Detroit Water and Sewerage Department

Wastewater Master Plan

DWSD Project No. CS-1314

Local Alternatives for SSO Control

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Local Alternatives for SSO Control

1. Introduction

This technical memorandum provides additional background on the development of the local alternatives for the sanitary sewer overflow (SSO) case study communities being performed as part of the Detroit Water and Sewerage Department (DWSD) Wastewater Master Plan (WWMP). An additional component of this plan is to review local and regional approaches to dealing with SSO problems within the system.
The purpose of the regional approach is to find a cost-effective solution to the elimination of sanitary sewer overflows from the DWSD service area. As part of this effort, the following local and regional alternatives are to be evaluated:

- Elimination of the sources of rain dependent inflow and infiltration (RDII) that cause SSOs;
- Local storage or treatment of SSOs; and
- Regional transmission, storage and treatment of SSOs.

These alternative evaluations are being performed for six case studies. 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

The purpose of each case study is not only to determine a cost-effective solution to the local SSO problems, but also to gain insight on how the results might be transferred to other potential or known problem areas in the DWSD service area.
This memorandum provides additional details and the technical basis for the development of local alternatives applied to the six case study communities.
The first portion of this memorandum focuses on defining the local alternatives and explaining the general approach used. The second portion of this memorandum explains the detailed analysis performed for each of the six case study communities.

2. Approach

2.1 Introduction

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

- Short-Term Control Measures
- Source Reduction
- Local Storage
- Treatment
- Transport Capacity

Short-term control measures and source reduction are described in detail in Section 3. Local storage, treatment, and transport capacity are described in detail in Section 4. Short-term control measures are viewed as temporary solutions to the sanitary sewer overflow problem. In all six case study communities, short-term control measures have either been completed or are on-going.

Source reduction, local storage, and transport capacity are viewed as long-term solutions to the sanitary sewer overflow problem. These alternatives require more time to plan, design, and construct. Although these are local alternatives, the regional implications of these long-term local solutions must be examined as well. Treatment alternatives must meet secondary treatment standards; however, some leeway may be given for sanitary sewage highly diluted by rainwater.

2.2 Model Development

2.2.1 Modeling Technical Memorandum Summary

The development of the models used to simulate wet weather events and the corresponding sanitary sewer overflows in the case study communities can be found in the technical memorandum titled *SSO Modeling and Calibration for SSO Case Studies.* The following is a summary of the technical memorandum.

To characterize the wet weather response in sanitary sewered areas, it is helpful to first understand its causes. By definition, separate sanitary systems are not designed for acceptance and conveyance of storm related flows. However, due to a number of factors, these systems can exhibit a wet weather response to storm events.

Generally, the sources of wet weather flows into a sanitary system are classified as infiltration-related sources or inflow-related sources. Infiltration is generally any water other than the intended wastewater that enters a sewer system from the ground through cracks or openings in defective pipes, connections, or manholes. Inflow

sources are generally any direct connection to the sanitary sewer such as roof leaders, yard drains, manhole covers, cross connections from storm drains, or basement foundation drains.

These sources of wet weather flows are defined as rain dependent inflow and infiltration (RDII) to distinguish from inflow and infiltration (I/I) that could occur during dry weather. The amount of response can vary, depending on the factors causing the response. For many older systems, footing drains of residential homes can be a major contributor. Footing drain connections to the sanitary sewer used to be allowed, provided the connections were above the normal groundwater levels.

RDII flow is an important component of the sanitary flow because all of it must be conveyed to the wastewater treatment plant (WWTP) for treatment. It is a significant source of flow in the regional collection system because of the size of the sanitary areas that are tributary to the DWSD WWTP. As a result, the RDII flows can impact the amount of WWTP capacity that is available for handling wet weather flows from the combined areas.

The approach used in characterizing the wet weather response for the six case studies is based on the approach used in the development of the Greater Detroit Regional Sewer System (GDRSS) Model. The GDRSS Model uses several modules of the U.S. EPA's Storm Water Management Model (SWMM) to predict wet weather response within the regional collection system. The SWMM RUNOFF module is used to predict the flows that are generated in response to wet weather for both combined and separated sewer systems. For combined areas, RUNOFF can estimate surface runoff and overland flow routing. For sanitary service areas, RUNOFF can estimate the rain dependent inflow/infiltration.

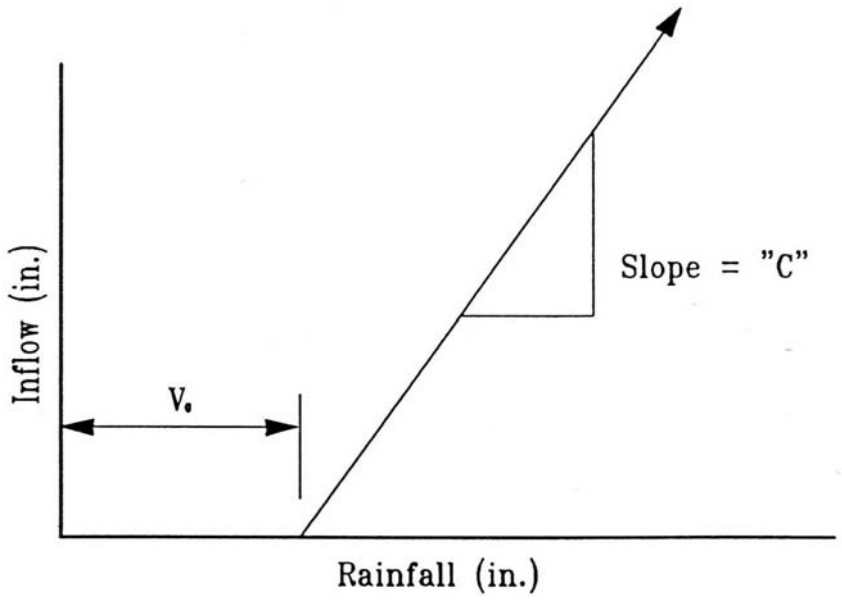
For sanitary areas, RUNOFF determines the RDII response as the fraction of rainfall that enters a sanitary sewer system during a rainfall event after satisfying the requirements of initial abstraction. The amount of RDII response to a rainfall event is calculated as follows:

$$\text{RDII Volume} = C\,(P - Vo)\,A$$

Where C is the RDII response factor, P is the rainfall, Vo is the initial abstraction (storage) or amount of rainfall below which a response is typically not seen, and A is the tributary area.

The RDII C factor has been defined as the slope of a best fit line which can be estimated by dividing the measured runoff by rainfall minus initial abstraction for a number of selected rainfall events, as shown in Figure 2.2.1.
In this figure, a fraction of rainfall described as Vo represents initial abstraction below which wet weather response is not realized in the collection system. The line is a best-fit line for a number of points determined as inflow and infiltration vs. rainfall. The slope of the line is defined as RDII C factor.

Figure 2.2.1. RUNOFF Characterization of RDII



The RDII C factor and initial abstraction are the RDII parameters used in RUNOFF to relate total response volumes to the precipitation. To quantify how this response volume is distributed over time into the collection system, up to three triangular unit hydrographs can be defined in RUNOFF so that one may define a fast response, a delayed response, and a lengthy response, as needed to properly represent the actual flow regime.

Parameters used to describe these hydrographs are T, K and the fraction of RDII C applied to each hydrograph. The T term represents the time from rainfall to the peak of the hydrograph and K is the ratio of the time to recession to the time to peak for the hydrograph. The fraction of RDII C applied to each hydrograph is based on the areas of each of the component hydrographs.

Case study models are based on the GDRSS model development. Local flow and rain data were used to determine the volume and shape parameters in the RUNOFF module of SWMM. Field data was used to determine the hydraulics of the system. The hydraulics of the case study communities were modeled in the Extended Transport (EXTRAN) module of SWMM.

2.2.2 Design Storms and Conditions

For the case studies, a series of design storm events were used for review of existing conditions. 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 SWMM models

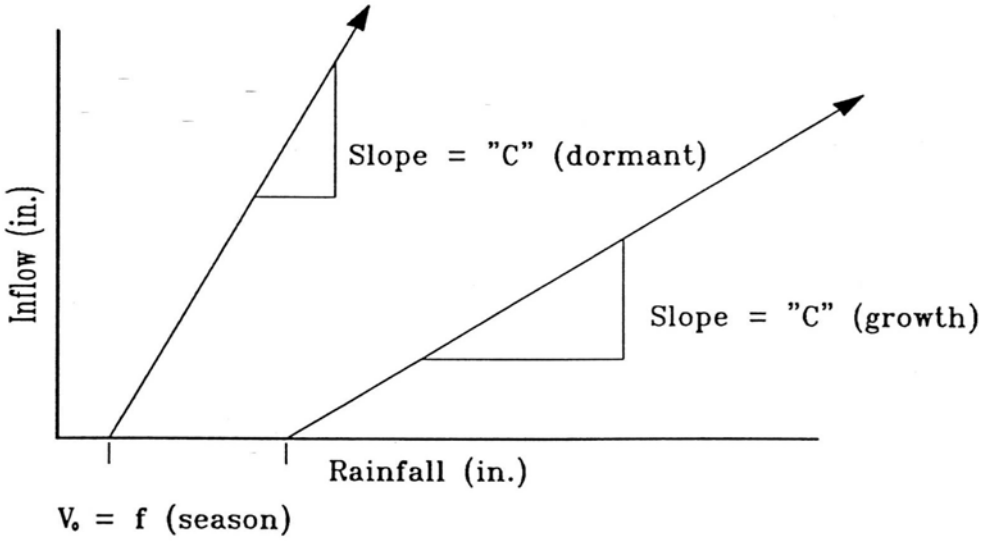
developed for each case study were used to predict the amount of wet weather that would be produced for each of these events.

For the five 24-hour design storms, the Brater-Sherrill rainfall distributions were used. The Brater-Sherrill method uses a different rainfall distribution for dormant and growth conditions, respectively.

During the GDRSS Model development, the inflow and infiltration vs. rainfall analysis conducted on the data provided by different communities tributary to the DWSD wastewater collection system revealed that the initial abstraction and RDII terms are seasonally dependent. This variation in the response is graphically shown in Figure 2.2.2.

This seasonal dependence can be attributed to the groundwater fluctuations due to natural recharge from rainfall and/or snowmelt and in the variation in the evapotranspiration rates throughout the year. With this representation, the wet weather response during dormant conditions is higher than during the growth conditions, as the initial abstraction is lower and the slope of the response (C) is higher.

Figure 2.2.2. Seasonal Variation in the RDII response



As explained in the introduction, the Wastewater Master Plan is a planning level document and study. Therefore, the local alternatives were modeled under both growth conditions and dormant conditions for the five design storm events in order to obtain a range of values for planning purposes.

2.3 Alternative Evaluation Methodology

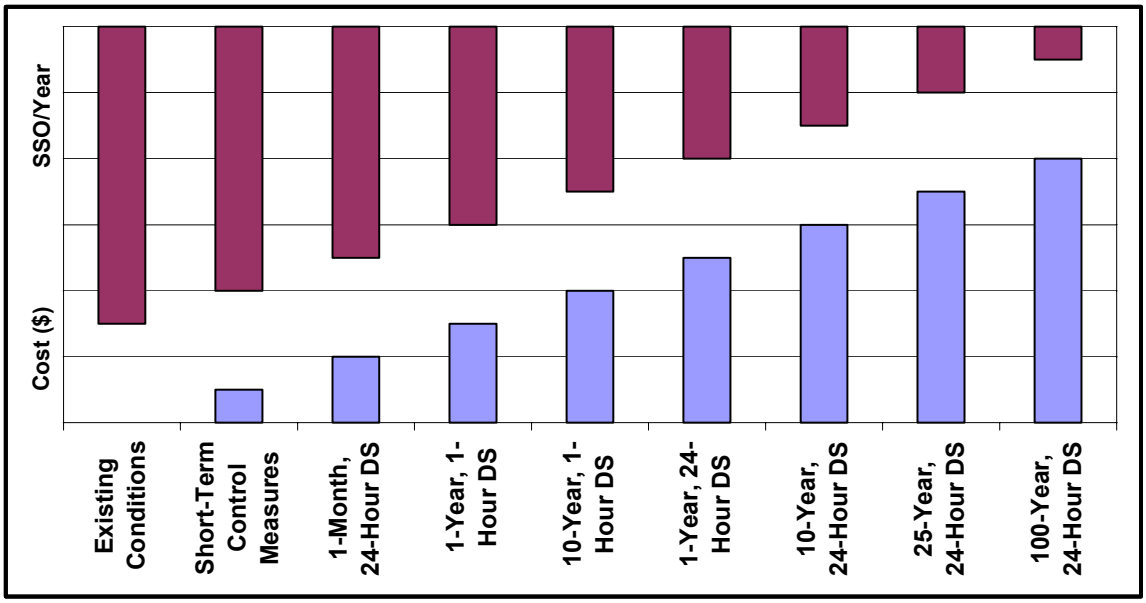
The local alternatives in the case study communities are studied for the seven design storms. For each of the local alternatives, the cost is directly proportional to sanitary sewer overflow prevention.

For example, a local alternative designed to prevent sanitary sewer overflows during the 10-year, 24-hour design storm would be less costly than the same alternative designed to prevent SSOs during the 25-year, 24-hour design storm. The same alternative designed to prevent SSOs during the 10-year, 24-hour design storm would be far more expensive than just relying on short-term control measures.

However, more SSOs would be prevented designing a local alternative to the 25-year, 24-hour design storm than designing to the 10-year, 24-hour design storm. More sanitary sewer overflows would be prevented designing a local alternative to the 10-year, 24-hour design storm than only using short-term control measures.

This cost/benefit analysis is generalized in Figure 2.3.1. The ultimate design level must not only take cost into consideration. It must also be in accordance with state and federal regulations.

Figure 2.3.1. Cost/Benefit Analysis for SSO Prevention



3. Flow Reduction

3.1 Short Term Control Measures

3.1.1 Description

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 short-term SSO control measures.

The attachment contained several actions that can and should be implemented in the short-term to minimize and partially control sanitary sewer overflows associated with capacity deficiencies or excessive wet weather flows. The list may be used as the basis for initial corrective actions in response to the Michigan Department of Environmental Quality's Sanitary Sewer Overflow (SSO) Strategy.

The following items were listed on the attachment:

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 force main 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 completion 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.

Engineering evaluation and selection of the final project(s) to eliminate SSOs and the subsequent design and construction of additional capital improvements will be, in many cases, beyond the scope of the short-term remedial measures. Long-term programs may be needed, especially in regional service systems, where it may be necessary to address deficiencies in downstream transportation or treatment facilities to accept additional peak flow rates and volumes, either during the wet weather event or during post-event retention system de-watering.

3.1.2 Modeling Approach

In some cases, recent flow and rainfall data were collected from the case study communities. The flow and rainfall data were 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 are reflected in the flow and rain data and thus are reflected in the model. Otherwise, the results of short-term control measures for each case study are explained qualitatively, but not quantitatively.

3.1.3 Other Approaches and Results

Just as the Michigan Department of Environmental Quality comprised a list of short-term measures to control SSOs in the state, the EPA has used a capacity, management, operation and maintenance (CMOM) approach to control SSOs nationwide. The EPA website, www.epa.gov, lists several communities that have reduced SSOs by implementing interim CMOM measures. Four of these case studies are detailed below. The Water Environment Federation (WEF) also published information on short-term control measures. That information was used in the North Huron Valley / Rouge Valley system and is presented below.

3.1.3.1 Fairfax County, Virginia

Fairfax County is a 399-square mile region in northeastern Virginia located along the western bank of the Potomac River. The Fairfax County Wastewater Collection Division (WCD) sewer collection system serves 234-square miles of the county and nearly 85% of its population. The system collects an average of 100 million gallons per day of flow and delivers it to five treatments plants.

WCD began tracking SSOs closely in 1995, when there were 128 occurrences. That same year, engineering design for upgrading and improving Alexandria Sewerage Authority (ASA) wastewater treatment plant was underway. WCD's peak wet weather flows of 80-MGD were well over its allocation of 65-MGD.

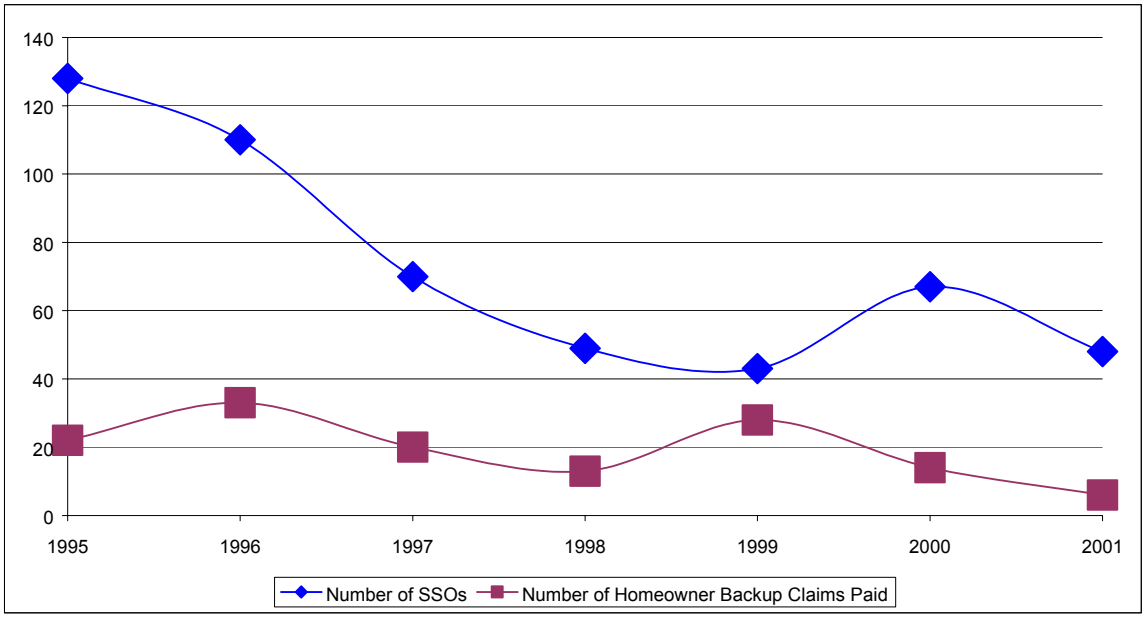
Rather than construct a large wastewater storage facility to contain excess peak volumes, WCD opted to reduce inflow and infiltration into its system in the service area contributing flow to ASA. Comprehensive television inspection was performed on all sewer mains, revealing a large number of deteriorated lines. The lines were

rehabilitated resulting in peak flows reduced to below 50-MGD, which are well below the target reduction of 65-MGD.

WCD realized that in order to address the blockages effectively, the program had to be expanded to the entire system, and had to address operation and maintenance (O&M) issues as well as rehabilitation needs. Major programs included a trunk line rehabilitation program, a pump station rehabilitation program, a sag elimination program, a flow meter replacement program, and appropriate training of employees on a regular basis.

Between 1995 and 2001, WCD rehabilitated or replaced over 127 miles of sewers, 77 manholes, and 22 pump stations. As a result, WCD reduced the number of SSOs by 67% and also made significant reductions in the impact of SSOs on the environment and private property. Figure 3.1.1 provides year-by-year results.

Figure 3.1.1. SSO Abatement Progress (Fairfax County, VA)



The primary performance measures for WCD's CMOM program are:

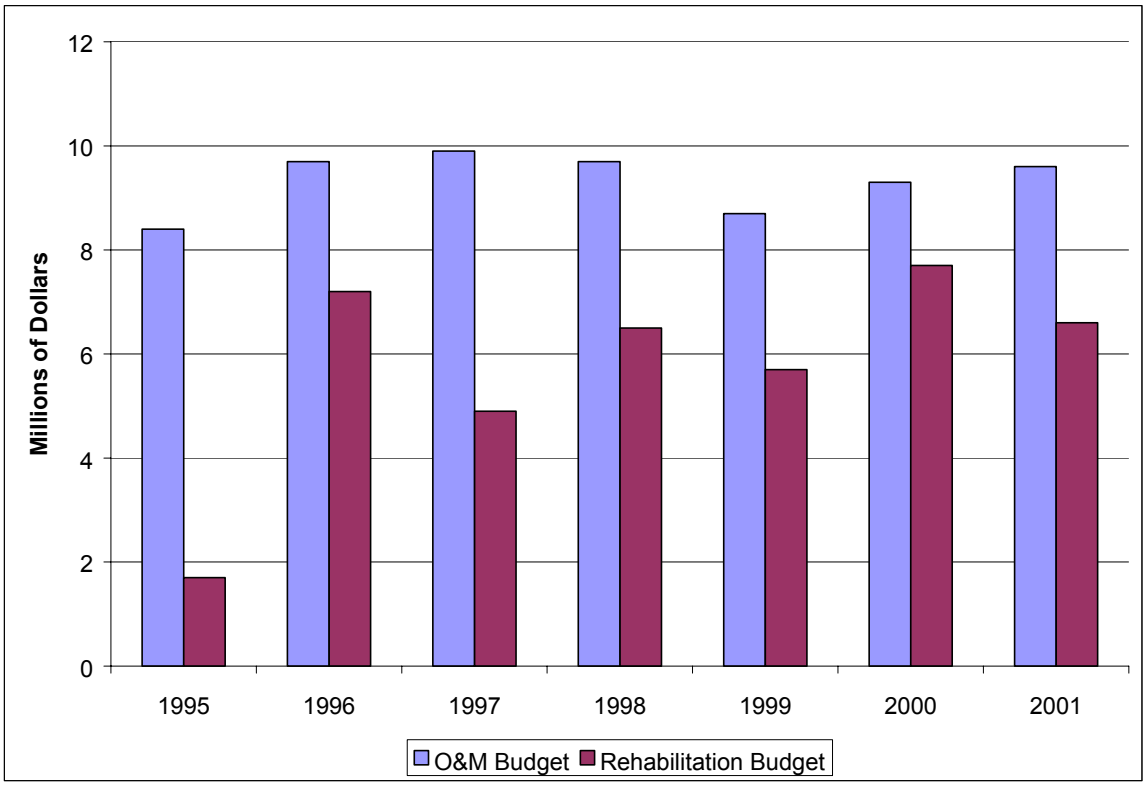
- Reductions in the number of backups and SSOs
- Reduction in peak flows in the system
- No pump station shut downs due to equipment malfunction

These measures are tracked and evaluated throughout the year. If performance goals are not met, program adjustments are made. For instance, in 2000, while the latter

two goals were satisfactorily achieved, the number of backups jumped from 43 to 67. By making necessary adjustments to its line inspection and cleaning programs, WCD was able to reduce the number of SSOs to 48 in 2001.

Between 1995 and 2001, WCD invested $106.4 million in its CMOM program. Of this total, 61%, or $65.3 million, was dedicated to operations and maintenance (O&M), compared to 39%, or $41.1 million spent on rehabilitation. The average annual O&M budget is $9.3 million and the average annual rehabilitation budget is approximately $6 million. WCD expects to continue this level of expenditure through its long-term planning cycle. Figure 3.1.2 breaks down the costs by year.

Figure 3.1.2. SSO Abatement Program (Fairfax County, VA)



Customer revenues cover WCD's annual operating expenses. Fees are charged at a rate of $2.81 per 1,000 gallons of water used. Established rate increases of between 2 percent and 4 percent ensure a stable rate structure that mitigates the impact of annual budget fluctuations.

3.1.3.2 Oklahoma City, Oklahoma

Oklahoma City's 320-square mile sanitary sewer service area lies completely within the municipal boundary and serves approximately 96% of the population. The system contains 2,200 miles of sewer line, 63 lift stations, and four wastewater treatment plants with a combined capacity of 101 MGD. The average dry weather

flow to the plants is 75 MGD. The Oklahoma City Water and Wastewater Utilities Department (CWD) operate the sanitary sewer collection system under the financial management of the Oklahoma City Water Utility Trust (OKWUT).

In the mid-1980s, Oklahoma City faced widespread sanitary sewer line failures that led to almost daily sanitary sewer overflow backups into homes and businesses. Between 1983 and 1987, CWD performed 805 home cleanups, an average of 161 per year. With so much effort focused on SSO response and home cleanups, CWD staff had little time for system evaluation, maintenance, or rehabilitation.

Beginning in 1986, CWD began replacing 22 miles per year of its sewer line, or approximately 1% of the system. The sections to be replaced are prioritized annually. By 1991, the frequency and magnitude of the backups had dropped off dramatically because the worst lines had been replaced.

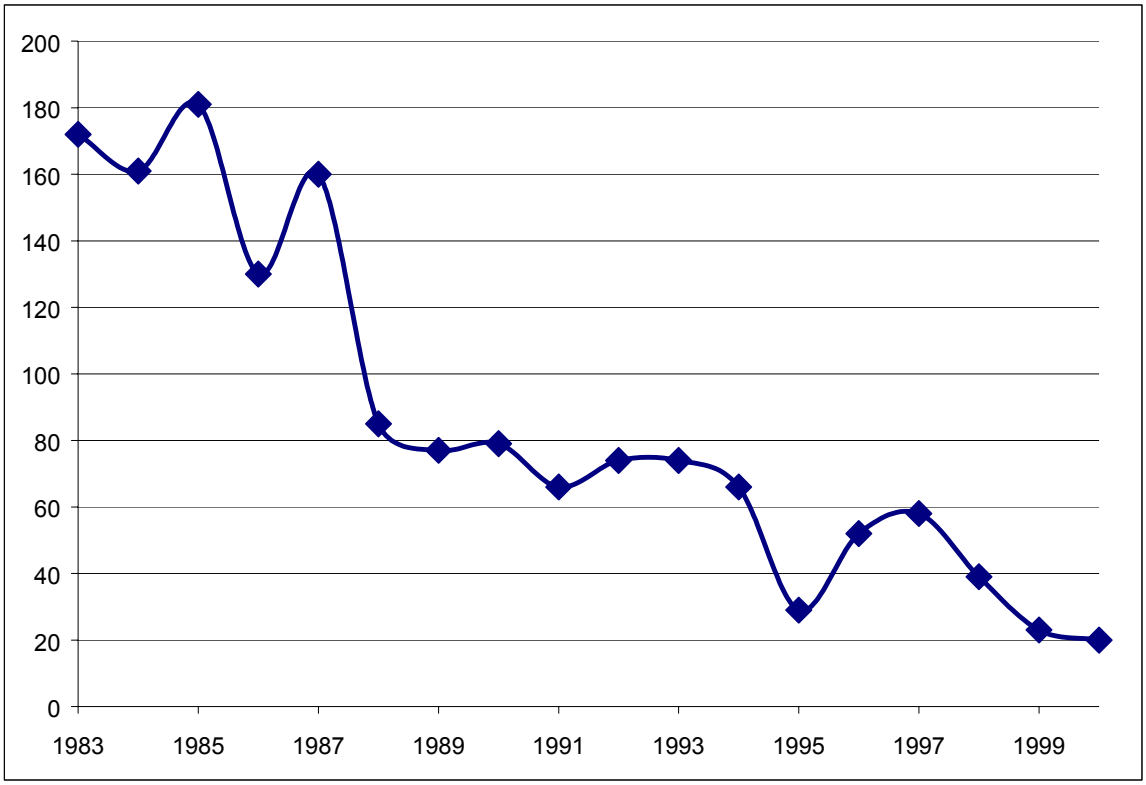
In addition to the new pipe, CWD upgraded the wastewater treatment plants, installed new service mains, rehabilitated, replaced, or retired a number of lift stations, and completed an extensive manhole rehabilitation and replacement program. CWD has established an annual maintenance program that includes cleaning and maintaining at least 2,000 manholes per year, cleaning and maintaining at least 237 miles of line, and televising at least 75 miles of line. Since data tracking began in 1996, CWD has exceeded these maintenance goals every year.

In 1986, OKWUT was established by the city manager as an enterprise trust. OKWUT provides the financing and management structure needed to create long-term solutions for the City's sanitary sewer, wastewater treatment, and drinking water systems. OKWUT operates like a profit-generating business, collecting and disbursing sewer system revenues to pay day-to-day program expenses and fund long-term capital improvements.

As of 2001, CWD and OKWUT have spent approximately $84 million on the sewer system rehabilitation. By 2086, the total price tag for the program is expected to amount to almost $1 billion, yet the cost to customers has been held to about $13 per person, or $6 million per year.

To date, the number of SSOs, as measured by sewer clean-up claims from private property owners, has dropped almost 80% from 1983. Figure 3.1.3 provides year-by-year results.

Figure 3.1.3. Number of Sewer Backup Claims Paid (Oklahoma City, OK)



3.1.3.3 Johnson County, Kansas

Throughout the early 1980s, the Johnson County, Kansas sewage collection system suffered numerous SSOs, mostly affecting residential and commercial buildings. The system was so heavily influenced by inflow and infiltration that even moderate amounts of rainfall exceeded its capacity.

Johnson County Wastewater (JCW) has a 20-square mile service area in eastern Kansas that shares a border with Kansas City, Missouri. The region is dominated by single-family homes, commercial businesses, and some light industry. The service area encompasses 22 communities with a population of approximately 500,000, and includes 1,650 miles of sewer line, nine wastewater treatment plants processing 38 MGD of dry weather flow, and 32,000 manholes.

In 1985, JCW implemented an inspection survey for both businesses and homes. Within a year, most of the 55,000 property owners had readily complied with the request to access their homes and buildings.

While on the property, the inspectors would tour the building interior and grounds, noting locations of any drains, downspouts, or other connections that appeared to be connected to the sewer system. The most common sources of inflow were foundation

drains, basement drains, sump pumps, cleanouts and downspouts, and outdoor drains. The actual percentages of each inflow source are displayed in Table 3.1.1.

Table 3.1.1. Inflow/Infiltration Sources (Johnson County, KS)

Inflow/Infiltration Source	Percent
Foundation Drains	59
Outdoor Drains	4
Downspouts	6
Sump Pumps	13
Basement Entry Drains	18

Private connections were catalogued according to their size, route of discharge, location in the watershed, and condition. All unpermitted sources were scheduled for disconnection, and those that were suspected of contributing storm water inflow were subjected to smoke and/or dye testing.

A hydrologic model was developed and applied to help JCW prioritize its remedial efforts, starting with the most serious problems first. Implementation of the entire program took just over five years to complete. The result of the inspection program included repair or replacement of 17,000 manhole structures and the disconnection of more than 15,600 unpermitted sources of storm water inflow on private property.

The inflow and infiltration program was completed in 1994. Post-reduction program flow monitoring conducted between 1995 and 1997 revealed that wet weather flows in the target communities had been reduced between 42% and 71%. Overall, inflow and infiltration during the 10-year, 1-hour storm were reduced from 494 MGD to 214 MGD.

The inflow and infiltration reduction program cost a total of $60 million. Of that total, the private connection program was the least expensive component, at just under $10.3 million. $30 million went to collection system improvements, and the remaining $19.7 million was used to cover program-specific engineering and administrative expenses.

JCW was able to obtain $12 million in grant funds and $18 million in low-interest state revolving loans, but the private connection work was not eligible for public funds. JCW covered the costs with obligation bonds that are being paid for through a tax increase.

3.1.3.4 Greenwood County, South Carolina

The collection system serving the City of Greenwood and environs sprawls over a 100-square mile area of Greenwood County, which is located in the historic and largely rural Upper Savannah Region. The Greenwood Metropolitan District (Metro) serves a population of 45,000, plus several large industrial facilities that account for 40% of the dry weather flow. The system was a patchwork of 38 small collection systems and pump stations that fed into Metro's trunk lines, two pump stations, and two wastewater treatment plants. The City of Greenwood's system was the oldest, with some 100-year-old components.

In 1998, chronic pump station overflows led the South Carolina Department of Health and Environmental Control (SCDHEC) to issue a Consent Order against Metro for allowing untreated wastewaters of the state. In 1999, Metro took ownership of several smaller systems and became responsible for maintaining and operating 350 miles of pipe, two wastewater treatment plants, 26 pump stations, and two septic tank effluent pump systems. The average daily combined dry weather flow to the wastewater treatment plants is 9 MGD.

During 2000, the first full year of data tracking, Metro recorded 77 sanitary sewer overflows, of which 48 were considered reportable to SCDHEC. Reportable SSOs must be over 500 gallons and pose an imminent health risk to the public or likely degrade environmental resources.

Also in 2000, Metro worked with SCDHEC to design and implement a CMOM program. The following are integral parts of Metro's ongoing CMOM program:

- Provide adequate maintenance facilities and equipment
- Develop and maintain a map of the collection system
- Conduct routine preventative operation and maintenance activities
- Assess the current capacity of the collection system and treatment facilities
- Identify and prioritize structural deficiencies
- Develop short- and long-term plans to address structural deficiencies
- Appropriate training on a regular basis
- Identify and inventory equipment and critical replacement parts

Metro has provided several monitoring programs to track the effectiveness of its CMOM activities in achieving the major program goals. In order to quantify inflow

and infiltration reduction, Metro tracks weekly inflow to its two treatment plants, in addition to weekly rainfall. Metro also continually monitors flow within the system to assess system function and identify hydraulic weakness. Metro also began a stream monitoring program in 1999 to evaluate water quality upstream and downstream of eight pipe crossings.

Metro estimates the annual cost of the CMOM program is $1.3 million per year, which is financed entirely by a $8.00 monthly CMOM fee. The cost breaks down to about $800,000 per year for operations and maintenance and $500,000 per year for capital projects. The City of Greenwood also contributed a one-time $3.6 million grant to fund high-priority remediation needed to satisfy the Consent Order, and to cover the CMOM start-up costs on its part of the system.

In just one year, Metro's CMOM program has already become an integral part of its sewer management philosophy and operational strategy. Metro and its member communities have been rewarded with improved customer service, better system operations, and reduced inflow/infiltration that is expected to lead to a substantial reduction in SSOs in less than three years.

3.1.3.5 Water Environment Federation

The Water Environment Federation in its publication *Control of Infiltration and Inflow in Private Building Sewer Connections*, presented estimated costs associated with a number of rehabilitation techniques, calculated on a per gallon basis. These costs are presented in Table 3.1.2.

Table 3.1.2. WEF Estimated Rehabilitation Costs

Control Option	1996 Unit Present Worth Cost ($/gal)
Construct new WWTP (0.1 to 1.0 MG)	3.81 to 18.80
I/I Removal - Public Facilities	
Manhole grouting	0.04 to 0.30
Main Line grouting (public works)	0.05 to 0.36
Main Line grouting (contractor)	0.16 to 2.22
I/I Removal – Private Facilities	
Footing drain removal	0.20 to 3.72
Building sewer replacement	0.20 to 0.27

The estimated cost per gallon removed varies significantly because the effort required is highly dependent on site-specific conditions. Estimates prepared by individual communities as part of Sewer System Evaluation Survey programs provide estimates specific to the local wastewater collection system, which typically show much less variation.

3.2 Source Reduction – Footing Drain Disconnection

3.2.1 Description

It is known that inflow and infiltration from footing drains that are connected to the sanitary sewer system add storm water to sanitary sewers. Studies have shown that up to 70% to 90% of the rain dependent inflow and infiltration is attributable to footing drains.

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. First, there will be limited construction in the street. Construction would take place between the sidewalk and the street. Second, flows to the interceptors are reduced.

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 $6,790 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.

3.2.2 Modeling Approach

Although studies have shown footing drains are responsible for up to 70% to 90% of rain dependent inflow and infiltration, the actual value varies by community. Therefore, footing drain flows were examined on a case-by-case basis.

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 needed homeowner participation depended on the design storm and local conditions. In some cases, 100% of homeowner participation is required in order for footing drain disconnection to be an effective local alternative.

3.3 Best Management Practices for New Construction

3.3.1 Uniform Plumbing Code

The International Association of Plumbing and Mechanical Officials (IAPMO) is publishing a 2003 updated Uniform Plumbing Code (UPC) for all new construction. A draft of the UPC was released in 2001. Chapter 7 of the UPC applies to sanitary drainage from new construction. The followings are excerpts from the sanitary drainage chapter of the UPC:

It shall be unlawful for any person to deposit, by any means whatsoever, into any plumbing fixture, floor drain, interceptor, sump, receptor or device which is connected to any drainage system, public sewer, private sewer, septic tank, or cesspool, any ashes, cinders, solids, rags, flammable, poisonous, or explosive liquids or gases, oils, grease, and any other thing whatsoever which would or could cause damage to the public sewer, private sewer, or private sewage disposal system.

No rain, surface, or subsurface water shall be connected to or discharged into any drainage system, unless first approved by the Authority Having Jurisdiction.

No cesspool, septic tank, seepage pit, or drain field shall be connected to any public sewer or to any building sewer leading to such public sewer.

No commercial waste grinder shall be connected to a private sewage disposal system unless permission has first been obtained from the Authority Having Jurisdiction.

Chapter 11 applies to storm drainage from new construction. The followings are excerpts from the storm drainage chapter of the UPC:

All roofs, paved areas, yards, courts, and courtyards shall be drained into a separate storm sewer system, or into a combined sewer system where a separate storm sewer system is not available, or to some other place of disposal satisfactory to the Authority Having Jurisdiction.

Storm water shall not be drained into sewers intended for sanitary drainage only.
Subsoil drains shall be provided around the perimeter of buildings having basements, cellars, or crawl spaces or floors below grade. Such subsoil drains may be positioned inside or outside of the footing, shall be perforated, or open-jointed approved drain tile or pipe not less than three inches in diameter, and shall be laid in gravel, slag, crushed rock, approved three-quarter inch crushed recycled glass aggregate, or other approved porous material with a minimum of four inches surrounding the pipe on all sides. Filter media shall be provided for exterior subsoil piping.

Subsoil drains shall be piped to a storm drain, to an approved watercourse, to the front street curb or gutter, or to an alley; or the discharge from the subsoil drains shall be conveyed to the alley by a concrete gutter. Where a continuously flowing spring or groundwater is encountered, subsoil drains shall be piped to a storm drain or an approved watercourse.

Where it is not possible to convey the drainage by gravity, subsoil drains shall discharge to an accessible sump provided with an approved automatic electric pump.

The sump shall be at least fifteen inches in diameter, eighteen inches in depth, and provided with a fitted cover. The sump pump shall have an adequate capacity to discharge all water coming into the sump as it accumulates to the required discharge point, and the capacity of the sump shall not be less than fifteen gallons per minute. The discharge piping from the sump pump shall be a minimum of one and one-half inches in diameter and have a union or other approved quick disconnect assembly to make the pump accessible for servicing.

For separate dwellings not serving continuously flowing springs or groundwater, the sump discharge pipe may discharge onto a concrete splash block with a minimum length of twenty-four inches. This pipe shall be within four inches of the splash block and positioned to direct the flow parallel to the recessed line of the splash block.

Subsoil drains subject to backflow when discharging into a storm drain shall be provided with a backwater valve in the drain line so located as to be accessible for inspection and maintenance.

3.3.2 EPA Storm Water Best Management Practice

The EPA has comprised several Best Management Practices (BMPs) relating to storm water and new construction. Four BMPs that could be applicable to the case study communities, storm drain inlet protection, eliminating curbs and gutters, porous pavement, and infiltration drainfields are detailed below. The following sections were obtained from the EPA website, www.epa.gov.

3.3.2.1 Storm Drain Inlet Protection

Storm drain inlet protection measures are controls that help prevent soil and debris from site erosion from entering the storm drain drop inlets. Typically, these measures are temporary controls that are implemented prior to large-scale disturbance of the surrounding site. These controls are advantageous because their implementation allows storm drains to be used during even the early stages of construction activities. The early use of storm drains during project development significantly reduces the occurrence of future erosion problems.

Three temporary control measures to protect storm drain drop inlets are:

- Excavation around the perimeter of the drop inlet
- Fabric barriers around inlet entrances
- Block and gravel protection

3.3.2.2 Eliminating Curbs and Gutters

Eliminating curbs and gutters involves promoting the use of grass swales as an alternative along residential streets. Curbs and gutters are designed to quickly convey

runoff from the street to the storm drain and, ultimately, to the local receiving water. Consequently, curbs and gutters provide little or no removal of storm water pollutants. Indeed, curbs often act as a pollutant trap where deposited pollutants are stored until they are washed out in the next storm. Many communities require curb and gutters as a standard element of their road sections, and discourage the use of grass swales. Revisions to current local road and drainage regulations are needed to promote greater use of grass swales along residential streets, in the appropriate setting.

The major maintenance requirement for grass swales involves mowing during the growing season, a task usually performed by homeowners. In addition, sediment deposits may need to be removed from the bottom of the swale every ten years or so, and the swale may need to be tilled and re-seeded periodically. Occasionally, erosion of swale side slopes may need to be stabilized.

3.3.2.3 Porous Pavement

Porous pavement is a special type of pavement that allows rain and snowmelt to pass through it, thereby reducing the runoff from a site and surrounding areas. In addition, porous pavement filters some pollutants from the runoff it maintained. Porous pavement may substitute for conventional pavement on parking areas, areas with light traffic, and the shoulders of airport taxiways and runways, provided the grades, sub-soils, drainage characteristics, and groundwater conditions are suitable. The advantages of using porous pavement include:

- Water treatment by pollutant removal
- Less need for curbing storm sewers
- Improved road safety because of better skid resistance
- Recharge to local aquifers

3.3.2.4 Infiltration Drainfields

Infiltration drainfields are innovative technologies that are specially designed to promote storm water infiltration into sub-soils. These drainfields help to control runoff and prevent the contamination of local watersheds. The system is usually composed of a pretreatment structure, a manifold system, and a drainfield.

Runoff is first diverted into a storm sewer system such as an oil and grit separator. The oil and grit chamber effectively removes coarse sediment, oils, and grease from the runoff. The storm water runoff then continues through a manifold system into the infiltration drainfield.

The manifold system consists of a perforated pipe, which distributes the runoff evenly throughout the infiltration drainfield. The runoff then percolates through an underlying aggregate sand filter and fabric into the sub-soils. Infiltration drainfields are most applicable on sites with relatively small drainage areas. They can be used to control runoff from parking lots, rooftops, impervious storage areas, or other land uses. Infiltration drainfields should not be used in locations that receive a large sediment load that could clog the pretreatment system, which in turn would plug the infiltration drainfield and reduce its effectiveness.

4. Local Storage, Treatment, and Transport Capacity

4.1 Local Storage

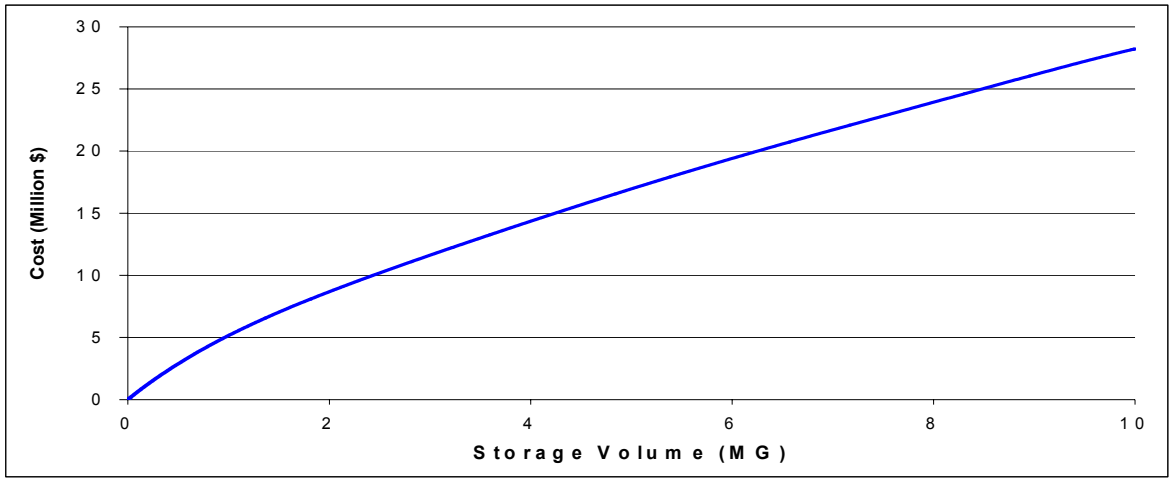
4.1.1 Description

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 does have disadvantages as well. The storage basins must be properly maintained. Therefore, access to storage basins is required. There are additional costs associated with the maintenance. Also, there is potential for odors in the storage basin.

The cost curve used for estimating storage costs is shown in Figure 4.1.1. These estimates include design engineering and construction costs. This curve is based on recent basins constructed in the region.

Figure 4.1.1. Storage Cost Curve



4.1.2 Modeling Approach

Local storage models were simulated for the seven design storms in both growth and dormant 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.

In each case study community, the storage volumes for the growth and dormant conditions were extrapolated for a range of RDII response factors. The seven design storm events were plotted on the same graph.

4.2 Treatment

4.2.1 Description

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. However, some leeway may be given for achieving 85% removal for sanitary flows that have been diluted with rainfall.

Locally, the City of Center Line and the City of Fraser both looked into treatment alternatives. The City of 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.

The City of Center Line submitted the grant application with the assistance of Anderson, Eckstein and Westrick, Inc. Sections of the grant application are listed in the following paragraphs.

While a permanent solution is being evaluated, the City would like to implement a pilot study of the oxygen enrichment system (OES) on the overflow occurring downstream of the Stephens Pump Station.

Traditional disinfection programs include sodium hypochlorite, peracetic acids, sodium bromide with sodium hypochlorite and ultraviolet/ozone. The City also wants to investigate the use of hydrogen peroxide as a disinfectant.

The goal of the proposed project is to eliminate the negative affects associated with the sanitary sewer overflow occurring at the Stephens Pump Station. Currently, this overflow flows during wet weather through 3.5 miles of enclosed pipe until it discharges in the open portion of Bear Creek. This pilot project would be implemented while allowing the City to continue to pursue system rehabilitation to meet the ultimate goal of eliminating the overflow altogether. This proposal parallels the draft rules proposed by the SSO Federal Advisory Committee at EPA, SEMCOG's SSO Task Force and the American Municipal Sewerage Association.

The City of Center Line proposes to work with Great Lakes Restoration (GLR), who developed an oxygen enrichment system. GLR is a nonprofit research and educational organization that has been investigating the bacteriological and chemical conditions of the Clinton River Watershed for the past five years. GLR is committed to developing creative and innovative Best Available Technologies for restoring the Clinton River. GLR has engineered technical solutions that address treatment of E. coli bacteria, sediment transport and removal, pollutant concentration and recovery, and long-term maintenance of the Clinton River. Bench testing of the OES technology has proven to be efficacious, based on scientific principles and cost effectiveness. The City will also evaluate other proposed vendors with proven experience in these applications.

The City's engineering firm, Anderson, Eckstein and Westrick, Inc. is intimately familiar with the City's sanitary and stormwater systems and discovered the overflow weir. They will be overseeing the evaluation of the technology, the installation of the treatment system, and the follow-up monitoring.

The OES pilot project involves the introduction of hydrogen peroxide at four treatment tiers that will be constructed within the Stephens Storm Drain, downstream of the Stephens Pump Station overflow. Each tier will be designed to initiate based on the volume of flow in the system. Using hydrogen peroxide, the OES will 1) reduce E. coli bacteria levels to less than 1-cfu/100-mL; 2) convert the 5 day biological oxygen demand (BOD_5), total organic compounds (TOC), fats, oils, and grease (FOG), and 5 day chemical oxygen demand (COD_5) into water, carbon dioxide, and oxygen; 3) remove organic matter that forms metal complexes from the clay sediments; 4) convert the bottom zone of the storm drain from a slow anaerobic system to a fast anaerobic system, which can metabolize and reduce BOD, COD, semi-volatile organic compounds, FOG, poly-nuclear aromatics, and total petroleum hydrocarbons (collectively known as muck levels); and 5) purge volatile organic compounds by changing the dissolved oxygen equilibrium. The use of the OES will be coupled with the use of a vortex separator, which will increase the efficiency of the OES by removing floatable and settleable solids. Total suspended solids removal by the separator is expected to be between 40% and 50%, which is equivalent to primary wastewater treatment.

The City will work with the MDEQ, the Macomb County Health Department, the Macomb County Office of Public Works Commissioner and the Macomb County Water Quality Board to evaluate the success of the pilot project. The MCHD has been collecting E. coli data at the

outlet of the Lorraine Drain on a weekly basis for the past year. This data will be used to establish the bacteria counts in the stormwater prior to project implementation.

The monitoring data that will be collected for the first 20 months following the system installation will be used to determine the efficacy of the system. The City will coordinate the monitoring with the MCHD and/or the MDEQ and provide split samples, if desired, to develop a statistically significant database on monitoring.

***Task 1: Engineering Design** - The City will work with its consultants to evaluate the state-of-the-art and then draw up plans and specifications for the treatment system. The system as currently envisioned will be designed to include a vortex separator to remove 40-50% of the total suspended solids prior to treatment with an oxygen enrichment system. The system currently envisioned includes a gravity flow system consisting of a tiered mixing and treatment system suspended on the overflow side of the cross connection. Each of the four treatment tiers is actuated by a solenoid, which is controlled by a depth transducer-controller. Sewage will overflow to the tiers in a cascade with each tier providing for uniform mixing of the sewage with the injected hydrogen peroxide. In low flow events tiers 1 and 2 will activate and higher flows will activate tiers 3 and 4. Each mixing tier will be designated to produce different dosing rates so that nonlinear changes in flows can be accomplished. The facility will be constructed to handle overflow events in excess of 2.5 million gallons.*

***Task 2: Facility Construction** - The facility will be constructed by the City's contractor to meet the requirements set forth in the approved plans and specifications. This includes survey and inspection of the sewer installation.*

***Task 3: Monitoring and Evaluation** - Monitoring stations will be selected as a part of the design and construction of the facility. Monitoring stations will consist of an access port to the treatment stream for sampling for E. coli, BOD, COD, FOG, TOC, temperature, DO, and pH. This data will be collected and evaluated to optimize the system. Once system optimization is complete, wet weather overflows will be monitored for at least 8 wet weather events. The contract will perform maintenance of the system during the initial monitoring stage. A maintenance plan will be developed for the system for the City to implement following the initial monitoring stage.*

***Task 4: Operation and Maintenance** - Once system optimization has been achieved and the initial monitoring has been completed, the City will take responsibility for the operation and maintenance of the system. This will include continued monitoring at three stations, upstream of the treatment system, downstream of the last tier and at the outlet of the Lorraine Drain to Bear Creek. Sampling will be conducted for the following parameters: E. coli, BOD, COD, FOG, TOC, temperature, DO, and pH. Maintenance reports will be completed in compliance with the maintenance plan.*

***Task 5: Reporting** - Quarterly status reports will be provided to the MDEQ. A final report will also be prepared summarizing the project findings at the end of the grant period. These reports will be provided in electronic, as well as, hard copy format. Finally, a release of claims statement will be submitted to the MDEQ at the end of the grant period.*

The total cost of the Peak Excess Flow Treatment Facility was $500,386. The City of Center Line requested $360,460 in grant dollars. The city also offered $139,926 in a local match. The cost breakdown of the proposed Peak Excess Flow Treatment Facility for the City of Center Line is in Table 4.2.1.

Table 4.2.1. Center Line Peak Excess Flow Treatment Pilot Project Budget

Budget Categories	Grant Funds	Local Match	Category Total
Staffing	$0	$13,025	$13,025
Fringe Benefits	$0	$4,689	$4,689
Indirect Costs	$0	$1,771	$1,771
Contractual Services	$360,460	$0	$360,460
Project Supplies and Equipment	$0	$120,313	$120,313
Travel	$0	$128	$128
GRAND TOTAL	**$360,460**	**$139,926**	**$500,386**

The grant application was submitted with the written support of the local state representative, the local state senator, the Southeast Michigan Council of Governments (SEMCOG), the Clinton River Watershed Council, the Macomb County Public Works Commissioner, the Macomb County Health Department, the Macomb County Water Quality Board, and the Macomb County Board of Commissioners. However, the grant application was rejected by the MDEQ. Therefore, the City of Center Line did not proceed with a treatment alternative.

4.2.2 Modeling Approach

The volume of the storage basin in the treatment alternative is directly related to the design storm and the minimum amount of contact time desired to treat the peak flow of the design storm.

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 unless specifically requested by a case study community.

4.3 Transport Capacity

4.3.1 Description

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 (ROW) and easements. Second, contractors are familiar with this construction method.

The relief sewer option has some disadvantages as well. 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 (HDPE) 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.

There are advantages to using pipe bursting. Pipe bursting construction has less of an impact on traffic than relief pipe construction does. 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.

There are also disadvantages to using the pipe bursting alternative. Access pits would be required to connect homes to the new pipe. A specialized contractor would be needed for all pipe bursting work. Also, larger peak flows could impact the interceptors. This could mean increased construction and costs downstream.

4.3.2 Modeling Approach

Increasing transport capacity will be modeled as a local alternative. Pipe bursting will be used if the existing pipe only needs to be enlarged by one or two diameter sizes. Otherwise, relief pipe will be used. Increasing transport capacity will be studied for the seven design storms.

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. Regional impacts resulting from increasing transport capacity will be studied as part of the regional alternatives portion of the SSO study.

5. Case Study Alternatives

Center Line, Clinton Township, Fraser, Melvindale, Allen Park, and Garden City were selected as case study communities for the regional analysis of SSOs in the DWSD service area. This section describes the local alternatives development involved with each of the six case studies.

5.1 Center Line

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 (993 acres). Additional information on the Center Line SSO can be found in Volume 6 of the Wastewater Master Plan.

5.1.1 Short Term Control Measures

Information regarding short-term control measures in Center Line was found in *City of Center Line Sanitary Sewer System Capacity Analysis and Study*, published by Anderson, Westrick and Eckstein (AEW).

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 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 133,000 linear feet of sanitary sewer and 120,000 linear feet of storm sewer. Eighty-three thousand linear feet of sanitary sewer were constructed prior to 1950. In 1998, a $10 million bond issue was passed to further sewer infrastructure repairs.

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.

The investigation of archived plans and documents show this to be 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 City of Warren sanitary 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). Flow rates of 7.4 cfs have been occasionally witnessed during wet weather events. This has only been observed under dramatically increased head caused by allowing the level in the wet well at the lift station to rise 15 to 20 feet to maximize system storage.

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 SSOs altogether:

- Installation of a depth-measuring and data-logger device at the Parshall Flume Chamber to allow for accurate measurement of any future overflow event.

- Construction of additional weir height (approximately 1.5-feet) above the crown elevation of the 24-inch interceptor sewer and optimization of the pump station controls to maximize system storage.

- 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.

- Continuing investigations through flow monitoring and proposed correction of potential causes of excessive infiltration and inflow to the sanitary sewer system under a schedule recently approved by MDEQ.

- 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.

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. Five taps remain under investigation and subsequent testing has cleared two taps of contamination.

The city has been working with the Macomb County Health Department (MCHD) on a dry weather-sampling program since August 18, 2000. Currently, the city and the MCHD are continuing city-wide dry weather sampling of sub-systems' 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

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 using 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.

5.1.2 Source Reduction

One alternative for eliminating sanitary sewer overflows in Center Line is through source reduction. Source reduction is achieved by reducing rain dependent inflow and infiltration.

Studies have also shown that the exact percentage varies by community. Peak flow reduction was determined from a 40-year analysis of rainfall data at Detroit Metro Airport. The RDII response factors for Center Line are 7.11% in growth and 13.28% in dormant conditions.

The Center Line model was run for the seven design storms. The effects of footing drain disconnections were modeled for both growth and dormant conditions. It was estimated that 1,978 homes in Center Line have footing drains connected to the sanitary sewer system.
If disconnecting 100% of the homes in Center Line still resulted in an SSO, the additional storage volume needed to eliminate the SSO is included. The model results are listed below in Tables 5.1.1 – 5.1.2. The model runs for source control do not include potential peak attenuation that would occur in the mile long pipe after the pump station. Actual effectiveness of source control could be greater than shown in

this table. The costs for local storage shown in Table 5.1.4 show results for both with and without this pipe.

Table 5.1.1. Center Line Source Reduction (Designed to Prevent SSOs)

Design Storm	Growth Conditions		Dormant Conditions	
	Homes Disconnected	Additional Storage (MG)	Homes Disconnected	Additional Storage (MG)
1-Month, 24-Hour (0.62″)	0	0	0	0
1-Year, 1-Hour (1.0″)	0	0	0	0
10-Year, 1-Hour (1.8″)	0	0	1978	0
1-Year, 24-Hour (2.2″)	0	0	1978	0
10-Year, 24-Hour (3.6″)	1117	0	1978	1.5
25-Year, 24-Hour (4.0″)	1387	0	1978	2.0
100-Year, 24-Hour (4.7″)	1857	0	1978	3.2

Table 5.1.2. Center Line Source Reduction (Designed to Prevent Contract Exceedances)

Design Storm	Growth Conditions		Dormant Conditions	
	Homes Disconnected	Additional Storage (MG)	Homes Disconnected	Additional Storage (MG)
1-Month, 24-Hour (0.62″)	0	0	0	0
1-Year, 1-Hour (1.0″)	13	0	1978	0.1
10-Year, 1-Hour (1.8″)	1263	0	1978	1.4
1-Year, 24-Hour (2.2″)	1978	0.1	1978	1.8
10-Year, 24-Hour (3.6″)	1978	0.9	1978	4.4
25-Year, 24-Hour (4.0″)	1978	1.2	1978	5.1
100-Year, 24-Hour (4.7″)	1978	1.8	1978	6.6

5.1.3. Local Storage

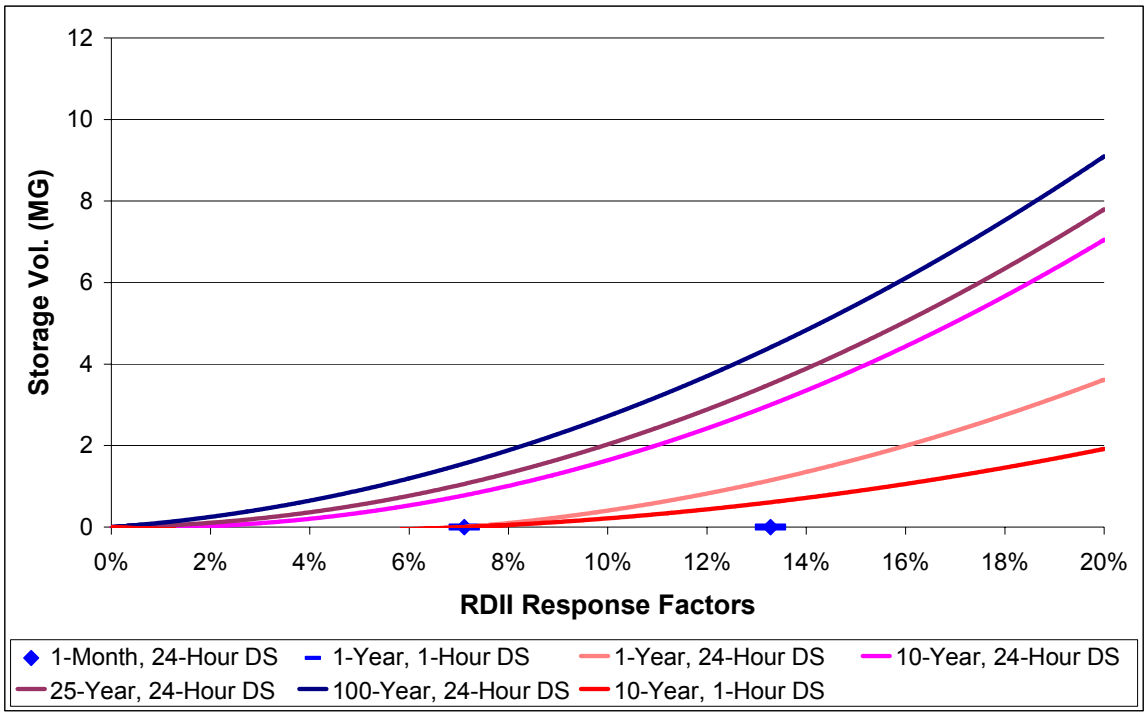
Local storage is also a local alternative. Local storage captures flows during wet weather and releases them after wet weather has passed. The Center Line model was simulated to determine the storage volume necessary to prevent sanitary sewer overflows under growth and dormant conditions for the seven design storms. The RDII response factors in Center Line are 7.11% for growth conditions and 13.28% for dormant conditions. Table 5.1.3 lists the results.

Table 5.1.3. Center Line Local Storage (Designed to Prevent SSOs)

Design Storm	Storage Volume (MG)	
	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62″)	0.00	0.00
1-Year, 1-Hour (1.0″)	0.00	0.00
10-Year, 1-Hour (1.8″)	0.00	0.61
1-Year, 24-Hour (2.2″)	0.00	1.15
10-Year, 24-Hour (3.6″)	0.76	3.00
25-Year, 24-Hour (4.0″)	1.06	3.51
100-Year, 24-Hour (4.7″)	1.56	4.41

Using the growth and dormant storage volumes, the data was then extrapolated to determine the storage volume necessary to prevent SSOs for a range of RDII response factors. Figure 5.1.1 graphs the storage volumes that result for RDII response factors ranging from 0% to 20%.

Figure 5.1.1. Center Line Local Storage (Designed to Prevent SSOs)



Center Line has a contract capacity of 6.5-cfs. In order to prevent SSOs and contract exceedances, storage volumes must be larger than those calculated to simply prevent SSOs. The Center Line model was simulated to determine the storage volume necessary to prevent contract exceedances under growth and dormant conditions for the seven design storms. Table 5.1.4 lists the results.

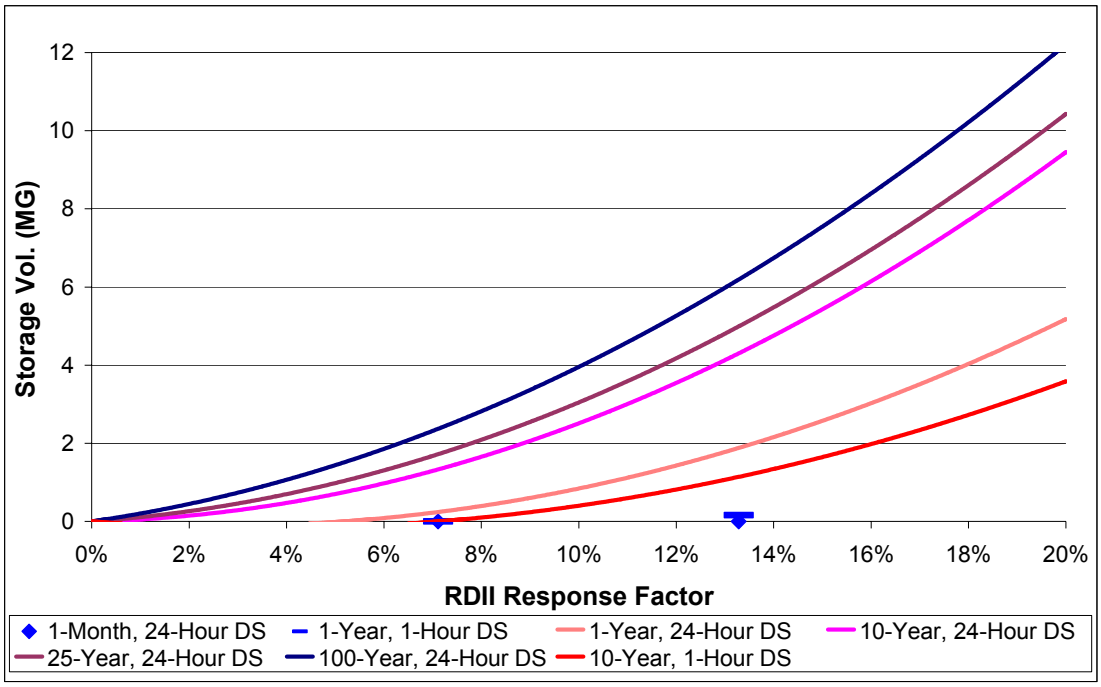
Table 5.1.4. Center Line Local Storage (Designed to Prevent Contract Exceedances)

Design Storm	Storage Volume (MG)	
	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62″)	0.00 (0.00)	0.28 (0.00)
1-Year, 24-Hour (1.0″)	0.3 (0.00)	1.8 (0.16)
10-Year, 24-Hour (1.8″)	1.6 (0.00)	4.6 (1.14)
1-Year, 24-Hour (2.2″)	2.1 (0.24)	5.0 (1.88)
10-Year, 24-Hour (3.6″)	4.5 (1.33)	9.6 (4.30)
25-Year, 24-Hour (4.0″)	5.2 (1.72)	10.9 (4.99)
100-Year, 24-Hour (4.7″)	6.4 (2.37)	13.3 (6.19)

Note: The values in parentheses include the attenuation provided by the mile long discharge pipe from the pump station.

Using the growth and dormant storage volumes, the data was then extrapolated to determine the storage volume necessary to prevent SSOs and contract exceedances for a range of RDII response factors. Figure 5.1.2 graphs the storage volumes that result for RDII response factors ranging from 0% to 20%.

Figure 5.1.2. Center Line Local Storage
(Designed to Prevent Contract Exceedances)



5.1.4 Transport Capacity

The Center Line model was simulated to determine the effect that increasing transport capacity had on the sanitary sewer overflow. Two options were studied. The first option involved the elimination of the inverted siphon along the 24-inch interceptor. The second option involved pipe bursting the 24-inch interceptor to 30-inches.

As previously mentioned, flow in the 24-inch interceptor downstream of the SSO currently passes through an inverted siphon under Warren's oversized 60-inch 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-inch interceptor would be bored through Warren's 60-inch sanitary sewer to increase capacity and eliminate a point of frequent maintenance.

The effects of eliminating the inverted siphon were modeled for the seven design storms. No relief pipe or pipe bursting occurred with this alternative. Results are listed in Table 5.1.5.

Table 5.1.5. Center Line Transport Capacity (Removal of Inverted Siphon)

Design Storm	Storage Volume (MG)	
	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62″)	0.00	0.00
1-Year, 1-Hour (1.0″)	0.00	0.00
10-Year, 1-Hour (1.8″)	0.00	0.39
1-Year, 24-Hour (2.2″)	0.00	0.84
10-Year, 24-Hour (3.6″)	0.54	2.19
25-Year, 24-Hour (4.0″)	0.78	2.57
100-Year, 24-Hour (4.7″)	1.16	3.23

In addition to eliminating the inverted siphon the model also looked at the effects of pipe bursting the 24-inches interceptor to 30-inches. This is presented in the Regional SSO Control Analyses – Capacity Constraints in the System technical memorandum.

5.1.5 Cost Summary

Present worth costs to prevent SSOs in Center Line are listed in Table 5.1.6. Present worth costs to prevent contract exceedances in Center Line are listed in Table 5.1.7. Present worth costs include capital costs as well as operation and maintenance costs and benefits over a 20-year cost analysis period.

Table 5.1.6. Costs in Center Line (Designed to Prevent SSOs)

Design Storm	Source Reduction		Storage	
	Growth	Dormant	Growth	Dormant
1-Month, 24-Hour (0.62″)	0	0	0	0
1-Year, 1-Hour (1.0″)	0	0	0	0
10-Year, 1-Hour (1.8″)	0	$16.8 M	0	$5.6 M
1-Year, 24-Hour (2.2″)	0	$16.4 M	0	$7.8 M
10-Year, 24-Hour (3.6″)	$8.0 M	$23.2 M	$6.3 M	$13.7 M
25-Year, 24-Hour (4.0″)	$10.0 M	$24.9 M	$7.4 M	$15.1 M
100-Year, 24-Hour (4.7″)	$13.3 M	$28.5 M	$9.2 M	$17.5 M

Table 5.1.7. Costs in Center Line (Designed to Prevent Contract Exceedances)

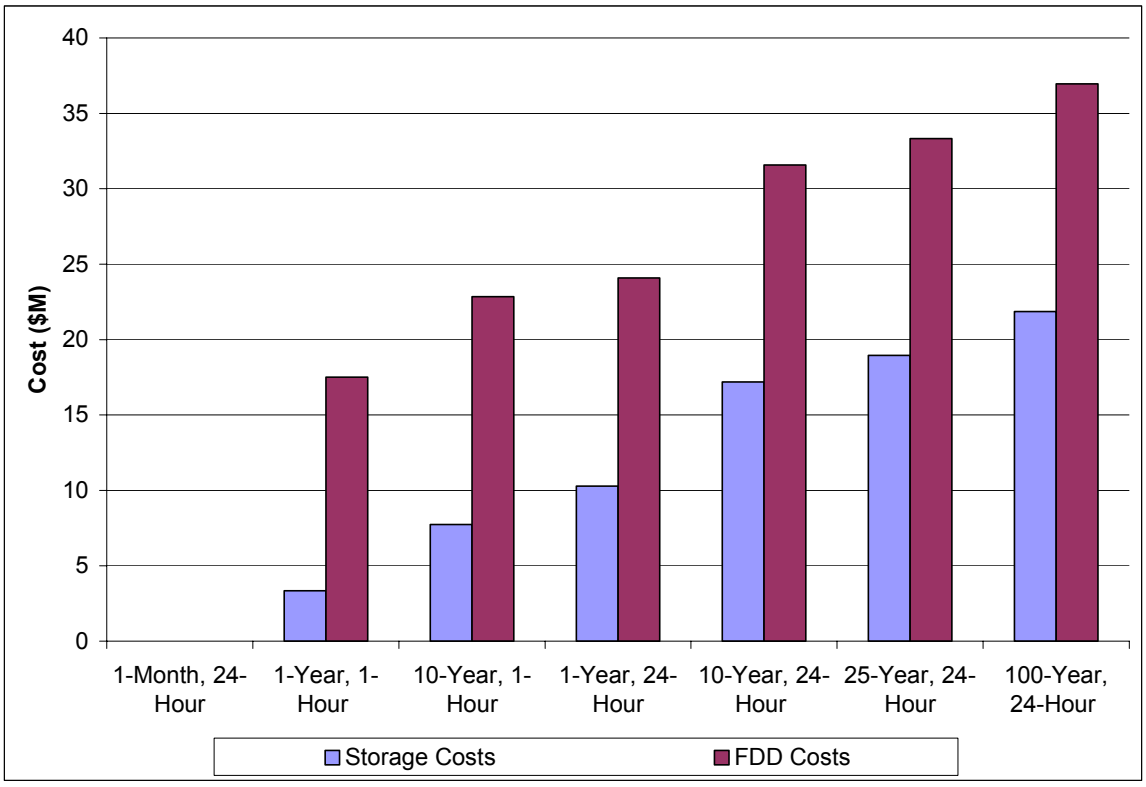
Design Storm	Source Reduction		Storage	
	Growth	Dormant	Growth	Dormant
1-Month, 24-Hour (0.62″)	0	0	0	0
1-Year, 1-Hour (1.0″)	$0.1 M	$17.5 M	0	$3.4 M
10-Year, 1-Hour (1.8″)	$9.1 M	$22.8 M	0	$7.7 M
1-Year, 24-Hour (2.2″)	$16.9 M	$24.1 M	$3.8 M	$10.3 M
10-Year, 24-Hour (3.6″)	$21.2 M	$31.6 M	$8.4 M	$17.2 M
25-Year, 24-Hour (4.0″)	$22.0 M	$33.3 M	$9.8 M	$19.0 M
100-Year, 24-Hour (4.7″)	$24.3 M	$37.0 M	$11.8 M	$21.9 M

Local costs are included in the increased capacity alternative. However, regional costs are also a significant factor. Therefore, increased capacity costs are determined in the regional analysis.

Figure 5.1.3 compares footing drain disconnection costs and storage costs for each design storm in Center Line. For this particular figure, the following assumptions were made:

- Footing drain disconnections and storage are designed to eliminate SSOs and contract exceedances
- Design storms occur during dormant conditions
- Operation and maintenance costs/benefits are included for storage facilities

Figure 5.1.3. Center Line Local Alternative Costs



5.2 Clinton Township

In the early 1980s, Clinton Township installed nine bypass relief pumps, with Michigan Department of Environmental Quality knowledge. The pumps are found in a 2,305-acre portion of Clinton Township stretching south to 14-Mile Road, north to Mt. Clemens, just west of Groesbeck, and just east of Gratiot.

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., study used to support information provided in this section.

The nine areas are composed of residential, commercial and industrial land uses. The nine districts contain 337,168 linear feet of 6-inch through 30-inch diameter pipe and 1,195 manholes.

Additional information on the Clinton Township sanitary sewer overflows can be found in Volume 6 of the WWMP.

5.2.1 Short Term Control Measures

The short-term control measures completed and underway by Clinton Township are listed in the current Administrative Consent Order.

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 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 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 was 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) $50,000 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.

5.2.2 Source Reduction

One alternative for eliminating sanitary sewer overflows in Clinton Township is through source reduction. Source reduction is achieved by reducing rain dependent inflow and infiltration.

Studies have also shown that the exact percentage varies by community. Peak flow reduction was determined from a 40-year analysis of rainfall data at Detroit Metro Airport. The RDII response factors for Clinton Township are listed in Table 5.2.1.

Table 5.2.1. Clinton Township RDII C Factors

SSO Tributary Area	RDII C Factor (Growth)	RDII C Factor (Dormant)
1	18.0%	3.5%
2	11.1%	3.1%
3	7.7%	3.1%
4	21.1%	4.7%
5	18.0%	8.4%
6	17.5%	7.7%
9	20.9%	8.4%

The Clinton Township model was run for the seven design storms. The effects of footing drain disconnections were modeled for both growth and dormant conditions. It was estimated that 2,507 homes in the Clinton Township SSO tributary areas have footing drains connected to the sanitary sewer system. If disconnecting 100% of the homes in the Clinton Township SSO tributary areas still resulted in an SSO, the additional storage volume needed to eliminate the SSO is included. The model results are listed below in Tables 5.2.1 – 5.2.2.

Table 5.2.2. Clinton Township Source Reduction (Designed to Prevent SSOs)

Design Storm	Growth Conditions		Dormant Conditions	
	Homes Disconnected	Additional Storage (MG)	Homes Disconnected	Additional Storage (MG)
1-Month, 24-Hour (0.62″)	0	0	0	0
1-Year, 1-Hour (1.0″)	0	0	1627	0
10-Year, 1-Hour (1.8″)	0	0	2507	0.3
1-Year, 24-Hour (2.2″)	0	0	1998	0
10-Year, 24-Hour (3.6″)	956	0	2507	0.4
25-Year, 24-Hour (4.0″)	1109	0	2507	0.6
100-Year, 24-Hour (4.7″)	1384	0	2507	1.2

Table 5.2.3. Clinton Township Source Reduction (Designed to Prevent Contract Exceedances)

Design Storm	Growth Conditions		Dormant Conditions	
	Homes Disconnected	Additional Storage (MG)	Homes Disconnected	Additional Storage (MG)
1-Month, 24-Hour (0.62″)	393	0	1304	0
1-Year, 1-Hour (1.0″)	1382	0	2507	0.7
10-Year, 1-Hour (1.8″)	1690	0	2507	2.2
1-Year, 24-Hour (2.2″)	2434	0	2507	2.5
10-Year, 24-Hour (3.6″)	2507	0	2507	6.1
25-Year, 24-Hour (4.0″)	2507	0	2507	7.0
100-Year, 24-Hour (4.7″)	2507	0.1	2507	9.2

5.2.3 Local Storage

Local storage is also a local alternative. Local storage captures flows during wet weather and releases them after wet weather has passed. The seven Clinton Township SSO tributary area models were simulated to determine the storage volume necessary to prevent sanitary sewer overflows under growth and dormant conditions for the seven design storms. The values from each of the seven SSO tributary areas were summed in order to obtain overall volumes for Clinton Township. Table 5.2.4 lists the results.

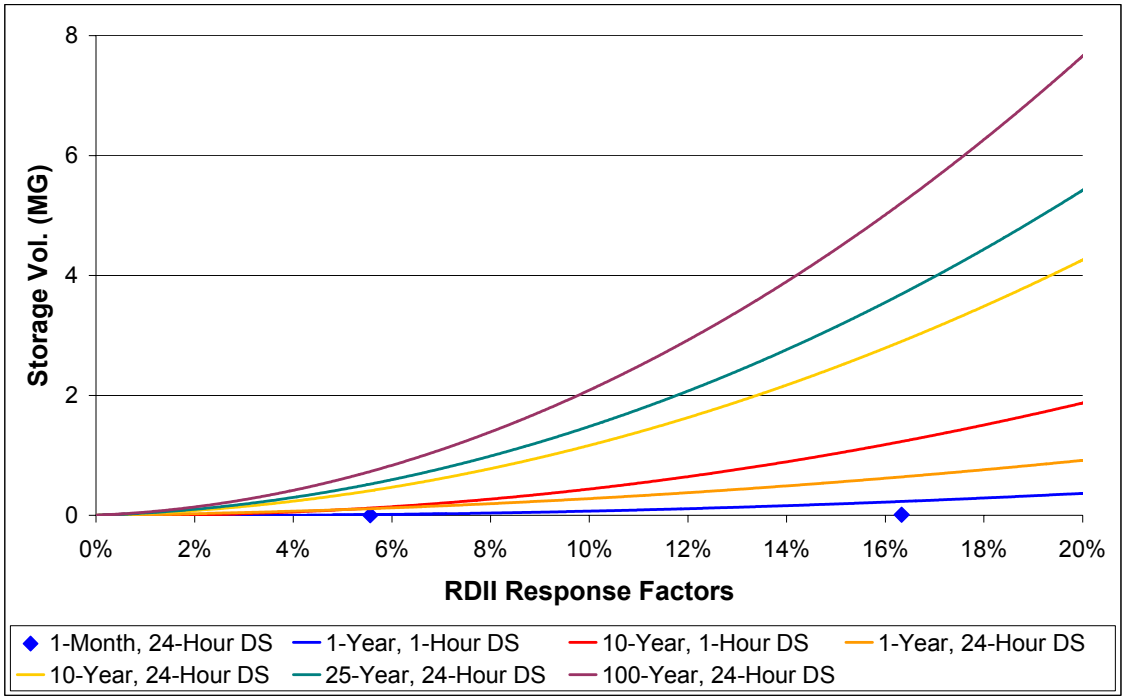
Table 5.2.4. Clinton Township Local Storage (Designed to Prevent SSOs)

Design Storm	Storage Volume (MG)	
	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62″)	0.00	0.01
1-Year, 1-Hour (1.0″)	0.00	0.23
10-Year, 1-Hour (1.8″)	0.00	1.23
1-Year, 24-Hour (2.2″)	0.00	0.64
10-Year, 24-Hour (3.6″)	0.41	2.90
25-Year, 24-Hour (4.0″)	0.52	3.69
100-Year, 24-Hour (4.7″)	0.73	5.21

Using the growth and dormant storage volumes, the data was then extrapolated to determine the storage volume necessary to prevent SSOs for a range of RDII response factors.

Figure 5.2.1 graphs the storage volumes that result for RDII response factors ranging from 0% to 20%. In order to determine one dormant and growth RDII C factor for Clinton Township, the RDII C factors were averaged from each of the seven SSO tributary areas.

Figure 5.2.1. Clinton Twp. Local Storage (Volume Required to Prevent SSOs)



Clinton Township has a contract capacity of 0.4-cfs per 1000 residents. Using population estimates for each of the seven SSO tributary areas, the maximum contract flow for each SSO tributary area was calculated in Table 5.2.5.

Table 5.2.5. Clinton Township Maximum Contract Flows

SSO Tributary Area	Estimated Population	Maximum Contract Flow (cfs)
1	495	0.20
2	3,385	1.35
3	1,045	0.42
4	2,046	0.82
5	967	0.39
6	464	0.17
9	2,280	0.91

The maximum contract flows were used to determine the contract exceedance volumes for Clinton Township. The contract exceedance volumes are the SSO volumes, which would result if the downstream system were limited to accepting the maximum contract flow rather than the design flow.

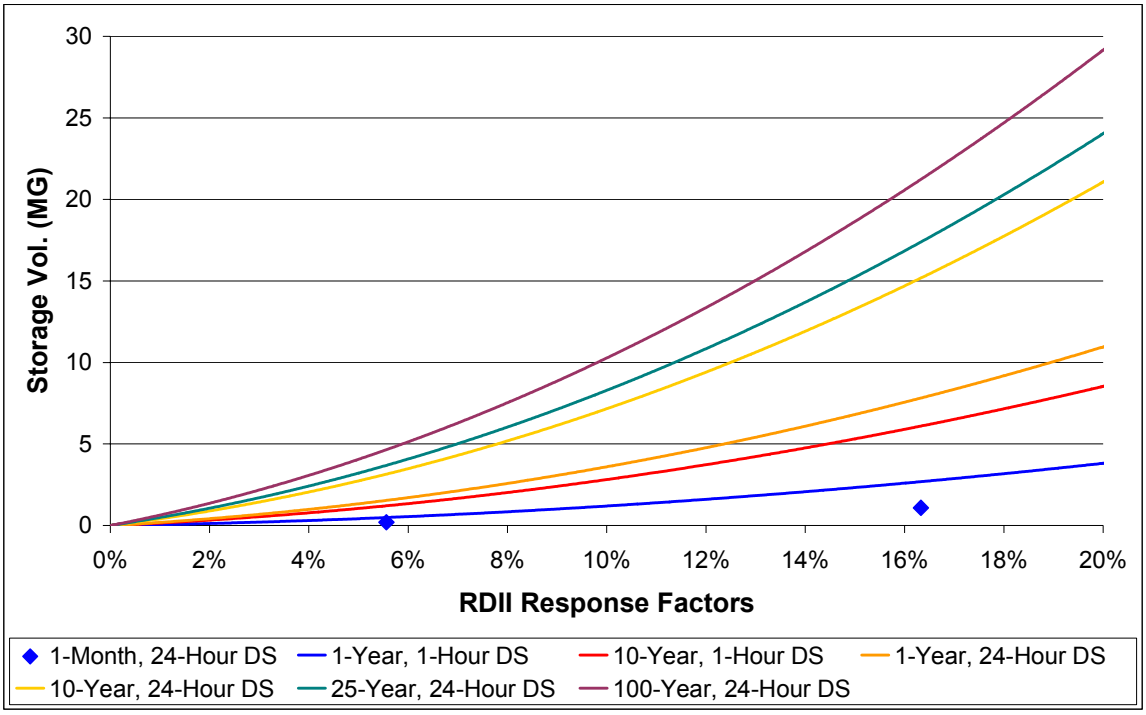
The model was simulated for the seven design storms in each of the seven SSO tributary areas for both dormant and growth conditions using the maximum contract flow as the downstream condition. The results from the seven SSO tributary areas were combined in order to determine the overall contract exceedance volumes for Clinton Township for the seven design storms. The contract exceedance volumes are listed in Table 5.2.6.

Table 5.2.6. Clinton Township Local Storage (Designed to Prevent Contract Exceedances)

Design Storm	Storage Volume (MG)	
	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62″)	0.20	1.09
1-Year, 24-Hour (1.0″)	0.49	2.69
10-Year, 24-Hour (1.8″)	1.21	6.10
1-Year, 24-Hour (2.2″)	1.54	7.82
10-Year, 24-Hour (3.6″)	3.15	15.18
25-Year, 24-Hour (4.0″)	3.69	17.39
100-Year, 24-Hour (4.7″)	4.65	21.23

Using the growth and dormant storage volumes, the data was then extrapolated to determine the storage volume necessary to prevent SSOs and contract exceedances for a range of RDII response factors. Figure 5.2.2 graphs the storage volumes that result for RDII response factors ranging from 0% to 20%.

Figure 5.2.2. Clinton Township Local Storage (Designed to Prevent Contract Exceedances)



5.2.4 Transport Capacity

In order to model the increased capacity option, dimensions of the Clinton Township sanitary sewer system outside of the SSO tributary area, from the pump stations to the DWSD interceptors, need to be obtained. Therefore, the results of the Clinton Township increased capacity alternative are presented in the Regional SSO Control Analyses – Capacity Constraints in the System technical memorandum.

5.2.5 Cost Summary

Present worth costs to prevent SSOs in Clinton Township are listed in Table 5.2.7. Present worth costs to prevent contract exceedances in Clinton Township are listed in Table 5.2.8. Present worth costs include capital costs as well as operation and maintenance costs and benefits over a 20-year cost analysis period.

Table 5.2.7. Costs in Clinton Township (Designed to Prevent SSOs)

Design Storm	Source Reduction		Storage	
	Growth	Dormant	Growth	Dormant
1-Month, 24-Hour (0.62″)	0	0	0	0
1-Year, 1-Hour (1.0″)	0	$11.7 M	0	$3.6 M
10-Year, 1-Hour (1.8″)	0	$22.0 M	0	$8.0 M
1-Year, 24-Hour (2.2″)	0	$16.4 M	0	$5.6 M
10-Year, 24-Hour (3.6″)	$6.9 M	$22.7 M	$4.7 M	$13.4 M
25-Year, 24-Hour (4.0″)	$8.0 M	$23.6 M	$5.1 M	$15.6 M
100-Year, 24-Hour (4.7″)	$9.9 M	$26.0 M	$6.0 M	$19.5 M

Table 5.2.8. Costs in Clinton Township (Designed to Prevent Contract Exceedances)

Design Storm	Source Reduction		Storage	
	Growth	Dormant	Growth	Dormant
1-Month, 24-Hour (0.62″)	$2.8 M	$9.4 M	$3.6 M	$7.5 M
1-Year, 1-Hour (1.0″)	$9.9 M	$24.1 M	$5.1 M	$12.8 M
10-Year, 1-Hour (1.8″)	$12.1 M	$29.4 M	$8.0 M	$21.7 M
1-Year, 24-Hour (2.2″)	$17.5 M	$30.3 M	$9.2 M	$25.6 M
10-Year, 24-Hour (3.6″)	$21.2 M	$39.7 M	$14.1 M	$40.4 M
25-Year, 24-Hour (4.0″)	$20.6 M	$41.7 M	$15.6 M	$44.5 M
100-Year, 24-Hour (4.7″)	$21.7 M	$46.5 M	$18.1 M	$51.2 M

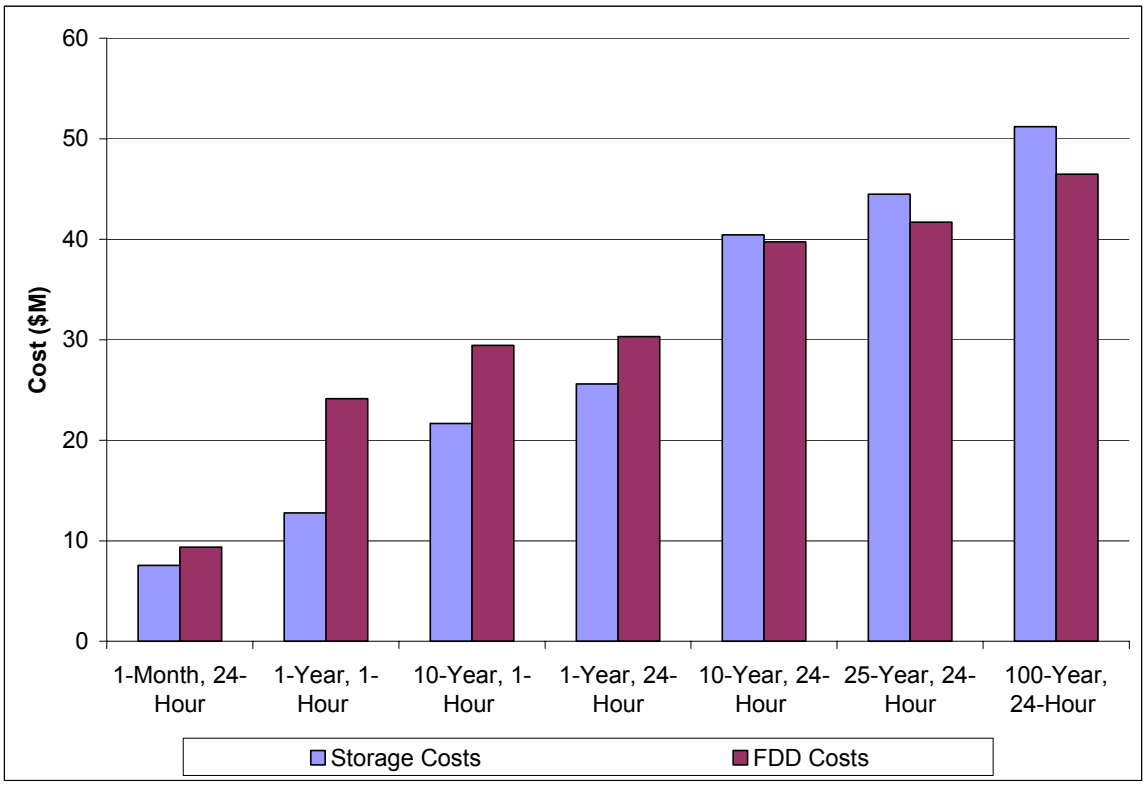
Local costs are included in the increased capacity alternative. However, regional costs are also a significant factor. Therefore, increased capacity costs are determined in the regional analysis.

Figure 5.2.3 compares footing drain disconnection costs and storage costs for each design storm in Clinton Township. For this particular figure, the following assumptions were made:

- Footing drain disconnections and storage are designed to eliminate SSOs and contract exceedances

- Design storms occur during dormant conditions
- Operation and maintenance costs/benefits are included for the storage facilities

Figure 5.2.3. Clinton Township Local Alternative Costs



5.3 Fraser

The Fraser Sewer Overflow is located at Beacon Pump Station, near the intersection of Masonic Boulevard and Beacon Lane. The sanitary sewer overflow tributary area is comprised of the southeastern corner of Fraser (364 acres). Additional information regarding the SSO in Fraser can be found in Volume 6 of the WWMP.

5.3.1 Short Term Control Measures

Short-term control measures completed and underway in Fraser were documented in the *City of Fraser Sanitary Sewer System Capacity Analysis and Study,* published by Anderson, Eckstein and Westrick.

Short-term control measures in Fraser began with a Sanitary Sewer Evaluation Survey (SSES), in order 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:

- 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.
- The city instituted a downspout program to route more flows into the storm sewers.
- 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.
- The city had the three pumps in the Beacon Pump Station rebuilt.
- The city installed an ultrasonic level on the dry weather pump in the Beacon Pump Station in order to maximize storage.
- The city cleaned and televised all sewers in the SSO tributary area.
- The city is studying treatment alternatives for SSOs.
- 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.

- 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. 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.

- 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.

- 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. 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.

5.3.2 Source Reduction

One alternative for eliminating sanitary sewer overflows in Fraser is through source reduction. Source reduction is achieved by reducing rain dependent inflow and infiltration.

Studies have also shown that the exact percentage varies by community. Peak flow reduction was determined from a 40-year analysis of rainfall data at Detroit Metro Airport. The RDII response factors for Fraser are 14.41% in growth and 24.66% in dormant conditions.

The Fraser model was run for the seven design storms. The effects of footing drain disconnections were modeled for both growth and dormant conditions. It was estimated that 1,367 homes in the Fraser SSO tributary area have footing drains connected to the sanitary sewer system. If disconnecting 100% of the homes in the Fraser SSO tributary area still resulted in an SSO, the additional storage volume needed to eliminate the SSO is included. The model results are listed below in Tables 5.3.1 – 5.3.2.

Table 5.3.1. Fraser Source Reduction (Designed to Prevent SSOs)

Design Storm	Growth Conditions		Dormant Conditions	
	Homes Disconnected	Additional Storage (MG)	Homes Disconnected	Additional Storage (MG)
1-Month, 24-Hour (0.62″)	0	0	0	0
1-Year, 1-Hour (1.0″)	814	0	1367	0.1
10-Year, 1-Hour (1.8″)	1346	0	1367	0.7
1-Year, 24-Hour (2.2″)	1367	0.2	1367	0.4
10-Year, 24-Hour (3.6″)	1367	0.6	1367	1.2
25-Year, 24-Hour (4.0″)	1367	0.7	1367	1.4
100-Year, 24-Hour (4.7″)	1367	0.9	1367	2.0

Table 5.3.2. Fraser Source Reduction (Designed to Prevent Contract Exceedances)

Design Storm	Growth Conditions		Dormant Conditions	
	Homes Disconnected	Additional Storage (MG)	Homes Disconnected	Additional Storage (MG)
1-Month, 24-Hour (0.62″)	558	0	820	0
1-Year, 1-Hour (1.0″)	1367	0	1367	0.4
10-Year, 1-Hour (1.8″)	1367	0.1	1367	1.0
1-Year, 24-Hour (2.2″)	1367	0.5	1367	1.1
10-Year, 24-Hour (3.6″)	1367	0.9	1367	2.4
25-Year, 24-Hour (4.0″)	1367	1.0	1367	2.8
100-Year, 24-Hour (4.7″)	1367	1.4	1367	3.7

5.3.3 Local Storage

Local storage is also a local alternative. Local storage captures flows during wet weather and releases them after wet weather has passed.

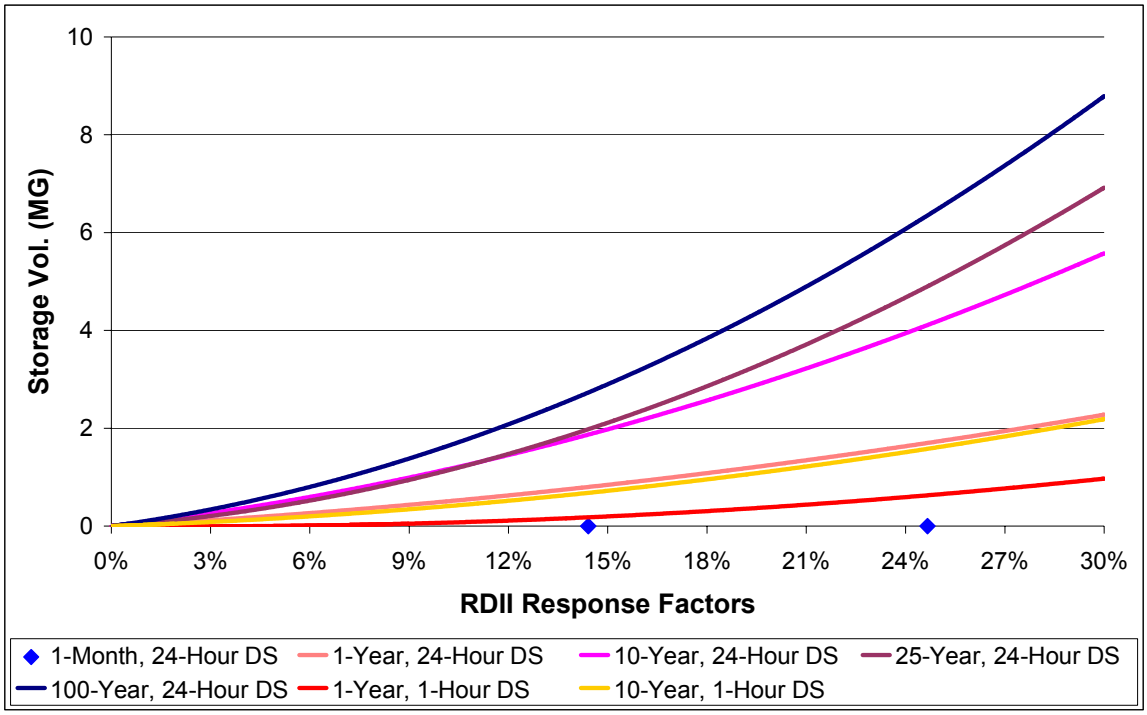
The Fraser model was simulated to determine the storage volume necessary to prevent sanitary sewer overflows under growth and dormant conditions for the seven design storms. The RDII response factors in Fraser are 14.41% for growth conditions and 24.66% for dormant conditions. Table 5.3.3 lists the results.

Table 5.3.3. Fraser Local Storage (Designed to Prevent SSOs)

Design Storm	Storage Volume (MG)	
	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62″)	0.00	0.00
1-Year, 1-Hour (1.0″)	0.18	0.63
10-Year, 1-Hour (1.8″)	0.68	1.58
1-Year, 24-Hour (2.2″)	0.80	1.70
10-Year, 24-Hour (3.6″)	1.87	4.11
25-Year, 24-Hour (4.0″)	1.98	4.90
100-Year, 24-Hour (4.7″)	2.73	6.35

Using the growth and dormant storage volumes, the data was then extrapolated to determine the storage volume necessary to prevent SSOs for a range of RDII response factors. Figure 5.3.1 graphs the storage volumes that result for RDII response factors ranging from 0% to 30%.

Figure 5.3.1. Fraser Local Storage
(Volume Required to Prevent SSOs)



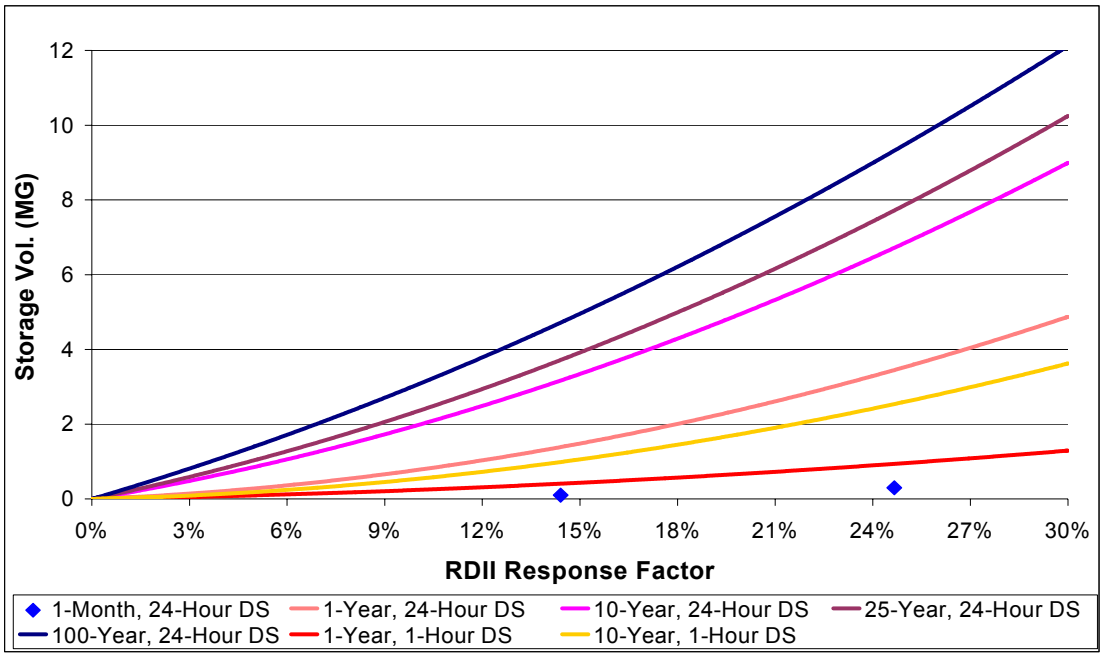
Fraser has a contract capacity of 0.4-cfs per 1,000 residents. Based on the estimated population of 3,930 residents in the SSO tributary area, the contract capacity for the SSO tributary area is 1.57-cfs. The Fraser model was simulated to determine the storage volume necessary to prevent sanitary sewer overflows and contract exceedances under growth and dormant conditions for the seven design storms. Table 5.3.4 lists the results.

Table 5.3.4. Fraser Local Storage (Designed to Prevent Contract Exceedances)

Design Storm	Storage Volume (MG)	
	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62″)	0.10	0.30
1-Year, 1-Hour (1.0″)	0.41	0.94
10-Year, 1-Hour (1.8″)	0.99	2.54
1-Year, 24-Hour (2.2″)	1.39	3.45
10-Year, 24-Hour (3.6″)	3.17	6.72
25-Year, 24-Hour (4.0″)	3.72	7.72
100-Year, 24-Hour (4.7″)	4.72	9.32

Using the growth and dormant storage volumes, the data was then extrapolated to determine the storage volume necessary to prevent SSOs and contract exceedances for a range of RDII response factors. Figure 5.3.2 graphs the storage volumes that result for RDII response factors ranging from 0% to 30%.

Figure 5.3.2. Fraser Local Storage (Designed to Prevent Contract Exceedances)



5.3.4 Transport Capacity

In order to model the increased capacity option, dimensions of the Fraser sanitary sewer system outside of the SSO tributary area, from the Beacon Pump Station to the DWSD interceptor, need to be obtained. Therefore, the results of the Fraser increased capacity alternative are presented in the Regional SSO Control Analyses – Capacity Constraints in the System technical memorandum.

5.3.5 Cost Summary

Present worth costs to prevent SSOs in Fraser are listed in Table 5.3.5. Present worth costs to prevent contract exceedances are listed in Table 5.3.6. Present worth costs include capital costs as well as operation and maintenance costs and benefits over a 20-year cost analysis period.

Table 5.3.5. Storage Costs in Fraser (Designed to Prevent SSOs)

Design Storm	Source Reduction		Storage	
	Growth	Dormant	Growth	Dormant
1-Month, 24-Hour (0.62″)	0	0	0	0
1-Year, 1-Hour (1.0″)	$6.2 M	$13.0 M	$3.5 M	$5.7 M
10-Year, 1-Hour (1.8″)	$9.7 M	$15.6 M	$5.9 M	$9.3 M
1-Year, 24-Hour (2.2″)	$13.3 M	$14.7 M	$6.4 M	$9.7 M
10-Year, 24-Hour (3.6″)	$15.3 M	$17.8 M	$10.2 M	$16.7 M
25-Year, 24-Hour (4.0″)	$15.6 M	$18.6 M	$10.6 M	$18.7 M
100-Year, 24-Hour (4.7″)	$16.6 M	$20.5 M	$12.9 M	$22.2 M

Table 5.3.6. Storage Costs in Fraser (Designed to Prevent Contract Exceedances)

Design Storm	Source Reduction		Storage	
	Growth	Dormant	Growth	Dormant
1-Month, 24-Hour (0.62″)	$4.0 M	$5.9 M	$3.0 M	$4.2 M
1-Year, 1-Hour (1.0″)	$9.8 M	$14.3 M	$4.7 M	$7.0 M
10-Year, 1-Hour (1.8″)	$12.8 M	$16.8 M	$7.2 M	$12.3 M
1-Year, 24-Hour (2.2″)	$14.7 M	$17.2 M	$8.6 M	$14.9 M
10-Year, 24-Hour (3.6″)	$16.8 M	$21.7 M	$14.1 M	$23.1 M
25-Year, 24-Hour (4.0″)	$17.2 M	$22.8 M	$15.7 M	$25.4 M
100-Year, 24-Hour (4.7″)	$18.4 M	$25.4 M	$18.3 M	$28.8 M

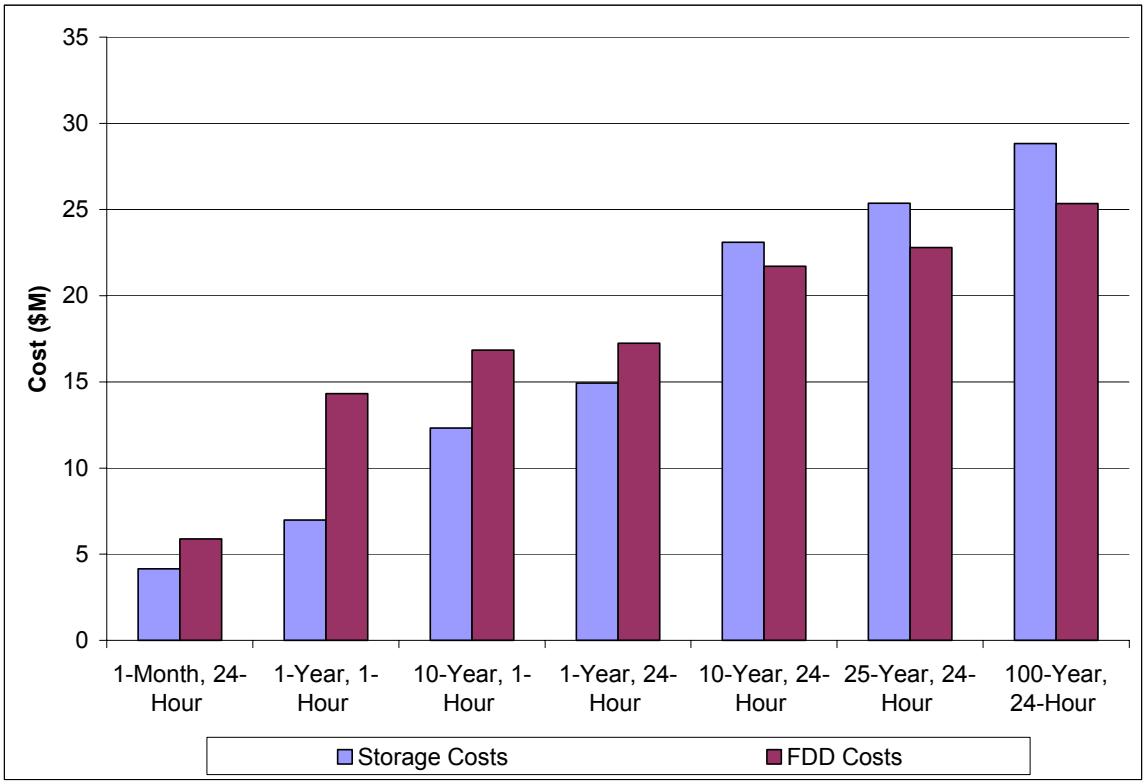
Local costs are included in the increased capacity alternative. However, regional costs are also a significant factor. Therefore, increased capacity costs are determined in the regional analysis.

Figure 5.3.3 compares footing drain disconnection costs and storage costs for each design storm in Fraser. For this particular figure, the following assumptions were made:

- Footing drain disconnections and storage are designed to eliminate SSOs and contract exceedances

- Design storms occur during dormant conditions
- Operation and maintenance costs/benefits are included for the storage facilities

Figure 5.3.3. Fraser Local Alternative Costs



5.4 Melvindale

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 the pumping station. The entire city is tributary to the SSO.

Additional information on the Melvindale SSO can be found in Volume 6 of the WWMP.

5.4.1 Short Term Control Measures

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.

5.4.2 Source Reduction

One alternative for eliminating sanitary sewer overflows in Melvindale is through source reduction. Source reduction is achieved by reducing rain dependent inflow and infiltration.

Studies have also shown that the exact percentage varies by community. Peak flow reduction was determined from a 40-year analysis of rainfall data at Detroit Metro Airport. The RDII response factors for Melvindale are 4.62% in growth and 6.70% in dormant conditions. Melvindale's contract capacity is based on its population. A capacity of 6.375 cfs is used for this analysis.

The Melvindale model was run for the seven design storms. The effects of footing drain disconnections were modeled for both growth and dormant conditions. It was estimated that 4,449 homes in Melvindale have footing drains connected to the sanitary sewer system. If disconnecting 100% of the homes in Melvindale still resulted in a contract exceedance, the additional storage volume needed to prevent contract exceedance is included. The model results are listed below in Tables 5.4.1.

**Table 5.4.1. Melvindale Source Reduction
(Designed to Prevent Contract Exceedances)**

Design Storm	Growth Conditions		Dormant Conditions	
	Homes Disconnected	Additional Storage (MG)	Homes Disconnected	Additional Storage (MG)
1-Month, 24-Hour (0.62″)	1792	0	2869	0
1-Year, 1-Hour (1.0″)	4499	0.10	4499	0.79
10-Year, 1-Hour (1.8″)	4499	1.04	4499	1.72
1-Year, 24-Hour (2.2″)	4499	0.98	4499	1.28
10-Year, 24-Hour (3.6″)	4499	2.45	4499	2.34
25-Year, 24-Hour (4.0″)	4499	2.86	4499	2.47
100-Year, 24-Hour (4.7″)	4499	3.62	4499	3.20

5.4.3 Local Storage

Local storage is also a local alternative. Local storage captures flows during wet weather and releases them after wet weather has passed.

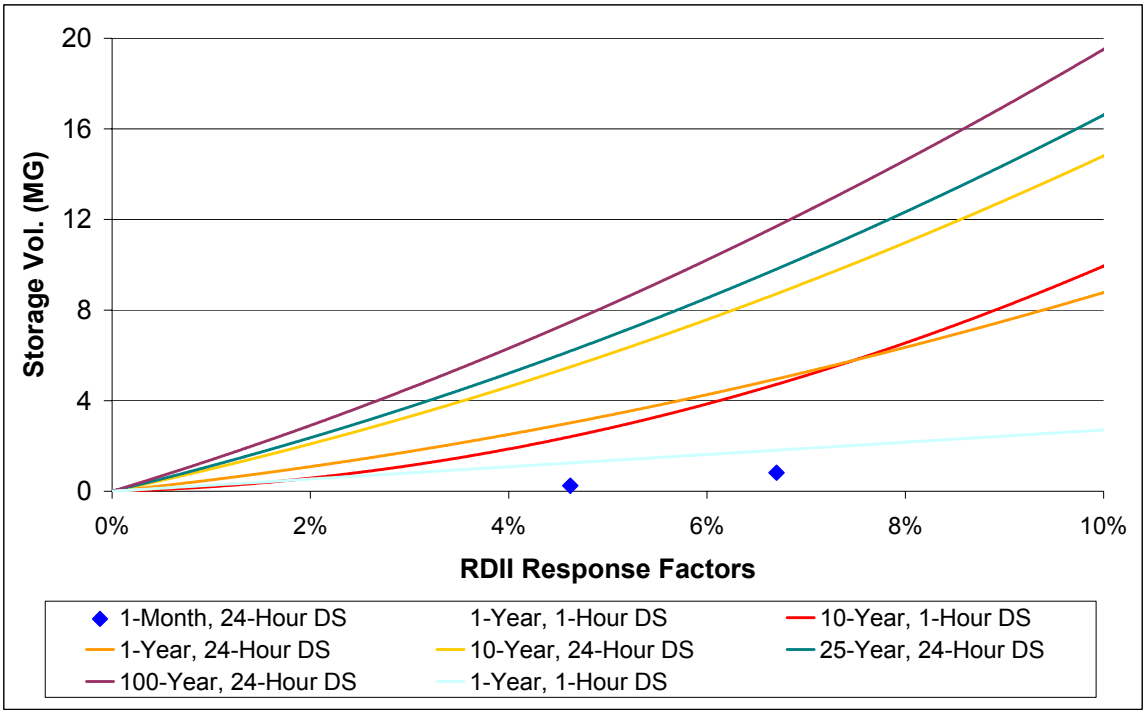
Melvindale was modeled with a contract capacity of 6.375-cfs. In order to prevent contract exceedances, storage volumes must be large enough to capture flows greater than 6.375-cfs. The Melvindale model was simulated to determine the storage volume necessary to prevent contract exceedances under growth and dormant conditions for the seven design storms. Table 5.4.2 lists the results.

Table 5.4.2. Melvindale Local Storage
(Designed to Prevent Contract Exceedances)

Design Storm	Storage Volume (MG)	
	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62″)	0.25	0.82
1-Year, 1-Hour (1.0″)	0.94	2.03
10-Year, 1-Hour (1.8″)	2.41	4.22
1-Year, 24-Hour (2.2″)	3.02	4.96
10-Year, 24-Hour (3.6″)	5.49	8.72
25-Year, 24-Hour (4.0″)	6.19	9.81
100-Year, 24-Hour (4.7″)	7.47	11.70

Using the growth and dormant storage volumes, the data was then extrapolated to determine the storage volume necessary to prevent contract exceedances for a range of RDII response factors. Figure 5.4.1 graphs the storage volumes that result for RDII response factors ranging from 0% to 10%.

Figure 5.4.1. Melvindale Local Storage
(Designed to Prevent Contract Exceedances)



5.4.4 Transport Capacity

Increasing local, or internal, transport capacity will not be modeled for Melvindale. However, increasing regional transport capacity for Melvindale are studied and modeled in Regional SSO Control Analyses – Capacity Constraints in the System technical memorandum.

5.4.5 Cost Summary

Present worth costs to prevent contract exceedances in Melvindale are listed in Table 5.4.3. Present worth costs include capital costs as well as operation and maintenance costs and benefits over a 20-year cost analysis period.

Table 5.4.3. Costs in Melvindale (Designed to Prevent Contract Exceedances)

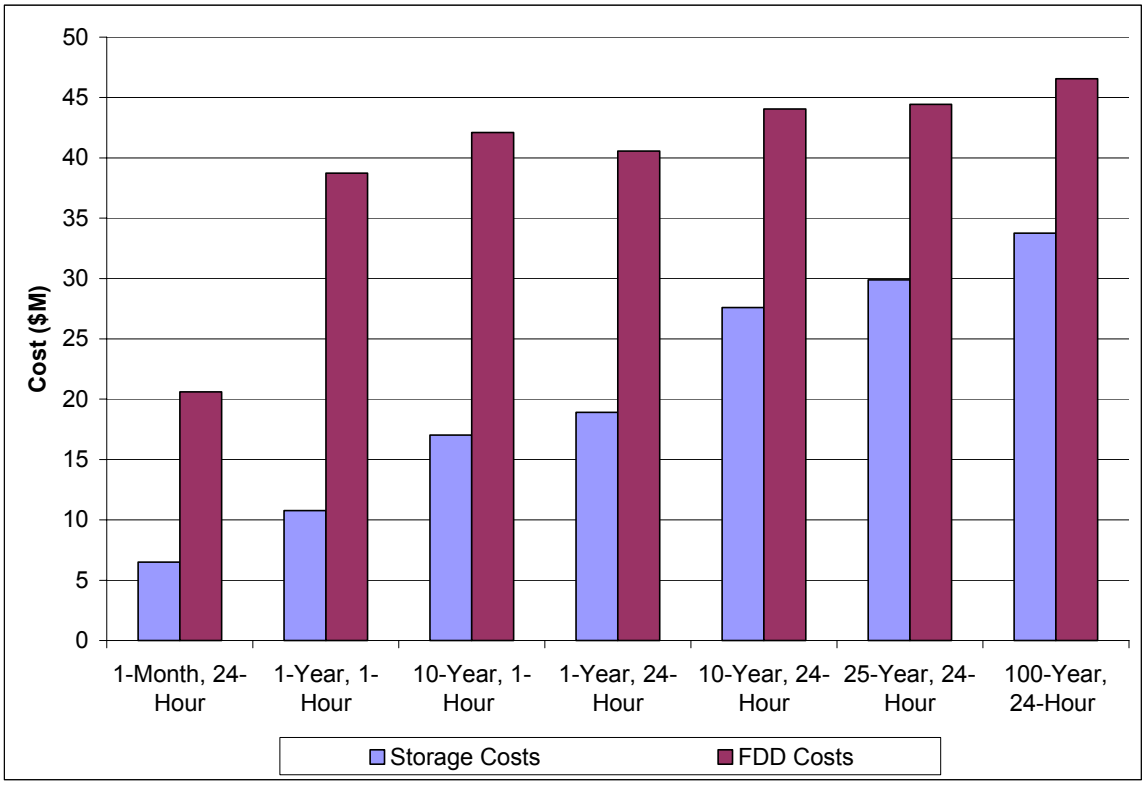
Design Storm	Source Reduction		Storage	
	Growth	Dormant	Growth	Dormant
1-Month, 24-Hour (0.62″)	$12.9 M	$20.9 M	$3.9 M	$6.5 M
1-Year, 1-Hour (1.0″)	$35.3 M	$38.7 M	$7.0 M	$10.8 M
10-Year, 1-Hour (1.8″)	$39.7 M	$42.1 M	$12.0 M	$17.0 M
1-Year, 24-Hour (2.2″)	$39.5 M	$40.6 M	$13.8 M	$18.9 M
10-Year, 24-Hour (3.6″)	$44.4 M	$44.0 M	$20.2 M	$27.6 M
25-Year, 24-Hour (4.0″)	$45.6 M	$44.4 M	$21.9 M	$29.9 M
100-Year, 24-Hour (4.7″)	$47.7 M	$46.6 M	$24.8 M	$33.8 M

Local costs are included in the increased capacity alternative. However, regional costs are also a significant factor. Hence, increased capacity costs are determined in the regional analysis.

Figure 5.4.2 compares footing drain disconnection costs and storage costs for each design storm in Melvindale. For this particular figure, the following assumptions were made:

- Footing drain disconnections and storage are designed to eliminate SSOs and contract exceedances
- Design storms occur during dormant conditions
- Operation and maintenance costs/benefits are included for the storage facilities

Figure 5.4.2. Melvindale Local Alternative Costs



5.5 Allen Park

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.

Additional information regarding the Allen Park SSO is located in Volume 6 of the WWMP.

5.5.1 Short Term Control Measures

Allen Park is not currently under an Administrative Consent Order with the MDEQ for the APS-1 service area, also known as 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 city-wide SSES for the next 1.5 years.

The 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 equivalent. 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. Since the contract capacity had not been agreed upon prior to the publication of this technical memorandum, a contract capacity of 6 cfs was assumed.

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.

5.5.2 Source Reduction

One alternative for eliminating sanitary sewer overflows in Allen Park is through source reduction. Source reduction is achieved by reducing rain dependent inflow and infiltration.

Peak flow reduction was determined from a 40-year analysis of rainfall data at Detroit Metro Airport. The RDII response factor for the residential portions of the Allen Park SSO tributary area is 9.00% in growth conditions and 19.01% in dormant conditions. The RDII response factor for the commercial and industrial portions of the Allen Park SSO tributary area is 2.47% in growth conditions and 5.21% in dormant conditions. Allen Park's contract capacity is assumed to be 6.0 cfs.

The Allen Park model was run for the seven design storms. The effects of footing drain disconnections were modeled for both growth and dormant conditions. It was estimated that 1,325 homes in Allen Park have footing drains connected to the sanitary sewer system. If disconnecting 100% of the homes in Allen Park still resulted in an SSO, the additional storage volume needed to eliminate the SSO is included. The model results are listed below in Table 5.5.1.

Table 5.5.1. Allen Park Source Reduction (Designed to Prevent Contract Exceedances(1))

Design Storm	Growth Conditions		Dormant Conditions	
	Homes Disconnected	Additional Storage (MG)	Homes Disconnected	Additional Storage (MG)
1-Month, 24-Hour (0.62″)	0	0	822	0
1-Year, 1-Hour (1.0″)	1325	0.1	1325	0.7
10-Year, 1-Hour (1.8″)	1325	0.4	1325	1.6
1-Year, 24-Hour (2.2″)	1325	0.4	1325	1.2
10-Year, 24-Hour (3.6″)	1325	0.9	1325	3.0
25-Year, 24-Hour (4.0″)	1325	1.1	1325	3.6
100-Year, 24-Hour (4.7″)	1325	1.5	1325	4.7

1) The contract capacity was being negotiated when the modeling was performed. The assumed contract capacity used for modeling was 6 cfs.

5.5.3 Local Storage

Local storage is also a local alternative. Local storage captures flows during wet weather and releases them after wet weather has passed.

Allen Park has an assumed contract capacity of 6.0-cfs. In order to prevent contract exceedances, storage volumes must be large enough to capture flows greater than 6.0-cfs. The Allen Park model was simulated to determine the storage volume necessary to prevent contract exceedances under growth and dormant conditions for the seven design storms. Table 5.5.2 lists the results.

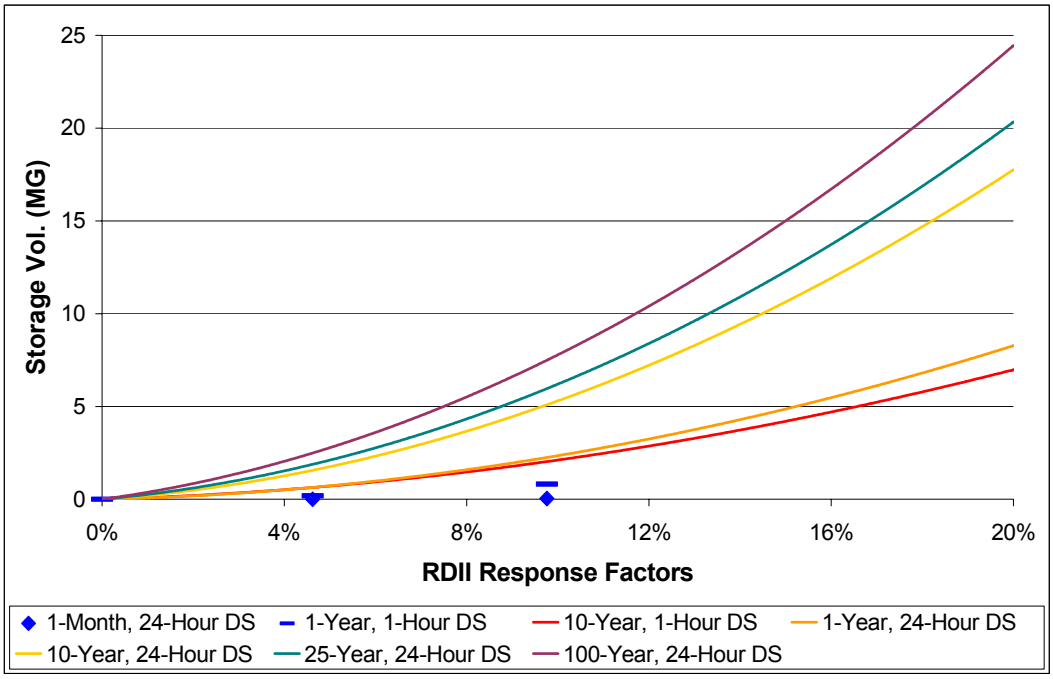
Table 5.5.2. Allen Park Local Storage
(Designed to Prevent Contract Exceedances(1))

Design Storm	Storage Volume (MG)	
	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62″)	0.00	0.04
1-Year, 1-Hour (1.0″)	0.18	0.81
10-Year, 1-Hour (1.8″)	0.63	2.03
1-Year, 24-Hour (2.2″)	0.64	2.25
10-Year, 24-Hour (3.6″)	1.56	5.09
25-Year, 24-Hour (4.0″)	1.88	5.96
100-Year, 24-Hour (4.7″)	2.49	7.49

1) The contract capacity was being negotiated when the modeling was performed. The assumed contract capacity used for modeling was 6 cfs.

Using the growth and dormant storage volumes, the data was then extrapolated to determine the storage volume necessary to prevent contract exceedances for a range of RDII response factors. Figure 5.5.1 graphs the storage volumes that result for RDII response factors ranging from 0% to 20%.

Figure 5.5.1 Allen Park Local Storage
(Designed to Prevent Contract Exceedances)



5.5.4 Transport Capacity

Increasing local, or internal, transport capacity is not modeled for Allen Park. However, increasing regional transport capacity for Allen Park are studied and modeled in the Regional SSO Control Analyses – Capacity Constraints in the System technical memorandum.

5.5.5 Cost Summary

Present worth costs to prevent contract exceedances in Allen Park are listed in Table 5.5.3. Present worth costs include capital costs as well as operation and maintenance costs and benefits over a 20-year cost analysis period.

Table 5.5.3. Costs in Allen Park (Designed to Prevent Contract Exceedances)

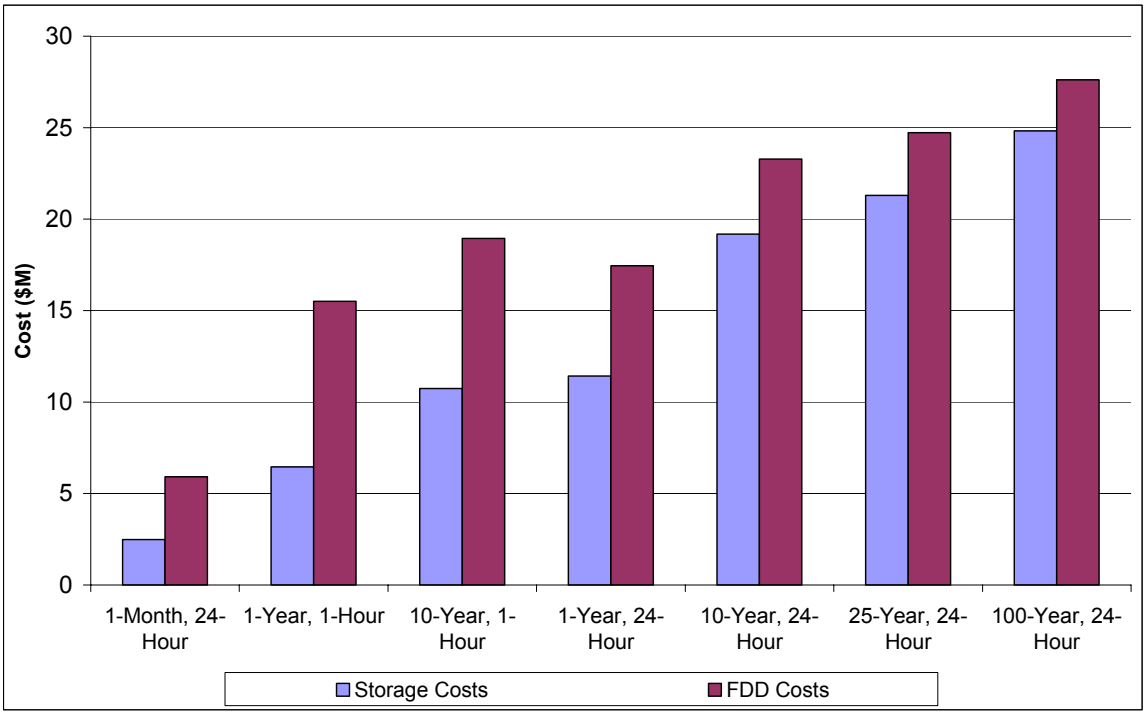
Design Storm	Source Reduction		Storage	
	Growth	Dormant	Growth	Dormant
1-Month, 24-Hour (0.62″)	0	$5.9 M	0	$2.5 M
1-Year, 1-Hour (1.0″)	$12.4 M	$15.5 M	$3.5 M	$6.5 M
10-Year, 1-Hour (1.8″)	$14.1 M	$18.9 M	$5.7 M	$10.7 M
1-Year, 24-Hour (2.2″)	$14.3 M	$17.4 M	$5.7 M	$11.4 M
10-Year, 24-Hour (3.6″)	$16.5 M	$23.3 M	$9.2 M	$19.2 M
25-Year, 24-Hour (4.0″)	$17.1 M	$24.7 M	$10.3 M	$21.3 M
100-Year, 24-Hour (4.7″)	$18.6 M	$27.6 M	$12.2 M	$24.8 M

Local costs are included in the increased capacity alternative. However, regional costs are also a significant factor. Therefore, increased capacity costs are included with the regional analysis.

Figure 5.5.2 compares footing drain disconnection costs and storage costs for each design storm in Allen Park. For this particular figure, the following assumptions were made:

- Footing drain disconnections and storage are designed to eliminate SSOs and contract exceedances
- Design storms occur during dormant conditions
- Operation and maintenance costs/benefits are included for the storage facilities

Figure 5.5.2. Allen Park Local Alternative Costs



5.6 Garden City

The history of sanitary sewer overflows in Garden City is explained in the draft report *City of Garden City Corrective Action Report - Step 7A,* published by Wade-Trim, Inc., in 2001. According to the report, 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 of 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 completed in 1998. The last phases of the partial 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.

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

Garden City SSOs are located at the following intersections:

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

5.6.1 Short Term Control Measures

According to Wade-Trim Inc., 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, Inc. 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 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.

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.

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 wanted to make sure corrections were made by June 2002.

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.

5.6.2 Source Reduction

One alternative for eliminating sanitary sewer overflows in Garden City is through source reduction. Source reduction is achieved by reducing rain dependent inflow and infiltration.

Studies have also shown that the exact percentage varies by community. Peak flow reduction was determined from a 40-year analysis of rainfall data at Detroit Metro Airport. The RDII response factors the Garden City SSO tributary area are 5.78% in growth conditions and 12.96% in dormant conditions. Garden City's contract capacity is 24.4-cfs.

The Garden City model was run for the seven design storms. The effects of footing drain disconnections were modeled for both growth and dormant conditions. It was estimated that 8,400 homes in Garden City have footing drains connected to the sanitary sewer system. If disconnecting 100% of the homes in Garden City still resulted in a contract exceedance, the additional storage volume needed to prevent contract exceedance is included. The model results are listed below in Table 5.6.1.

**Table 5.6.1. Garden City Source Reduction
(Designed to Prevent Contract Exceedances)**

Design Storm	Growth Conditions		Dormant Conditions	
	Homes Disconnected	Additional Storage (MG)	Homes Disconnected	Additional Storage (MG)
1-Month, 24-Hour (0.62″)	0	0	3861	0
1-Year, 1-Hour (1.0″)	3011	0	8400	2.2
10-Year, 1-Hour (1.8″)	8084	0	8400	6.8
1-Year, 24-Hour (2.2″)	7598	0	8400	7.4
10-Year, 24-Hour (3.6″)	8400	0.8	8400	16.2
25-Year, 24-Hour (4.0″)	8400	1.1	8400	18.3
100-Year, 24-Hour (4.7″)	8400	1.7	8400	23.3

5.6.3 Local Storage

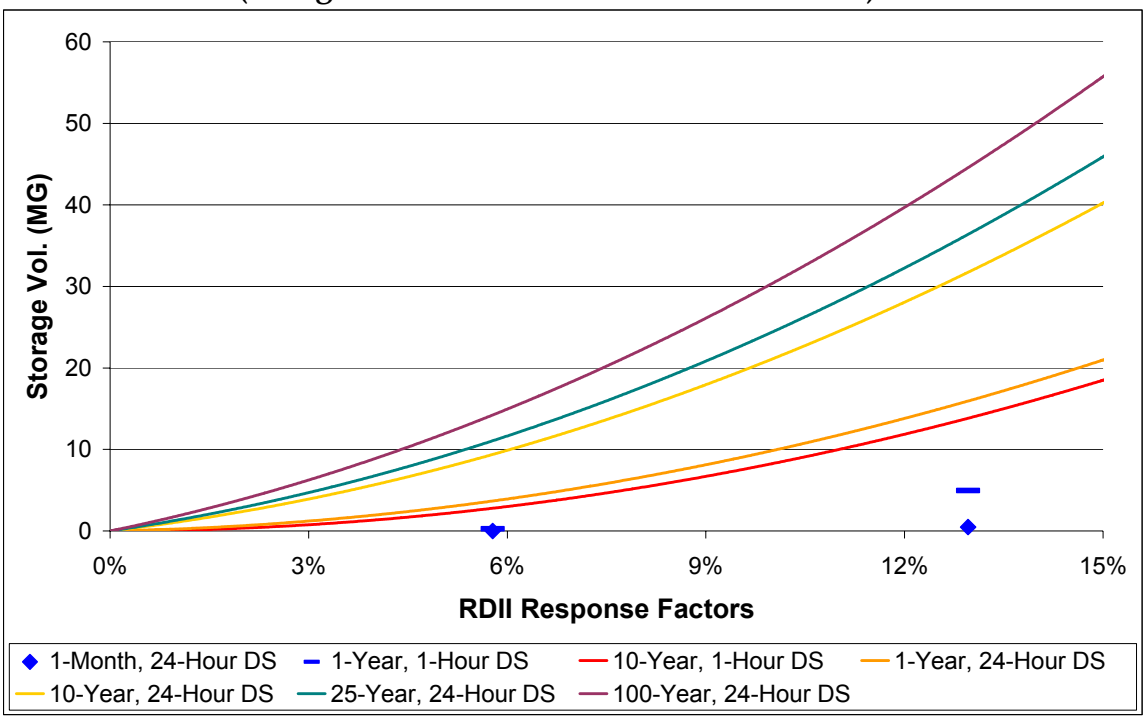
Local storage is also a local alternative. Local storage captures flows during wet weather and releases them after wet weather has passed. Garden City has a contract capacity of 24.4-cfs. In order to prevent contract exceedances, storage volumes must be large enough to capture flows greater than 24.4-cfs. The Garden City model was simulated to determine the storage volume necessary to prevent contract exceedances under growth and dormant conditions for the seven design storms. Table 5.6.2 lists the results.

**Table 5.6.2. Garden City Local Storage
(Designed to Prevent Contract Exceedances)**

Design Storm	Storage Volume (MG)	
	Growth Conditions	Dormant Conditions
1-Month, 24-Hour (0.62″)	0.00	0.48
1-Year, 1-Hour (1.0″)	0.26	4.95
10-Year, 1-Hour (1.8″)	2.79	13.83
1-Year, 24-Hour (2.2″)	3.68	15.94
10-Year, 24-Hour (3.6″)	9.39	31.73
25-Year, 24-Hour (4.0″)	11.07	36.38
100-Year, 24-Hour (4.7″)	14.23	44.56

Using the growth and dormant storage volumes, the data was then extrapolated to determine the storage volume necessary to prevent contract exceedances for a range of RDII response factors. Figure 5.6.1 graphs the storage volumes that result for RDII response factors ranging from 0% to 15%.

Figure 5.6.1 Garden City Local Storage
(Designed to Prevent Contract Exceedances)



5.6.4 Transport Capacity

Additional transport capacity for Garden City is studied in the Regional SSO Control Analysis – Capacity Constraints in the System technical memorandum.

5.6.5 Cost Summary

Present worth costs to prevent contract exceedances in Garden City are listed in Table 5.6.3. Present worth costs include capital costs as well as operation and maintenance costs and benefits over a 20-year cost analysis period.

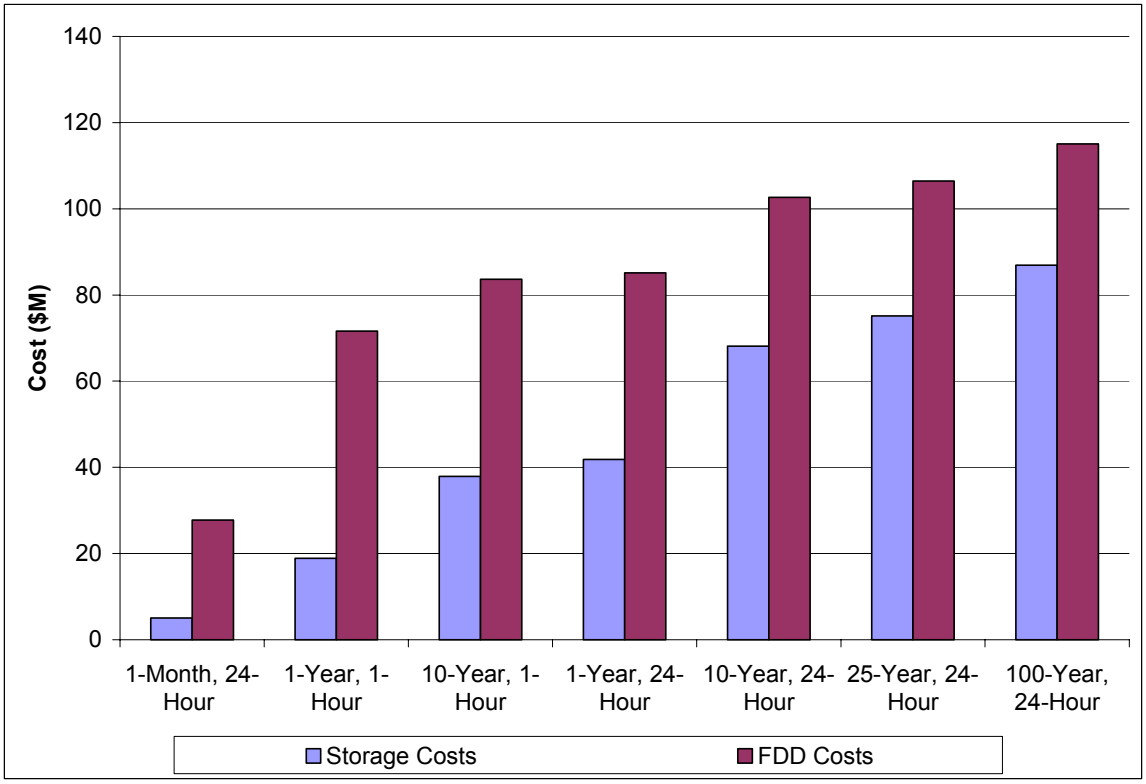
Table 5.6.3. Costs in Garden City (Designed to Prevent Contract Exceedances)

Design Storm	Source Reduction		Storage	
	Growth	Dormant	Growth	Dormant
1-Month, 24-Hour (0.62″)	0	$27.8 M	0	$5.1 M
1-Year, 1-Hour (1.0″)	$21.6 M	$71.6 M	$3.9 M	$18.9 M
10-Year, 1-Hour (1.8″)	$58.1 M	$83.6 M	$13.1 M	$37.9 M
1-Year, 24-Hour (2.2″)	$54.6 M	$85.1 M	$15.6 M	$41.9 M
10-Year, 24-Hour (3.6″)	$66.9 M	$102.7 M	$29.0 M	$68.1 M
25-Year, 24-Hour (4.0″)	$68.1 M	$106.5 M	$32.5 M	$75.1 M
100-Year, 24-Hour (4.7″)	$70.1 M	$115.1 M	$38.7 M	$86.9 M

Figure 5.6.2 compares footing drain disconnection costs and storage costs for each design storm in Garden City. For this particular figure, the following assumptions were made:

- Footing drain disconnections and storage are designed to eliminate SSOs and contract exceedances
- Design storms occur during dormant conditions
- Operation and maintenance costs/benefits are included for the storage facilities

Figure 5.6.2. Garden City Local Alternative Costs



6. Regional Alternatives

One of the most valuable aspects of a regional study is the ability to analyze potential regional solutions that can benefit multiple communities. This is also important as local solutions can affect the regional system, such as DWSD not having enough capacity to dewater storage basins in a timely manner before the next event occurs. The regional impacts of the local alternatives considered are evaluated in the Regional SSO Control Analyses – Capacity Constraints in the System technical memorandum.

The following regional issues and alternatives are considered in that technical memorandum.

- How can the current regional system be more efficiently used in order to accept more of the SSO volumes to the regional system?
- Can the regional system handle the amount of dewatering necessary for all the current CSO and potential SSO storage basins?
- Where and how much are CSOs increased if SSO volumes are routed into the regional system? What are the corresponding water quality impacts?

- Where can existing and new regional storage facilities be used in order to be able to accept more SSO flows to the regional system?

- Where can existing and new regional treatment facilities and wastewater treatment plants be used to handle SSO volumes.

The local models for most case study communities have not been connected to the regional model at this time. However, the model for Allen Park is connected to the regional model. Allen Park was used to provide an example of a regional alternative analysis.

A preliminary analysis of increasing the allowable peak discharge rate from Allen Park (the local system) to the DWSD regional system from 6-cfs to 50-cfs was evaluated. For the 25-year, 24-hour storm the model indicates a CSO increase from the DWSD system of 16 MG (from 802 MG to 818 MG). However, the CSO would get some treatment (screening and disinfection) and discharge to the Rouge River, instead of flooding residential homes. It was also found that storms with lower return periods would essentially not increase the amount of CSO volume.

7. Summary and Conclusions

The results presented here represent a preliminary evaluation of the potential local alternatives. Based on the work performed to date, the following conclusions can be made.

1. The storage alternative is typically more economical for smaller design storms (less than 10-year, 24-hour return periods) while footing drain disconnection is more economical for larger storms (greater than 25-year, 24-hour). This is because of the high capital costs associated with footing drain disconnection. However, for large storms source reduction is more efficient as it continues to reduce RDII at a given percentage while the required storage tank size continues to increase in direct proportion to the storm volume.

2. The information provided in here is useful as an initial review of local alternatives for the individual case study communities. This information can also be used on a planning level basis to generalize what other non-case study communities can expect to achieve using each of the alternatives. These generalized conclusions are incorporated into the overall Wastewater Master Plan alternatives.

3. The information provided is adequate for a planning level evaluation of SSO control alternatives only. Any final selection of alternatives should include further evaluation of community specific variables and constraints. This may include further data collection, greater modeling detail, and pilot programs.

8. References

Anderson Eckstein and Westrick, Inc. "City of Center Line Sanitary Sewer System Capacity Analysis and Study (Draft)" April 2001.

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