Detroit Water and Sewerage Department

Wastewater Master Plan
Volume 3

Wastewater Service Alternatives

CDM Camp Dresser & McKee

Draft — June 25, 2003

Detroit Water and Sewerage Department

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Technical Memoranda*

The Following Technical Memoranda were used in the preparation of *Wastewater Service Alternatives,* Volume 3 of the Detroit Water and Sewerage Department's Wastewater Master Plan.

- *Preliminary Flow Projections for Alternatives Analysis*
- *Expanded Treatment Facilities within the City of Detroit*
- *Technical Feasibility of Satellite Treatment*
- *Technical Feasibility of a Wet Weather Flow Treatment Facility*
- *Review of Source Water Protection and Related Watershed Management Regulations and Programs*
- *Evaluation of Wastewater Treatment Plants in St. Clair County*
- *Urban Streams Restoration, City of Detroit*

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

Executive Summary

This is Volume 3 of the Detroit Water and Sewerage Department (DWSD) Wastewater Master Plan. This *Report on Wastewater Service Alternatives* presents wastewater flow projections and wastewater service alternatives for the planning area.

Flows

Population in the planning area will grow by about 11 percent through 2050, with Oakland and Macomb counties showing high rates of growth in outlying areas and Wayne County populations staying essentially unchanged (See Figure 1).

Much of the growth in the latter part of this time period — from 2030 to 2050 — will be small areas that "fill in" areas of the community already sewered. In general there are no areas that show major growth that will require large-capacity sewers. As an example, an extension of a sewer to Metamora Township in Lapeer County could be a new area for growth with a small-capacity sanitary sewer. There is demand currently for sewers along Lapeer Road in Metamora Township and sewers may be needed before 2030.

Figure 2 shows sewered areas in the planning area in 2000. Figure 3 shows projected sewer growth in the planning area by 2050. There are some areas on the map where future sewer needs could not be determined with the criteria that have been described. These areas are blank on the map and will be filled in after consultation with county representatives.

Most of the growth would be served by community sewers. A sewer extension to Lapeer County would require evaluation of the transportation network from Lapeer to the DWSD Wastewater Treatment Plant to evaluate the impact this might have.

Basis of Flows

Flow projections were developed through 2050 based on available flow data and future population projections for the service area. The service area includes the Rouge River and Clinton River watersheds plus adjacent portions of the St. Clair River and Detroit River watersheds.

The peak hourly flow factor was selected based on a comparison of available metering data to the National Sanitation Foundation (NSF) study *Sewerage and Drainage Problems and Administrative Affair*, Ten State Standards for wastewater facilities

Figure 1: Total County Populations and Projections, 1900-2050 (millions)

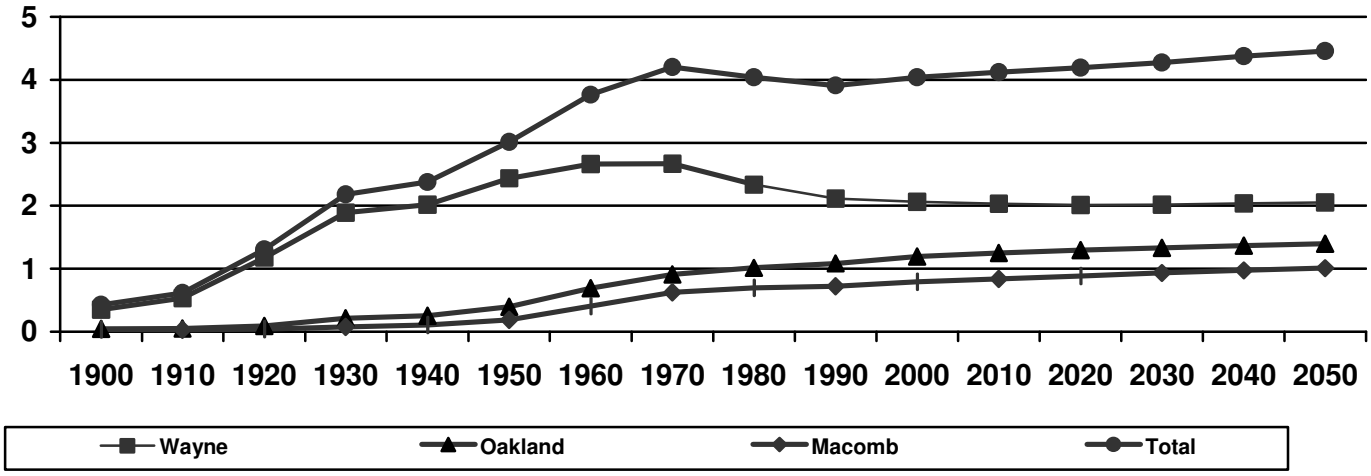


Figure 2: Sewered Areas in the Planning Area in 2000

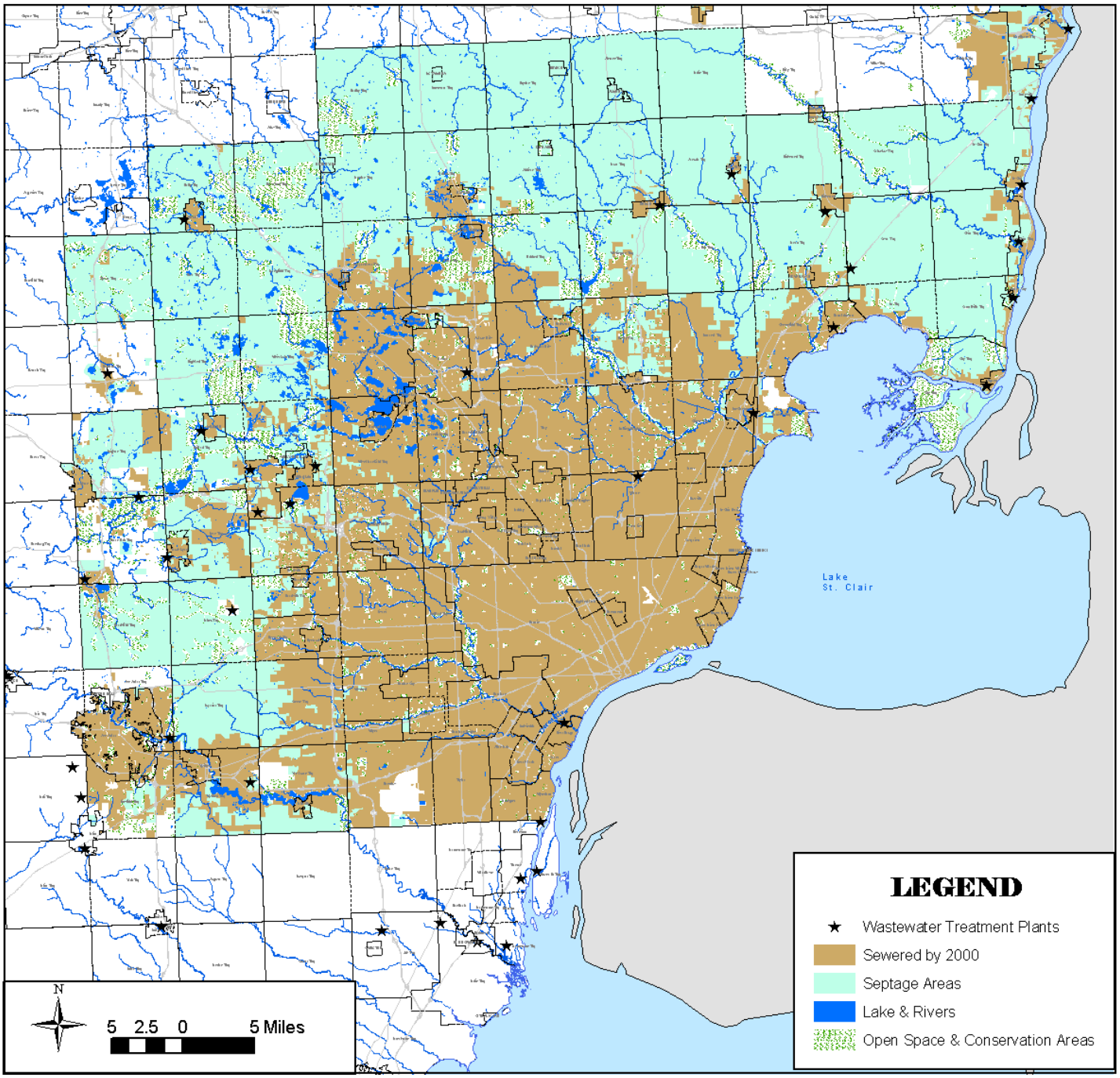


Figure 3: Projected Sewered Areas in 2050

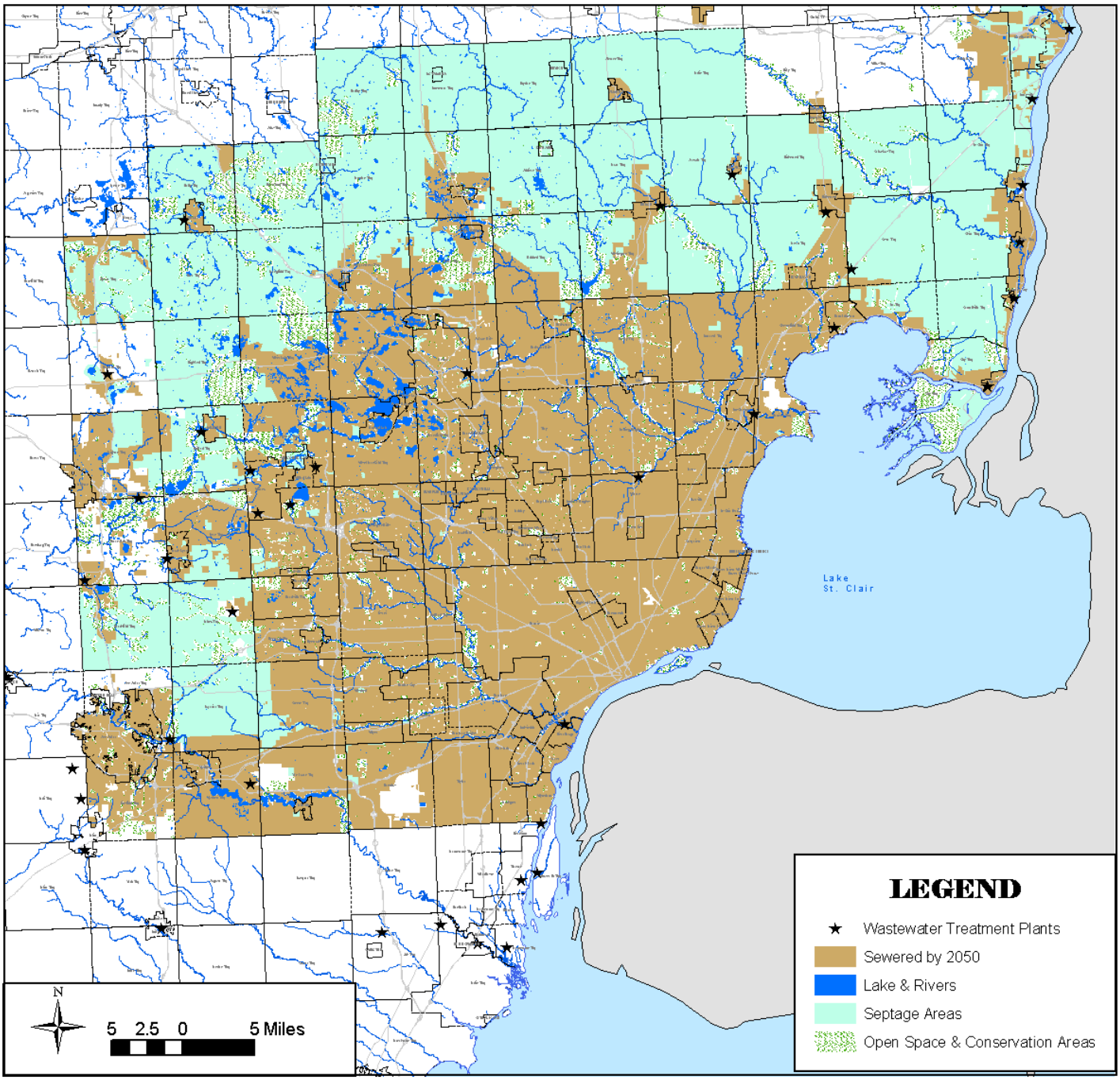
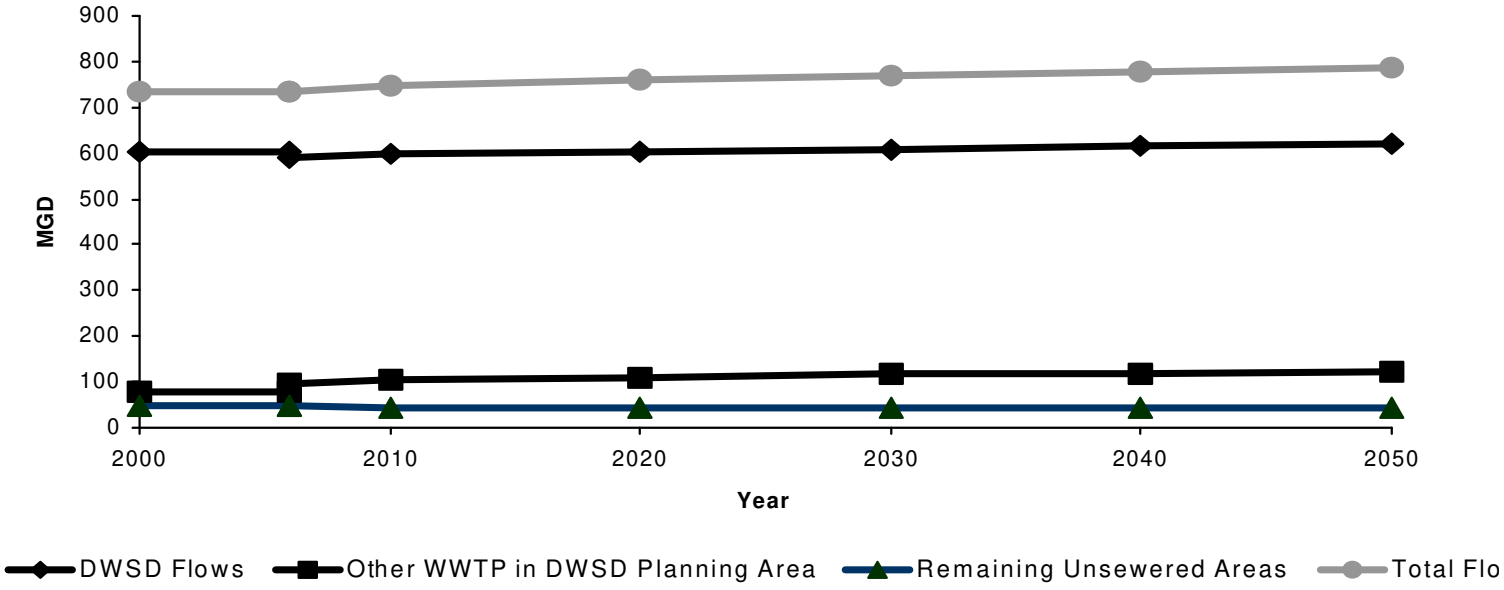


Figure 4: Planning Area Flow Projections



design, and the American Society of Civil Engineers (ASCE) study *Design Construction of Sanitary and Storm Sewers*. The selected peaking factor was larger than recommended by the technical references, because those references apply to new collection systems that receive little inflow and infiltration.

Wet weather flows depend on rainfall, groundwater and antecedent soil conditions, pipe capacity to transmit flows, and capacity in the DWSD system to accept flows. Wet weather flow projections are also dependent on the results of the emerging policy in Michigan for controlling sanitary sewer overflows. The existing interceptor system can deliver approximately 3,500 mgd from the service area to the site of the wastewater treatment. The two pumping stations at the treatment plant can lift about 1,700 mgd to treatment. The remaining 1,800 mgd in the interceptors (the flow that exceeds the capacity of the pumping stations at the treatment plant) discharge through combined sewer overflows and CSO treatment facilities.

An analysis of potential solutions to SSOs in the service area is presented in Volume 6, *Evaluation of Regional SSO Controls*.

Figure 4 shows projected average flows in the planning area identified by flows handled by DWSD, flows handled by other wastewater treatment providers and flows generated from areas projected to remain unsewered. The shift in DWSD and other providers' flows in 2006 reflects the plans of the Western Township Utilities Authority to divert its flow to the Ypsilanti Community Utility Authority (YCUA) that year. Table 1 shows average and maximum daily flows in those three categories in 2000 and 2050. Table 2 shows the current projections for the 10-year, 1-hour storm from the 21 major districts.

Table 1: Average & Maximum Daily Flows (mgd) in Service Area

	2000	2050
	Average Flow	Average Flow
DWSD	605	620
Other Service Providers	80	124
Unsewered Areas	50	44

Alternatives

Four conceptual alternatives have been identified for wastewater service for the planning area. Each of these alternatives represents a different approach for wastewater service, and the alternatives have been purposefully configured to distinguish a unique approach. The four alternatives can be thought of in terms of four corners of a box, with each corner being one extreme. The most cost-effective solution for the planning area is a combination of parts of each alternative, and found in the figurative center of the box. See Figure 5. Components of the four conceptual alternatives are described below.

Flow Management Alternative

The goal of this alternative is to reduce dry weather I/ I to free up capacity for increased dry weather flows due to population growth in the planning area. Key components of this alternative include:

- Maintain 930/ 1700 (secondary/ primary) permitted capacity at 9300 West Jefferson
- Implement an aggressive dry weather inflos and infiltration (DWI/ I) reduction program in Detroit; provide technical assistance to wholesale customers with inflow and infiltration (I/ I) removal projects
- Revise wholesale customer contracts to provide incentives for infiltration/ inflow reduction

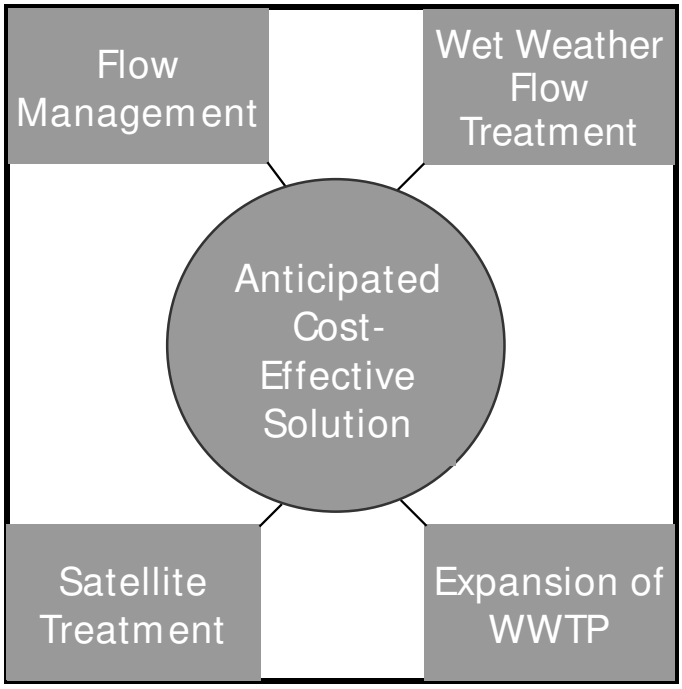
Table 2: Projected Peak Hour Flow Rates for Representative Service Districts (cfs)

Flow District	10-Year, 1-Hour Peak Flow Rate
Suburban	
Allen Park	6*
Center Line	7
Clinton-Oakland	93
Dearborn	100
Evergreen-Farmington	148
Farmington	6*
Grosse Pointe	192
Grosse Pointe Farms	342
Grosse Pointe Park	25
Macomb County	258
Melvindale	15
N.E. Wayne District	127
S.E. Oakland	270
Western Wayne	349
Detroit	
Baby Creek	364
Central City	445
Conner Creek	230
E. Jefferson/Fox Creek	(610)**
Hubbell/Southfield	86
Oakwood	24
Rouge River	216

*Peak rate is assumed to not exceed contract capacity.
**Net discharge towards treatment is negative because of overflow discharges within the district.

- Where technically feasible and where the age of sewers requires complete reconstruction, construct new separate sanitary and storm sewers in some areas of Detroit in conjunction with redevelopment project
- Develop urban stream renewal plan for City of-

Figure 5: Conceptual Treatment Alternatives



Detroit (separated storm water)

Wet Weather Flow Treatment Alternative

The goal of this alternative is to provide a parallel wastewater treatment process at or near 9300 West Jefferson to handle wet weather flows and for treatment of stored wet weather flows after storm events. Key components of this alternative include:

- Maintain 930/ 1700 (secondary/ primary) permitted capacity at 9300 West Jefferson
- Implement partial I/ I reduction program
- Complete construction of Upper Rouge CSO tunnel as currently planned in the update of the Long Term CSO Control Plan
- Construct additional headworks pumping capacity to augment Pump Station 1 and Pump Station 2
- Construct physical/ chemical treatment process for providing the equivalent of secondary treatment for flows exceeding the permitted secondary capacity of 930 mgd
- Consider a second wet weather tunnel along the Detroit River to consolidate overflows for treatment

Satellite Treatment Alternative

The goal of this alternative is to provide additional dry weather treatment capacity at locations other than 9300 West Jefferson to meet future needs. Key components of this alternative include:

- Maintain 930/ 1700 (secondary/ primary) permitted capacity at 9300 West Jefferson
- Implement partial I/ I reduction program
- Perform expansions at other treatment providers

Expanded Central Treatment Alternative

The goal of this alternative is to provide expanded dry weather treatment capacity to meet additional future needs at 9300 West Jefferson, along with transport capacity where needed. Key components of this alternative include:

- Expand 930/ 1700 (secondary/ primary) capacity at 9300 West Jefferson to about 1200/ 2000 (Use physical chemical treatment at 9300 West Jefferson to expand primary capacity)
- Implement partial I/ I reduction program
- Upgrade the plant to remove additional phosphorus or ammonia, or tertiary treatment

See Table 3 for a summary of these alternatives.

Components Common to All Alternatives

Key components of all alternatives include:

- Relieve or rehabilitate interceptors and pump stations to achieve capacities consistent with the treatment alternatives
- Complete long-term CSO plan and build stand-alone CSO treatment facilities that meet WQS
- Regional Operations Plan to provide operating

Table 3: Treatment Alternatives Summary

Alternative	Additional Capacity (mgd)	Degree of Treatment	Capital Costs [1] ($ million)	Annual O&M ($ million)	Present Worth Cost [2] ($/gal./day)
Wet Weather Flow Treatment	100	Secondary Equivalent	43	1.2	0.6
Expansion of Existing Plant	100	Secondary	256	28	6
Satellite Treatment [3]	11	Tertiary	62	6	12.4
	21	Tertiary	161	12	14.8
	54	Tertiary	256	24	10.3

Note: See more details of costs in Chapter 3.
1. Capital cost includes treatment facilities and new interceptors to convey the additional flows to the treatment facilities.
2. Present worth calculated based on 5 percent discount rate and 20-year economic life. Values are unitized to show cost per gallon per day of treatment capacity.
3. Three representative examples are shown. See Table 3.5 for additional alternatives.

protocols for high flows and for dewatering and wastewater treatment

- Infrastructure upgrades (repair and replace) to provide acceptable life and reduce maintenance needs
- Educational, environmental and access improvements at 9300 West Jefferson in accordance with Rouge Gateway project

Findings

The findings of the technical studies for this report lead to the following findings regarding the four conceptual alternatives.

Flow Management: Detroit and a number of communities in the DWSD service area are performing projects to reduce sources of excessive infiltration/ inflow. These efforts, along with trends in residential and industrial water conservation show that DWSD can manage flows within its existing treatment plant capacity. A detailed examination of dry weather and wet weather infiltration/ inflow rates was performed to develop target reductions for dry weather infiltration/ inflow by community.

Specific infiltration/ inflow projects should only be performed when the cost to eliminated the flow is less than $5 per gallon per day.

Wet Weather Flow Treatment: Technology exists to provide treatment to the equivalent of secondary standards using physical chemical processes which can be used in conjunction with existing biological treatment processes at the Wastewater Treatment Plant. This technology, known as ballasted flocculation, is in operation at several wastewater treatment plants. The current upgrade at the Wastewater Treatment Plant (PC-744) is expected to meet NPDES permit requirements for primary treatment of wet weather flows in excess of secondary treatment capacity by 2007. After 2007, the major new source of flows at the Wastewater Treatment Plant will be the flows from the dewatering of planned CSO storage basins, plus possible flows from new SSO storage basins. When these new flows are on-line, a number of factors need to be reviewed to determine if additional treatment of wet weather flows is needed. These factors include:

- Experience with dewatering of CSO and SSO storage basins;
- Operational data on the performance of flow blending at the wastewater treatment plant;
- Future NPDES permit requirements.

Expansion of the Existing Treatment Plant: Ex-

pansion of the Wastewater Treatment Plant at the existing site is difficult because of space limitations and the configuration of the existing process layout. Flow projections for this Master Plan show that an expansion would not be necessary if anticipated flow management actions are successful. If flows do increase beyond those projected, then a cost-effective alternative would be the construction of a second facility located so as to classify as a modification of the existing wastewater discharge. By the end of the planning period, the new facilities under construction will be over 40 years old, and the oldest elements of the plant will be over 100 years old. This Master Plan will outline a general plan for reconstruction of the plant at its existing site by the end of the planning period. This reconstruction will provide for the newest and most efficient technologies and will enhance operational flexibility and reliability.

Satellite Treatment: The construction of new satellite treatment plants and the expansion of existing plants operated by other wastewater service providers were evaluated. Satellite treatment is a feasible option. However, on a unit-of-flow basis, the cost of satellite treatment is two to three times more expensive than expansion of facilities in Detroit. The higher costs of satellite treatment are due to more stringent effluent requirements and costs to change the interceptor and pumping system to convey flows to the expanded plants. Small increases in the capacity of some satellite plants may be cost-effective where major conveyance system changes are not required.

Certain elements of each conceptual alternative are feasible and cost-effective. These optimal elements need to be adopted by DWSD in a time line as follows:

1) Proceed with flow management efforts immediately, and pursue these as a continuing effort through the planning period.

2) Wait until 2007 or later, when major CSO and SSO basin dewatering flows are a reality, and determine if additional wet weather flow treatment is needed.

3) Should flows increase beyond the projections in this plan, or should other treatment providers in the planning area need to abandon their plants, consider expansion of existing treatment facilities located near to the existing plant, but at a separate site.

4) Provide existing customers and other providers information regarding DWSD rate projections for 10 years so that wholesale customers can make informed decisions on the cost-effectiveness of new satellite facilities.

Conclusions

This report of the Wastewater Master Plan has developed four conceptual alternatives for wastewater service for the DWSD over the next 50 years. The DWSD invites comments on these alternatives from its retail customer representatives, its wholesale customer communities, and other stakeholders in the planning area.

The master planning team has developed the following tentative conclusions from the study of alternatives presented in this report:

1. Future wastewater flows in the planning area can be characterized as follows:

- The greatest growth in flows is projected to be in areas that are currently unsewered.
- The second-greatest rate of growth is in areas served by other treatment providers.
- The third-greatest rate of growth is the unsewered area within the contract service area of DWSD.

2. The PC-744 project and other ongoing improvements in DWSD's 2002 CIP will provide sufficient capacity for secondary treatment for projected peak hour dry weather flows from the cur-

rent contract service area through 2050. There is also sufficient capacity for DWSD to provide wastewater treatment for some new customers outside of the contract service area, including areas that are currently not sewered. Other treatment providers may choose to join the regional system.

3. The volume of flow that DWSD can accept from new customers will depend on the success of DWSD's dry and wet weather flow management efforts. At present, wet weather flows cause capacity problems at about 20 points within the city collection system and the suburban interceptor system of the DWSD. These problems need to be addressed to allow DWSD to reliably provide wastewater treatment service to new customers. Relief sewer construction is discussed in Volume 4, *Capital Improvement Program*.

4. The DWSD is making progress on understanding and reducing peak wet weather flows and excessive dry weather infiltration/ inflow in its service area. Current efforts include the flow management efforts of this Master Plan, the regional SSO study, the Detroit I/ I study, and the development of a regional operational plan. Other wastewater treatment providers in the planning area are also grappling with wet weather flow management problems.

5. DWSD's current NPDES permit allows for the discharge of primary treatment effluent when flows exceed the secondary treatment capacity of 930 mgd (inclusive of recycle and after PC-744 is completed). The duration of the allowable primary treatment discharge is dependent on the volume of rainfall and extends up to 72 hours after a storm event. DWSD used the primary effluent provision 114 days in 2001, 118 days in 2002 and 36 days in 2003 through April 18.

6. DWSD can provide wastewater service to most communities in the planning area at costs that are lower than the cost of individual communities building or expanding their own treatment plants. This is because the DWSD system is large and has secondary treatment capacity requirements, while other plants on the Huron, Rouge, or Clinton rivers require tertiary treatment. However, communities are concerned about the rate of increase of DWSD sewer rates, the complexity of contracting with the DWSD, and the need to also contract with an existing first-tier or second-tier customer. For these reasons, communities may choose service from other treatment providers in the planning area.

7. The Pontiac and Mt Clemens wastewater treatment plants have the greatest potential for expansion to serve more communities in Oakland and Macomb counties. Oakland and Macomb counties each have studies ongoing or proposed to look at the cost-effectiveness of expanding these plants. Preliminary engineering performed for this Master Plan indicates that major expansions that involve new interceptors would be more costly compared to the cost of DWSD service today. Any study of cost-effectiveness needs to consider anticipated rate increases by the DWSD. Projections of future sewer rates are addressed in Volume 5, the *Report on Customer Service*.

Figure 1.1: DWSD Wastewater Master Plan Planning Area

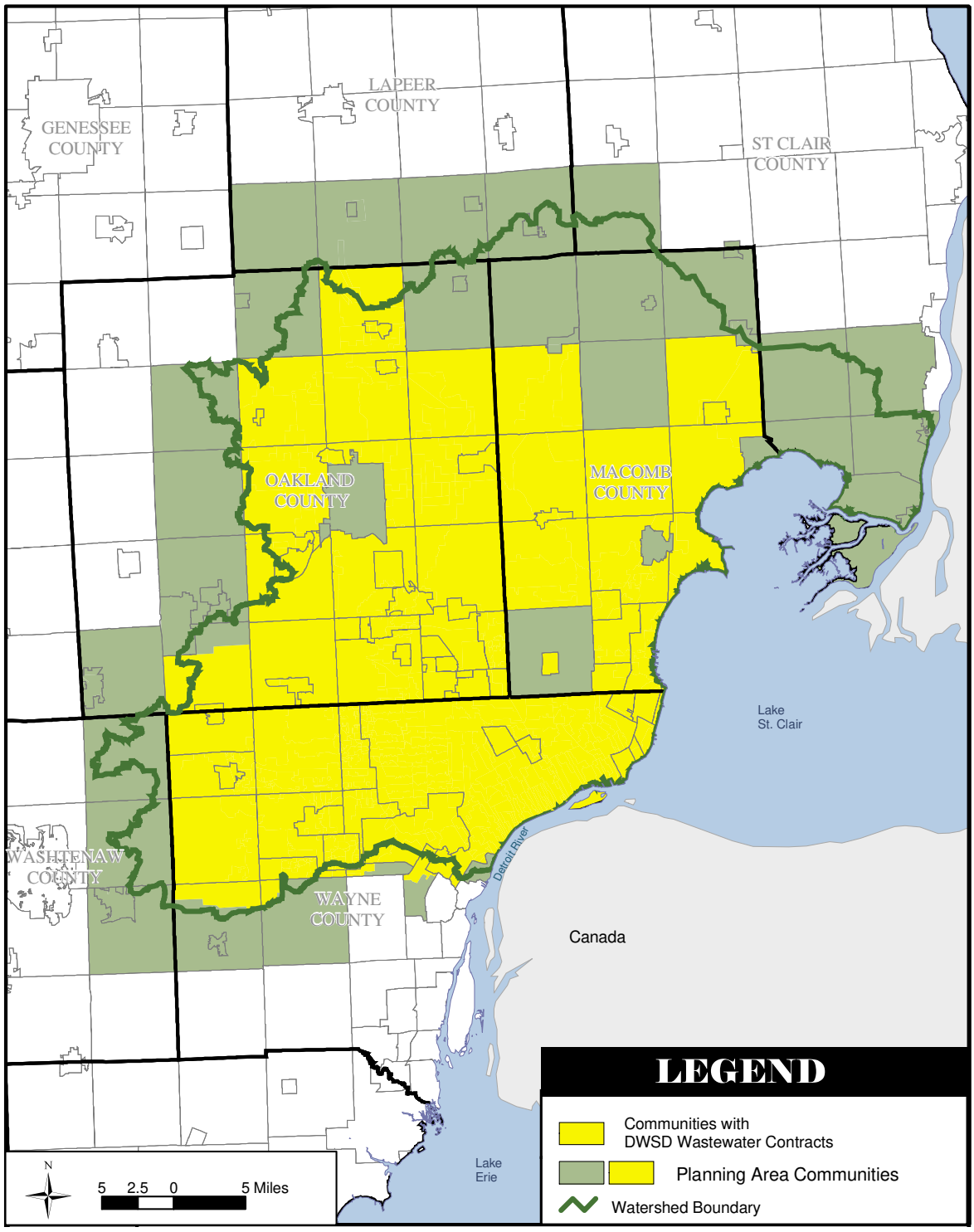
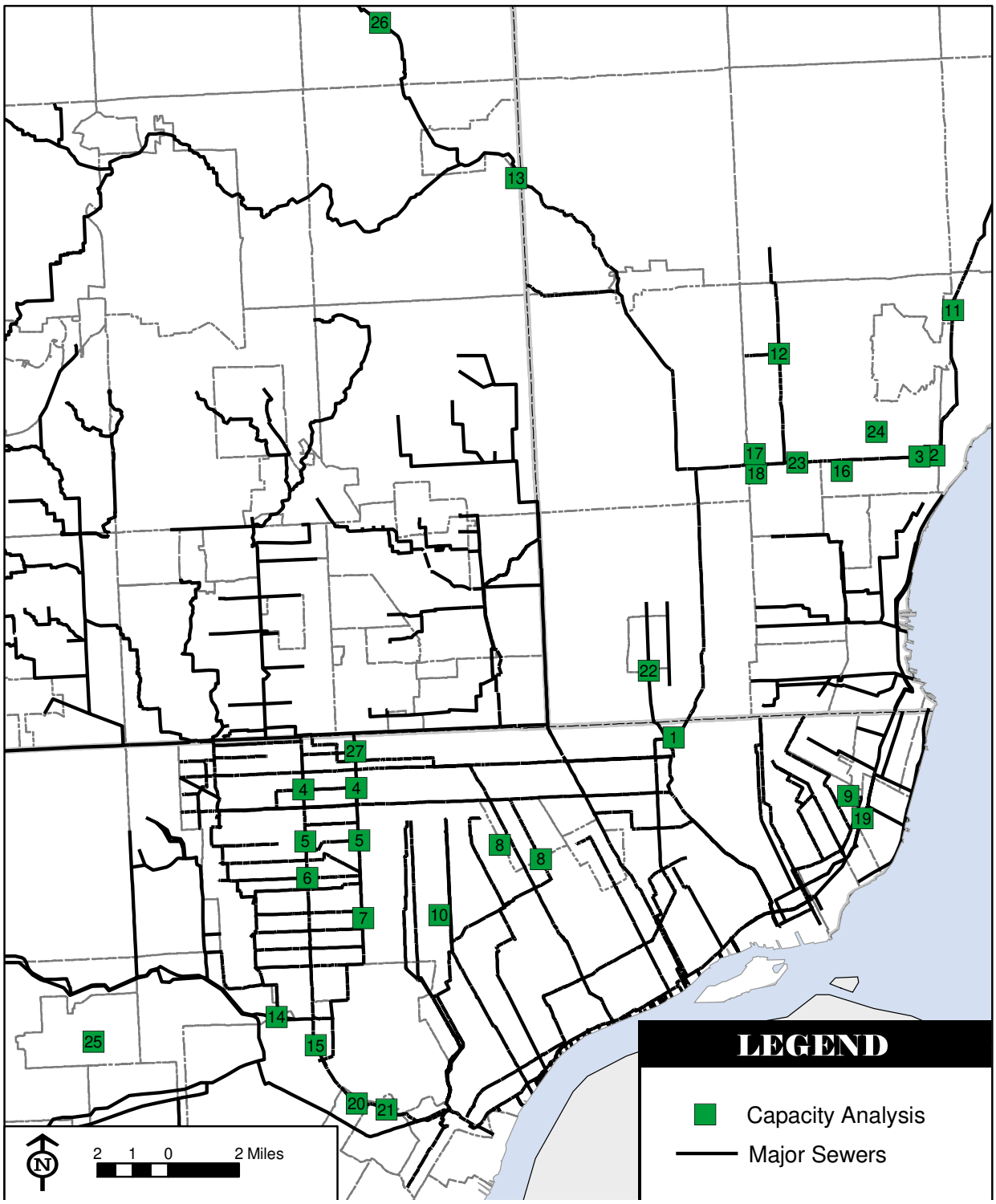


Figure 1.2: Capacity Constraints in DWSD Service Area



1. Introduction

1.1 Background of This Report

This is Volume 3 of the Detroit Water and Sewerage Department Wastewater Master Plan. This *Report on Wastewater Service Alternatives*, describes an array of possible solutions to providing wastewater service in the future throughout the planning area. These alternatives provide a framework for the Master Plan to develop the most cost-effective solution for wastewater service in the planning area over the next 50 years.

1.2 Scope of This Report

This report presents wastewater flow projections and wastewater service alternatives for the planning area, which is shown in Figure 1.1. Average dry weather daily wastewater flow is expected to increase from about 735 mgd to 790 mgd in the 124-community planning area during the scope of this Master Plan. Dry weather flows within DWSD's existing contract service area are expected to increase from 605 mgd to 620 mgd over the next 50 years. Maximum daily flows that will require secondary treatment are expected to increase from 790 mgd in 2000 to 810 mgd in 2050. Estimates of future wastewater flows are explained further detail in Chapter 2.

Four conceptual alternatives were identified to provide treatment for future wastewater flows:

- **Flow management** – reduce extraneous dry weather and wet weather flows to a degree that allows for future new growth without major new wastewater treatment facilities; also, make greater use of decentralized wastewater treatment technologies for new growth in the upper reaches of the watersheds.
- **Wet weather flow treatment** – construct new facilities dedicated to wet weather flow so that existing facilities can be used for secondary treatment of sanitary sewage flows.
- **Satellite treatment** – construct new wastewater treatment facilities where growth is occurring in Macomb and Oakland counties, or expand facilities at the sites of existing wastewater treatment plants in those counties.
- **Expand existing treatment plant** – expand the 9300 West Jefferson treatment plant for future flows, or build additional facilities at a location that would meet requirements for a modification to an existing discharge.

These four alternatives are compared based on costs, regulatory issues, environmental impacts, and a schedule for when decisions would need to be made.

There are currently a number of pipeline capacity constraints that affect the delivery of flow to treatment facilities. These pipeline problems result in sanitary sewer overflows during wet weather, hydraulic backups, or other issues. Figure 1.2 shows the location of constraints that have been identified for this Master Planning study. The solution to these constraints could be made by a combination of new construction, completion of ongoing projects and reduction in flows. In general, these constraints must be solved regardless of which approach to wastewater service is selected.

2. Wastewater Flow Projections

2.1 Population, Employment and Sewer Service Area Growth

Estimates of dry weather flow origin and quantity are based upon population and employment projections. This report on *Wastewater Service Alternatives* used Southeast Michigan Council of Governments (SEMCOG) projections for the Master Plan planning area which are based on the 2000 U.S. Census.

2.1.1 Methodology

Projections for the DWSD service area were obtained by using well-established computer modeling based on data from the U.S. Census, the Michigan Employment Security Commission and other sources. SEMCOG's Regional Development Forecast (RDF) began by developing Regional Forecast Totals. These totals relate to the seven-county area that comprises the SEMCOG region and are derived from data compiled by the University of Michigan's Institute of Labor and Industrial Relations.

Population and employment projections are described in detail in Volume 1: *Report on Planning Criteria*. A brief summary of the projections is presented below.

Household and economic interactions within the region were determined by using a second well-established population modeling system. This model divides the larger region into districts called Minor Civilian Divisions (MCD).

Finally, the districts were further broken down into Traffic Analysis Zones (TAZ). Zone forecasts were then added up to make the projections for each community within the DSWD planning zone and the community projections were further added to obtain county and watershed numbers.

2.1.2 Population Projections

Most of the area encompassed by the Master Plan will show significant increases in population through 2050 with the exception of Wayne County, which will show no significant change. Macomb will be the growth leader, going from 788,000 residents in 2000 to just over a million by 2050. Oakland County will also grow steadily, with the northern and western areas showing marked increases and the "inner ring" suburbs maintaining or slightly losing residential numbers.

Total population in the planning area will increase by about a half million by 2050, to 4,269,000 residents. Tri-county population changes by decade are shown in Figure 1 in the Executive Summary of this volume.

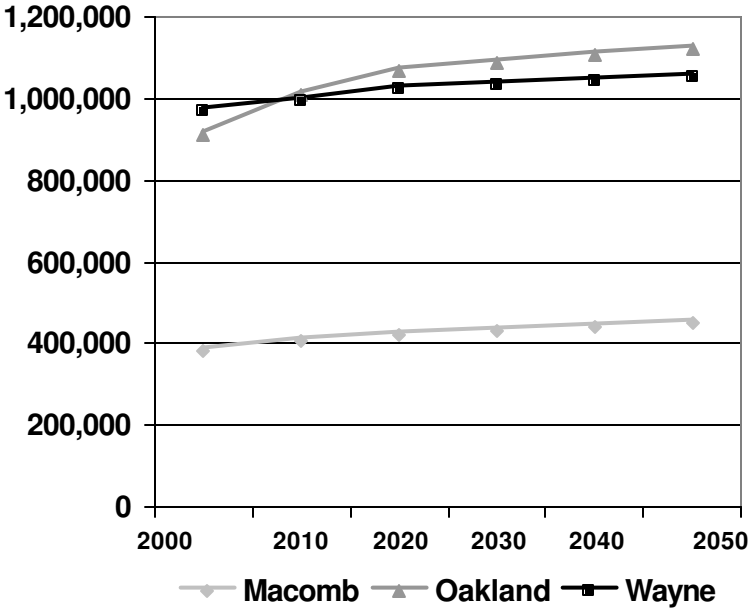
Populations in communities in the other counties constituting small portions of the planning area – Lapeer, St. Clair and Washtenaw counties – will all grow over the next half decade with the exception of the city of Ypsilanti in Washtenaw County, which will remain steady.

2.1.3 Employment Projections

Employment will increase faster in the planning area than population through 2050, showing an increase of 18 percent over the next five decades. Oakland County will lead the way in job growth, with more than 100,000 new jobs, but each county will show increases.

Manufacturing will fall in virtually every part of the planning area, but service jobs will increase at a 30 percent rate, more than overcoming the loss in the manufacturing sector. Projected employment growth in Wayne, Oakland and Macomb counties is shown in Figure 2.1.

Figure 2.1: Tri-county Employment and Projections, 2000-2050



2.2 Projected Sewer Area Growth

The anticipated growth of the metropolitan Detroit sewer service area to the year 2050 has been mapped. Figure 2.2 shows sewered areas in 2000. Figure 2.3 shows projected sewered areas in 2010. Figure 2.4 shows projected sewered areas in 2030. Figure 2.5 shows projected sewered areas in 2050. SEMCOG had previously prepared projections of sewer service areas for the period 2000 to 2030. This Master Plan has refined the earlier mapping by SEMCOG and has extended the projections to the year 2050.

- A summary of the basis of the projections is presented below.
- *Southeast Michigan Regional Sewer Service Areas Map* developed by SEMCOG
- Projected population and employment data 2000-2050, Excel spreadsheet, February 2002, SEMCOG, file DWSD2050.xls.
- Regional Future Land Use map, 2000, SEMCOG, file REGMPL01
- Seven County Region 1995 Land Use/ Land Cover map, SEMCOG, file REGUSE
- 1990 Transportation Analysis Zones map, SEMCOG, file TAZ (Traffic Analysis Zones)
- 2030 Regional Development Forecast TAZ Detail Table, Excel spreadsheet, SEMCOG, file 2030rdf_taz_blocked.xls
- Information from township supervisors and other representatives of communities on the outer edge of the current sewer service area. If a community has indicated by its master plan or growth policy that it will not be served by sanitary sewers, no sewer projections were made.
- Technical Memorandum, *DWSD Wastewater Plan, DWSD Project No. CS-1314, Soil Suitability for Onsite Sewage Disposal Systems, Section 1.8, Memo of Comments from Communities Using Onsite Sewage Systems in DWSD Service Area.* April 2002

New growth was assumed to be at a density of two dwelling units per acre. This calculated result gives the number of acres of households that could be served by sanitary sewers. This acreage was then distributed to already sewered areas, along major roads in the TAZ or to areas identified by the community as the place where growth was likely to occur based on the land use plans. If a community had indicated that future growth was to be served by onsite sewage systems, sewer service area projections were not considered for that community. Communities planning to continue to use septic systems were identified from phone calls to township supervisors and other representatives of communities. Areas that are designated recreation or open spaces were not considered for sewer extensions.

The above information was overlain on the map of the Southeast Michigan Regional Sewer Service Areas. This overlay provided a visual representation of areas where growth was expected to occur from 2000 to 2050 and where population densities were two or more dwelling units per acre. Two

Figure 2.2: Sewered Areas in the Service Area in 2000

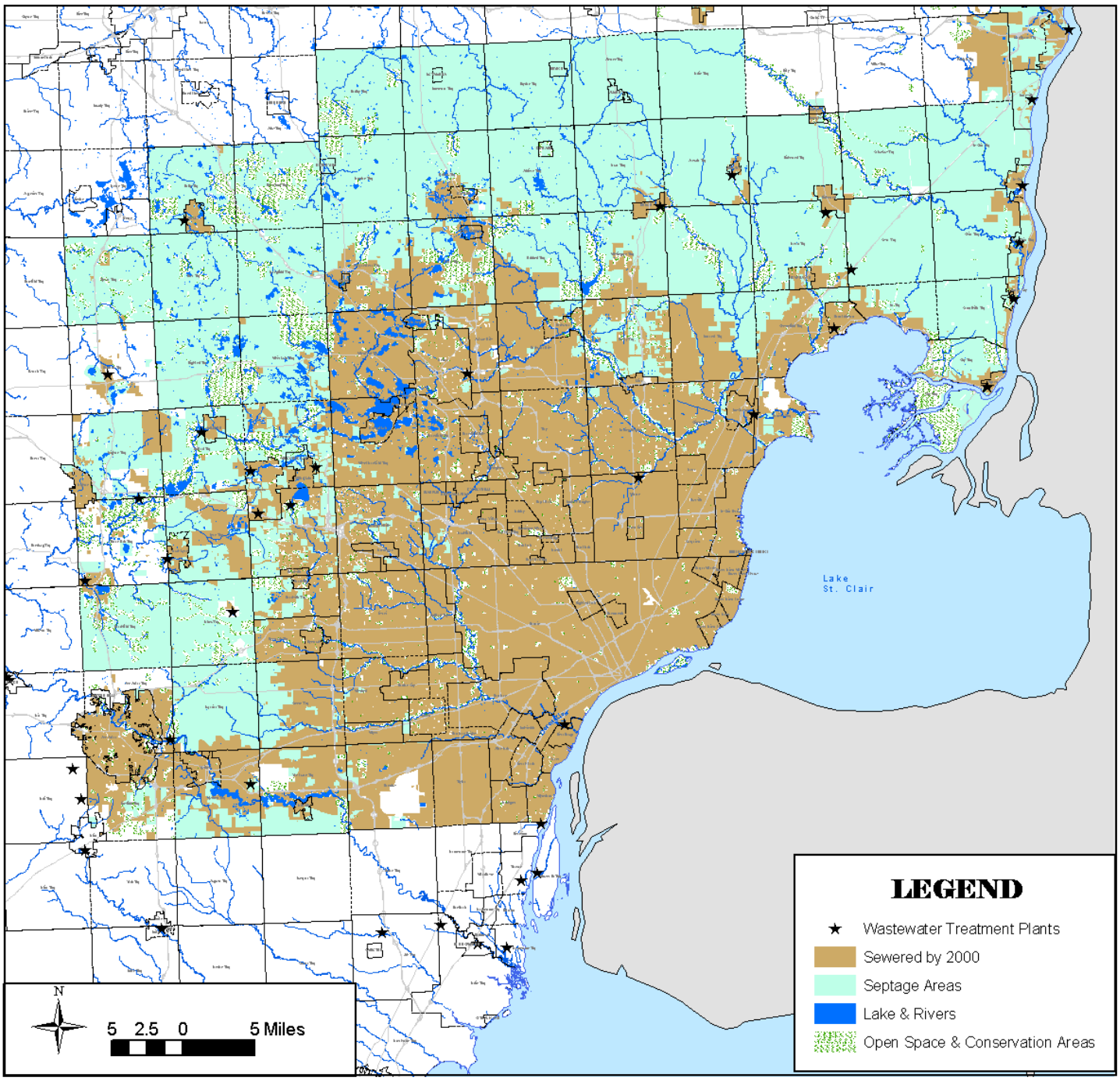


Figure 2.3 Projected Sewered Areas in the Service Area in 2010

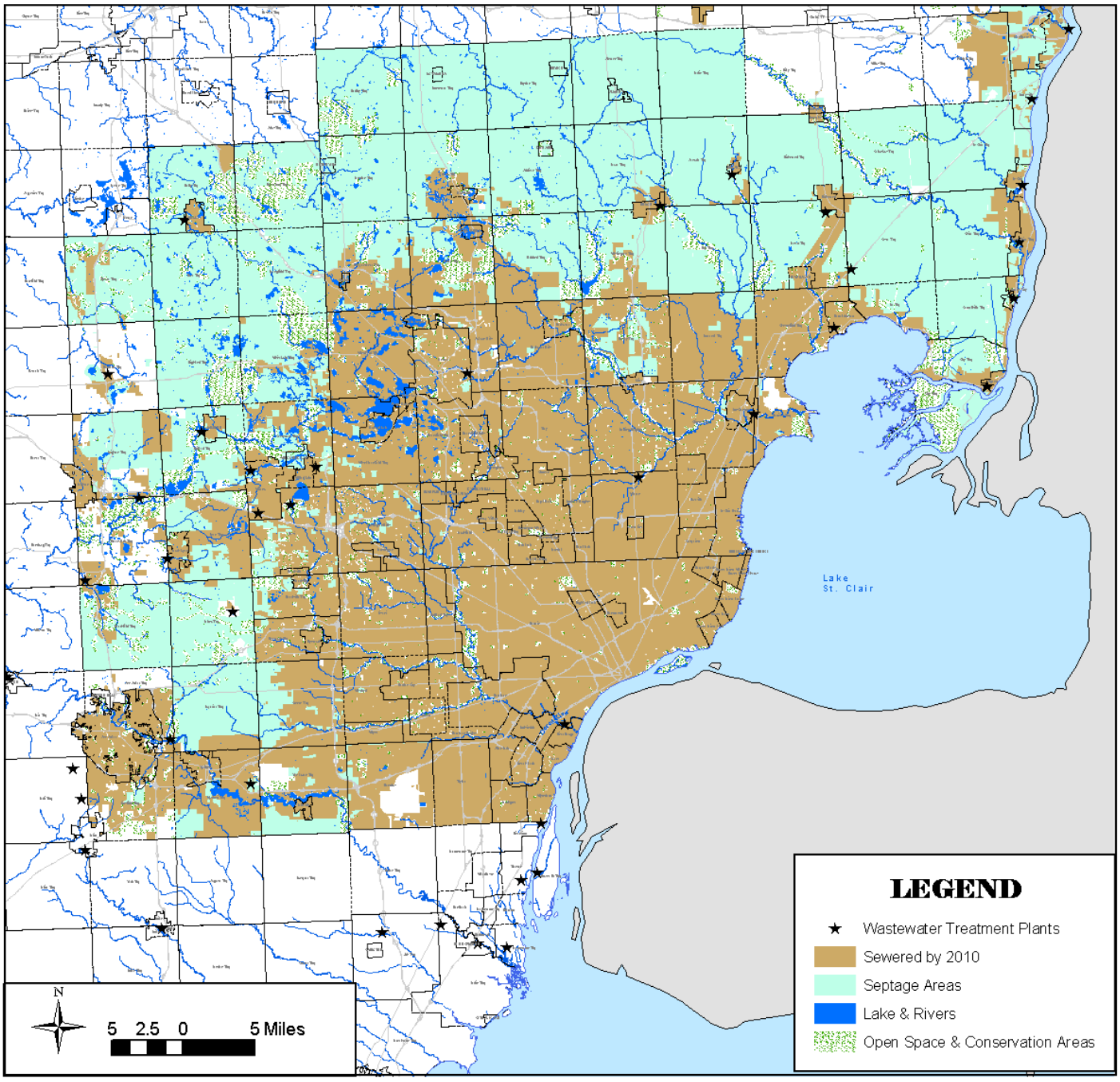


Figure 2.4: Projected Sewered Areas in the Service Area in 2030

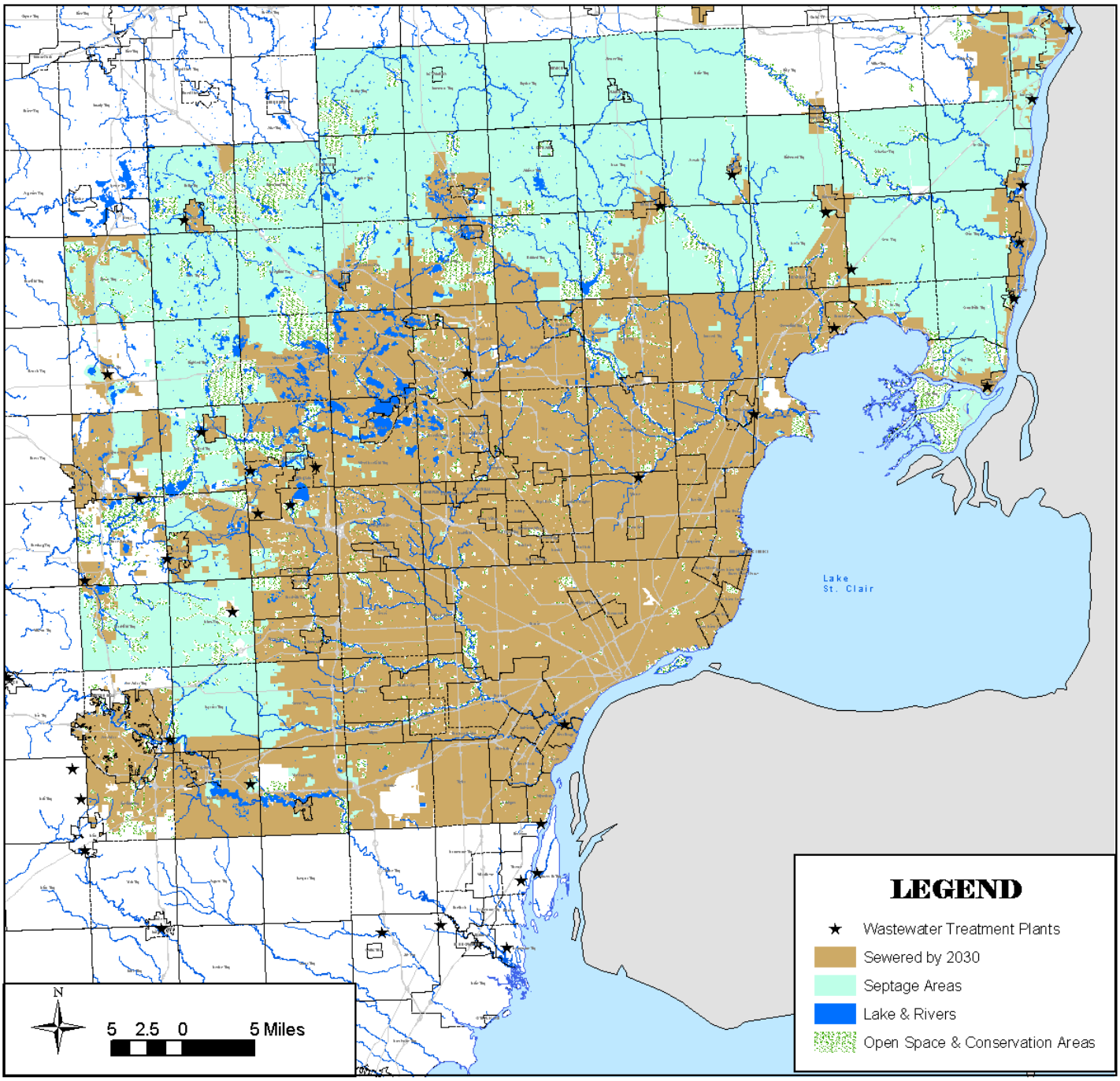
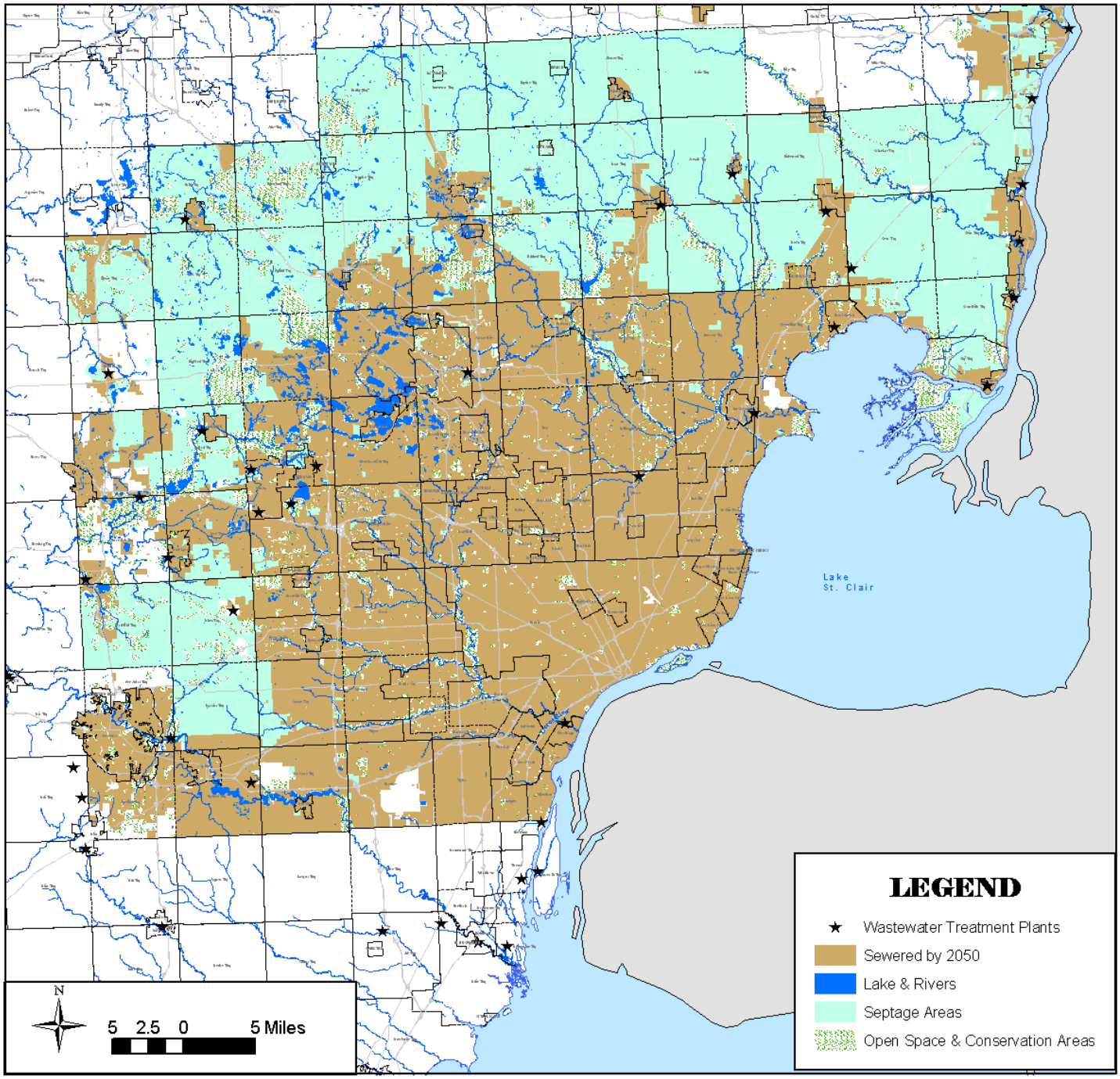


Figure 2.5: Projected Sewered Areas in the Service Area in 2050



dwelling units per acre or more for new construction is the density that usually justifies installing sanitary sewers. Most onsite sewage systems are installed on parcels that are one acre or larger in size. (The Oakland County Health Division Sanitary Code, Article II Groundwater Protection requires in Section 2.2 "… a minimum of one (1) acre of area for each three-bedroom residence." for a lot served by and onsite sewage disposal system.)

SEMCOG was consulted on the procedure it used to make population projections. The projections made here are similar to the method used by SEMCOG for 2000. This work extends the projections to 2050.

Findings: Many of the areas where growth will occur from 2030-2050 will be small areas that "fill in" areas of the community already sewered. In general there are no areas that show major growth that will require large-capacity sewers. An extension of a sewer to Metamora Township in Lapeer County will be a new area for growth with a small-capacity sanitary sewer. There is current demand for sewers along Lapeer Road in Metamora Township and sewers may be needed before 2030.

There are some areas on the map where future sewer needs could not be determined with the criteria that have been described. These areas are blank on the map. Copies of the projected sewer service areas for each community were sent to all 76 wholesale customers as part of a customer survey for this Master Plan.

2.3 Wastewater Flow Projections

Flow projections were developed through 2050 based on available flow data and future population projections for the planning area. The planning area includes the Rouge River and Clinton River watersheds plus adjacent portions of the St. Clair River and Detroit River watersheds.

This section includes a summary of the projection process and the flows used in the preliminary design calculations for the wastewater service treatment alternatives.

2.3.1 Methodology for Calculating Future Flows

Average Daily Flows

Average daily flows were calculated based on the sum of four flow components: residential, employment-based, Significant Industrial Users (SIUs), plus calculated dry weather infiltration/ inflow. The approach for each component is described below.

Residential population flows were estimated using the average per capita wastewater flow rate of 77 gpd per resident. Commercial water usage was estimated to be 50 gpd per employee. The residential and employee per capita estimates were used throughout the entire service area, regardless of the current wastewater treatment provider. The significant industrial user (SIU) flows were assigned to the appropriate TAZ based on the Volume 1 *Report on Planning Criteria*.

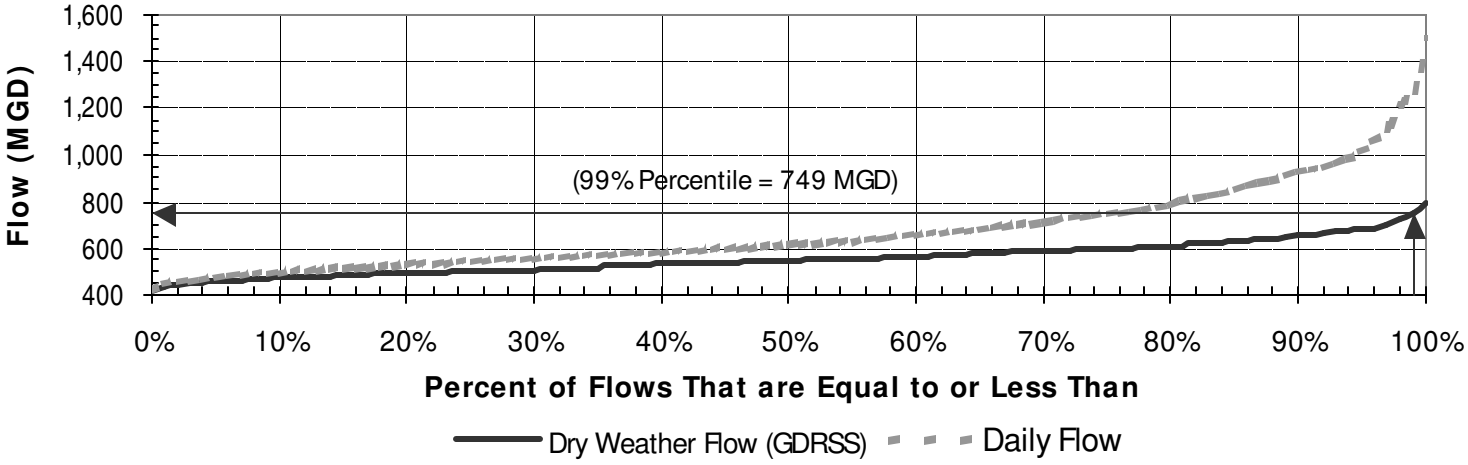
DWI/ I was derived using two methods. For the current DWSD service area, DWI/ I was estimated based on Greater Detroit Regional Sewer System (GRDSS) meter data. Outside the service area, representative data was used where available, and estimated for the remaining areas. For example, DWI/ I was estimated for the Warren service area using two-years of metering data. The DWI/ I was divided by the representative tributary area and applied to the Mount Clemens and Pontiac service areas, assuming that all three communities were established about the same time and were in similar condition.

The average dry weather flow for each sanitary district was calculated using the following equation:

Average Flow = (Resident Population x 77 gpd) +

(Employee Population x 50 gpd) +

Figure 2.6: Flow Exceedance Statistics for WWTP 1997- 2001



SIU Flow + DWI/I Flow

After the development of the current flow projections, they were compared to existing flows at the DWSD, Pontiac, Mount Clemens, and Warren WWTPs to verify that the methodology provided representative results.

Figure 2.6 shows a flow exceedance curve based on GDRSS meter data from 1997 to 2001. This is consistent with the results shown in the equation above.

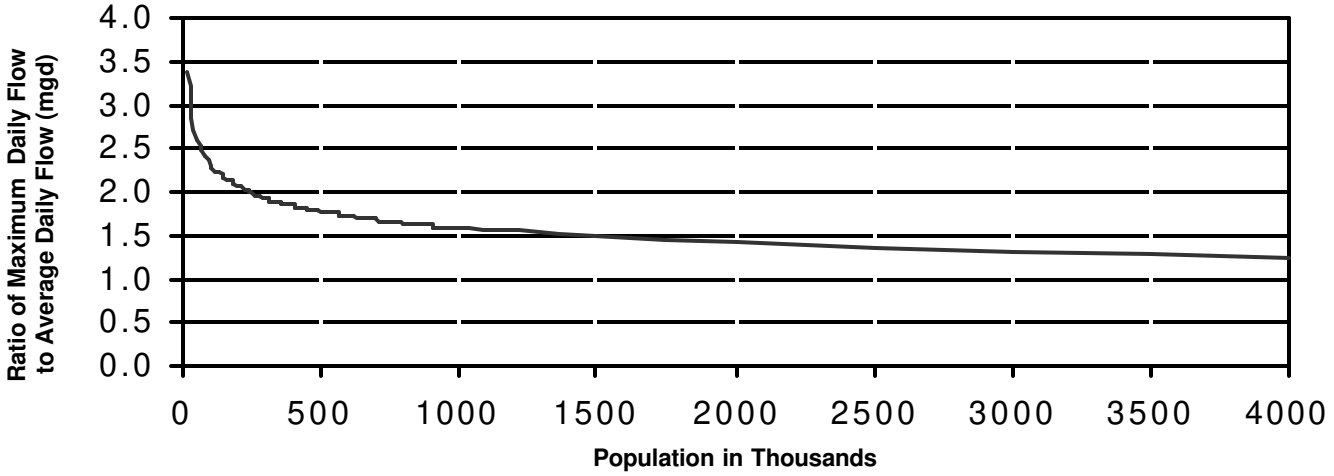
Once the data was verified, the SEMCOG population and employee projections through 2050 were utilized to project future wastewater flows. SIU flows were held constant over the 50-year planning period for reasons noted in Volume 1, *Planning Criteria*. Water treatment plant backwash water and sludge flows discharged to the wastewater treatment plant from Springwells, Northeast, and Waterworks Park are projected to remain constant, at approximately 9 mgd, even with the completion of planned projects to dewater sludges. Final projected discharges will be determined based on water treatment plant projected flows determined by the Water Master Plan (CS-1278).

Dry weather infiltration/ inflow was assumed to remain constant for the purpose of the flow projections. However, recommendations have been made as part of this Master Plan to reduce dry weather and wet weather inflows in the future. The Flow Management alternative presented in Chapter 3 outlines an emerging plan to reduce infiltration and inflow. The Western Township Utilities Authority (WTUA) is currently planning to divert all of its flow, estimated at 15 mgd in 2001, to the Ypsilanti Community Utility Authority (YCUA) in 2006 when the expansion of the YCUA wastewater treatment plant is completed. Therefore, the average daily flow projections for the Rouge Valley/ North Huron Valley system reflect that reduction in flow.

Peaking Factors

The peak hourly flow factor was selected based on a comparison of available metering data to the National Sanitation Foundation (NSF) study *Sewerage and Drainage Problems and Administrative Affair*, Ten State Standards for wastewater facilities design, and the American Society of Civil Engineers (ASCE) study *Design Construction of Sanitary and Storm Sewers*. The selected peaking factor was larger than recommended by the technical references, because those references apply to new collection systems that receive little inflow and infil-

Figure 2.7: Relationship of Max. Daily Flow to Ave. Daily Flow From ASCE



tration.

The maximum day peaking factor was selected by comparing the past four years of influent flow data from the DWSD wastew ater treatment plant with the technical standards. It was determined that the ASCE Curve "A" closely approximated the maximum day peaking factor observed at the WWTP. ASCE Curve "A" is shown in Figure 2.7. The basis and methodology of the peaking factors and flows are further explained in the technical memorandum *Preliminary Flow Projections for Alternatives Analysis* found on the CD which accompanies this report.

2.2.2 Flow Projections

Average daily dry weather flow, peak month dry weather flow, peak day dry weather flow and peak wet weather flow rates were developed for the Cty of Detroit and the 17 first-tier customers through 2050. The development of these flow projections has been supported by a subcommittee of the WWMP Technical Work Group.

Wastewater flows for which projections are required are considered to consist of three components: Sanitary, Dry Weather Inflow/ Infiltration (DWI/ I), and Wet Weather Flow (WWF). Sanitary flow includes residential flow, commercial/ business/ institutional flow and significant industrial users flow. Change in future residential flow is a function of change in residential population. Change in commercial, business, and institutional flow has been related to change in employed populations within the service area. The current significant industrial users (SIUs) flows were obtained from a 2000 data set. For purposes of projecting to future conditions, it is assumed that the current flow production will remain a constant over the 50-year planning horizon of the WWMP.

DWI/ I is a function of a number of variables, including sewer density, soil types, construction methods, the presence of footing drains, ground water levels, and annual precipitation. While the sanitary flow component is considered to be related primarily to population and SIUs, the DWI/ I flow component is considered to be more of a function of the sewered area. For purposes of the Master Plan, the DWI/ I flow is assumed to remain the same in the future for the existing sewered ar-

eas. That is, any increase in these flows that might be expected due to systems getting older is anticipated to be offset by maintenance of the systems. For areas to be sewered in the future, a unit rate based on an average rate of selected areas was use to project these flows.

Flow projections for the existing DWSD service area were also previously presented in Figure 3 of the Executive Summary. Figure 2.8 illustrates the current DWSD meter district boundaries. Tables 2.1A, 2.1B and 2.1C contain the flow projections for the planning area and septage service planning area for 2000 and projections for 2050. Table 2.2 shows projected peak hour flow rates for service districts. A peaking factor of 1.31 was used for the DWSD planning area as a whole; higher peaking factors were utilized for smaller drainage districts. Figure 2.9 illustrates the various service areas and the unserved areas in the DWSD planning area.

Wet weather flows are discussed in Volume 5 of the Master Plan, *Customer Service and Technical Support Program.*

Table 2.1A: 2000 and Projected 2050 Dry Weather Flows in the DWSD Contract Area

	Population#		Flow (MGD)	
Contract Area	**2000**	**2050**	**2000**	**2050**
Allen Park	2,822	2,550	1.67	1.53
Center Line	8,523	8,514	1.19	1.13
City of Detroit	948,886	843,246	296.40	285.99
Clinton-Oakland	243,861	299,119	31.27	39.57
Dearborn	98,314	108,132	22.06	23.19
Dearborn Heights District 2	409	444	0.07	0.07
Evergreen-Farmington	271,572	271,239	42.53	44.96
Farmington	7,941	7,904	1.39	1.35
Grosse Pointe	5,638	5,292	1.70	1.67
Grosse Pointe Farms	9,164	8,176	2.93	2.86
Grosse Pointe Park	12,037	10,851	1.45	1.36
Hamtramck	22,967	28,697	4.99	5.39
Harper Woods	1,712	1,812	0.84	0.85
Highland Park	16,638	13,038	3.41	3.05
Macomb	365,546	594,951	51.20	73.71
Melvindale	10,773	10,011	1.60	1.51
N.E. Wayne	175,878	161,080	24.63	23.22
N. Huron Valley/ Rouge Valley	518,755	598,131	67.69	75.05
Redford Township	337	290	0.08	0.08
S.E. Oakland	295,336	263,141	47.25	44.96
Wayne Co Area 6	912	942	0.16	0.16
(Unsewered Areas)*	171,701	147,739		
Totals	3,189,722	3,385,299		

'Population numbers reflect population of sewered areas only

Table 2.1B: Projected Average Daily Flows for Other Providers in the Planning Area

WWTP	Population#		Flow (MGD)	
	2000	2050	2000	2050
Algonac WWTP	14,000	15,679	2.6	3.1
Armada WWTP	1,362	1,917	0.3	0.4
Commerce Twn. WWTP	12,420	69,581	2.7	12.7
Lyon TWP	4,026	43,427	2.4	7.5
Marine City WWTP	2,360	6,065	0.6	1.2
Memphis WWSL	894	1,268	0.2	0.4
Mt. Clemens WWTP	17,168	17,542	3.4	3.4
New Baltimore WWTP	7,314	14,271	1.4	2.1
Pontiac City WWTP	66,234	78,727	11.2	12.9
Richmond WWTP	4,439	8,980	1.0	1.7
Romeo WWTP	4,006	7,077	1.0	1.8
Salem Township WWTP	52	1,098	0.1	0.5
South Lyon City WWTP	7,038	9,764	1.0	1.4
South Huron Valley	7,180	9,585	1.7	2.2
St. Clair Sanitary Authority	299	804	0.6	1.0
Walled Lake/Novi WWTP	11,585	17,034	2.2	2.7
Warren WWTP	137,598	131,386	21.6	21.0
Wayne/Wyandotte WWTP	70,662	66,745	13.9	14.8
Wixom City WWTP	9,157	24,132	2.2	4.1
YCUA WWTP	68,763	111,454	11.2	17.4

'Population numbers reflect population of sewered areas only

Table 2.1C: 2000 and 2050 Projected Flows in the Septage Service Planning Area

OSDS Areas	Population#		Flow (MGD)	
	2000	2050	2000	2050
Lapeer	21,310	33,591	1.6	2.6
Macomb	88,624	72,137	6.7	5.5
Oakland	168,603	155,497	12.8	11.8
St. Clair	27,781	32,585	2.1	2.5
Washtenaw	18,815	22,732	1.4	1.7
Wayne	28,216	20,593	2.1	1.6
Totals	**353,349**	**337,135**	**26.9**	**25.6**

'Population numbers reflect population of sewered areas only

Table 2.2: Projected Peak Hour Flow Rates for Representative Service Districts (cfs)

Flow District	10-Year, 1-Hour Peak Flow Rate
Suburban	
Allen Park	6*
Centerline	7
Clinton-Oakland	93
Dearborn	100
Evergreen-Farmington	148
Farmington	6*
Grosse Pointe	192
Grosse Pointe Farms	342
Grosse Pointe Park	25
Macomb County	258
Melvindale	15
N.E. Wayne District	127
S.E. Oakland	270
Western Wayne	349
Detroit	
Baby Creek	364
Central City	445
Conner Creek	230
E. Jefferson/Fox Creek	(610)**
Hubbell/Southfield	86
Oakwood	24
Rouge River	216

*Peak rate is assumed to not exceed contract capacity.
**Net discharge towards treatment is negative because of overflow discharges within the district.

Figure 2.8: DWSD Meter District Boundaries

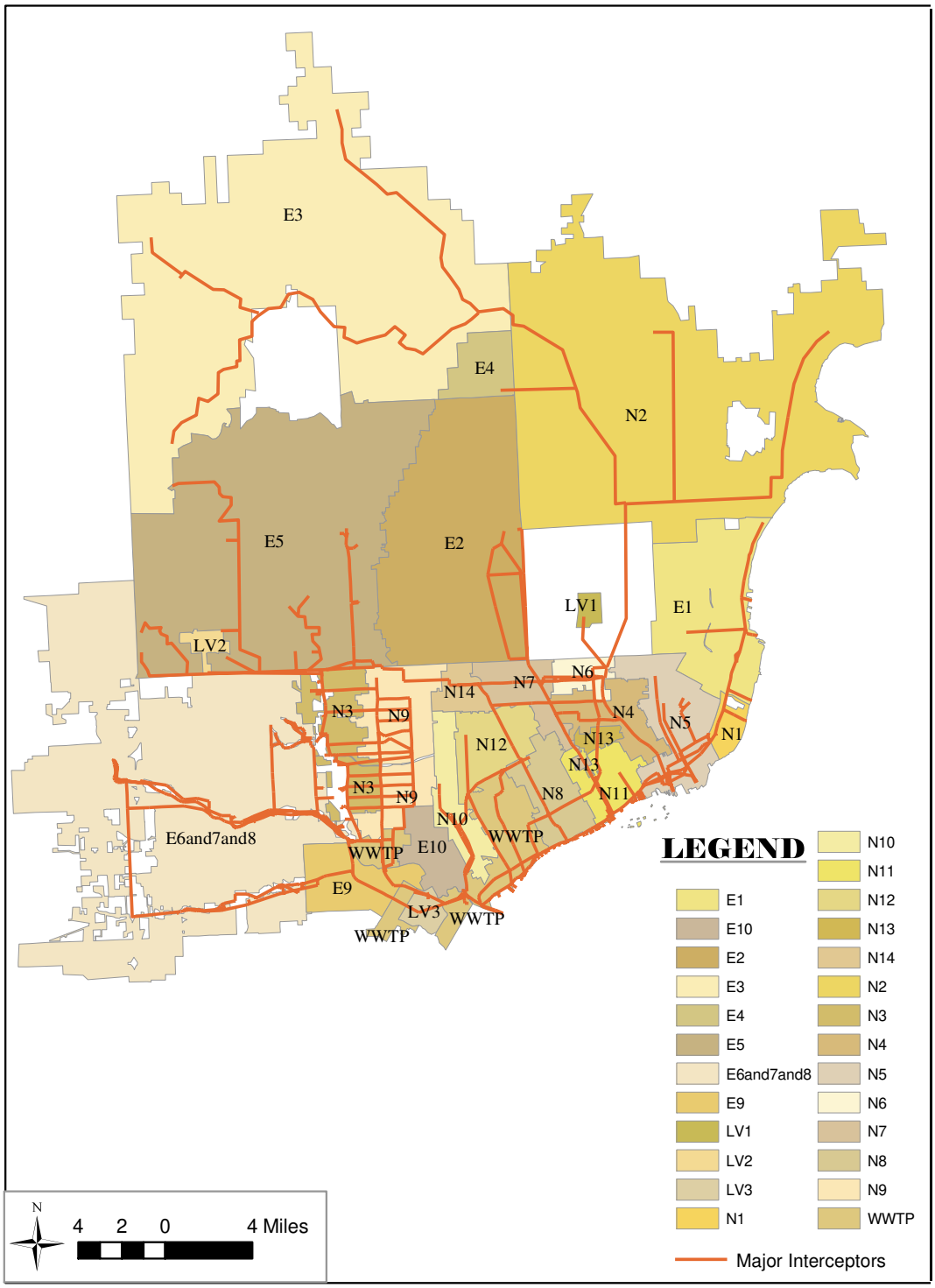
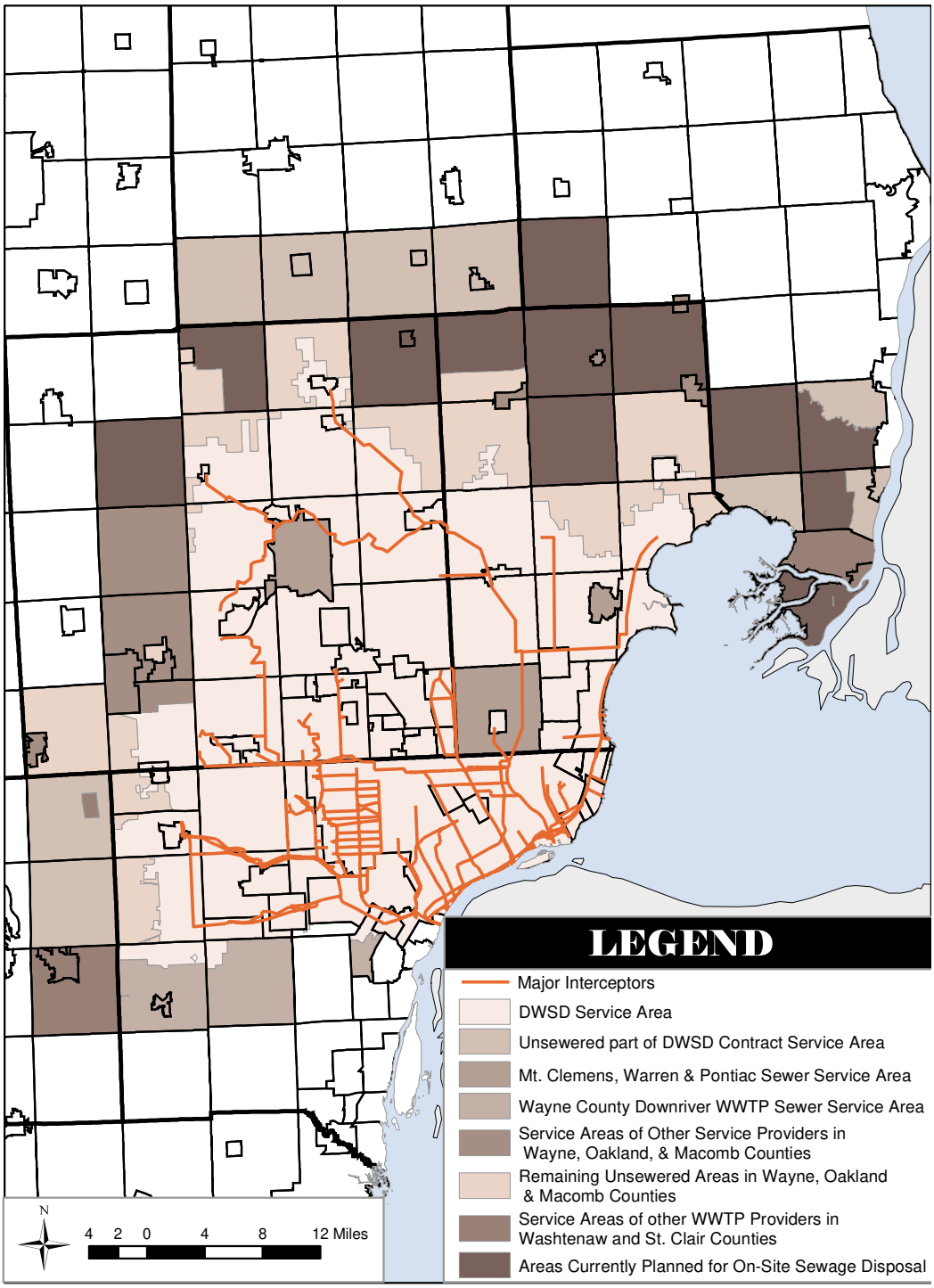


Figure 2.9: Service Provider Areas in the DWSD Planning Area

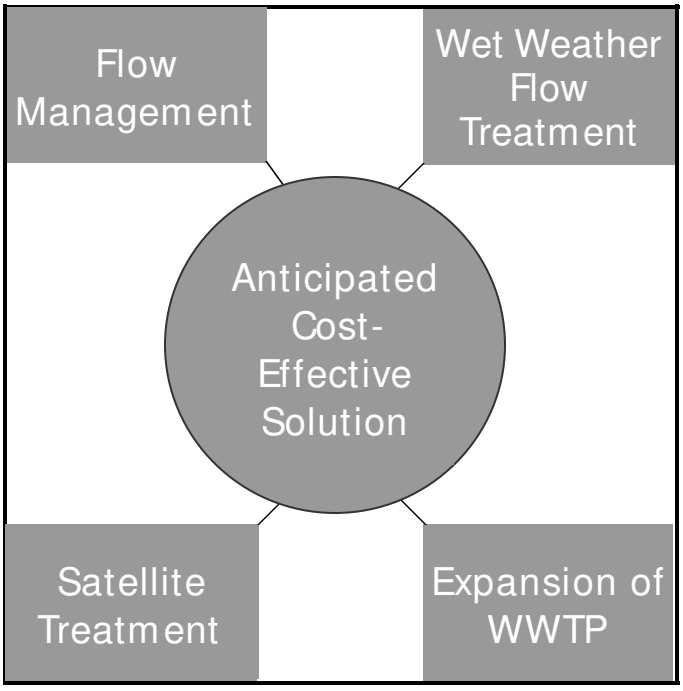


3. Wastewater Service Alternatives

3.1. Overview of Alternatives

Four conceptual alternatives have been identified for wastewater service for the planning area. Each of these alternatives represents a different approach for wastewater service, and the alternatives have been purposefully configured to distinguish a unique approach. The four alternatives can be thought of in terms of four corners of a box, with each corner being one extreme. It is expected that the most cost-effective solution for the planning area will be a combination of parts of each alternative, and found in the figurative center of the box. See Figure 3.1. Components of the four conceptual alternatives are described below.

Figure 3.1: Conceptual Treatment Alternatives



Flow Management Alternative

The goal of this alternative is to reduce dry weather I/ I to free up capacity for increased dry weather flows due to population growth in the planning area. Key components of this alternative include:

- Maintain 930/ 1700 (secondary/ primary) permitted capacity at 9300 West Jefferson
- Implement an aggressive DWI/ I reduction program in Detroit; provide technical assistance to wholesale customers with I/ I removal projects
- Revise wholesale customer contracts to provide incentives for infiltration/ inflow reduction
- Where technically feasible and where the age of sewers requires complete reconstruction, construct new separate sanitary and storm sewers in some areas of Detroit in conjunction with redevelopment project
- Develop urban stream renewal plan for City of Detroit (separated storm water)

Wet Weather Flow Treatment Alternative

The goal of this alternative is to provide a parallel wastewater treatment process at or near 9300 West Jefferson to handle wet weather flows and for treatment of stored wet weather flows after storm events. Key components of this alternative include:

- Maintain 930/ 1700 (secondary/ primary) permitted capacity at 9300 West Jefferson
- Implement partial I/ I reduction program
- Complete construction of Upper Rouge CSO tunnel as currently planned in the update of the Long Term CSO Control Plan
- Construct additional headworks pumping capacity to augment Pump Station 1 and Pump Station 2
- Construct physical/ chemical treatment process for providing the equivalent of secondary treatment for flows exceeding the secondary permitted capacity of 930 mgd

- Consider a second wet weather tunnel along the Detroit River to consolidate overflows for treatment

Satellite Treatment Alternative

The goal of this alternative is to provide additional dry weather treatment capacity at locations other than 9300 West Jefferson to meet future needs. Key components of this alternative include:

- Maintain 930/ 1700 (secondary/ primary) permitted capacity at 9300 West Jefferson
- Implement partial I/ I reduction program
- Perform expansions at other treatment providers

Expanded Central Treatment Alternative

The goal of this alternative is to provide expanded dry weather treatment capacity to meet additional future needs at 9300 West Jefferson, along with transport capacity where needed. Key components of this alternative include:

- Expand 930/ 1700 (secondary/ primary) permitted capacity at 9300 West Jefferson to about 1200/ 2000 (Use physical chemical treatment at 9300 West Jefferson to expand primary capacity)
- Implement partial I/ I reduction program
- Upgrade the plant to remove additional phosphorus or ammonia, or tertiary treatment

Components Common to All Alternatives

Key components of all alternatives include:

- Relieve or rehabilitate interceptors and pump stations to capacities consistent with the treatment alternatives
- Human resource plan consistent with treatment alternatives
- Customer service plan
- Complete long-term CSO plan and build standalone CSO treatment facilities that meet WQS
- Regional Operations Plan to provide operating protocols for high flows and for dewatering and wastewater treatment
- Infrastructure upgrades (repair and replace) to provide acceptable life and reduce maintenance needs
- Educational, environmental and access improvements at 9300 West Jefferson in accordance with Rouge Gateway project
- Other wastewater treatment operators in the service area continue to operate

3.2 Future Treatment Needs

The firm treatment capacity of the WWTP, after all projects initiated under the Program Management Contract (PC-744) have been completed, will be 830 mgd secondary capacity and 1700 mgd primary capacity. This capacity is based on raw wastewater flows and assuming a maximum internal plant recycle flow of 100 mgd. The actual recycle rate is between 50 and 70 mgd. However, 100 mgd is used as an upper bound for permitting.

Based on this 830 mgd secondary treatment capacity at WWTP, flow projections for 2050 indicate that available secondary capacity to treat dry weather flows would vary from a deficit of two mgd (if the 2050 service area remained the same as in 2000) to a deficit of 202 mgd (if the entire DWSD planning area had to be served in 2050). This is based on using a maximum day peaking factor of 1.31 for the service and planning areas.

In addition to dry weather flows, treatment of wet weather flows must be provided. New SSO and CSO retention basins will be built over the next 50 years. The total SSO storage in the DWSD system is expected to be about 20 million gallons. It is expected that future regulations may require that secondary treatment capacity beyond expected peak dry weather flows be available to treat dew a-

tered SSO flows. If stored SSOs were dewatered in 24 hours following a storm, an additional secondary capacity of 20 mgd would be required for SSO dewatering.

The 1700 mgd primary capacity at the WWTP is intended to treat wet weather flows, including dewatered CSO flows. New CSO storage in the DWSD system over the next 50 years is expected to be 200-300 MG. If this volume were dewatered over a 48- to 72-hour period, additional dewatered CSO flows would be 67-150 mgd. Future treatment requirements for wet weather flows (including dewatered CSO flows) could range anywhere from primary to secondary effluent limits, and could require new wet weather treatment facilities or retrofits to existing facilities. For planning purposes, enhanced primary treatment in the form of physical-chemical ballasted flocculation or an equivalent process was considered for this Master Plan, and used as the basis for cost projections.

The Great Lakes Water Quality Agreement (GLWQA) set forth a process to assess problems and implement the required remedial actions for the Great Lakes. This process is contained in a *Lakewide Management Plan* (LaMP). The LaMP for Lake Erie, which was published in 2000, contains the means needed to bring Lake Erie back to chemical, physical, and biological integrity. In order to achieve this goal, the LaMP states toxic chemical and biological contaminant loadings within the basin must decline to a level that would permit sustainable use of natural resources. To reduce phosphorus loading to Lake Erie, wastewater treatment plants may be required to discharge phosphorus at levels less than the GLWQA concentration of 1 mg/ l. Other nutrients and their various forms, such as nitrates, will be included in future assessment impacts of Lake Erie.

If the recommendations of the Lake Erie LaMP are implemented, they will impact wastewater treatment plant discharges to the Detroit River. Inland wastewater treatment plant discharges to the Clinton River would also be impacted. A requirement to treat treatment plant effluent to concentrations of phosphorus and ammonia below current concentrations could impact the sizes and processes designed for existing, expanded or new wastewater treatment plants.

In order to meet a more restrictive phosphorus limit, treatment plants would have several options. For plants already designed to treat phosphorus, additional ferric chloride could be added to remove more phosphorus. The addition of more ferric chloride would generate more sludge, which would need to be disposed of. This would result in higher costs due to increased ferric chloride use and increased sludge disposal. Depending on the phosphorus limit to be met, additional sludge storage, chemical addition, and filters might be needed; this would increase the area needed to treat the same volume of flow. This would result in less treatment capacity for the same land area.

Another treatment process to meet a less than 1 mg/ l phosphorus limit is biological phosphorus removal. This would require either retrofitting some of the current clarifiers or building new biological reactors. This process involves exposing the mixed liquor to an anaerobic/ aerobic sequence in the biological reactor where microorganisms remove phosphorus. This process has the advantage of lowering sludge production. Biological phosphorus removal might be followed by ferric chloride addition for further phosphorus removal. The biological phosphorus removal process might mean that additional equipment would be needed. Either retrofitting the current treatment process or adding new equipment to perform the biological phosphorus removal process would take away available land or process capacity. This would result in less treatment capacity for the same land area.

The wastewater treatment plants discharging to the Clinton River have already been designed to remove nitrogen. In order to meet an ammonia-nitrogen limit of less than the design concentration of 0.5 mg/l, additional detention time in the secondary treatment, as well as sufficient dissolved oxygen would be needed to allow a more complete nitrification of ammonia nitrogen. The subsequent denitrification step, which converts nitrate to nitrogen gas, would need to be adequately sized to handle the increased loading from the nitrification process. The longer detention time would require a lower flow rate through the currently designed secondary treatment system, resulting in less treatment capacity for the same land area.

The new wastewater treatment plants discharging to the Detroit River were designed to meet secondary effluent limits. Secondary limits do not include any limitation for ammonia nitrogen. Therefore, these plants use a conventional activated sludge process instead of nitrification-aeration basins. Major design changes would need to be made to these plants in order for them to meet a low ammonia nitrogen limit.

3.3 No-Action Alternative

The "no-action alternative" is conceptually the continuation of the status quo. The Long Term CSO Program would be completed as outlined in the Updated Plan presented by DWSD in December 2001. DWSD currently prepares five-year capital improvement plans (CIPs) based on projected needs. In recent years, the wastewater CIP has been $300 million to $500 million annually. This amount includes the one-time PC-744 upgrade costs. Infiltration/inflow would continue to be a substantial percentage of the average daily flow. Sewer rehabilitation in Detroit will continue at the rate of about 20 miles per year. Communication and coordination with wholesale customers is facilitated through the First Tier Customer Steering Committee and several work groups focusing on specialized technical issues.

3.4 Flow Management

3.4.1 Description

Previous studies documented in Volume 2, *Report on Critical Facilities and Capacity Management* identified the feasibility of eliminating 50 to 85 mgd of dry weather infiltration and inflow in the DWSD service area. The average daily dry weather flow at the DWSD Wastewater Treatment Plant was 605 mgd, in 2001 and within this total are an estimated 242 mgd of dry weather infiltration and inflow. Future flow projections show that new sanitary sewage flows in the planning area will increase by approximately 60 mgd.

Wet weather flows can also be reduced in the future. The Volume 2 *Report on Critical Facilities and Flow Management* also identified the cost-effectiveness of techniques to reduce wet weather flows in collection systems tributary to the DWSD system. These techniques include the removal of footing drains in separate sanitary sewer systems and the construction of storage tanks to reduce peak wet weather flows.

The flow management alternative includes a series of actions that DWSD can perform to reduce dry weather and wet weather infiltration/inflow in its facilities and in the systems owned by its suburban customers.

3.4.2 Design Criteria

The objective of the flow management alternative is to reduce average annual dry weather infiltration/inflow by a minimum of 2 mgd per year for the next 25 years. Table 3.1 shows a list of major wastewater utilities and the percentage of annual infiltration/inflow to total average daily flow. Note that the data represent total wet and dry weather I/I. The comparable wet and dry infiltra-

Table 3.1: Major Wastewater Utilities Average Flows

Utility Name	Estimated Ave. Daily Flow (mgd)	Infiltration/Inflow (mgd)	Percentage Infiltration/ Inflow
MWRA (Boston)	340	149	44%
N.E. Ohio Regional Sewer District	175	88	50%
Washington D.C.	370	113	31%

Table 3.2: Annual Flow Variation in DWSD System

Year	Pumped Influent (mgd)	DWF (mgd)	DWI/I (mgd)	Precipitation (inches)
1998	728	647	541	158	32.14
1999	726	651	559	176	32.01
2000	735	653	554	171	36.23
2001	797	724	596	212	35.43

Dry weather flow and dry weather inflow & infiltration are based on influent data, i.e., recycle flow removed.

tion and inflow percentage for DWSD from Nov. 1 2000 to Oct. 31, 2001 was 47 percent. The objective of reducing dry weather I/ I is to bring DWSD closer to the norm of larger old combined sewer systems in the northern United States.

Dry weather infiltration/ inflow in the DWSD system varies from year to year based on river and lake levels and annual rainfall. Table 3.2 shows the annual variation of DWI/ I from June 1997 to June 2002 based on the metering program that DWSD has implemented under its GDRSS Metering Project. Dry weather flows for this table were calculated by a different method thn the one used in Chapter 2 because data collection was not as complete prior to 2001.

3.4.3 Location of Facilities

There are opportunities for flow management throughout the DWSD service area. Figure 3.2 shows the location of flow meter districts and the respective amount of dry weather infiltration/ inflow.

Locations of work to reduce flows include:

Private Property

- Disconnection of footing drains where connected to separate sewer systems
- Replacement of old sewer service connections that are damaged or leaking
- Downspout disconnection programs
- Disconnection of sump pumps where connected to the building sewer service connection (which is not legal according to sewer use ordinances)

Wholesale Customer Collection Systems

- Sewer system evaluation surveys to identify specific infiltration/ inflow sources
- Sewer system rehabilitation to minimize or eliminate infiltration/ inflow
- Manhole rehabilitation to minimize or eliminate infiltration/ inflow
- Construct equalization basins to reduce peak wet weather flow rates delivered to DWSD

DWSD Interceptor and Trunk Sewers

- Sewer outfall, regulator and backwater gate surveys
- Sewer system rehabilitation to minimize or eliminate infiltration/ inflow
- Manhole rehabilitation to minimize or eliminate infiltration/ inflow

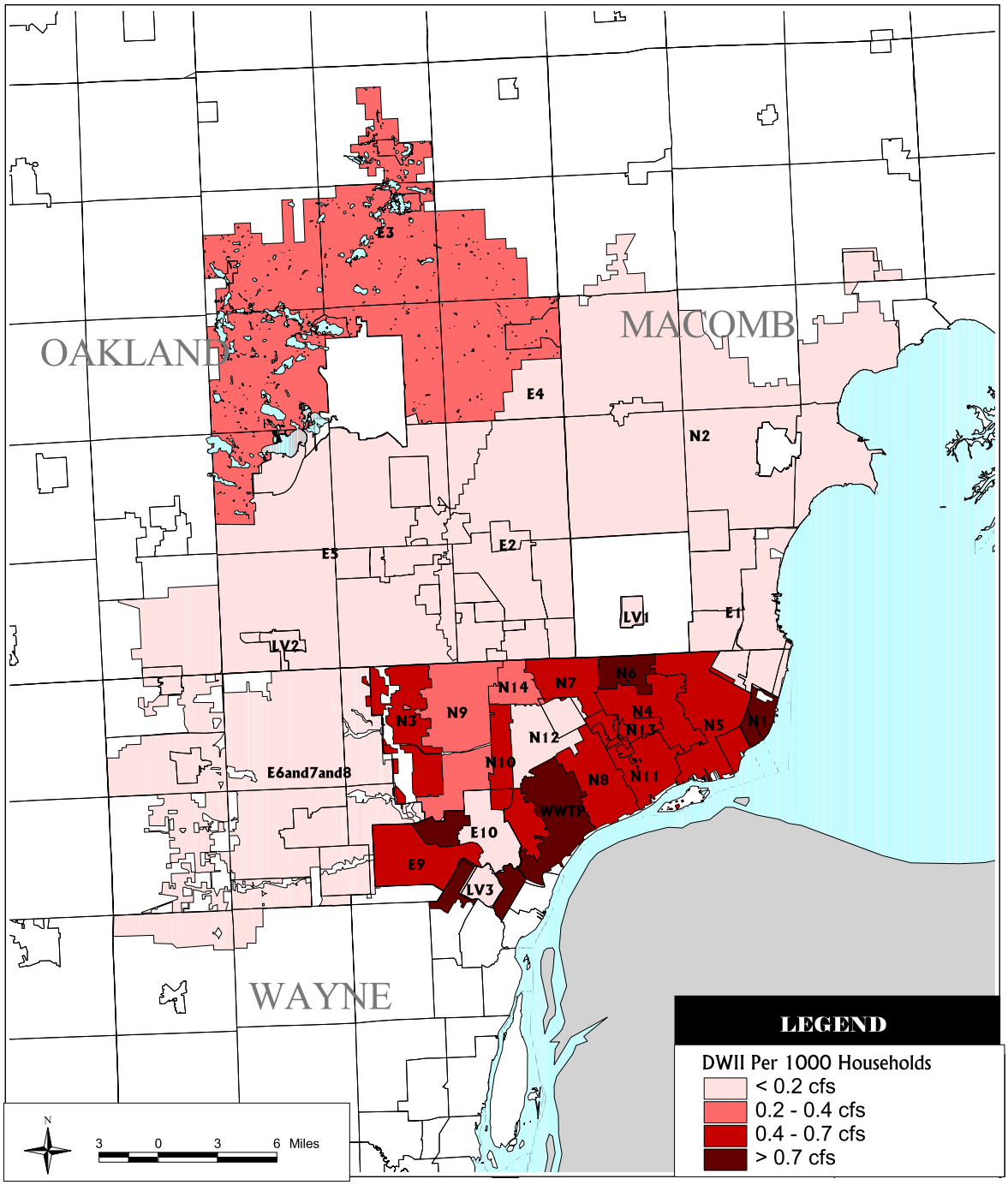
DWSD Lateral Sewers in Detroit

- Sewer system evaluation surveys to identify specific infiltration/ inflow sources
- Sewer system rehabilitation to minimize or eliminate infiltration/ inflow
- Manhole rehabilitation to minimize or eliminate infiltration/ inflow
- "Daylighting" and separation of selected storm sewers connected to the combined sewer system

DWSD Wastewater Treatment Plant

- Reduce recycle flows, now about 100 mgd

Figure 3.2: DW/II Within DWSD Meter District Boundaries (1997 Through 1999 Data)



3.4.4 Distribution of DWI/I Reductions

The DWSD Wastewater Master Plan has made estimates of the flow generated by Detroit and each of its customers. These flows have been categorized as being sourced from residential, industrial and commercial, and significant industrial sources. Estimates have also been made of the amount of dry weather flow that comes from inflow and infiltration (DWI/I) sources. This component of flow is important since, when reduced, there can be an increase in other flow.

An important element of the Master Plan is to use flow management to better control these DWI/I sources to accommodate anticipated customer growth. Flow management refers to controlling the amount of extraneous flows in the collection system. Currently, the average dry weather flow is approximately 605 mgd. Of this, about 242 mgd is DWI/I.

DWI/I flows can come from leaking cracks and joints in sewer pipes, leaks in manholes and similar structures, and house drainage entering through foundation footing drains connected to sanitary collection systems. In combined systems, there are additional dry weather inflow sources that can include river inflow through backwater gates. In all cases, the groundwater supplies the water that enters the system. This groundwater can be replenished through rainfall, but can also come from water distribution systems. Water distribution systems can contribute to the dry weather flows seen in combined systems through the use of hydrant flushing, fire fighting, and water main leaks.

A number of approaches can be used to reduce DWI/I by 20 percent, or about 50 mgd. The approaches address the distribution of the DWI/I among first-tier customers and look at how to best allocate the 50 mgd reduction to customers in ways that that both account for their prior DWI/I reduction efforts and reflect the opportunities to reduce these flows because of the types of collection systems in use.

Table 3.3 lists first-tier customers, shows each of their tributary areas and presents the estimated DWI/I. Some customers are entirely served by sanitary sewers, others entirely by combined sewer systems, and others by a sanitary/combined mix.

DWI/I is shown in both millions of gallons per day and inches. The latter method is important because Southeast Michigan receives an average of about 33 inches of rainfall annually. In general, about 10 to 15 inches finds its way to the groundwater table andthen into collection systems. Therefore, if the DWI/I values shown exceed 10-15 inches it is likely that other sources contribute to these flows. These can include flows from the water distribution system with uses that discharge flows into the collection system.

Alternative Allocation Approaches

Three alternative approaches are provided to assign responsibility for reducing DWI/I. Estimates of the DWI/I goals for each of the communities are provided.

Proportional Reduction Approach

The first approach assigns responsibility for reducing DWI/I based on proportionality. Each customer would be required to reduce DWI/I by an equal 20 percent.

Advantages:

- Simple to calculate required reductions
- Applies uniformly to all customers
- Requires all customer to reduce DWI/I
- Every community is asked to contribute to the overall flow management solution

Disadvantages:

Table 3.3: First-Tier Customer Information

First Tier Customer	Type	Total Area (acres)	Combined (acres)	Separate (acres)	Metered DWF	DWI/I (mgd)	DWI/I (inches)
Allen Park	Sanitary	1,716	0	1,716	1.7	0.28	2.20
Center Line	Sanitary	1,031	0	1,031	1.2	0.06	0.76
City of Detroit	Combined	82,555	82,555	0	296	185	30.15
Clinton-Oakland	Sanitary	75,822	0	75,822	31.3	3.2	0.56
Dearborn	Mixed	14,823	10,000	4,823	22.1	6.6	5.95
Dearborn Heights Dist 2	Sanitary	17	17	0	0.07	0.04	31.82
Evergreen-Farmington	Mixed	62,681	3,850	58,831	43	7.4	1.58
Farmington	Sanitary	1,376	0	1,376	1.4	0.41	4.02
Grosse Pointe	Mixed	684	271	413	1.7	0.92	18.05
Grosse Pointe Farms	Mixed	1,384	1,337	48	2.9	1.9	18.05
Grosse Pointe Park	Sanitary	1,283	0	1,283	1.4	0.34	3.54
Hamtramck	Combined	1,347	1,347	0	5.0	2.9	28.57
Harper Woods	Storm	188	188	0	0.84	0.70	50.03
Highland Park	Combined	1,870	1,870	0	3.4	1.7	12.12
Macomb	Sanitary	84,248	0	84,248	51	12	1.97
Melvindale	Sanitary	1,757	0	1,757	1.6	0.36	2.75
N.E. Wayne	Mixed	20,410	8,106	12,304	25	7.6	5.03
North Huron/Rouge Val	Mixed	98,063	6,155	91,908	68	10	1.40
Redford Township	Combined	49	49	0	0.08	0.05	13.64
S.E. Oakland	Sanitary	42,146	22,997	19,149	47	8.6	2.76
Wayne Co Area 6	Combined	81	81	0	0.16	0.08	13.64
Totals		493,529	138,822	354,707	605	251*	6.83

*Total includes 9 mgd of wastewater treatment plant washwater. Actual DWI/I is 242 mgd.

- Differences of DWI/ I inherent in collection system types not accounted for
- Impacts of soils or geography not accounted for
- Customers who are already engaged in active flow management programs do not receive credit for work completed
- Flows identified by this approach may not be the most economical to remove

General Standard Approach

A second approach is to develop a standard limit in terms of the acceptable level of DWI/ I that a community can accept in their collection system. This approach is based on factors such as the flow per unit of tributary area or based on flow per inch-mile of installed pipeline. Once a standard is developed, this would be applied uniformly to all communities. Those that have DWI/ I flows that are less than the standard allowed have no further responsibility for reducing flows within their community. Those communities with flows that exceed the standard are obligated to reduce DWI/ I flows until they achieve the standard.

Advantages:

- Acknowledges communities that have worked to remove DWI/ I
- Can easily calculate required reductions
- Standard applied uniformly to all customers

Disadvantages:

- Differences of DWI/ I inherent in collection system types not accounted for
- Impacts of soils or geography not accounted for

- Flows identified for removal may not be the most economical to remove

System Standard Approach

A third approach is to develop different DWI/ I standards that are applied to different collection system types. This approach recognizes that there are fundamental differences in how sanitary and combined collection systems operate and that the amount of DWI/ I that enters these systems varies. These different standards acknowledge these differences and require that all customers and Detroit manage their DWI/ I flows to within the standards that are set.

One issue is how to set these standards to provide goals that ensure that there is good flow management of the DWI/ I while simultaneously not placing an economic burden on certain types of customers for the majority of the work.

Advantages:

- Acknowledges communities that have worked to remove DWI/ I
- Required reduction for each community can be calculated
- Recognizes differences in collection system performance
- Requires flow management work within different types of collection systems
- Cost effectiveness of removal factored into standards set

Disadvantages:

Table 3.4: DWI/I Reduction by Approach

First Tier Customer	Metered DWF	DWI/I (MGD)	DWI/I (in)	Proportional		General		System Type Standard			
				MGD		MGD		MGD	Comb.	Sep.	
Allen Park	1.7	0.28	2.20	0.06	0%	0	0%	.15	.	.15	0%
Center Line	1.2	0.06	0.76	0.01	0%	0	0%	.	.	.	0%
City of Detroit	296	185	30.15	36.9	74%	49	98%	40.8	40.8	.	82%
Clinton-Oakland	31.3	3.2	0.56	0.63	1%	0	0%	.	.	.	0%
Dearborn	22.1	6.6	5.95	1.31	3%	0	0%	.	.	.	0%
Dearborn Heights Dist 2	0.07	0.04	31.82	0.01	0%	0	0%	.01	.01	.	0.02%
Evergreen-Farmington	43	7.4	1.58	1.47	3%	0	0%	.	.	.	0%
Farmington	1.4	0.41	4.02	0.08	0%	0	0%	.31	.	.31	0.6%
Grosse Pointe	1.7	0.92	18.05	0.18	0%	0	0%	.41	.38	.03	0.8%
Grosse Pointe Farms	2.9	1.9	18.05	0.37	1%	0	0%	.	.	.004	0.0%
Grosse Pointe Park	1.4	0.34	3.54	0.07	0%	0	0%	.24	.	.24	0.5%
Hamtramck	5.0	2.9	28.57	0.57	1%	0.6	1.3%	.51	.51		1.0%
Harper Woods	0.84	0.70	50.03	0.14	0%	0.4	0.8%	.37	.37	.	0.7%
Highland Park	3.4	1.7	12.12	0.34	1%	0	0%	.	.	.	0%
Macomb	51	12	1.97	2.46	5%	0	0%	6.1	.	6.1	12%
Melvindale	1.6	0.36	2.75	0.07	0%	0	0%	.23	.	.23	0.5%
N.E. Wayne	25	7.6	5.03	1.52	3%	0	0%	.92	.	.92	1.8%
North Huron/Rouge Val	68	10	1.40	2.04	4%	0	0%	.	.	.	0%
Redford Township	0.08	0.05	13.64	0.01	0%	0	0%	.	.	.	0%
S.E. Oakland	47	8.6	2.76	1.72	3%	0	0%	.	.	.	0%
Wayne Co Area 6	0.16	0.08	13.64	0.02	0%	0	0%	.	.	.	0%
Totals	605	251	6.83	50		50		50	42	8	

- Impacts of soils or geography not accounted for
- Flows identified for removal may not be the most economical to remove

Recommended Approach

Comparison of Approaches

Table 3.4 shows the application of these different approaches to the first-tier customers.

- **Approach 1** - For these calculations, the assumption is that a 20 percent reduction in DWI/ I is required for each customer.
- **Approach 2** - The standard was set so that the overall goal of a 50 mgd reduction was achieved. To accomplish this, the goal of 22.2 in/ yr (1,650 gpd/ ac) was found to provide the needed reduction. See Figure 3.3.
- **Approach 3** - For the final approach, two separate standards were set so that the goal of 50 mgd DWI/ I reduction would be achieved. In this case, the standard for the sanitary collection systems was set at 1.0 in/ yr (75 gpd/ ac) and the standard for the combined areas set at 23.5 in/ yr (1,750) gpd/ ac). See Figure 3.4.

Description of Selected Approach

It is recommended that the System Standard Approach be taken. This approach recognizes that there are differences in the acceptable DWI/ I depending on whether the community is served by separate or combined sewers. Since different standards are applied to these different types of com-

Figure 3.3: General Standard Approach

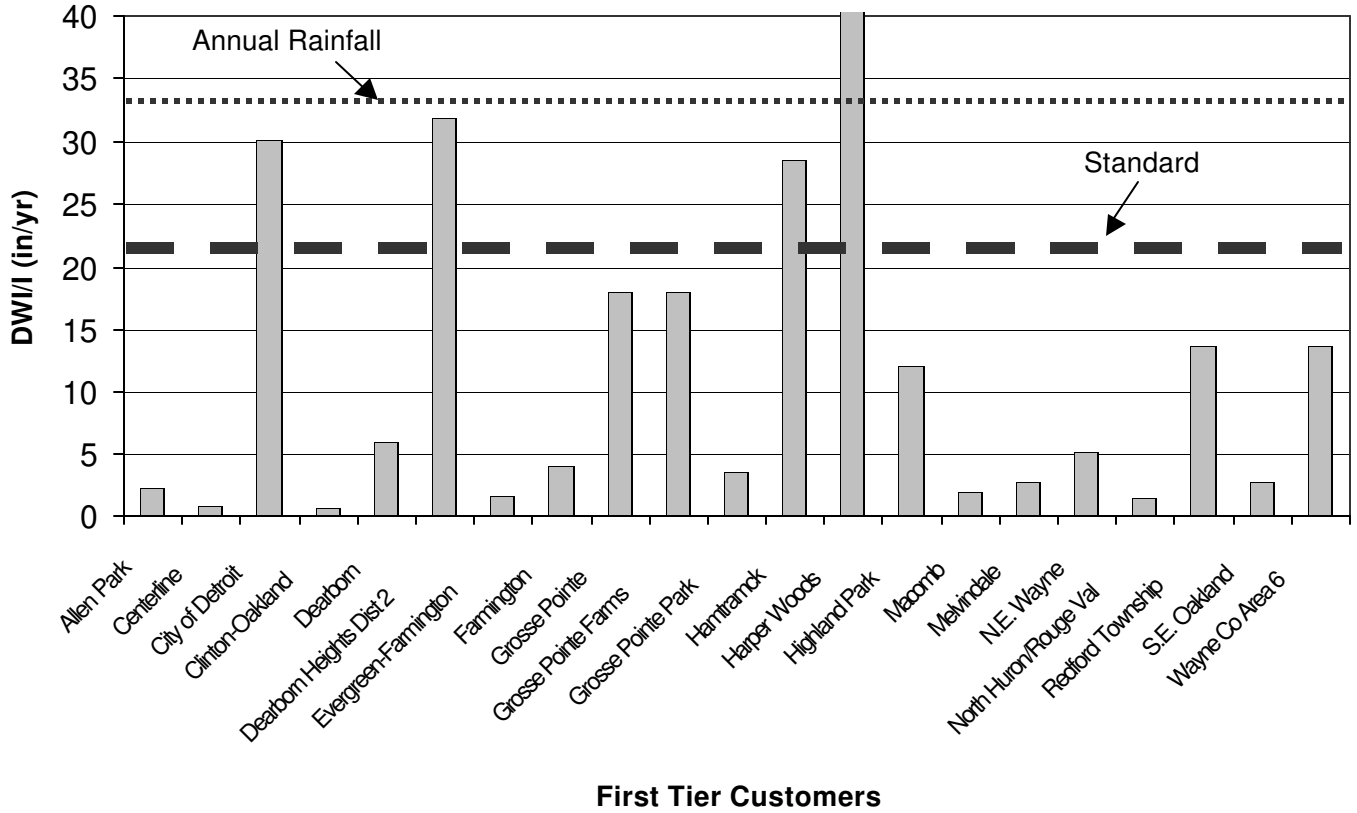
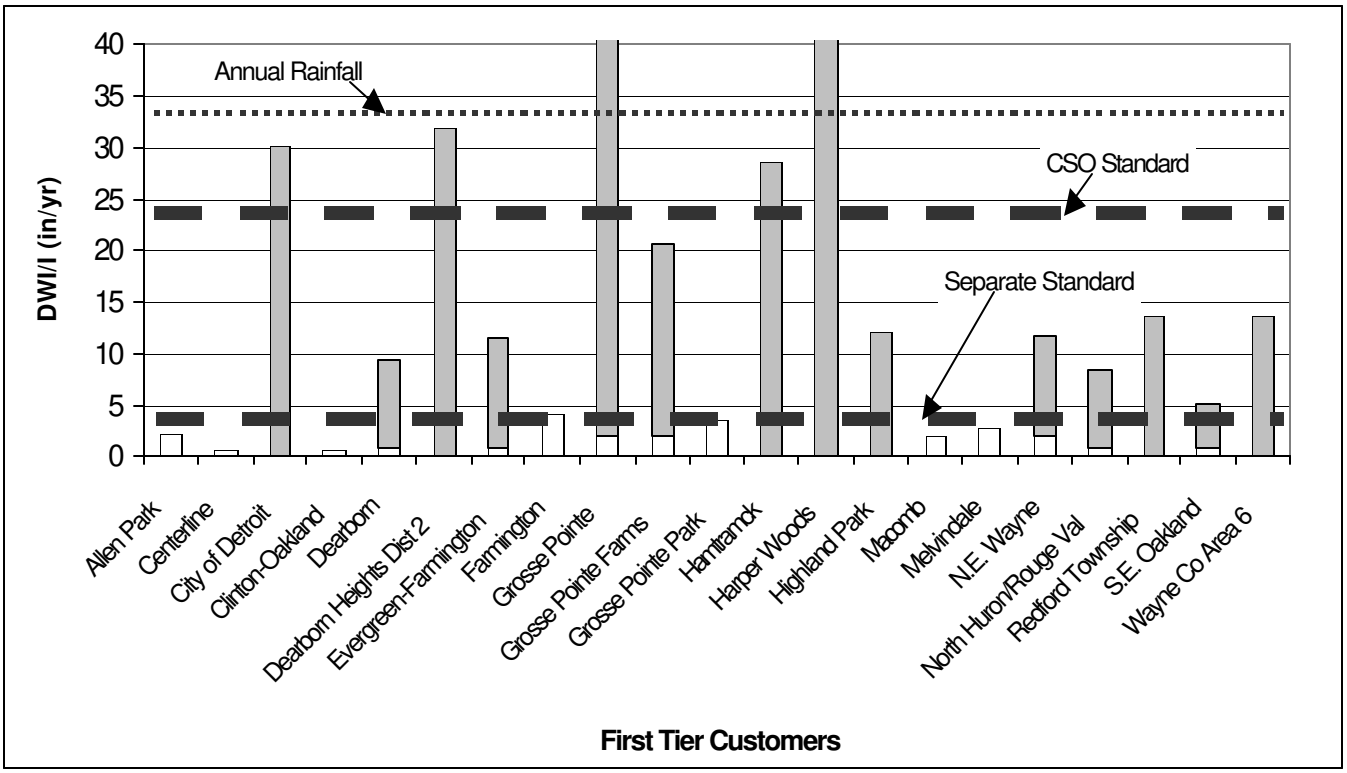


Figure 3.4: System Standard Approach



munities, there is recognition for those that have already invested in reducing the amount of DWI/I in their systems.

Recommended Reductions

The recommended reductions in terms of flows are provided in the final set of columns in Table 3.3. This table shows the reduction in terms of mgd of DWI/I that would be expected. In cases where first tier customers have both separate and combined systems, the amount of DWI/I reduction by system type is shown. The final column shows the percentage of the overall 50 mgd DWI/I reduction goal that each community has responsibility for.

3.4.5 Operation and Maintenance Considerations

The following approach is proposed to operate the flow management alternative:

- Three-year contract
- Establish full-time staff at DWSD, setting up a special unit that consolidates staff from the three divisions currently involved
- Every six-months check accountability to list of actions and flow reductions measured

DWSD would provide competitive grants to its suburban customers for funding SSES studies.

3.4.6 Urban Stream Restoration

Detroit's earliest sewers were constructed in order to keep waste from flowing in the open drainage ditches that carried rainwater to the natural rivulets and streams in the city. These historical drainage courses provided natural drainage paths for storm water to flow toward either the Detroit or Rouge rivers. Significant I/I is likely to be found

in these older sewers constructed in streambeds. Potentially significant flow reductions from redeveloped areas can be achieved if locations for restoration of urban streams can be identified, and storm water and groundwater flows now being transported to the Detroit WWTP are returned to open watercourses.

This concept of diverting urban streams to their natural drainage paths is discussed in Volume 2 *Critical Facilities and Flow Management*. Now, a stream that could be considered for restoration has been identified. Figure 3.5 shows the area near the Jeffries Freeway and W. Outer Drive where the stream is located. Most of the lots on Greydale Ave. are vacant. A streambed there could reduce storm water flow to the DWSD system by 10-11 mg per year if drainage is diverted to the "new" stream. Details are on the technical memorandum *Urban Stream Restoration, City of Detroit* on the CD accompanying this report.

3.4.7 Decentralized Wastewater Systems

Several communities in the DWSD service area will continue to use onsite sewage disposal systems. The technical memorandum *Septage Transport and Disposal to the Detroit Wastewater System* estimated there would be about 103,000 onsite sewage systems in use in 2050 in the DWSD service area serving a population of about 260,000. The soil and groundwater conditions in portions of the areas that will continue to rely on onsite sewage systems, are poor or marginal for a standard septic tank soil absorption system. An estimated 143,500 people will need sewer service or a decentralized wastewater system.

Decentralized wastewater systems include larger septic tank soil absorption systems and advanced wastewater treatment with land disposal of the effluent. Advanced treatment methods that are available include; sand filters, aerobic treatments units, drip irrigation, pressure-dosed systems, recirculating sand filters, lagoons, and spray irrigation. These systems can overcome some soil limitations and provide better treatment of wastewater than standard septic tank soil absorption systems if they are maintained.

A detailed review of the economic benefits and costs of decentralized technologies will be available from the Rocky Mountain Institute (RMI) study that is due to be completed June 30, 2003. Three townships in the DWSD service area have been recommended to be included in this RMI study. Information from the study will identify the economic benefits and costs of decentralized wastewater systems as well as their societal impact. Decentralized wastewater systems provide an alternative to extension of sanitary sewers. They require regular maintenance and will generate biosolids that must be disposed of. Biosolids could be disposed of at the septage unloading stations that drain to the DWSD sewerage system. Other potential impacts on the DWSD sewerage system are the delay or elimination of sewer extensions and connections to the DWSD wastewater system.

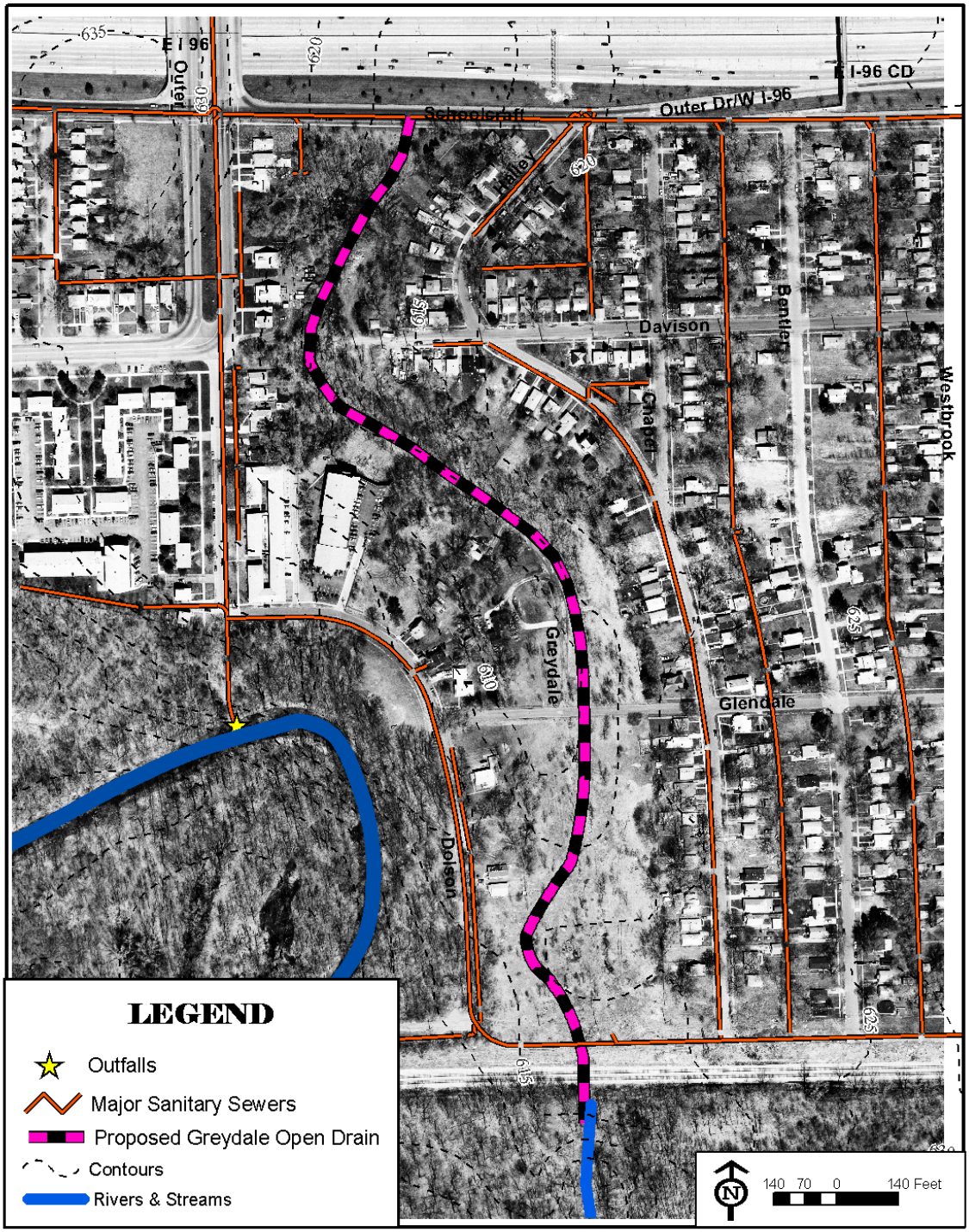
3.5 Wet Weather Flow Treatment

3.5.1 Description

Construction of a wet weather flow treatment facility is one treatment alternative considered. The DWSD WWTP has a primary treatment capacity of 1700 mgd for excess flows during wet weather conditions. Four variations were considered:

- Building a new wet weather flow treatment facility near the WWTP to increase wet weather treatment capacity;
- Retrofitting a wet weather flow treatment facility within existing primary clarifiers at the WWTP; and
- Building a wet weather flow treatment facility dedicated to treating dewatered flow from the

Figure 3.5: Urban Stream Restoration Location



proposed joint CSO tunnel system. This facility would be operated during wet weather events, and would be capable of intermittent operation with short startup and shutdown times (typically, less than 20-30 minutes).

- Wet weather flow treatment facility

3.5.2 Design Criteria

The wet weather flow treatment facility was designed based on a physical-chemical process such as ballasted flocculation. A typical ballasted flocculation treatment process for wet weather flow includes an influent pump station, screening, chemical addition, rapid mix or flash mix tank, flocculation or maturation tank with microsand and polymer addition, high-rate up flow clarifier, disinfection, and discharge to a receiving stream. Ancillary processes such as sludge-microsand separation, and sludge thickening and dewatering would also be required.

Typical design criteria for a wet weather flow treatment facility utilizing ballasted flocculation are:

Screening: one-quarter to one-half inch openings.

Rapid mix tank: detention time of two minutes, with coagulant added upstream of tank.

Flocculation tank: detention time of four to five minutes, with polymer and microsand added at entrance to tank.

Clarifier tank: high-rate up flow clarification with rise rates of 40-60 gpm/ sf using inclined plate or tube settlers with sludge collected at bottom of tank.

Sludge-microsand separation: using hydrocyclones separated sludge would be pumped to a sludge thickener while microsand would be pumped back to the sand storage tank.

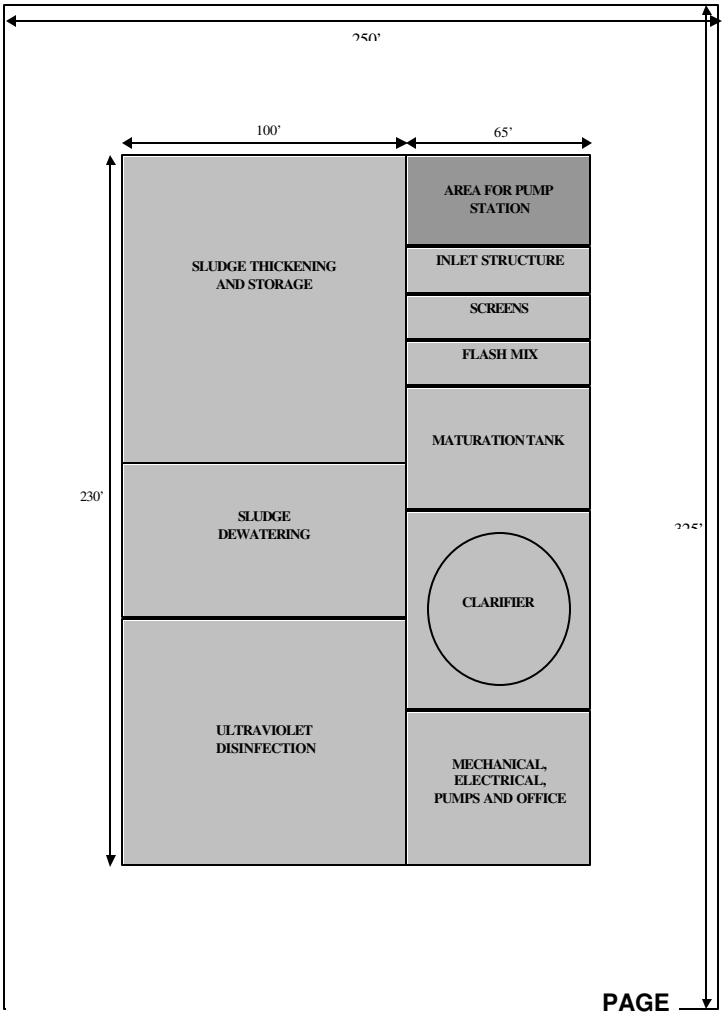
Disinfection: ultraviolet disinfection or chlorination/ dechlorination.

Sludge thickening and dewatering: lamella plate-settlers for thickening and centrifuges for dewatering.

Based on manufacturer-provided data, typical percent removals through ballasted flocculation or equivalent processes are 85-90 percent removal of TSS, 50-70 percent removal of $CBOD_5$, and about 85 percent removal of total phosphorus. Alum or ferric chloride is typically used as a coagulant at a dose of about 40 mg/ L. The polymer usage is approximately 1 mg/ L.

Based on providing a stand-alone wet weather flow treatment facility, the land required for a 100 mgd facility would be approximately two acres (325 by 250 feet). Figure 3.6 is a layout for a 100 mgd wet weather flow treatment facility.

Figure 3.6: Layout for a Wet Weather Flow Treatment Fa-



3.5.3 Location of Facilities

Since all wastewater in the DWSD collection system flows to the WWTP, a location at or near the plant is an obvious choice. Another location to consider is a site close to the dewatering pump station for the proposed joint CSO tunnel system. These options are detailed here. Figure 3.7 shows locations for each option.

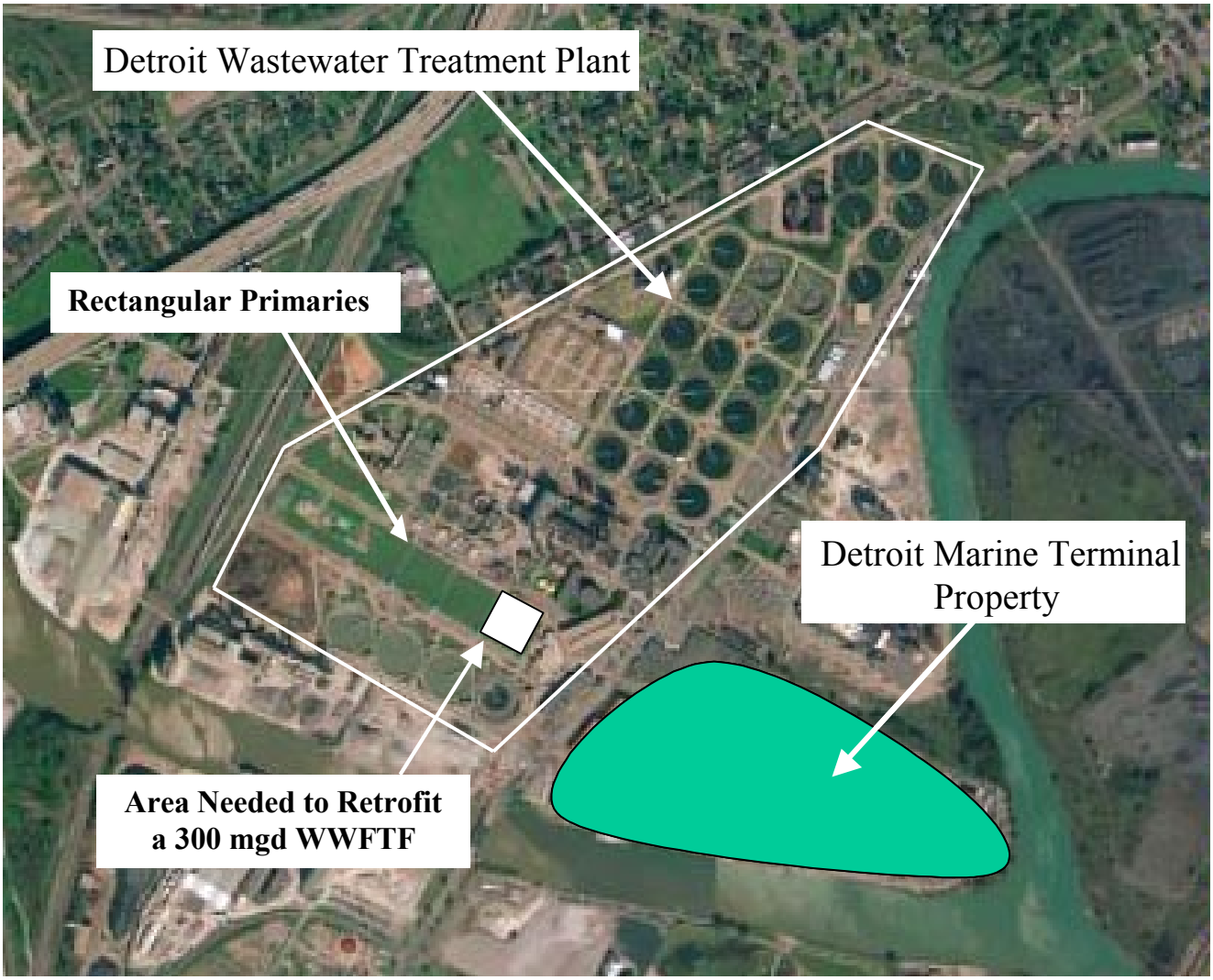
Wet Weather Flow Treatment Facility Near the WWTP: The Detroit Marine Terminal (DMT) owned by DWSD would be a potential site. Located across West Jefferson from the WWTP, the new DRO2 outfall and chlorination/ dechlorination facilities are under construction at the DMT. A diversion structure would be built at pump station PS-1 to divert excess flow to the wet weather flow treatment facility. After treatment, the effluent could either be disinfected onsite using UV disinfection and discharged to the DRO1/ DRO2 outfalls, or could be discharged to the DRO1/ DRO2 outfalls prior to the chlorination/ dechlorination facility. The sludge could either be treated onsite or pumped to WWTP's sludge-handling facilities.

Retrofitting Within Rectangular Primary Clarifiers at the WWTP: The WWTP has twelve rectangular primary clarifiers, each with a capacity of 90 mgd. Each rectangular primary is 273 feet by 112 feet, with a side depth of 10-14 feet. Up to a 300 mgd of wet weather flow treatment facility could be retrofitted within two rectangular primaries if existing sludge handling and disinfection facilities at the WWTP were utilized for the new facility. This would increase the total wet weather capacity from 1700 mgd to 1820 mgd. Due to higher head losses through the wet weather flow treatment facility compared to the primary clarifiers, some of the pumps at pump stations PS-1 and PS-2 could be modified and dedicated to the wet weather flow treatment facility or a new 300 mgd booster pump station could be built ahead of the facility .

Wet Weather Flow Treatment Facility Near the Dewatering Pump Station of Proposed Joint CSO Tunnel: Negotiations were ongoing between Detroit, Dearborn, and MDEQ on the feasibility of a joint CSO tunnel system when this study was performed. The joint tunnel system is no longer an option, but the conclusions of this study are still applicable to the planned Upper Rouge Tunnel in Detroit. The joint tunnel system would have been a capture tunnel system with a volume of 210 million gallons. The plan was to dewater the tunnel system to the Northwest Interceptor after a rain event when there is sufficient transport capacity in the interceptor. A new wet weather flow treatment facility could have been dedicated to the tunnel system and treated effluent would have been discharged to the Rouge River. Based on 24- to 48-hour dewatering times, the wet weather flow treatment facility would be designed for about 100 or 200 mgd capacity. This location for a wet weather treatment facility was not recommended based on the information available for this study.

Wet Weather Flow Treatment Facility Near the WWTP and Extension of the Joint CSO Tunnel System: In addition to a wet weather flow treatment facility as described in the third option, the joint tunnel system would be extended to the wet weather flow treatment facility by building a deep rock tunnel, approximately eight miles long, from the proposed tunnel dewatering pump station location to the wet weather flow treatment facility location. The dewatering pump station would instead be built at the wet weather flow treatment facility site and would serve as an influent pump station. The tunnel extension would be generally along the route of the Northwest Interceptor, and would provide relief, redundancy and potential replacement for this interceptor.

Figure 3.7 Location of Wet Weather Treatment Facilities



3.5.4 Implementation Considerations

All options except the proposed joint CSO tunnel would discharge treated effluent to the Detroit River, which has a high base flow and thus is preferred. The CSO tunnel option would discharge to the Rouge River, which has a lower base flow.

The CSO tunnel would require dedicating the wet weather flow treatment facility to the joint CSO tunnel system, which may impose a greater financial burden on communities utilizing the system. The extended joint CSO tunnel system would require construction of a new eight mile deep-rock tunnel and would not be economically attractive unless providing relief to the Oakwood-Northwest Interceptor was essential.

Building the wet weather flow treatment facility new the WWTP or retrofitting such a facility within rectangular primary clarifiers at the WWTP would be the least costly alternative. A 300 mgd wet weather flow treatment facility under the former option would increase the wet weather treatment capacity of 300 mgd. A 300 mgd facility under the latter option would result in a net increase

Table 3.5: Conceptual Costs for 100 mgd WWFTF Options

Option	Construction Cost	Land Required	Sludge Handling and Disinfection	Annual O&M Cost
Near the DWWTP	$34.9 Million	One acre (325 ft by 130 ft)	Excluded	$1.25 Million
Near the DWWTP	$42.7 Million	Two acres (325 ft by 250 ft)	Included	$1.2 Million
Retrofitted at DWWTP	$26.7 Million	No additional land required	Uses WWTP facilities	$1.2 Million

in wet weather treatment capacity of 120 mgd. However, land acquisition would not be required for retrofitting. Conceptual construction costs and land required for 100 mgd wet weather flow treatment facilities for these preferred options are presented in Table 3.5.

3.5.5 Operation and Maintenance Considerations

Conceptual operation and maintenance (O&M) costs were developed assuming that the wet weather flow treatment facility would be operated for approximately 100 days a year. Since the facility would be a physical-chemical process, operators would need training in the startup and operation of the facility. Since the facility would be located close to the WWTP and would be operated intermittently, some of the WWTP operators could be trained to operate it so that operation and maintenance staff would also continue to work at the WWTP.

3.6 Satellite Treatment

3.6.1 Description

Suburban wastewater treatment plants may present a viable alternative for expanding treatment of flows beyond the Detroit Wastewater Treatment Plant. The three plants considered under this scenario are:

- City of Pontiac Wastewater Treatment Plant
- City of Warren Wastewater Treatment Plant
- City of Mount Clemens Wastewater Treatment Plant

In addition, the construction of a new treatment plant is an option. The Clinton River and the Detroit River are the two watersheds considered under this option.

3.6.2 Design Criteria

The expanded and new wastewater treatment plant processes were designed based upon the *Recommended Standards for Wastewater Facilities*, 1997, published by the Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers (Ten States Standards). Additionally, the expanded and new wastewater treatment plants were designed to meet Class I Reliability Criteria as defined by the EPA in *Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability*.

For design purposes, it was assumed that wastewater plants discharging to the Clinton River would need to meet tertiary treatment standards, while plants discharging to the Detroit River would need to meet secondary treatment standards.

The treatment processes considered for the expansion and building of wastewater treatment plants were:

Preliminary Treatment

- Coarse bar screens
- Grit chamber – aerated

Table 3.6: Potential Sites for New WWTP

Site	Area (acres)	Distance to Water Body	Jurisdiction	Current Land Use	Closest DWSD interceptor
Oakland County Community College	63	3,450 ft to Clinton River	Auburn Hills	Fields and forest	4,000 ft
FOMOCO Proving Grounds	211	At Clinton River Middle Branch, 4,900 ft to Clinton River	Shelby Township	Field in middle of track	1,800 ft
S of M-59	220	10,400 ft.	Sterling Heights	Forested	10,400 ft

- Equalization basin (if needed)

Primary Treatment

- Primary clarifiers – circular

Secondary Treatment

- Aeration basin (only one of the two types listed below would be used at the facility)
  - Single stage nitrification
  - Conventional activated sludge
- Secondary clarifiers – circular

Tertiary Treatment (if needed)

- Tertiary filters

Ultraviolet Disinfection

Biosolids Dewatering and Disposal

- Gravity belt thickener
- Centrifuge
- Landfill

3.6.3 Location of Facilities

New Wastewater Treatment Plants

Potential sites for a new treatment plant were reviewed using the following engineering and environmental criteria that would affect construction and operation:

Only sites that were identified as Agricultural/ Rural Residential, Commercial, Industrial, or Other by the GIS were considered.

- Sites that were not within two miles of DWSD interceptors in Oakland and Macomb counties were eliminated.
- Sites that were not far enough down the interceptor system to provide an estimated 2050 average flow greater than 20 mgd were eliminated.
- Sites that were not within a mile of the Detroit or Clinton rivers or one of the major Clinton River tributaries were eliminated.
- Sites had to be of sufficient area (50 acres for this study) to accommodate the proposed facility and an appropriate buffer.
- The elevation of the sites should allow efficient conveyance of sewage to the plant and conveyance of treated effluent to the receiving water.
- Sites should have adequate vehicle access to and from major roadways.
- Sites should not have steep slopes.
- Sites should not be long and narrow in shape.
- Sites should not be in the vicinity of state parks, active airport operations, transmission towers, cemeteries or conservation areas.

Table 3.6 summarizes the results of the site search.

Based on the above criteria, three expansion options were designed for the Pontiac WWTP (21, 31 and 35 mgd), two expansion options for the Warren WWTP (14 and 40 mgd), and three for the Mt.

Clemens WWTP (11, 36 and 54 mgd). The three sites along the Clinton River were designed for 21, 56, and 62 mgd respectively. Table 3.7 shows the summary of costs associated with the expanded and new treatment plant options as well as the costs for a wet weather flow treatment facility. Figure 3.8 shows the location of the sites as well as the three existing treatment plants considered for expansion. Figures 3.9 and 3.10 show service area options for the Mt. Clemens and Pontiac WWTPs. For details, see the technical memorandum *Technical Feasibility of Satellite Treatment* on the CD that accompanies this report.

3.6.4 Implementation Considerations

The Clinton and Detroit rivers were the receiving streams considered for a new or expanded wastewater treatment plant due to their relatively high base flows, location relative to the DWSD interceptors and proximity to areas with substantial dry weather flows. The three major components of any wastewater treatment system are the:

- Pipelines needed to convey the wastewater to the treatment plant
- Treatment plant
- Outfall pipe that will convey the treated effluent to the receiving water body

The treatment plant would need to be designed to meet several goals:

Environmental

- Avoid or minimize impacts to the environment
- Preserve and enhance water quality
- Protect public health

Technical

- Design the wastewater treatment, conveyance, and disposal system to be efficient and reliable
- Balance costs with the risks and maintain the flexibility to respond to changes in growth projections, technology, and regulations
- Ensure the wastewater system is designed and constructed to meet regulatory requirements
- Pontiac and Warren treatment plants would have to become NPDES compliant before adding new flows

3.6.5 Operation and Maintenance Considerations

Several of the Pontiac Wastewater Treatment Plant expansion alternatives include the construction of a retention or equalization basin upstream of the primary clarifiers. The Warren Wastewater Treatment Plant has a 50 million gallon equaliza-

Table 3.7: Treatment Alternatives Summary

Alternative	Additional Capacity (mgd)	Degree of Treatment	Capital Costs [1] ($ million)	Annual O&M ($ million)	Present Worth Cost [2] ($/gal./day)
Wet Weather Flow Treatment	100	Secondary Equivalent	43	1.2	0.6
Expansion of Existing Plant	100	Secondary	256	28	6
Satellite Treatment [3]	11	Tertiary	62	6	12.4
	21	Tertiary	161	12	14.8
	54	Tertiary	256	24	10.3

Note: See more details of costs in Chapter 3.
1. Capital cost includes treatment facilities and new interceptors to convey the additional flows to the treatment facilities.
2. Present worth calculated based on 5 percent discount rate and 20-year economic life. Values are unitized to show cost per gallon per day of treatment capacity.
3. Three representative examples are shown.

Figure 3.8: Location of Potential Satellite Treatment Facilities

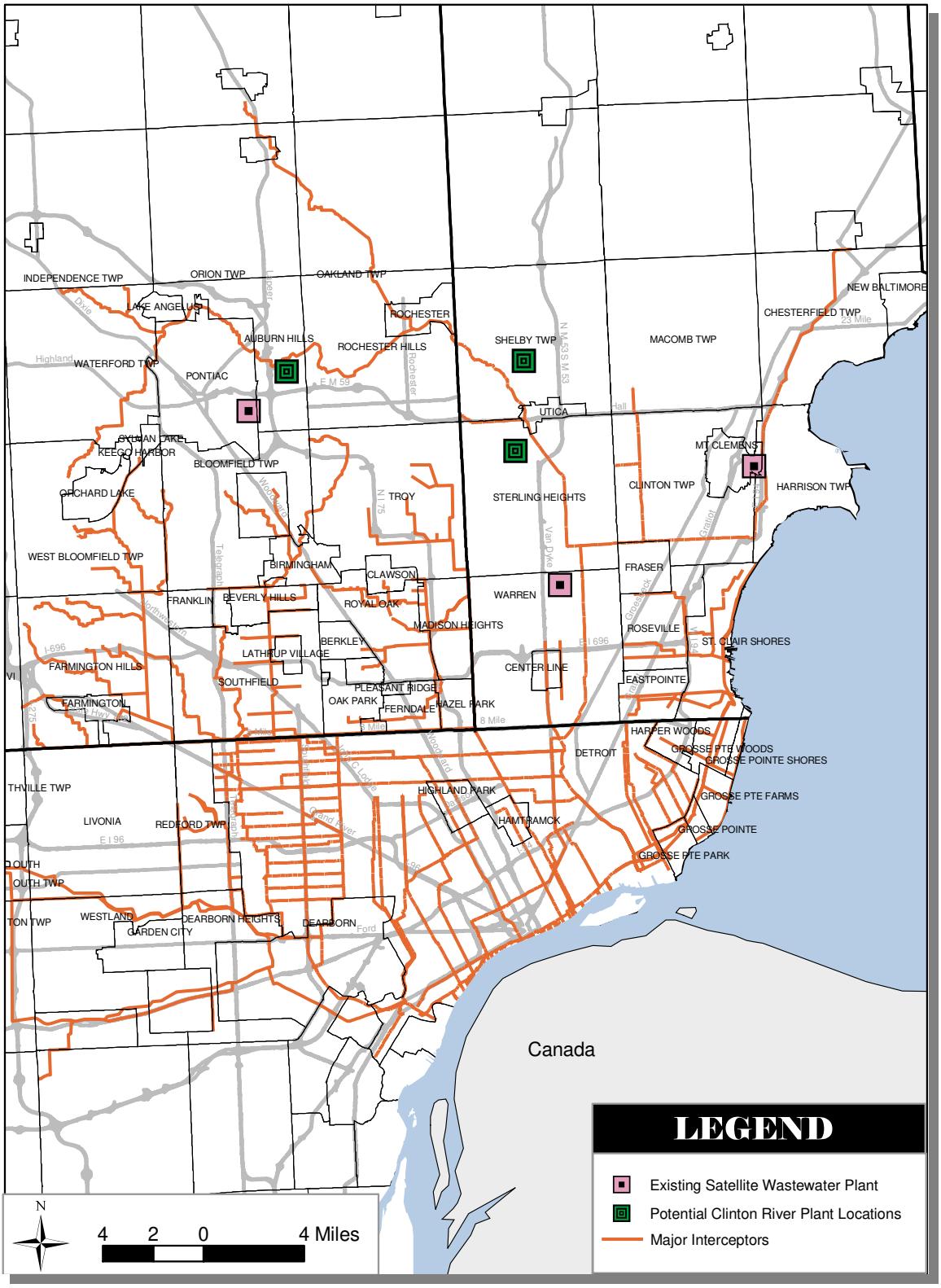


Figure 3.9: Service Area Options for Mt. Clemens WWTP

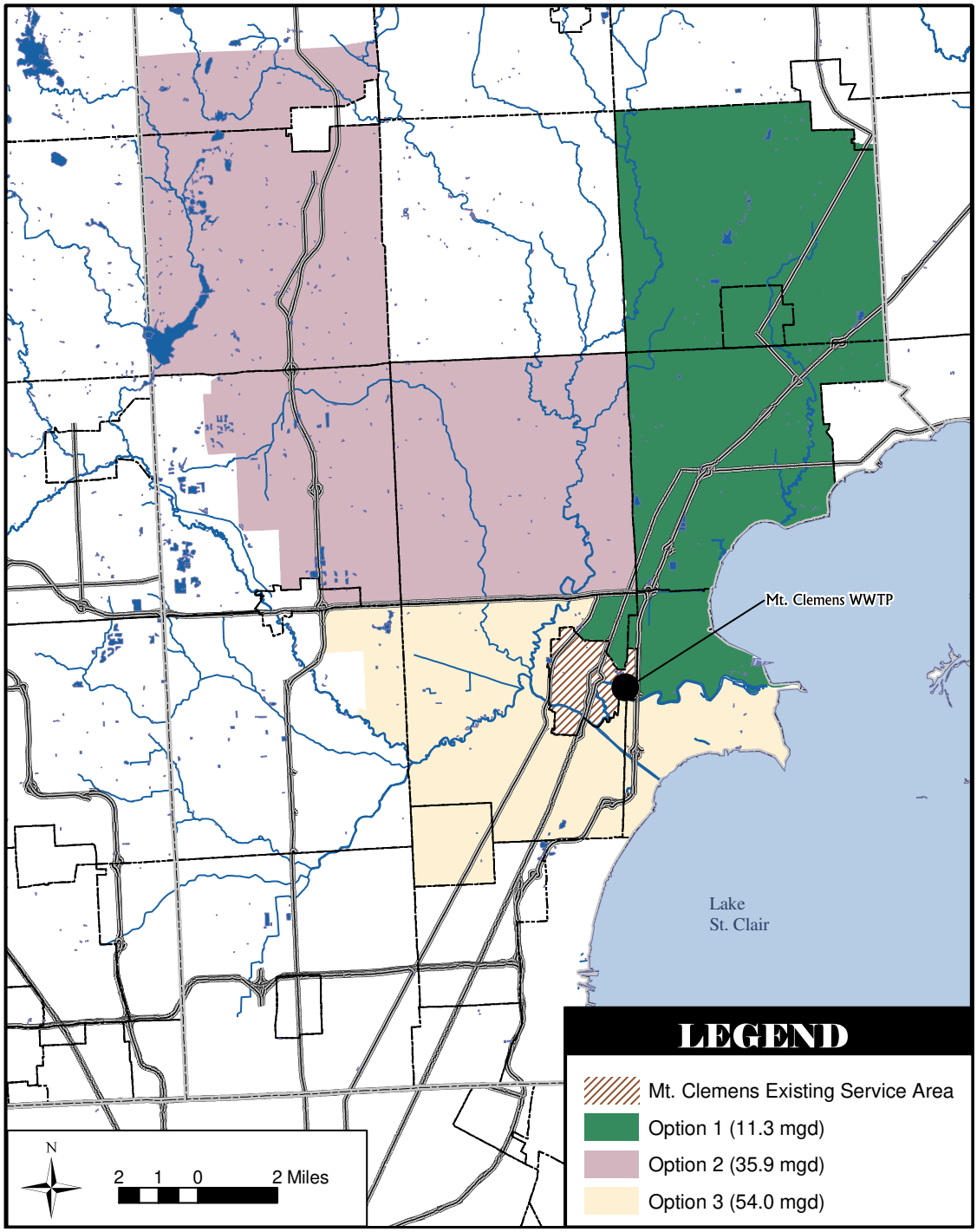
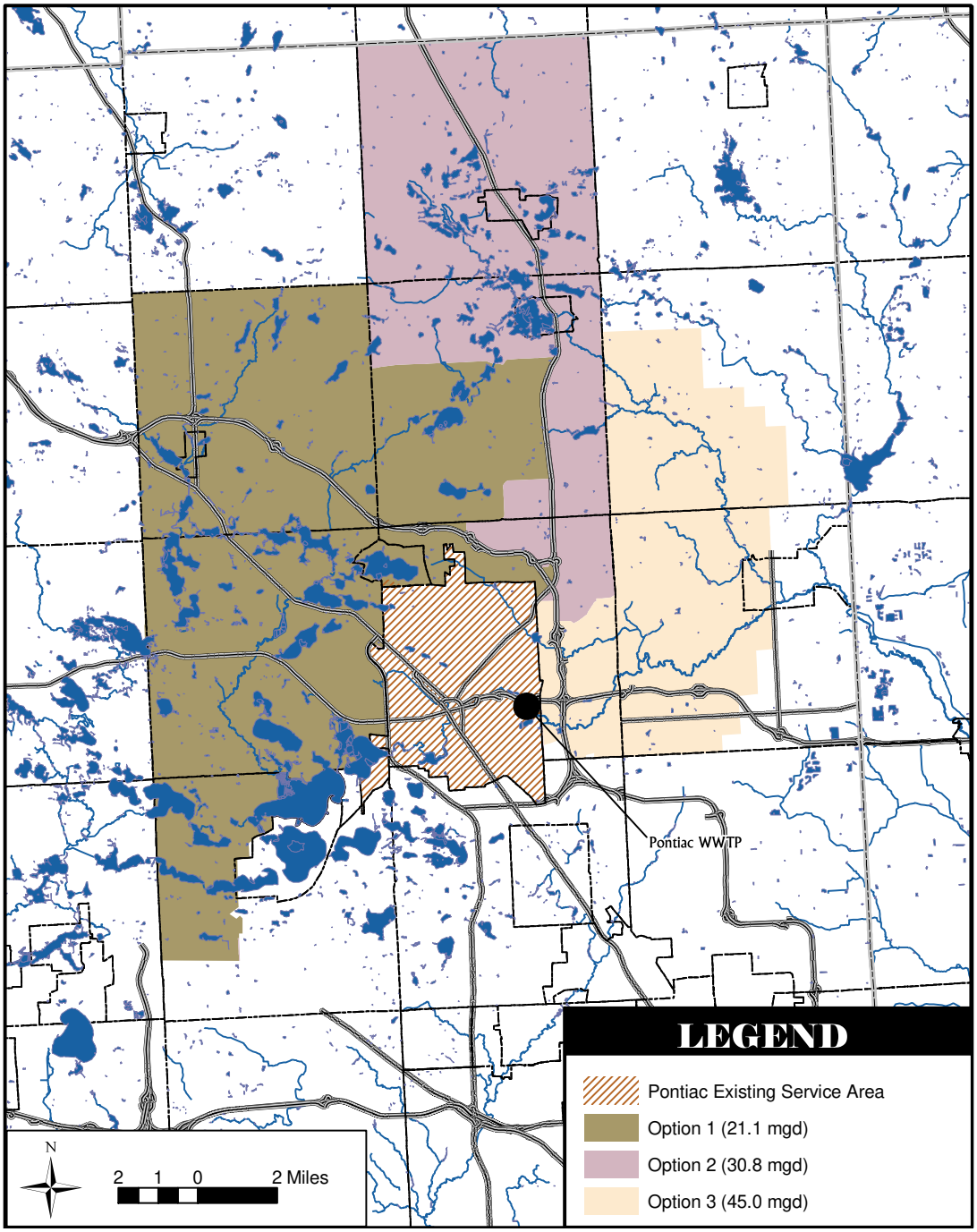


Figure 3.10: Service Area Options for Pontiac WWTP



tion basin. It is assumed that the infiltration and inflow problem at Warren will be addressed prior to the proposed expansion. At that time, the equalization basin would be available to be used to equalize the flow at the expanded plant. The remaining alternatives do not include equalization basins because the peak hourly flow to the plants would be limited by diverting only a certain amount of wastewater from an existing DWSD interceptor. Any excess flow would be allowed to continue to flow to the existing DWSD plant for treatment.

Pontiac and Warren incinerate their sludge and dispose of the ash at a landfill. The costs in this report only include biosolids handling for the expansion at these plants. In addition, disinfection at both plants is currently accomplished by chlorination followed by dechlorination. The expansions propose that ultraviolet disinfection be used. As with the solids handling, the ultraviolet disinfection equipment has only been sized to the expansion flows at these facilities.

3.7 Expanded Facilities Within the City of Detroit

3.7.1 Description

Expanding the capacity of the existing Detroit wastewater treatment plant or building a new plant in the city are alternatives for treating potential future flows.

3.7.2 Design Criteria

Expansion of the Current DWSD WWTP

The DWSD Wastewater Treatment Plant is the largest wastewater treatment plant in the world in terms of peak-hour capacity. The plant opened in 1940, and was expanded following previous master plans. The plant was rehabilitated in the late 1970s and early 1980s to address permit compliance issues. The plant operated satisfactorily until the late 1990s, when changes in the permit and operational challenges resulted in a new program of rehabilitation and expansion of some processes at the plant. The current WWTP Rehabilitation and Upgrade Program (PC-744) will be completed by 2006 and will result in substantial upgrades.

The current Wastewater Treatment Plant is located on relatively small acreage for a plant of its size, constrained by the I-75 freeway on the north, the Rouge River and industrial facilities on the west and south and residential neighborhoods to the east. The only available expansion area is the neighborhoods to the east, and expansion proposals in this area have resulted in significant community opposition in the past.

Plant processes were examined to see if additional capacity would be available for increased 2050 flows after completion of the current program. If extra capacity was not available, the processes were examined to see whether new construction on the current site could accommodate the need for new capacity.

Conclusions

- Liquid treatment processes are still mainly constrained by the number of available primary and secondary clarifiers, which require additional (and unavailable) space on the plant site.
- Solids treatment processes need rehabilitation and expansion to meet current volumes of sludge produced. Critical decisions on the back end of the treatment train (incineration alternatives and lime mixing facilities) are not finalized and may affect the final rehabilitation plans for all sludge processing. It is likely that some of the processes may require additional land.
- Ability of the plant to handle additional flows such as dewatering flows is currently unknown and would require a stress test. Acceptance of additional wet weather flows is largely limited currently by the hydraulics of the incoming flow

at the pump stations.

- Operational flexibility is currently limited in the following areas: directing of flows from PS-1 and PS-2 to the clarifiers, directing of flows from the Intermediate Lift Stations to the Aeration Decks, dewatering conveyance system, and incinerator and lime mixing facility capacity. Some (but not all) of these limitations may be addressed by PC-744 and current ongoing projects.
- Expansion of the current site to accommodate improvements in the treatment processes is extremely difficult given the natural and man-made barriers, and potential community opposition.
- As discussed in the technical memorandum *Review of Large Treatment and Collection Systems,* there are very few treatment plants in the world that serve such a large area and population. In most metropolitan areas, operational economies of scale dictate the construction of smaller plants with a more limited service area. While the cost of treatment in such a large plant is generally lower than multiple plants, the operating difficulties multiply substantially with a larger plant, given the large number of personnel required, consumable chemicals and materials, and capital improvements.
- Backup services to a metropolitan area in the event of breakdowns or emergencies are unavailable when wastewater treatment is so highly concentrated in a single plant. From a reliability standpoint, smaller (but still very large) plants that are interconnected provide insurance that wastewater service will not be affected by a breakdown in operations at one plant.
- Permitted discharge limits can be expected to constrain the expansion of already-large wastewater treatment plants, as the discharge from a single point source can have a large effect on water quality if the water volume in the river is low. DWSD is already addressing this by construction of an additional outfall on the Detroit River and removal of an outfall on the Rouge River. However, sites for new outfalls near the plant are also limited.
- Changes in permit limits and regulated contaminants are unpredictable but generally do not get less stringent. Current treatment limitations are noted for removal of some regulated wastewater constituents. In the future, treatment processes other than the current high purity oxygen aerobic treatment system may be required.

New WWTP within the City of Detroit

Criteria for a new treatment plant in Detroit were designed based upon the *Recommended Standards for Wastewater Facilities*, (1997, Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers.). Additionally, the new wastewater treatment plants were designed to meet Class I Reliability Criteria as defined by the EPA in *Design Criteria for Mechanical, Electric, and Fluid System and Component Reliability*.

The treatment processes considered for building of a new treatment plant were:

Preliminary Treatment

- Coarse bar screens
- Grit chamber – aerated

Primary Treatment

- Primary clarifiers – circular

Secondary Treatment

- Aeration basin (either single stage nitrification or conventional activated sludge will be used)
- Secondary clarifiers – circular

Ultraviolet Disinfection

Biosolids Dewatering and Disposal

Gravity belt thickener

Table 3.8: Potential Detroit Site for New WWTP

Site	Area (acres)	Distance to Water Body	Jurisdiction	Current Land Use	Closest DWSD interceptor
Conner Creek	50	4,500 ft to Detroit River	Detroit	Parking Lot	Next to several pump stations

Centrifuge

Landfill

3.7.3 Location of Facilities

New Wastewater Treatment Plant

The potential sites within Detroit were screened using the following engineering and environmental constraints that would affect the construction or operation of a wastewater treatment plant:

- Only sites that were identified as Agricultural/ Rural Residential, Commercial, Industrial, or Other by the GIS were selected for further investigation.
- Sites that were not within two miles of the current DWSD interceptors in were eliminated.
- Sites where the nearby interceptor could not provide an estimated 2050 average flow greater than 20 mgd were eliminated.
- Sites that were not within a mile of the Detroit River were eliminated.
- Sites had to be of sufficient area (a minimum of 50 acres) to accommodate the proposed facility and an appropriate buffer.
- The elevation of the sites should allow efficient conveyance of sewage to the plant and conveyance of treated effluent to the receiving water.
- Sites should have adequate vehicle access to and from major roadways.
- Sites should not have steep slopes.
- Sites should not be long and narrow in shape.
- Sites should not be in the vicinity of state parks, active airport operations, transmission towers, cemeteries or conservation areas.

The site at Conner Creek was chosen since it met these criteria. The current and projected 20-year land use of the site is commercial. An area designated "medium/ high density residential housing" surrounds the site. The site is located near the Conner, Freud, and Fairview pump stations of the interceptor system. These pump stations could provide flow to the potential WWTP. The Conner Creek site is located northwest of the site where the Conner Creek combined sewer overflow (CSO) basin is being constructed. See Table 3.8.

Table 3.9 shows the summary of costs and variables for a new treatment plant along the Detroit River.

Figure 3.11 shows the location of the above site as well as the current Detroit Wastewater Treatment Plant.

3.7.4 Implementation Considerations

Discharge limits from the Conner Creek WWTP are expected to be equivalent to secondary treatment standards. Secondary limits could be granted if the plant discharges to the Detroit River, which is approximately 4,500 feet from the proposed site.

Table 3.9: Projections for New WWTP on Detroit River

	Option 1	Option 2
Additional Capacity (avg. mgd)	100	125
Degree of Treatment	Secondary	Secondary
Capital Costs ($ million)*	256.3	297.3
Annual O&M Costs ($ million)*	27.5	33.4
Capital Costs ($/gal./day)	2.56	2.38

*In April, 2002 Dollars

Figure 3.11: Proposed Location for New Detroit WWTP



The Conner Creek WWTP would require that an NPDES permit application be filed with the MDEQ. An antidegradation statement would need to be filed with the application to identify social or economic impact.

3.7.5 Operation and Maintenance Considerations

The wastewater would be supplied to the proposed Conner Creek plant from the Conner Creek and Freud pump stations, located at or near the site. This would eliminate the need for a conveyance system.

The Conner Creek alternatives include single-stage nitrification aeration basins and sand filters. The Detroit River has a significantly higher base flow than the Clinton River, which allows plants to meet secondary limits that are achievable using conventional activated sludge without sand filters.

For solids handling, the sludge from the secondary clarifiers would be treated in the gravity belt thickeners, which would thicken the biosolids to 8 percent. The primary sludge and thickened secondary sludge would be mixed in the centrifuge feed tank. The centrifuge would thicken the sludge to about 20 percent. The dewatered sludge would then be taken to a landfill.

4. Comparison of Alternatives

4.1 Criteria

Four wastewater treatment alternatives – flow management, wet weather flow treatment, satellite treatment, and expanded facilities within the City of Detroit – were identified in Chapter 3. There were five criteria developed for analyzing and comparing these alternatives.

4.1.1 Capital Costs

Estimated capital costs were developed for each alternative and for various options under each alternative. The capital cost was comprised of construction cost, conveyance cost, and startup cost. The estimated cost figure also included 20 percent engineering design fees, 10 percent legal and administrative charges, and 20 percent contingency expenditures. The capital costs were compared on a unit cost basis.

4.1.2 Operation and Maintenance Costs

Annual operation and maintenance (O&M) cost was developed for various options under each of the four alternatives. The O&M cost estimate included labor and preventative maintenance, energy, and expenditure for chemicals. The annual O&M costs were compared on a unit cost basis.

4.1.3 Regulatory Constraints

Regulatory constraints for this comparison were defined as the degree of difficulty in obtaining regulatory approval for a particular option. Based on the alternatives and options under each alternative, the various constraints are ranked in the order from least to highest degree of difficulty in obtaining regulatory approval.

Some of the issues that will affect regulatory approval are:

- Effluent receiving stream (whether to the Detroit, Clinton, or Rouge river) and level of treatment (secondary versus tertiary)
- Facility location (proximity to residential areas, and distance from major interceptors and receiving streams)
- Construction of a new facility versus expansion of an existing facility versus expansion and construction of multiple facilities
- Site-specific issues

4.1.4 Environmental Factors

Environmental issues that would affect the comparison of these four alternatives include water quality impacts (which could be either beneficial or adverse); construction impacts; odor, noise and visual impacts of a new or expanded facility; and proximity to ecologically sensitive areas.

4.1.5 Regional Operation and Control

This criterion evaluates the various options developed under the four alternatives for their ease in allowing regional control and operation of new and expanded facilities. New facilities in suburban communities may be more amenable for regional operation and control compared to expanding facilities owned and operated by suburban utilities.

4.1.6 Findings

The findings of the technical studies for this report lead to the following findings regarding the four conceptual alternatives.

Flow Management: Detroit and a number of communities in the DWSD service area are performing projects to reduce sources of excessive infiltration/ inflow. These efforts, along with trends in residential and industrial water conservation show that DWSD can manage flows within its existing treatment plant capacity. A detailed exami-

nation of dry weather and wet weather infiltration/ inflow rates was performed to develop target reductions for dry weather infiltration/ inflow by community. The target reductions are shown in Table 4 in the Executive Summary.

Wet Weather Flow Treatment: Technology exists to provide treatment to the equivalent of secondary standards using physical chemical processes that can be used in conjunction with existing biological treatment processes at the wastewater treatment plant. This technology, known as ballasted flocculation, is in operation at several wastewater treatment plants. The current upgrade at the wastewater treatment plant (PC-744) is expected to meet NPDES permit requirements for primary treatment of wet weather flows in excess of secondary treatment capacity by 2007. After 2007, the major new source of flows at the wastewater treatment plant will be the flows from the dewatering of planned CSO storage basins, plus possible flows from new SSO storage basins. When these new flows are on-line, a number of factors need to be reviewed to determine if additional treatment of wet weather flows is needed. These factors include:

- Experience with dewatering of CSO and SSO storage basins;
- Operational data on the performance of flow blending at the Wastewater Treatment Plant;
- Future NPDES permit requirements.

Expansion of the Existing Treatment Plant: Expansion of the Wastewater Treatment Plant at the existing site is difficult because of space limitations and the configuration of the existing process layout. Flow projections for this Master Plan show that an expansion would not be necessary if anticipated flow management actions are successful. If flows do increase beyond those projected, then a cost-effective alternative would be the construction of a second facility located so as to classify as a modification of the existing wastewater discharge. By the end of the planning period, the new facilities under construction will be over 40 years old, and the oldest elements of the plant will be over 100 years old. This Master Plan outlines a general plan for reconstruction of the plant at its existing site by the end of the planning period. This reconstruction provides for the newest and most efficient technologies and would enhance operational flexibility and reliability.

Satellite Treatment: The construction of new satellite treatment plants and the expansion of existing plants operated by other wastewater service providers were evaluated. Satellite treatment is a feasible option. However, on a unit-of-flow basis, the cost of satellite treatment is two to three times more expensive than expansion of facilities in Detroit. The higher costs of satellite treatment are due to more stringent effluent requirements and costs to change the interceptor and pumping system to convey flows to the expanded plants. Small increases in the capacity of some satellite plants may be cost-effective where major conveyance system changes are not required.

Certain elements of each conceptual alternative are feasible and cost-effective. These optimal elements need to be adopted by DWSD in a time line as follows:

1) Proceed with flow management efforts immediately, and pursue these as a continuing effort through the planning period.

2) Wait until 2007 or later, when major CSO and SSO basin dewatering flows are a reality, and determine if additional wet weather flow treatment is needed.

3) Should flows increase beyond the projections in this plan, or should other treatment providers in the planning area need to abandon their plants, consider expansion of existing treatment facilities located near to the existing plant, but at a separate site.

4) Provide existing customers and other providers with information regarding DWSD rate projections for 10 years so that wholesale customers can make informed decisions on the cost-effectiveness of new satellite facilities.

This report of the Wastewater Master Plan has developed four conceptual alternatives for wastewater service for the DWSD over the next 50 years. The DWSD invites comments on these alternatives from its retail customer representatives, its wholesale customer communities, and other stakeholders in the planning area.

The master planning team has developed the following tentative conclusions from the study of alternatives presented in this report:

1. Future wastewater flows in the planning area can be characterized as follows:

- The greatest growth in flows is projected to be in areas that are currently unsewered.
- The second-greatest rate of growth is in areas served by other treatment providers.
- The third-greatest rate of growth is the unsewered area within the contract service area of DWSD.

2. The PC-744 project and other ongoing improvements in DWSD's 2002 CIP will provide sufficient capacity for secondary treatment for projected maximum daily dry weather flows from the current contract service area through 2050. There is also sufficient capacity for DWSD to provide wastewater treatment for some new customers outside of the contract service area, including areas that are currently not sewered and other treatment providers that may choose to join the regional system.

3. The volume of flow that DWSD can accept from new customers will depend on the success of DWSD's dry and wet weather flow management efforts. At present, wet weather flows cause capacity problems at about 20 points within the city collection system and the suburban interceptor system of the DWSD. These problems need to be addressed to allow DWSD to reliably provide wastewater treatment service to new customers. Solutions to these problems are presented in Volume 4, *Capital Improvement Program*, to be issued in December.

4. The DWSD is making progress on understanding and reducing peak wet weather flows and excessive dry weather infiltration/ inflow in its service area. Current efforts include the flow management efforts of this Master Plan, the regional SSO study, the Detroit I/ I study, and the development of a regional operational plan. Other wastewater treatment providers in the planning area are also grappling with wet weather flow management problems.

5. Future flows projected in this Master Plan can be treated under current permit requirements, but it is recognized that treatment for stored wet weather flows (both CSO and SSO) are subject to change. Providing primary treatment for stored wet weather flows as authorized in the current permit appears to be the most cost-effective solution for treating dry and wet weather flows through 2050.

6. DWSD can provide wastewater service to most communities in the planning area at costs that are lower than the cost of individual communities building or expanding their own treatment plants. This is the case because the DWSD system is large and it has secondary treatment capacity requirements, while other plants on the Huron, Rouge, or Clinton rivers require tertiary treatment. However, communities are concerned about the rate of increase of DWSD sewer rates, the complexity of contracting with the DWSD, and the need to also contract with an existing first-tier or second-tier customer. For these reasons, communities may choose service from other treatment providers in

the planning area.

7. The Pontiac and Mt Clemens wastewater treatment plants have the greatest potential for expansion to serve more communities in Oakland and Macomb counties. Oakland and Macomb counties each have studies ongoing or proposed to look at the cost-effectiveness of expanding these plants. Preliminary engineering performed for this Master Plan indicates that major expansions that involve new interceptors would be more costly than the cost of DWSD service today. Any study of cost-effectiveness needs to consider anticipated rate increases by the DWSD. Future rate increases are addressed in Volume 4 of this report, *Customer Service and Technical Support Program.*

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