Detroit Water and Sewerage Department

Wastewater Master Plan

DWSD Project No. CS-1314

Interceptors and Trunk Sewers

Technical Memorandum
Original Date: May 2, 2002
Revision Date: May 31, 2003
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Interceptors and Trunk Sewers

1. Introduction

The purpose of this Technical Memorandum is to compile available information regarding the design, construction and operation of interceptor and trunk sewers located within the City of Detroit and Macomb County.

This effort provides long range planning tools for assessment and planning efforts relating to interceptor and trunk sewers. These tools provide DWSD with a comprehensive summary of interceptor and trunk sewer assets. The key tools that have been produced under this task are sewer profiles, detailing major elements; spreadsheets containing the detailed information used to develop the profiles; and, summaries of construction and inspection information consolidated from a number of reports previously completed for the DWSD.

1.1 Scope

This Memorandum details work that has been conducted under *Task B.1.b – Analyze Critical Facilities – Interceptors and Trunk Sewers*. In total, eight subtasks are established as follows:

1.1.1 Define Terminology

Definitions of terminology pertaining to DWSD wastewater collection system components are included. These definitions reflect the current vernacular of the Detroit Waster and Sewerage Department. Definitions are included for the following wastewater collection system components: interceptors, trunk sewers, pumping stations, lateral sewers, service connections, outfalls, special structures, regulators, CSO storage or treatment facilities, customer billing meters and master meters. These definitions provide a reference for other reports.

1.1.2 Identification of Interceptors and Trunk Sewers

Three interceptors and twenty-three critical trunk sewers in the DWSD collection system, located in Detroit and Macomb County, are identified. The trunk sewers considered in this report represent approximately 25% of the total number of trunk sewers in the system. These sewers are selected because they are larger and/or have a more significant impact on the overall hydraulic function of the system. A map showing the locations of the interceptors and trunk sewers is included in Appendix A.

1.1.3 Compile Assessment Data

A comprehensive search was conducted to obtain assessment data for the trunk and interceptor sewers. The information that was obtained is summarized and bound in notebooks, along with reference material. Information regarding construction history, inspection history, current and future use, pumping stations, special structures, system hydraulics, and emergency management and redundancy is included.

1.1.4 Sewer Profiles

A profile is prepared for each of the interceptors and trunk sewers that were examined. Profiles, in 11 x 17 format, are included in Appendix A. Sewer profiles are prepared by investigating prior DWSD contract work, Wastewater Master Plan library drawings, and DWSD As-built drawings. The profiles show the sewer elevation profile, major street intersections, major connections with other sewers, dates of construction, and materials of construction. In addition to the Sewer profiles, spreadsheets detailing the sewer attributes, obtained from As-built drawings, have also been prepared.

1.1.5 Wholesale Customer Meters

The locations of wastewater wholesale customer meters and customer connection points are incorporated into the sewer profiles.

1.1.6 Sediment Deposits

Estimates of sediment deposits in trunk sewers are prepared based on a review of existing inspection records and facility condition reports. An assessment of sediment deposits has been made for each of the interceptors and trunk sewers where information was available. Preliminary recommendations for cleaning and a routine inspection program are based on the information collected. Information regarding sediment build up in the sewers has been shown on the profiles. Recommendations with respect to a sedimentation management program are represented on a map of the DWSD Wastewater Collection System.

1.1.7 Physical Inspection Information

A conceptual plan for the physical inspection of interceptors and trunk sewers (to supplement existing survey data) is detailed in Section 5.2. This plan is based on the review of existing inspection records and facility condition reports. Detailed recommendations for inspection locations are incorporated into other reports and are represented on a map of the DWSD Wastewater Collection System.

1.1.8 Pipeline Team

A list of DWSD divisions that represent the appropriate stakeholders are developed in order to form a *Pipeline Team*. The team has continued to review project deliverables in order to achieve a high level of input from the DWSD.

1.2 Criteria

The Technical memorandum shall discuss the following:

- Data sources for the various sub-tasks.
- Design criteria for the identified interceptors and trunk sewers.
- Details of sewer construction.
- Sewer maintenance and rehabilitation assessments.
- Observations for collection system improvements.
- An appendix that includes the profile and spreadsheets of the interceptors and trunk sewers identified in this report.

2. Identification of Components

The information presented in the report can be divided into three components, namely Terminology, Notebook Summaries, and Profiles.

2.1 Terminology

INTERCEPTOR - A large sewer that receives flow from a number of trunk sewers and transports the flow to the wastewater treatment plant. These sewers do not connect to homes, buildings or streets. Detroit's system drains to four main interceptors the Detroit River Interceptor (DRI), the North Interceptor - East Arm (NI-EA), the Oakwood North West Interceptor (ONWI).

TRUNK SEWER - A sewer that receives flows from lateral sewers and sends the flow to an interceptor. These sewers have only a few connections to homes, buildings or streets.

PUMPING STATION - A structure containing pumps and the associated piping, valves and other mechanical and electrical equipment for pumping wastewater. Also called a lift station when it is used to lift wastewater from a low point to a higher pipe so that it can be transported by gravity.

LATERAL SEWER - A sewer that collects flows from homes and businesses for discharge into trunk sewers. It has no other common sewers tributary to it. There are thousands of lateral sewers throughout the collection system tributary to Detroit.

SERVICE CONNECTION - A pipe that carries the wastewater flow from a customer's facility to a point where it is joined to the public sewer system.

This joining may be in the form of a manufactured plumbing piece [such as a "Y" or a "T"], or a custom-made opening in the public sewer main where the customer's pipe penetrates the lateral sewer.

OUTFALL - The sewer pipe where a combined sewer discharges into a lake or river. Detroit has 81 outfalls that discharge the Rouge and Detroit Rivers. Combined sewage is discharged through these outfalls during heavy rains to prevent backups in residential basements and on streets. Each outfall is listed in the NPDES discharge permit issued to the City of Detroit.

SPECIAL STRUCTURE – Structures in the collection system other than sewer lines and access manholes. These facilities include valve chambers, meter chambers, dams, and weirs as well as other structures used to control or monitor flow.

REGULATOR - Flow control device that restricts flow from trunk sewers into interceptors or rivers based on the wastewater level. A sluice gate is an example of a regulating device.

CSO STORAGE/TREATMENT FACILITY – A facility into which overflow from a combined sewer outfall is directed. Generally these facilities completely capture the overflow from small storms and provide screening and disinfection for larger storms. *Further consultation with DWSD required.*

CUSTOMER BILLING METER - Commonly referred to as Suburban Flow meters, these devices are responsible for the accurate measurement of wastewater flow and subsequently the accurate billing of the suburban sewer districts. Six types of flow meters are used in the system: Parshall flume, magnetic, sonic, v-notch weir, open-flow nozzle and veuturi.

MASTER METER – Meters located within the collection system for internal verification and measurement of flows. These meters are not used for billing purposes.

2.2 Notebook Summaries

Notebooks are included for the interceptors and trunk sewers in order to compile available information, which had been previously contained in various DWSD reports. The notebooks contain copies of the pages from various reports that have pertinent information. Summaries are prepared for each of the sewers, consolidating the information contained in the notebooks. Each of the summaries contain the available information regarding:

- Construction History
- Inspection History
- Current and Future Use

- Pumping Stations
- Special Structures
- System Hydraulics
- Emergency Management and Redundancy

The summaries for each of the interceptors and trunk Sewers have been considered. Key information from these summaries is consolidated into Table 1. Table 1 contains years of construction, range of sizes, range of invert depths, range of capacities, materials of construction and approximate lengths.

	Name	Year of Construction	Diameter Range	Invert Depth Range (feet)	Capacity Range (cfs)	Material of Construction	Length (feet)
I-1	Detroit River Interceptor (DRI)	1927, 1935, 1936	8'-0" - 16'-0"	17 - 43	126 - 1400	Concrete, Brick	66,500
I-2	North Interceptor - East Arm (NIEA)	1969, 1973, 1976	12'-0" - 17'-6"	32 - 73	341 - 454	Reinf. Conc.	79,400
I-3	Oakwood-Northwest Intecpter (ONWI)	1928, 1931, 1950	6'-3" - 12'-9"	12 - 80	169 - 521	Concrete	86,800
T-4	Mack Ave. Relief	1967	9'-3" - 14'-0"	30 - 50	286 -1350		10,500
T-5	Fox Creek Enclosure	1927, 1929	14'-0" - 11'-6"x16'-6"□	17 - 25	519		17,200
T-6	Ashland Relief	1961	6'-3" - 16'-0"	40 - 53	154 - 1328	Reinf. Conc.	39,600
T-7	East Jefferson Relief (East Arm)	1928	14'-0"	37 - 43	772	Reinf. Conc.	5,900
T-8	West Jefferson Relief (West Arm)	1930	3'-0" - 14'-0"	30 - 40	25 - 772	Concrete, Brick	5,700
T-9	Conner Creek Enclosure	1921-25, 1928	varies	17 - 35		Concrete	30,900
T-10	Conant-Mt. Elliot	1955, 1957, 1958	9'-0" - 10'-0"x10'-6"□	24 - 50	168 - 812	Reinf. Conc.	45,400
T-11	First-Hamilton	1962, 64, 65, 88	8'-0" - 10'-0"x10'-6"□	15 - 57	634 - 3500	Reinf. Conc.	75,000
T-12	Livernois Relief	1952	10'-6"	23 - 32	283 - 491	Reinf. Conc.	23,400
T-13	Elmer Ternes	1961	14'-6" - 14'-6"x14'-6"□	17 - 29	636 - 810	Reinf. Conc.	13,500
T-14	Lonyo	1919	11'-6" 3& - 14'-6" 2□	22 - 29	1282 - 2033	Reinf. Conc.	8,600
T-15	Baby Creek Enclosure	1937, 1962	14'-6" x 17'-6" 2□, 3□	13 - 24		Reinf. Conc.	8,600
T-16	Hubbell	1925, 27, 29, 30, 48, 99	8'-3" - 12'-0"x14'-3" 2□	26 - 49	267 - 819	Reinf. Conc.	46,200
T-17	Southfield	1926-1930, 1954	6'-9" - 10'-9"	28 - 50	150 - 781	Reinf. Conc.	44,400
T-18	Hubbell-Southfield	1948, 1949	13'-4"x14'-3" 3□, 14'-6" x 12'-0" 2□	16 - 29		Reinf. Conc.	8,500
T-19	Six Mile Relief	1958	11'-3" - 14'-0"x14'-0"□	22 - 48	482 - 656		20,800
T-20	Schoolcraft Relief	1963	11'-3" - 13'-0"	26 - 41	317		18,400
M-1	Lakeshore Interceptor	1972	11'-0"	46 - 54	230	Reinf. Conc.	36,000
M-2	Garfield/Romeo Interceptor	1973, 1974, 1999	7'-0" - 11'-0"	28 - 66	107 - 246	Conc. (Tunnel)	32,500
M-3	Oakland Arm	1970, 1972	8'-0" - 9'-6"	16 - 62	288 - 350	Conc. (Tunnel)	57,600
M-4	Avon Arm	1974	3'-0" - 4'-0"	10 - 41	14 - 31	Conc.	14,100
M-5	15 Mile Rd. Interceptor	1973, 1974, 1975, 1984	5'-0" - 11'-0"	12 - 68	32 - 274	Reinf. Conc.	36,400
M-6	Edison Corridor	1969	12'-9"	60 - 108	213 - 555	Conc. (Tunnel)	41,300

Notes: Approxmately 25% of the Trunk sewers in the DWSD system were considered in this Memorandum.
These particular sewers were chosen because they are larger and/or have more significant impacts on the overall hydraulic funtion of the system.

2□ - double box
3□ - triple box
3& - triple barrel

Table 1: Interceptor and Trunk Sewer Summary Information

2.3 Profiles

Profiles are included for each of the interceptors and trunk Sewers. The profiles include major feature and structures in the sewers as well as information with respect to sludge deposition and structural conditions. In addition to showing the slope, diameter, and surface elevation, the profiles include (where information is available):

- Groundwater elevations
- Sewer Connections
- Major Structures including pump stations, level sensors, valves, gates, dams, and flow meters.

- Majors intersecting roads
- Sediment deposits, (sludge and large debris)
- Structural Conditions (spalling or concrete cut, hairline cracks, cracks open to the soil, joint leaks, pipe failure)

The profiles are presented in Appendix A along with spreadsheets, which contain the detailed information used to construct the profile. In addition to the physical elements that have been included in the profiles and spreadsheets, information regarding construction contracts is included.

3. Data Sources

Existing DWSD records are used to prepare the information detailed in this memorandum. No additional inspections were conducted. As-built records were obtained from the DWSD in order to construct the sewer profiles. The quality of the As-built information varies due to the age of some of the records, but generally sufficient information is available to construct representative profiles. Information regarding the contract number and drawing sheet is included on the spreadsheets, which are included for each of the profiles.

The notebook summaries and condition assessment information, included in Table 2, are prepared using previously completed DWSD reports. Specific references that are used for individual notebooks are included at the end of each summary.

Information regarding sludge deposition and structural conditions of the sewers is primarily derived from the CS-1158 report, which was published in 1996. In addition, a 2001 internal DWSD memo regarding sludge deposition in the NI-EA is used.

Table 2. Interceptor and Trunk Sewer Condition Assessment

	Name	Sludge Depositon	Large Debris	Spalling or Concrete Cut	Hairline Cracks	Cracks Open to Soil	Joint Leaks	Pipe Failure
I-1	Detroit River Interceptor (DRI)	700 ft @ 24"			950 ft			
I-2	North Interceptor - East Arm (NIEA)	1,050 @ "depth ?"						
I-3	Oakwood-Northwest Intecptor (ONWI)							
T-4	Mack Ave. Relief							
T-5	Fox Creek Enclosure							
T-6	Ashland Relief							
T-7	East Jefferson Relief (East Arm)							
T-8	West Jefferson Relief (West Arm)							
T-9	Conner Creek Enclosure	5,000 ft						
T-10	Conant-Mt. Elliot	3,900 ft @ 7"						
T-11	First-Hamilton							
T-12	Livernois Relief							
T-13	Elmer Ternes							
T-14	Lonyo							
T-15	Baby Creek Enclosure	4,000 ft						
T-16	Hubbell							
T-17	Southfield	11,000 ft	150 ft	2150 ft	2,200 ft	50 ft	450 ft	100 ft
T-18	Hubbell-Southfield							
T-19	Six Mile Relief							
T-20	Schoolcraft Relief							
M-1	Lakeshore Interceptor							
M-2	Garfield/Romeo Interceptor	1,300 ' @ 12"						
M-3	Oakland Arm							
M-4	Avon Arm							
M-5	15 Mile Rd. Interceptor	2,600 @ 10" - 20"						
M-6	Edison Corridor	1750' @ 10"						

4. Findings

Most of the findings from the examination of the interceptors and trunks sewers are detailed in the sewer profiles, which are included with this Memorandum. A brief summary of the key elements examined for these sewers follows.

4.1 Interceptor and Trunk Sewer Design Criteria

The capacities of the interceptors and trunk sewers vary considerably. Two sets of capacity values are presented in the material included with this Memorandum. The notebook summaries contain capacity information that was previously presented in reports to the DWSD. Many of the reported capacities are generated using models of the collection system and represent the predicated carrying capacity of the sewers.

To supplement the information outlined above, theoretical carrying capacities are generated from the profile spreadsheets. Due to the complexity of the collection system, the theoretical capacities have limited application in the evaluation of flow management alternatives for the collection system.

4.2 Interceptor and Trunk Sewer Construction

The first trunk sewer in the DWSD collection system was constructed over 90 years ago. Since then, a number of different construction techniques have been used. The majority of the sewers are constructed of concrete. A few older sections of the DRI are multi-ring brick sewers. Deeper sewers were most often installed using pre-cast concrete liners in tunnels. For some smaller diameter, shallow sections, pre-cast

concrete pipe was used. Further, cast-in-place reinforced concrete was employed during the construction of some box sections and structures, such as outfalls and dams.

Figure 1 illustrates the approximate length of trunk and interceptor sewers built by decade. This Figure can be used in future planning efforts to approximate the length of sewer that will reach the end of its useful life over each of the next five decades.

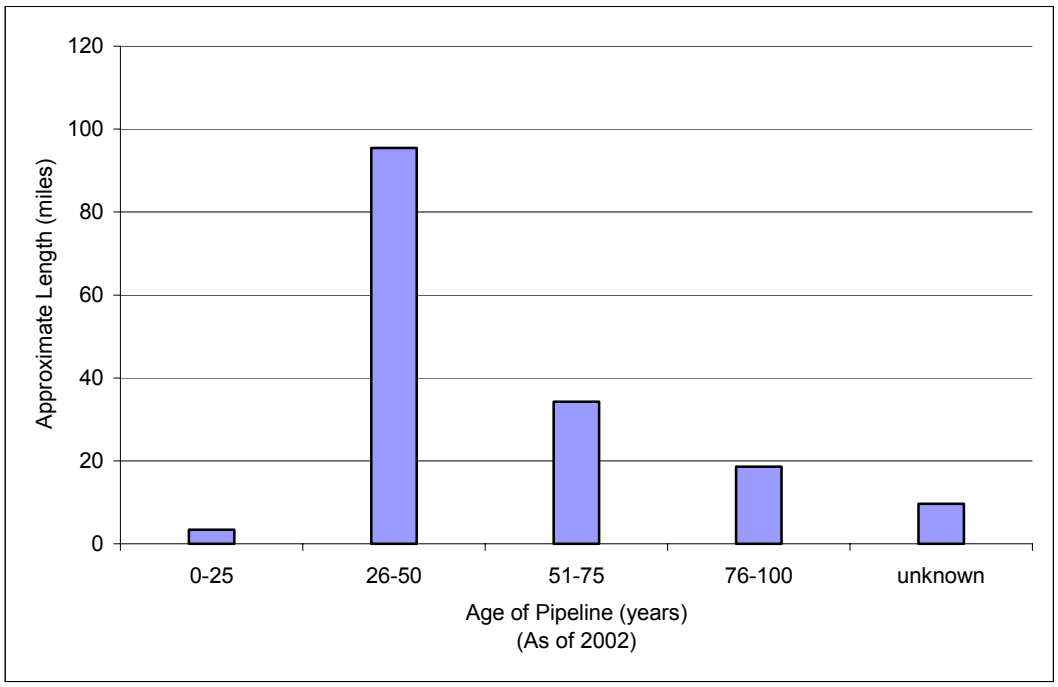

Figure 1. Age of Interceptors and Trunk Sewers (As of 2002)

4.3 Literature Review Condition Assessment

Available documents regarding the sludge deposition in the DWSD collection system were collected and reviewed. The latest reports completed on this subject are the CS-1158 report from 1996 and a corresponding Best Management Practices Report. These reports document a review of DWSD inspection data, collected between 1981 and 1992, that was conducted by the CSO Team under the *Long Term CSO Control Plan for the Detroit and Rouge Rivers*. The team recommended additional inspections and verification of old inspection data. Further, they developed a protocol for field inspection.

The CSO Team and DWSD staff performed field inspections for the Mt. Elliot, First Hamilton and the DRI, in addition to other sewers not considered in this report. A combination of video inspection and direct observation (walking) were used.

Generally, it was concluded that DWSD data are representative of current conditions and that the sections that were inspected are in good structural shape.

Sludge deposition in the sewers that were inspected is rated from Level 1 to Level 3, with Level 3 being in the poorest condition. Of the interceptor and trunk sewers, sludge buildup data is available for five, listed as follows:

- DRI
- Conner Creek Enclosure
- Conant – Mt. Elliott
- Southfield
- Baby Creek

Information pertaining to sludge buildup is included in Table 2. Further, information on the structural condition of three sewers is available for the following three sewers:

- DRI
- Conner Creek Enclosure
- Southfield

The information found in the CSO Team report is summarized in Table 2. In addition to the data found in the CS-1158 report, an internal DWSD memorandum, circulated in 2001, is available for review. Generally, the focus of the memorandum concerns potential sludge deposition in a 13'6" diameter section of the NI-EA located under Fort Street, between 23rd Street and Dearborn Avenue. This length of the interceptor was laid at a zero percent slope in order to avoid conflicts with other subsurface infrastructure. The memo also details the procedures that have to be followed to inspect the sewer. It is not know if an inspection was ever completed.

5. Analysis

In order to accurately assess the capital improvements needed to maintain the interceptors and trunk sewers, an analysis has been completed. This analysis includes 1) the estimated useful life of interceptors used by other organizations, 2) inspection and maintenance needs and 3) available replacement and rehabilitation techniques that can be used for large sewers.

5.1 Estimated Useful Life

Predicting the useful life of large trunk and interceptor sewers is not an easy task. The useful life of a pipeline is a function of its use, construction, and, soil and groundwater conditions. Table 3 lists a number of values used to estimate the useful life of interceptors by a variety of organizations. These numbers, for the most part,

are used for accounting purposes and may not reflect the real world useful life of the sewers.

In addition to the specific references included in Table 3, the American Society of Civil Engineers (ASCE) indicates that the life expectancy of a conduit constructed of traditional materials can be more than 100 years, in the absence of particularly harsh conditions. Many vitrified clay and brick sewers constructed in the 1800s are still in use and are in good condition.

Table 3. Estimated Useful Life of Interceptors

Source	Estimated Life (years)
DWSD Wastewater Master Plan	
DWSD WWMP Rate Study	100
Boston WSC	60
Chicago	100
Metropolitan Sewer District of Greater Cincinnati	100
Milwaukee	50-75
New York City	100
National Association of State Auditors, Comptrollers and Treasurers	
City of Chattanooga, TN	50
Metropolitan Council of the Twin Cities	60-80
Washington State Auditors Office	25-40

5.2 Inspections and Maintenance

A systematic inspection and maintenance program is not currently in place for trunk and interceptor sewers. A systematic inspection program is warranted due to the age of the large pipelines in the DWSD system. Maintenance requirements for large pipelines can be determined based on a systematic inspection.

5.2.1 Inspection

Due to the difficulty in accessing large, deep sewers that are in active service, inspections are difficult and costly. The DWSD has crews that inspect larger sewers (greater than four foot diameter) in walk through inspections where they can be safely entered. The crews cannot safely inspect a number of trunk and interceptor sewers, due to size and/or high dry weather flows.

Under the *Long Term CSO Control Plan for the Detroit and Rouge Rivers,* some pilot inspections were undertaken using raft mounted video cameras. Approximately 10,000 linear feet of large sewers were inspected. The sewers were found to be in good condition. It was further recommended that DWSD inspect 4,000 feet per year of the DRI, Oakwood North West, First-Hamilton, Mt. Elliott, and Oakland Arm Corridor.

The cost for inspection, reported in the Long Term CSO Control Plan, was $2.75 per linear foot for large quantities of work, in 1995 dollars. This value can be escalated to

approximately $3.20 in 2001 dollars. For the pipelines considered above, a budgetary cost of $600,000 (1995 dollars) was estimated.

Considering the difficulty in determining the useful life of large sewers, DWSD needs to carefully consider an inspection program to assess the existing conditions in trunk and interceptors sewers and develop a long term inspection program that can be used to monitor the condition of the pipelines as they age.

One approach that can be used to reach these goals is to prepare a baseline assessment of the existing conditions and use that assessment to generate recommendations regarding the appropriate inspection intervals for various sewers. Inspection intervals are a function of the age, construction and condition of each of the sewers. The baseline assessment would essentially consist of an extensive inspection program and corresponding recommendations.

The entire system does not have to be inspected, only a representative portion. A cross section of sewers of varying age, construction and historic use could be inspected in order to generate an accurate understanding of the conditions that might be expected in various sewers. It can then be assumed that the conditions found in this representative portion will likely be found in the remainder of the un-inspected sewers with similar characteristics. This approach enables the DWSD to minimize the effort needed to establish a baseline assessment but not compromise the quality.

Characteristics that would be considered in determining what sewers to inspect include age, material of construction, depth, hydraulics, special structures and historic use. The oldest sewers should be the focus of most of the inspection effort. Representative sections of pipelines constructed at different depths, methods and materials must be included.

It can be expected that an inspection of 10% to 25% of the system would provide a comprehensive understanding of the existing conditions. The total length that should be inspected and areas of the system, which should be the focus of the most intensive efforts, should be established with the input of the Pipeline Team. The trunk and interceptor sewers considered in this report total approximately 161 miles. Considering this and using the budgetary cost estimate for inspection from the *Long Term CSO Plan*, the cost to complete a baseline inspection can be estimated to be between $275,000 and $675,000.

It is expected that recommended inspection intervals, which are generated from the baseline assessment, would range from re-inspection every few years to every fifty years.

5.2.2 Planned Maintenance

A regular maintenance program for large pipelines should not be approached in the same manner as maintenance of collector sewers. Typically, periodic maintenance of collector sewers involves cleaning, and in some cases, televising sewer lines to

identify areas, which would benefit from preventative maintenance. The effort required to clean large pipelines on a periodic basis does not warrant the potential benefits. In lieu of periodic cleaning a program of "planned maintenance" is recommended. Using this approach, maintenance activities would be scheduled based on inspection reports. Maintenance activities typically fall into two categories, namely removal of sludge and debris and limited repairs.

Due to the high costs and difficulty associated with working in large, deep pipelines, it is envisioned that planning maintenance would likely take place months or even years after deficiencies are identified. This would allow DWSD to budget for these operations and adequately prepare operational plans to redirect or reduce flows from the pipelines that are being maintained.

The criteria for cleaning and repairs should be established with input from the Pipeline Team. These criteria would be applied to the inspection reports outlined above in order to focus on areas in need of attention. The criteria should be clear and concise in order to avoid subjective decisions.

5.2.3 Emergency Maintenance

As detailed in the attached notebook summaries, most of the larger pipelines do not have redundancy in the case of failure. As portions of the DWSD trunk and interceptor system are reaching the end of their expected useful life, the DWSD needs to develop contingency plans to prepare for potential pipeline failures. Existing emergency plans need to be further assessed and plans updated.

5.3 Rehabilitation / Replacement

Catastrophic sewer collapses are rare but becoming more common as infrastructure ages across the nation. According to the American Society of Civil Engineers (ASCE), some of the most common reasons for failure include difficult ground conditions, large wastewater flows, and deep excavations. While any failures are unwanted, collapse of critical sewers would have a significant impact on the users of the sewer system and potentially the environment.

Generally the criteria used to determine if a sewer is critical include; age (older than 50 years), deep installation, large diameter, brick construction, difficult access, difficult to bypass, as well as others. The interceptors and trunk sewers included in this report are all considered critical sewers. The ASCE suggests that, as a rule of thumb, post failure rehabilitation of critical sewers costs twice as much as planned replacement and three to four times the cost of planned rehabilitation.

Given the critical nature of these interceptors and trunk sewers, a planned program of replacement and rehabilitation, based on the base line inspection outlined above, is warranted. This rehabilitation program would likely include some sewers that are recommended for short-term rehabilitation (within 10 years) and some sewers where rehabilitation is not warranted during the fifty-year CIP being developed under the WWMP.

A brief description of rehabilitation (and replacement) techniques, that are applicable for large sewers, follows:

5.3.1 Replacement

Replacement of sewers that have reached the end of their useful life is a possible option. The most likely approach for replacement would be to construct a parallel sewer, and associate diversion structures. Once the new sewer is operational, the old sewer should be removed from service.

5.3.2 Pipe Lining

A variety of pipe linings can be installed inside of existing sewers to extend their lives. Polyethylene (PE) liners are available in sizes up to 12-foot diameter. Jacking pits must be constructed to place equipment into the sewer. The annular space between a PE liner and the wall of the existing pipe is filled with grout to provide additional strength. Fiber-glass-reinforced plastic (FRP) liners are also available, in sizes up to 14-foot diameter, and can be installed using the same approach used for PE liners. Plastic liners can be installed with some wastewater flow in the pipeline.

Steel liners are available in diameters up to 12 foot. Steel pipe is not easily installed where bends are present and must be welded, which requires the pipe being completely free of flowing water.

5.3.3 Cured-In-Place Pipe (CIPP)

CIPP can be used to reline existing sewers. A flexible lining is inserted into a sewer line and expanded into place using water, winch, or, air inversion. Hot water or steam is used to cure the lining, providing a rigid final lining. Flows to the sewer must be completely diverted. Sewers up to 8 foot in diameter have been successfully rehabilitated using this technique, but installation in larger sewers can be difficult.

5.3.4 Segmental Liners

Segmental liners form a composite system with the existing sewer and high strength grout that is installed between the liner and existing sewer. This type of liner system is suitable for sewers with diameters greater than 4 foot and can be made to fit a variety of shapes. Segments can be installed through existing manholes. Bypass pumping must be used to keep the pipeline dry during installation. A variety of materials are available for segmented liners including fiber-glass-reinforced cement, FRP, Polyethylene, PVC and steel.

5.3.5 Structural and Nonstructural Coatings

Shotcrete or Cast-in-place concrete can be used to reline existing sewers. Reinforcement, which is tied to the existing sewer, is usually used with both of these methods. It should be noted that in order to rehabilitate a sewer that is in service, the sewer must be dewatered and taken out of service. The cost for flow diversion is a significant portion of the total cost for rehabilitation. The system wide implications of rehabilitation must be considered. The flows in reconditioned pipes may be increased (lowering surface roughness) or decreased (reduction of inside pipe diameter).

6. Follow-up work

As noted in the introduction the profiles and summaries presented in this memorandum are intended to be planning tools. These tools form the basis for the development of a plan, which outlines the long-term requirements for collection system improvements. Specifically, a long term Capital Improvement Plan is developed in Volume 4, which incorporates capital spending requirements needed to maintain the interceptors and trunk sewers.

6.1 Pipeline Team

The Pipeline Team has continued to remain active and provide input during the development of the Capital Improvement Plan. The Pipeline Team consists of DWSD personnel that are most familiar with the collection system and can provide valuable information on the current operations and past design and construction efforts. The Pipeline Committee includes the following people:

Name	Department/Organization
Sergio Dioso	DWSD
Clarence Dishman	DWSD
Bharat Doshi	DWSD
Vincent Galloway	DWSD
George Haberer	DWSD
Ronald Holloway	DWSD
Milton Johnson	DWSD
Michael Kubien	DWSD
Ted Znoy	DWSD
John Bona	CDM
Lori Cipparone	CDM
Dave Goodman	CDM
Jeff Mitsopoulos	TYJT
Bhagu M. Patel	TYJT

In order to develop accurate cost estimates, feasible rehabilitation and/or replacement methods must be established. Considering that the existing system is continuously used, the selection of viable methods for infrastructure renewal must be given careful thought in order to develop accurate cost estimates.

The Pipeline Team has been consulted in order to establish the most cost-effective approaches to rehabilitation/replacement of the interceptors and trunk sewers, which do not have a detrimental effect on the operation of the collection system.

6.2 Capital Improvement Plan

The information presented in this Technical Memorandum has been used as a tool to develop the Capital Improvement Plan for interceptors and trunk Sewers. The profiles and summaries can be used to identify areas with needs for immediate improvements and areas where improvements will be needed. A detailed inspection

program for interceptors and trunk sewers will be included in the Volume 4.

7. References

1. City of Detroit
   Long Term CSO Plan for the Detroit and Rouge Rivers July 1, 1996.

Volume 1	*10.06*		*Collection System Rehabilitation*
Volume 2	*10.06A*		*Collection System Rehabilitation*
Volume 3	*10.06A*		*Collection System Rehabilitation- Appendix D and Inspection Reports*
Volume 4	*10.02*	*E1*	*Inflatable Dams*
	10.02	*E2*	*Identify Sludge Build-Up*
	10.02	*E3*	*Identify Conditions of System*
	10.02	*E6*	*Identify Planned Improvements*

2. DWSD Contract PC-698 Contract Documents for In-System Storage, Book 2 of 2, March 1996.
3. DWSD Contract CS-1329 *In-System Storage Design*, January 2002.
4. DWSD PC-744 *Asset Audit Report*, December 19, 2001.
5. DWSD *Operational Plan*, October 1994.
6. DWSD CS-1281 Assistance with Phase III – *CSO Program, Department-Wide Instrumentation, Control and Computer System Program II, Wastewater Collection System Operational Elements Data, Existing and Currently Planned and Recommended*, March 15, 2001.
7. DWSD PC-665 System-*Wide Instrumentation and Control, Westin Engineering, Inc., Wastewater Collection System, Valve Remotes*, March 1993.
8. DWSD *Wastewater Collection System Operation and Maintenance Manual, Volume 1 and 2,* September 1988.
9. Existing Sewer Evaluation & Rehabilitation, ASCE Manual and Report on Engineering Practice No. 62, 1994.