dry	Leak; repaired
	9/27/00	Michigan and Haggerty	0.0045	0	dry	Leak; repaired
	1/31/01	Lower EQ Basin	0.005	0.25	wet	Only reported once to date
	2/10/01	Michigan and Haggerty	1.625	1.32	wet	Only reported once as wet SSO
	3/21/01	Ward and Tyler	0.0001	0	dry	Leak; repaired
	8/27/01	Michigan Rd. near Wiard	0.00001	0.01	dry	Leak; repaired
	9/14/01	7 Mile Rd at Hines Drive	0.0003	0	dry	Construction related
	9/23/01			0.08	dry	No detail available
	11/2/01			0.3	dry	No detail available
	2/13/02	Michigan and Haggerty	0.00005	0	dry	Air release valve failure
	3/25/02	Michigan and M-12	0.00003	0	dry	Air release valve failure
	4/12/02	Michigan and M-12	0.00005	0	dry	Air release valve failure
	5/12/02	1190 Parkway Drive	0	0.94	wet	Only reported once to date

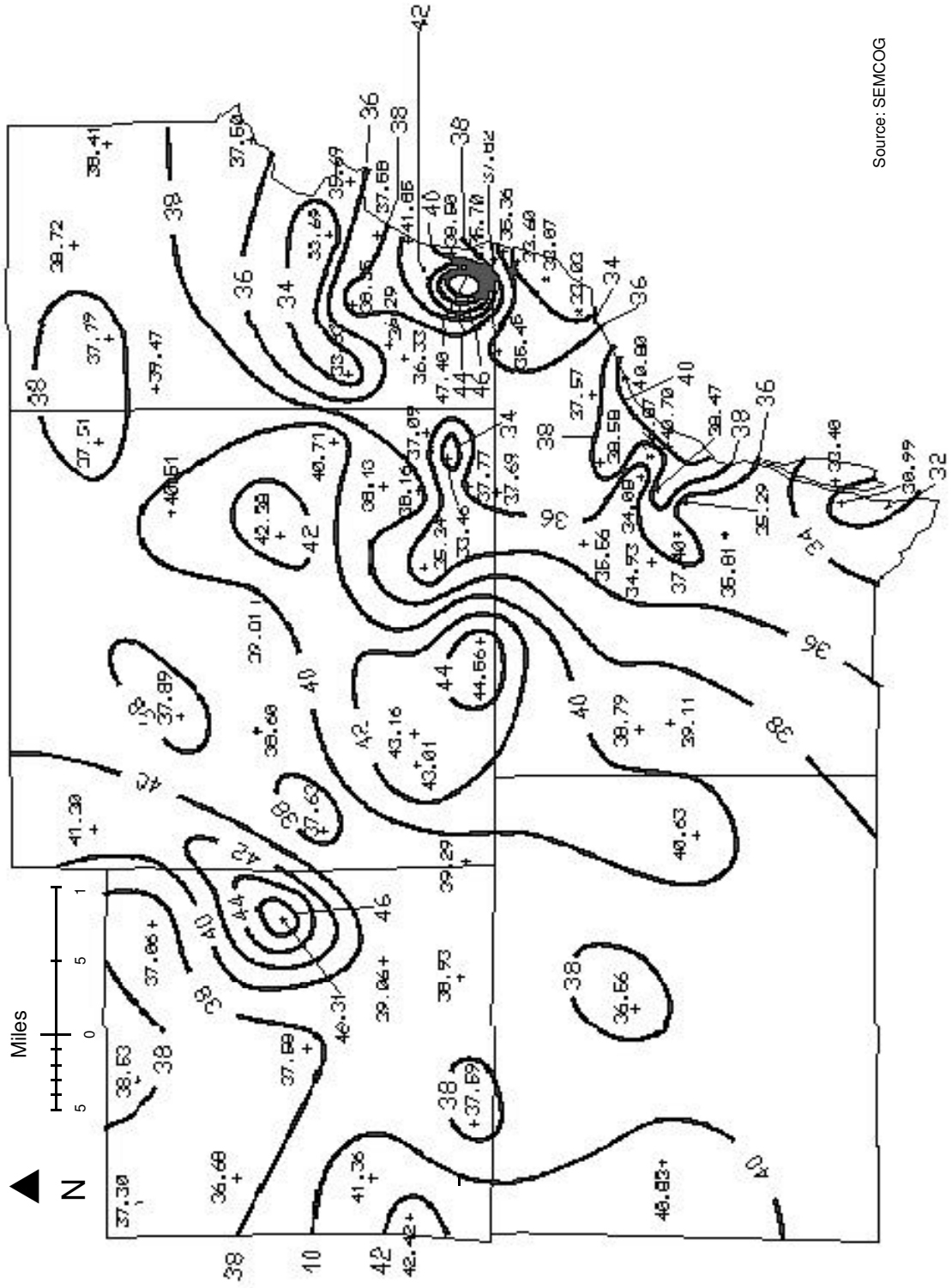


Figure 3.2: Rainfall Amounts in Southeast Michigan in 2000

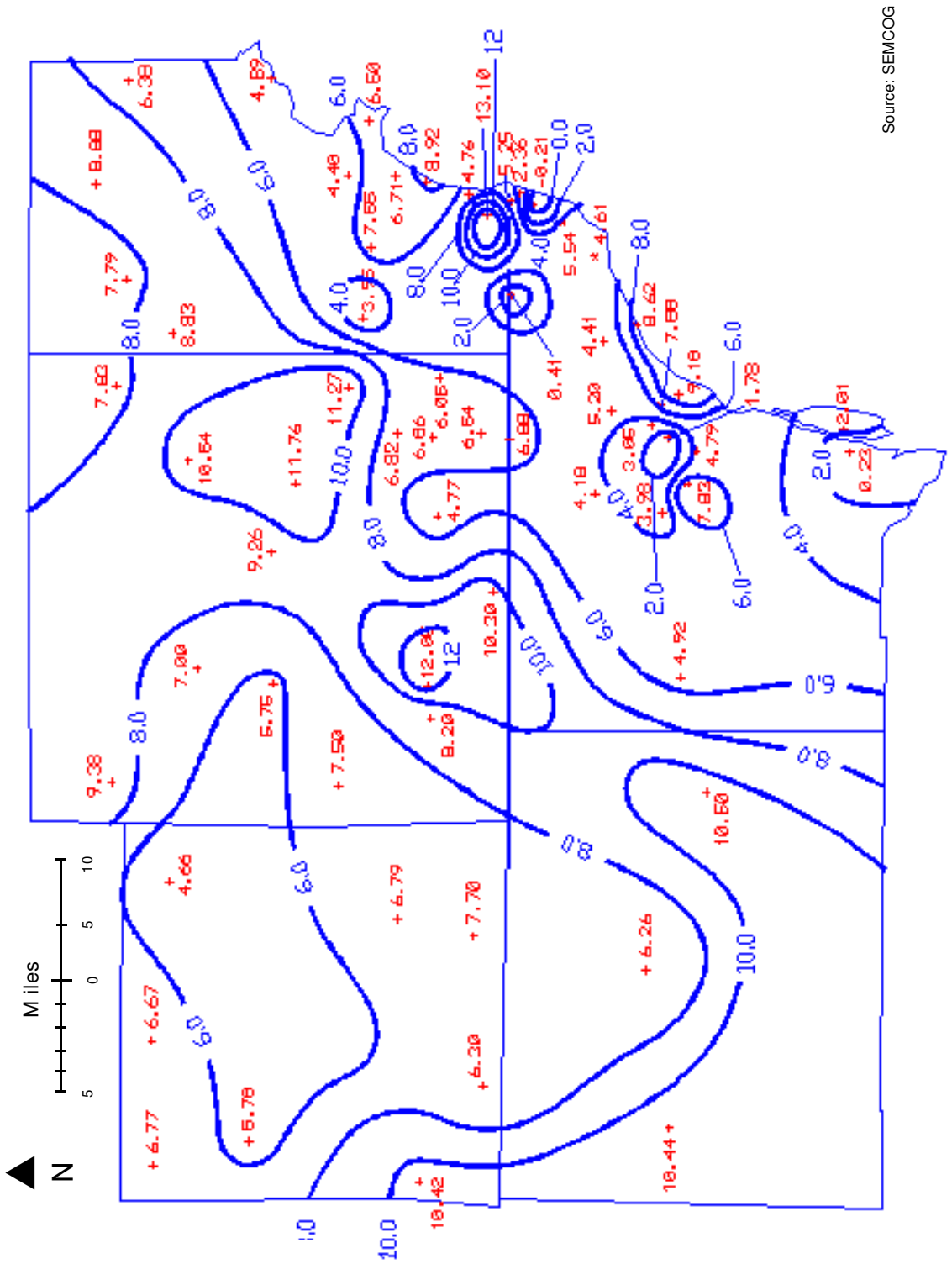
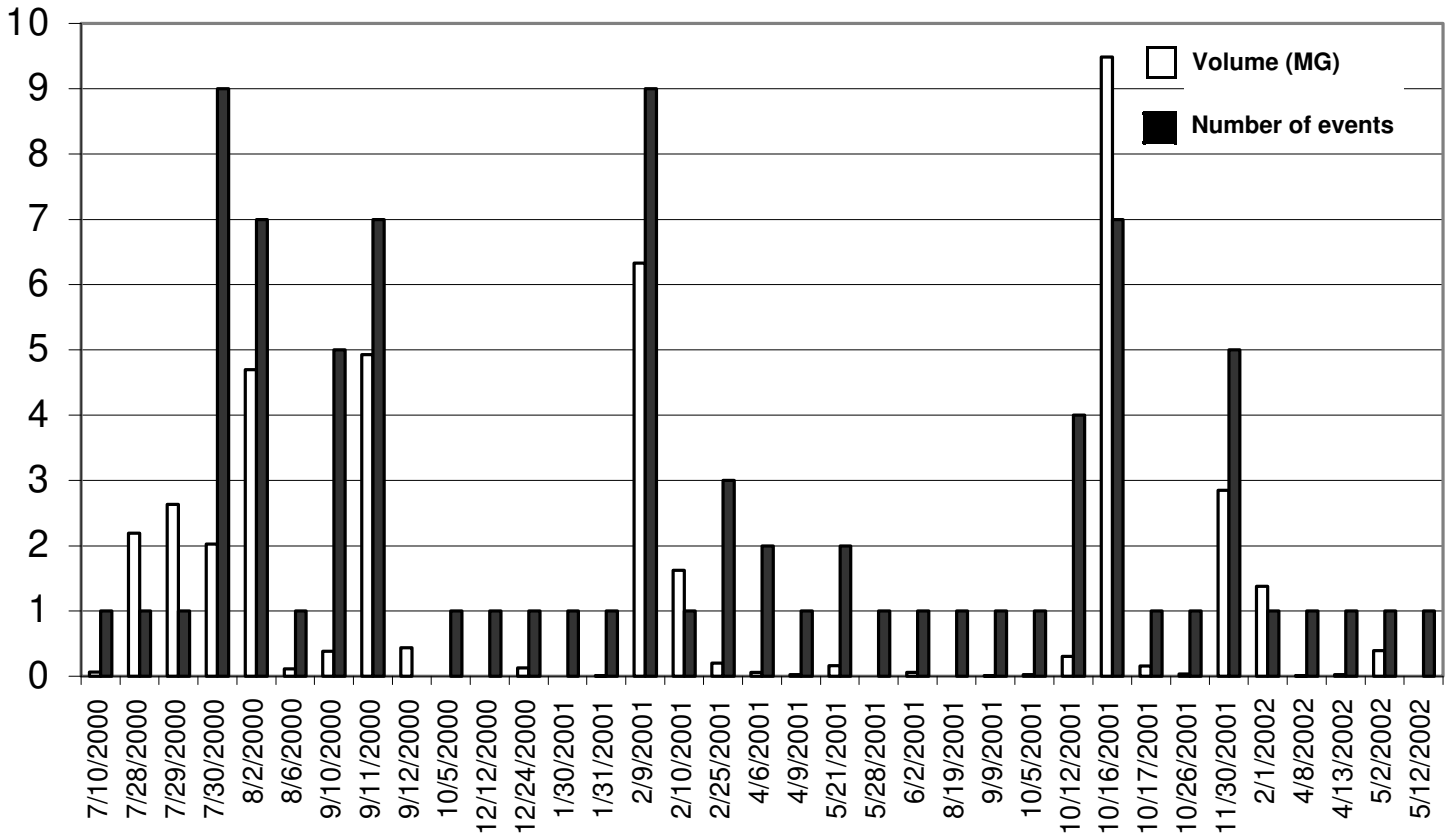


Figure 3.3: Deviations From Average Rainfall Amounts in Southeast Michigan in 2000

Figure 3.4: Wet Weather SSO Volumes, Precipitation Amounts and Number of Events



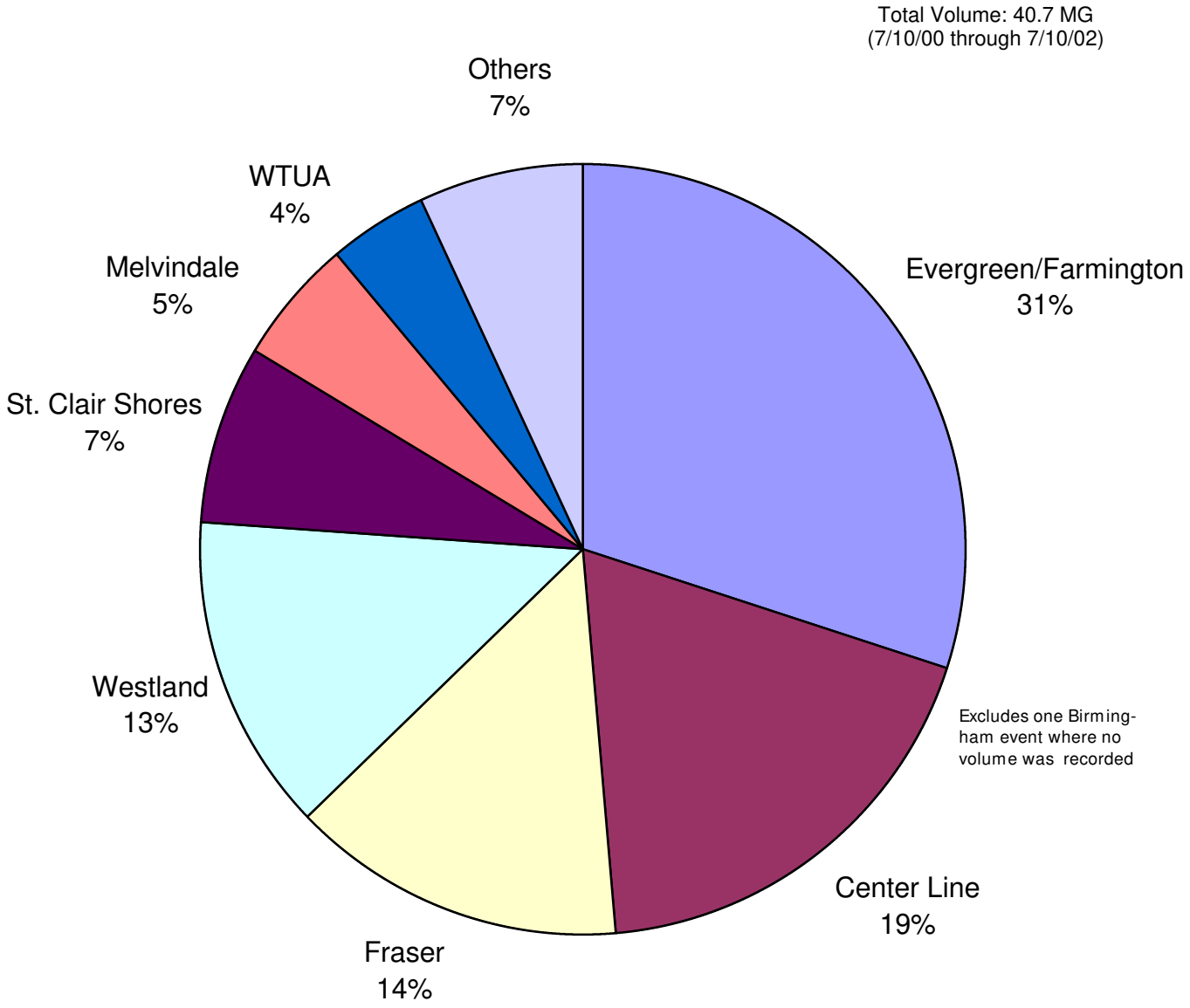
Date	Volume (MG)	Precip. (inches)	Number of Events
7/10/00	0.06	1.64	1
7/28/00	2.19	4.24	1
7/29/00	2.63	4.26	1
7/30/00	2.03	2.96	9
8/2/00	4.69	1.45	7
8/6/00	0.12	0.78	1
9/10/00	0.39	2.3	5
9/11/00	4.93	3.01	7
9/12/00	0.44	3.71	1
10/5/00		0.32	1
12/12/00		1.18	1
12/24/00	0.13	0.07	1

Date	Volume (MG)	Precip. (inches)	Number of Events
1/30/01	0	0.41	1
1/31/01	0.01	0.25	1
2/9/01	6.33	0.94	9
2/10/01	1.63	1.32	1
2/25/01	0.2	1.33	3
4/6/01	0.06	0.83	2
4/9/01	0.02	0.63	1
5/21/01	0.16	2	2
5/28/01	0	0.63	1
6/2/01	0.06	1.34	1
8/19/01	0	2.44	1
9/9/01	0.01	1.45	1

Date	Volume (MG)	Precip. (inches)	Number of Events
10/5/01	0.02	1.52	1
10/12/01	0.31	1.2	4
10/16/01	9.49	1.52	7
10/17/01	0.15	1.44	1
10/26/01	0.04	0.72	1
11/30/01	2.85	2.44	5
2/1/02	1.38		1
4/8/02	0.01		1
4/13/02	0.02		1
5/2/02	0.39		1
5/12/02	0		1

Between 7/10/00 and 7/10/02 for Current DWSD Customers. Source: MDEQ and Communities

Figure 3.5: % Wet Weather SSO Volumes in SE Michigan

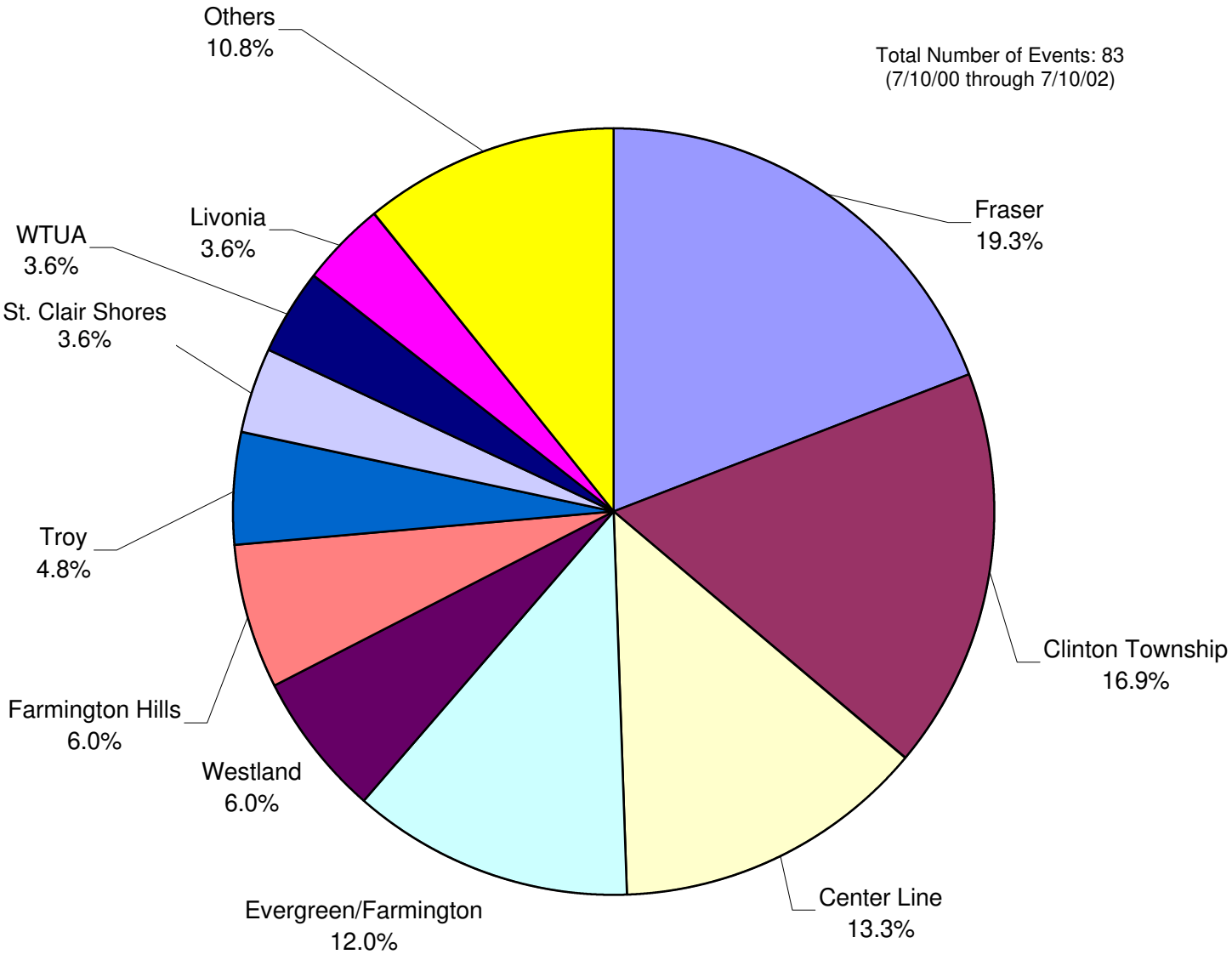


Entities having more than one SSO location for a rain event are counted as only having one occurrence per rain event

The following communities recorded SSO volumes of less than one percent and make up the "Others" category in this figure: Clinton Township, Garden City, Hazel Park, Wayne, Waterford, Livonia, and Farmington Hills

For Current DWSD Customers Source: MDEQ and communities

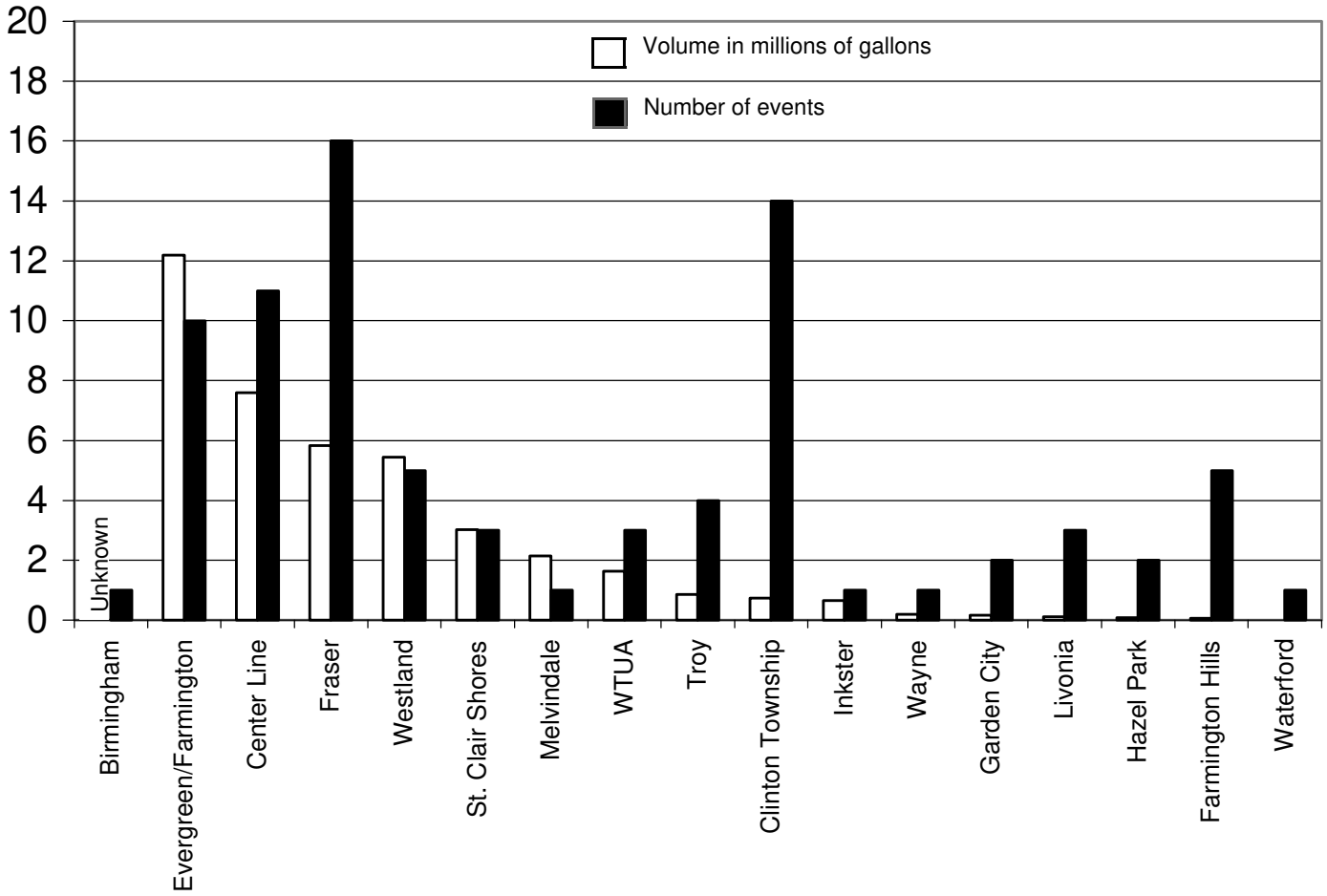
Figure 3.6: % Wet Weather SSO Events in SE Michigan



The following communities recorded two or fewer SSO events and make up the "Others" category in this figure: Garden City, Hazel Park, Birmingham, Melvindale, Inkster, Wayne and Waterford.

For Current DWSD Customers Source: MDEQ and communities

Figure 3.7: Wet Weather SSO Volume, Events by Community



Community/ Authority	# of Events	Volume (MG)
Birmingham	1	No data
Evergreen/Farmington	10	12.19
Center Line	11	7.59
Fraser	16	5.84
Westland	5	5.44
St. Clair Shores	3	3.03
Melvindale	1	2.14
WTUA	3	1.63
Troy	4	0.86

Community/ Authority	# of Events	Volume (MG)
Clinton Township	14	0.74
Inkster	1	0.66
Wayne	1	0.20
Garden City	2	0.16
Livonia	3	0.11
Hazel Park	2	0.09
Farmington Hills	5	0.06
Waterford	1	0.00

Source: MDEQ and communities

Table 3.3: Wet Weather SSO Causes As Estimated by SSO Communities

Community/District	Contains Areas Formerly with Combined Sewers	General Cause of Overflows				
		Footing Drains	Internal Collection System Capacity	Interceptor / Delivery Capacity	Lack of Contract Capacity	Excess Flows
Birmingham	✓	✓	✓			
Center Line	✓	✓		✓	✓	✓
Clinton Township		✓	✓	✓	✓	✓
Evergreen/Farmington		✓	✓		✓	
Farmington Hills		✓		✓		✓
Fraser		✓	✓	✓	✓	✓
Garden City	✓	✓	✓		✓	✓
Hazel Park	✓	✓				✓
Inkster	✓	✓	✓	✓		✓
Livonia	✓	✓	✓		✓	
Melvindale		✓		✓	✓	✓
St. Clair Shores	✓	✓		✓		✓
Troy		✓	✓			✓
Waterford		✓				
Wayne	✓	✓				
Westland	✓	✓	✓		✓	
WTUA	✓	✓				✓

Source: Reports to federal court, community interviews, community survey

Figure 3-8: Summary of SSO Statistics in the Current DWSD Service Area

7/10/00 to 7/10/02

Wet weather induced SSOs

83	Reported SSOs	**40.7**	Known SSO volume (MG)*
44	SSO points	**35**	Days with SSOs
17	Responsible communities/authorities	**4**	Communities currently under an ACO

With footing drains

17	Entities (100 percent)

Formerly Combined Systems

10	Entities (59 percent)
18.9	Million gallons of volume (46 percent)
56	Occurrences (67 percent)

From Areas Perceived to have . . .

Limited local transport capacity

9	Entities (53 percent)
26	Million gallons of volume (64 percent)
56	Occurrences (67 percent)

Limited interceptor capacity

7	Entities (41 percent)
20.1	Million gallons of volume (49 percent)
56	Occurrences (67 percent)

Limited contract capacity

8	Entities (47 percent)
34.2	Million gallons of volume (84 percent)
62	Occurrences (75 percent)

Excessive inflow and infiltration

11	Entities (65 percent)
22.8	Million gallons of volume (56 percent)
62	Occurrences (75 percent)

Dry weather SSOs

26	Reported SSOs	**0.72**	Known SSO volume (MG)
22	SSO points	**24**	Days with SSOs
12	Communities/authorities reporting a dry-weather SSO		

*12 percent of total SSO volume occurred during events with greater than 4 inches of total rainfall

4. Case Study: Center Line

This section describes the background information that has been assembled for the Wastewater Master Plan on the nature of SSOs in the City of Center Line. This community is one of six selected as case studies for the regional analysis of SSOs in the DWSD service area. This information has been developed in cooperation with Center Line and its engineering consultants. The purpose of each case study is to compare the relative cost-effectiveness of three types of solutions:

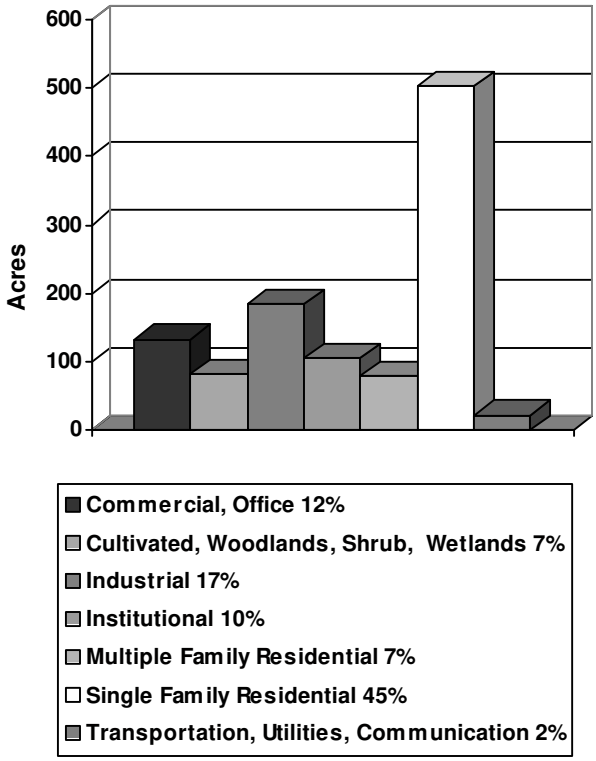
- Local removal of I/ I sources to eliminate SSOs;
- Local storage and/ or treatment; and
- Regional transport, storage and treatment

Center Line is located in Macomb County in southeast Michigan and is surrounded by the City of Warren.

According to SEMCOG, the 2000 population of Center Line was 8,303. There are 3,821 single family and multi-family residential units in Center Line and the average household size is 2.18 persons.

The total land area of Center Line is 1,112 acres (1.7 square miles). Figure 4.1 breaks down the acreage according to land use.

Figure 4.1: Land Use in Center Line



4.1 Description, Characterization and History of SSOs

According to the draft report *"City of Center Line Sanitary Sewer System Capacity Analysis and Study,"* published by Anderson Eckstein and Westrick, Inc. (AEW) in April 2001, the Center Line SSO was found in 1999 during a continuation of the 1998 Sanitary Sewer Televising & Cleaning Project. A review of documents showed the overflow structure was constructed per the plans for the *"Sanitary Interceptor Sewer, Outfall Sewer, and Relief Sewers"* by Pate and Hirn, Inc. dated Dec. 1, 1960. Record plans indicate a July 25, 1963 as-built date.

The Center Line Sanitary Sewer Overflow is located at Van Dyke Avenue and Stephens Avenue, just downstream of the Stephens Pump Station. The sanitary sewer overflow tributary area is comprised of the entire city. A map of both the Center Line SSO and the corresponding tributary area is located in Figure 4.4 at the end of this chapter.

Sanitary sewage enters the pump station in a 48-inch diameter pipe. There are three pumps in the pump station. Pump 1 has a pumping capacity of 1.6 cubic feet per second (cfs). Pump 2 has a capacity of 3.5 cfs. Pump 3 has a capacity of 5.5 cfs.

The sewage exits the pump station in an 80-foot long, 30-inch diameter pipe. Under dry weather conditions, the sewage continues south along Van Dyke in a 24-inch diameter pipe en route to the Detroit Wastewater Treatment Plant. The pathway

from the Stephens Pump Station to the DWSD Conner Creek Interceptor is shown in Figure 4.5 at the end of this chapter.

However, during wet weather conditions sewage can overflow via a weir and into a 36-inch diameter pipe. This pipe empties into a 78-inch diameter storm sewer pipe. The 78-inch diameter pipe empties into the Lorraine County Drain, an 11-foot diameter county storm drain which discharges into Bear Creek.

The sanitary sewer overflow pathway, from the Stephens Pump Station to Bear Creek, is also shown in Figure 4.4 at the end of this chapter.

The Michigan Department of Environmental Quality has published several sanitary sewer overflow events from Center Line. The events are located on the MDEQ Web page, http:/ / www. michigan.gov/ deq, in the CSO and SSO Database and are summarized in Figure 4.2. Events occurring after July 10, 2002 are not documented in this report.

4.2 Sewer System Design Criteria and Footing Drain Locations

The Center Line wastewater collection system was originally constructed as a combined system. Road drainage was later directed to a separate storm water collection system. Generally, footing drains remain connected to the sanitary system. Because of the history of the sewer collection system, it is assumed that nearly all residences with basements in Center Line have footing drains connected to the sanitary sewer system. However a 1962 sewer use ordinance (5-604 Section 74-29) banned footing drain connections to the sanitary system in new structures built in the city.

Center Line ordinance 5-609 Section 74-34 and 5-610 Section 74-35 prohibits the connection of downspouts directly into the sanitary collection system. There is nearly full residential compliance. Recent investigations have shown about 95 percent commercial compliance. Approximately 25 percent of industrial facilities have been inspected with full compliance.

4.3 Flow Data

The contract capacity with DWSD for Center Line is 6.5-cfs. The 24-inch pipe that transports flows downstream from the sanitary sewer overflow relief point has a design capacity of 7.2-cfs.

In order to determine existing dry weather flows and predict design wet weather flows in the sanitary sewer system, portable flow meters were installed throughout Center Line. Sewage flow was recorded from August 2000 to December 2000. Rainfall amounts were also recorded.

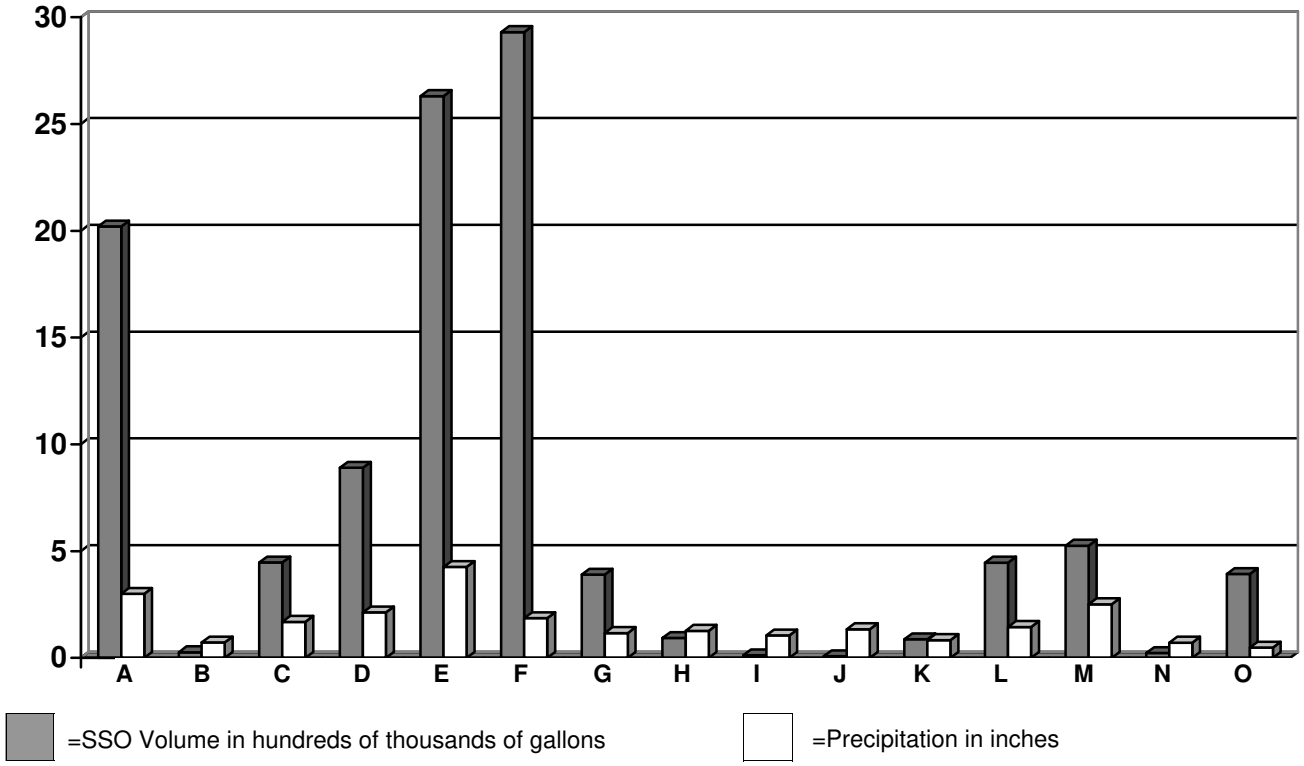
AEW divided Center Line into 23 flood districts. Seven of the 23 sanitary sewer districts within Center Line were metered. Seven Sigma area-velocity flow meters were initially installed and recorded flow, level, and velocity in five-minute intervals. Center Line later added several additional flow meters. A rain gauge also recorded rainfall in five-minute intervals.

After four months of monitoring, the data for each sub-system was analyzed for a dry weather flow rate, calculated rain-dependent inflow and infiltration (RDII), predicted flow rate, and a peaking ratio.

Theoretical dry weather flow values were calculated based on a population-estimated flow of 70 and 120 gallons per-person per-day. Any sub-area with actual dry weather flow values higher than the calculated values based on 120 gallons per-person per-day was considered to have excessive dry weather inflow and infiltration (DWI/ I). Five areas were determined to have excessive DWI/ I. These areas are being further investigated by AEW.

For wet weather events, RDII was plotted versus rainfall amounts. These values were used to ex-

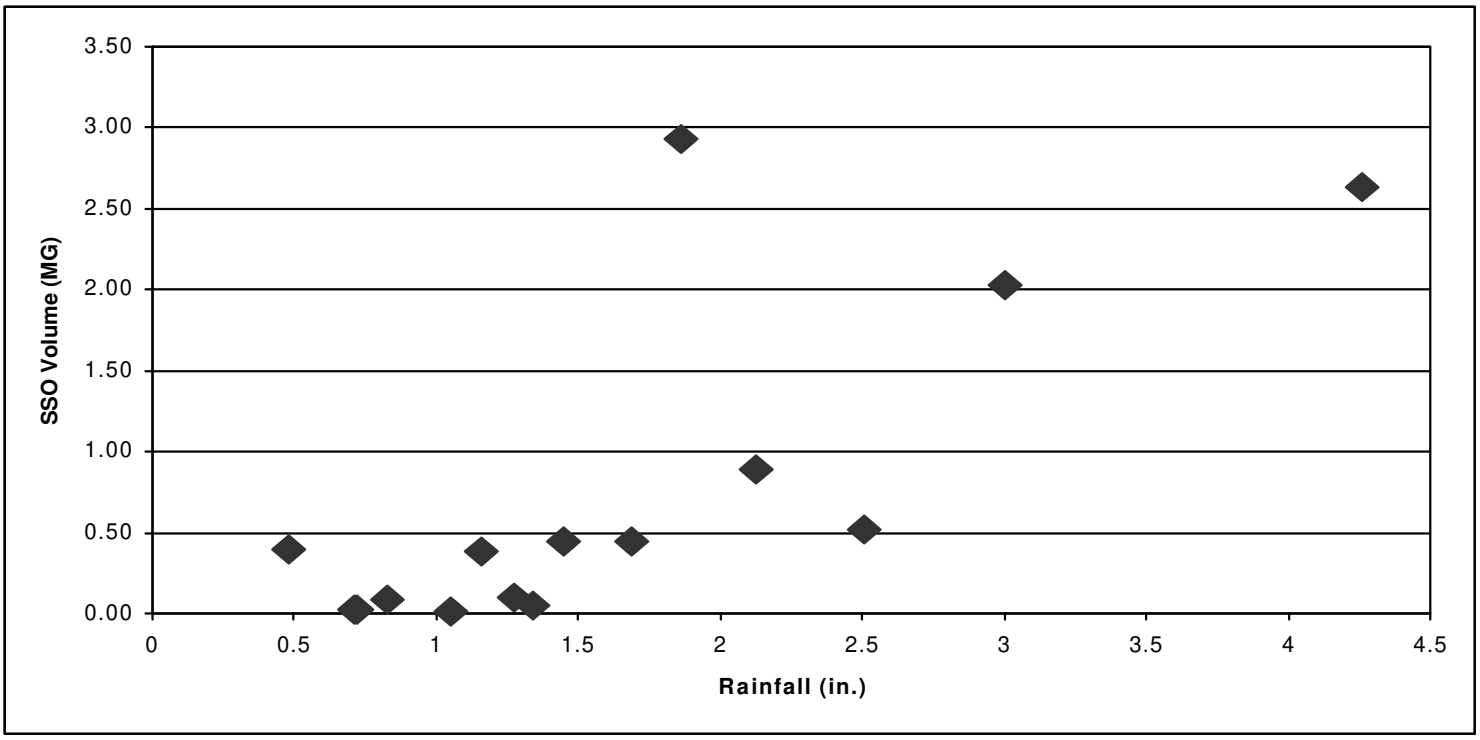
Figure 4.2: Center Line SSO Events



	Start Date	End Date	Volume (gallons)	Rain (inches)	Notes
A:	4/20/00	4/21/00	2,023,085	3.00	Estimated volume
B:	5/9/00	5/9/00	27,715	0.72	
C:	5/18/00	5/19/00	447,118	1.69	
D:	6/24/00	6/25/00	890,000	2.13	Estimated volume due to equipment failure
E:	7/29/00	7/30/00	2,633,307	4.26	
F:	8/2/00	8/3/00	2,934,226	1.86	
G:	2/9/01	2/10/01	389,241	1.16	Includes significant snow melt
H:	2/25/01	2/25/01	93,394	1.27	
I:	4/6/01	4/6/01	11,602	1.05	
J:	6/2/01	6/2/01	55,176	1.34	
K:	10/12/01	10/13/01	87,400	0.83	Estimated volume due to equipment failure
L:	10/16/01	10/17/01	446,000	1.45	Estimated volume due to equipment failure
M:	11/30/01	11/30/01	525,073	2.51	
N:	4/13/02	4/13/02	23,347	0.71	
O:	5/2/02	5/2/02	392,907	0.95	

Source: MDEQ and AEW

Figure 4.3: Center Line SSO Volume vs. Rainfall Amount



trapolate an RDII value for a 10-year, 24-hour design rainfall event. Sufficient data was collected to estimate RDII values in seven of the 13 flow meter locations.

Predicted flow rates at seven flow meter locations were calculated by adding the RDII value to the dry weather flow rate. A peaking ratio (flow rate divided by dry weather flow) was also calculated. The peaking ratios ranged from 5.53 to 71.03.

According to Anderson Eckstein and Westrick, Inc., the city's metered flows (average, peak, and projected) exceed theoretical flows. The high levels of flow within the system are due to RDII. Infiltration, evident in dry weather, is most likely attributed to leaking joints, shifted lateral connections, and cracks in pipes. Inflow can be attributed to footing drains, and structures in low-lying areas.

In a Sewer System Evaluation Survey prepared in 1999 for the South Macomb Sanitary District, flood testing indicated that each household could contribute up to six gallons per minute to the sanitary system, via footing drains during intense rain events. The flows that were recorded by the meters in Center Line tend to support this calculation.

4.4 Estimated SSO Volumes for Different Design Storms

As shown in Figure 4.2, a number of SSO events in Center Line have been documented. The SSO events in which both SSO volume and rainfall amount are available are plotted in Figure 4.3 to show the relationship between the SSO event volumes and the size of the wet weather events.

Rainfall Dependent Inflow and Infiltration (RDII) response factors (percentage of total rainfall entering the sanitary sewer system) were obtained for Center Line from both the GDRSS model and 2001 field events. Review of flow and rainfall data col-

Table 4.1: Center Line SSO Volumes for Design Storm Events (millions of gallons)

Design Storm Event Rainfall (inches)	Wet Weather Vol.		Contract Exceedance		SSO Vol.	
	Growth	Dormant	Growth	Dormant	Growth	Dormant
1-Month, 24-Hr. (0.62)	0.64	1.68	0	0	0	0
1-Year, 1 Hr. (1.0)	1.38	3.05	0	0.16	0	0
10-Year, 1 Hr. (1.8)	2.91	5.91	0	1.14	0	0.61
1-Year, 24-Hr. (2.2)	3.68	7.35	0.24	1.88	0	1.15
10-Year, 24-Hr. (3.6)	6.36	12.35	1.33	4.3	0.76	3
25-Year, 24-Hr. (4.0)	7.13	13.78	1.72	4.99	1.06	3.51
100-Year, 24-Hr. (4.7)	8.47	16.28	2.37	6.19	1.56	4.41

lected indicated a seasonal variation in RDII response. Two seasons, dormant (winter) and growth (summer), were defined for the GDRSS model for all separate sewer service areas. Dormant months are November through April. Growth months are June through September. The months of May and October are defined as transitional months. For Center Line, the response factors of 13 percent, 7 percent, and 10 percent were determined for the dormant, growth, and transitional periods respectively.

The RDII response factors were used to predict wet weather, contract exceedance and SSO volumes for various design events. For Center Line, seven different design storms are modeled. The design storms used are the 1-month, 24-hour storm (0.617 inches); the 1-year, 1-hour storm (1.0 inches); the 10-year, 1-hour storm (1.8 inches); the 1-year, 24-hour storm (2.2 inches); the 10-year, 24-hour storm (3.6 inches); the 25-year, 24-hour storm (4.0 inches); and the 100-year, 24-hour storm (4.7 inches). The Brater-Sherrill winter and summer rainfall distributions were used for dormant and growth conditions respectively.

The RUNOFF Module and Extended Transport (EXTRAN) Module of the EPA's Storm Water Management Model (SWMM) were used to model the wet weather response in Center Line. A more detailed analysis of the model development can be found in the *"SSO Modeling and Calibration for SSO Case Studies"* on the CD which accompanies this report.

The seven design storms were simulated during the dormant season (April) and the growing season (June) to provide a range of wet weather, contract exceedance, and SSO volumes. Two actual rain events in which the SSO volumes were known were used to calibrate the in-system storage component of the model. Currently, SSO volumes are based on this limited data set. The predicted wet weather volumes generated and the corresponding SSO volumes for the seven design storm events are presented in Table 4.1. Also included in Table 4.1 are contract exceedance volumes produced by each design storm. Center Line has a contract of 6.5 cfs, which includes both dry and wet weather flows. Contract exceedance volumes were calculated by placing a 6.5 cfs flow limit downstream of the overflow on the 24-inch pipe.

A detailed analysis of the design wet weather volumes, contract exceedance volumes and SSO volumes can be found in the technical memorandum *"SSO Modeling and Calibration for SSO Case Studies"* which accompanies this report.

4.5 Corrective Actions Completed and Underway

Information on recent improvements and ongoing sanitary sewer overflow studies in Center Line was found in *"City of Center Line Sanitary Sewer System Capacity Analysis and Study."*

The sewerage system in Center Line was developed over two periods of time. The initial system, constructed prior to World War II, was sized to accommodate combined sewage. The pipe used was clay with oakum and mortar joints spaced at approximately four feet. A program for sewer separation was undertaken after World War II. As part of the program, both sanitary and storm sewers were constructed city-wide, dramatically reducing wet weather sanitary flows and basement flooding. During this second phase, the sanitary sewer pipe used was primarily clay with premium-type joints spaced at six to eight feet on center.

In addition, Center Line adopted a sewer use ordinance in 1962 forbidding the connection of roof drains to the sanitary system. The ordinance has been widely enforced with the exception of a few commercial facilities.

However, footing drains in Center Line remain connected to the sanitary system and are probably the largest source of infiltration. In most cases, disconnecting footing drains would require installing a sump pump to direct flows into the storm sewer.

Center Line has 164,579 linear feet of sanitary sewers. As of December 2002, an estimated 49,535 linear feet (approximately 30%) has been rehabilitated by cured in place pipe lining, pipe bursting, or open cut replacement within the last seven years.

The Sanitary Lift Station went through a two-phase investigation and rehabilitation program. Phase I consisted of the emergency replacement of the three main pumps.

Phase II was the primary renovation of the station to increase the safety and operational efficiency. This included the installation of mag-meters on the three main pump discharge lines and a "Muffin Monster" grinder preceding the pump inlets to eliminate the coarse screen manual cleaning and required confined space entry, new power controls, explosion-proof fixtures, roof repair and an emergency generator.

The City of Center Line investigated the overflow weir. The weir is constructed with a top of weir elevation at the crown of the 24-inch sewer to allow for overflow from the 24-inch interceptor to a 36-inch reinforced concrete pipe storm sewer which leads to the Lorraine County Drain. Original construction of the overflow chamber set the top of the weir wall at 620.14 feet. Approximately 18 inches of additional block height was added to the weir wall in May 2000. Current elevation is 621.64 feet.

The investigation of archived plans and documents show this was a part of the original pump station and interceptor design plans from December 1, 1960. The overflow weir was required by the city's contract with the DWSD. It was also a state requirement for issuance of a construction permit for the lift station in 1963. This also revealed a Parshall Flume Chamber on the 36-inch overflow sewer and an inverted siphon on the 24-inch sanitary, which allowed the sanitary to cross under an existing 60-inch storm sewer.

A subsequent hydraulic study of the interceptor using StormCAD and SWMM showed that the 24-inch interceptor at a 0.10 percent slope could carry approximately 7.2-cfs flowing full assuming the downstream sewer (Conner Creek) is not surcharged (slightly more than the city's contract capacity of 6.5-cfs).

Since the SSO events of spring 2000, Center Line has been proceeding with the following program

to mitigate SSOs and work toward the elimination of the SSO altogether.

1. Installation of a depth-measuring and data-logger device at the Parshall Flume Chamber to allow for accurate measurement of any future overflow event. The sonic depth measuring device and data logger was installed with battery power and mounted inside the Parshall Flume Chamber in May 2000. In October 2002, the data logger was transferred to a newly installed control cabinet in the Stephens Ave. right-of-way and provided with a feed from Detroit Edison. Concurrent with this work, an indicator light was installed on the control cabinet as a visual alert to personnel when flow is being registered in the Parshall Flume to initiate sampling protocols.

2. Construction of additional weir height (approximate-ly 1.5-feet) above the crown elevation of the 24-inch interceptor sewer and optimization of the pump station controls to maximize system storage. Construction of additional weir height was completed in May 2000. Optimization of the pump station controls to maximize system storage began immediately after the first reported SSO and is a continuing process.

3. Investigation of added flow area at the inverted siphon under Warren's oversized 60" sanitary sewer. Based on Center Line's flow metering of that sewer, Warren has given preliminary approval to eliminate the inverted siphon. Center Line's 24" interceptor would be bored through Warren's 60" sanitary sewer to increase capacity and eliminate a point of frequent maintenance. The siphon behaves in a similar fashion to the trap beneath a common sink. Sludge and debris commonly settle at the lowest point and periodic clogging occurs. The siphon periodically requires cleaning with a sewer jet. Center Line DPW makes an effort to clean the siphon approximately every other month. Center Line has prepared plans for the City of Warren, DWSD, and State of Michigan review.

4. Continuing investigations through flow monitoring and proposed correction of potential causes of excessive infiltration and inflow (I/ I) to the sanitary sewer system under a schedule recently approved by the MDEQ (ACO-SW01-006, approved Aug. 24, 2001).

5. Proposed pilot Peak Excess Flow Treatment Facility using a combination of Oxygen-Enrichment Technology disinfection with dynamic separation comparable to primary treatment. This would parallel the draft rules proposed by the SSO Federal Advisory Committee at EPA, SEMCOG's SSO Task Force, and the American Municipal Sewerage Association.

On October 9, 2000, Center Line and Macomb County Office of Public Works began an immediate investigation to locate the source of high levels of E. coli in the city's storm sewer system, including the overflow pathway.

Center Line contracted S.O.S. Services to walk the Center Line Relief Drain to identify all taps and sample any dry weather flows. These samples indicated eight taps influent to the Center Line Relief Drain with E. coli levels at an elevated level warranting further investigation. All eight taps were examined. One tap has been diverted to the sanitary system. Three taps remain under investigation and subsequent testing and repairs have cleared four taps of contamination.

The city also has been working with the Macomb County Health Department (MCHD) on an Illicit Discharge Elimination Program (IDEP) since August 2000. Currently, the city and the MCHD are continuing citywide dry weather sampling of subsystems influent to the Center Line Relief Drain and the Lorraine Drain. Review of television inspection tapes and subsequent dye testing revealed six sanitary cross connections to the storm system. These six connections have been corrected. The program is ongoing.

Further investigations include:

Manhole inventory/ inspection

Structure mapping

Smoke testing

Sewer / catch basin cleaning

Television inspection

Inflow and infiltration monitoring

Dry weather sampling

Manhole repairs

Cured in-place pipe

Open cut excavation

Lateral grouting/ repairs

Pump station rehabilitation

In addition, Center Line is looking at long-term solutions for sanitary sewer overflows in the city:

1. Transporting overflow to the WWTP via a new sewer line to address the limited capacity of the 24-inch Van Dyke Interceptor.

2. Storing overflow in an equalization basin during intense storm events.

3. I/ I elimination, which is consistent with the previous on-going work done by the city. The Sanitary Sewer Evaluation Study is assisting in prioritizing the areas and types of rehabilitation work being done and scheduled to be done in the city.

4. The use of Oxygen Enrichment System methods as proposed by Great Lakes Restoration.

On August 24, 2001, Center Line entered into an Administrative Consent Order (ACO-SW01-006) with the Michigan Department of Environmental Quality. Corrective actions by Center Line must be in accordance with the Administrative Consent Order. Paragraphs 24-31, which deal with the corrective actions, are:

24. Detroit Water and Sewerage Department (DWSD) is in the process of completing a Wastewater Master Plan (WWMP) for all of Southeast Michigan, including Macomb County. The WWMP is currently scheduled to be completed by August 2003, and is to include recommendations regarding additional measures to ensure adequate transport and treatment capacity within DWSD's service area. Paragraphs 28 through 31 provide a schedule, which is based on DWSD's timely completion of the WWMP. Because the additional transport and treatment measures DWSD may recommend in the WWMP are as of yet unknown, both the City and the DEQ acknowledge that the dates and requirements specified in paragraphs 28 through 31 may require modification upon completion of the WWMP.

25. On or before January 15, 2002, the City shall complete the system-wide infiltration and inflow investigation, which includes commercial property dye testing and roof conductor separation.

26. On or before July 15, 2002, the City shall complete and evaluate the System Rehabilitation Pilot Projects, which include footing drain disconnection and sump pump installation.

27. On or before July 15, 2004, the City shall implement the System Rehabilitation Projects that are based on the results of pilot projects that were completed and evaluated in Paragraph 26, and shall have completed the post-project flow monitoring and data analysis. Progress reports shall be submitted to the DEQ on a quarterly basis that shall be due on or before April 15, July 15, October 15, and January 15 of each calendar year.

28. On or before October 15, 2003, the City shall use its best efforts to complete negotiations with DWSD to obtain additional treatment capacity from DWSD and/ or with the Macomb County Public Works Office (MCPWO) to arrange for an exchange of sewage volume utilizing the Mt. Clemens Waste Water Treatment Plant (WWTP).

29. If additional treatment capacity from DWSD

and/ or the Mt. Clemens WWTP becomes available by October 15, 2003, the City shall on or before December 31, 2005, have designed and completed construction of any necessary sanitary connections (provided the proper Part 41 permits are obtained for the project as required) and/ or implemented any other necessary measures to secure and begin using such additional treatment capacity from the DWSD or the Mt. Clemens WWTP. If the City cannot obtain additional treatment capacity from the DWSD or the Mt. Clemens WWTP by October 15, 2003, and the City still exceeds contract capacity with the DWSD after implementation of the System Rehabilitation Projects in paragraph 27, then the City shall on or before December 31, 2006, or such other date agreed to by the parties in an amendment to this ACO complete the appropriate engineering and structural improvements to its sewer system, to meet all applicable state and federal law pertaining to SSOs.

30. On or before December 31, 2007, the City shall submit to the DEQ, the Project Performance Certification program report for the implemented selected feasible alternative by the DEQ for the elimination of the SSOs.

31. If the City does not certify that the implemented selected feasible alternative approved by the DEQ meets the required basis of design standard of the elimination of the SSOs, then the City shall submit an approvable Corrective Action Program work plan to the DEQ on or before July 31, 2008.

In addition to highlighting completed, current, and proposed corrective actions to SSOs, the ACO also imposes penalties for failure to comply. The following items are listed in the Penalties Section of the Administrative Consent Order, Paragraphs 32-37:

32. The City agrees to pay the State of Michigan twenty-five hundred ($2,500) dollars as partial compensation for the cost of investigations and enforcement activities arising from the discharge of a combination of storm water and sanitary sewage to waters of the State.

33. The City agrees to pay a civil penalty of fifty thousand ($50,000) dollars for the alleged illegal discharge of a combination of storm water and sanitary sewage to waters of the State. Of this amount, the City agrees to pay twenty-five thousand ($25,000) dollars to the general fund of the State of Michigan within 30 days of entry of this ACO.

34. The City agrees to pay the remaining twenty-five thousand ($25,000) dollars in the form of three Supplemental Environmental Projects (SEP) in accordance with Department Policy and Procedure No. 04-002 (November 10, 1997). The City shall provide the Department with documentation to confirm the expenditure of at least $25,000 for the agreed upon SEPs within 30 days of the completion of the SEPs. In the event that less than $25,000 is expended for the agreed upon SEP, the difference shall be paid to the general fund of the State of Michigan within 30 days of completion of any SEP, according to the procedure described in Paragraph 36. The City agrees to complete the following SEPs:

a) The City shall continue to perform dry weather E. Coli sampling and dye testing of the storm water system to identify illicit sanitary connections for a period of two years. The City shall complete this SEP by December 31, 2003, and shall submit confirmation documenting the completion of this SEP to the DEQ on or before January 31, 2004. This sampling would be an extension of a sampling program the City voluntarily began in partnership with the Macomb County Health Department on November 30, 2000, but will otherwise be discontinuing its financial commitment to continue this fiscal year. The cost of this SEP is estimated to be $37,500 and the DEQ shall give the City a credit of $20,000 towards the completion of this SEP.

b) The City shall make a donation of $2,500 payable to the Clinton River Watershed Council, Bear Creek Steering Committee to be used for environmental projects. This SEP shall be paid within 30 days of entry of the ACO.

c) The City shall make a donation of $2,500 payable to the Macomb County Health Department for their assistance with a dry weather sampling program to identify cross connections within the City. This SEP shall be paid within 30 days of entry of this ACO.

35. The City agrees to pay stipulated penalties of one thousand ($1,000) dollars per day for each failure to meet the requirements or dates in paragraphs 25 through 31 of this ACO. The City shall pay accrued stipulated penalties by check made payable to the State of Michigan and delivered to the address in Paragraph 36 no later than 10 days after the end of the month in which violations occurred without request from the DEQ.

Figure 4.4: Center Line SSO Pathway

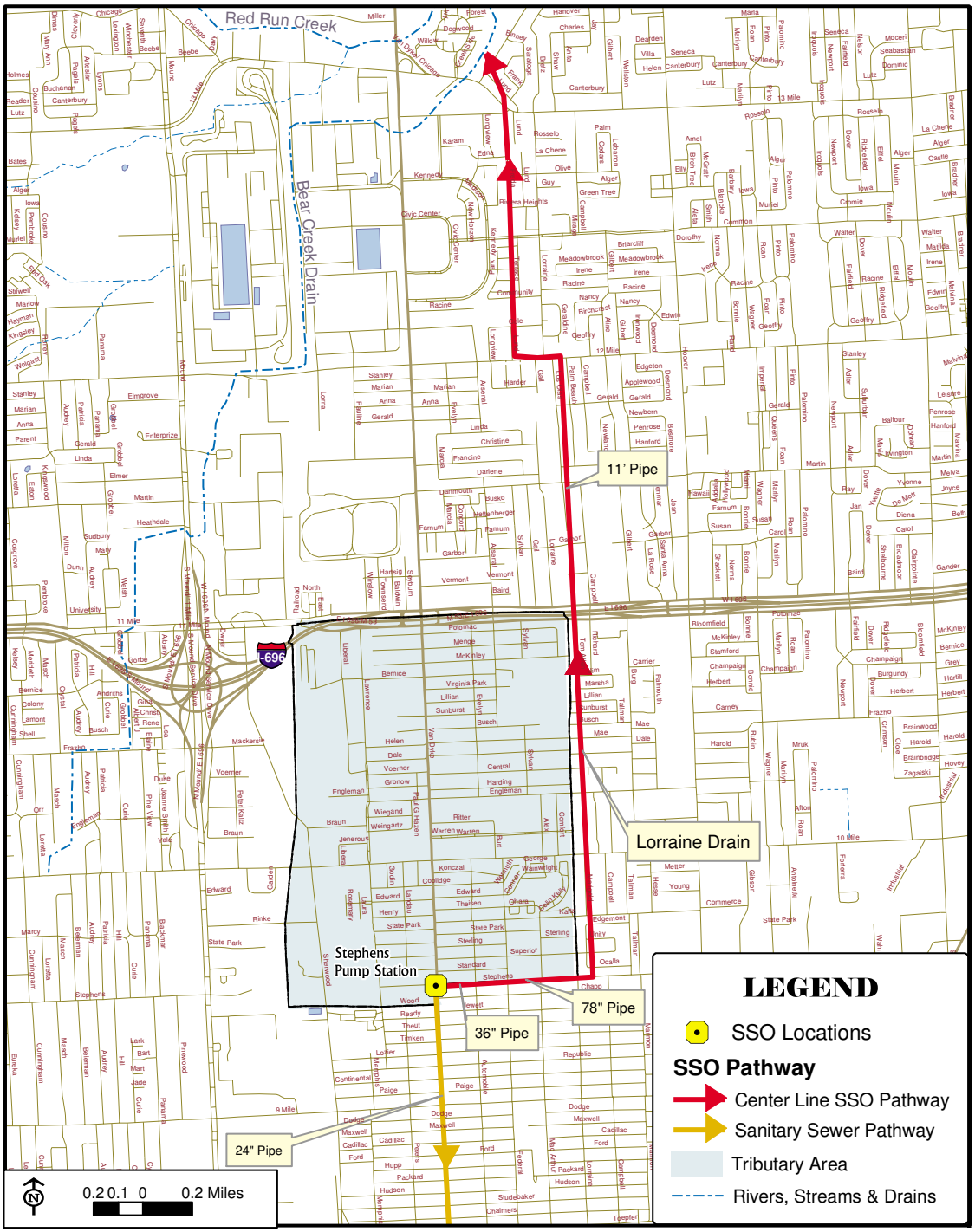
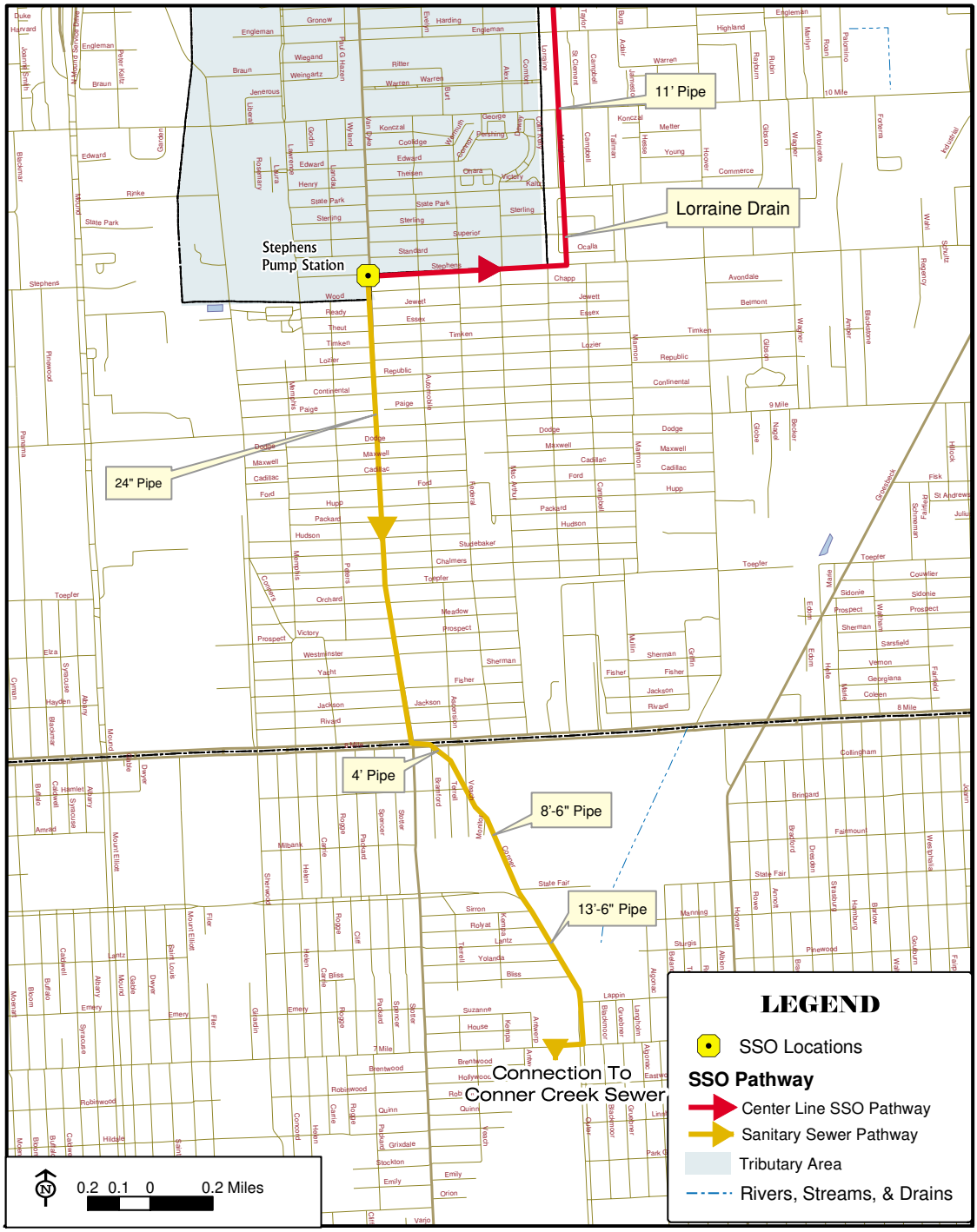


Figure 4.5: Center Line Sanitary Sewer Pathway to Conner Creek Sewer



5. Case Study: Clinton Township

This section describes the background information that has been assembled for the Wastewater Master Plan on the nature of SSOs in Clinton Township. This community is one of six selected as case studies for the regional analysis of SSOs in the DWSD service area. The background information presented here has been developed in cooperation with Clinton Township and its engineering consultants. The purpose of each case study is to compare the relative cost-effectiveness of three types of solutions:

Local removal of I/ I sources to eliminate SSOs;

Local storage and/ or treatment; and

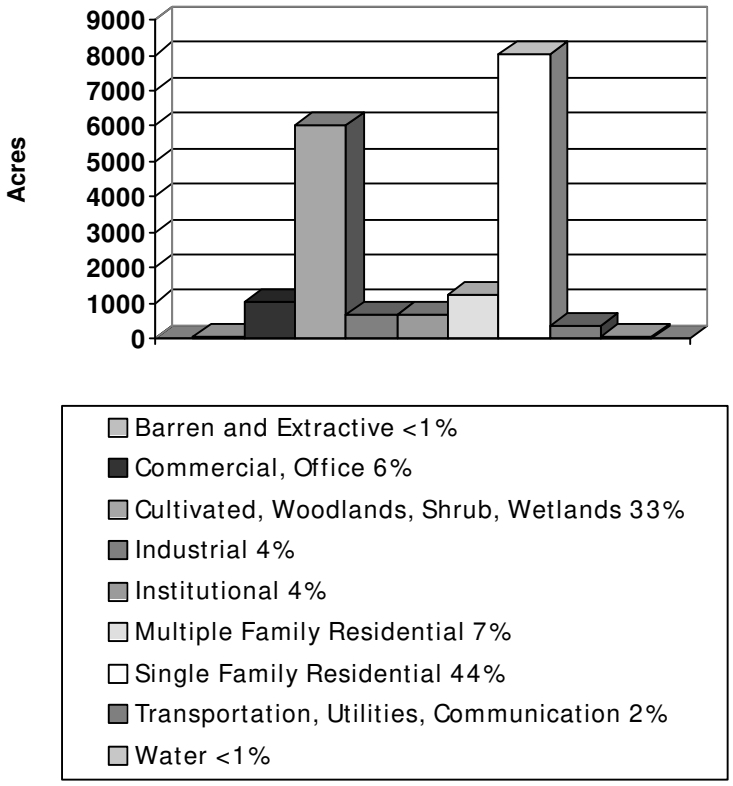
Regional transport, storage and treatment

Clinton Township is located in Macomb County in southeast Michigan. Clinton Township is bordered by Fraser, Roseville, and St. Clair Shores on the south, Harrison Township on the east, Macomb Township on the north, and Sterling Heights on the west. Additionally, Clinton Township surrounds the city of Mt. Clemens.

According to SEMCOG, the 2000 population of Clinton Township was 93,436. There are 40,299 households in Clinton Township and the average household size is 2.35 persons.

SEMCOG reports that the total land area of Clinton Township is 18,037 acres (28.2 square miles). Figure 5.1 breaks down the acreage according to land use.

Figure 5.1: Land Use in Clinton Twp.



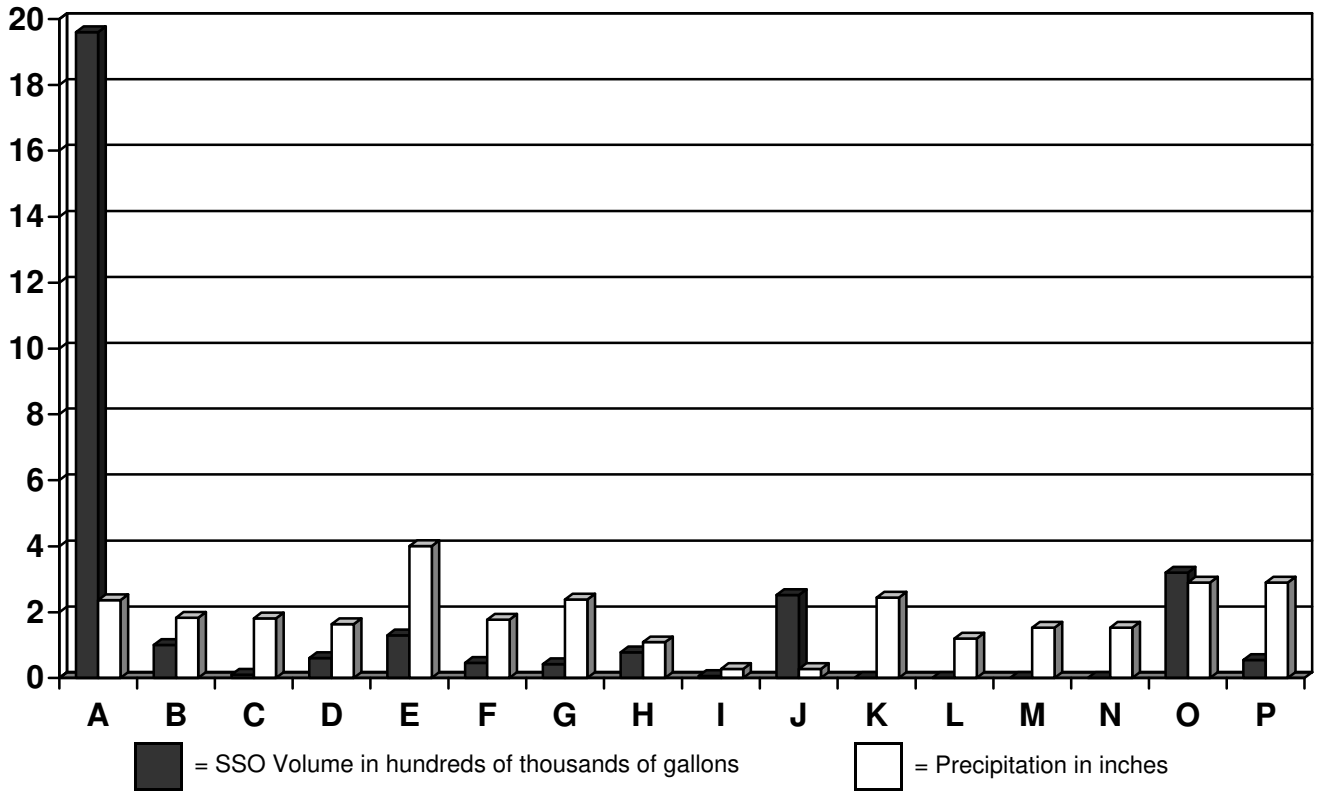
5.1 Description, Characterization, and History of SSOs

In the early 1980s, Clinton Township installed, with the Michigan Department of Environmental Quality (MDEQ) knowledge, nine bypass relief pumps. The pumps are found in a 2,305-acre portion of Clinton Township (12.8 percent of the township) stretching south to 14-Mile Road, north to Mt. Clemens, just west of Groesbeck, and just east of Gratiot. An estimated 2,507 homes in the SSO tributary area have footing drains. Two of the pumps are no longer in operation.

A map of the nine Clinton Township SSO districts, SSO pathways and corresponding tributary areas is located in Figure 5.4 at the end of this chapter. Relief pumps are no longer operational in Districts 7 and 8. Therefore, these two districts no longer have SSOs, but they were still included in the Spalding DeDecker Associates, Inc., (SDA) study used to support information provided in this section.

The nine areas are composed of residential, commercial and industrial land uses. The nine districts

Figure 5.2: Clinton Township SSO Events



	Start Date	End Date	Volume (gallons)	Rain (inches)	Pump Stations	Notes
A:	04/20/00	04/20/00	1,963,020	2.37	2, 3	
B:	05/18/00	05/19/00	101,000	1.83	1, 2, 3, 6	
C:	06/24/00	06/25/00	10,530	1.81	6, 9	
D:	07/10/00	07/10/00	62,085	1.64	1, 2, 3, 4, 6	
E:	07/30/00	07/30/00	132,790	4.01	1, 2, 3, 4, 6, 9	
F:	08/02/00	08/03/00	45,830	1.78	1, 2, 3, 4, 6, 9	
G:	09/11/00	09/11/00	42,290	2.39	1, 2, 3, 4, 6	
H:	02/09/01	02/09/01	78,070	1.09	1, 3, 9	
I:	05/18/01	05/18/01	6,230	0.27	—	Private Residence
J:	05/18/01	05/18/01	252,000	0.27	—	Malfunction
K:	08/19/01	08/19/01	10	2.44	—	Private Residence
L:	10/12/01	10/12/01	N/A	1.20	9	
M:	10/16/01	10/16/01	N/A	1.53	6	
N:	10/16/01	10/16/01	330	1.53	9	
O:	11/30/01	11/30/01	322,950	2.90	1, 2, 4, 9	
P:	11/30/01	11/30/01	54,000	2.90	—	Private Residence

Source: MDEQ and SDA

contain 337,168 linear feet of 6-inch through 30-inch diameter pipe and 1,195 manholes.

The Michigan Department of Environmental Quality has published several SSO events from Clinton Township. The events are located on the MDEQ Web page, http://www.michigan.gov/deq, in the CSO and SSO Database and are summarized in Figure 5.2. A large percentage of the reported SSO volume occurred during dry weather system failures on May 18, 2001. Those problems have been corrected.

5.2 Sewer System Design Criteria and Footing Drain Locations

SDA was interviewed regarding footing drain connections to the sanitary sewer system within Clinton Township. SDA reported that all homes within the designated SSO areas with basements are assumed to have footing drains connected to the sanitary system based on the history of the sewer system construction. Approximately 73 percent of homes in Clinton Township have basements. In most cases, footing drains are connected to the sanitary plumbing under the basement slab with a single vitrified clay lead.

Clinton Township reported no downspouts connected to the sanitary system. Ordinance No. 299, adopted in April 1997, prohibits such connections.

5.3 Flow Data

As part of an Administrative Consent Order (ACO) detailed in Section 5.5, SDA completed an inflow and infiltration study in 2000. The report detailing the inflow and infiltration study proposal, *"Flow Monitoring Work Plan for Clinton Township,"* was released in February 2000. Data was also collected between April 1, 2000 and July 1, 2000. The report detailing the results of the inflow and infiltration study, *"Infiltration and Inflow Study for Clinton Township,"* was released in August 2000.

Table 5.1: Rain Events of 0.5-inches or More During I/I Study Period

Date	Rain (inches)
April 20, 2000	2.37
May 9, 2000	1.56
May 18, 2000	1.83
June 20, 2000	0.50
June 24, 2000	1.81

Nine primary flow meters were installed directly downstream of the relief pump station locations to collect dry and wet weather flow data for each pump district. Three secondary flow meters were installed to further delineate the Districts 2 and 7 and to isolate the commercial flow from the residential flow in these two districts.

To collect rain data, two gauges were used. The rain gauges were placed in an open area and mounted on a PVC pole with a concrete base. The gauges tabulated flow every 15-minutes.

Seven data loggers were installed on the discharge force main of the emergency bypass pump stations to collect SSO flow data. Data loggers were not installed at Pump Stations 7 and 8 since these pump stations have been disabled by the Township. The data loggers recorded the time the pumps were activated and the flow rate through the discharge pipe. Each ultrasonic logger was calibrated to the configuration of the pump station.

During the inflow and infiltration study, five rain events occurred that were greater than 0.5-inches in a 24-hour period. Table 5.1 lists the rain events by date.

During these rain events, several of the emergency bypass pumps were in operation. Spalding DeDecker Associates, Inc. tracked the date and time the emergency bypass pumps were in opera-

Table 5.2: Clinton Twp. Pump Station Summary (4/00 - 6/00)

Station Number	Start Time	Off Time	Volume (gallons)	Rain (inches)
1	5-18-00 (8:54 a.m.)	5-19-00 (1:37 p.m.)	62,000	1.83
2	4-20-00 (12:35 p.m.)	4-20-00 (11:10 p.m.)	1,132,090	2.37
2	5-18-00 (8:49 a.m.)	5-19-00 (2:18 p.m.)	22,000	1.83
3	4-20-00 (8:55 a.m.)	4-20-00 (11:15 p.m.)	830,930	2.37
3	5-18-00 (8:43 a.m.)	5-19-00 (9:41 a.m.)	5,000	1.83
6	5-19-00 (7:13 a.m.)	5-19-00 (12:15 p.m.)	12,000	1.83
6	6-25-00 (3:20 a.m.)	6-25-00 (4:20 a.m.)	2,380	1.81
9	6-24-00 (10:33 p.m.)	6-25-00 (4:01 a.m.)	8,150	1.81

tion, as well as the volume of SSO.

Table 5.2 contains the emergency bypass pump station summary.

An analysis of the flow data from the study area determined that the nine study areas in Clinton Township produce approximately 8.38 million gallons of average day base flow annually from the study area.

SDA recommended that a Sewer System Evaluation Survey (SSES) be performed on each of the nine study areas. An SSES includes the following sewer system investigative techniques: subdistricting, manhole inspection, smoke testing, dye water testing, and TV inspection.

SDA published the *"Sewer System Evaluation Survey Work Plan for Clinton Township"* in September 2000. The goal of the work plan was to set a program to locate and quantify sources of inflow and infiltration.

The work plan called for the SSES to be divided into three main parts. The first is a physical survey that includes an above-ground survey, manhole inspections, sewer inspections, and smoke testing.

The second component is rainfall simulation. This includes a dye-water test and a water-flooding test. Dye-water testing involves pouring a miscible, biodegradable and non-toxic dye into the suspected source. The dye is then looked for in the closest downstream manholes. Water-flood testing is a rainfall simulation technique used to identify the amount of I/ I that can enter a section of sewer. It will be used to quantify the flow into structurally damaged manholes and will be used on selected sewers where smoke testing and dye-water testing have revealed sources of inflow.

The third component is an internal sewer inspection. This includes performing work on sewers having high sources of inflow not found during smoke testing or dye testing; identifying sections by location and manhole numbers; physical characteristics, and cleaning methods; television inspections; and performing additional dyed-water testing for unknown connections found during the final inspection.

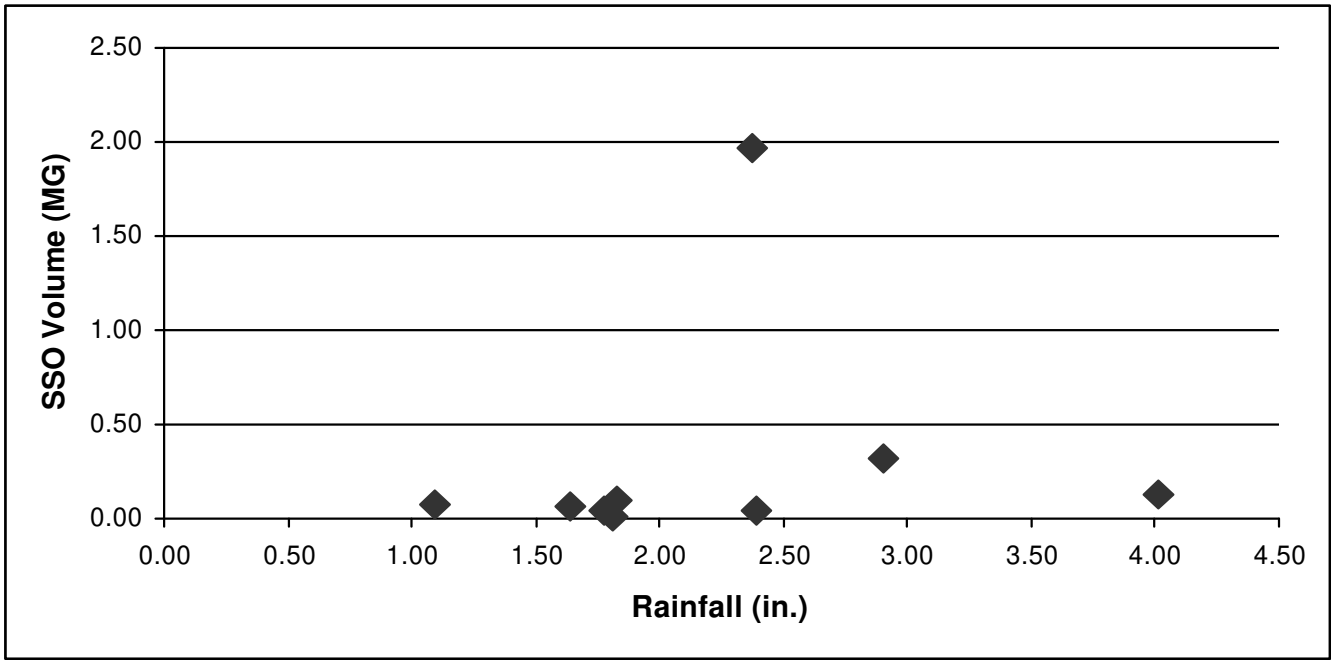
The final SSES will consist of a minimum of five sections: Work task description, data analysis, cost-effective analysis, rehabilitation and correction program, and documentation.

Dry weather flows were estimated for all seven SSO tributary areas. Area 1 has a dry weather flow of 0.025 cfs; Area 2 is 1.090 cfs; Area 3 is 0.468 cfs; Area 4 is 0.258 cfs; Area 5 is 0.041 cfs; Area 6 is 0.020 cfs; Area 9 is 0.425 cfs.

5.4 Estimated SSO Volumes for Different Design Storms

As shown in Figure 5.2, a number of SSO events in Clinton Township have been documented. The SSO events in which both SSO volume and rainfall amount are available are plotted in Figure 5.3 to

Figure 5.3: SSO Volume vs. Rainfall Amount in Clinton Township



show the relationship between the SSO event volumes relative to the size of the wet weather events.

Clinton Township Rainfall Dependent Inflow and Infiltration (RDII) response factors (percentage of total rainfall entering the sanitary sewer system) for each of the seven remaining SSO areas were determined from flow and rain data collected in April through June 2000 from the I/ I study described in the previous section.

For Clinton Township, seven different design storms are modeled for each of the seven active SSO tributary areas. The design storms used include the 1-month, 24-hour storm (0.617-inches); the 1-year, 1 hour storm (1.0 inches); the 10-year, 1-hour storm (1.8 inches); the 1-year, 24-hour storm (2.2-inches); the 10-year, 24-hour storm (3.6-inches); the 25-year, 24-hour storm (4.0-inches); and the 100-year, 24-hour storm (4.7-inches). The Brater-Sherrill winter and summer rainfall distri-

Table 5.3: Clinton Township SSO Volumes for Design Storm Events (million of gallons)

Design Storm Event Rainfall (inches)	Wet Weather Vol.		Contract Exceedance		SSO Vol.	
	Growth	Dormant	Growth	Dormant	Growth	Dormant
1-Month, 24-Hr. (0.62)	0.58	2.15	0.20	1.09	0	0
1-Year, 1 Hr. (1.0)	1.30	4.40	0.49	2.69	0.01	0.23
10-Year, 1 Hr. (1.8)	2.74	8.96	1.21	6.10	0.12	1.23
1-Year, 24-Hr. (2.2)	3.39	11.00	1.54	7.82	0.11	0.64
10-Year, 24-Hr. (3.6)	5.88	18.84	3.15	15.18	0.41	2.90
25-Year, 24-Hr. (4.0)	6.60	21.08	3.69	17.39	0.52	3.69
100-Year, 24-Hr. (4.7)	7.86	25.01	4.65	21.23	0.73	5.21

butions were used for dormant (winter) and growth (summer) conditions respectively.

The RDII response factors and field data were used to model the wet weather response of Clinton Township using The RUNOFF Module and Extended Transport (EXTRAN) Module of the EPA's Storm Water Management Model (SWMM). RDII response factors varied for all seven SSO areas in Clinton Township. Each SSO area was modeled separately. The results were summed for each design storm. A more detailed analysis of the model development can be found in the *"SSO Modeling and Calibration for SSO Case Studies"* on the CD which accompanies this report.

The seven design storms were simulated during the dormant season (April) and the growing season (June) to provide a range of wet weather, contract exceedance, and SSO volumes. The predicted wet weather volumes generated and the corresponding SSO volumes for the seven design storm events are presented in Table 5.3. Also included in Table 5.3 are contract exceedance volumes produced by each design storm. Clinton Township is a second tier customer under Macomb County, who has a contract of 0.4-cfs per 1,000 people. Applying this rate, the contract capacity in the SSO tributary areas, based on a population of 10,682, is 4.27-cfs, which includes both dry and wet weather flows. The contract capacity for each individual SSO area can be found in the *"SSO Modeling and Calibration for SSO Case Studies"* Technical Memorandum.

5.5 Corrective Actions Completed and Underway

On March 3, 2000, Clinton Township entered into an Administrative Consent Order (ACO-SW00-002) with the Michigan Department of Environmental Quality (MDEQ). The ACO was revised on January 7, 2002. The revised Administrative Consent Order (ACO-SW02-001) nullifies the original ACO. David A. Hamilton, Chief of the MDEQ Quality Surface Water Quality Division, and Robert Cannon, Clinton Township Supervisor, signed the revised copy of the ACO.

The amended ACO is divided into seven sections: Statutory Provisions, Findings, Order, Penalties, Submittals, General Conditions, and Force Majeure.

A detailed description of the SSO and corrective actions underway by the Clinton Township are listed in the Findings Section of the ACO. The Findings Section of the Administrative Consent Order, paragraphs 7-17, is listed below.

7. On March 3, 2000, Clinton Township (Township) and the Michigan Department of Environmental Quality (Department), entered into an Administrative Consent Order (Order) ACO-SW00-002 requiring the Township to eliminate untreated sewage bypasses from several sanitary sewer overflow (SSO) locations within the Township. ACO-SW00-002 was entered after the Township discovered and voluntarily disclosed the existence of nine SSO pumps. The purpose of this Amended Administrative Consent Order (Amended Order) is to revise the corrective program schedule of the original Order.

8. On May 10, 2000, the Department issued its "*Strategy for the Regulatory Control and Correction of Illegal Overflows from Separate Sanitary Sewer Systems in Michigan*." Under the Strategy, the Department required Michigan municipalities to report all known SSOs that have occurred in the past five years, and requested that the communities promptly report all future SSOs. In addition, under the Strategy, a municipality could avoid significant penalties and sanctions for SSO discharges if it disclosed the existence of all known SSOs, and voluntarily proposed an SSO corrective program.

9. As required by ACO-SW00-002, on or before January 31, 2000, the Township implemented a

notification procedure through which the Surface Water Quality Division (SWQD), Southeast Michigan District Office (SEMDO) of the Department, the Macomb County Health Department and affected communities downstream are notified as soon as possible but no later than 24 hours from the time the Township becomes aware of the circumstances of raw sewage discharges to the Clinton River in accordance with a plan submitted to the Department.

10. As required by ACO-SW00-002, on or before January 31, 2000, the Township submitted to the Department for approval, their revised wastewater flow monitoring work plan for all sewered areas that contribute wastewater flows to all SSO locations. The Department approved this work plan on March 27, 2000.

11. As required by ACO-SW00-002, on or before April 1, 2000, the Township initiated their wastewater flow monitoring program for all sewered areas that contribute wastewater flows to all SSO locations. The Township notified the Department, in writing, of compliance with this requirement on or before April 15, 2000.

12. As required by ACO-SW00-002, on or before August 15, 2000, the Township submitted to the Department for approval, a final report for their wastewater flow monitoring program. The Department approved the final report on November 13, 2000.

13. As required by ACO-SW00-002, on or before September 1, 2000, the Township submitted to the Department for approval, their Sanitary Sewer Evaluation Survey (SSES) work plan for all sewered areas that contribute wastewater flows to all SSO locations. The Department approved this work plan on November 13, 2000.

14. As required by ACO-SW00-002, on or before October 1, 2000, the Township initiated their SSES in accordance with the approved work plan. The Township notified the Department, in writing, of compliance with this requirement on or before October 15, 2000.

15. As required by ACO-SW00-002, on or before October 1, 2001, the Township submitted to the Department for approval, their SSES Report for all sewered areas that contribute wastewater flows to all SSO locations. The report is currently under review.

16. Although not required by ACO-SW00-002, the Township has voluntarily contracted at an approximate cost of $2.6 million for cured in-place pipe (CIPP) relining of sewer lines in the service area for the SSO pumps. This relining is expected to be completed by December 15, 2001.

17. The Detroit Water and Sewerage Department (DWSD) is in the process of completing a Wastewater Master Plan (WWMP) that will include recommendations regarding additional measures to ensure adequate transport and treatment capacity for DWSD's service area. The WWMP is currently scheduled to be completed by August 2003. Additionally, the City of Mount Clemens is considering expanding its Wastewater Treatment Plant (WWTP) to accept wastewater from other communities for treatment. These actions, as well as other wastewater treatment alternatives currently under consideration, will have a direct impact on the options available to the Township to comply with Part 31 of NREPA.

Corrective actions by Clinton Township must be in accordance with the Administrative Consent Order. Current and future corrective actions are listed in the Order Section of the ACO. The Order Section of the Administrative Consent Order, Paragraphs 18-28, is listed below.

18. Paragraphs 19 through 28 of this Amended Order provide a corrective program schedule, which is based on DWSD's timely completion of the WWMP. Because the additional transport and treatment measures DWSD may recommend in

the WWMP are as of yet unknown, both the Township and the Department acknowledge that the dates and requirements specified in paragraphs 19 through 28 may require modification upon completion of the WWMP.

19. On or before October 1, 2001, the Township shall complete an SSES Study Report and commence a Manhole Rehabilitation Program, which shall be completed on or before September 15, 2002 at an estimated cost of approximately $1.1 Million.

20. On or before December 31, 2002, the Township shall complete evaluation of the feasibility of a footing drain disconnection pilot project. If the Township determines that the footing drain disconnection pilot project is feasible, the Township shall submit a proposed schedule to the Department on or before February 15, 2003, for implementation of the footing drain disconnection pilot project.

21. On or before February 1, 2004, the Township shall submit to the Department for approval the post-pilot project flow monitoring and data analysis for the footing drain disconnection pilot project.

22. On or before April 1, 2004, if the Township determines it will still exceed contract treatment capacity with the DWSD after completion of the Manhole Rehabilitation program, sewer relining, and footing drain disconnection project, the Township shall use its best efforts to complete negotiations with DWSD to obtain additional treatment capacity from DWSD and/ or arrange for an exchange of sewage volume utilizing the Mt. Clemens WWTP. If these negotiations are successful, the Township shall on or before December 31, 2005, have designed and completed construction of any necessary sewer connections and/ or implemented any other necessary measures to secure and begin using such additional treatment capacity from the DWSD or the Mount Clemens WWTP.

23. If the Township cannot obtain additional treatment capacity from DWSD or the Mt. Clemens WWTP or identify another feasible alternative that provides sufficient treatment capacity by October 15, 2003, and the Township determines it will still exceed contract capacity with the DWSD after completion of the Manhole Rehabilitation program, sewer relining, and footing drain disconnection projects, then the Township shall on or before December 31, 2006, or such other date agreed to by the parties in an amendment to this Amended Order, complete the appropriate engineering and structural improvements to its sewer system (provided the appropriate Part 41 permits are obtained for the project as required), to meet all applicable state and federal law pertaining to SSOs.

24. On or before July 1, 2006, the Township shall submit to the Department for approval, a work plan for conducting a Sanitary Sewer Project Performance Certification (PPC) Program to certify that the engineering and structural improvements the Township has implemented meet all applicable state and federal law pertaining to SSOs.

25. On or before November 30, 2006, the Township shall have initiated the Sanitary Sewer System PPC Program in accordance with the approved work plan. The Township shall notify the Department, in writing, of compliance with this requirement by December 15, 2006. The PPC program shall be conducted for a period of no less than one year.

26. On or before December 31, 2007, the Township shall submit to the Department for approval, the Sanitary Sewer System PPC Program report.

27. If the Township does not certify that the engineering and structural improvements the Township has implemented meet all applicable state and federal law pertaining to SSOs, then the Township shall submit an approvable Corrective

Action program work plan to the Department on or before July 31, 2008.

28. Progress reports shall be submitted to the Department beginning upon the entry date of this Amended Order on a quarterly basis that shall be due on or before April 15, July 15, October 15, and January 15 of each calendar year.

In addition to highlighting completed, current, and proposed corrective actions to SSOs, the ACO also imposes penalties for failure to comply. The following items are listed in the Penalties Section of the Administrative Consent Order, Paragraphs 29-32.

29. The Township has paid the State of Michigan (State) twenty-five hundred ($2,500) dollars as partial compensation for the cost of investigations and enforcement activities arising from the illegal discharge of untreated sanitary sewage to waters of the State. This compensation was paid within 30 days of the entry of the original Order, ACO-SW00-002.

30. The Township was assessed a civil penalty of two hundred thousand ($200,000) dollars for the illegal discharge of untreated sanitary sewage to waters of the State per the original order, ACO-SW00-002. The Township has paid one hundred thousand ($100,000) dollars of this amount to the State per the schedule in the original Order, ACO-SW00-002. The Township agrees to pay the remaining one hundred thousand ($100,000) dollars per this Amended Order to the general fund of the State in two payments according to the following schedule and mailed to the address in Paragraph 33:

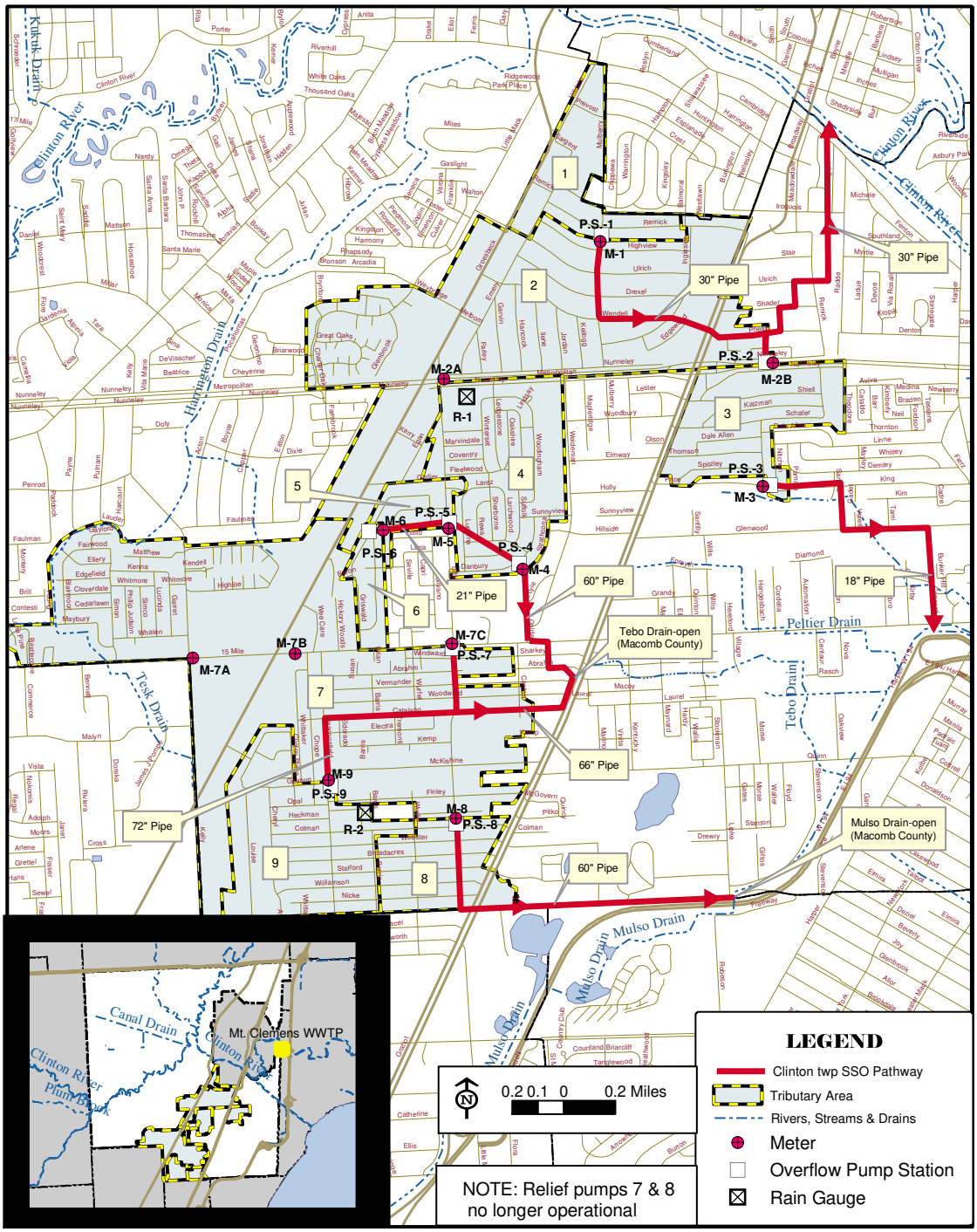
a) $50,000 shall be paid on or before March 1, 2002

b) $100,000 shall be paid on or before March 1, 2003

31. The Township has documented that it has spent fifty thousand ($50,000) dollars for several Supplemental Environmental Projects (SEPs) approved by the Department as required by the original Order, ACO-SW00-002.

32. The Township agrees to pay stipulated penalties of one thousand ($1,000) dollars per day for each failure to meet the requirements or dates of any items listed in Paragraphs 19 through 27 above of this Amended Order. The Township shall pay accrued stipulated penalties by check made payable to the State and delivered to the address in Paragraph 33 no later than 10 days after the end of the month in which violations occurred and without request from the Department.

Figure 5.4: Clinton Township SSO Pathways



6. Case Study: Fraser

This section describes the background information that has been assembled for the Wastewater Master Plan on the nature of SSOs in Fraser. This community is one of six selected as case studies for the regional analysis of SSOs in the DWSD service area. The background information presented here has been developed in cooperation with Fraser and its engineering consultants. The purpose of each case study is to compare the relative cost-effectiveness of three types of solutions:

Local removal of I/ I sources to eliminate SSOs;

Local storage and/ or treatment; and

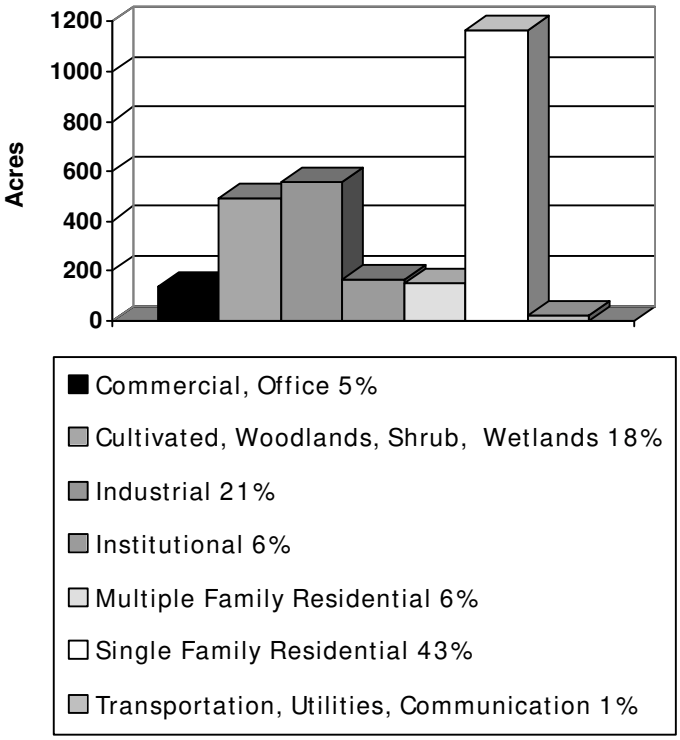
Regional transport, storage and treatment

Fraser is located in Macomb County in southeast Michigan. Fraser is bordered by Roseville on the south and east, Clinton Township on the east and north, and Sterling Heights and Warren on the west.

According to SEMCOG, the 2000 population of Fraser was 14,807. There are 6,062 households in Fraser and the average household size is 2.49 persons.

SEMCOG reports that the total land area of Fraser is 2,680 acres (4.2 square miles). Figure 6.1 breaks down the acreage according to land use.

Figure 6.1 Land Use in Fraser



6.1 Description, Characterization, and History of SSOs

According to the Anderson, Eckstein and Westrick, Inc. (AEW) February 2000 draft report, "*City of Fraser Sanitary Sewer System Capacity Analysis and Study,*" Fraser Department of Public Works informed AEW of a sanitary sewer overflow in 1998.

The Fraser SSO is located at the Beacon Pump Station, near the intersection of Masonic Boulevard and Beacon Lane. A map of both the SSO and the corresponding tributary area is located in Figure 6.4 at the end of this chapter.

A sewered population of 3,930, spread out over a 364-acre tributary area (13.6 percent of the city), contributes flow to the Beacon Pump Station. An estimated 1,367 homes in the SSO tributary area have footing drains. At the Beacon Pump Station, the sewage is pumped up and then continues to flow to the north by gravity in a 24-inch sanitary sewer. The sewage enters the Detroit Sanitary Sewer Interceptor at the intersection of Garfield Road and 15 Mile Road and is currently metered.

It is assumed that sometime in the mid-1960s, the Beacon Station was reconfigured to bypass sanitary sewage during rain events into a storm sewer system in the Masonic and Beacon Lane vicinity.

The reconfigured Beacon Pump Station consists of three pumps. The first pump, which connects to the sanitary system, has a capacity of approxi-

mately 3.5-cfs. This is the pump that operates under dry weather conditions.

When the upstream flow exceeds this rate in wet weather, the second and/ or third pump begins to operate. The second pump operates at approximately 4.0-cfs. The third pump operates at approximately 3.5-cfs. Both lift sewage directly into the storm sewer system.

Based on the capacity of the 24-inch sewer downstream of the pump station, it is not feasible to simply redirect the two pump discharges into the sanitary sewer.

Once in the storm system, the sewage flows into a 14 acre-foot detention pond, and eventually into the Sweeney Drain. The flow in the Sweeney Drain enters the Harrington Drain, which flows into the Clinton River. The Sweeney Drain is tested every time there is an overflow at locations upstream, downstream and at the overflow tap location. The City is working with the County Public Works office to systematically cleanout the county drains within the City. This winter the Harrington Drain upstream from the Sweeney Drain is proposed for cleaning.

Figure 6.4 includes a diagram of the sanitary sewer overflow pathway from the Beacon Pump Station to the Sweeney Drain.

The Michigan Department of Environmental Quality (MDEQ) has published several sanitary sewer overflow events from Fraser. The events are located on the MDEQ Web page, http:/ / www. michigan.gov/ deq, in the CSO and SSO Database and are summarized in Figure 6.2.

6.2 Sewer System Design Criteria and Footing Drain Locations

For the most part, footing drains in the Beacon Pump Station area are connected to the sanitary sewer system. This is because many of the homes in the Fraser SSO tributary area were designed and built between 1958 and 1962, before the 1973 prohibition against connection of footing drains to the sanitary sewer system was enacted. Further, the storm water collection system was designed to handle only road drainage.

Thirty-two houses have been selected for a pilot disconnection program. Currently, city personnel have inspected the inside of 22 homes. Construction is expected in the spring of 2003. Also, a downspout disconnection ordinance is in effect in Fraser with enforcement completed by the end of 1998.

6.3 Flow Data

According to Anderson, Eckstein and Westrick, Inc. (AEW) in the draft copy of *"City of Fraser Sanitary Sewer System Capacity Analysis and Study,"* once aware of the suspected SSOs and after conducting an initial survey of the system, MDEQ and the Macomb County Health Department were notified.

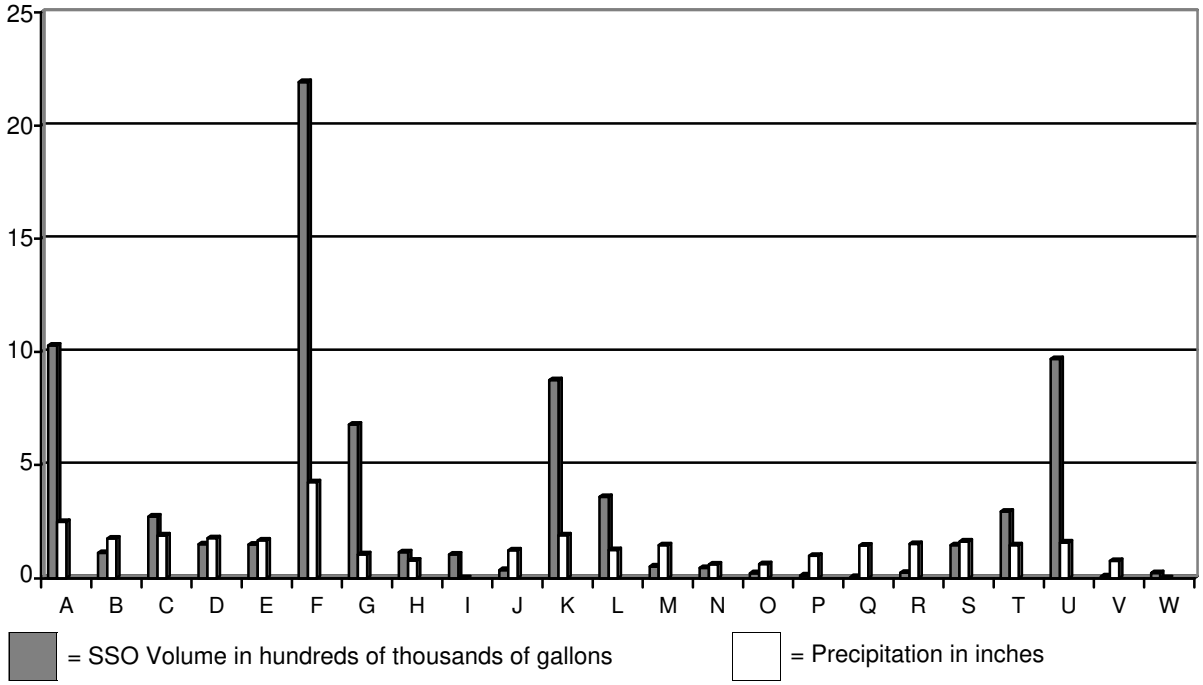
In December 1998, AEW presented the city with a hydraulic metering plan to determine the capacity of the existing system and assess the quantity of inflow and infiltration.

Fraser was divided into 11 districts. The districts were named A thru K. Flows from Districts A thru J enter the DWSD system in the 11-foot Romeo Arm Interceptor at the intersection of 15 Mile and Garfield Road. Flows from District K enter the DWSD system in the 11-foot Romeo Arm Interceptor at the intersection of 15 Mile and Hayes Road. Equivalent populations were found in each flow district.

In order to properly determine alternative solutions to the problem at the Beacon Pump Station, an analysis of both dry weather inflow and infiltration (DWII) and rainfall dependent inflow and infiltration (RDII) in all areas of the city was recommended in order to develop the most cost-effective plan to resolve the sanitary sewage overflow problem.

Eleven meters, installed at the outlet of each district, were used to monitor the total contributing

Figure 6.2: Fraser SSO Events*



	Start Date	End Date	Volume (gallons)	Rain (inches)	Peak Hour Rainfall (inches)
A:	04/20/00	04/21/00	1,028,044	2.48	0.37
B:	05/09/00	05/09/00	112,552	1.75	0.68
C:	05/19/00	05/19/00	271,793	1.88	0.41
D:	06/24/00	06/25/00	150,670	1.76	0.58
E:	07/09/00	07/09/00	149,144	1.66	1.63
F:	07/28/00	07/30/00	2,193,151	4.24	0.82
G:	08/02/00	08/03/00	678,840	1.06	0.30
H:	08/06/00	08/06/00	115,267	0.78	0.37
I*:	08/14/00	08/14/00	105,094	----	----
J:	09/10/00	09/10/00	36,487	1.24	0.50
K:	09/11/00	09/12/00	875,579	1.89	1.58
L*:	02/09/01	02/09/01	359,100	1.25	----
M:	02/25/01	02/25/01	51,896	1.46	0.28
N:	04/06/01	04/06/01	45,755	0.61	0.61
O:	04/09/01	04/09/01	22,186	0.63	0.49
P:	05/21/01	05/21/01	12,558	1.00	0.52
Q:	09/09/01	09/09/01	5,312	1.45	0.62
R:	10/05/01	10/05/01	24,702	1.52	0.16
S:	10/12/01	10/12/01	146,658	1.62	0.22
T:	10/16/01	10/16/01	293,307	1.46	0.28
U*:	11/30/01	11/30/01	968,660	1.58	0.49
V*:	04/08/02	04/08/02	8,408	0.77	----
W*:	05/05/02	05/06/02	22,772	----	----

I* Lift pump failure L* Significant snowmelt U* Previous day rainfall 0.79" V* MCC rainfall estimate W* Wet well sensor malfunction

*Source: MDEQ and AEW

flow, level, and velocity of sewage at that location in the system. All 11 meters were in place on Feb. 15, 1999. All 11 were removed by July 8, 1999.

All meters were Sigma area-velocity meters programmed to record the flow, level, and velocity in five-minute intervals. Data was recorded in two-minute intervals at flow meters that were influenced by the Beacon Station pumping cycles. Cleaning was performed as necessary to ensure that meters were free of debris and receiving clear signals.

In order to relate increases in flow to rainfall, one tipping bucket rain gage was installed in Fraser. Rainfall was recorded in five-minute intervals. The rain gage was purchased by the city and will remain in place indefinitely.

To assess the possibility of dry weather infiltration, groundwater tubes were installed in two manholes on opposite sides of the pilot footing drain disconnection study area. Groundwater levels indicated that the trunk line sewers were below the groundwater table throughout the data collection period.

The metered flows were compared to the Theoretical Wastewater Production Rate (TWWPR), the Theoretical Peak Daily Dry Weather Flow, and the Theoretical Peak Hour Wet Weather Flow. The TWWPR estimates average dry weather flow based on the concept that 90 percent of residential water usage enters the sanitary sewer system. The Theoretical Peak Daily Dry Weather Flow, representing base flow and acceptable levels of inflow and infiltration, is based on 120 gallons per capita per day (gpcd).

The Theoretical Peak Hour Wet Weather Flow is based on 275-gpcd. In evaluating sanitary systems, the MDEQ typically uses flow for the 10-year storm when comparing to the 275-gpcd guideline. The mean duration of the recorded rain events was used in the RDII analysis. This equated to a seven-hour storm. The Rainfall Frequency Atlas for the Midwest published by the National Weather Service, predicts that a 10-year, seven-hour storm generates 2.41 inches of rainfall in this region of the state. Using the RDII flow for this rainfall amount, the total flow can be estimated for a 10-year storm event by combining this RDII value and the average daily dry weather flow.

In nine of the city's 11 flow districts, including all five districts of the SSO tributary area, the metered daily dry weather flow exceeded the Theoretical Wastewater Production Rate. In eight of the 11 flow districts, including all five districts of the SSO tributary area, the metered peak daily dry weather flow exceeded the Theoretical Peak Daily Dry Weather Flow.

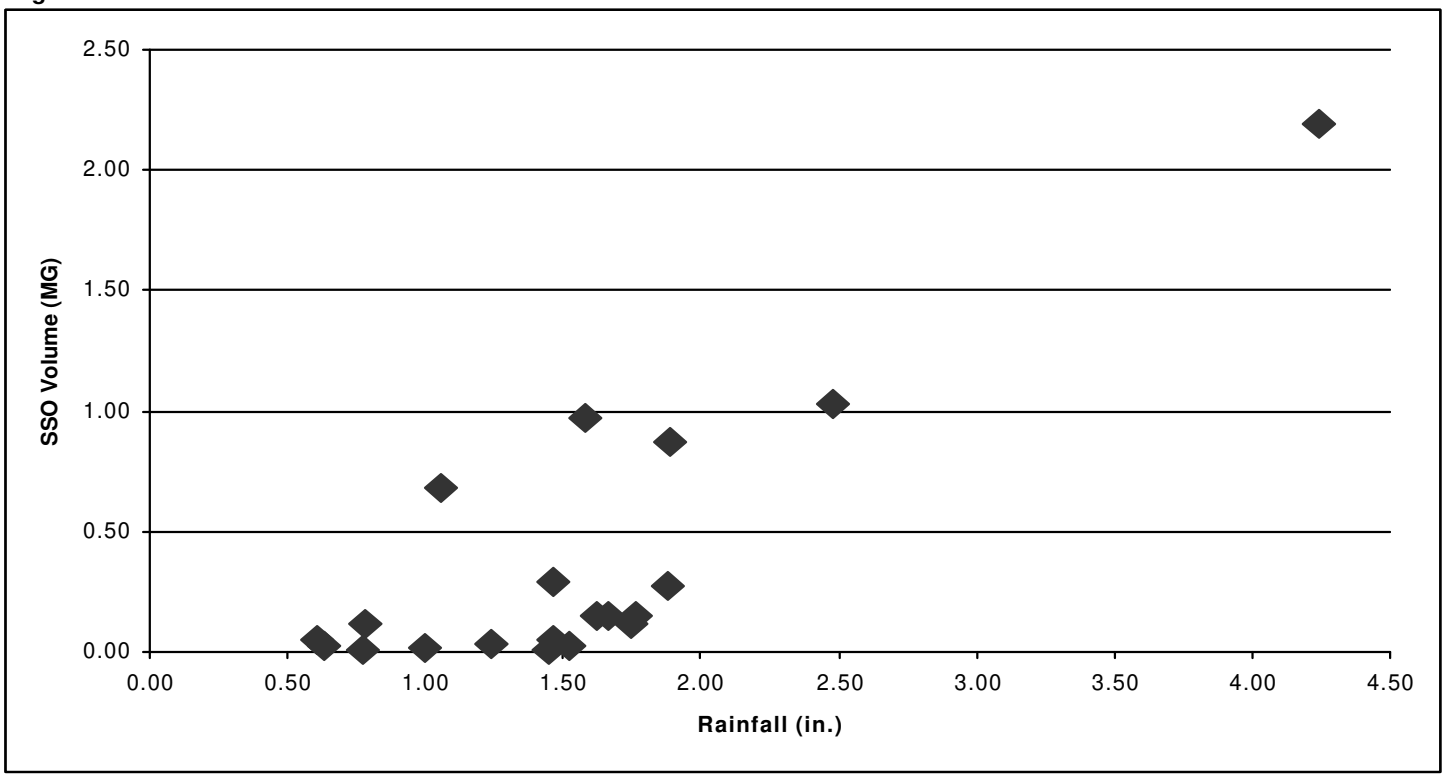
In nine of the city's 11 flow districts, the metered data was sufficient to predict projected wet weather flow values for the 10-year, seven-hour design storm. In eight of the nine districts, the estimated peak wet weather flow values were greater than the Theoretical Peak Hour Wet Weather Flow.

For dry weather flow, the average and peak values are most likely larger than the theoretical values due to infiltration. The ground water levels are higher in elevation than the majority of the sanitary sewers, especially the trunk lines.

Table 6.1: AEW Wet Weather Flow Study

Flow District	Equivalent Population	Contract Capacity (cfs)	Peak Wet Weather Flow (cfs)	Peak WWF/ Contract Capacity
A	2,877	1.15	-----	-----
B	1,552	0.62	2.42	390%
C	3,215	1.29	5.52	429%
D	2,883	1.15	3.01	261%
E	29	0.01	-----	-----
F	608	0.24	2.07	863%
G	1,972	0.79	4.66	590%
H	1,204	0.48	4.66	971%
I	117	0.05	0.66	1320%
J	3,121	1.25	1.91	153%
K	1,906	0.76	0.58	76%

Figure 6.3: SSO Volume vs. Rainfall Amount in Fraser



For wet weather events, meter data indicated that the lag time, the time from the beginning of a rain event to the time a meter records peak flow, is relatively short. This indicates that inflow exists throughout Fraser.

It is reasonable to believe that connections of footing drains to the sanitary system are a major contributing factor to the RDII. In a Sanitary Sewer Evaluation Survey prepared in 1999 for the South Macomb Sanitary District, which borders Fraser, flood testing indicated that each house could contribute up to 6.4 gallons per minute to the sanitary system via footing drains during intense rain events. The flows that were recorded by the meters in Fraser support this calculation.

AEW then compared the peak wet weather flow for the 10-year, seven-hour storm (2.41-inches) to the contract capacity for each flow district. The contract capacity for Fraser is 0.4-cfs per 1,000 people. Table 6.1 lists each flow district, the equivalent population, the contract capacity, the estimated peak wet weather flow for a 10-year, seven-hour design storm, and the ratio of the two. Districts E thru I represent the SSO tributary area.

The 2001 flow data was analyzed. The estimated dry weather flow for the Fraser SSO area is 0.6 cfs. Dry weather flow factors were obtained from the Macomb County updates to the GDRSS model.

6.4 Estimated SSO Volumes for Different Design Storms

As shown in Figure 6.2, a number of SSO events in Fraser have been documented. The SSO events in which both SSO volume and rainfall amount are available are plotted in Figure 6.3 to show the relationship between the SSO event volumes and the size of the wet weather events.

Flow and rain data from 2001 field events in the SSO tributary area was used to predict Fraser's wet weather response. The flow and rain data was collected by AEW. Review of flow and rainfall

Table 6.2: Fraser SSO Volumes for Design Storm Events (millions of gal-

Design Storm Event Rainfall (inches)	Wet Weather Vol.		Contract Exceedance		SSO Vol.	
	Growth	Dormant	Growth	Dormant	Growth	Dormant
1-Month, 24-Hr. (0.62)	0.59	1.02	0.10	0.30	0	0
1-Year, 1 Hr. (1.0)	1.14	1.95	0.41	0.94	0.18	0.63
10-Year, 1 Hr. (1.8)	2.28	3.90	0.99	2.54	0.68	1.58
1-Year, 24-Hr. (2.2)	2.85	4.88	1.39	3.45	0.80	1.70
10-Year, 24-Hr. (3.6)	4.84	8.28	3.17	6.72	1.87	4.11
25-Year, 24-Hr. (4.0)	5.41	9.26	3.72	7.72	1.98	4.90
100-Year, 24-Hr. (4.7)	6.41	10.96	4.72	9.32	2.73	6.35

Districts E thru I represent the portion of Fraser that contributes to the sanitary sewer overflow

data collected indicated a seasonal variation in the RDII response. Two seasons, dormant (winter) and growth (summer), were defined for the Fraser SSO tributary area. Dormant months are November through April. Growth months are June through September. The months of May and October are defined as transitional months. For the Fraser SSO area, the response factors of 24 percent, 14 percent, and 19 percent were determined for the dormant, growth, and transitional periods respectively. The RDII response factors were used to predict wet weather, contract exceedance and SSO volumes.

For Fraser, seven different design storms are modeled. The design storms used are the 1-month, 24-hour storm (0.617 inches); the 1-year, 1 hour storm (1.0 inches); the 10-year, 1-hour storm (1.8 inches); the 1-year, 24-hour storm (2.2 inches); the 10-year, 24-hour storm (3.6 inches); the 25-year, 24-hour storm (4.0 inches); and the 100-year, 24-hour storm (4.7 inches). The Brater-Sherrill winter and summer rainfall distributions were used for dormant and growth conditions respectively.

The RUNOFF Module and Extended Transport (EXTRAN) Module of the EPA's Storm Water Management Model (SWMM) were used to model the wet weather response in Fraser. A more detailed analysis of the model development can be found in the *"SSO Modeling and Calibration for SSO Case Studies"* on the CD which accompanies this report.

The seven design storms were simulated during the dormant season (April) and the growing season (June) to provide a range of wet weather, contract exceedance, and SSO volumes. The predicted wet weather volumes generated and the corresponding SSO volumes for the seven design storm events are presented in Table 6.2. Also included in Table 6.2 are contract exceedance volumes produced by each design storm. Fraser is a second tier customer under Macomb County which has a contract of 0.4-cfs per 1,000 people. Applying this rate, the contract capacity in the SSO tributary area, based on a population of 3,930, is 1.57-cfs, which includes both dry and wet weather flows.

6.5 Corrective Actions Completed and Underway

Since flows exceed MDEQ's guidelines, a Sanitary Sewer Evaluation Survey (SSES) is in progress to better quantify and isolate the exact sources of inflow and infiltration.

A SSES is a systematic evaluation of the sewer system and usually includes a physical survey, rainfall simulation, internal inspection, and survey report.

The Physical Survey involves aboveground inspection, flow monitoring, and manhole and sewer inspection. Rainfall simulation is utilized to identify sources of inflow and infiltration and can

be completed by smoke testing and water flooding tests. Internal inspection, such as televising, is completed to determine the location, condition, and estimated flow for each source of inflow and infiltration in the system.

Once these procedures have been performed, a summary of the results, a cost-effectiveness analysis, and recommendations for rehabilitation of the system are completed.

In addition to the inflow and infiltration study and the ongoing SSES, Fraser has also made several other recent improvements. These include:

1. In 1997, the city removed road drains and parking lot drains that were connected to the sanitary sewer system near the intersection of Utica Road and 14 Mile Road.

2. The city instituted a downspout program to route more flows into the storm sewers.

3. The city used smoke testing and metering to better understand flows in the sanitary sewer system. Three illicit connections were found and are in the process of being removed. Also, as a result of this project Fraser is working on a manhole rehabilitation project.

4. The city had the three pumps in the Beacon Pump Station rebuilt.

5. The city installed an ultrasonic level sensor on the dry weather pump in the Beacon Pump Station in order to maximize storage.

6. The city cleaned and televised all sewers in SSO tributary area.

7. The city is studying treatment alternatives for the SSO.

8. The city has identified several homes that have drains from sunken patios connected to the sanitary sewer system. Removal of these patio drains is being studied as part of a long-term solution.

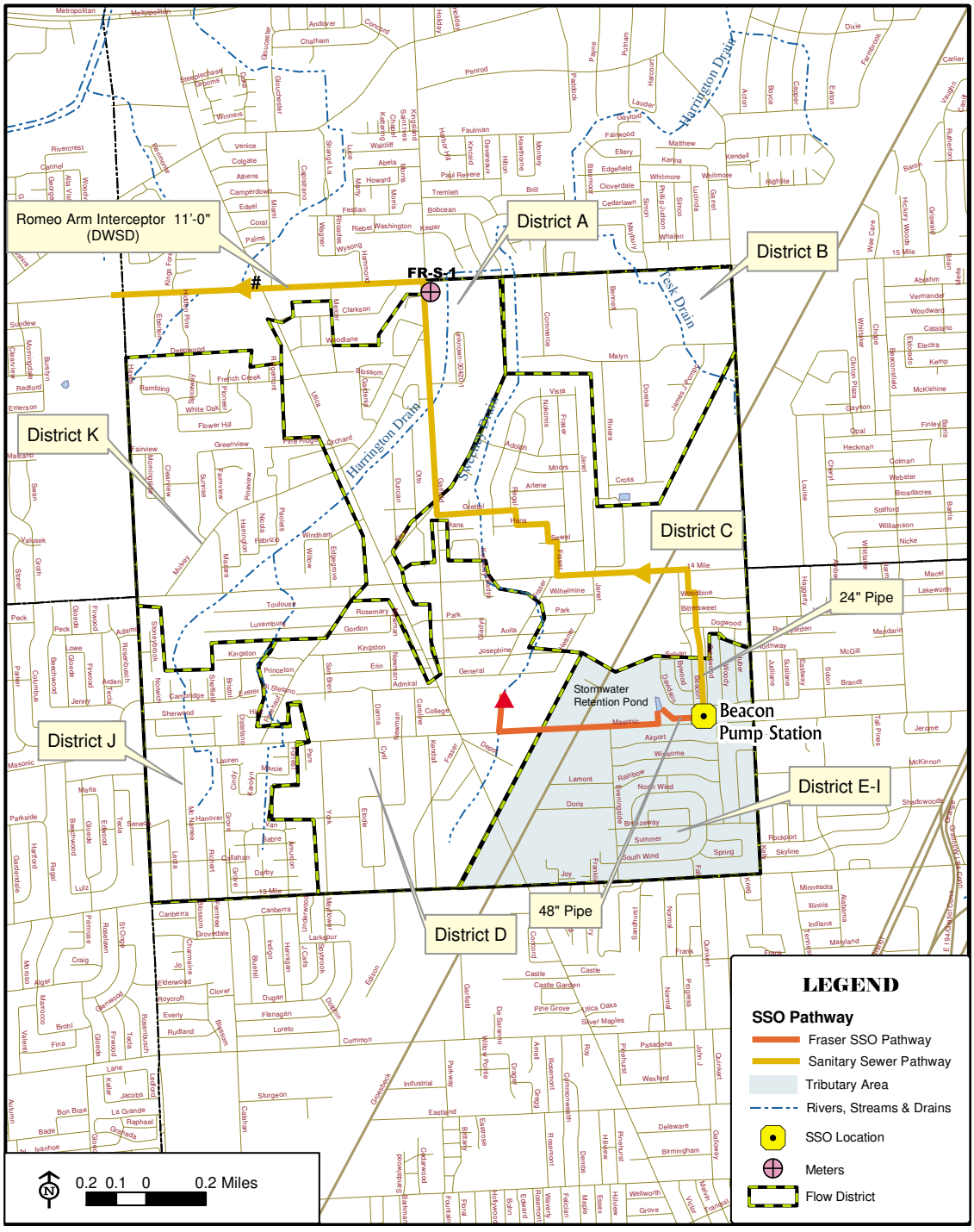
The following three items are tentative options for future discussion. A final determination will be forthcoming after the SSES is completed in the Beacon Station Study Area.

1. The overflow would be transported via a new sewer line that would tap into the Detroit Sanitary Sewer Interceptor near the 15-Mile and Hayes intersection. Construction would involve 12,000 lineal feet of sewer pipe, along with permit and tapping fees. A 12" force main is anticipated. However, a small portion of gravity sewer of unknown size may be required. The tapping permit may not be attainable due to the amount of storm water in the sewage and the city's classification by Macomb County and Detroit of having a separated sewer system. Additional treatment fees would also be incurred for the sewage that is now being transported to the Interceptor, which had previously been discharged into the storm system.

2. Store the overflow in an equalization basin during intense storm events, and pump it back into the system when flows decrease below the maximum allowable flow rate. Assuming storage capacity for a 25-year storm, this underground basin would be approximately 3.5-million gallons requiring a large area of land (10 feet deep, 1.06-acres) and regular maintenance. This alternative would also involve increased treatment fees.

3. Separate the storm water from the existing sanitary system in the southeast quadrant districts. This would involve a new storm and sanitary system, each approximately 25,000-feet in length, and removal and replacement of effected street pavement. Only homes located in the SSO tributary area would be affected. This alternative does not require a new tap, continuous maintenance, or additional treatment fees. Treatment fees would be reduced to the minimization of inflow and infiltration flows from the sanitary sewer system.

Figure 6.4: Fraser SSO Pathway



7. Case Study: Melvindale

This section describes the background information that has been assembled for the Wastewater Master Plan on the nature of SSOs in the city of Melvindale. This community is one of six selected as case studies for the regional analysis of SSOs in the DWSD service area. The background information presented here has been developed in cooperation with Melvindale and its engineering consultants. The purpose of each case study is to compare the relative cost-effectiveness of three different types of solutions:

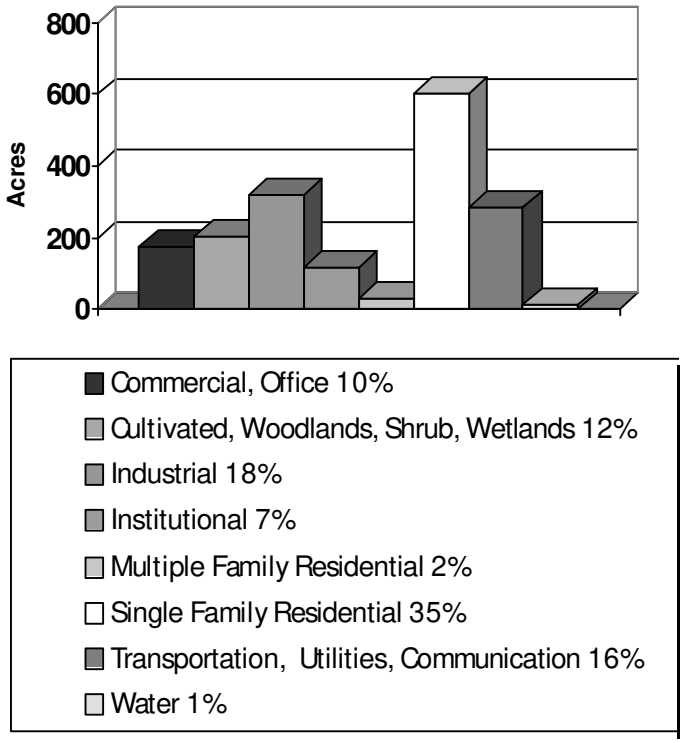
- Local removal of I/ I sources;
- Local storage and/ or treatment; and
- Regional transport, storage and treatment.

Melvindale is located in Wayne County in southeast Michigan. Melvindale is bordered by Lincoln Park to the south, Detroit to the east, Dearborn to the north, and Allen Park to the west.

According to SEMCOG, the 2000 population of Melvindale was 10,095. There are 4,499 households and the average household size is 2.38 persons.

The Southeast Michigan Council of Governments reports that the total land area of Melvindale is 1,734 acres (2.7 square miles). Figure 7.1 breaks down the acreage according to land use.

Figure 7.1: Land Use in Melvindale



7.1 Description, Characterization, and History of SSOs

Construction began on the sewer system in Melvindale in 1929 as a separate system with residential footing drains connected. The original system discharged directly to the Rouge River, but was eventually connected to the DWSD Northwest Interceptor using a pump station. This connection included an emergency bypass to the river for surcharge conditions. The pump station was located along the bank of the Rouge River near Greenfield Avenue and Wall Street.

In 1996 the deteriorating pump station was replaced. The new pump station is located several hundred feet away. As there was potential to damage the aging interceptor, Melvindale was required to use the existing tap into the Northwest Interceptor (NWI). This required a 16" force main from the new pump station up to the original pump station location. The original emergency bypass to the Rouge River is available for surcharged conditions.

The only reported wet weather sanitary overflow point in Melvindale is this emergency bypass on the force main downstream of their pumping station. The entire city is tributary to the SSO. A map of the location of this bypass and the corresponding tributary area is shown in Figure 7.2. The second reported event was a dry weather maintenance issue that has been resolved.

Table 7.1: Melvindale SSO Events

Start Date	End Date	Vol. (gallons)	Rain (inches)
09/11/00	09/12/00	2,140,776	3.37
03/22/01	03/22/01	N/A	0*

*Maintenance Issue that was resolved

Melvindale's current contract capacity is 0.5 cfs/ thousand people but was modeled as 6.375-cfs maximum flow. However, under wet weather conditions, the new pump station is operated to discharge flows at about 15-cfs into the Northwest Interceptor. During three rain events over the last five years, Melvindale has opened the emergency bypass to the Rouge River in order to reduce basement backups occurring due to upstream surcharging. By opening the bypass, the pumps are able to operate at about 18-cfs, as the discharge head is reduced.

The Michigan Department of Environmental Quality (MDEQ) Web site lists two separate sanitary sewer overflow events from the City of Melvindale. These events, are located on the MDEQ web page, http:/ / www.michigan.gov/ deq, in the CSO and SSO database and are summarized in Table 7.1.

7.2 Sewer System Design Criteria and Footing Drain Locations

Residential footing drains are connected to the sanitary system throughout the city.

Most houses in Melvindale are of similar construction. Large portions of the residences were constructed in the early 1940s, with the last subdivision being built between 1955 and 1965. Houses in this area generally have basements where separate storm and sanitary cleanouts are located. The footing drain and sanitary plumbing are connected inside the house to a single house lead.

A downspout disconnection ordinance has been in effect for more than 20 years. The ordinance is enforced through inspection at the time of sale. An estimated 10 percent of homes in Melvindale are sold, and therefore inspected, annually.

7.3 Flow Data

The Charles E. Raines Company performed an infiltration and inflow determination study for Melvindale as documented in an April 1989 report. In this study, flow monitoring was performed at 20 manholes in order to identify areas with high inflow and infiltration. In most cases measured flows were much higher (up to 50 percent higher) than what would be expected based on the original design criteria. The monitoring also revealed that some sewer sections had velocities low enough to cause settling of solids. Flow monitoring indicated possible flow blockages at some locations. According to Melvindale officials, the high I/ I observed in this study is primarily due to footing drain connections. It is less likely that the I/ I is due to infiltration through leaks and joints as the pipes in the system were all backfilled with hard clay instead of sand. Based on observations during sewer inspections and rehabilitation work, this theory has been reinforced.

Flow data from the 2001 records data period was analyzed and the estimated dry weather flow for the tributary area was 4.3 cfs. The previouos annual average DWF estimate from the GDRSS model was 4.64 cfs.

7.4 Estimated Contract Exceedance Vol. for Various Design Storms

Flow data for Melvindale from February 2001 to October 2001, was obtained from the billing meter for the city. From the flow and rainfall data, 10 rain

events were selected and analyzed. For the purposes of modeling, two seasons, dormant (winter) and growth (summer), were defined for the Melvindale SSO tributary area. Dormant months are November through April. Growth months are November through April. The months of May and October are defined as transitional months.

A regression analysis was used to develop a best-fit line for each condition. The corresponding Rainfall Dependent Inflow and Infiltration (RDII) response factors (percentage of total rainfall entering the sanitary sewer system) for the events were 6.7 percent and 4.6 percent for dormant and growth conditions, respectively. The RDII response factors are lower than what was previously determined from the correlation to age used in the GDRSS model, which was 15 percent for dormant and 8 percent for growth. One possible reason for this may be due to the fact that the residential areas make up only 37 percent of the total tributary area. No data was collected at internal locations to determine if the response is higher in the residential areas than in the non-residential areas.

For Melvindale, seven different design events are modeled. The 1-month, 24-hour storm (0.617 inches); the 1-year, 1-hour storm (1.0 inches); the 10-year, 1-hour storm (1.8 inches); the 1-year, 24-hour storm (2.2 inches); the 10-year, 24-hour storm (3.6 inches); the 25-year, 24-hour storm (4.0 inches); and the 100-year, 24-hour storm (4.7 inches). The Brater-Sherrill winter and summer rainfall distributions were used for dormant and growth conditions, respectively.

The RUNOFF Module and Extended Transport (EXTRAN) Module of the EPA's Storm Water Management Model (SWMM) were used to model the wet weather response in Melvindale. A more detailed analysis of the design storm modeling is available in the *"SSO Modeling and Calibration for SSO Case Studies"* technical memorandum which accompanies this report.

Table 7.2: Melvindale Volumes for Design Storm Events (millions of gallons)

Design Storm Event (inches)	Wet Weather Volume		Contract Exceedance	
	Growth	Dormant	Growth	Dormant
1-Month, 24-Hr. (0.62)	0.64	1.29	0.25	0.82
1-Year, 1 Hr. (1.0)	1.36	2.33	0.94	2.03
10-Year, 1 Hr. (1.8)	2.88	4.53	2.41	4.22
1-Year, 24-Hr. (2.2)	3.64	5.64	3.02	4.96
10-Year, 24-Hr. (3.6)	6.29	9.47	5.49	8.72
25-Year, 24-Hr. (4.0)	7.05	10.57	6.19	9.81
100-Year, 24-Hr. (4.7)	8.37	12.49	7.47	11.70

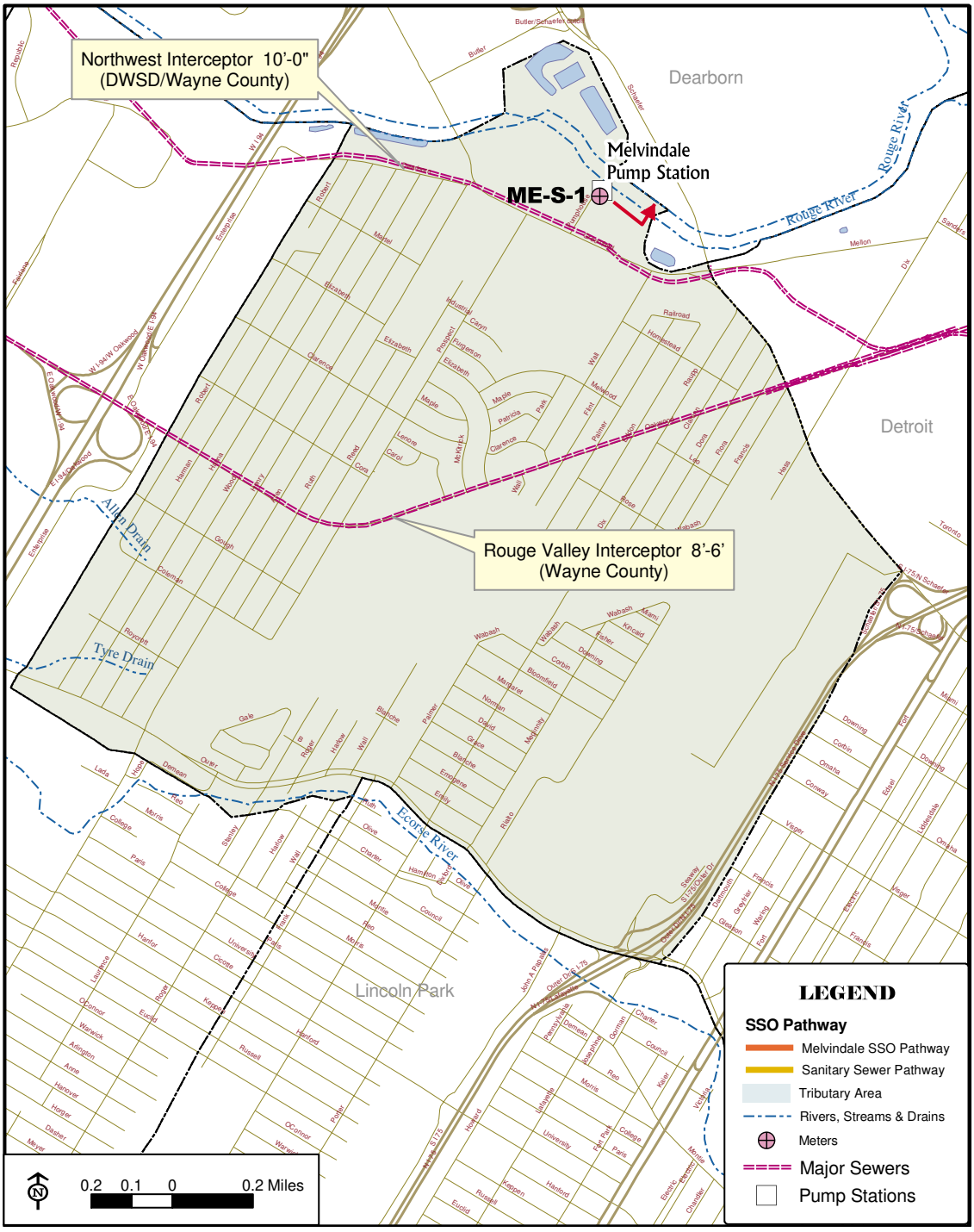
* Based on existing Contract of 6.375 cfs

The seven design storms were simulated during the dormant season (April) and the growing season (June) to provide a range of wet weather and contract exceedance volumes. The contract capacity for the Melvindale SSO tributary area is 6.375-cfs. The predicted wet weather volumes generated and the contract exceedance volumes are presented in Table 7.2.

7.5 Corrective Actions Completed and Underway

Melvindale has and enforces a city ordinance prohibiting the connection of residential and commercial downspouts to the sanitary system. The city has also performed flow analysis and smoke testing to identify areas of high inflow and infiltration. Melvindale is also working on a draft ACO with MDEQ that will include and interim treat-and-release system to prevent basement backups. The long-term plan will include installing a series

Figure 7.2: Melvindale SSO Location



8. Case Study: Allen Park

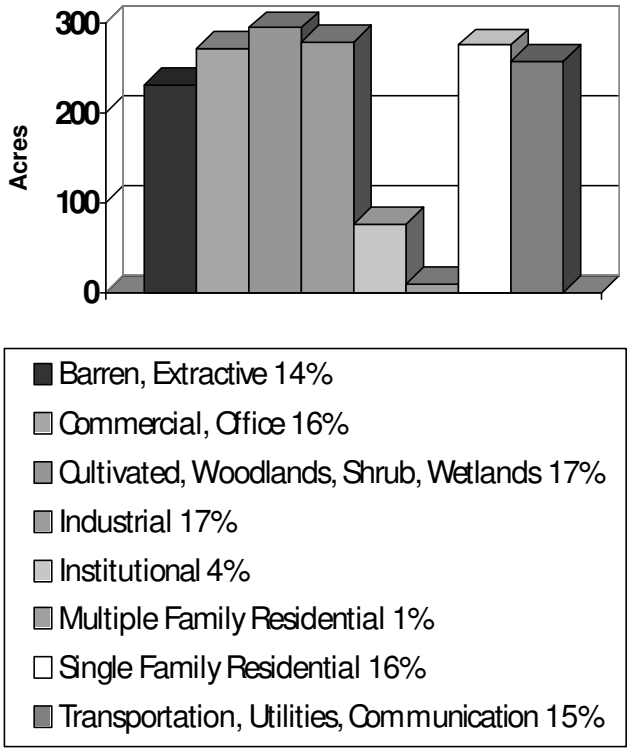
This section describes the background information that has been assembled for the Master Plan on the nature of SSO's in the city of Allen Park. This community is one of six selected as a case studies for the regional analysis of SSOs in the DWSD service area. The background information presented here has been developed in cooperation with Allen Park and its engineering consultants. The purpose of each case study is to compare the relative cost-effectiveness of three different types of solutions:

- Local removal of I/ I sources;
- Local storage and/ or treatment; and
- Regional transport, storage and treatment.

Allen Park is located in Wayne County in southeast Michigan. Allen Park is bordered by Southgate to the south, Lincoln Park and Melvindale to the east, Dearborn to the north, and Dearborn Heights and Taylor to the west. Allen Park is tributary to both the DWSD sanitary system and the Wayne County Downriver sanitary system. This report will refer to the portion of Allen Park that is serviced by the DWSD sanitary system as Allen Park District 1. This service area is shown in Figure 8.4.

According to SEMCOG, the 2000 population of Allen Park District 1, the portion of the city that drains to DWSD, was 2,713. The legal description that is referenced in the existing wastewater agreement that Allen Park has with Detroit does not match the boundary shown in the contract agreement. Efforts are currently underway to establish the most current boundary of District 1 and the associated acreage. Allen Park District 1 comprises approximately 1,716 of the city's 4,524 acres. Figure 8.1 breaks down the 1995 land use in Allen Park District 1.

Figure 8.1: Land Use in District 1



8.1 Description, Characterization, and History of SSOs

The northern portion of Allen Park consists of two connections to Detroit's Northwest Interceptor (NWI). These connections are currently designated as APS-1 and APS-2. Parts of Allen Park District 1 were formerly Ecorse Township. In an agreement dated March 13, 1947, the Township of Ecorse granted the City of Detroit a perpetual right of way for the Northwest Interceptor, and Detroit agreed to permit the Township of Ecorse to make connection and discharge its wastewater (storm water excluded) into the Northwest Interceptor.

History of APS-1 Connection

By an agreement dated July 29, 1959, Detroit agreed to accept into the Northwest Interceptor wastewater flow from the area in Allen Park

served by the Allen Park Drain. This area is currently referred to as APS-1. The APS-1 service area consists of a 24-inch connection to the Northwest Interceptor that runs from the Northwest Interceptor to the Southfield Freeway along Enterprise Drive. It has a west service arm extending to the Southfield Freeway, and an east service arm extending to Allen Road. These sanitary trunk facilities were constructed in 1960 upon request of Allen Park to the Wayne County Drain Commissioner.

The original sewer design included a metering and overflow chamber upstream of the connection to Detroit's Northwest Interceptor. The 24-inch overflow relief pipe was designed to discharge to the Rouge River. In 1970, the Army Corps of Engineers designed a flood control project that realigned and paved the old Rouge River Channel. Design plans from the Army Corps of Engineers indicate that the overflow to the Rouge River from Allen Park would be preserved. Field investigations conducted by Allen Park in 2001 indicate that although an overflow pathway to the Rouge River exists, it has not provided relief during recent storm events as an internal flap gate has been corroded shut. This overflow location is shown in Figure 8.4.

The sanitary sewers servicing the APS-1 outlet currently consists of three upstream sewage pump stations located at Outer Drive, Lawrence Avenue, and Watson Avenue. Allen Park assumed ownership of the sewage pump station and related sewer lines servicing APS-1 from Wayne County in 1988. It is estimated that the APS-1 meter was first installed in the early 1960s. This meter was not producing reliable data and Allen Park decided to upgrade the meter with an Accusonics meter in 1999. This Accusonics meter is currently in place at the end of this system and is referred to as APS-1. DWSD has recently upgraded the Accusonics meter and intends to use it for billing purposes. Recent flow data and field investigations have confirmed that the Northwest Interceptor surcharges and has backflowed into the Allen Park APS-1 connection. DWSD recommends a red valve check valve to prevent this.

History of APS-2 Connection

In 1955 the Township of Ecorse did not have a wastewater collection system to serve the Ford Motor Company facilities at 17000 Oakwood Blvd. Subsequently, Ford and Detroit entered into an agreement dated April 25, 1955 with the approval of the township for the disposal of its wastewater (storm water specifically excluded) through a 15-inch connection to the Northwest Interceptor. In 1957, Allen Park included within its boundaries that part of Ecorse Township in which the Northwest Interceptor and the Ford facilities are located. In 1974, Allen Park requested permission from DWSD for additional wastewater disposal service to address the need to service new developments and allow an additional connection point to the Northwest Interceptor. The 1974 agreement defined the boundary of the sewer district and allowed for a new connection to the Northwest Interceptor to replace the 15-inch connection used by Ford. In the mid 1970s a new 30-inch connection to the Northwest Interceptor was constructed. This connection currently services the Fairlaine Business Park and the Ford Clay Mine Landfill. This connection does not have an overflow to the Rouge River. A meter was first installed at APS-2 in the mid to late 1970s. This meter was not producing reliable data and Allen Park decided to upgrade the meter with an Accusonics meter in 1999. DWSD has recently installed a magmeter at this location with the intent of using it for billing purposes.

History of Sanitary Sewer Overflows

Although the sanitary sewer system in the Allen Park Drainage District is separate by design, the sewers have been subjected to excess flow. Historically, it has been necessary for city personnel

to utilize portable pumping equipment to discharge sanitary sewage into the North Branch of Ecorse Creek during wet weather conditions to prevent basement flooding in the upstream residential areas of District 1. MDEQ has been made aware of these discharges, but no SSO events are published on its Web site for District 1.

Over the past 25 years the city has performed numerous projects to try to identify and eliminate excess wet weather flows in District 1. The studies have not indicated any significant cross connections between the storm and sanitary systems. However, the city has undertaken several construction projects to reduce the impact of the Ecorse Creek on the sanitary sewer. Allen Park has retained Anderson Eckstein & Westrick, Inc. (AEW) to perform an exhaustive sewer system evaluation survey (SSES). AEW has listed all pipe and manhole defects that have been found in District 1 and will be developing a prioritized list of system defects to be rehabilitated in the near future. Sewer backups and basement flooding have continued to occur. All three residential sub areas within Allen Park District 1 have experienced basement flooding in the past. Allen Park District 1 experienced basement flooding during an extreme rain event (greater than 100-year return frequency) on September 11-12, 2000. The city performed bypass pumping to the Ecorse Creek during this storm event.

8.2 Sewer System Design Criteria

The residential housing stock in Allen Park District 1 was predominantly built in the mid 1960s. The homes were built with footing drains connected to the sanitary system, which was common practice at that time. The city currently requires that homeowners who undertake major improvement programs such as basement waterproofing have their footing drains disconnected and a sump pump installed at the time of construction.

Also, in an attempt to alleviate flooding problems, Allen Park adopted an ordinance in 1972 prohibiting the connection of downspouts to the sanitary sewer system.

Table 8.1: Allen Park Volumes for Design Storm Events (millions of gallons)

Design Storm Event (inches)	Wet Weather Volume		Contract Exceedance	
	Growth	Dormant	Growth	Dormant
1-Month, 24-Hr. (0.62)	0.38	1.11	0	0.04
1-Year, 1 Hr. (1.0)	0.81	2.02	0.18	0.81
10-Year, 1 Hr. (1.8)	1.71	3.91	0.63	2.03
1-Year, 24-Hr. (2.2)	2.16	4.87	0.64	2.25
10-Year, 24-Hr. (3.6)	3.73	8.17	1.56	5.09
25-Year, 24-Hr. (4.0)	4.18	9.13	1.88	5.96
100-Year, 24-Hr. (4.7)	4.96	10.78	2.49	7.49

8.3 Wet Weather Flow Analysis

In 1999, Allen Park retained Wade-Trim, Inc., to analyze their sewer system and develop alternatives to address flooding problems. As part of this study, flow and rainfall data have been collected for storm events and used to develop rainfall dependent inflow and infiltration (RDII) response factors (percentage of total rainfall entering the sanitary sewer system) for the city.

For estimating flows for Allen Park District 1, the existing factors developed for the GDRSS Model were used. Review of flow and rainfall data collected as part of the development of the GDRSS Model indicated a seasonal variation in the RDII response. Two seasons, dormant (winter) and growth (summer), were defined for the GDRSS Model for all separate sewer service areas. Dormant months are November through April. Growth months are June through September. May and October were defined as transitional months.

Figure 8.2: Plan view of APS-1 Submodel

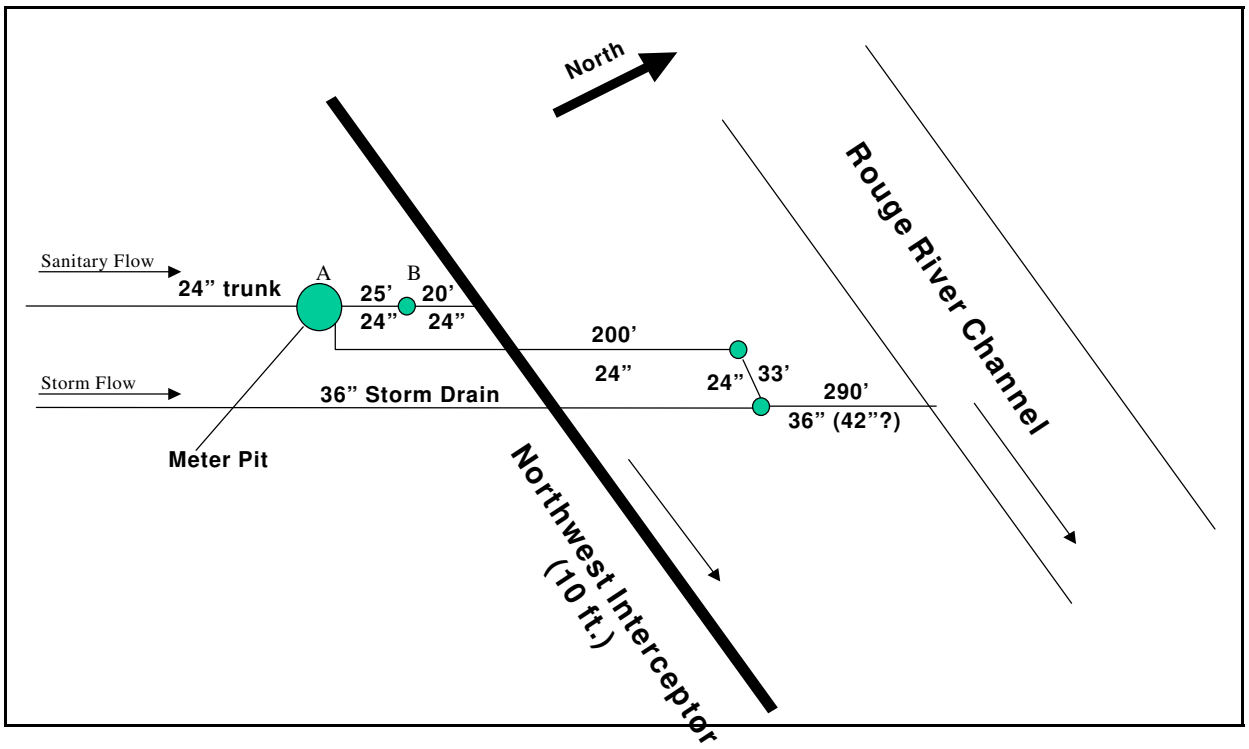
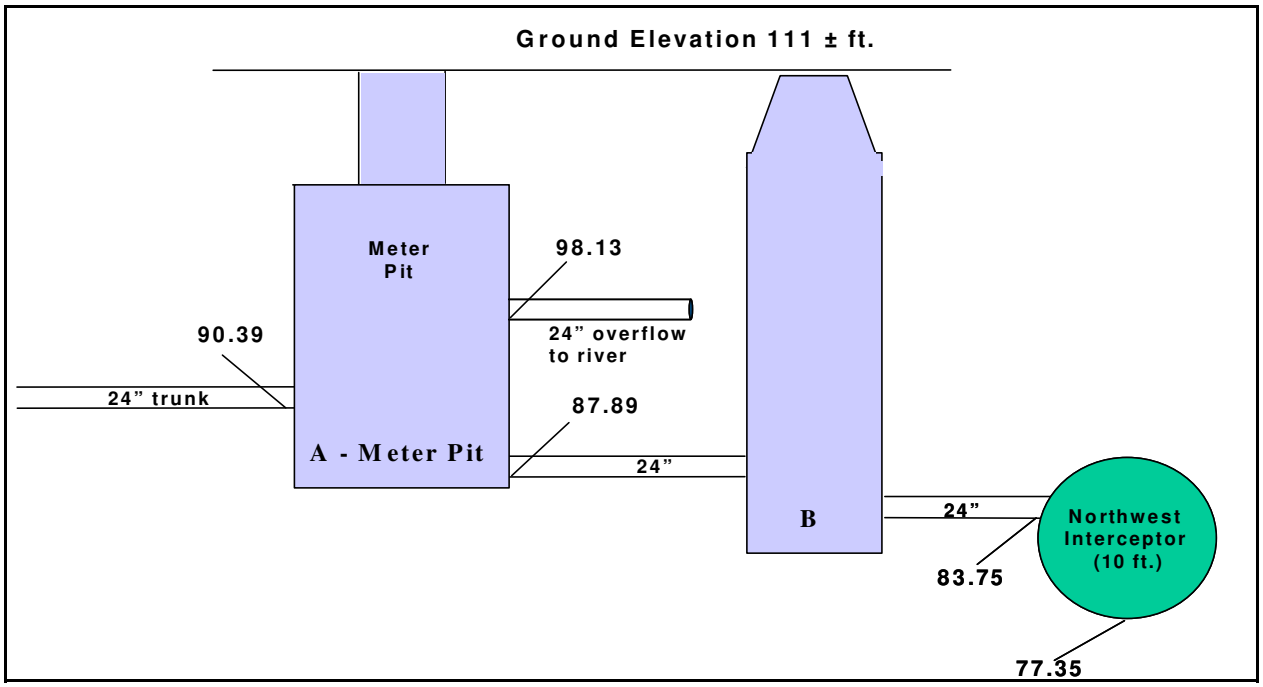


Figure 8.3: Section view of APS-1 Submodel



For Allen Park, the response factors of 10 percent, 5 percent and 7 percent were defined for the dormant, growth, and transitional periods, respectively. The growth factors were found to be comparable to the city's results.

8.4 Estimated Contract Exceedance Vol. for Various Design Storms

The RDII response factors were used to predict the wet weather response for seven different design storms. The design storms used include the 1-month, 24-hour storm (0.617-inches); the 1-year, 1-hour storm (1.0-inches);the 10-year, 1-hour storm (1.8-inches); the 1-year, 24-hour storm (2.2-inches); the 10-year, 24-hour storm (3.6-inches); the 25-year, 24-hour storm (4.0-inches); and the 100-year, 24-hour storm (4.7-inches). The Brater-Sherrill winter and summer rainfall distributions were used for dormant and growth conditions respectively.

The RUNOFF Module of the EPA's Storm Water Management Model (SWMM) was used to predict Allen Park's wet weather response. The Extended Transport (EXTRAN) Module was used to develop a submodel to represent the APS-1 connection to the Northwest Interceptor and the 24-inch overflow relief pipe. A plan view of the submodel is shown in Figure 8.2, and a section view is shown in Figure 8.3. A more detailed analysis of the model development can be found in the *"SSO Modeling and Calibration for SSO Case Studies"* on the CD which accompanies this report.

For these simulations, the wet weather event was defined to occur during the dormant season (April) and the growing season (June). The predicted wet weather volumes generated are presented in Table 8.1. These wet weather responses were routed through the EXTRAN submodel to predict the SSO volumes that would be generated by these storm events. If the submodel was defined to have free discharge into the Northwest Interceptor, the model predicts that no overflow would occur. This result might be expected, as the discharge pipe to the NWI is the same size as the trunk sewer conveying flows from Allen Park to the meter pit/ overflow chamber. If the discharge is artificially limited to the contract capacity of 6 cfs, then the model predicts overflows for the seven design events. Since this analysis was performed, the current contract capacity has been identified at 7 cfs, instead of 6 cfs. The contract exceedance volumes are also listed in Table 8.2.

8.5 Corrective Actions Completed and Underway

Allen Park is not currently under an Administrative Consent Order with the MDEQ for District 1. Allen Park is under an Administrative Consent Order in the Downriver System. Allen Park has spent over $73 million in recent years to improve its sanitary sewer system and reduce inflow and infiltration. The City is currently working on a citywide SSES for the next 1.5 years.

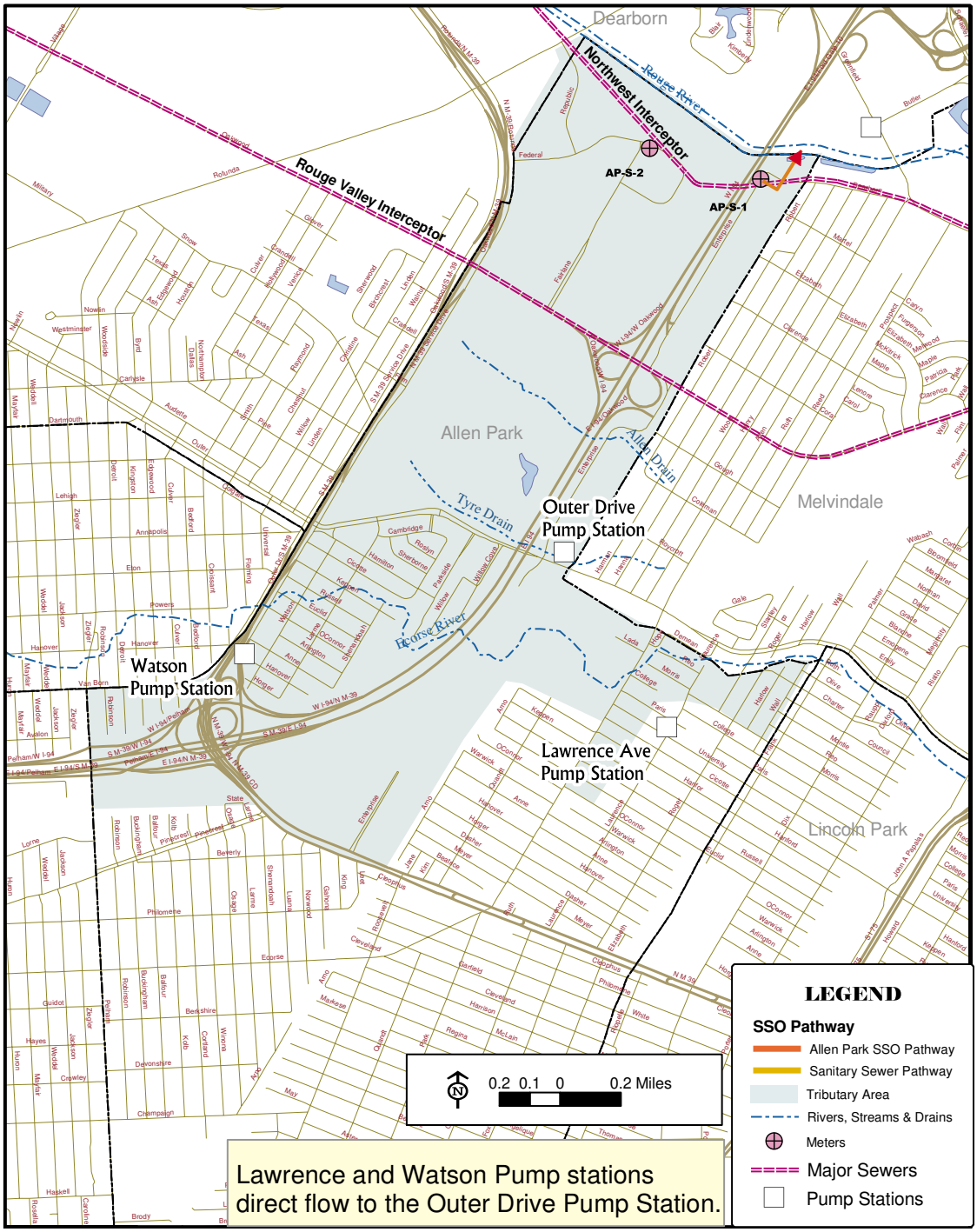
MDEQ is aware that Allen Park has had to perform bypass pumping of sewage to the Ecorse Creek in District 1 to prevent basement flooding. The MDEQ was informed of bypass pumping performed in District 1 that occurred in April 2000. In response to this notification, the MDEQ has required that Allen Park submit a Corrective Action Plan to the Department. Allen Park has informed the MDEQ of its frequent inability to discharge peak flows to Detroit due to surcharged levels in the Northwest Interceptor which have been documented by the recent metering program.

Allen Park's meetings with DWSD have also initiated the process for developing a mutual understanding of the current contract capacity allocated to Allen Park in the existing wastewater disposal agreement with Detroit. The contract does not identify a specific numerical limit, but allows 0.4 cfs per 1000 people or industrial hydraulic equiva-

lent. The information obtained from these meetings will be used to evaluate potential regional and local solutions to address SSOs that occur in Allen Park District 1.

Potential options to be considered for local alternatives include relief sewers, storage facilities and/ or wet weather pumping facilities. Sizing of these facilities is dependant on the selected design storm, existing contract limit from DWSD, potential I/ I flow reductions, and allowance for treated SSO for storm events greater than the selected design storm to protect against future basement flooding.

Figure 8.4: Allen Park SSO Pathway



9. Case Study: Garden City

This section describes the background information that the Master Plan has assembled on the nature of SSOs in Garden City. This community is one of six selected as case studies for the regional analysis of SSOs in the DWSD service area. The background information presented here has been developed in cooperation with Garden City and its engineering consultants. The purpose of each case study is to compare the relative cost-effectiveness of three different types of solutions:

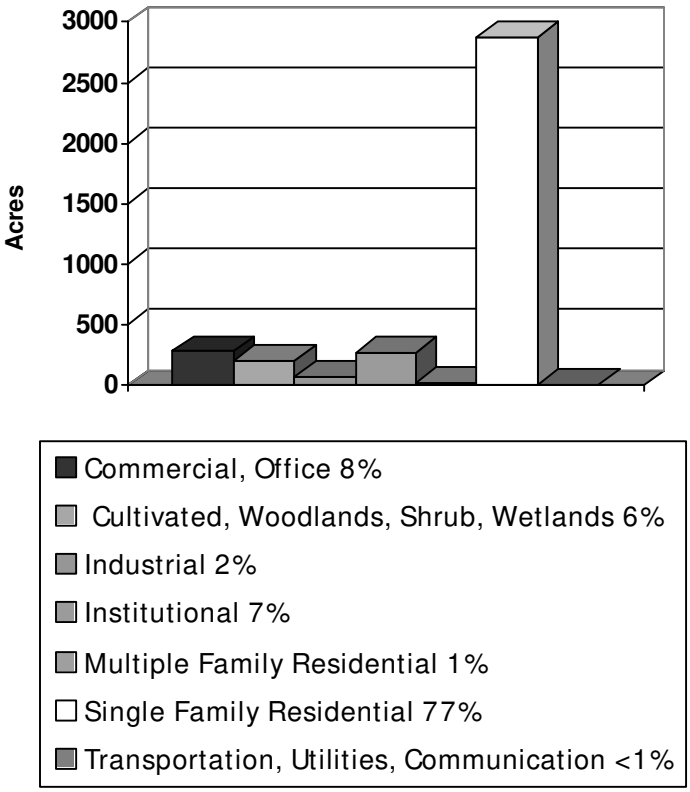
- Local removal of I/ I sources to eliminate SSOs;
- Local storage and/ or treatment; and
- Regional transport, storage and treatment

Garden City is located in Wayne County in Southeast Michigan. Garden City is surrounded by Westland on the north and west, Westland and Inkster on the south, and Dearborn Heights on the east.

According to SEMCOG, the 2000 population of Garden City was 30,047. There are 10,500 households in Garden City.

SEMCOG reports that the total land area of Garden City is 3,754 acres (5.9 square miles). Figure 9-1 breaks down the acreage according to land use.

Figure 9.1: Land Use in Garden City



9.1 Description, Characterization, and History of SSOs

According to the draft report *"City of Garden City Corrective Action Report - Step 7A," (*Wade-Trim, Inc., 2001) construction of the Garden City sewer system began around 1939. The sewer system was built mostly as a combined system.

In the 1970s, the city adopted partial separation as its CSO philosophy and approximately one-third of the city had been separated at the end of the decade.

In the 1980s, Garden City began to initiate several large projects on its combined sewer system, including the construction of separate storm sewers.

In 1993, Garden City participated in the Rouge Valley Combined Sewer Overflow Control Project. Garden City developed a proposal that compared costs between separating the remaining portions of its sewer system and building combined sewer overflow retention basins.

Garden City chose to separate the remaining portions of its sewer system. The last partial separation in Garden City was complete in 1998.

The last phases of the full separation project included placing bulkheads at the overflows on both the Middlebelt and Merriman sanitary trunk lines, and installing in-line vortex valve/ weir plate structures in the upstream sewers for in-line storage.

Table 9.1: Garden City SSO Events

Start Date	End Date	Vol. (gallons)	Rain (inches)
09/11/00	09/12/00	125,000	3.33
10/26/01	10/26/01	35,000	0.72

Garden City does not have a long history of sanitary sewer overflows. This is because until 1998 the sewer system had been combined.

According to the Michigan Department of Environmental Quality (MDEQ), Garden City reported four SSO locations (temporary bypass pumping sites) during a September 11-12, 2000 storm. The SSOs were located at the following intersections:

- Garden and Dawson
- Deering and Dawson
- Harrison and Kathryn
- Maplewood and Middlebelt

MDEQ has published several sanitary sewer overflow events from Garden City. The events are located on the MDEQ Web page, http:/ / www. michigan.gov/ deq, in the CSO and SSO Database and are summarized in Table 9.1.

Figure 9.2, a map of Garden City showing the four SSO locations, is located at the end of this chapter. The SSOs are pumped into local storm drains that run into the Rouge River via open drains and pipes.

9.2 Sewer System Design Criteria and Footing Drain Locations

Garden City has two major sanitary trunk lines that carry flow to the Wayne County Interceptor. These trunk lines run north along Middlebelt Road and Merriman Road through the City of Westland and outlet to the 42-inch Wayne County Interceptor located at Hines Park.

The Middlebelt Road trunk line has a 72-inch diameter. The Merriman Road trunk line has a 60-inch diameter.

Most homes in Garden City were built before 1970 and had footing drains connected to the combined sewer system. Footing drain connections were not removed as part of the sewer separation. An estimated 25 percent of homes in Garden City are built on slabs without basements and therefore do not have footing drains. Most other homes probably have footing drains connected to the sanitary sewer.

Based on recent investigations and discussions with local plumbers, most residential footing drains connect to the house sanitary lead inside the foundation of the house. At this connection there are two separate cleanouts in the basement: one for the sanitary lead and one for the footing drain line.

9.3 Flow Data

Garden City has a contract capacity of 24.4-cfs with Wayne County. It discharges into the Wayne County Interceptor. The dry weather flow in Garden City is 6.61 cfs.

Wade-Trim, Inc. is currently examining the impacts that the one-year, one-hour, 10-year, one-hour, and 25-year, 24-hour design storms will have on the Garden City system.

Wade-Trim is also examining various alternatives to reduce inflow and infiltration, store excess flows, and purchase additional capacity to the Wayne County Interceptor.

9.4 Estimated Contract Exceedance Vol. for Various Design Storms

The Garden City SSO tributary area was divided into two areas: GC-1 and GC-2. GC-1 is 1,883-acres. GC-2 is 1,616-acres. The dry weather flow for the Garden City SSO tributary area is 6.61-cfs. It was estimated that the dry weather flow for GC-1 is 3.68-cfs, and the dry weather flow for GC-2 is 2.93-cfs. Rainfall Dependent Inflow and Infiltration (RDII) response factors (percentage of total rainfall entering the sanitary sewer system) for GC-1 are 13 percent and 7 percent for dormant (winter) and growth (summer) conditions, respectively. The RDII response factors for GC-2 are 13 percent and 4 percent for dormant and growth conditions, respectively. The RDII response factors were used to predict wet weather volumes and contract exceedance volumes.

For Garden City, seven different design events are modeled. The design storms used are the 1-month, 24-hour storm (0.617 inches); the 1-year, 1-hour storm (1.0 inches); the 10-year, 1-hour storm (1.8 inches); the 1-year, 24-hour storm (2.2 inches); the 10-year, 24-hour storm (3.6 inches); the 25-year, 24-hour storm (4.0 inches); and the 100-year, 24-hour storm (4.7 inches). The Brater-Sherrill winter and summer rainfall distributions were used for dormant and growth conditions, respectively.

The RUNOFF Module and Extended Transport (EXTRAN) Module of the EPA's Storm Water Management Model (SWMM) were used to model the wet weather response in Garden City. A more detailed analysis of the model development can be found in the *"SSO Modeling and Calibration for SSO Case Studies"* on the CD which accompanies this report.

The seven design storms were simulated during the dormant season (April) and the growing season (June) to provide a range of wet weather and contract exceedance volumes. The contract capacity for the Garden City SSO tributary area is 24.4-cfs. The predicted wet weather volumes generated and the contract exceedance volumes are presented in Table 9.2.

Table 9.2: Garden City Volumes for Design Storm Events (millions of gallons)

Design Storm Event (inches)	Wet Weather Volume		Contract Exceedance	
	Growth	Dormant	Growth	Dormant
1-Month, 24-Hr. (0.62)	2.06	5.77	0	0.48
1-Year, 1 Hr. (1.0)	3.99	10.47	0.26	4.95
10-Year, 1 Hr. (1.8)	8.04	20.32	2.79	13.83
1-Year, 24-Hr. (2.2)	10.06	25.28	3.68	15.94
10-Year, 24-Hr. (3.6)	17.14	42.44	9.39	31.73
25-Year, 24-Hr. (4.0)	19.16	47.39	11.07	36.38
100-Year, 24-Hr. (4.7)	22.70	55.98	14.23	44.56

9.5 Corrective Actions Completed and Underway

According to Wade-Trim, since completing the last partial sewer separation project in 1998, Garden City has been unable to certify that its flows are within the allowable 24.4-cfs contract capacity to the Wayne County Interceptor during the 10-year, one-hour wet weather event.

Because of this, a Corrective Action Plan was developed with MDEQ to ultimately place the city in compliance with the contract capacity in the Wayne County Interceptor System. Garden City is currently working on its Corrective Action Plan.

Wade-Trim performed an extensive flow-monitoring program on the Garden City sewer system from April 1999 to July 1999. The flow monitoring analysis indicated that three metered districts (Districts 1, 6, and 8 on Figure 9.2) were contributing a disproportionately high percentage

of inflow volume to the system.

Complete smoke testing of these sub-areas was proposed as a method by which above-ground point sources could potentially be identified quickly and cost-effectively. This smoke testing was performed between October 1999 and December 1999. Some minor corrections were made, but no major source of inflow or infiltration was found.

Smoke testing was performed on other areas where cross-connections between the storm and sanitary systems were suspected. This work was performed between March 2000 and May 2000. Again, some minor corrections were made, but no major source of inflow or infiltration was found.

In the summer of 2001, approximately 75 percent of the commercial roof area in Garden City was visually screened and/ or dye tested. A list of rooftop areas that are connected to the sanitary system has been developed. The results indicate that approximately 10 percent of the rooftop area surveyed is connected to the sanitary sewer. The City has notified those business owners who have been identified as being connected to the sanitary sewer, and the City will be following up to make sure corrections are made by June 2003.

Currently, the city is undertaking a GIS project that will aid in providing an inventory of its sewer system.

In the *"Field Investigations Report"* submitted to MDEQ on June 27, 2000, Garden City identified several sources of inflow and infiltration into the system, along with possible solutions. Identified avenues of inflow and infiltration into the Garden City sewer system include:

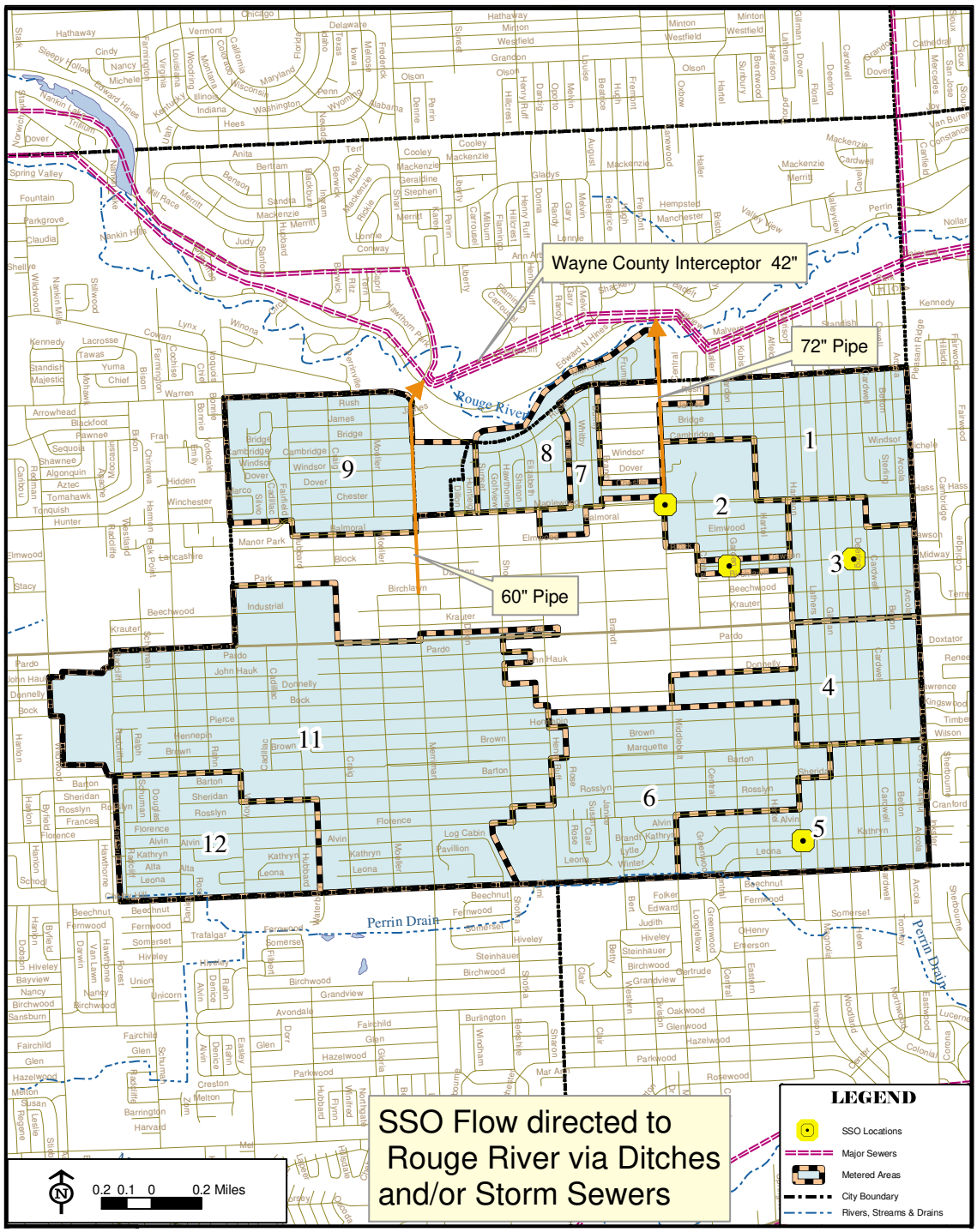
- Footing drains
- Illegal downspout connections from rooftops
- Illegal storm connections from private parking lots and rear yard easements
- Leaking bulkheads, manholes and pipes within

Garden City/ Wayne County Right-Of-Ways

Garden City is also looking at a variety of local and regional alternatives. Local alternatives include an aggressive inflow and infiltration removal program, purchasing more capacity in the Wayne County Interceptor, and several storage and/ or storage and treatment options.

Garden City has been notified it has been awarded a grant as the lead community to collect additional information related to the quality of SSOs and their potential effect on water quality impacts to the Rouge River. It is intended that this information will further the discussion on design storm criteria to be used for sizing cost-effective facilities to control SSOs.

Figure 9.2: Garden City SSO Locations



10. Field Data Collection Program

A limited field data collection program was conducted under the Wastewater Master Plan to provide a better understanding of the nature of SSOs in Southeast Michigan. This program has two central goals: To assess the impact of SSOs on water quality and to quantify flows from residential footing drains.

10.1 SSO Impact on Water Quality

An assessment of the impact of SSOs on water quality was used in the evaluation of the relative benefits of SSO control alternatives, which were examined as part of this study. A comparison is made to other water quality impacts attributable to point sources, including, the Detroit WWTP and CSOs. In addition to the results of the WWMP sampling program, the findings of a number of other pertinent local water quality studies are summarized. The third aspect of water quality that was examined was the relative pollutant loading from sources within the DWSD service area.

10.1.1 WWMP / Case Study Community SSO Sampling Program

A field-sampling program was established under the WWMP in order to collect grab samples from SSOs occurring within the DWSD service area. The objective of the water quality sampling program is to characterize the impact of SSOs, on water quality within the DWSD Service Area, based on available data and field measurements. Arrangements were made to collect up to a total of six wet weather grab samples from case study community discharge points. A detailed description of the sampling procedure and a more in depth analysis of available data is contained in the *Field Data Collection and Water Quality Issues for SSO Control* on the CD which accompanies this report.

The sampling program was not intended to provide the data needed for a comprehensive assessment of the impact of SSOs on the environment, but rather used to characterize the case study SSOs. Water quality samples collected provide data for use in planning level design of SSO control solutions and to assess the impact of SSOs on receiving water quality. Analysis was completed for five parameters: Biochemical oxygen demand (BOD), total suspended solids (TSS), total phosphorous, ammonia, and *Escherichia Coli (E. Coli.)*. These parameters are commonly used to characterize wastewater.

The sampling program focused on four of the case study communities that have active SSO points. Center Line, Fraser, and Clinton Township either conducted water quality sampling and/ or planned to perform water quality sampling with the assistance of local consultants, independently of the WWMP. For these communities, sampling procedures and collection were coordinated with ongoing or planned work. In addition, Melvindale participated in the sampling program. Sampling work was coordinated with municipal and local consultant field personnel for all of the communities. Garden city is planning an independent study and did not participate in the sample program coordinated under the WWMP. Case study sampling locations established during this program are shown in Figure 10.1.

Where feasible, sampling locations have been selected to include the sanitary sewer overflow prior to mixing with a receiving water or storm drainage. Where possible, additional sampling locations were selected to include receiving waters immediately upstream and downstream of the SSO. In some cases suitable sampling locations which could be accessed during rainstorms without risk

Figure 10.1: Case Study Sampling Locations

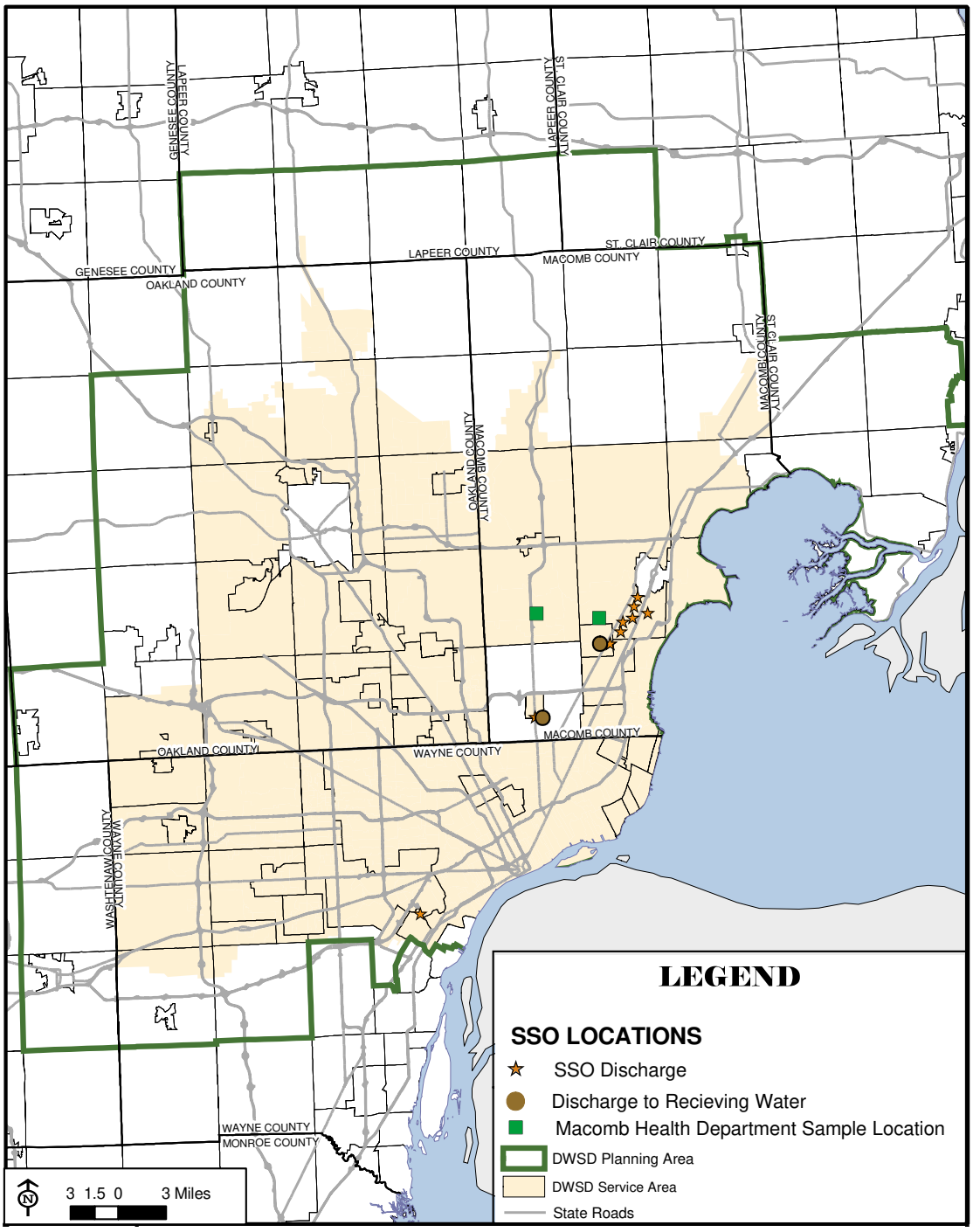


Table 10.1: Potential SSO Sampling Stations

Community	Sampling Location(s)
Melvindale	• Bypass chamber between the Pumping Station and discharge to the Northwest Interceptor
Center Line	• Parshall flume in bypass meter pit chamber located in Stephens Road, near Van Dyke • Center Line Storm Sewer at connection to the Loraine Drain.
Fraser	• Bypass manhole to storm sewer along Davidson Road, near Beacon. (S0) • Outlet of twin 24" forcemains just north of Masonic Road, along the Sweeney Drain (S1). • Approximately 600 feet downstream of S1 in the Sweeney Drain. (S2) • Approximately 600 feet upstream of S1, just south of Masonic Road, in the Sweeney Drain
Clinton Township	• Seven (7) potential sampling locations have been identified at each of the operating bypass pumping stations. Sampling will be conducted at only one of the pumping stations for each event. The station to be sampled can be randomly selected by township personnel. In addition, sampling locations will be selected upstream and downstream of one of the outfalls to the Clinton River.

to the personnel conducting the sampling were not available.

Table 10.1 lists the potential sampling locations that were established for four of the case study communities. These locations were selected, in consultation with the participating municipalities, based on historical overflow locations, and historical sampling efforts.

An SSO sampling procedure was provided to each of the four case study communities participating in the sampling program. The sampling procedure has been included as an attachment to the *Water Quality Technical Memorandum* which accompanies this report.

To date, sampling results from four events in Center Line and two events in Fraser are available. Some of the samples were collected directly by the communities' local consultants who subsequently provided the results for inclusion in this report. No samples are available from Melvindale or Clinton Township. Melvindale has not had an SSO since the sampling program was initiated.

For Center Line and Fraser, a sample was collected directly from the overflow as well as a point after mixing with storm water had occurred, during at least one event. In the case of Fraser, sanitary overflows from the Beacon Lift Station discharge into a storm water detention pond. Water from the pond is pumped into the Sweeney Drain. The detention pond effluent was sampled at the discharge point into the Sweeney Drain.

In Fraser samples were collected during storm events occurring on February 9 and November 16, 2001. The sample results are presented in Table 10.2 and include a number of additional wastewater parameters not included in the sample program outlined above.

Center Line collected wastewater samples during five SSO events, which are summarized in Table 10.2. During four of the events analysis was completed for all five wastewater parameters being examined in this study. Additional analysis was completed in some cases as part of Center Line's abatement work.

Two sampling locations have been established by Center Line. The first is the Parshall flume that is located in their bypass chamber, which contains undiluted wastewater bypassed from the pumping station. A second sampling location, which was used during several events, is the manhole directly upstream of the connection between Center Line's storm sewer and the enclosed Loraine Drain, which is owned by Macomb County.

To assess the relative impact of SSOs on regional waters a comparison was made by AEW between the SSO sample data and CSO data from Macomb

Table 10.2: Macomb County SSO and CSO Water Quality Data

Parameter (mg/L)	Raw Sewage Avg.*	SSO Sample Data						CSO Data**			
		Fraser 2/9/01	Fraser 10/16/0	Center Line 2/9/01	Center Line 10/16/01	Center Line 11/30/01	Center Line 10/10/02	Avg.	Avg.	Min.	Max.
BOD_5	217	70	26	100	53	37	110	62	78	21	376
$CBOD_5$	454	57	25	99	49	56	---	58	---	---	---
Oil & Grease	100	11	6	56	12	102	---	21	---	---	---
Nitrogen - Ammonia	21	0.74	0.63	1.9	1.43	1.41	5.6	1.18	2.36	0.44	7.25
N - Nitrate	---	4.62	3.49	5.98	5.57	6.76	---	4.92	---	---	---
N - Nitrate & Nitrite	22	4.79	4.39	6.21	7.04	6.94	---	5.61	---	---	---
N - Nitrite	---	0.17	0.9	0.23	1.47	0.18	---	0.69	---	---	---
DO	---	9.47	6.68	7.84	4.7	6.81	---	7.17	---	---	---
pH[1]	---	6.84	7.12	7.3	6.85	7.17	---	7.03	---	---	---
TP	13	1	0.6	1.2	1.4	0.85	2.3	1	1.2	0.3	3.7
TDS	627	490	278	520	360	370	---	412	---	---	---
TSS	217	70	62	130	89	75	260	88	205	26	766
E coli[2]	8600000	250000	>100000	640000	>100000	710,000	50000	445000	---	---	---

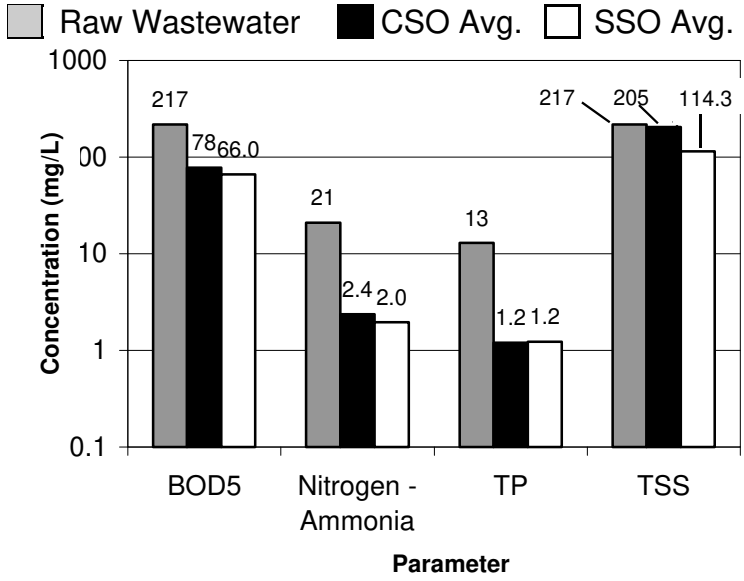
1 Unitless
2 MPN/100 mL

*Based on values reported by Macomb County communities
**Based on sampling from Macomb County CSO basins

County as well as typical values found in raw sewage generated by Macomb County Communities. The results are presented in Table 10.2.

Data for the five wastewater parameters considered in this study, was extracted from Table 10.2 and is shown in Figure 10.2. Based on the information collected from Center Line and Fraser, Sanitary Sewer Overflows contained lower concentrations of key pollutants than CSOs, and considerably less that raw wastewater.

Figure 10.2: Water Quality Comparison



10.1.2 Other Water Quality Studies

The findings of several water quality studies are summarized in Table 10.3. The goal of this analysis is to provide additional insight regarding the impact of SSOs relative to other point source discharge sources related to wastewater collection

systems within the DWSD service area. The key studies that are summarized include:

- Macomb County Health Unit Surface Water Sampling Program
- DWSD Long Term CSO Program
- Dearborn Heights Corrective Action Plan

The Macomb County Health Department has been operating a surface water quality sampling program since 1998. A series of 57 sampling sites have been established where *E. coli* samples are collected weekly. Additional samples are also collected at selected sites in response to rainfall events. The additional sites are typically located in areas that receive discharges from CSOs or SSOs.

Sampling results for locations downstream from SSO discharge points in Macomb County were extracted from an online database maintained by the health department. Data reported by the Macomb County Health Department for sites downstream of the Center Line and Fraser discharge points was plotted along with SSO discharge volumes and rainfall in order to determine if a correlation existed between wet weather overflows and adverse water quality. There does not appear to be a correlation between elevated *E. coli* levels and SSO events in either the Loraine or Sweeny drains, as detailed in the *Field Data Collection and Water Quality Issues for SSO Control* on the CD which accompanies this report.

Two of the workgroups formed under the Long Term CSO Control Plan have extensively studied water quality issues related to CSOs. The Water Quality Workgroup has complied a large amount of data regarding pollutant concentrations in both Detroit and Rouge rivers. The Treatment Efficiency Workgroup has focused on pollutant concentrations entering CSO basins and the removal efficiency under various conditions.

The complexity of CSO water quality issues indicate that while average pollutant concentrations may be applicable during high-level planning efforts, it is clear that a full characterization of SSO water quality would require an extensive effort.

Dearborn Heights collected a series of water quality samples between June and September 1999. This sampling program was conducted in order to evaluate the impact of diverting potential SSO flows to an existing CSO basin. Samples were collected directly from a sewer line during six storm events during the monitoring period. During one of the events, additional samples were collected at the Dearborn Heights CSO basin to provide a direct comparison. The results of the sampling program, including the impact on the basin performance, were summarized in a June 28, 2000 letter by Wade-Trim Associates to MDEQ.

The average concentrations of key pollutants were extracted from the report for the June 28, 1999 event where sampling was conducted of both the sanitary flows and the influent to the Dearborn Heights CSO basin. Generally, pollutant concentrations in the SSO samples are lower than those seen in the CSO samples, with the exception of phosphorous which is slightly higher. These findings are consistent with data reported from Macomb County.

10.1.3 Summary

The information presented in the chapter has been summarized in Table 10.3, along with data from additional sources. This is not a comprehensive listing of water quality information, but does provide the level of detail needed for planning level assessments of the relative water quality impact attributable to SSOs.

Generally, the concentrations found in both CSO and SSO are less than typically found in wastewater, with neither type of overflow having obviously higher concentrations.

The relative impact of pollutant loading to the environment due to SSOs, the Detroit Wastewater Treatment Plant, and CSOs was investigated by comparing reported pollutant concentrations in

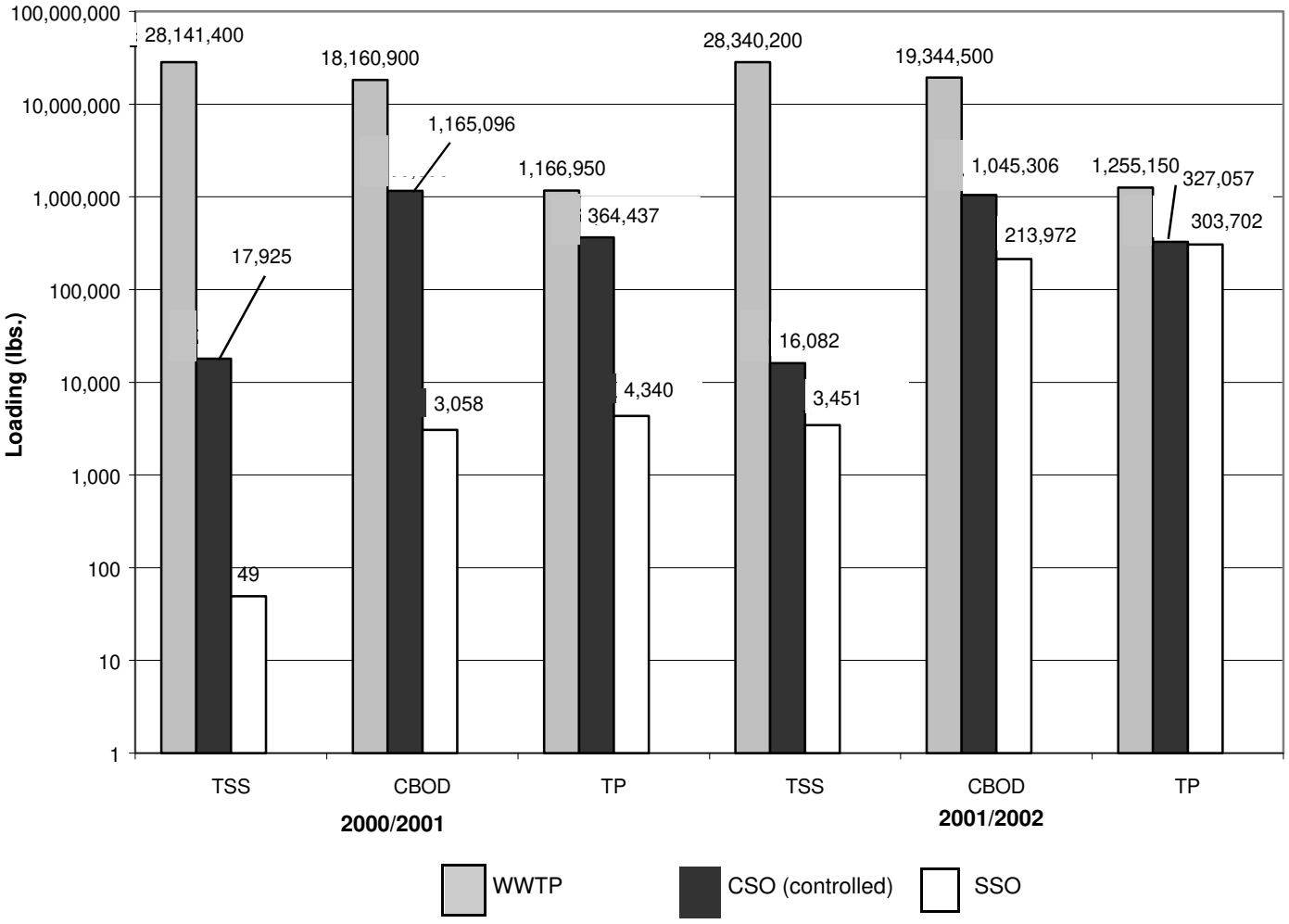
Table 10.3: Summary of Water Quality Data

			BOD5 (mg/L)	CBOD5 (mg/L)	DO	TSS (mg/L)	E Coli (X10^6) (MPN/100mL)	Oil & Grease (mg/L)	Ammonia (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate & Nitrite (mg/L)	PH	Phosphorus (mg/L)	TDS (mg/L)
Wastewater	Center Line & Fraser Study[1]	Min													
		Avg	215			217	8.6	100	21			22		13	627
		Max													
	WW Engineering Text Book[4]	Min	110			100	10							4	
		Avg													
		Max	400			350	100			0				15	
	Detroit WWTP	Min	37			46				2.8				0.8	
		Avg	94			135				9.5				2.6	
		Max	230			622				16.8				4.8	
CSO or CSO Basin Influent	Center Line & Fraser Study[1]	Min													
		Avg	78			205			2.36					1.2	
		Max													
	DBHCAP Study[2]	Min		10		10						0.1		0.1	
		Comp													
		Max		175		300						6.5		4.1	
	RRNWWPD[3] Up to June '98	Min	51	10		14			.03	0.25					
		Avg													
		Max	257	130		778			11.6	3.75					
	WW Engineering Text Book[4]	Min	60			270	0.2							1.2	
		Avg													
		Max	220			550	1.1							2.8	
	Cleveland[6]	Min													
		Avg	51			360	0.312								
		Max													
	AMSA[7]	Min					0.1								
		Avg	63			275									
		Max					10								

Table 10.3: Summary of Water Quality Data (continued)

			BOD5 (mg/L)	CBOD5 (mg/L)	DO	TSS (mg/L)	E Coli (X10^6) (MPN/100mL)	Oil & Grease (mg/L)	Ammonia (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate & Nitrite (mg/L)	PH	Phosphorus (mg/L)	TDS (mg/L)
SSO	Center Line & Fraser Study[1]	Min													
		Avg	85	78	8.7	100	0.4	34.5	1.32	5.3	0.2	5.5	7.07		505
		Max													
	DBHCAP Study[2]	Min	60	19		19						0.19		0.6	
		Comp	110	274		274						4.5		3.3	
		Avg	243	213		213						4.7		4.7	
		Max	360	1130		1130						15		13	
	EPA[5]	Min													
		Avg				44-170									
		Max													
	Cleveland[6]	Min													
		Avg	45			55									
		Max													
	AMSA[7]	Min					0.1								
		Avg	70			95									
		Max					10								

Figure 10.3: WWTP, CSO and SSO Pollutant Loadings



each of the three. Using the water quality information, detailed in above, a comparison of pollutant loadings from SSOs, CSOs and the Detroit WWTP has been made. Wastewater discharge volumes were collected in addition to the water quality information, in order to calculate pollutant loadings. The key pollutants that examined were TSS, CBOD, Total Phosphorus (TP) and Ammonia. A loading was not calculated for *E-coli* since that parameter is not reported as a concentration, but rather used as an indicator.

Loadings were calculated for two periods that parallel the analysis of SSO flows conducted as part of the WWMP. These two periods are July 10, 2000 through July 9, 2001 (2000/ 2001) and July 10, 2001 through July 10, 2002 (2001/ 2002). Figure 10.3 shows the comparative discharge volume from the three sources for both periods. A notable difference can be seen in the SSO flows between the two periods. This may be attributable to the variation in precipitation during those two periods.

Figure 10.4: Footing Drain Flow Studies by Type

Sanitary Sewer Monitoring		Direct FD Flow Measurements	
Single Area: Pre/Post	Different Areas	Individual Measurements	Continuous Monitoring
Beverly Hills	Oakland County	Ann Arbor 2000	Ann Arbor 2002
Canton TWP	GDRSS	Dearborn Heights	DWSD WWMP
Auburn Hills		Troy	Toledo
West Lafayette		Southfield	SMSD
		Evergreen/Farmington	

10.2 Footing Drain Flow Characterization

Based on previous studies and the survey results presented in Section 2 of this report, inflow from footing drains is thought to be the most significant source of wet weather flows in wet sanitary systems. The quantification of footing drain flows for representative residences within the service area will provide the base data needed to evaluate the cost of removal of flows from the sanitary system as compared to regional alternatives, such as increasing treatment and/ or transportation capacity within the existing system. Additional information was obtained from other pertinent studies to provide a comparison to results from the WWMP footing drain monitoring program.

10.2.1 Ongoing FD Flow Studies

To further help understand characteristics of footing drain flows a summary of footing drain flow information collected from other reports, primarily from Southeast Michigan communities, was obtained and is summarized below. A brief description of some ongoing studies, and the results to date, has also been included.

Existing studies on footing drain flows can be classified into two main types. Figure 10.4 lists the existing studies reviewed in detail in the *Review of Footing Drain Disconnection Projects* technical memorandum on the CD which accompanies this report, by type of study. The first type of study, sanitary sewer monitoring, measures sanitary sewer flows and compares peak flows in areas with and without footing drains. The comparison areas can either be different subdivisions with and without footing drain connections or the same area using flow data from before and after removal of footing drains. This type of study measures the effective peak flow in the sewer from all footing drain connections.

The second type of footing drain flow study is direct measurement of flows from residential house leads. This is done either by making individual measurements of flow or using a continuous monitor.

In addition to these studies, other supporting information readily available from this project was evaluated. Included were studies that provided data on peak flow rates from areas with footing drain connections.

The results reported in these studies are summarized in Section 10.2.3, along with the results of the WWMP footing drain field monitoring program.

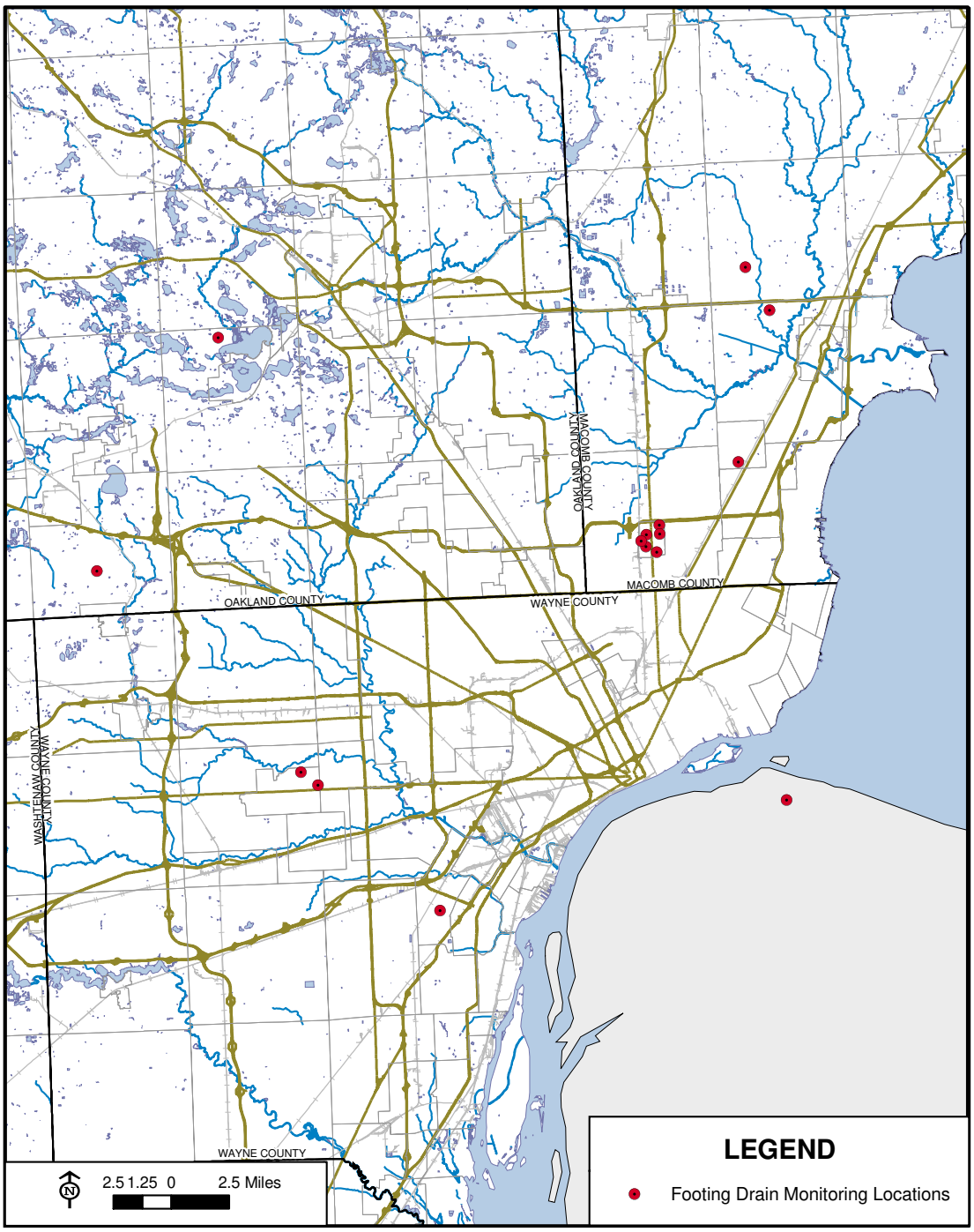
Several Southeast Michigan communities have ongoing or planned studies to measure FD flows, including:

- Ann Arbor (continuous)
- Auburn Hills (sanitary sewer monitoring)
- Fraser (sanitary sewer monitoring)

10.2.1 WWMP Footing Flow Field Monitoring Program

One of the tasks under the Wastewater Master Plan (WWMP) is to examine the impact of footing drain flows on SSOs within the DWSD service

Figure 10.5: Footing Drain Flow Monitor Locations



area. To better understand the range of flows expected from residential footing drains connected to sanitary systems, a monitoring program was conducted. The data collected during this study was used in conjunction with information reported from other studies to support a regional assessment of potential solutions to SSOs. The scope of this investigation is limited in both the number of locations being investigated and the duration of the study. As a result, the data set generated during the WWMP footing drain field investigation is intended to be used for planning activities of a regional scope. The data that was collected during the field monitoring program indicates that the flow rates from footing drains in some SSO-prone areas within the service area are significant and further studies by local communities are warranted.

In the fall of 2001 the six case study communities were asked to provide the names of local residents who were willing to participate in the footing drain field monitoring program. Volunteers were found in five of the six case study communities, as well as in additional communities. In total, footing drain flows were monitored at 15 single-family homes in the region. The first flow monitor was installed October 31, 2001 and the most recent installation was completed on April 23, 2002. Figure 10.5 shows the geographic distribution of the footing drain flow monitor locations.

Flow monitors were installed in eight communities in the DWSD service area. The largest number (six) were installed in Center Line, largely due to the cooperation received by that community during the selection of sites and installation of the monitors. Fourteen of the sites were located within the DWSD sanitary sewerage service area, with a single monitor installed in Ontario. The site in Ontario was initially selected as a temporary location early in the study in order to test the

Figure 10.6: Typical Footing Drain vs. Rainfall - Rapid Response

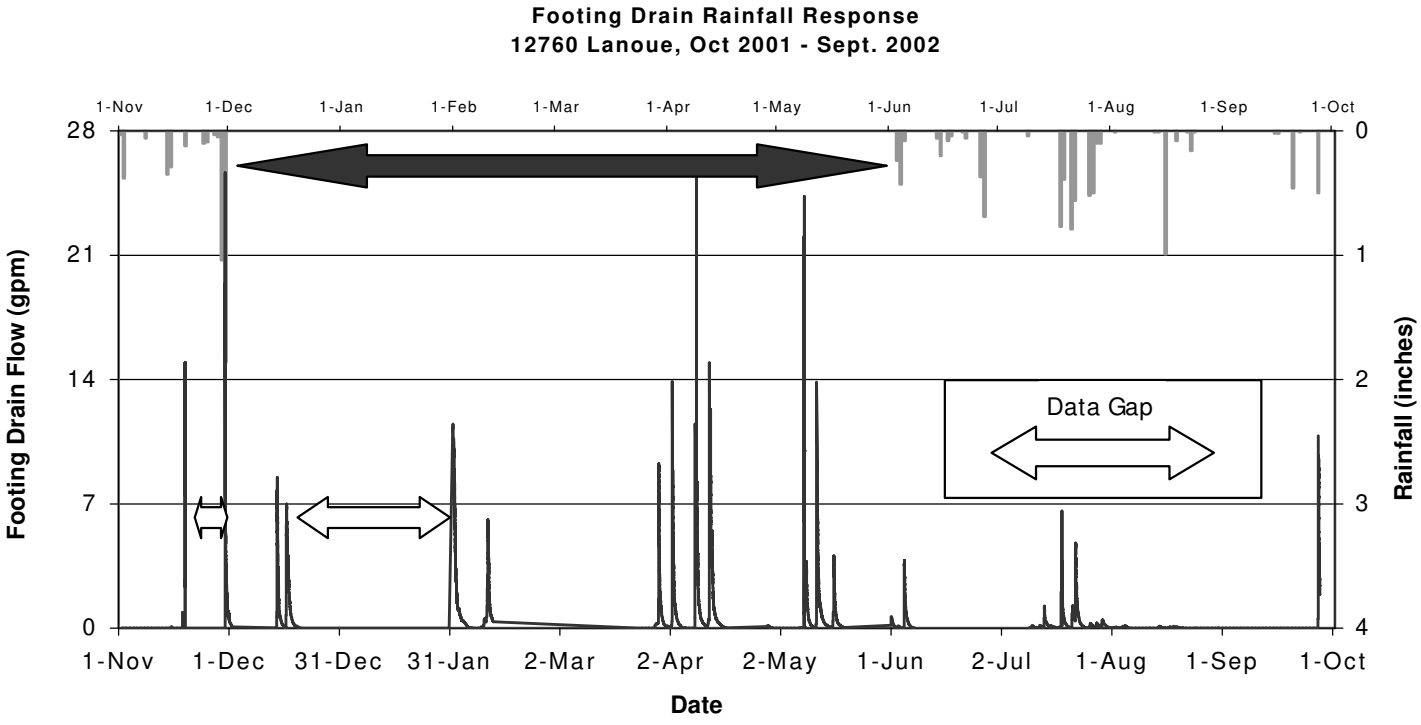
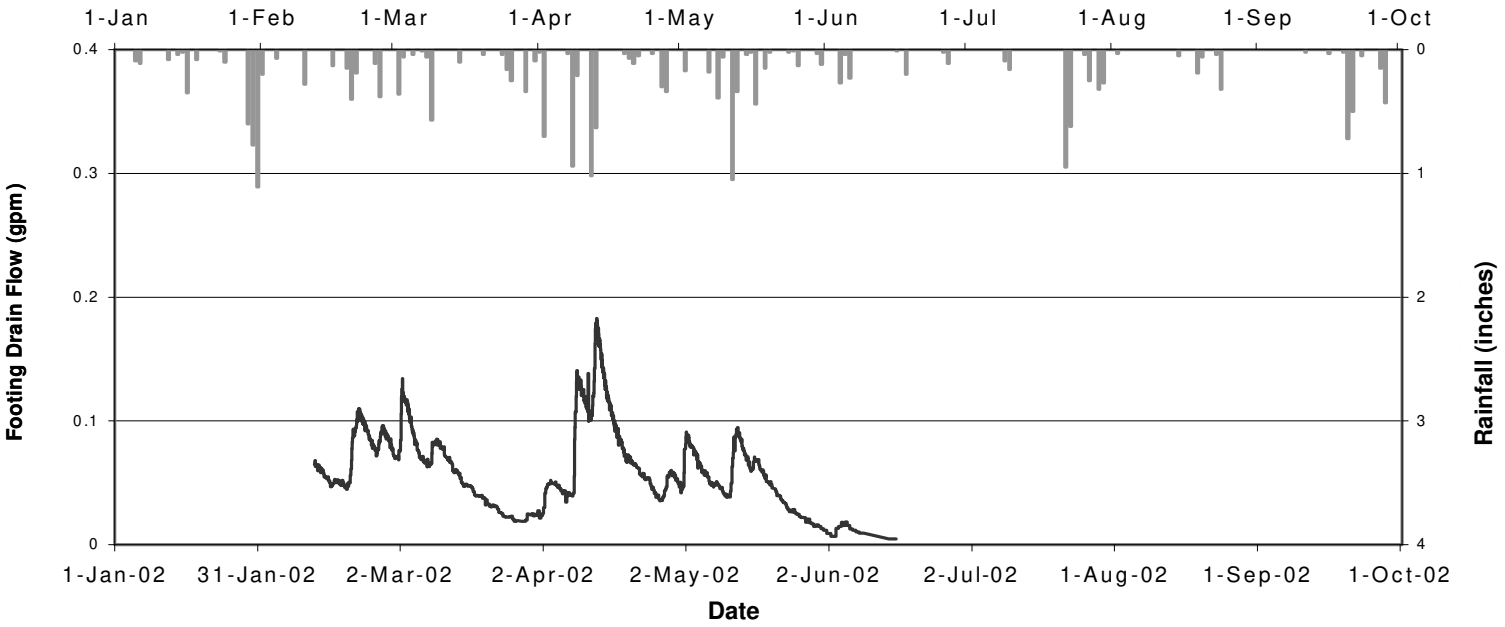


Figure 10.7: Typical Footing Drain vs. Rainfall-Extended Infiltration



equipment setup. Early results for the site in Ontario yielded the highest peak footing drain flows and as a result the monitor was left in place for the duration of the study.

The methodology and equipment used during the field monitoring program, as well as detailed information with respect to each of the individual monitoring locations, is contained in the *Footing Drain Technical Memorandum* on the CD which accompanies this report.

Footing drain flow rates were calculated for each of the sites and plotted with respect to time. Rainfall was added to each of the plots to enable a visual comparison of the flows generated by rain events. Rainfall data was used from SEMCOG, MCC, and AEW as described in the technical memorandum. The two key characteristics of these flow rate plots are the peak flow rate observed and the length of time the flow rates are elevated over normal base flow rates after a storm event. Given the numerous variables among the site conditions and each of the rainfall events, each site plot has unique characteristics. Figures 10.6 and 10.7 show the footing drain response plots for a site which exhibit large peaks which rapidly return to normal and a site where footing drain flow rates are elevated for an extended period of time after a rain event, respectively. These two sites represent extreme cases with most sites exhibiting characteristics similar to both these sites.

Analysis and interpretation of the footing drain flows was primarily focused on wet weather response but dry weather flow was also examined to a lesser extent in order to characterize base flow at the sites. As expected, dry weather footing drain flows are a function of site characteristics, with some sites having no flow during dry weather and others having a continuous flow at all times. Most notably, during the spring the dry weather flow at 8548 Dale was approximately 1800 gallons per day. The average dry weather

Figure 10.8: Peak Footing Drain Flow Response to Rainfall – All Sites

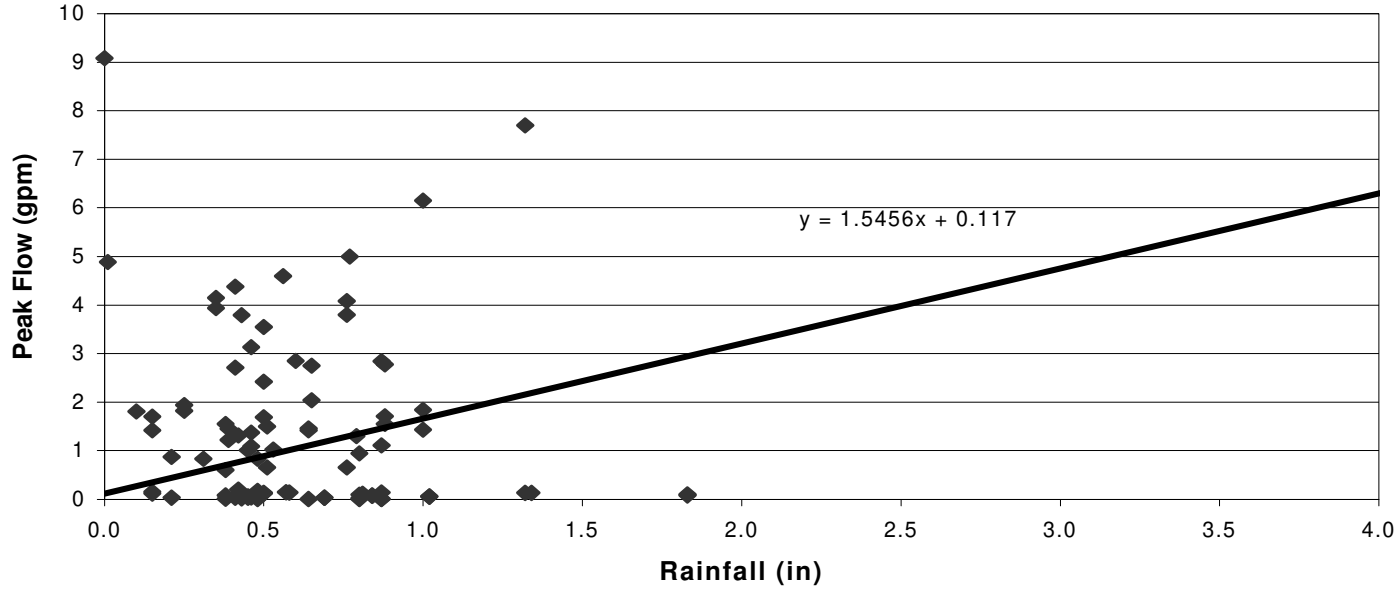
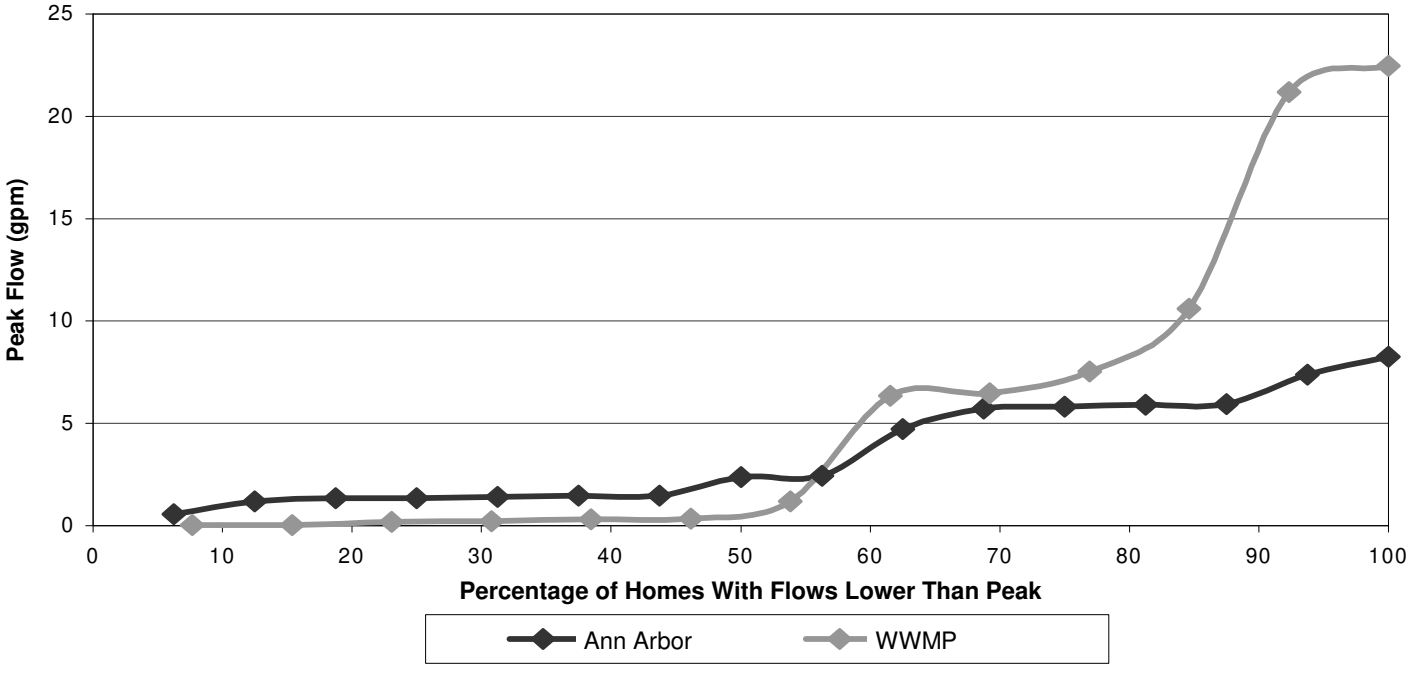


Figure 10.9: Distribution of Projected Peak Flows (4" event)



footing drain flow from the houses monitored is 172 gpd/ house. This average includes 8548 Dale (it is possible there is a leak in the water line to the house). The average not including this extreme value is 91 gpd/ house. As a comparison the volume of wastewater generated from a typical single-family home is 250 gallons per day.

Due to the variations in site characteristics, storm events, and seasonal variability, it is difficult to establish trends between each of the individual peak response plots. In order to establish an average peak flow response, the peak storm event flows for 13 of the sites was plotted. The fifteenth site, in Ontario, was not used to develop the trend line since it is not located in the service area and the peak flows recorded at that site are significantly higher than any of the other sites. A plot of the peak flow responses is shown in Figure 10.8.

In the absence of any extreme storm events, a linear trend line was fit to the peak flow data set. The projected average peak flow, for a 4-inch storm event is 6.4 gpm. This average is based on the estimated peak flows, from the 13 sites for all storm events. Events that yielded no flow were included in the average.

The distribution of peak flows for the Wastewater Master Plan data set was also examined. The projected peak footing drain flow resulting from a 4-inch storm event was tabulated for all of the sites but Coolidge. The distribution of peak flows is shown in Figure 10.9. Approximately half of the homes monitored during this study are expected to have no or extremely low responses to a significant storm event. The median peak flow is projected to be approximately 0.5 gallons per minute. Approximately 40 percent of the homes are expected to generate peak flows above the average projected peak flow rate of 6.2 gpm.

The distribution of peak flows from the Ann Arbor data set is also shown for comparison.

The distribution shows that high footing drain flows appear to be strongly related to geographic location. The sites in Fraser, Clinton Township and Macomb Township all exhibited high peak flow rates. These sites are near areas that have historically had problems with SSOs.

In addition to peak flows, the volume of water carried by footing drains due to storm events was examined. The volume of water added to sanitary sewer systems may be as or even more important than peak flow rates in large systems with long transport times. To facilitate comparisons between the various sites and storm events, the total flow over a 24-hour period was selected as a basis. Some sites exhibited increased footing drain flows rates for days after storm events while others experiences high peak flow rates which quickly returned to baseline levels.

The projected average volume generated during a 4-inch storm event was 1,250 gallons, over a 24-hour period. This is approximately five times the volume of sanitary wastewater that is typically generated in a single family home.

The variation in footing drain response to storm events during the summer and winter is important for this study since the results are being used to support modeling efforts as detailed in the *SSO Modeling and Calibration for SSO Case Studies* Technical Memorandum. Runoff and storm characteristics are different for growth (summer) and dormant (winter) periods.

A preliminary assessment of the seasonal variation in footing drain response to wet weather was completed, and is include in the *Footing Drain Technical Memorandum* on the CD that accompanies this report.

Key findings of the WWMP footing drain flow monitoring field program include:

- Approximately half of the homes monitored during this study are expected to have no, or extremely low, responses to a significant storm event.

Table 10.4: Summary of Footing Drain Flow Studies

Downstream System Metering	Wet Weather Sanitary Flow		Peak Drain Flows			Projected Footing Drain Flows	
	Peak Flow with FD (cfs/1000)	Peak Flow Without FD (cfs/1000)	Flow (gpm/house)	Rainfall (inches)	RDII from FD (%)	4" Linear	4" Log
Beverly Hills	1.56	0.38[5]	2.5	2.23"	76%	2.1	1.7
Oakland County 1967	1.76	0.53	1.8	1.86"	70%	3.8	3.0
1968 Study		---	2.1	---	---	---	---
Canton Township FD Removal	2.7	---	3.0	2.50"[3]	---	3.0	1.8
GDRSS Data[4]	2	0.63	1.5	2.0	69%	---	---
Clinton Township Data	3.3	---	3.3	---	---	---	---
Auburn Hills Data	1.8	---	1.1[3]	1.8 in/hr	70%	3.7	1.7
Center Line Data	1.7	---	1.7	---	---	---	---
West Lafayette, In	---	---	5[1]	---	---	---	---
Midland	---	---	5[1]	---	---	---	---

Direct Measurement Metering	Wet Weather Sanitary Flow			Observed Footing Drain Flows			Projected Footing Drain Flows	
	Peak Flow with FD (cfs/1000)	Peak Flow Without FD (cfs/1000)	Average Flow (gpm/house)	Peak Flow (gpm/ house)	Rainfall[2]	RDII from FD (percent)	4" Linear	4" Log
Ann Arbor 2000 FD Study	2.5	---	1.3	8.7	4.01"	60-90%	4.5	3.1
Dearborn Heights Study	3.0	---	0.55	1.0	0.87"	85-90%	2.2	1.1
WWMP Monitors	---	---	1.7	25.0	1.86"	---	3.0	1.7
Ann Arbor FD Monitoring 2002	----	---	1.0	8.5	1.81"	---	---	---
Toledo	---	---	0.3	3.3	1.72"	---	1.6	0.9
South Macomb Sanitary District:	---	---	---	3.2	1.73"	---	6.5	3.8
Simulated Rainfall Events	---	---	6.4	10.1	2.7 in/hr	---	--	---
Other Oakland County Studies	---	---	2.5 to 10	---	---	---	---	---

1- Based on model results, not direct metering. 2- Rainfall is displayed in total volume (") or intensity (in/hr) 3- Based on interpolation of data.
4. See 2nd paragraph of GDRSS analysis section 5- After removal of footing drain connections to sanitary sewer

• 35 percent of homes in the study generate more than the projected average footing drain flow of 1,250 gallons expected from a 4-inch storm event.

• Approximately 40 percent of the homes are expected to generate peak flows above the average projected peak flow rate of 6.2 gpm.

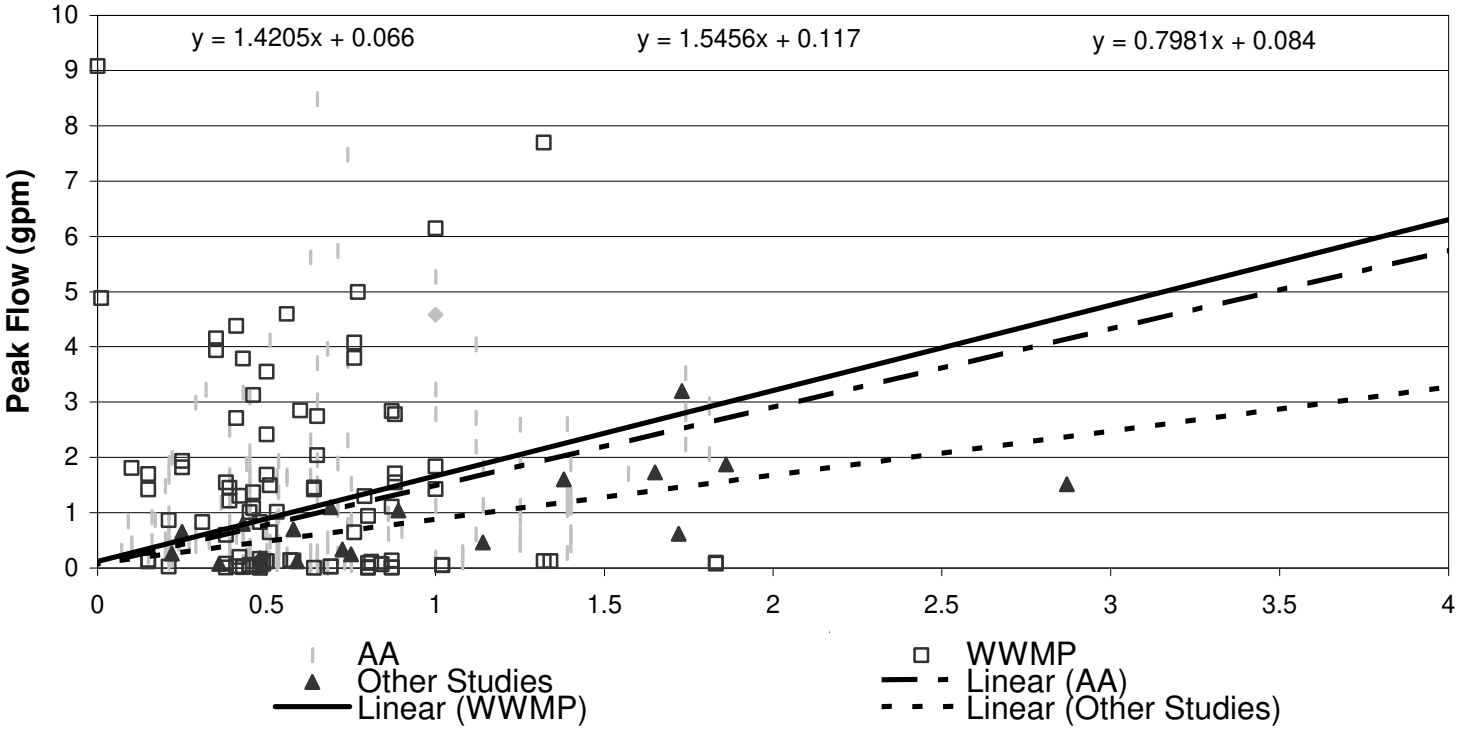
• The median volume generated is approximately 500 gpd or twice the typical sanitary wastewater volume for a single-family home.

• The projected average flow generated from an event during the growth (summer) season is 8.2 gpm while the projected flow from an event during the dormant (winter) season is 2.5 gpm.

• The median peak flow is projected to be less than 0.5 gallons per minute.

• The estimated average volume generated during a 4-inch storm in the growth season is 1,400 gallons and the estimated average volume generated during the dormant season is 1,200 gallons.

Figure 10.10: Reported Footing Drain Rainfall Responses



10.2.3 Summary of Footing Drain Flow Study Results

Table 10.4 contains a summary of key information from the footing drain studies discussed in this report. In many cases, obtaining values for this table required additional analysis of the original data, as detailed in the *Footing Drain Technical Memorandum*.

The summaries in this table represent measured values, many of which occurred during storm of less than two inches of total rainfall. Therefore the results represent minimum expected values. In some cases extrapolating to larger events can lead to predicted flows two times or more than was measured.

A significant amount of information regarding footing drain flows, has been consolidated in the *Review of Footing Drain Disconnection Projects.* The sources of information used include: published study reports, a large data set from an ongoing study being conducted by Ann Arbor; and the results of the WWMP footing drain field monitoring program. Figure 10.10 shows the peak footing drain flow rates from these studies on a single graph. A separate linear trend line was generated for each of the three sets. The trends for the Ann Arbor data set and the WWMP are in close agreement with projected flow rate for a 4-inch inch storm of 5.8 gpm and 6.2 gpm, respectively. The projection for the other studies is considerably less at 3.2 gpm. Considering the results from all of the studies, the projected peak footing drain flow rate is approximately 5.5 gpm for a 4-inch storm event.

Key findings consolidated from the footing drain studies include:

• Areas with footing drains appear to have peaking factors three to four times higher than areas

Table 10.5: Summary of Projected Footing Drain Flows for Storm Events

Design Storm	Rainfall (in)	Footing Drain Flow (gpm)		
		WWMP	Ann Arbor	All Data
1-mo., 24 hr.	0.62	1.04	0.95	0.92
1-yr, 1-hr.	1	1.6	1.49	1.43
10-yr, 1-hr.	1.8	2.78	2.62	2.5
1-yr, 24-hr.	2.2	3.37	3.19	3.03
10-yr, 24-hr.	3.6	5.44	5.18	4.91
25-yr, 24-hr.	4	6.03	5.75	5.45
100-yr, 24-hr.	4.7	7.06	6.74	6.39

without footing drain connections.

- Peak wet weather flows range from 0.8 to 4.9 cfs/ 1000 people. This is significantly higher than the typical design criterion of 0.4 cfs/ 1000 people.

- Footing drains can account for 60-90 percent of wet weather flow in connected areas (as long as there are no other significant RDII problems).

- The effective wet weather peak in sewers attributed to footing drains depends on the amount of rainfall and other site-specific parameters, however, during large storms (greater than 3 inches total rainfall) average footing drain flows can range from 2.5 to 10 gpm per house. Individual houses can contribute significantly higher amounts (up to 25 gpm)

A summary of footing drain flows for a variety of storm events, ranging from the 1-month, 24-hour to the 100-yr, 24-hour event is shown in Table 10.5. The flows listed were generated using the linear fits, as detailed in the *Footing Drain Technical Memorandum.*

11: Local Alternatives Analysis

Five local alternatives were evaluated during the SSO study. They are:

- Short-Term Control Measures
- Local Storage
- Source Reduction (Local footing drain disconnection)
- Treatment
- Transport Capacity

In addition to the analysis presented in this chapter, information on local alternatives can be found in the Technical Memorandum *"Local Alternatives for SSO Control"* on the CD which accompanies this report.

11.1 Local Alternatives and Analysis Approach

Short-Term Control Measures

Short-term control measures are viewed as temporary solutions to the sanitary sewer overflow problem. On October 23, 2001, the Michigan Department of Environmental Quality Surface Water Quality Division sent a letter to all municipalities with sanitary sewers. Attached to the letter was a list of 13 short-term SSO control measures that can and should be implemented in approximately 36 months to minimize and partially control sanitary sewer overflows associated with capacity deficiencies or excessive wet weather flows. The 13 short-term SSO control measures, which include inflow and infiltration reductions, sewer use ordinances, and leak detection, are defined in Chapter 13. In all six case study communities, short-term control measures have either been completed or are ongoing.

In some cases, recent flow and rainfall data was collected from the case study communities. The flow and rainfall data was then used in the development of the case study community models. Any short-term control measures that were completed or ongoing during the data collection time period will be reflected in the flow and rain data and thus will be reflected in the model. Otherwise, the results of short-term control measures for each case study will be explained qualitatively, but not quantitatively (See Corrective Actions Completed and Underway – Chapters 4-9).

Local Storage

The local storage alternative consists of placing storage basins in the system to temporarily store sewage during heavy rainfall events. This would enable peak flows to be reduced downstream of the basins by storing it until the rainfall intensity has been reduced.

The local storage alternative has several advantages. Most importantly, additional peak flows are not moved downstream into the trunk sewer system. This option does not require additional downstream construction, which helps to offset its cost.

The local storage alternative also has disadvantages. The storage basins must be properly maintained. Therefore, access is required. There are additional costs associated with the maintenance. Also, there is potential for odors in the storage basin.

Local storage models were simulated for the seven design storms in both growth (summer) and dormant (winter) conditions. In three case study communities, two storage volumes were calculated for each design storm. The first volume was the volume needed to prevent SSOs in the case study communities. The second volume was the volume needed to prevent SSOs and contract exceedances in the case study communities. In three case study communities, only the volume required to prevent SSOs and contract exceedances was found.

Source Reduction (Local Footing Drain Disconnection)

The source reduction alternative, or footing drain disconnection alternative, prevents storm water from reaching the sanitary sewer system. A sump pump would be installed in each home that has the footing drain disconnected. The sump pump would direct all storm water into the backyard or storm sewer system. Reducing the volume of water that enters the sanitary sewer system reduces the peak flows during a storm and therefore reduces surcharging.

The footing drain disconnection alternative has several advantages. Source reduction decreases the amount of storm water unnecessarily treated. Also, it provides protection against storms larger than the selected design storm as it also prevents a portion of the rainfall over the design event from entering the sanitary sewer system. Also, there will be limited construction in the street. Construction would take place between the sidewalk and the street. Finally, footing drain disconnection allows for unique implementation programs, such as a time-of-sale ordinance, which may be financially more attractive. These types of programs can be implemented over a longer time period (20 years).

The footing drain disconnection alternative also has several disadvantages. First, it requires construction in basements and lawns. Construction on private property can be difficult. Second, homeowners are responsible for maintaining the sump pumps that would be installed along with the footing drain disconnect. Third, the sump pumps must be connected to the storm sewer system.

Footing drain disconnections have an estimated cost of $6,300 per home, including engineering and construction costs. This estimate is based on ongoing projects in southeast Michigan. It includes sump pump installation, installing a new curb drain along the street that ties into the existing storm system, and installing a new house lead from the sump pump to the new curb drain. However, there are alternative approaches that can be as much as a half to a third of this cost. An example is a Canton Township system that installs a pump that allows dry weather flow to continue to the sanitary sewer, but routes wet weather flow to the backyard. This may eliminate the need for an additional storm system, as the backyard is already wet, and therefore the discharge is not as much of a nuisance. Garden City is piloting a similar approach that is estimated to cost $2,500 per house.

Table 11.1: Average Peak Footing Drain Flows

Design Event (inches)	Average Peak Footing Drain Flow (gpm)
1-Month, 24-Hr. (0.62)	1.1
1-Year, 1-Hr. (1.0)	1.7
10-Year, 1-Hr. (1.8)	3.3
1-Year, 24-Hr. (2.2)	2.1
10-Year, 24-Hr. (3.6)	3.5
25-Year, 24-Hr. (4.0)	4.0
100-Year, 24-Hr. (4.7)	4.6

Studies have shown footing drains are responsible for up to 70-90 percent of rain dependent inflow and infiltration. However, since the actual value varies by community, footing drain flows were modeled on a case-by-case basis. In order find the amount of RDII from footing drains for each community, an estimate of the expected average peak footing-drain flow was used. These rates are given in Table 11.1 and are based on the work detailed in the *Summary of Footing Drain Flow Studies* technical memorandum which can be found on the CD which accompanies this report.

Local models were used to compute the sewer system response to design events. The number of homes needed to reduce the these hydrographs in

order to prevent SSO and meet the contract capacity was found based on the expected average peak footing drain flows. The details of this work are explained in the *Local Alternatives for SSO Control* technical memorandum on the CD which accompanies this report.

The effects of footing drain disconnection also depend on homeowner participation. For each community, the number of homes with footing drains was estimated. The degree of homeowner participation needed depended on the design storm and local conditions. In some cases, 100 percent of homeowner participation is required in order for footing drain disconnection to be an effective local alternative.

Treatment

Like the local storage alternative, the treatment alternative consists of placing storage basins in the system to temporarily store sewage during heavy rainfall events. Unlike the local storage alternative, the treatment alternative does not allow for the complete storage of the SSO and/ or contract exceedance volume. Rather, this alternative would allow for a minimum amount of contact time in order to treat the sewage before it is discharged.

Under the treatment alternative, sanitary sewer overflows would not necessarily be prevented. However, the sanitary sewage would first be treated before it is released and potentially overflowed. This could range from screening and disinfection techniques to more advanced techniques such as ballasted flocculation and the use of other physical and chemical treatment options to meet secondary treatment standards. Current regulations require full secondary treatment for any sanitary flow. In order for these alternatives to be possible, some leeway would need to be given for achieving 85 percent removal for sanitary flows that have been diluted with rainfall.

Locally, the cities of Center Line, Fraser, and Melvindale looked into treatment alternatives. Center Line submitted a grant application to the Michigan Department of Environmental Quality Surface Water Quality Division for a Peak Excess Flow Treatment Facility (PEFT) Pilot Project.

Due to the regulatory uncertainty regarding the possibility of this alternative actually being a viable and/ or legal solution to sanitary sewer overflows, the treatment and discharge alternative is not being modeled.

Transport Capacity

The transport capacity alternative can either consist of building relief sewers or pipe bursting. Relief sewer construction consists of placing a parallel pipe next to a pipe that is already in the ground and is of insufficient capacity. This will enable the flow that is currently in one pipe to be divided between two pipes.

The relief sewer option has several advantages. First, construction is performed in existing right-of-way and easements. Second, contractors are familiar with this construction method.

The relief sewer option also has disadvantages. Construction causes disruption in the streets. Also, larger peak flows would impact the interceptor system. This could mean additional relief pipe or other construction would have to be completed further downstream in the sewer system.

Pipe bursting consists of a bursting tool that splits the existing pipe while simultaneously installing a new High Density Polyethylene pipe of the same size or larger where the old pipe existed. The pipe bursting tool is designed and manufactured to force its way through existing pipe materials by fragmenting the pipe and compressing the old pipe sections into the surrounding soil as it progresses. Pipe bursting more than two diameter sizes is becoming more common. However, this depends upon existing pipe material, soil conditions, and advances in technology.

As an advantage, pipe bursting construction has

less of an impact on traffic than relief pipe construction. Pipe bursting can also be completed in a relatively short time. Even the open trench option may be beneficial, if there is limited space to place a relief sewer.

As a disadvantage, access pits would be required to connect homes to the new pipe. A specialized contractor would be needed for all pipe bursting. Also, larger peak flows could impact the interceptors. This could mean increased construction and costs downstream.

It is important to note that this is considered a local alternative because it eliminates a local SSO. However, increasing transport capacity also increases flows downstream of the local community. Therefore, increasing transport capacity is modeled as part of the regional alternatives portion of the SSO study (Chapter 12).

11.2 Local Storage Costs

The local storage alternative costs were calculated for the six case study communities. Storage volumes were based on the amount of overflow found for seven different design storm for each case study in both dormant (winter) and growth (summer) conditions. The seven design storms are the 1-month, 24-hour storm (0.617 inches); the 1-year, 1-hour storm (1.0 inches); the 10-year, 1-hour storm (1.8 inches); the 1-year, 24-hour storm (2.2 inches); the 10-year, 1-hour storm (3.6 inches); the 25-year, 24-hour storm (4.0 inches); and the 100-year, 24-hour storm (4.7 inches). For more information on the storage volumes, see Chapters 4-9 as well as the *Local Alternatives for SSO Control* technical memorandum, which accompanies this report.

Capital costs for storage were based on the cost curve given in Figure 11.1. This curve was based on the costs to build similar basins in the southeast Michigan area and is detailed in the *Local Alternatives for SSO Control* technical memorandum. A present worth analysis including the cost of treatment and annual operation and maintenance costs was made for a 20-year cost analysis period.

In Center Line, Fraser, and Clinton Twp. local storage costs were calculated for eliminating SSOs and contract exceedances (Tables 11.2-11.4). For Melvindale, Allen Park, and Garden City local storage costs were calculated for eliminating contract exceedances only (Tables 11.5-11.7).

11.3 Local Source Reduction (F.D. Disconnection) Costs

Footing drain disconnection costs were calculated for the six case study communities. Footing drain disconnection costs were based on the reduction of peak flow found for seven different design storm for each case study in both dormant (winter) and growth (summer) conditions. The seven design storms are the 1-month, 24-hour storm (0.617 inches); the 1-year, 1-hour storm (1.0 inches); the 10-year, 1-hour storm (1.8 inches); the 1-year, 24-hour storm (2.2 inches); the 10-year, 1-hour storm (3.6 inches); the 25-year, 24-hour storm (4.0 inches); and the 100-year, 24-hour storm (4.7 inches). For more information on footing drain disconnection, see Chapter 10 as well as the *Local Alternatives for SSO Control* technical memorandum on the CD which accompanies this report.

Capital costs for storage were based on the number of homes disconnected. The estimated cost of disconnecting the footing drains from the sanitary sewer and re-directing the flows into the storm system was $6,300 per house. For each case study community, the number of homes with footing drains connected to the sanitary sewer system was estimated: Center Line, 1,978 homes; Clinton Township, 2,507 homes; Fraser, 1,367 homes; Melvindale, 4,165 homes; Allen Park, 1,325 homes; and Garden City, 8,400 homes. If an overflow continued to occur after all homes were disconnected, a storage basin was constructed to handle the excess flows. Annual operation and maintenance

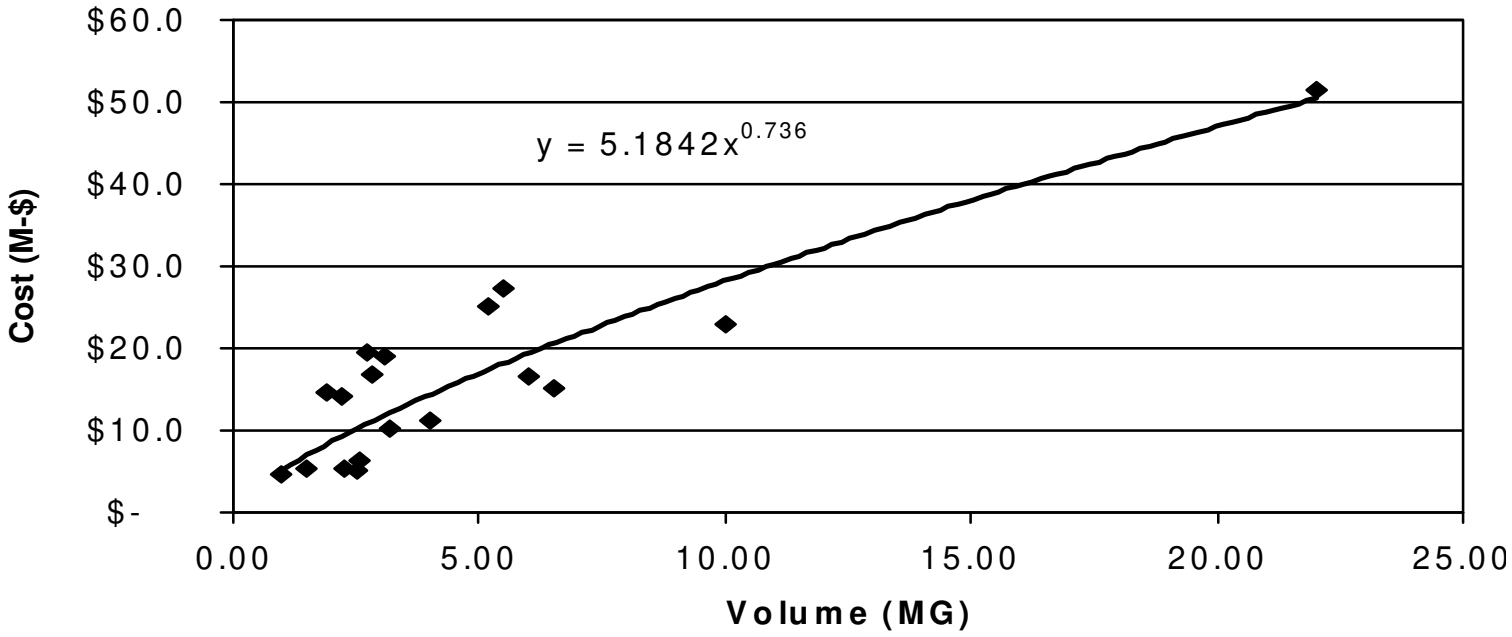
costs including sump pump maintenance were factored in. Annual operation and maintenance benefits including a reduction of flow treated at the wastewater treatment plant were also included. The footing drain disconnection costs reflect a present worth cost over a 20-year cost analysis period.

In Center Line, Clinton Township and Fraser, footing drain disconnection costs were calculated for eliminating SSOs and for eliminating SSOs and contract exceedances (Tables 11.8-11.10). In Melvindale, Allen Park and Garden City, footing drain disconnection costs were calculated for eliminating SSOs and contract exceedances (Tables 11.11-11.13).

11.4 Summary of Costs

Two of the key storms being studied for the SSO study are the 10-year, 1-hour design storm and the 25-year, 24-hour design storm. Cost summaries for both storms are provided in Table 11.14 and Table 11.15.

Figure 11.1: Storage Cost Curve



Basin	Year	Volume (MG)	Cost ($M)	2002 cost ($M)
Dearborn Heights		2.70	$19.5	$19.5
Hubbell-Southfield		22.00	$51.4	$51.4
Puritan-Fenkell		2.80	$16.7	$16.7
Seven Mile		2.20	$14.0	$14.0
Inkster		3.10	$19.0	$19.0
Acacia Park		4.00	$11.1	$11.1
Bloomfield Village		10.00	$22.8	$22.8
Birmingham		5.50	$27.3	$27.3
Redford		1.90	$14.6	$14.6
River Rouge		5.20	$25.1	$25.1
Farmington	1990	3.2	$7.3	$10.2
Livonia	1988	1.5	$3.7	$5.4
Wayne	1995	1	$3.8	$4.6
Kenallwood	1989	2.26	$3.8	$5.4
Lathrup Village	1990	2.57	$4.5	$6.3
St. Clair	2002	2.5	$5.0	$5.0
Grosse Ille Twp.	2002	6.5	$15.1	$15.1
SHVUA	2003	6	$16.7	$16.7

Table 11.2: Center Line Storage Costs (millions of dollars)

Design Storm (inches)	Designed to Prevent SSOs Storage Costs		Designed to Prevent Contract Exceedances Storage Costs	
	Growth Conditions	Dormant Conditions	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62")	0	0	0	0
1-Year, 1-Hour (1.0")	0	0	0	$3.4
10-Year, 1-Hour (1.8")	0	$5.6	0	$7.7
1-Year, 24-Hour (2.2")	0	$7.8	$3.8	$10.3
10-Year, 24-Hour (3.6")	$6.3	$13.7	$8.4	$17.2
25-Year, 24-Hour (4.0")	$7.4	$15.1	$9.8	$19.0
100-Year, 24-Hour (4.7")	$9.2	$17.5	$11.8	$21.9

Table 11.3: Clinton Twp. Storage Costs (millions of dollars)

Design Storm (inches)	Designed to Prevent SSOs Storage Costs		Designed to Prevent Contract Exceedances Storage Costs	
	Growth Conditions	Dormant Conditions	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62")	0	0	$3.6	$7.5
1-Year, 1-Hour (1.0")	0	$3.6	$5.1	$12.8
10-Year, 1-Hour (1.8")	0	$8.0	$8.0	$21.7
1-Year, 24-Hour (2.2")	0	$5.6	$9.2	$25.6
10-Year, 24-Hour (3.6")	$4.7	$13.4	$14.1	$40.4
25-Year, 24-Hour (4.0")	$5.1	$15.6	$15.6	$44.5
100-Year, 24-Hour (4.7")	$6.0	$19.5	$18.1	$51.2

Table 11.4: Fraser Storage Costs (millions of dollars)

Design Storm (inches)	Designed to Prevent SSOs – Storage Costs		Designed to Prevent Contract Exceedances – Storage Costs	
	Growth Conditions	Dormant Conditions	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62")	0	0	$3.0	$4.2
1-Year, 1-Hour (1.0")	$3.5	$5.7	$4.7	$7.0
10-Year, 1-Hour (1.8")	$5.9	$9.3	$7.2	$12.3
1-Year, 24-Hour (2.2")	$6.4	$9.7	$8.6	$14.9
10-Year, 24-Hour (3.6")	$10.2	$16.7	$14.1	$23.1
25-Year, 24-Hour (4.0")	$10.6	$18.7	$15.7	$25.4
100-Year, 24-Hour (4.7")	$12.9	$22.2	$18.3	$28.8

Table 11.5: Melvindale Storage Costs Designed to Prevent Contract Exceedances (millions of dollars)

Design Storm (inches)	Storage Costs	
	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62")	$3.9	$6.5
1-Year, 1-Hour (1.0")	$7.0	$10.8
10-Year, 1-Hour (1.8")	$12.0	$17.0
1-Year, 24-Hour (2.2")	$13.8	$18.9
10-Year, 24-Hour (3.6")	$20.2	$27.6
25-Year, 24-Hour (4.0")	$21.9	$29.9
100-Year, 24-Hour (4.7")	$24.8	$33.8

Table 11.6: Allen Park Storage Costs Designed to Prevent Contract Exceedances (millions of dollars)

Design Storm (inches)	Storage Costs	
	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62")	0	$2.5
1-Year, 1-Hour (1.0")	$3.5	$6.5
10-Year, 1-Hour (1.8")	$5.7	$10.7
1-Year, 24-Hour (2.2")	$5.7	$11.4
10-Year, 24-Hour (3.6")	$9.2	$19.2
25-Year, 24-Hour (4.0")	$10.3	$21.3
100-Year, 24-Hour (4.7")	$12.2	$24.8

Table 11.7: Garden City Storage Costs (millions of dollars)

Design Storm (inches)	Storage Costs	
	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62")	0	$5.1
1-Year, 1-Hour (1.0")	$3.9	$18.9
10-Year, 1-Hour (1.8")	$13.1	$37.9
1-Year, 24-Hour (2.2")	$15.6	$41.9
10-Year, 24-Hour (3.6")	$29.0	$68.1
25-Year, 24-Hour (4.0")	$32.5	$75.1
100-Year, 24-Hour (4.7")	$38.7	$86.9

Table 11.8: Center Line FDD Costs (millions of dollars)

Design Storm (inches)	Designed to Prevent SSOs				Designed to Prevent Contract Exceedances			
	Disconnection Costs				Disconnection Costs			
	Growth		Dormant		Growth		Dormant	
	Homes	Cost	Homes	Cost	Homes	Cost	Homes	Cost
1-Month, 24-Hour (0.62")	0	0	0	0	0	0	0	0
1-Year, 1-Hour (1.0")	0	0	0	0	13	$0.1	1978	$17.5
10-Year, 1-Hour (1.8")	0	0	1978	$16.8	1263	$9.1	1978	$22.8
1-Year, 24-Hour (2.2")	0	0	1978	$16.4	1978	$16.9	1978	$24.1
10-Year, 24-Hour (3.6")	1117	$8.0	1978	$23.2	1978	$21.2	1978	$31.6
25-Year, 24-Hour (4.0")	1387	$10.0	1978	$24.9	1978	$22.0	1978	$33.3
100-Year, 24-Hour (4.7")	1857	$13.3	1978	$28.5	1978	$24.3	1978	$37.0

Table 11.9: Clinton Twp. FDD Costs* (millions of dollars)

Design Storm (inches)	Designed to Prevent SSOs				Designed to Prevent Contract Exceedances			
	Disconnection Costs				Disconnection Costs			
	Growth		Dormant		Growth		Dormant	
	Homes	Cost	Homes	Cost	Homes	Cost	Homes	Cost
1-Month, 24-Hour (0.62")	0	0	0	0	393	$2.8	1304	$9.4
1-Year, 1-Hour (1.0")	0	0	1627	$11.7	1382	$9.9	2507	$24.1
10-Year, 1-Hour (1.8")	0	0	2507	$20.6	1690	$12.1	2507	$29.4
1-Year, 24-Hour (2.2")	0	0	1998	$16.5	2434	$17.5	2507	$30.3
10-Year, 24-Hour (3.6")	956	$6.9	2507	$27.0	2507	$21.2	2507	$39.7
25-Year, 24-Hour (4.0")	1109	$8.0	2507	$28.7	2507	$20.6	2507	$41.7
100-Year, 24-Hour (4.7")	1384	$9.9	2507	$32.3	2507	$21.7	2507	$46.5

Table 11.10: Fraser FDD Costs (millions of dollars)

Design Storm (inches)	Designed to Prevent SSOs				Designed to Prevent Contract Exceedances			
	Disconnection Costs				Disconnection Costs			
	Growth		Dormant		Growth		Dormant	
	Homes	Cost	Homes	Cost	Homes	Cost	Homes	Cost
1-Month, 24-Hour (0.62")	0	0	0	0	558	$4.0	820	$5.9
1-Year, 1-Hour (1.0")	814	$6.2	1367	$13.0	1367	$9.8	1367	$14.3
10-Year, 1-Hour (1.8")	1346	$9.7	1367	$15.6	1367	$12.8	1367	$16.8
1-Year, 24-Hour (2.2")	1367	$13.3	1367	$14.7	1367	$14.7	1367	$17.2
10-Year, 24-Hour (3.6")	1367	$15.3	1367	$17.8	1367	$16.8	1367	$21.7
25-Year, 24-Hour (4.0")	1367	$15.6	1367	$18.6	1367	$17.2	1367	$22.8
100-Year, 24-Hour (4.7")	1367	$16.6	1367	$20.5	1367	$18.4	1367	$25.4

Table 11.11: Melvindale FDD Costs Designed to Prevent SSOs (millions of dollars)

Design Storm (inches)	Disconnection Costs			
	Growth		Dormant	
	Homes	Cost	Homes	Cost
1-Month, 24-Hour (0.62")	1792	$12.9	2869	$20.9
1-Year, 1-Hour (1.0")	4499	$35.3	4499	$38.7
10-Year, 1-Hour (1.8")	4499	$39.7	4499	$42.1
1-Year, 24-Hour (2.2")	4499	$39.5	4499	$40.6
10-Year, 24-Hour (3.6")	4499	$44.4	4499	$44.0
25-Year, 24-Hour (4.0")	4499	$45.6	4499	$44.4
100-Year, 24-Hour (4.7")	4499	$47.7	4499	$46.6

Table 11.12: Allen Park FDD Costs Designed to Prevent SSOs (millions of dollars)

Design Storm (inches)	Disconnection Costs			
	Growth		Dormant	
	Homes	Cost	Homes	Cost
1-Month, 24-Hour (0.62")	0	0	822	$5.9
1-Year, 1-Hour (1.0")	1325	$12.4	1325	$15.5
10-Year, 1-Hour (1.8")	1325	$14.1	1325	$18.9
1-Year, 24-Hour (2.2")	1325	$14.3	1325	$17.4
10-Year, 24-Hour (3.6")	1325	$16.5	1325	$23.3
25-Year, 24-Hour (4.0")	1325	$17.1	1325	$24.7
100-Year, 24-Hour (4.7")	1325	$18.6	1325	$27.6

Table 11.13: Garden City FDD Costs Designed to Prevent SSOs (millions of dollars)

Design Storm (inches)	Disconnection Costs			
	Growth		Dormant	
	Homes	Cost	Homes	Cost
1-Month, 24-Hour (0.62")	0	0	3861	$27.8
1-Year, 1-Hour (1.0")	3011	$21.6	8400	$71.6
10-Year, 1-Hour (1.8")	8084	$58.1	8400	$83.6
1-Year, 24-Hour (2.2")	7598	$54.6	8400	$85.1
10-Year, 24-Hour (3.6")	8400	$66.9	8400	$102.7
25-Year, 24-Hour (4.0")	8400	$68.1	8400	$106.5
100-Year, 24-Hour (4.7")	8400	$70.1	8400	$115.1

Table 11.14: 10-Year, 1-Hour Design Storm (1.8-in.) Costs (millions of dollars)

Community	Growth Conditions		Dormant Conditions	
	Storage Cost	FDD Cost	Storage Cost	FDD Cost
Center Line (SSO)	0	0	$5.6	$16.8
Center Line (Con. Ex.)	0	$9.1	$7.7	$22.8
Clinton Twp. (SSO)	0	0	$8.0	$20.6
Clinton Twp. (Con. Ex.)	$8.0	$12.1	$21.7	$29.4
Fraser (SSO)	$5.9	$9.7	$9.3	$15.6
Fraser (Con. Ex.)	$7.2	$12.8	$12.3	$16.8
Melvindale (Con. Ex.)	$12.0	$39.7	$17.0	$42.1
Allen Park (Con. Ex.)	$5.7	$14.1	$10.7	$18.9
Garden City (Con. Ex.)	$13.1	$58.1	$37.9	$83.6

Note: (SSO) is designing to prevent SSOs. (Con. Ex.) is designing to prevent contract exceedances and SSOs.

Table 11.15: 25-Year, 24-Hour Design Storm (4.0-in.) Costs (millions of dollars)

Community	Growth Conditions		Dormant Conditions	
	Storage Cost	FDD Cost	Storage Cost	FDD Cost
Center Line (SSO)	$7.4	$10.0	$15.1	$24.9
Center Line (Con. Ex.)	$7.7	$22.0	$19.0	$33.3
Clinton Twp. (SSO)	$5.1	$8.0	$15.6	$28.7
Clinton Twp. (Con. Ex.)	$15.6	$20.6	$44.5	$41.7
Fraser (SSO)	$10.6	$15.6	$18.7	$18.6
Fraser (Con. Ex.)	$15.7	$17.2	$25.4	$22.8
Melvindale (Con. Ex.)	$21.9	$45.6	$29.9	$44.4
Allen Park (Con. Ex.)	$10.3	$17.1	$21.3	$24.7
Garden City (Con. Ex.)	$32.5	$68.1	$75.1	$106.5

Note: (SSO) is designing to prevent SSOs. (Con. Ex.) is designing to prevent contract exceedances and SSOs.

Chapter 12 Regional SSO Control Analysis

12.1 Introduction

In addition to the local solutions investigated for the six case studies, the feasibility of regional solutions for SSO control has been evaluated. Regional solutions for SSO control involve conveying excess wet weather volumes to the DWSD interceptor system for the six case study communities. This section summarizes the analysis of various regional alternatives analyzed for SSO control. Further detail on this work can be found in the *Regional SSO Control Analysis* on the CD that accompanies this report.

Also investigated is the extent to which some communities are already discharging excess wet weather flows to the regional system. Many communities have excess wet weather flows, but do not have reported SSOs or basement flooding. Amount of flow over contract was reviewed to quantify the extent of this phenomenon. In addition, the potential for providing additional capacity for Wayne and Oakland counties was investigated.

12.2 Approach

The WWMP Hydraulic Model was used to review the regional impact of accepting these increased flows into the regional collection system. These impacts were quantified in terms of changes in the following items:

- Amount of flows accepted by the regional system,
- Estimates of CSO displaced in the regional system (determined by change in CSO volumes),
- Change in peak hydraulic gradeline for selected locations,
- Amount of flows directed to the WWTP.

The peak hydraulic grade lines (HGLs) simulated were reviewed in critical locations for potential to cause adverse impacts such as basement and street flooding. Modeled peak HGLs were compared to critical HGLs to determine whether an alternative solution would contribute to flooding. Critical HGLs were obtained from Detroit's Long-Term CSO Control Plan for major interceptors. If the modeled HGLs were at or above a critical HGL, under existing conditions, then no more flow was allowed, no matter how small the additional flow might be. Likewise, if an alternative resulted in the critical HGL being exceeded, then that alternative was considered to be unfeasible.

Information available from local engineering studies was used as available to understand the local improvements that might be required to transport the flows to the regional system. Preliminary estimates of costs associated with these improvements were developed to try to quantify the true cost of conveying excess wet weather flows downstream as opposed to handling the flows through local solutions.

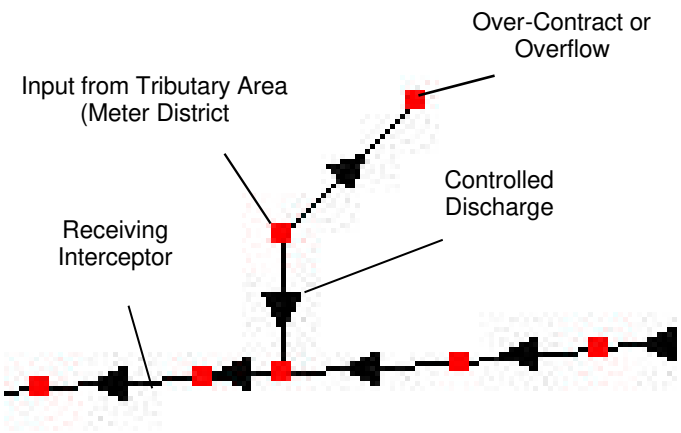
12.3 WWMP Model Configuration and Assumptions

12.3.1 General

The GDRSS Model as released in 1999 was configured for baseline (1998) and future conditions. The future condition version included all known facilities planned or being constructed at the time of the model development. The GDRSS Model was updated in 2001 to incorporate new information on various CSO Control Plan components and other facilities within the regional system since the model was released in 1999. This update included the CSO Control Plan elements such as the screening and disinfection facilities and revising the representation of the number and locations of the in-system storage facilities.

Further updates have been made to the model for

Figure 12.1: Controlled Discharge



purposes of the regional analysis as well as other analyses needed by the WWMP project. The primary update to the model consisted of developing submodels for the Clinton-Oakland sewer district and the Macomb sewer district. Previously these two districts were each represented by one subarea, and the interceptors were not explicitly included. As part of this update, the representation of the Northeast Pump Station (NEPS) was revised to include a new variable speed pump that is to be added at that station. With this upgrade, the firm capacity of the station is now 400 cfs.

These updates provide the level of detail required for the analysis of the three case studies in the Macomb District. The model with these updates is referred to as the WWMP Model for this project. The model includes accounting for the expansion of the GWK (Twelve Towns) Basin. It does not include the connecting sewer that will connect the Upper Rouge Tunnel with the Dearborn Tunnel, but it does include the two tunnels as envisioned during the development of the future condition. It also uses dry weather flow levels as originally projected to 2020; these have not been updated at this time for these simulations.

12.3.2 Integration of Case Studies

The model was further modified to integrate additional details for the six case studies as available. These details included any subarea delineation or additional hydraulic information that was developed in modeling these areas for review of local alternatives. Garden City was already incorporated into the model and required no additional changes. Both Center Line and Allen Park detailed models included additional information on the connecting sewers as well as the configuration of the overflows that were incorporated into the model.

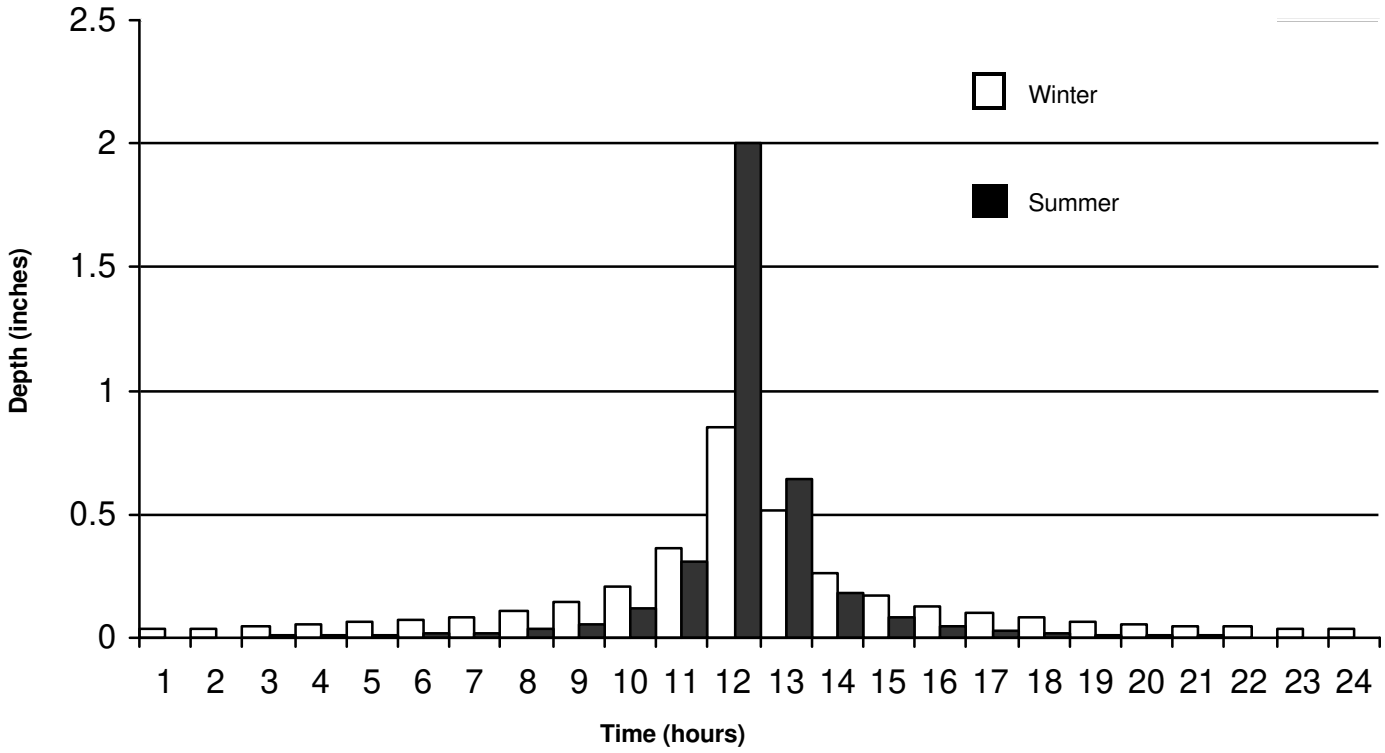
The connecting sewers for Clinton Township, Fraser and all Macomb meter districts were approximated by defining a connecting sewer and an overflow or overflow conduit, as shown in Figure 12.1. The connecting sewer was configured to represent the hydraulic limit as estimated from review of the actual pipe size and slope as well as review of actual meter data. This configuration allowed for applying a contract limit to these communities, depending on the alternative being reviewed.

Fraser and Clinton Township SSO areas were subsets of subareas defined in the WWMP Model. The subareas in the model were revised to include these as additional subareas. For all the case studies, the SSO parameters as developed for the local models analyses were incorporated into the regional model.

12.4 Design Storm Events

Two events were used for these simulations, the 25-year, 24-hour event and the 10-year, 1-hour event. The rainfall depths for these two events are 4.0 and 1.8 inches, respectively. For the 25-year event, an areal reduction factor of 0.91 was used, which resulted in the total rainfall depth being reduced from 4.0 inches to 3.6 inches. Other events were also simulated, but were dropped from fur-

Figure 12.2: Winter and Summer Rainfall Distribution



ther review when the SSO Work Group began to focus on the 10-year event and the 25-year event for the regional analysis. Both winter and summer rainfall distributions were used, depending on the given simulation. Figure 12.2 depicts these two distributions for the 25-year event with areal reduction.

12.5 Alternative Strategies

The model was configured for review of several different scenarios as follows:

1. Baseline: Current conditions with regard to peak discharge rates to DWSD, even if the case study areas or other first-tier communities are over their contract limits in some cases.

2. Accept SSO: Representation of the case studies only revised to direct all excess wet weather to the regional interceptor system.

3. Contract Limited: All case studies, first-tier communities and Macomb County communities held to their current contract limit at their point of connection to the DWSD interceptors. Excess flows in this alternative are diverted (removed) from the system and tracked as over-contract flows.

4. Contract Limited-NEPS: The same as Contract Limited, but with the contract limit for the Macomb and Clinton-Oakland communities applied at the Northeast Pump Station instead of at their point of connection to the DWSD interceptors.

5. Center Line: Connection of Center Line to DWSD changed from Conner Creek, which was found to not have additional capacity available, to

the NIEA or the Edison Corridor, which were determined to have additional capacity available.

6. Oakland County: Review potential for providing additional capacity to the Evergreen-Farmington system by using the existing connection to the Southfield Sewer (the original path before connection to First Hamilton was built).

7. Wayne County: Review potential for providing additional capacity for the North Huron Valley/ Rouge Valley (NHV/ RV) system in the Northwest Interceptor (NWI).

To represent current conditions under Alternative 1 (Baseline), the contract flow limit set in the WWMP Model at the connection to the interceptor for Allen Park was removed in the existing model setup. Similarly, the Melvindale pump station capacity was increased to 18 cfs from its contract capacity 6.375 cfs and an overflow conduit was added for flows that exceeded this rate. No other changes were made to the model for this alternative.

To represent Alternative 2 (Accept SSO) the representation of the case studies was revised to direct all excess wet weather flows to the regional system. In each case, the representation of the overflow was removed from the model and, generally, the excess flows were allowed to discharge to the receiving interceptor via the existing connecting sewer as represented in the model.

For Center Line, a representation of the actual connecting sewer is included in model. This sewer was increased in size from 24-inches to 30-inches, representing a possible pipe-bursting improvement. For Garden City, the flow limits on the regulator connections were removed.

For the remainder of the case studies, no changes were made to the representation of the connections to the receiving interceptor in the model. The excess flows were directed via the connecting sewers or pump stations, depending on the configuration for each case study. Local improvements that would be required to convey the excess flows to the receiving interceptors were not modeled explicitly. The model representation and analysis of model results were focused on the impact these excess flows might have on the regional system once introduced and not on the internal improvements that might be required.

For Alternative 3 (Contract Limited) all first-tier customers were held to their contract capacity, including the districts in Macomb County. For communities without an explicit control, such as a pump station, regulator, or a hydraulic limit, a control was set at the point of connection to the interceptor, generally the location of the billing meters, as previously shown in Figure 12.1. Excess flows in this alternative are diverted (removed) from the system and tracked as over-contract flows. This alternative investigates the extent of communities that might not have reported SSOs or basement flooding, but are nonetheless discharging excess flows to the regional system.

Alternative 4 (Contract Limited-NEPS) is the same as Alternative 3 except for the communities in Macomb County District and Clinton-Oakland district. For these districts, instead of holding the communities to their contract limit at their point of connection to the DWSD interceptors, the control was set at the Northeast Pump Station.

The other three alternatives were developed as additional alternatives to look at various communities or districts specifically, as opposed to all the case studies together. These alternatives are described further in the *Regional SSO Control Analysis* technical memorandum which accompanies this report.

12.6 Regional SSO Control Analysis and Results

For each alternative, the results were reviewed for impacts downstream in terms of changes to the peak HGLs. In addition, changes in outfall and

Table 12.1: Total SSO Volume (MG) for Case Study Areas

Case Study	10-yr, 1-hr Summer		25-yr, 24-hr Summer		25-yr, 24-hr Winter	
	Baseline	Accept SSO	Baseline	Accept SSO	Baseline	Accept SSO
Allen Park	0.0	0.0	0.9	0.0	1.5	0.0
Center Line	0.0	0.0	0.8	0.0	2.5	0.0
Clinton Township SSO	0.0	0.0	0.2	0.0	3.3	0.0
Fraser SSO	0.8	0.0	1.9	0.0	4.1	0.0
Garden City	2.2		8.2	0.0	33.4	0.0
Melvindale	0.0	0.0	2.1	0.0	0.7	0.0
Total	**3.0**	**0.0**	**14.0**	**0.0**	**45.5**	**0.0**

WWTP volumes are tabulated. The grouping of the results for the alternatives reflects the development of these alternatives with the SSO Work Group input. Results for Alternatives 1 and 2 were provided at the November 4, 2002, work group meeting. Alternatives 3 and 4 were presented together at earlier meetings. Alternative 5 through 7 are additional individual alternatives.

12.6.1 Acceptance of SSO for Case Studies – Alternatives 1 & 2

The WWMP Model was configured for existing conditions and for accepting excess wet weather flows from the case studies, as described in the previous section. Three events were reviewed for these alternatives: the 10-year, 1-hour summer event, the 25-year, 24-hour summer event and the 25-year, 24-hour winter event.

The total SSO for the case studies is provided in Table 12.1. For the Baseline Alternative, the total SSO from these areas is 3, 14, and 45.5 MG for the three events. As should be expected under the alternative of accepting SSOs, the total SSO from these areas is zero.

Table 12.2 summarizes the impact of accepting case study SSO flows by presenting the change in volume of discharge by all outfall types in the system.

Generally, the acceptance of the excess wet weather flows from the case studies resulted in little change for the following outfall types: CSO

Table 12.2: Volume of Discharge by Outfall Type (MG)

Type of Discharge	10-yr, 1-hr Summer			25-yr, 24-hr Summer			25-yr, 24-hr Winter		
	Baseline	Accept SSO	Change	Baseline	Accept SSO	Change	Baseline	Accept SSO	Change
CSO Basin	1,267	1,265	-2	3,619	3,612	-6	2,816	2,819	3
Untreated CSO	783	781	-2	1,987	1,986	-1	1,479	1,482	2
Ground Flooding	2	2	0	5	6	1	1	1	0
Screening and Disinfection	269	271	2	789	777	-11	636	638	2
Untreated SSO	8	5	-3	30	17	-13	95	54	-40
CSO TUNNEL	313	316	3	1,052	1,053	1	628	627	-2
WWTP	5,133	5,161	27	5,509	5,544	34	6,543	6,576	33

Basin, Untreated CSO, Ground Flooding, Screening and Disinfection, and CSO Tunnel. The changes for these outfall types are essentially within the range of continuity error inherent in the SWMM program used by the WWMP Model. The SSOs, however, are reduced by the amount produced by the case studies.[1] The reduction in SSO volume is mostly offset in an increase in the total volume treated at the WWTP. The increases do not exactly equal the decreases due to the continuity error as well as changes in the amount of in-system storage that exists at the completion of these simulations.

The changes in volumes by outfall types give only a partial picture of the impact of the results. Changes in the peak HGLs generated by accepting the SSO flows are also reviewed to determine feasibility of this regional SSO control.

Center Line: Center Line discharges to the Conner Creek Enclosure. There is concern for potential street and basement flooding near Six Mile and Seven Mile roads as the enclosure accepts flows from this area of Detroit. For these simulations, the flow depths were found to exceed the critical HGL for all events. In addition, there is the concern of other regional regulatory issues such as comingling with combined sewerage and possible displacing some combine flow at the Conner Creek outfall (causing an increase in CSOs downstream.) Thus, even though the flows from Center Line are very small compared to the peak flows in the enclosure, the strict criterion of the critical HGL being exceeded excludes use of Conner Creek sewer as a regional solution for SSO control for Center Line. A possible regional solution would be for the flows to be directed to the NIEA or Corridor Interceptor. This was investigated under Alternative 5 – Center Line, and is discussed in greater detail in the *Regional SSO Control Analysis* technical memorandum which accompanies this report.

Clinton Township and Fraser: Both Clinton Township and Fraser SSO areas are tributary to the DWSD interceptors in Macomb County, which ultimately discharges to the NIEA at the Northeast Pump Station. No houses are connected to the NIEA in Detroit. There are connections at three points: Conant-Mt. Elliot, First Hamilton, and Meldrum. The results indicate that the flows depths would not reach ground, but they do get within five feet of design elevation and seven feet of ground within Detroit. In addition, the changes in flows were determined to not impact the flows from Conant-Mt. Elliot and First Hamilton sewers, but the change would reduce the amount of relief available to the Meldrum sewer.

The model results indicate that the DWSD interceptors in Macomb County can handle the increase in flows; however, it is noted that accepting the 25-year flows could potentially limit future growth for areas further to the north. In addition, there is concern that there is some deterioration in the 15-mile Interceptor and at the Clintondale Pump Station that might need to be addressed before these flows could be accepted.

Allen Park and Melvindale: Allen Park and Melvindale both discharge to the Northwest Interceptor where the only flooding concern is to ground (no houses are connected in the area). For the events reviewed, the flow depths do not reach ground level. However, the interceptor is surcharged by over 10-feet, which does impact the gravity discharge from Allen Park as well as the pumping capacity of flows from Melvindale. In both cases, the overflow was removed in the model representation, but the capacity for discharging to the interceptor was not modified. It is anticipated that Allen Park would require a pump station to maintain its discharge capacity to be able to eliminate the need for the emergency over-

[1] The amounts of SSOs still indicated under the Accept SSO alternative are almost all in the NHV/ RV system and generally for those areas that have had their sewer systems recently separated. The representations of these areas in the model have not been updated with data collected since these separation projects have been completed.

Table 12.3: Summary of Impact of Accepting Case Study SSO Volumes

Case Study	Receiving Interceptor	Can Current Regional System Accept Case Study SSO Flow? 10-yr, 1-hr Summer	25-yr, 24-hr Summer	25-yr, 24-hr Winter	Co-mingling Issues	Potential to Increase CSO	Comments	Costs to accept
Center Line	Conner Creek	No	No	No	Yes	Yes	Can potentially rout flows to NIEA	Increase Conner Creek capacity, NIEA connection cost
Allen Park and Melvindale	Northwest	Yes*	Yes*	Yes*	Yes	Yes	No HGL limits set, but 25-yr event causes 10 feet of surcharge	None if this is acceptable, else increase capacity costs and/or tunnel
Macomb County: Upper Reaches	15-Mile, Romeo, Oakland, Corridor	Yes	No**	No**	No	No	15-Mile and Clintondale PS are limiting capacity	Relief sewer costs (found by Clinton Twp)
Macomb County: Inside Detroit	NIEA	Yes	Yes	Yes	No	Yes	Interceptor gets to within 5 feet of design HGL. Reduces amount of relief from Meldrum to NIEA	None, but limits on growth
Garden City	Northwest	Yes	No	No	Yes	Yes	Review of impact to Middle Rouge Interceptor not included	Increase interceptor capacity costs
Oakland County	Southfield	No	No	No	Yes	Yes		Increase capacity cost and/or use of tunnel costs
Wayne County	Northwest	Yes*	Yes*	Yes*	Yes	Yes	No HGL limits set, but 25-yr event causes 10 feet of surcharge	Increase capacity costs and/or use of tunnel costs

*Potential adverse impact due to amount of surcharging in the NWI not known
**Operational data indicates potential capacity problems

flow. Likewise, Melvindale would like to increase the capacity of the existing pump station to be able to handle the surcharge conditions in the receiving interceptor.

In addition, there is concern of other regional regulatory issues such as co-mingling with combine sewerage and possible displacement of combined flow at a downstream outfall such as the Baby Creek outfall.

Garden City: Garden City discharges to the Middle Rouge Interceptor, which is within the North Huron Valley/ Rouge Valley sewer system. Acceptance of additional flows does increase the HGL in this interceptor. For the 10-year, 1-hour event, HGLs are under the critical HGL (no surcharging), but surcharging occurs for the 25-year, 24-hour event, making it unfeasible. This interceptor is tributary to the Northwest Interceptor via the Lift Station 1A Pump Station. At this point of connection to the NWI, like Allen Park and Melvindale, the only flooding concern is to ground as no houses are connected in the area.

In addition, as with Allen Park and Melvindale, there is the concern of other regional regulatory issues such as co-mingling with combine sewerage and possible displacement of combine flow at a downstream outfall such as the Baby Creek Outfall.

Evaluation of Results

A summary of the analysis is provided in Table 12.3. In general, the flows from the 10-year event, but not from the 25-year event, can be handled. The only case study whose flows could not be handled for the 10-year event is Center Line, due to the acceptable HGL already being exceeded in the receiving interceptor.

The table also includes an evaluation for the three counties, Macomb, Oakland, and Wayne (Rouge Valley).

12.6.2 Contract Limited – Alternatives 3 and 4

Alternatives 3 and 4 expand the scope of the first two alternatives by including a review of flows from all First Tier customers in addition to the Case Study areas. The alternatives essentially apply to the billing meter districts in Macomb County as well as the Clinton-Oakland County at their point of connection at their boundary with Macomb County. Essentially all other districts are limited to their contract capacity by design, either through a pump station capacity, a regulator capacity, or by the hydraulic capacity of the connecting sewers. The exceptions, other than the Macomb Districts and Clinton-Oakland, are Allen Park and Melvindale. For these two alternatives, a flow limit of 6 cfs was set for Allen Park and a peak pumping capacity of 6.4 cfs was set for Melvindale.

The results for these two alternatives are provided in Table 12.4. The 25-year summer event was not used in this analysis; results are therefore provided for only the 10-year summer event and the 25-year winter event.

For Baseline conditions, the total SSOs as predicted by the model for these two events are 7.6 and 94.6 MG respectively. If the communities are limited to their contract capacity (Alternative 3), the total SSOs increase to 33 and 206 MG. These results reflect the extent to which some communities are using the regional system to handle excess wet weather volumes. In this case, it is noted that the excess volumes are being defined by a contract limit. And for the Macomb meter districts and for Clinton-Oakland, this limit is 0.4 cfs/ 1000 people.

If the contract limit is applied at the location of the NEPS vs. the point of connection for the Macomb meter districts and for Clinton-Oakland (Alternative 4), the amount of overflow is reduced significantly. For the 10-year event, the overflow is reduced from 33 to 9 MG and for the 25-year

Table 12.4: Total SSOs Volume for Contract-Limited Alternatives (MG)

District/Community	10-Year, 1-Hour Summer Event			25-Year, 24-Hour Winter Event		
	Alt.1 Baseline	Alt.3 Contract Limited	Alt.4 Contract Limited-NEPS	Alt.1 Baseline	Alt.3 Contract Limited	Alt.4 Contract Limited-NEPS
Allen Park	0.0	0.6	0.6	1.5	5.2	5.2
Center Line	0.0	0.2	0.2	2.5	4.8	4.8
Chesterfield	0.0	0.0	0.0	0.0	0.7	0.0
Clinton Township	0.0	5.3	0.0	0.0	18.7	0.0
Clinton Township SSO	0.0	0.0	0.0	3.3	3.5	0.0
Clinton-Oakland	0.0	0.0	0.0	0.0	6.1	0.0
Fraser	0.0	4.7	0.0	0.0	10.6	0.0
Fraser SSO	0.8	0.8	0.0	4.1	4.1	0.0
Garden City	2.2	2.2	2.2	33.4	33.3	33.3
Grosse Pointe Shores	0.3	0.3	0.3	3.5	3.5	3.5
Harrison Township	0.0	0.2	0.0	0.0	2.3	0.0
Mac.,Shelby,Utica,Wash.	0.0	1.2	0.0	0.0	10.7	0.0
Melvindale	0.0	1.0	1.0	0.7	6.8	6.8
Shelby Township	0.0	0.2	0.0	0.0	4.0	0.0
Sterling Heights	0.0	11.4	0.0	0.0	45.1	0.0
Utica	0.0	0.0	0.0	0.0	0.9	0.0
Western Wayne	4.3	4.3	4.3	45.6	45.3	45.3
Total	**7.6**	**32.6**	**8.7**	**94.6**	**205.7**	**98.9**

event, the overflow is reduced from 206 to 99 MG. This alternative assumes that the flows can get into the receiving interceptor and would require the same improvements needed for Alternative 2 – Accept SSOs for the Macomb districts and for Clinton-Oakland district. It also resulted in the Edison Corridor being surcharged by over 50 feet at its downstream end. Under the contract-limited alternative, the Corridor Interceptor is only partially filled. Under Baseline alternative, the interceptor is surcharged, but only by about 20 feet at the downstream end. What these results demonstrate is that the Corridor Interceptor is providing some in-system storage under Baseline Conditions. If the NEPS capacity is held to a contract limit, however, the system would experience significant amounts of surcharging. Whether this level of surcharging would exceed an acceptable level of surcharging was not determined. Also, the amount of storage that might have been effectively used in the model representation was not examined.

12.6.3 Community Specific Regional Alternatives

At the SSO Technical Work Group meeting on April 24, 2003, the work group requested that the Wastewater Master Plan project present a justification for a regional SSO control alternative that would allow certain communities to have higher periodic wet weather flow limits than the 10-year 1-hour allowable flow contract limits being recommended by the Wastewater Master Plan (see section 14.2)

The three communities are included in this alternative are shown in Table 12.5.

This alternative will result in approximately 5.1 million gallons per year of CSO displacement as

Table 12.5: Requested Wet Weather Capacities

Community	Calculated 2020 Flow Need	Alternative Wet Weather Capacity
Allen Park	10.6 cfs	30.0 cfs
Melvindale	10 cfs	15.0 cfs*
Center Line	11 cfs	12.0 cfs
Fraser	9.7 cfs	11.0 cfs
Wayne County	278 cfs	380 cfs**

* This would not be a change from current operations, as this is currently being done.

** The alternative wet weather capacity maintains the current contract limit

shown in Table 12.6. There is no increased displacement as a result of Center Line and Fraser flows in this alternative, because these communities would discharge to the NIEA, which has sufficient capacity for the extra flows. Center Line currently discharges to Connor Creek, but would need to change its discharge point to the NIEA to prevent flooding from Connor Creek. Likewise, there would be no increase in CSOs for Wayne County as it maintains its current contract limit. The 5.1 million gallon estimate is based on continuous simulations using 40 years of rainfall data. Displacement will occur at the Baby Creek outfall, which has an annual average discharge of approximately 2,643 million gallons per year. Therefore the displacement represents about 0.2 percent of the annual flow. The Baby Creek outfall will be screened and disinfected by 2008, and construction is anticipated to start in 2003.

Table 12.7: Summary of Costs for SSO Local and Regional Alternatives (Million $)

	Local Control		Regional Control	
Community	Local Storage	Source Reduction	Alt A	Alt B
Allen Park	24	8 to 31	23	15
Center Line	20	22	15	13
Clinton Twp	32	21	26	NA
Fraser	16+	17+	11	10
Garden City	33	68	NA	NA
Melvindale	22	46	5	2 to 4

12.7 Regional Alternatives Costs

Based on the regional analysis described previously and the proposed contract limits based on an "allowable 10 year, 1 hour" flow, two different regional alternatives are recommended for consideration as part of the overall wastewater master plan.

Regional Alternative A: Accept up to an "allowable 10-year, 1hour" flow for all communities.

Regional Alternative B: Accept higher periodic wet weather flows for certain communities over the 10-year 1-hour allowable flow contract limits.

Table 12.7 summarizes the costs identified for each of these alternatives for the 25-year, 24-hour growth (summer) design event. Regional costs are compared to local costs. Further details of what each costs includes are listed in Tables 12.8.1-12.8.6.

Table 12.6. Summary of Potential Displacement

Community	Proposed Contract 2020 (cfs)	Requested Wet Weather Limit (cfs)	Potential Displacement (MG/yr)	Displacement Events (no./yr)
Allen Park	10.6	30	1.2 (0.05% increase)	8
Melvindale	10	15	3.9 (0.15% increase)	8

Table 12.8: Summary of Costs for SSO Local and Regional Alternatives (Million $)

Table 12.8.1: Allen Park SSO Control Options

	Costs (M$)	Comment
Local Storage	24.1	Includes 1.9 MG of storage and $13.8 million in local transport and pump station costs to bring flows to the NWI connection
Local Source Reduction	30.9	Includes 1.1 MG of storage and $13.8 million in local transport costs for flows that FDD does not remove
Local Source Reduction (potential)	7.6	If majority of wet weather flow is coming form FDs, cost could be this low as no storage/transport would be needed
Regional Alt A (10.6 cfs)	23	Includes 1.57 MG of storage and $13.8 million in local transport costs to bring flows to the NWI connection
Regional Alt B (30 cfs)	14.8	Local transport and pump station costs to bring flows to the NWI plus added costs for a larger pump station at the NWI

Table 12.8.2: Center Line SSO Control Options*

	Costs (M$)	Comment
Local Storage	19.5	Includes 5.2 MG of storage; no transport costs
Local Source Reduction	22	Includes 1.2 MG of storage for flows that FDD does not remove
Regional Alt A (7.5 cfs)	15.3	Includes 3.6 MG of storage; no transport costs included
Regional Alt B (12 cfs)	12.5	Includes 1.2 MG of storage and 4.6 million in transportation costs to bring flows to the Corridor Interceptor

Center Line costs do not include attenuation through 1.5 mile connection pipe. Accounting for it will reduce costs

Table 12.8.3: Fraser SSO Control Options

	Costs (M$)	Comment
Local Storage	15.7+	Includes 3.7 MG of storage; still need to add transport costs to get flows to the basin (from AEW)
Local Source Reduction	17.2+	Includes 1 MG of storage for flows that FDD does not remove; still need to add transport costs to the basin (from AEW)
Regional Alt A (9.7 cfs)	10.6	Includes 1.1 MG of storage and $3 million in transport costs
Regional Alt B (11 cfs)	9.8	Includes 0.9 MG of storage and $3 million in transport costs

Table 12.8.4: Clinton Township SSO Control Options

	Costs (M$)	Comment
Local Storage	32.1	Includes 3.7 MG of storage plus transport costs to get to the basins
Local Source Reduction	20.6	Includes FDD only, no additional storage is required
Regional Alt A (41.9 cfs)	25.9	Includes 1.6 MG of storage plus transport costs to get to the basins
Regional Alt B	NA	NA

Table 12.8.5: Garden City SSO Control Options

	Costs (M$)	Comment
Local Storage	32.5	Includes 11.1 MG of storage; no transport costs are required
Local Source Reduction	68.1	Includes 1.1 MG of storage for flows that FDD does not remove
Regional Alt A	NA	NA
Regional Alt B	NA	NA

Table 12.8.6: Melvindale SSO Control Options

	Costs (M$)	Comment
Local Storage	21.9	Includes 6.2 MG of storage; no transport costs are required
Local Source Reduction	45.6	Includes 2.9 MG of storage costs for flows that FDD does not remove
Regional Alt A (10 cfs)	5.1	Includes 0.5 MG of storage; no transport costs are required
Regional Alt B (15 cfs)	2 to 4	Includes pump station upgrades and a range of storage volumes as identified by performance

13. Regulatory Status

Sanitary sewer overflows are the object of state and federal regulations, and the regulatory goals for SSO control are evolving. This section reviews the current regulations and strategy of the Michigan Department of Environmental Quality (MDEQ) and proposed federal regulations of the US Environmental Protection Agency (EPA). Also discussed is the status of working group efforts to resolve issues related to SSO regulation. Finally, a review of design storms for SSO control from around the United States is presented.

13.1 MDEQ SSO Regulations, Strategy

Discharges of wastewater with less than secondary treatment from a separated sewer system (not a combined sewer system) are illegal under the Federal Clean Water Act and the Michigan Environmental Code. The state law was amended in 2000 to require any discharge of sanitary sewage with less than secondary treatment to be reported to MDEQ and the media, similar to CSO reporting requirements already in effect. National Pollutant Discharge Elimination System (NPDES) discharge permits typically allow bypasses of untreated or partially treated wastewater from the treatment plant or the collection system only for emergency conditions where necessary to protect health, life or property.

The Michigan Department of Environmental Quality published its SSO control program titled *"Strategy for the Regulatory Control and Correction of Illegal Overflows from Separate Sanitary Sewer Systems in Michigan"* on May 10, 2000 and on July 10, 2000 an amendment to Section 3112a, of Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451 was adopted to require reporting of SSOs. This strategy report is located on the MDEQ Web page, http:/ / www.michigan.gov/ deq. The following is a summary of that report:

The goal of MDEQ is to identify the separate sanitary sewer overflow discharges in Michigan and take appropriate regulatory actions to eliminate all identified overflows. When MDEQ becomes aware of chronic SSOs, it initiates a five-step enforcement process.

Step 1. Identification of all SSOs. Through outreach efforts and a review of its records, and requirements for reporting, MDEQ's Surface Water Quality Division (SWQD) is identifying all known SSOs. MDEQ has issued the following regulation for reporting sanitary sewer overflows.

"The municipality responsible for the discharge of untreated or partially treated sewage to the waters of the state shall immediately, but not more than 24 hours after the discharge begins, notify the department and others as specified in the law. The *"Report of Discharges of Untreated or Partially Treated Sewage"* shall be submitted by the responsible municipality to the appropriate District Office at the conclusion of the discharge."

All county health departments are notified of each reported SSO.

MDEQ maintains a public record of reported SSOs titled: *"Report of Discharges of Untreated or Partially Treated Sewage"*. This report is located on the MDEQ Web page. It requires that municipalities provide:

- Description of/ reason for the discharge(s)
- Name of wastewater treatment facility normally receiving sewage
- Location of the discharge(s)
- Surface waters impacted by the discharge(s)
- Land impacted by the discharge(s)
- Were initial notification procedures followed?
- Event start date and time

- Event end date and time
- Volume discharged
- Quality of discharge(s)
- Precipitation type and measurements
- Actions taken to stop and/ or minimize discharge(s)
- Actions taken to prevent reoccurrence of discharge(s)
- Compliance status
- Results of *E. coli* testing

Initially the MDEQ included basement backups as an SSO to be reported, but this was subsequently retracted in a letter from the MDEQ to the SSO communities dated October 23, 2001. On January 2, 2002, Michigan Public Act No. 222 became law. This amendment to PA 170 established laws regarding sewer backups and municipal responsibilities for them.

Step 2. Revocation of the Discharge Authorization for any Existing Permitted SSOs. MDEQ is revoking existing SSO permits, or is requesting voluntary termination of this authorization by the permit holder.

Step 3. Regulatory Compliance Actions. The SWQD notifies all municipalities and other responsible parties in the SSO database of the need to eliminate SSOs via a legally enforceable program.

Step 4. Enforcement Schedules and Settlements. MDEQ strives to eliminate all discharges of untreated sewage into Michigan waters in an expeditious manner. Where an SSO exists in a community, MDEQ develops with the community a corrective action program (CAP) to eliminate the SSO. The corrective action programs are incorporated into compliance actions, enforcement settlements or, if necessary, litigation.

In general, these corrective programs are designed to be completed within two to three years, where possible. To encourage the voluntary and accelerated correction of SSO problems, communities may have the opportunity to complete corrective programs without incurring a significant penalty for past violations.

The MDEQ will also consider other factors in developing enforcement settlements such as ability to pay, degrees of cooperation or recalcitrance of the violator, period of time the SSOs were allowed to occur, prior efforts to eliminate the SSOs, and the damage done to the natural resources of the state.

Step 5. Improved Legislation. MDEQ has indicated support for legislative amendments that assist in the identification and elimination of SSOs including the requirement to report SSO releases and testing similar to that currently required for releases of untreated or partially treated sewage from CSOs. MDEQ also supports improvements to notification to the public about SSO discharges.

13.2 Existing ACOs and Schedules

Within the DWSD service area as of December 2002, the only communities with Administrative Consent Orders (ACO) related to SSO control are Clinton Township, Center Line, Hazel Park and St. Clair Shores. These communities report that they are performing corrective work as required by their ACOs.

In the meantime, the DEQ and the SSO Work Group described in section 12.4 have established a set of short-term (approximately 36 months) actions for SSO control. These actions form the basis for SSO control measures and will ultimately be written into new ACOs with SSO communities. After initiating these actions, it may be found necessary to undertake additional engineering evaluation towards the selection of final infrastructure solutions. The measures, taken directly

from the DEQ letter, are:

1) Document current sewer system conditions including the size, age, and condition of sanitary sewers, and the carrying capacity of existing sewers (in most cases main or trunk sewers) that are likely to contribute to the creation of sewer surcharges or SSO conditions; determine the estimated frequency, volume, location, and receiving water of SSO discharges; perform staff training in monitoring and reporting of untreated or partially treated sewage discharges onto land or into the waters of the state to assure that required notifications and reports are submitted accurately and timely; develop a data system for reporting of sewage backup into basements; determine the impact of any requests for new sewage loading to sewers in areas subject to basement backups, SSOs, or treatment facility bypassing; identify areas that may have inadequate storm sewer systems that may contribute to the problems within the sanitary sewer system.

2) Quantify existing flows (average and peak for dry and wet weather conditions) through a flow monitoring program; determine infiltration and inflow (I/ I) contributions for logical sub sections of the sewer system; collect rainfall measurements with recording rain gauges for further flow monitoring data analysis; collect groundwater table level measurements for flow monitoring analysis.

3) Determine the "excessive" component of I/ I based on a comparison of the estimated cost required to remove the flow versus the cost to transport and adequately treat wet weather flows; this assessment may need to be carried out on a phased basis, with elimination of readily removable I/ I sources being completed before attempting a more rigorous cost comparison addressing more difficult sources.

4) Estimate or measure the contribution from footing drains (if footing drains are connected to the system or if footing drain flow is discharged to the sewerage system by sump pumps) and determine what potential methods are available to remove/ reduce this flow component; undertake pilot projects to assess the feasibility of voluntary or mandatory footing drain removal as potential approaches to this activity; provide public education of the economic and capacity benefits of footing drain removal.

5) Prepare and implement a detailed operation and maintenance plan to ensure optimum utilization of existing facilities (including sewers, pump stations, metering devices, etc.) to consolidate, prevent or minimize sanitary sewer overflows to the maximum extent possible; perform staff training, or training updates, on issues of wet weather flow exclusion from sanitary sewers and SSO prevention.

6) Provide power reliability equipment for pump stations using emergency generators, portable pumps, or dual power supplies; provide modifications to pumping stations for generator hookup or forcemain pump around flanges.

7) Evaluate sewer use ordinances to assure that clear water from new footing drains, roof downspouts, or other inflow sources are not authorized to be connected to sanitary sewers. Consider ordinance revisions, including revisions that would require footing drain disconnection from sanitary sewers; train building inspectors, meter readers, water and wastewater utility staff on ordinance compliance; conduct sewer system assessments to determine compliance with footing drain, downspout and yard drain prohibitions; compile and analyze data to identify priority areas for ordinance compliance initiatives.

8) Conduct physical surveys and smoke and dye testing in suspect areas to ensure that inflow sources are not connected.

9) Develop and design the project(s) needed to remove excess I/ I (including footing drain flows, if feasible) based on a schedule that includes com-

pletion of a Sanitary Sewer Evaluation Survey to specifically identify the sources of excess I/ I, followed by construction of needed short term sewer rehabilitation project(s); coordinate implementation of storm sewer system improvements in areas with poor drainage.

10) Propose, seek approval where necessary, and implement beneficial short-term SSO and basement backup control measures which may be applicable to the conditions existing in the community.

11) Identify measures and schedules necessary to assure timely funding availability for necessary short and long term projects.

12) Proceed with the development of an evaluation of additional long term SSO control measures which may be necessary, in addition to the removal of excess I/ I, including storage facilities and/ or transport to and necessary expansion of treatment facilities.

13) Conduct public education programs throughout the investigation and program development period to assure public understanding of the issues involved and support for the needed improvement actions being taken.

13.3 Status of Proposed Federal Regulations

On January 5, 2001, the Environmental Protection Agency Administrator signed the long-awaited draft rule on sanitary sewer overflows. As with other regulations, the 120-day public comment period does not begin until the proposed rule is published in the Federal Register. That publication was delayed in January to give the Bush Administration an opportunity to review it.

Since January 2001, EPA has received hundreds of comments to the original draft and now it has directed the Office of Water Management to:

• Propose regulations consistent with those originally recommended (no changes to the 9 pages on new regulations);

• Summarize all comments received since January and incorporate them into the preamble to the regulations; and

• Provide preamble discussion regarding the comments.

The Office of Water Management is currently reviewing the revised preamble with the Regions and expects to forward the revised draft to the Office of Management and Budget (OMB) by early 2003. After OMB review, EPA plans to publish the draft SSO regulation and revised preamble in the Federal Register. EPA's current estimate for publication is late Spring 2003.Roughly 22,000 cities in the United States experience SSOs during wet weather conditions. Despite the lack of formal SSO regulations, these unpermitted and untreated discharges are still prohibited under the Clean Water Act and subject to enforcement action.

The SSO draft regulations were developed on the premise that utilities that routinely evaluate and improve their sanitary sewer system will reduce their likelihood of a Clean Water Act violation, extend the life of their infrastructure, and provide better customer service. The following is an overview of the four-part draft regulation:

Municipal Satellite Collection System – This section of the draft regulation will require owners of municipal satellite sanitary systems to obtain a no-discharge National Pollutant Discharge Elimination System (NPDES) permit or issue a permit amendment to the owner of the Publicly Owned Treatment Works (POTW) facility that receives wastewater from the satellite collection system. For many communities, this will be a new permit with all the enforcement powers of the NPDES regulations.

Municipal Sanitary Sewer System – Capacity, Management, Operation and Maintenance (CMOM) Program – All NPDES permittees

(including Satellite Collection System with SSOs) will be required to develop and implement a comprehensive CMOM program following the standards prescribed in the regulation. The key elements of a sound CMOM include:

1. Planning to ensure adequate capacity during dry and wet weather

2. Effective overall system management, including maintenance tracking, mapping, training, and supervision

3. Efficient operations, measured in spending, equipment performance, and efficiency

4. Regular system maintenance

Municipal Sanitary Sewer Systems – This portion defines the general prohibition of SSO discharges and the use of enforcement discretion for SSOs caused by "severe natural conditions" and affirmative defenses for discharges caused by other factors beyond the "reasonable control" of the utility. The affirmative defense clause is critical to POTWs to provide appropriate liability protection for SSOs that are beyond the "reasonable" control of the utility.

Municipal Sanitary Sewer Systems: Reporting, Public Notification, and Recording – This portion of the rule defines what is considered an SSO and defines – in a certain level of detail – procedures for agency notification and public reporting, and record keeping. EPA has broadened the definition of SSOs to include discharges that reach waters of the U.S., as well as overflows that do not reach waters of the U.S. and wastewater backups into buildings caused by utility operations.

An advanced copy of the more than 160-page proposed rule (141 pages of preamble) can be found on EPA's Web site at http:/ / www.cfpub.epa.gov/ npdes/ home.cfm?program_id=4. The revised preamble mentioned above is not currently available for public review or comment. EPA is only conducting an internal review of the documents before issuing the revised draft to OMB for their formal review. It is anticipated that copies of the documents will be available for public review upon submittal to the OMB.

13.4 MDEQ SSO Work Group

The MDEQ held a statewide workshop on SSOs in April 2001 in Lansing, Michigan, to discuss SSO problems, solutions, and regulations. Following the workshop, MDEQ has continued a dialogue with communities and planning agencies concerned about SSO control requirements. This MDEQ SSO Work Group addressed the following topics:

- Reporting requirements for SSOs and basement flooding events;
- Funding availability and financial capability;
- Responsibility of local governments for discharges from non-publicly owned systems (e.g. trailer parks, private developments);
- The roles and responsibilities of local sewer system operators as distinct from wastewater treatment operators;
- The need for an affirmative defense provision for unavoidable overflows;
- Identification of the "short term" remedial measures that need to be pursued immediately even if they do not result in the total elimination of all SSOs;
- Development of appropriate design standards;
- Interpretation of existing state and federal laws and regulatory requirements; and
- Development of appropriate measures to deal with growth and/ or sewer extensions on systems with chronic basement back-up flooding problems.

Based on work group discussions, the MDEQ director released a supplemental sanitary sewer

overflow policy statement in December 2002. In this statement, MDEQ clarified that a growth (summer) rainfall event under normal soil conditions should be used for design purposes.

13.5 SEMCOG Task Force

In the spring of 2000, the Rouge Steering Committee and SEMCOG initiated a task force that includes participants from local communities and MDEQ to develop a strategy to find cost-effective solutions to SSO problems in the Rouge River watershed. This work group completed a report in August 2000 that documents their strategy proposals (see References, Section 14). The task force developed the following principles to guide the development of the implementation strategy for SSO controls.

1. The SSO implementation strategy is intended to eliminate or minimize SSOs and their impact on public health and water quality.

2. SSO control programs should be integrated with other programs targeted for meeting public health protection and water quality.

3. It is recognized that SSOs vary significantly in their frequency, magnitude, and impact on public health and water quality.

4. The SSO program should be structured to differentiate between the various types of SSO and their impact when evaluating alternative courses of action.

5. Remedial actions and enforcement actions for specific SSOs should be based on all of the following:

- Public health and water quality impact,
- Public health and water quality benefit, and
- Cost-effectiveness of the action as compared to other possibilities for addressing public health and water quality concerns in the impacted area.

6. SSOs are one of several sources of water quality impairment. Remediation strategies should be consistent with watershed management plans developed to address the relative impacts of these various sources.

7. SSO remediation and enforcement action should be determined in the context of several water quality improvement programs including: sewer capacity, management, operation and maintenance (CMOM), storm water, Total Maximum Daily Loads, Combined Sewer Overflows, Remedial Action Plans, etc.

8. It is recognized that sewer system bypasses are needed in *unavoidable* circumstances to prevent more severe public health concerns, such as basement flooding.

9. *Unavoidable* events will be determined based upon a combination of the following:

- Magnitude of storm event (if weather related),
- Existing system capacity and design,
- Type/ cause of emergency or accident (if applicable),
- Status of corrective action programs and
- Adequacy of and conformity with agency-accepted system capacity, management, operation and maintenance (CMOM) programs.

13.6 DWSD SSO Technical Work Group

In Chapter 1 of this report, the purpose and goals of the DWSD SSO Technical Work Group were presented. The DWSD SSO Technical Work Group acts in a review capacity to the DWSD in the regional analysis of SSO controls that is being performed under the Wastewater Master Plan. The DWSD SSO Work Group is represented on the MDEQ SSO Work Group.

13.7 National Review of Design Storms

The proposed federal regulations provide for enforcement discretion for SSOs caused by "severe natural conditions" and affirmative defenses for discharges caused by other factors beyond the "reasonable control" of the utility. (The Environmental Protection Agency is requesting comments in the preamble of the draft regulation to define this term. At this time, there is no general agreement on standard design storms by which to measure of "severe natural conditions." However, a number of communities around the country are planning, or implementing SSO controls, and each of these projects has used a design storm as the basis of engineering.

There are currently no states known to have a written policy regarding allowable design storms for design of SSO facilities. Several states have allowed SSO facilities to be planned for and/or built that are based on different return period events, but the states have not explicitly stated approval of a specific return period event.

Based on a survey of various projects across the nation, it appears that states will in many cases accept whatever is being planned if it is based on sound engineering judgment. This is especially true if supported by an affordability study. At this time it appears the EPA has been reluctant to officially establish a design standard. It seems that a two-year storm frequency is typically being used in the Southeast, while New England and the Midwest are moving towards a higher standard (5-year and 10-year storm frequency).

A summary of surveyed projects across the nation listing the design criteria being used is given in Table 13.1.

Table 13.1: Summary of National SSO Design Criteria

City/Authority	Design Criteria	State Determination	Last Checked
Somerset Valley Sewerage Authority, NJ	1-2 overflows/yr		12/01
Henrico County, VA	1-yr Storm		12/01
Fort Smith, AR	1-yr Storm	No Comment	12/01
Monroe, LA	2 yr Storm		12/01
Charlotte, NC	2-yr Storm		12/01
Western Carolina Regional Sewer Authority	2-yr Storm		12/01
Orange County, CA	2-yr Storm		12/01
Greensboro, NC	2-yr Storm		12/01
Knoxville, TN	2-yr Storm		12/01
Winston-Salem, NC	2-yr Storm		12/01
Miami-Dade, FL	2-yr Storm		12/01
State of Texas: coastal areas	2-yr Storm	Accepted	12/01
Galveston, TX	2-yr Storm		12/01
St. Charles Parish, LA	2-yr Storm		12/01
Jefferson Parish, LA	2-yr Storm		12/01
Jackson, MS	2-yr Storm		12/01
Biloxi, MS	2-yr Storm		12/01
Norman, OK	2-yr Storm		12/01
Houston, TX	2-yr/6-hr Storm	Permitted	12/01
Exeter, NH	5-yr Storm		12/01
State of Texas: non-coastal areas	5-yr Storm	Accepted	12/01
San Antonio, TX	5-yr Storm		12/01
Saugus, MA	10-yr Storm		12/01
Cincinnati, OH	10-yr Storm		12/01
Columbus, OH	5- to 10-yr Storm		12/01
Greene County, OH	10-yr Storm		12/01
Oxford, OH	10-yr Storm		12/01
Tri-cities WW Authority (Dayton area), OH	10-yr Storm		12/01
Springfield, OH	10-yr Storm		12/01
Richmond, IN	10-yr Storm		12/01
Western Lake Superior Sewer District, MN	10-yr/1-hr Storm	Verbal Approval	12/01
Minneapolis, MN	10-yr/6-hr Storm		12/01
Toledo, OH	10-yr/1-hr Storm	Federal Consent Decree	12/02

14. Summary

14.1 Conclusions

The following is a list of conclusions for each of the key components of this study.

SSO Characteristics in the DWSD system

1. Wet weather SSOs in the DWSD system are not primarily the result of limited transport capacity, but the result of rainfall dependent inflow and infiltration in excess of original design expectations. Typically, in areas where it appears the cause is due to limited capacity, it is only limited because of the amount of excess flow entering the system.

2. Footing drain inflow is one of the greatest causes of RDII, especially from areas built between the 1950 and 1980. In general it appears that the amount of flow entering systems from footing drains was underestimated when these systems were designed. Another potentially significant source is illegal sump pump connections to the sanitary system.

3. In areas built before 1950 and in sanitary systems originally built as combined systems sources other than footing drains play a significant role in the cause of SSOs. This includes illicit cross-connections and leaky infrastructure. Residential and commercial downspout disconnection programs are in place and enforced to varying degrees amongst the different communities. Overall, downspouts appear to be a limited contributor to the problem, but could be significant in localized areas. Therefore, downspout disconnection codes should be rigorously enforced.

4. The total annual volume of SSOs from the system is very small in volume compared to annual CSO and WWTP discharges (0.024 percent). In some cases, however, SSOs may affect small drains or streams which receive other significant point source loads.

Local Alternatives

1. Costs for local storage and footing drain disconnection have been developed over the full range of SSO control levels. Local storage costs are generally more cost-effective than footing drain disconnection for smaller design storms (less than the 25-year, 24-hour storm). However, for larger storms, footing drain disconnection can be more cost-effective.

2. The percent contribution from footing drains of total wet weather inflow and infiltration can vary significantly between communities (25 to 90 percent). For areas with high contributions from footing drains, FDD can be a cost-competitive local alternative. As a further advantage, it can also be implemented over a longer period of time. For example, ordinances requiring disconnection at the time of sale, could necessitate a 20-30 year timeframe.

3. Footing drain disconnection helps provide additional protection for storms larger than the design storm by removing a portion of the total inflow and infiltration. This can be particularly helpful in areas where basement flooding is a concern for very large events where a higher level of service may be needed.

4. Footing drain disconnection costs were based on a complete disconnect including a new curb drain installation. It is also possible to perform a partial disconnect allowing dry weather flows to continue to enter the sanitary system and pump wet weather flows into backyards. The flow discharged to the backyard may not be a nuisance since it is already wet from the rainfall. The cost of a partial disconnection can be as little as a one third the cost of a full disconnection. It can also cause less disruption to homeowners.

5. In general, the 25-year, 24 hour growth (summer) design event is at the knee of the cost curve for most of the case study communities. This means that designing SSO controls up to this

point yields a proportional benefit versus cost. Design storms above this event, including the 25-year, 24-hour dormant event, yield little benefit for unproportionally high costs.

Regional Alternatives

1. Costs for regional alternatives have only been developed for controlling SSOs to a smaller design event (less than 25-year storm). Issues such as potential basement and street flooding in Detroit, and incremental impacts on CSO discharges may make it difficult to accept higher level flows. Once recommended improvements are made, the basement and street flooding are expected to be eliminated inside Detroit for events up to the 10-year storm.

2. Many communities that have not reported SSOs or basement flooding have similar excess RDII, but are at a geographical advantage to enter the regional system, and convey flows which may exceed their contract capacity. For example, the hydraulic model indicates for a single event Sterling Heights may have more over-contract volumes than the total SSO volume from all other Macomb County communities.

3. Even though MDEQ officials have not yet established SSO guidelines, it appears that they will accept the 25-year, 24-hour growth (summer) design event as the level of SSO control. However, it is unclear whether CSO displacement will be approved as a long-term solution.

14.2 Recommendations

Based on the above conclusions it recommended that DWSD establish an upper bound on contract limits based on the "allowable 10-year 1-hour flows" (which are very close to current limits). The "allowable 10-year, 1-hour flow" is the flow generated from a local collection system during the 10-year 1-hour design storm that conforms to criteria for peak hour flow to average daily flow for growth (summer) antecedent conditions and "best practices for system maintenance" developed by the Wastewater Master Plan and endorsed by the Contracts Work Group.

The "best practices for system maintenance" is a list of collection system inspection, analysis, and rehabilitation practices to be further developed by the Wastewater Master Plan. It has the purpose of providing each community a list of things that should be done to minimize wet weather infiltration/ inflow. The list is consistent with MDEQ short-term measures for SSO communities. MDEQ short-term measures focus on reducing SSOs. The "best practices for system maintenance" expands this focus to provide general guidelines for every community (even those without SSOs) to apply to their system. A preliminary list of these practices include:

- Perform periodic cleaning and televising of sewers to understand condition (5-10 years)
- Review manhole structures and have a cross-connection program
- Program rehabilitation or replacement of defective sections if needed
- Develop ordinance and supporting inspection and enforcement programs for reconnected sump pumps, downspouts, etc.
- Perform periodic flow metering to understand performance and reductions from rehabilitation work (10-20 years)

Ultimately, following the "best practices for system maintenance" should lead to reducing flows to within a maximum peak flow allowed for the 10-year, 1-hour event. The primary factor in determining this "allowable 10-year, 1-hour flow" for each community is the percent of homes with connected footing drains. Based on an analysis of the current peak flows from each community a standard of 0.4 cfs/ 1000 people to 0.8 cfs/ 1000 people is proposed as shown in Figure 14.1. Table 14.1

gives a summary of the current modeled peak rates and the proposed standard rate for each of the DWSD sanitary customers. Based on previous contracts, areas having portions with combined sewers are based on 0.5 cfs/ 1000 people for the combined population.

Local SSO solutions such as storage and footing drain disconnection will be needed for flows over the allowable 10-year, 1-hour flow up to the level of control the MDEQ establishes (most likely the 25-year, 24-hour growth (summer) event). Communities not reporting SSOs but which are over this contract amount will also need to reduce wet weather flows to meet the "allowable 10-year, 1-hour flow."

Details of how this will be implemented and enforced will be determined by the CS-1314 contract work groups and reported in later WWMP documentation. However, the general recommended framework is summarized in Table 14.2.

Regional Alternative B. The recommendations above are based on the regional analysis describe as Regional Alternative A in section 12.7. It is further recommended that Regional Alternative B be considered to address community-specific needs where feasible. This alterative would allow certain communities to have higher periodic wet weather flow limits than the 10-year 1-hour allowable flow contract limits. Alternative B will result in a cost savings to Allen Park, Melvindale, Center Line, and Fraser as detailed in Section 12.6.3.

However, this alternative will increase CSO displacement in the DWSD system an estimated 2,643 MG/ yr at the Baby Creek CSO facility. Displacement can occur when sanitary flow is discharged to the DWSD combined system, taking up room for other combined flows. The sanitary flow receives secondary treatment, however, CSOs are increased. The MDEQ may object to this as a long-term solution.

The MDEQ SSO Policy of December 2002 does not discuss displacement of CSO as part of a solution to SSO control, but allows for case-by-case review and consideration of site-specific conditions. The Long Term CSO Program will be in implementation until at least 2015, and the volume of untreated CSO will be much greater than the displaced treated CSO volume created by Regional Alternative B. Therefore, there is negligible negative water quality impact associated with Regional Alternative B, and at the same time there is a positive water quality and public health impact of mitigating basement flooding and untreated SSOs to Ecorse Creek and the Rouge River. Furthermore, CSO displacement is currently occurring within the DWSD service area. Alternative B would increase current amounts.

Figure 14.1: Current 10-yr 1-hr Flows vs. Proposed Upper Limit

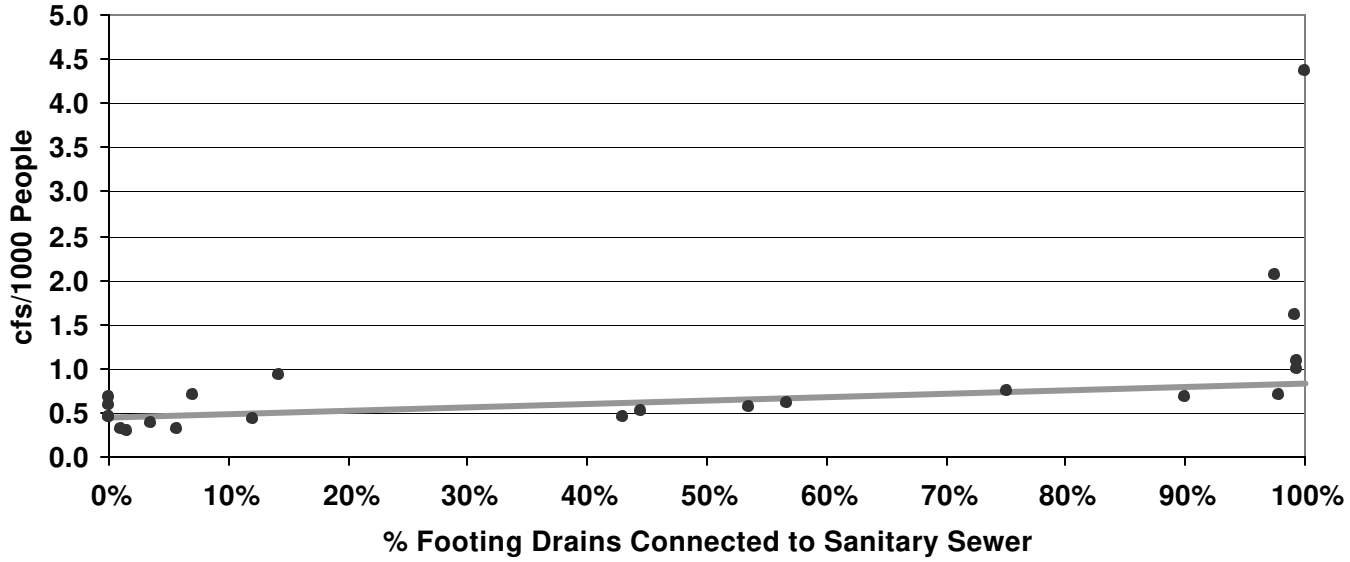


Table 14.1: Proposed Upper Limit for Contracts

Community	% FDs*	CFS/1000 People**	Proposed Standard Peak Rate (cfs)***
Dearborn (Miller Road PS)	99%	1.09	55.1
Dearborn (Greenfield PS)	99%	1.00	54.0
Evergreen/ Farmington	43%	0.46	184.7
SEMSD-NEWC (WM-S-2)	98%	0.69	181.3
NE Wayne NHV/RV (WC-S-1,2,3)	57%	0.62	367.3
Allen Park	100%	4.58	5.3
Center Line	75%	0.75	7.0
Chesterfield	1%	0.32	14.8
Clinton Twp (CT-S-1,3,4)	3%	0.39	21.8
Clinton Twp. (CT-S-2)	45%	0.51	14.5
Farmington	90%	0.67	6.7
Fraser	54%	0.56	10.5
Grosse Pointe Park	97%	2.05	9.8
Harrison Twp (HR-S-1,3)	7%	0.69	9.3
Harrison Twp (HR-S-2)	6%	0.32	2.4
Macomb Twp	0%	0.58	28.8
Melvindale	99%	1.61	9.2
Clinton-Oakland	2%	0.30	107.5
Rochester Hills	0%	0.45	7.8
Shelby Twp (SY-S-1)	0%	0.44	4.1
Shelby Twp2 (SY-S-2)	0%	0.67	2.8
Sterling Heights	14%	0.93	63.7
Utica	12%	0.43	2.4

*Based on SEMCOG TAZ data and community supplied information
** CFS/1000 people is based on peak flow from WWMP 10-yr, 1-hr storm model

*** Based on proposed standard rate times residential population plus needs for SIUs and employed population (50 gepd). Areas with portions of combined sewers are based on 0.5 cfs/1000 people for population on the combined areas.

Table 14.2: Recommended SSO Regional Implementation Plan

Goals:
- Provide cost-effective solutions to eliminate SSOs from the DWSD service area.
- Deal with all customers equitably.
- Manage the regional system optimally and responsibly.
- Comply with state and federal regulations

Program Elements	Details
Regulatory Direction	The MDEQ is developing an SSO guidance document. Although this document has not yet been finalized, the following key elements appear to be consistent with what SSO communities will be required to meet. • Over the first three years, implement the short-term measures outlined in a letter sent by the MDEQ to SSO communities dated 10/23/01. • Develop a long-term plan to eliminate preventable SSOs in 10-20 years. Events over a 25-yr 24-hr design storm during growth (summer) conditions will be considered an "extreme event" and therefore unpreventable.
System and Economic Considerations	The **regional system role** will be to accept customer flows up to the 10-year, 1-hour flow, that the system is generally designed around. It is not possible to accept flows above this from all communities without significant system changes and CSO displacement. The **local system role** is to manage wet weather peak flows to the "allowable 10-year, 1-hour " based on system type and age. It is not cost-effective to use the system to handle to excessive peak flows as this limits the dry weather flow capacity.
DWSD Responsibilities	• Revise and renegotiate contracts based on upper limit of "allowable 10-year, 1-hour flows." • Eliminate regional system bottlenecks that prevent acceptance and conveyance of the 10-year, 1-hour flow. • Work with communities as a technical resource to help advance customer flow management programs
Customer Responsibilities	• Review current allowable 10-year, 1-hour flows. • Implement the "best practices for system maintenance" relevant to system and MDEQ short term measures. • Communities with current peak flow above their "allowable 10-year, 1-hour flow", establish with DWSD a timeframe (eg. 10-20 years) to achieve compliance. • Use local SSO control alternatives for flows above the "allowable 10-year, 1-hour flow" (up to the 25-year, 24-hour unpreventable event). • Continue following ACOs with the MDEQ.

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Comments from: George Haberer, DWSD; Larry Witt, DWSD; Mohammad Gill, DWSD; Jim Porter, Oakland County; Vyto Kaunelis, Wayne County; Ken Bonin, Macomb County; Jeff Bednar, AEW; Paul Guinnane, AEW; Christopher Frayer, AEW; Jack Patel, SDA; George Nichols, SDA; John Kozuh, Allen Park; Eric Witte, Melvindale and Mark Schobert, Wade-Trim.