Summary Report

Comprehensive Water Master Plan
DWSD Contract No. CS-1278

Final Report

For Submittal to

Detroit Water and Sewerage Department

June 2004

CH2MHILL

IN ASSOCIATION WITH CDM

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Acronyms and Abbreviations

ADD	Average Daily Demand
APD	average population density
AWWA	American Water Works Association
AWWARF	American Water Works Association Research Foundation
CIP	capital improvement program
CSO	combined sewer overflow
CWMP	Comprehensive Water Master Plan
DB	design build
DBB	design, bid, build
DBP	disinfection byproduct
DWRF	Drinking Water Revolving Fund
DWSD	Detroit Water and Sewerage Department
EPA	Environmental Protection Agency
ft.	feet
FY	Fiscal Year
GA	Genetic Algorithm
GCDC	Genesee County Drain Commission
GLCUA	Greater Lapeer County Utilities Authority
HAA	haloacetic acid
HPZ	High Pressure Zone
HR	Human Resources
HRIS	Human Resources Information System
IPZ	Intermediate Pressure Zone
LCPC	Lapeer County Planning Commission
LH or LHWTP	Lake Huron WTP
LPZ	Low Pressure Zone
M	million
MDD	Maximum Day Demand
MDEQ	Michigan Department of Environmental Quality
MG	million gallons
MGD	million gallons per day
NE	Northeast Water Treatment Plant
NSC	North Service Center
NTU	Nephelometry Turbidity Units

O&M	Operations and Maintenance
PAC	powdered activated carbon
PCD	per capita demand
PM	program management
ppa	people per acre
psi	pounds per square inch
R&R	rehabilitation and replacement
R&R Program	Rehabilitation and Replacement Program
SDWA	Safe Drinking Water Act
SEMCOG	Southeast Michigan Council of Government
SEOCWA	Southeastern Oakland County Water Authority
SPW	Springwells Water Treatment Plant
SSO	sanitary sewer overflow
SW	Southwest Water Treatment Plant
SWAP	source water assessment program
SWP	source water protection
SWPP	Source Water Protection Program
TAC	Technical Advisory Committee
TAZ	Traffic Analysis Zone
TOC	total organic carbon
TTHM	total trihalomethane
Twp	Township
T&O	taste-and-odor
UFW	unaccounted-for-water
USGS	U. S. Geological Survey
UV	ultraviolet
WQMP	Water Quality Management Plan
WSC	West Service Center
WSSMP	Water Supply and Service Management Plan
WTP	Water Treatment Plant
WWP	Water Works Park WTP
WWP II	Water Works Park II WTP
WWTP	Wastewater Treatment Plant
YCUA	Ypsilanti Community Utilities Authority

SECTION 1

Executive Summary

The Detroit Water and Sewerage Department (DWSD) has developed a large-scale master planning project known as the Comprehensive Water Master Plan (CWMP). The purpose of this effort is to assess the Department's infrastructure needs over the next 50 years. A series of reports has been prepared to document the analyses and recommendations resulting from this project. This Summary Report gives an overview of these documents.

DWSD provides potable water to nearly 4 million people in the City of Detroit and 126 neighboring communities in southeast Michigan (see Figure 1-1). The system draws its fresh water from Lake Huron and the Detroit River through three intake facilities. DWSD's five water treatment plants have a total capacity of approximately 1,720 million gallons per day (MGD). The average day and maximum day water demands in the year 2000 were 653 MGD and 1,431 MGD. The water distribution system includes about 770 miles of 24-inch and larger transmission mains and 2,700 miles of distribution mains owned by DWSD, plus approximately 9,000 miles of connected mains owned by wholesale customers. The system includes 21 booster pump stations and 32 water storage reservoirs located throughout the system, plus auxiliary facilities.

The overall population in the communities served by DWSD's water system continues to grow, and the likelihood that additional communities within a 9-county study area may become customers during the 50-year planning period has been accounted for in the CWMP. An analysis of system needs has been completed, addressing the growing service population, evolving drinking water regulations, and the condition of current infrastructure. Needed improvements in the treatment, pumping, storage and transmission portions of the water system infrastructure have been identified.

Two alternative system-wide water delivery modes have been evaluated. The CWMP recommends that DWSD's current practice of maintaining water pressure in the system exclusively by pumping be replaced by a new mode of operation. The new mode would incorporate the existing pumping scheme with high-ground storage reservoirs to provide water to certain areas by gravity during peak periods. This practice is predicted to result in energy savings.

Alternative disinfection strategies capable of meeting new, more stringent disinfection goals have also been considered by the CWMP, and it has been recommended that all five of the water treatment plants be upgraded to include an integrated ozone/ultraviolet light/chlorine system to provide multiple disinfection barriers.

To determine the potential for new customers to join the system, a decade-by-decade phasing plan was developed by examining hydraulic performance under anticipated maximum demand days for existing customers for each decade under consideration. "Decade Plans" were developed to identify hydraulic improvements recommended for each decade, including looping of transmission mains to provide additional and more secure feeds to customer communities, new parallel transmission mains to alleviate high head losses in existing mains, new pump stations and storage tanks to alleviate low system water pressures and provide additional emergency storage, and transmission main extensions to serve new customers. Scheduling of the rehabilitation, upgrading and expansion needs for the water treatment plants, provision of emergency storage, and replacement of aging transmission mains have also been addressed in the Decade Plans.

The CWMP-recommended capital improvements over the 50-year planning period are expected to cost approximately $8.9 billion (in Year 2003 dollars), which includes expenditures for treatment, pumping, storage, transmission and urban distribution facilities. A significant amount of these expenses will be incurred during the early years of the plan; it is projected that more than half of the total, or approximately $4.6 billion, will be needed by the year 2020, largely due to the need to catch up on previously deferred rehabilitation and replacement (R & R) of aged infrastructure. Approximately 70 percent of the cost of the 50-year CIP is associated with both immediate and ongoing R & R of water infrastructure; 26 percent is for new or expanded water infrastructure, including the upgrading of treatment facilities to comply with new and anticipated state and federal standards; and 4 percent is for technology upgrades, consisting primarily of computer systems.

There are two individual components of the required R&R program that can themselves be identified as major programs. The first is the rehabilitation program identified by the Needs Assessment reports for the Northeast, Springwells and Southwest water treatment plants, which is expected to be completed within the first decade of the plan; because this program has a limited time-frame, it can best be managed in a manner similar to the current program underway at the wastewater treatment plant using an external program manager. The second involves the pipeline replacement program; because this important program will continue for the entire 50-year planning period of the CWMP, DWSD should develop a dedicated in-house team to manage it.

The scope of the CIP as projected is such that the current resources within DWSD will need to be expanded or supported significantly to expedite the work as scheduled.

The recommended capital expenditures will place significant financial burdens on DWSD, Detroit's retail customers and the wholesale suburban customers. Overall, the annual revenue requirement is projected to increase from $283 million in 2004 (in Year 2004 dollars) to $1.2 billion in 2050 (in Year 2050 dollars). Over the fifty-year implementation timeframe, the revenue requirement for the Department is projected to increase by an annual average rate of about 3.4 percent. The timing of the increases is heavily front-end loaded with much larger increases in the early years than in later years.

Water rates are projected to increase by an average of approximately 7.4 percent annually through 2010 and by an average of 5% to 8% annually through the first twenty years of the planning period. However, these average annual rates of change will fall significantly towards the end of the planning period, and annual rate increases for all customers over the full 50-year planning period are projected to average about 3.4 percent. The impact of the CIP will be mitigated by the long implementation timeframe of the CIP and the advantages of replacing expiring debt with newly issued bonds.

It is recommended that the CWMP be updated each decade to reflect updated census data, actual requests for service by new customer communities and other significant events.

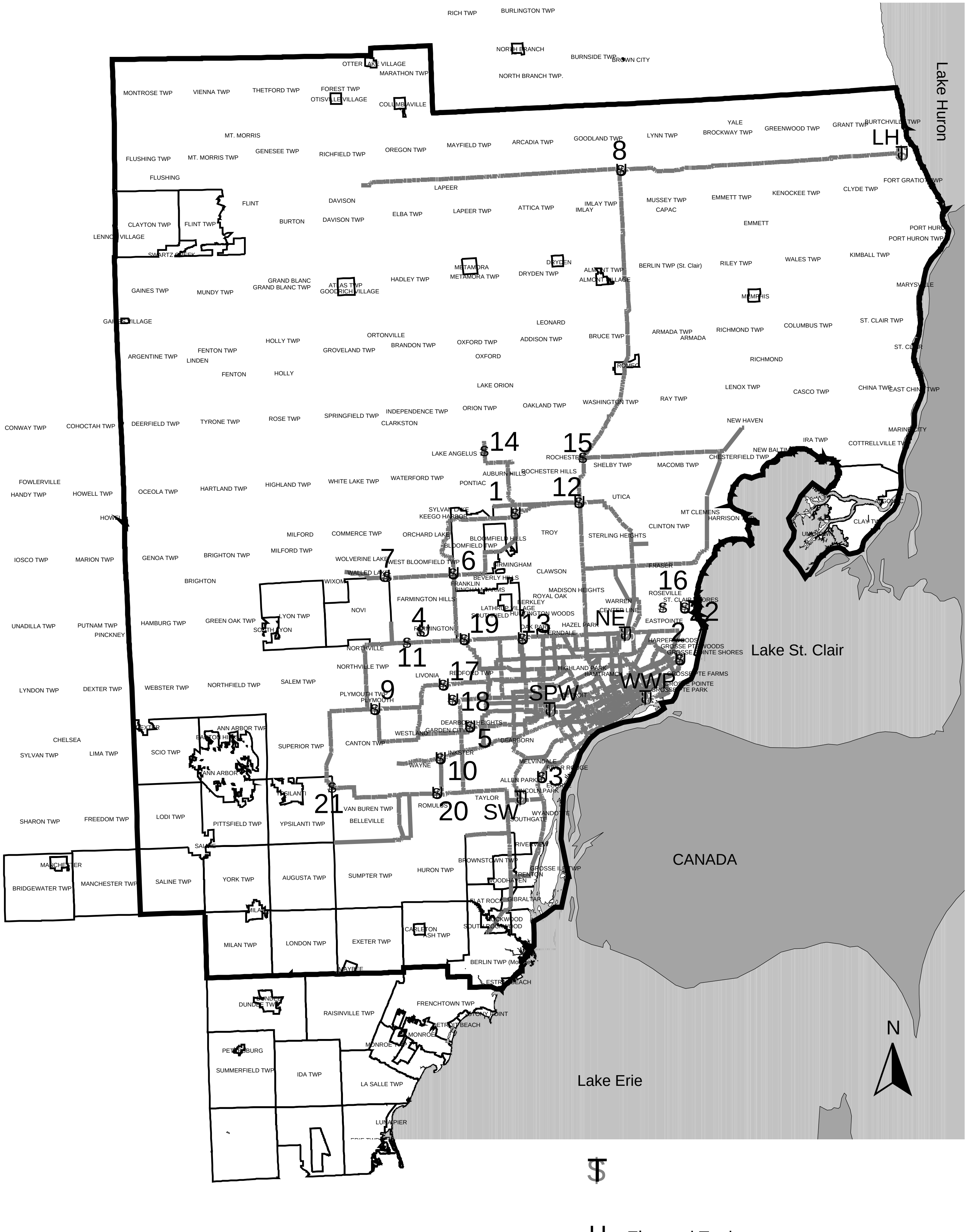


FIGURE 1-1: Current DWSD Water System

SECTION 2

Purpose

The purpose of this document is to present a summary of the "Comprehensive Water Master Plan" (CWMP), which consists of a series of task reports containing approximately 2000 pages of text, tables and figures.

The CWMP has been developed to provide guidance and direction for the continuing, orderly upgrading and growth of the regional water system of the Detroit Water and Sewerage Department (DWSD) to meet the needs of its expanding service population. The CWMP builds on previous DWSD master plans and other studies and reports that have been developed since the most recent master plan, which was completed in 1959 and updated in 1966. This plan proposes a capital improvement program (CIP) that DWSD should implement over a fifty-year planning period to provide a reliable, high quality water supply to the service area and maintain compliance with the requirements of the Safe Drinking Water Act. It also includes a Human Resources Plan to operate the system and a Financial Plan to support the capital and operation & maintenance expenditures and estimate how the CWMP will affect rates.

The task reports, listed at the end of the table of contents of this report, have been prepared to document the analyses and recommendations resulting from the work on Tasks A through J of the CWMP. This summary gives an overview of these documents in less detail, while attempting to present the information needed by local officials during the decision-making process that will shape the future of the DWSD regional water system.

SECTION 3

Project Background

As the first stage of the CWMP, a review of all related previous and ongoing studies was conducted. This review is summarized in the Task A Report entitled "A Review of Previous and Ongoing Studies, DWSD Policies and Regulations Related to DWSD Comprehensive Water Master Plan." The Task A Report provides insight into the issues and requirements that needed to be addressed by the CWMP.

3.1 Study Area Characteristics

3.1.1 Delineation of Study Area of the CWMP

The study area for the CWMP, shown in Figure 3-1, includes all or portions of the following counties: Wayne, Oakland, Macomb, St. Clair, Lapeer, Genesee, Washtenaw, Livingston and Monroe. The study area encompasses 246 communities within these nine counties. About half of these communities presently receive water from DWSD.

In order to assess the 50-year planning needs for the DWSD water system, an analysis has been conducted of the needs, growth and development trends in areas adjacent to the existing DWSD water service area to identify additional water system customers who may need to obtain service within the planning period (the approximate extent of the existing DWSD service area is indicated in Figure 1-1 by the boundaries of the shaded areas labeled "existing customers"). The Task B "Planning Criteria" Report presents the detailed analysis summarized in this section.

3.1.2 Land Use in Study Area

The study area is comprised of 2.3 million acres of land in Southeast Michigan. Land use and land cover information has been obtained from the Southeast Michigan Council of Governments (SEMCOG) and is summarized in Table 3-1.

TABLE 3-1
Land Use by Category (1995)

Category	Detroit Acres %	Suburban Area Acres %	Total Acres %
Residential	53,566 (60%)	560,901 (25%)	614,467 (26%)
Commercial/Office	9,200 (10%)	44,733 (2%)	53,933 (2%)
Institutional	4,691 (5%)	37,064 (1%)	41,755 (2%)
Industrial	8,964 (10%)	58,854 (3%)	67,818 (3%)
Transportation & Utility	4,181 (5%)	45,315 (2%)	49,496 (2%)
Recreational/Open/Extractive	5,711 (6%)	69,664 (3%)	75,375 (3%)
Cultivated	1,521 (2%)	1,012,005 (45%)	1,013,526 (44%)
Woodland/Wetland	1,066 (1%)	357,216 (16%)	358,282 (15%)
Water	119 (0%)	51,841 (2%)	51,960 (2%)
TOTALS	**89,018**	**2,237,594**	**2,326,612**

As expected, the distribution of land use varies considerably across the study area with significant residential, commercial and industrial development in the heavily developed urbanized area, and increased acreages of agricultural, wooded and open land in the outlying suburban areas. Land use statistics reflect the distribution of all property within the study area, including areas that are not currently served by the DWSD water system.

3.1.3 Population in Study Area

DWSD currently provides more than 230 billion gallons of treated water annually to nearly 4 million people in the City of Detroit and 126 suburban communities. In 2000, nearly 75 percent of the study area population of 5.2 million received water from DWSD.

The overall population served by DWSD's water system continues to increase, particularly in suburban areas where growth has more than offset the declining populations of older cities such as Detroit and the older ring of its suburbs.

DWSD currently supplies water to both individual communities and to groupings of communities or water authorities. Table 3-2 lists these customer groupings along with the current population served by DWSD and the average consumption of water provided by DWSD in millions of gallons per day (MGD). The development of the population and water usage figures is discussed in the Task C "Water Supply and Service Management Plan" Report (WSSMP Report). A breakdown of water usage for each of the individual communities served entirely or partially by DWSD is included in Appendix A.

TABLE 3-2
Population Served by DWSD and Water Usage by Customer Grouping (Year 2000)[1]

Public Water System	Population Served by DWSD	Avg. Usage Supplied by DWSD, MGD
Detroit and DWSD's Individual Customer Communities[2]	3,197,435	456.58
Customer Grouping or Water Authority		
Ash Twp. System	4,852	0.79
Berlin Twp. (Monroe) System	4,494	0.47
Flint and GCDC Systems	233,851	31.29
GLCUA System	14,326	2.70
Orion Twp. System	14,288	3.58
St. Clair County Board of Public Works System	0	0.40
SEOCWA System	210,444	29.15
West Bloomfield System	56,704	7.19
YCUA System	100,181	15.43
Subtotal	**3,836,573**	**548**
Unaccounted for Water (Distributed among all communities – see Section 4)		**106**
Total		**653**

[1]Source: Appendix B of Task C WSSMP Report
[2] Not including Wixom, which joined DWSD system in 2001.

3.2 Existing DWSD Facilities

DWSD operates the following major drinking water facilities:

1. A total of five water treatment plants (WTPs) having a combined treatment capacity of 1720 MGD;
2. 22 booster pumping stations;
3. 34 water storage reservoirs, including 14 finished water reservoirs at the WTPs having a combined volume of 192 million gallons (MG) and 20 storage reservoirs at the booster pumping stations having a combined volume of 178 MG; and
4. more than 770 miles of transmission mains and 2600 miles of distribution mains.

3.2.1 Water Treatment Plants

DWSD owns and operates five WTPs: Northeast, Springwells, Southwest, Lake Huron, and Water Works Park II (which recently replaced the old Water Works Park WTP).

Plant Siting and Layout

Table 3-3 summarizes the design capacities and other basic information on the five WTPs. The plant locations within DWSD's service area are shown in Figure 1-1.

Details of the five water plants, including site plans and process schematics, are presented in the Task D "Water Quality Management Plan" Report (WQMP Report).

TABLE 3-3
Existing Treatment and Storage Capacities at DWSD Water Treatment Plants (2004)

	Year WTP was Built	Treatment Capacity, MGD	Finished Water Reservoir Volume, MG	Fig. 1-1 Key
Northeast WTP	1956	300	30	NE
Springwells WTP	1930 first train; 1958 second train	540	60	SPW
Southwest WTP	1963	240[1]	30	SW
Lake Huron WTP	1974	300[2]	44	LH
Water Works Park II WTP	2003	240	28	WWP
Total		**1,720**	**192**	

[1] Reliable production is currently limited to 180 MGD due to filter capacity limitations

[2] Capacity will be upgraded to 400 MGD in 2004.

Treatment Process

Table 3-4 compares the major unit processes and chemical feed systems for the five DWSD WTPs. With respect to unit processes, all plants have conventional treatment process trains employing rapid mix, coagulation, flocculation, sedimentation, granular media filtration, and disinfection. The Water Works Park II WTP also includes intermediate ozonation. With respect to chemical systems, all plants use alum for coagulation, chlorine for preoxidation and primary disinfection (except for Water Works Park II, which uses ozone for primary disinfection), powdered activated carbon (PAC) for controlling taste-and-odor (T&O), phosphoric acid for corrosion control, and fluoride for dental health protection. Polymers are also added at several plants to further enhance the particle and alum floc settling and removal during the sedimentation and filtration processes. Treatment process schematics and layouts for the five WTPs are provided in the Task D WQMP Report.

TABLE 3-4
Comparison of DWSD Water Treatment Plants – Existing (2004) Unit Processes and Chemical Systems

Parameter	Lake Huron(1)	Northeast	Southwest	Springwells	Waterworks Park II(2)
Design Flows					
Nominal Plant Capacity	300(3)	340	240(4)	540	240
Major Unit Processes					
Rapid Mixing	Mechanical mixing with vertical turbine impellers	Mechanical mixing with vertical turbine impellers	Mechanical mixing with vertical turbine impellers	1958 Plant: mechanical mixing with vertical turbine impellers; 1930 Plant: hydraulic mixing with 3 baffled channel compartments	Pumped mixing system
Flocculation	Mechanical flocculation with multiple-stage vertical turbine flocculators	Mechanical flocculation with 7 parallel channels per train and 4-stage horizontal-shaft reel paddle flocculators	Hydraulic flocculation. Walking-beam mechanical flocculators are provided but not used currently	1958 Plant: mechanical flocculation with 5-stage horizontal-shaft reel paddle flocculators; 1930 Plant: hydraulic mixing added by SP-546	Mechanical flocculation with 3-stage vertical turbine flocculators
Sedimentation	Horizontal-flow rectangular basins with manual desludging (2)	Horizontal-flow rectangular basins with manual desludging	Horizontal-flow rectangular basins with manual desludging	Horizontal-flow rectangular basins with manual desludging	Inclined-plate settling with continuous mechanical desludging
Filtration	A signal from the settled water setpoint to the filters determines the rate of flow for the filter. dual-media (18"anthracite and 7" sand for #1-#20; 12" anthracite and 12" sand for #21-#30) filtration (39-in depth with gravel) with pumped backwash and rotating surface wash system	Constant-rate dual-media (7" anthracite-19" sand) filtration (36-in depth with gravel) with pumped backwash and rotating surface wash system	Variable-rate dual-media (7" anthracite-22" sand) filtration (45-in depth with gravel) with pumped backwash and rotating surface wash system	Constant rate dual-media (20"-sand) filtration (36-38-in depth with gravel) with pumped backwash and rotating surface wash system	Constant-rate monomedium (anthracite) filtration (48in depth) with pumped backwash and air scour system
Disinfection	Chlorination with feed points in raw water conduits, filter effluent	Chlorination with feed points at raw water tunnel, filter effluent	Chlorination with feed points at raw water tunnel, filter effluent. Feed points also available at settled water, reservoir return, and rapid mix.	Chlorination with feed points at raw water tunnel, filter effluent; Additional points at mixing chamber, rapid mix, and prior to filter.	Prechlorination with feed points at raw water tunnel, filter effluent; Intermediate ozonation for primary disinfection and taste and odor control
Chemical Systems					
Chemical Systems	Alum, chlorine, fluoride, carbon, phosphoric acid, coagulant aid polymer, filter aid polymer	Alum, chlorine, fluoride, carbon, phosphoric acid, coagulant aid polymer, filter aid polymer	Alum, chlorine, fluoride, carbon, phosphoric acid	Alum, chlorine, fluoride, carbon, phosphoric acid	Alum, chlorine, fluoride, carbon, phosphoric acid, ozone, sulfuric acid, sodium bisulfite, sodium hydroxide, filter aid polymer, sludge conditioning polymer

(1) Lake Huron WTP to convert to "modified" direct filtration process in 2003, eliminating sedimentation process.
(2) Waterworks Park II WTP has been online since October 2003.
(3) The Lake Huron WTP design capacity will be upgraded to 400 mgd once the residual management project is completed in 2004.
(4) The current actual capacity of the SW WTP is 180 mgd, which is limited by the filter capacity. The Low Lift PS capacity is currently limited to 210 mgd. SW WTP can only reach the design capacity of 240 mgd after completion of the filter and Low Lift PS upgrade projects proposed under the NAS.

3.2.2 Pump Stations and Reservoirs

As shown in Figure 1-1, DWSD operates 22 booster pumping stations. A summary of these pumping stations, their pumping capacities, and associated storage reservoir volumes (if applicable) is shown in Table 3-5. The identification number shown in the table corresponds with the station's location in Figure 1-1. It should be noted that three of the stations, Farmington, Roseville and St. Clair Shores, actually pump water within their respective wholesale communities and are not directly connected to DWSD's transmission system.

To maintain desired operating pressures, DWSD uses variable-speed pumps and throttled pump discharge valves at pumping stations and at WTPs. DWSD does not currently operate any elevated storage reservoirs to assist in meeting peak hour water demands. Instead, DWSD uses off-line ground storage reservoirs located at most of the pumping stations to provide additional water beyond the amount that is pumped from the WTPs.

TABLE 3-5
Summary of Existing Booster Pumping Stations, Capacities and Reservoir Volumes

Figure 1-1 Key	Pumping Station Name	Existing Rated Station Capacity[1] (MGD)	Reservoir Volume (MG)	Comments
1	Adams Road	109	10	
2	Eastside (Canyon)	30	10	
3	Electric Avenue	24	6.6	Two 3.3 MG tanks
4	Farmington	4	1.0	Not directly connected to DWSD's transmission system. Station and reservoir serve customer's distribution system
5	Ford Road	90	10	
6	Franklin	164	10	
7	Haggerty	70	10	New pump station
8	Imlay	575	20	
9	Joy Road	94	10	Two 5 MG tanks
10	Michigan Avenue	29	6.8	3.5 MG (east) and 3.3 MG (west)
11	Newburgh	52	0	No reservoir
12	North Service Center	227	20	Two 10 MG tanks
13	Northwest	50	10	
14	Orion	14	0	No reservoir
15	Rochester	58	0	No reservoir
16	Roseville	11	0	No reservoir. Not directly connected to DWSD's transmission system. Station serves customer's distribution system
17	Schoolcraft	80	10	
18	West Chicago	36	9.5	
19	West Service Center	148	20	Two 10 MG tanks
20	Wick Road	60	10	
21	Ypsilanti	54	0	No reservoir
22	St. Clair Shores	12	4	Not directly connected to DWSD's transmission system. Station and reservoir serve customer's distribution system.

[1] Assumes largest pump at each station is out of service.

3.2.3 Transmission Mains

Presently, there are three pressure zones within the DWSD system, identified as the Low, Intermediate and High Pressure Zones (LPZ, IPZ and HPZ). The approximate coverage areas are shown in Figure 3-2.

The LPZ includes Detroit's downtown central business area and extends eastward to residential areas near the Detroit River to the north and just east of the Water Works Park II WTP. The transmission mains in downtown Detroit are generally the oldest in the DWSD system, with many sections dating from the late 19th century. The LPZ has operating pressures ranging from 40 to 60 psi and is separated from other pressure districts by gate valves that are normally closed. Treated water within the LPZ is typically supplied by the Water Works Park II WTP through pressure-reducing valves.

The IPZ includes most of the City of Detroit (excluding the LPZ and the northern and western portions of the city) and the southern and western suburbs. The Water Works Park II, Springwells and Southwest WTPs serve the IPZ with pressures ranging from 65 to 85 psi.

The HPZ includes the northern and western portions of the City of Detroit and the northern and northwestern suburbs. The Northeast, Springwells, and Lake Huron WTPs meet the water demands in the HPZ. Pressures in this zone typically range from 40 to 180 psi.

The DWSD water transmission system, shown in Figure 3-2, consists of about 770 miles of mains. Most of the transmission piping is 24 inches to 120 inches in diameter, but about 34 miles of smaller-sized (mostly 16") pipes are included.

The transmission pipes were grouped into six types based on the pipe material, as presented in Table 3-6. Figures 3-2, 3-3 and 3-4 provide an overview of the layout, age, size and materials of the DWSD transmission mains.

TABLE 3-6
Water Main Types in DWSD Transmission System

No.	Water Main Type	Description
1	Unlined CI<1923	Unlined cast-iron pipes installed before 1923
2	Unlined CI 1923~1940	Unlined cast-iron pipes installed 1923–1940 (Class 150)
3	Unlined CI>1940	Unlined cast-iron pipes installed after 1940 (Class 250)
4	St-lined	Cement-lined steel pipes[1]
5	Lined DI	All ductile-iron pipes[1]
6	Conc	Concrete, prestressed and reinforced concrete pipes

[1] According to DWSD, all the ductile-iron piping in the Detroit system is cement lined.
Steel piping in the system was not lined when installed, but all was cement lined during 1974–1975.

As shown in Figure 3-3, the DWSD transmission system consists of approximately 57% concrete, 34% cast iron, 8% lined and unlined steel and less than one percent ductile-iron piping. The installation years for each of these pipe types are indicated in Figure 3-4. In general, cast-iron piping was installed from the late 1850s to the late 1940s, and this piping varied in manufacturing method and wall thickness. According to DWSD, cast-iron pipe purchased and installed prior to 1923 was manufactured by the pit-cast process, which gave long, trouble-free service. From 1923 to 1932, cast-iron pipe (Class 150) made by a centrifugal process (spun-cast) was purchased and installed in the Detroit system. The Department experienced serious trouble with the spun-cast pipe that was installed during this period, and a life span of 35 to 40 years has been suggested for this class of pipe. Starting in 1940, DWSD began using Class 250 spun-cast pipe for additional wall thickness to combat corrosion. DWSD officially adopted the standard use of Class 250 cast-iron pipe in 1945. Cast iron was used mainly for mains of 48 inches in diameter or less until the early 1970s, when DWSD began using cement-lined ductile-iron pipe for this size range (Class 250 cast-iron pipe has not been manufactured since the late 1970s). Steel pipe was installed between the 1910s and 1970s, and concrete pipe has been installed since the late 1940s.

FIGURE 3-3
Fraction of the Existing DWSD Water Transmission Pipes by Pipe Type

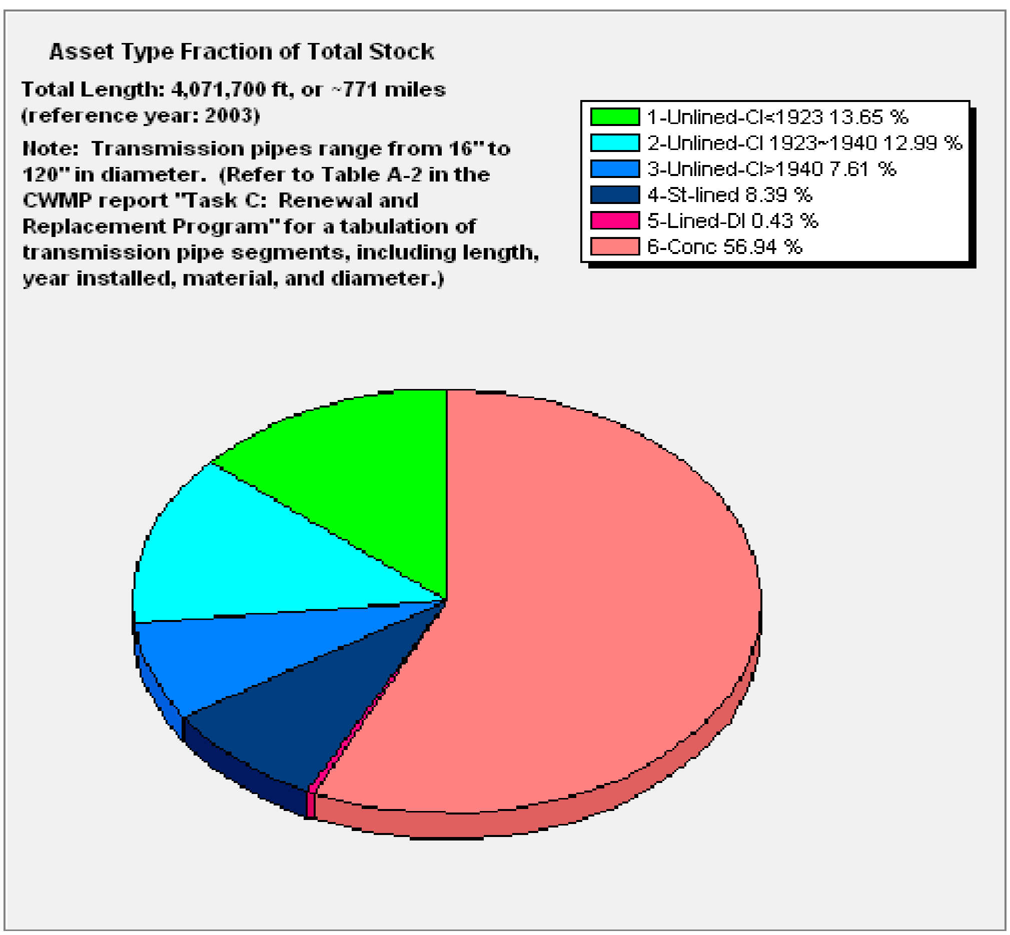
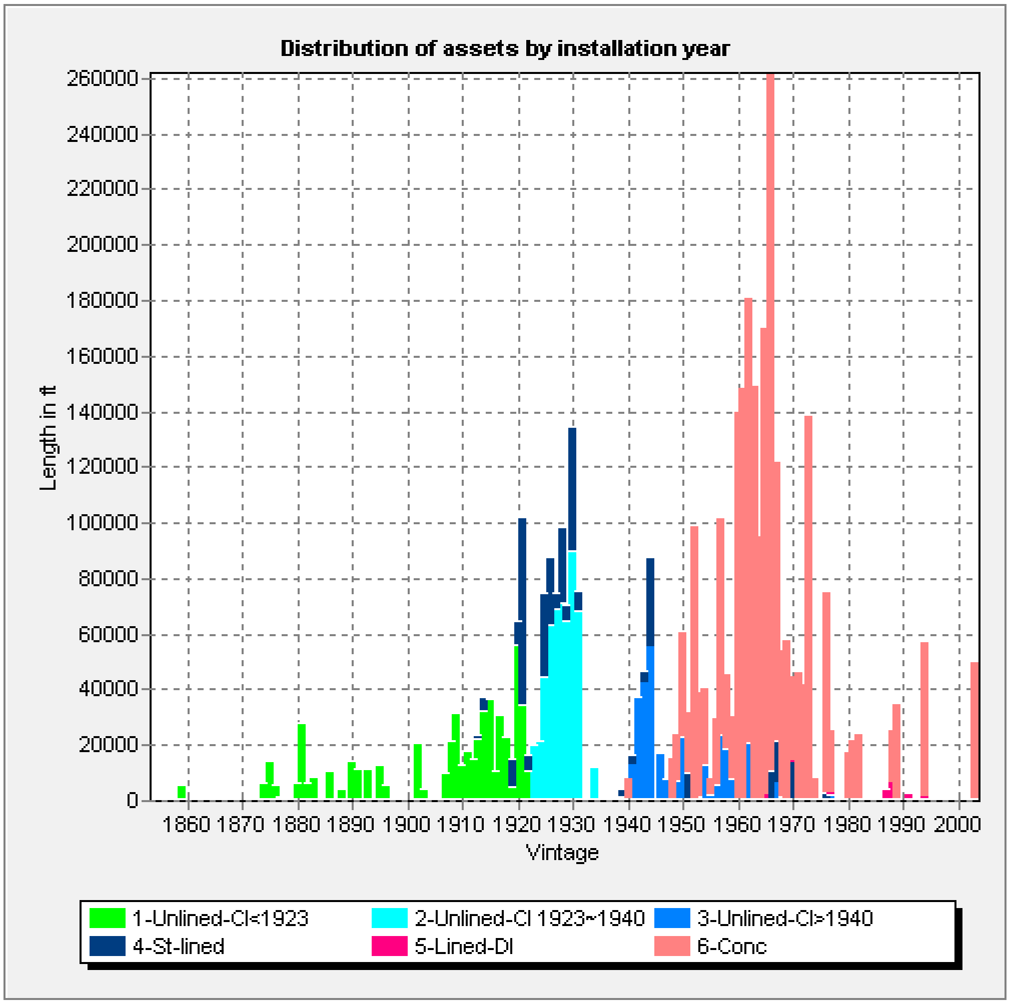


FIGURE 3-4
Installation Year of the Existing DWSD Water Transmission Pipes by Pipe Type



3.3 Other (Non-DWSD) Water Systems

Besides DWSD's water system, nearly 60 other public water supply systems are operated in the study area. These public water supply systems are listed in Table 3-7. The current population served by these systems is approximately 509,000 with a combined average-day water consumption rate of approximately 77 MGD. It is possible that some of the non-DWSD public water supply systems may become customers of DWSD during the 50-year planning period, and the impacts of providing service are being included in DWSD's recommended capital improvements program.

TABLE 3-7
Non-DWSD Public Water Systems in the Study Area and Water Usage[1]

Community	Public Water Supply System	Served Population	Avg. Usage, MGD
Algonac	Algonac	4,617	0.559
Clay Twp	Algonac	6,205	0.685
Ann Arbor	Ann Arbor	108,326	15.963
Ann Arbor Twp	Ann Arbor	4,031	0.370
Scio Twp	Ann Arbor	7,758	0.667
Armada	Armada	1,548	0.112
Barton Hills	Barton Hills	335	0.088
Brighton	Brighton	6,479	1.100
Capac	Capac	1,555	0.125
Columbiaville	Columbiaville	938	0.068
Davison	Davison	5,658	0.598
Dexter	Dexter	2,175	0.362
Dryden	Dryden	643	0.057
China Twp	East China	238	0.033
East China Twp	East China Twp.	3,416	0.465
Fenton	Fenton	10,429	1.400
Grand Blanc	Grand Blanc	7,966	1.173
Grosse Pointe	Grosse Pte Frm.	5,186	0.928
Grosse Pte Farms	Grosse Pte Frm.	9,320	2.497
Highland Park	Highland Park	17,277	4.686
Highland Twp	Highland Twp.	833	0.102
Holly	Holly	5,827	0.474
Genoa Twp	Howell System	3,531	0.376
Oceola Twp	Howell System	N/A	N/A
Independence Twp	Independence	10,077	1.176
Ira Twp	Ira Twp	4,172	0.706
Linden	Linden	2,415	0.260
Marine City	Marine City	4,590	0.484
Cottrellville Twp	Marine City, Clay & Ira Twp.	1,779	0.132
Marysville	Marysville	9,203	2.535
Maybee	Monroe	N/A	N/A
Memphis	Memphis	1,220	0.120
Metamora	Metamora	435	0.042
Milan	Milan	4,413	1.118
Milford	Milford	6,366	0.552
Mt Clemens	Mt Clemens	16,640	3.388
New Baltimore	New Baltimore	6,992	1.068
Oakland Twp	Oakland Twp	4,500	0.803
Oxford	Oxford	2,929	0.558

TABLE 3-7 (continued)
Non-DWSD Public Water Systems in the Study Area and Water Usage[1]

Community	Public Water Supply System	Served Population	Avg. Usage, MGD
Clyde Twp	Port Huron	2,106	0.183
Fort Gratiot Twp	Port Huron	10,487	0.909
Kimball Twp	Port Huron	3,770	0.327
Port Huron	Port Huron	32,279	6.198
Port Huron Twp	Port Huron	7,895	0.684
Richmond	Richmond	4,141	0.406
Rochester	Rochester & DWSD (through Shelby Twp)	9,500	2.732
Romeo	Romeo (DWSD provides service to Ford Motor Co. only)	3,721	0.500
Saline	Saline	7,150	1.108
South Lyon	South Lyon	7,776	0.872
St. Clair	St. Clair	5,398	0.900
St. Clair Twp	St. Clair & Marysville	2,406	0.263
Waterford Twp	Waterford Twp	70,122	8.000
White Lake Twp	White Lake Twp	3,125	0.425
Wixom[2]	Wixom	9,972	1.610
Wolverine Lake	Wolverine Lake	2,000	0.174
Wyandotte	Wyandotte	30,938	5.336
Yale	Yale	1,977	0.224
Totals		**508,908**	**77.07**

[1] Data based on review, during 2000, of previous surveys completed in 1995, 1999 and 2000.
[2] Wixom joined the DWSD system during 2001.

SECTION 4

Overview of System Needs

4.1 Regulatory Requirements and Compliance Status

4.1.1 Drinking Water Regulations and DWSD Water Quality Goals

Drinking water quality is an important focus for DWSD. The CWMP team met with DWSD plant, water quality and water production managers numerous times to discuss and set drinking water quality goals. The CWMP team coordinated with the Needs Assessment teams, which were commissioned to identify needed process, mechanical, architectural, structural, and instrumentation system improvements at the Springwells, Northeast and Southwest WTPs. These efforts resulted in the establishment of consistent water quality goals. In some cases, DWSD's goals exceed those set forth in federal and state regulations to better protect public health. In other cases, DWSD has established goals that are not yet required by regulations, but meet customer desires for drinking water aesthetics.

Tabulations comparing DWSD's near-term (10-year) and long-term water quality goals with the requirements of the Safe Drinking Water Act (SDWA) and potential regulatory trends, respectively, are presented in Section 2 of the Task D WQMP Report. The following goals led to recommended water system improvements to be implemented over the next 10 years:

- **Particulate Removal.** DWSD has adopted a filtered water turbidity goal of 0.1 NTU, which is three times more stringent than the SDWA requirement. This goal has led to planning for improvements to all particle removal processes, including rapid mixing, flocculation, settling, and filtration.

- **Disinfection.** DWSD has adopted disinfection goals for *Giardia*, viruses, and *Cryptosporidium* that are more stringent than current regulations. These goals have led to planning for improvements to disinfection systems that include the use of chlorine, ozone, and ultraviolet (UV) light. Additional disinfection improvements will include more effective chlorine contact time and a reduced water age in the distribution system.

- **Disinfection Byproducts.** DWSD disinfection byproduct (DBP) goals for total trihalomethanes (TTHM) and haloacetic acid (HAA) are twice as stringent as regulations. DWSD source water is naturally low in the organic precursors for these byproducts, so major treatment improvements are not necessary. The addition of ozone and UV will provide flexibility to meet potentially more stringent regulations in the future.

- **Taste and Odor (T&O).** DWSD has adopted a goal for no objectionable T&O in the drinking water. The addition of ozone will assist in meeting this goal while contributing to disinfection goals as well.

- **Inorganics.** Lead is the only inorganic element with which DWSD has had regulatory issues, but DWSD's phosphoric acid facilities have reduced lead levels to less than half the regulatory limit. Also, DWSD has adopted a voluntary aluminum goal of <0.2 mg/L in the finished water, equivalent to the National Secondary Drinking Water Regulation, which is not currently enforceable in Michigan. Coagulation facility upgrades such as better mixing, use of polymers, and improved storage and feed equipment will assist in meeting this goal.

Beyond the first ten years of the planning period, regulatory trends point to the potential need for increased removals of particulates, pathogens, disinfection byproducts and organics. More stringent regulations are also likely for maintaining water quality in the distribution system, addressing requirements for sensitive populations (such as the old, young and immune compromised) and source water protection. DWSD will need to keep abreast of these trends and prepare for the potential that optimized or alternative treatment systems may be required in the future.

4.1.2. Current Water Quality and Performance Status

Four of DWSD's five WTPs draw water from the Detroit River, which has low turbidity and total organic carbon (TOC) levels. The Lake Huron WTP draws its water from Lake Huron, which generally has even better water quality than the Detroit River.

The performance of DWSD's five WTPs is documented in the Task D WQMP Report. The Lake Huron, Northeast, and Water Works Park WTPs have the lowest mean filtered-water turbidities, while the Southwest and Springwells WTPs have slightly higher filtered-water turbidities. Overall, all five WTPs have an excellent turbidity removal performance, with a mean filtered-water turbidity of 0.07 NTU and maximum filtered-water turbidity of 0.25 NTU (which is better than the regulatory requirement of less than 0.3 NTU in 95% of the samples). All except the Southwest and Springwells WTPs also meet DWSD's goal of 0.1 NTU in 95% of the samples. DWSD has CIP projects planned to renovate the filters at the Springwells and Southwest WTPs and the flocculators and sedimentation basins at the Northeast WTP. These improvements should allow DWSD to reliably meet its filtered-water turbidity goals for many years to come.

All five WTPs also meet the finished water DBP regulations and all other current drinking water regulations.

4.2 Projected Water Demand

Determining future water demand (usage) is important in planning the system's infrastructure needs to meet future service goals. As water use is heavily tied to the service population, the first step in projecting water use over the planning horizon is to forecast population growth.

The population projections used for the CWMP relied on year 2000 census data for all 246 communities within the study area as the basis for projection. These projections were performed by three authoritative planning agencies in the region—the Southeast Michigan Council of Governments (SEMCOG), the Lapeer County Planning Commission (LCPC), and the Genesee County Drain Commission (GCDC).

The projected service populations for each community were coupled with historical water consumption data obtained from DWSD and other public water systems within the study area to estimate the future water demands for both average and maximum demand day conditions for each individual customer community through the year 2050. The projected overall system water demand represents a combination of the growing demand from the existing customers and addition of new customers.

4.2.1 Population Projections

SEMCOG performed 50-year population projections for individual community and Traffic Analysis Zones (TAZs) within a community in the seven counties it represents. These projections were based on data from the 2000 census, and they extend through 2050.

The total population forecast for the study area was presented in Appendix B of the Task C WSSMP Report and is summarized in Table 4-1. As shown, the population is projected to increase from 5.2 to 6.15 million (or 18 percent) within the 50-year planning horizon.

TABLE 4-1
Population Forecast for the Study Area

Planning Year	Projected Total Population (in millions)	% Population Increase from 2000
2000	5.20	-
2010	5.41	4.0
2020	5.61	7.9
2030	5.81	11.7
2040	5.99	15.2
2050	6.15	18.3

4.2.2 Baseline Water Demand

Baseline water demand typically includes both customer demand and unaccounted-for-water (UFW). Usually, the Average Daily Demand (ADD) is the baseline to which a variety of peaking factors and demand multipliers can be applied. For the CWMP, the ADD was estimated for each of DWSD's existing and potential new customer communities by using a per capita demand (PCD) times the projected service population, as explained in the Task C WSSMP Report. The PCD was developed for each community based on historical water consumption data over the last 30 years.

From 1991 to 2000, the historical UFW for the DWSD system varied from 12.7 to 19.5 percent of the average consumption, as tabulated in the Task C "An Evaluation of Unaccounted-For Water Report. An average UFW of 16.3 percent was used for the CWMP. Compared with other utilities, the 16.3 percent is near the average (16 percent) of 469 water utilities in the United States, according to an AWWA survey. However, the UFW will be reduced by the Department's continuous implementation of its leak detection programs.

4.2.3 Peaking Factor or Base Demand Adjustment Ratio

A peaking factor is the ratio of flow associated with the demand condition of interest to the baseline demand, which is usually the ADD condition. It is used to estimate the maximum day water demand (MDD).

Peaking Factor = $Q_{\text{maximum day demand}} / Q_{\text{average daily demand}}$

The peaking factor for each existing wholesale customer community was developed based on available data from 1986 to 1999 for the DWSD system. It was determined that the record high maximum-day flow rate and system maximum-day to average-day ratio (2.13) occurred on July 7, 1988, so fiscal year 1989 was used to develop the peaking factor for each existing community.

4.2.4 Potential New Customers for DWSD

DWSD does not solicit communities to become part of its regional water system. DWSD supplies information upon request so each home-rule community can make its own decision based on the cost of service and other factors.

Criteria used in the CWMP to identify potential new customers for DWSD over the planning period are presented in detail in Section 3 of the Task C WSSMP Report. The main criteria used to project potential new customers for DWSD from communities currently using private wells were population density and the distance of a community from existing DWSD customer pipelines.

In addition, each individual community currently supplied by a public water system other than DWSD was examined separately by considering its current situation and future plans regarding its water source, treatment capacity and CIP.

4.2.5 Projected Water Demand to the DWSD System by Decade

The served population and water demand projections through 2050 were determined as explained in Section 3 of the Task C WSSMP Report and are summarized in Figures 4-1 through 4-3. Detailed breakdowns of projected service populations and water demands by community for each decade are provided in Appendix D of the Task C WSSMP Report.

FIGURE 4-1
Service Population Projection

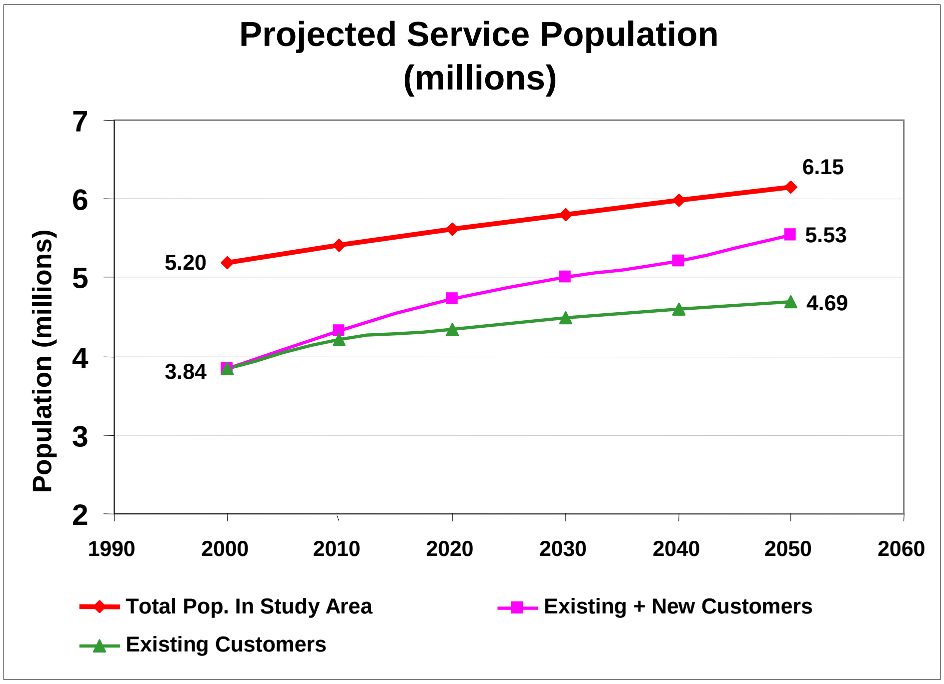
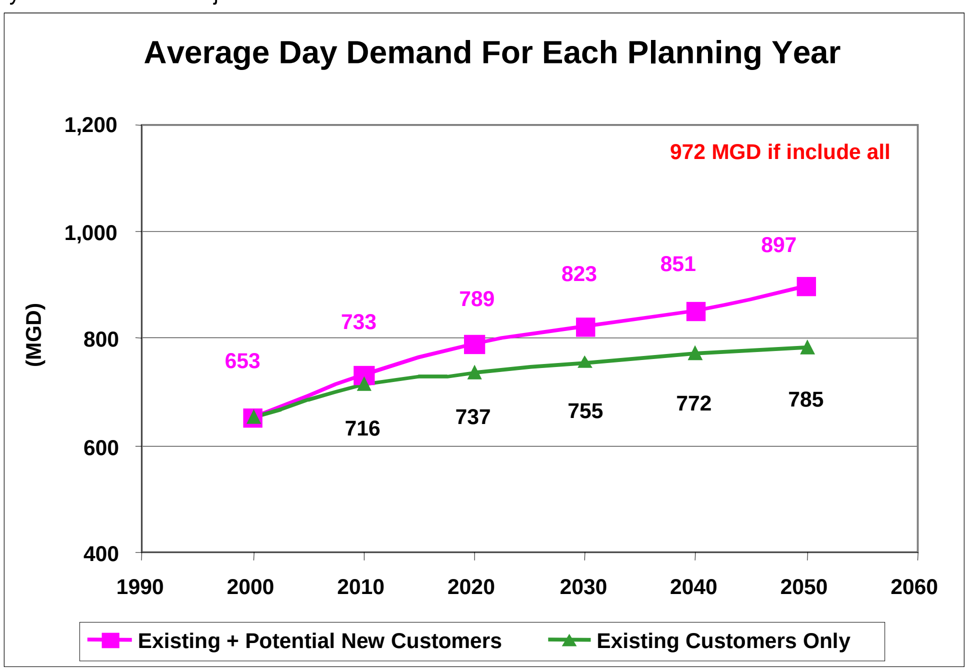
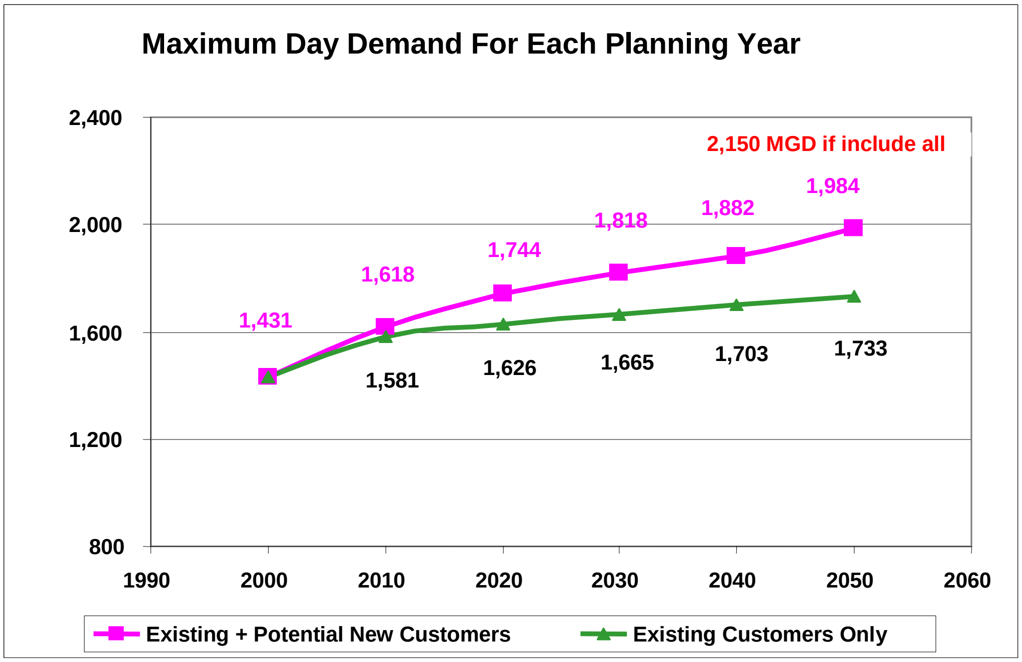


FIGURE 4-2
Average Daily Water Demand Projection



(The average daily demand in year 2050 is projected to be 972 MGD if include all the 246 communities within the defined study area)

FIGURE 4-3
Maximum Daily Water Demand Projection



(The maximum daily demand in year 2050 is projected to be 2,150 MGD if include all the 246 communities within the defined study area)

4.3 Overall Assessment of System Needs Associated with Existing Facilities and Emergency Storage

4.3.1 Source Water Protection

DWSD has three intakes that draw water from the Detroit River and Lake Huron. Both water bodies are part of the Great Lakes System and are shared with Canada. The three intakes supply raw water to DWSD's five water treatment plants.

The 1996 SDWA amendments require states to develop programs for assessing potential contamination threats to the watersheds and groundwater protection areas of drinking water sources. With assistance from the U. S. Geological Survey (USGS), the Michigan Department of Environmental Quality (MDEQ) is working with DWSD in identifying such threats by preparing Source Water Assessment reports for DWSD's three intakes. Drafts of these reports were completed in early 2003, but the reports are still under review and the source water assessment program (SWAP) has not yet been finalized. DWSD is currently developing a framework and recommendations for a Source Water Protection Program (SWPP) as part of the CWMP effort. As a first step of this envisioned long-term and dynamic process, the initial effort will:

- provide regulatory background on source water protection (SWP), and discuss other watershed management components related to SWP;

- summarize the results of the DWSD Source Water Assessment reports, the status of the DWSD particle transient modeling effort, and the evaluation of potential early warning monitoring systems;
- survey some of the large water providers in the U.S. about their status and plans on SWP; and
- develop a framework of SWP for DWSD.

The Task D "Source Water Protection" Report, completed in February 2004, summarizes the findings of the source water assessment program (SWAP) and the SWPP framework development and recommendations that are being developed. Many other Clean Water Act programs and upcoming regulations, particularly those related to watershed management, are also summarized in this report, which focused on potential contaminant sources in the United States and did not fully cover contaminant sources in Canada. The SWAP found that:

- The Belle Isle Intake source water "is categorized as highly susceptible (to contamination), given land uses and potential contaminant sources within the source water area." A total of 321 potential contaminant sources are identified within the portion of the watershed in the United States. Combined sewer overflows (CSOs) and urban and agricultural runoff are also identified as potential contaminants.
- The Fighting Island Intake source water is also categorized as "highly susceptible (to contamination), given land uses, potential contaminant sources, and commercial and transportation activities within the source water area." A total of 189 potential contaminant sources are identified "within the susceptible area," 67 known CSOs and sanitary sewer overflows (SSOs) are identified on the United States side, and urban and agricultural runoff are also identified as potential contaminants.
- The Lake Huron Intake source water "is categorized as having moderately low susceptibility, given the lack of potential contaminant sources, other than shipping, within the source water area." Forty potential contaminant sources are identified in the intake's source water area, there are no known CSO or SSO outfalls on the U.S. side, and urban and agricultural runoff from numerous small watersheds in the U.S. are also potential sources of contamination.

4.3.2 Water Treatment Plants

The capital improvement needs at the five water plants over the next 50 years will consist mostly of structural, process, and equipment rehabilitation. The water supply and service management plan developed in the Task C WSSMP Report has determined that only the Lake Huron WTP will require expansion of its treatment capacity.

The Needs Assessment reports, prepared during 2002 and 2003 by consultants for DWSD, examined the Northeast, Springwells and Southwest WTPs. The reported improvement and rehabilitation needs for each individual WTP and estimated costs to address these needs and WTP expansion requirements are tabulated in detail in the Task D WQMP Report. The improvement and rehabilitation needs are briefly summarized below.

Northeast Water Plant

This plant's treatment process and mechanical equipment have been in service for 30 to 45 years and require increasingly frequent preventive and corrective maintenance. The key recommended improvements are summarized as follows:

- The rapid mixers are obsolete and should be replaced.
- The flocculation basins have several deficiencies. They should be modified and the flocculator drives replaced.
- The sedimentation basins are overloaded and should be retrofitted with inclined-plate settlers. A continuous mechanical sludge removal system should be installed to eliminate sludge buildup.
- The filter media is 45 years old and needs replacement with new dual media. Filter instrumentation, valves and piping are also in need of replacement.
- Low-lift and high-lift pumps need refurbishing, and related valves need replacing.
- There are no residuals treatment facilities on site. A residuals treatment facility is needed to prevent the discharge of sludge to the sewer system and resulting operational problems at the DWSD Wastewater Treatment Plant (WWTP).
- The chlorine-only disinfection system does not meet the DWSD goal for inactivating *Cryptosporidium*.

Springwells Water Plant

This plant's treatment process and mechanical equipment have been in service since original installation (in 1930 and 1958) and require increasingly frequent preventive and corrective maintenance. The key recommended improvements are summarized as follows:

- The rapid mixers in the 1930 train need to be replaced, and those in the 1958 mixing system need modification.
- The 1930 flocculation and sedimentation facilities are deficient and should be demolished. The 1958 flocculation and sedimentation facilities should be upgraded to increase their capacity to 540 MGD.
- The 1958 filters need substantial rehabilitation, and surface wash is needed for the 1930 filters. New backwash pumps and motors are needed.
- Much of the lineup of low-lift pumps, motors, switchgear and controls is antiquated and unreliable, and the entire lineup should be replaced.
- The 16 high-lift pumps and header are old and may be operating beyond their design capacity during high-demand periods. They should be replaced by 12 new pumps and a new double header.
- Continuous mechanical sludge collection facilities are needed for the sedimentation basins, along with a sludge pumping station and sludge equalization basins.
- There are no residuals treatment facilities on site. A residuals treatment facility is needed to prevent the discharge of sludge to the sewer system and resulting operational problems at the DWSD WWTP.
- The chlorine-only disinfection system does not meet the DWSD goal for inactivating *Cryptosporidium*.

Southwest Water Plant

This plant, built in 1963 and one of the newer of DWSD's five plants, is in need of the least amount of rehabilitation of the three plants for which needs assessments were done. However, some components of the plant's treatment process and mechanical equipment have been in service for nearly 40 years and require increasingly frequent preventive and corrective maintenance. The key deficiencies and recommended improvements are summarized as follows:

- Valves, valve operators and the flushing water system for the sedimentation basins need replacement, and basin concrete needs repair.
- Filter media and equipment need replacement.
- Components of the chemical feed system need replacement and repair.
- Low-lift pumping capacity needs to be increased from 210 MGD to 240 MGD.
- There are no permanent residuals treatment facilities on site. A permanent facility is needed.
- The chlorine-only disinfection system does not meet the DWSD goal for inactivating *Cryptosporidium*.

Lake Huron Water Plant

The Lake Huron WTP (LHWTP) is a relatively new plant, built in 1974. Several major rehabilitation and upgrades have already been initiated (e.g., the backwash and residuals treatment and handling project to be completed in 2004). No significant rehabilitation needs have been identified that are not already under contract, except for the need to provide a disinfection system that meets the DWSD goal for inactivating *Cryptosporidium*.

The CWMP has identified the LHWTP as the WTP to be expanded to meet the majority of the growing future system demand. The most significant growth of DWSD's water system is projected to occur within the northern and northwestern suburbs of Detroit. This growth is anticipated as a result of increased demand from existing customers and the likelihood of new customers joining the system. The northern and northwestern areas are located primarily within the LHWTP's service area, making it the most appropriate water treatment plant to supply the future growing demands of current and new customers. Other reasons the LHWTP was selected to meet most of the future customer demand are its large intake capacity (the capacities of the intakes in Detroit are limited) and the fact that the LHWTP has adequate space within its current property boundaries to add additional treatment and pumping facilities.

Water Works Park II Plant

The Water Works Park II WTP (WWP II) is a brand new plant just brought on line at the end of 2003. This plant will require the least amount of capital improvement of the DWSD's five WTPs in the near future. It is already equipped with many of the facilities the other WTPs lack, including intermediate ozonation and permanent on-site residuals treatment facilities.

Though most of the original WWP WTP is being demolished, several components from the original plant have been rehabilitated and retained in the new plant. These include the high-lift pump station, screen house building and the auxiliary low-lift pump station. The near-term needs at WWP II include rehabilitation of the raw water booster station building, its instrumentation & controls and the Belle Isle dike. A UV disinfection system is also needed.

4.3.3 Pump Stations and Reservoirs

Rehabilitation Needs

Some of the pumping stations and storage reservoirs within the DWSD system are old and require repair or replacement. Others may require rehabilitation or replacement if the current or future desired pressures are not satisfied. New pumping stations will also be needed to satisfy growth in water demand (see Sections 5 and 6). The needs identified in this subsection relate to existing pump stations and reservoirs.

Identified Pumping Station and Reservoir Needs During 2004 - 2010

For the next seven years, DWSD has identified (in its CIP dated July, 2003) a series of ongoing and new rehabilitation/improvement projects to address the identified needs at its pumping stations and reservoirs including equipment repairs and replacement and structural rehabilitation. The costs identified in DWSD's CIP have been used in developing the CWMP Recommended CIP that is included in the Task F "Financial Plan" Report.

General Pumping Station and Reservoir Needs During 2011 – 2050

The long-term (beyond 2010) rehabilitation needs of the pumping stations and reservoirs have not been identified in the CWMP, but an annual budget for ongoing renewal and rehabilitation of these facilities has been established for inclusion in the CWMP Recommended CIP that is included in the Financial Plan. The budget was estimated as follows:

1. Estimate the full asset value of the stations and reservoirs,
2. Divide the asset into the structural facilitates and mechanical equipment.
3. Estimate the annual rehabilitation/replacement costs over the long term. These costs were estimated by dividing the replacement costs by assumed life expectancy. For purposes of the CWMP, structures were assumed to have a typical life span of approximately 100 years; therefore, the expected annual average rehabilitation and replacement rate is 1 percent of the total structural asset value. On the other hand, life expectancy for equipment in the plant was assumed to be about 30 years; so, the annual replacement and rehabilitation rate is 3.33 percent. In summary, the annual rehabilitation and replacement rate/cost was set as 1 percent of the structural facilities plus 3.33 percent of the equipment's asset value.

Emergency Storage Needs

Storage is needed in a water system for equalization of diurnal demands, fire-fighting, or other emergencies. Equalization storage is used to enable sources (WTPs) and pumping facilities to operate at a predetermined, constant rate to provide water more efficiently. This is accomplished by using water in storage to meet the peaks in diurnal demands. The amount of storage used to fight fires is that volume required to supplement the capacity of the water supply during a fire. Emergency storage is based on the perceived vulnerability of a utility's water supply. Standard engineering practice is to provide enough storage in the system for equalization plus the fire or emergency demand, whichever is greater.

The CWMP has determined that the long-term plan for the DWSD system should provide sufficient storage for equalization and for emergency uses. Little fire demand storage is needed for large water systems, such as the DWSD system, where fire flows are small compared to treatment capacity. However, recent events, such as the major power outage in 2003 that affected the entire northeastern region of the country, point to the need for emergency storage (especially gravity storage). It was determined that storage capacity for approximately 50% to 60% of an average day's demand should be adequate for emergency purposes for a large water supply system such as the DWSD system.

The DWSD water system currently has a total of 173 million gallons transmission system storage facilities (excluding storage downstream from its wholesale customers' meters) and another 192 million gallons of finished water storage at the treatment plants. This amounts to a total of 365 million gallons of storage, or approximately 56% of present average day demand.

The Task D WQMP Report and the Task C WSSMP Report identified the need for an additional forty-one (41) million gallons of storage for equalization purposes by the year 2050. Based on a water quality analysis that determined the maximum additional storage volume the system can accommodate without creating water quality concerns due to degradation of the chlorine residual below 0.2 mg/L at the wholesale meters, the Task D WQMP Report also recommended the construction of another 149 million gallons of storage for emergency purposes by 2050. This will bring the total system storage to 555 million gallons, or approximately 62% of the year 2050 projected average-day demand. The costs of the recommended emergency storage are estimated in the Task D WQMP Report and have been included in the CWMP Recommended CIP that is included in the Task F "Financial Plan" Report.

4.3.4 Transmission System

Many of the water mains serving the City of Detroit were installed in the early part of the 20th century or the later part of the 19th century, and are now reaching the end of their useful life span. As the pipe starts to exceed its life expectancy, problems arise such as frequent breakage, exfiltration of treated water through leaks, cracks and corroded joints; hydraulic constrictions due to tuberculation on the unlined interior pipe surfaces which increase pumping costs due to reduced hydraulic capacity; and in severe cases, surface subsidence and/or flooding problems. Cracked pipe can provide a source of entry for contaminants and pathogens into the drinking water supply. Heavily corroded pipe can create an additional chlorine demand and lower the system chlorine residual. Both are water quality concerns. Reduced pipe hydraulic capacity can compromise the deliverable fire flow as well, which can be a safety concern.

Currently, DWSD prioritizes its water distribution main replacement program based on records of recent break frequencies, corrosion issues (low C-factors), and customer complaints. The prevalent methodology is a reactive approach, in which DWSD primarily selects water mains for evaluation and prioritization based on failures that have already occurred. For example, standard DWSD policy is to evaluate pipeline replacement when a threshold of five breaks per 1,000 ft of pipeline is experienced within a particular section of pipe. Priorities of water main replacement are then based on a consideration of factors including:

- Reduced hydraulic capacity due to low “C” factor as a result of tuberculation.
- Inadequate fire protection availability due to reduced hydraulic capacity,
- Increased pumping costs as a result of frictional increases,
- The age and structural condition of the water main, and
- Proposed redevelopment in the vicinity.

DWSD currently has no rehabilitation and replacement program for its water transmission mains.

Transmission System Needs Identified by CWMP for 2004 – 2050

A renewal and replacement program for the DWSD transmission system was developed in the Task C “Renewal and Replacement Program” (R&R Program) Report. KANEW, a statistical model, was used to forecast the transmission pipe replacement needs mainly due to aging. KANEW is usually used for planning guidance on the length of pipes of certain categories that need to be rehabilitated and replaced each year. The forecast is based on the development of statistical survival functions that will be applied to the current transmission main inventory to simulate the aging process and calculate the length of the pipes that reach the end of their useful lives each year.

For KANEW analysis, the transmission main was separated into six categories. KANEW analysis also requires realistic estimation of life span because the progression of water mains in time due to be replaced is simulated based on probability distributions of life spans according to particular aging behavior. Estimated life spans for each water main type are shown in Table 4-2, based on experience with DWSD system and information on 28 other utilities collected during a 1998 AWWARF (American Water Works Association Research Foundation) survey.

TABLE 4-2
Estimated Life Expectancies for DWSD Transmission Pipes and AWWARF Survey Results on Life Expectancies

Water Main Type for KANEW Run		Range of Water Main Life Expectancies (yrs)						General Range of Water Main Life Expectancies (yrs) from AWWARF Report					
		100% (short~long)		50% (short ~ long)		10% (short ~ long)		100% (short~long)		50% (short ~ long)		10% (short ~ long)	
1	Unlined cast iron installed before 1923	55	90	75	115	100	150	20[1]	90[1]	30[1]	115[1]	50[1]	150[1]
2	Unlined cast iron installed 1923–1940	20	50	35	75	60	90						
3	Unlined cast iron installed after 1940	40	75	60	100	90	130						
4	Lined steel	50	75	70	100	95	125	20[2]	75[2]	40[2]	100[2]	60[2]	125[2]
5	Lined ductile Iron	50	100	80	150	100	200	30	100	50	150	90	200
6	Concrete	65	100	95	150	130	200	30	100	40	150	60	200

[1] The range listed here is for unlined cast-iron pipe.

[2] The range listed here is for steel pipe.

The KANEW output of the annual replacement/rehabilitation rates by pipe type is presented in Figure 4-4. It represents the medium scenario result from one of the three life-expectancy scenarios—short (pessimistic), medium, and long (optimistic). Short life expectancy predicts the most aggressive replacement needs and long, the least.

Figure 4-4 illustrates that under the medium life expectancy scenario, most cast-iron (more than 85 percent for each of the three types) and approximately 88 percent of the steel pipes will need to be replaced within the next 50 years; this replacement should start immediately. Replacement of concrete pipes will be required beginning in the mid-2030s.

FIGURE 4-4
KANEW Results—Annual Replacement Rates by Pipe Type (medium life expectancy scenario)

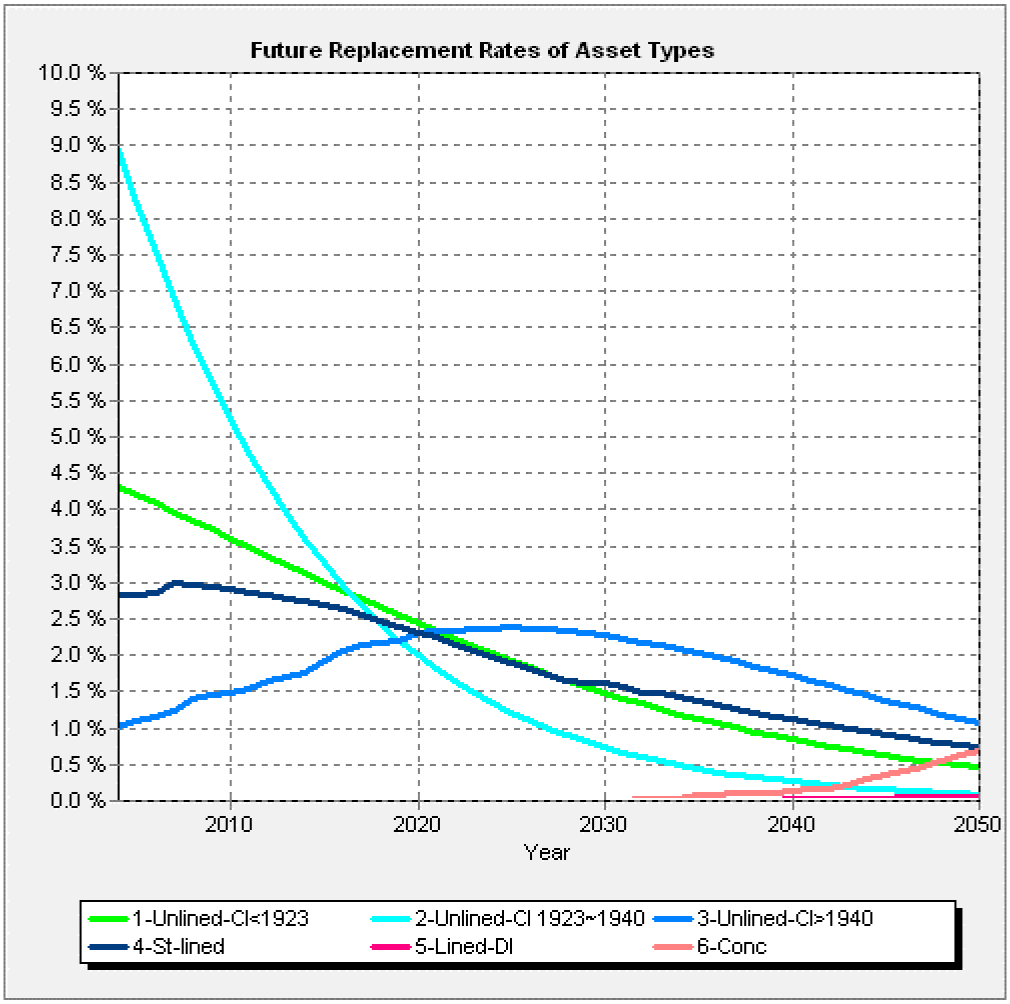


Figure 4-5 shows the predicted annual replacement rate for the entire DWSD transmission system under the short, medium, and long service life expectancy scenarios. Under all three, higher replacement rates are needed in the first two decades, and the rates decrease after 2020. The average annual replacement rates are 0.7, 0.9, and 1.3 percent respectively in terms of the transmission system's total length (i.e., about 6, 7, and 10 miles of pipes per year) at long, medium, and short service-life expectancy scenarios, respectively (data in Table 4-3).

FIGURE 4-5
KANEW Results— Annual Replacement Rates for the DWSD Transmission System - data in Table 4-3

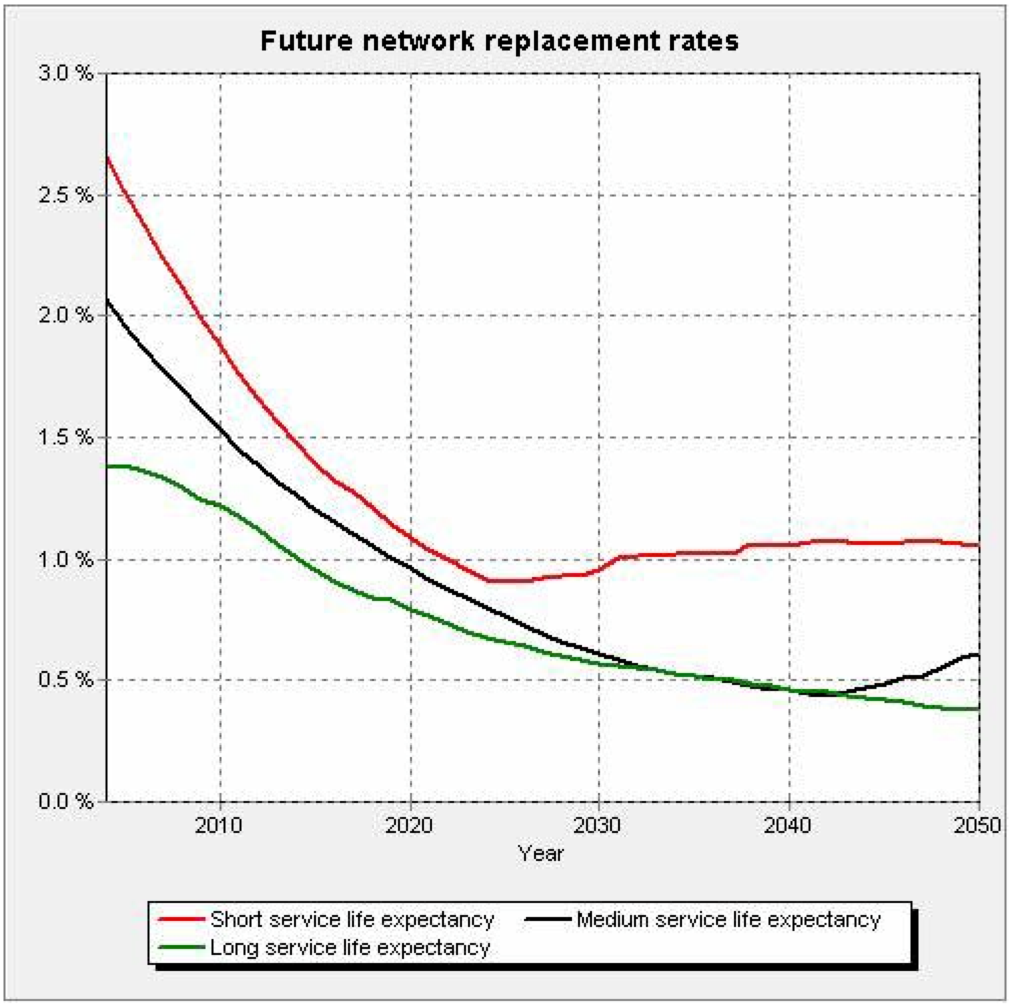


TABLE 4-3
KANEW Results— Summary of the Forecasted Rehabilitation and Replacement Needs for the DWSD Transmission System

Year	Short Service Life Expectancy	Medium Service Life Expectancy	Long Service Life Expectancy
Total Replacement Rate by Year 2050 (%)	60.10	42.16	34.60
Average Annual (2004-2050) Replacement Rate (%)	1.28	0.90	0.74
Average Annual (2004-2050) Replacement Length (miles)	9.86	6.92	5.68

Besides KANEW predictions, additional pipes were identified for replacement as a result of the transmission system hydraulic modeling analysis using EPANET. Their replacement is needed in order to meet established service criteria including provision of adequate pressures in the system and minimization of head losses.

Summary of the Recommended Pipe Replacement

A map of the proposed water main replacements (from both KANEW and Service Criteria) for the entire 2004 to 2050 planning period can be found in Figure 4-6. A breakdown of these replacement segments and their estimated costs by proposed replacement year are presented in Table A-7 of Appendix A of the Task C R&R Program Report. The costs of this work are included in the CWMP Recommended CIP that is included in the Task F "Financial Plan" Report.

It should be noted that the pipe replacement forecast of the CWMP does not necessarily represent actual pipe replacement projects. The decision to replace particular sections of pipe should be reached by considering the pipe's actual condition, location and other factors. It may be useful to do field and lab investigations of pipe condition to verify pipe life expectancies and investigate the possibility of saving money by rehabilitating/relining some pipe sections instead of replacing them. The replacement needs and costs presented in the CWMP are for planning purposes only.

FIGURE 4-6
Pipe Replacement Forecast by Decade for DWSD Transmission Mains

SECTION 5

Identification and Analysis of Alternatives and Recommendations

5.1 System-Wide Water Delivery Mode Alternatives and Recommendations

5.1.1 Objectives and Constraints

The objectives of the system-wide delivery mode alternatives evaluation were:

- To produce and supply sufficient water to meet the future system demand.
- To identify the future mode of water system operation that is the most reliable, and least in capital and O&M cost.

5.1.2 Identification of the Alternatives

Alternative schemes were developed based on two alternative modes of operation:

1. **Current Mode of Operation Plan (Pumping Only):** Under this alternative mode of operation, DWSD's current practice would be continued, and system pressures would continue to be maintained exclusively by pumping. Pumping facilities would be strategically located downstream of the treatment plants to maintain adequate pressures at key remote monitoring sites. Some stations would also have reservoirs to provide system storage closer to the demands. All reservoirs would use pumping as the means to deliver stored water to the system.

2. **Hybrid Plan (Combination of Pumping and High Ground Storage):** This alternative mode of operation would combine the existing pumped system with the concept of high ground storage. Under this mode of operation, it has been determined that it is not practical to provide high ground storage within the portions of the system having ground surface elevations below 860 feet. However, this mode would use the higher elevation areas in the northern and western portions of the expanding system to supplement the pumping facilities with reservoirs that "float" on the system, creating a series of nine pressure zones within which pressures are maintained between 40 psi minimum and 100 psi maximum. Water would be provided from the reservoirs by gravity during periods of peak demand, with associated energy savings. The floating storage reservoirs under this scheme would be strategically located adjacent to and higher than the pressure zones they serve. The reservoirs would be low-profile in height (< 30 feet), to make them more aesthetically acceptable.

5.1.3 Evaluation of the Alternatives

Evaluation Process and Criteria

To identify the optimal plan for serving the DWSD system**,** one could evaluate an infinite number of combinations of pipe sizes and layouts, pump station capacities and locations, and storage tank volumes and locations. A Genetic Algorithm (GA) computer optimization technique has been employed to identify the most cost-effective and hydraulically efficient plan for each mode of operation.

The GA process evaluates hundreds of thousands of possible design alternatives and identifies the least-cost alternative that meets a specified level of service. Level-of-service criteria used to evaluate various alternatives include pressures, velocities, and head loss gradients as follows (refer to Section 4.3.1 of the Task C WSSMP Report for the sources of these criteria):

- A minimum of 20 psi was required throughout the entire transmission system.
- A maximum velocity of 10 feet/second was permitted.
- A maximum head loss of 3 feet/1,000 feet on average for mainline transmission mains (excludes small connector mains) was used as a guideline.
- Maximum pressures were maintained below the design pressures in new and existing pipes.
- A minimum pressure of 40 psi was required at each wholesale meter.

Moreover, the capital cost and the energy component of O&M costs have been computed for each potential alternative as described in Section 4 of the Task C WSSMP Report, and the total of these costs has been used as the primary measure of an alternative’s ranking.

Emergency storage requirements were not evaluated as part of the GA computer optimization, but were considered separately (see Section 4.3.3 of this report).

5.1.4 Recommended Alternative

The most optimum system of transmission mains, equalization storage reservoirs, pumping stations and individual water treatment plant capacities was developed for each of the two alternative modes of operation using the GA optimization technique. Both optimal plans were based on serving the entire population of all the communities within the study area in 2050, termed “Build Out” herein. A cost analysis was then performed to compare the total costs of each of the optimal plans over the 50-year planning period in current dollars. Table 5-1 presents the results of this analysis, which determined that the optimized Hybrid Plan is about 20% more cost effective than the optimized Current Mode of Operation Plan. This analysis, in combination with an evaluation of non-cost factors that is also presented in Section 4 of the Task C WSSMP Report, led to the selection of the Hybrid Plan as the recommended alternative.

TABLE 5-1
Total Cost Comparison Through 2050 for Alternative Modes of Operation for Year 2050 Build Out (current dollars)

Cost Items	Optimized Current Mode of Operation Plan Cost ($Million)	Optimized Hybrid Plan Cost ($Million)	Cost Savings Using Optimized Hybrid Plan ($Million)
Capital Improvement	2,348	2,138	210
Energy	2,308	1,564	744
Sum of Capital and Energy Cost	4,656	3,702	954

5.2 Water Plant Disinfection Strategy Alternatives and Recommendations

All five DWSD water treatment plants currently practice pre- and post-chlorination for disinfection. The newly constructed Water Works Park II WTP has intermediate ozonation, but with a limited *Cryptosporidium* inactivation goal in its current design.

As indicated in the previous section of this report, DWSD has adopted aggressive disinfection goals that are more stringent than existing or proposed regulatory requirements to improve public health protection. Both the CWMP and the Needs Assessment studies have recommended that additional disinfection barriers be incorporated into the existing water treatment processes at all five of DWSD's WTPs in the near future.

5.2.1 Description of the Alternatives

Four alternatives were considered for water plant disinfection:

A. **No Action (relying on existing chlorination only):** Chlorine is not an effective disinfectant in inactivating *Cryptosporidium*, which is a critical regulatory concern. DWSD water quality goals establish a 1-log *Cryptosporidium* inactivation in the short term, and a 2-log inactivation in the long term. In addition, chlorine is not able to address the taste-and-odors (T&O) aspect of the water quality issue.

B. **Add Ozonation at the Northeast, Southwest, Springwells and Lake Huron WTPs and expand the ozone systems at the WWP II WTP**: Ozone will provide sufficient inactivation of *Cryptosporidium* in warm water, but not during the cold-water conditions of winter. To achieve 1-log inactivation of *Cryptosporidium* throughout the year, an ozone system would have to be designed with many generators and large contactors, which is both costly and space demanding.

C. **Add Only UV at All Five Water Plants:** UV is the most effective disinfection technology in inactivating *Cryptosporidium*. It is cost effective and space-friendly. However, it does not provide the benefit of controlling drinking water T&O.

D. **Implement an Integrated Disinfection Strategy Which Requires the Installation of Both Ozone and UV at All Five WTPs:** This concept will utilize the advantages of both ozone and UV technologies. It also provides the multiple disinfection barriers for *Cryptosporidium* and enhances the process reliability. This approach also addresses the T&O concerns of the DWSD drinking water. This approach also uses less space and is cost competitive versus the ozonation-alone approach.

5.2.2 Evaluation of the Alternatives

DWSD currently uses chlorine for primary disinfection and powdered activated carbon (PAC) for partial reduction of T&O. These treatment processes are not adequate to meet the *Cryptosporidium*-based disinfection goals cited above and the goal of no objectionable T&O in the finished water for the following reasons:

- In the current PAC application mode at all five WTPs, PAC is fed in high doses (> 40 mg/L) and, in some cases, is only marginally effective for controlling T&O when compared to ozone. The high doses also exert high chlorine demands and can negatively impact filter performance.
- Chlorine is not an effective disinfectant for *Cryptosporidium* inactivation. Therefore, alternative disinfectants, such as ozone or UV, must be considered to meet DWSD's goal of providing a disinfection treatment barrier (beyond removal by filtration) against this and other chlorine-resistant pathogens.

Besides being a reliable, effective, and long-term T&O solution, ozone also provides other benefits: It provides baseline disinfection against viruses and *Giardia*, and (along with UV) forms multiple disinfection barriers against *Cryptosporidium*; it can provide chemical oxidation for a variety of chemicals and can address future chemical concerns (such as endocrine disruptors); and it improves the filtration process and reduces coagulant dose.

Table 5-2 compares the alternatives with respect to several evaluation criteria.

5.2.3 Recommended Alternative

The CWMP and Needs Assessment studies have recommended that the integrated disinfection alternative, which includes Ozone/UV/Chlorine as multiple disinfection barriers, be implemented by DWSD in the future at all five of its WTPs.

TABLE 5-2
Summary of the Alternatives for DWSD WTP Long-term Disinfection Strategy

	Chlorine Only (No Action)	Chlorine + Ozone	Chlorine + UV	Chlorine + Ozone + UV
Water Quality Objective:				
T&O Removal	Only Partially, with PAC	Yes	No	Yes
Disinfection Objective:				
Virus	Yes	Yes	Yes	Yes
Giardia	Yes	Yes	Yes	Yes
Cryptosporidium	No	Summer only	Yes	Yes
Multiple Disinfection Barriers for Crypto	No	No	No	Yes
Space Requirement	None (existing)	Large	Small	Medium
Constructibility	N/A	Poor	Good	Good
Capital Cost*	Low $0 (existing)	High $250,000,000	Moderate $132,000,000	High $274,000,000
O&M Cost	Low	High	Moderate	High
Recommended	No	No	No	Yes

*Conceptual order-of-magnitude cost estimate only.

5.3 Water Treatment Plant Upgrade Alternatives and Recommendations

5.3.1 Introduction

Based on the changes in DWSD's drinking water quality goals (as summarized in Section 4.1 of this report), the projected increase in water demand (as summarized in Section 4.2), the WTP rehabilitation needs (as summarized in Section 4.3) and the disinfection recommendations (as summarized in Section 5.2), it is clear that each of DWSD's five WTPs will require some degree of rehabilitation and/or replacement activity early in the planning period.

The CWMP recommendations for the five DWSD WTPs are summarized below. An itemized tabulation for each plant is provided in the Task D WQMP Report.

5.3.2 Northeast WTP

The improvement recommendations for the rapid mixers, flocculation basins, sedimentation basins, filters, low-lift and high-lift pumps, residuals treatment facilities and additional miscellaneous items should be completed by 2013.

The CWMP has considered two siting alternatives for implementing an integrated disinfection strategy at the plant. Under the preferred alternative, the pre-ozone generator building, contactor and oxygen storage area will be located on the west side of the plant across from the chemical building, and the central UV facility will be located east of Filtered Water Junction Box No. 2. The integrated ozone/UV system should also be completed by 2013.

These improvements will increase the nominal treatment and firm pumping capacity of the plant to 340 MGD. No additional expansion or major plant rehabilitation is expected during the 50-year planning period.

5.3.3 Springwells WTP

The improvements recommended for the rapid mixers, flocculation basins, sedimentation basins, filters, low-lift and high-lift pumps, residuals treatment facilities and other miscellaneous items should be completed by 2013.

The CWMP has considered two siting alternatives for implementing an integrated disinfection strategy at the plant. Under the preferred alternative, the intermediate-ozone generator building, contactor and oxygen storage area will be located on the existing site of the 1930 sedimentation basin, which is proposed to be abandoned. The central UV facility should be located on the north end of Clearwell No. 3, which is to be divided. The integrated ozone/UV system should also be completed by 2013.

These improvements will upgrade the plant to be capable of producing 540 MGD peak capacity reliably. No additional expansion or major plant rehabilitation is expected during the 50-year planning period.

5.3.4 Southwest WTP

The improvements recommended for the flocculation/sedimentation basins, filters, chemical feed system, low-lift pumps, residuals treatment facilities and other miscellaneous items should be completed by 2013.

The CWMP has considered two siting alternatives for implementing an integrated disinfection strategy at the plant. Under the preferred alternative, the intermediate ozone generator building, contactor and oxygen storage area will be located on the northeast side of the plant across from the sedimentation basins, and the central UV facility will be located north of the main office/pump building, next to the service road, or north of the existing emergency generators, between the reservoirs and high-lift pump station. The integrated ozone / UV system should also be completed by 2013.

These improvements will increase the reliable treatment capacity of the plant to its current nominal capacity of 240 MGD. No additional expansion or major plant rehabilitation is expected during the 50-year planning period.

5.3.5 Lake Huron WTP

It is projected that the system demand at the Lake Huron WTP will exceed its 400 MGD treatment capacity by the year 2012. Two alternatives exist to increase filtration capacity. The first would be to re-rate the filters to a higher unit loading rate by demonstrating to the MDEQ that regulatory standards can be met at the higher rate. The second option is to expand capacity by increasing filter surface area. For planning purposes, it has been conservatively assumed that new filters will be added at the plant to increase capacity and that an expansion to 535 MGD will be accomplished by making use of ten offline empty filter boxes that exist in the Filter Building. Other related expansion activities will also be required at this time, including increasing the capacity of low-lift and high-lift pumps and expansion / upgrade of chemical storage and feed systems.

It is estimated that system demand will surpass the 535 MGD capacity by the year 2025, and a second plant expansion will be required by that year. This expansion would be sized to meet the year 2050 water demand, as estimated using the 2050 Decade Model (see Section 6 of this Summary Report).

The CWMP has considered two siting alternatives for the UV portion of the integrated disinfection strategy at the plant. Under the preferred alternative, two distributed UV facilities will be located near the north and south ends of the north and south filtered water influent channels.

It has been assumed that the construction of the integrated ozone / UV disinfection facilities for the Lake Huron WTP would be deferred until the 2025 expansion, and that no CIP projects would be required at this plant during the remainder of the 50-year planning period.

5.3.6 Water Works Park II WTP

The new Water Works Park II WTP has a design capacity of 240 MGD, which is adequate to meet the water demands expected from it throughout the 50-year planning period.

Ongoing construction of the new plant under WW-534 (“New Water Works Park II WTP”) will continue through early 2005. Under the same contract, demolition of the original plant’s low-lift pump station, pre-chlorination building, sedimentation basins and filter building is expected to be completed by October, 2004. A few ongoing design and construction projects to upgrade the components of the old plant that are being integrated into the new plant are slated for completion through the 2006-2007 fiscal year, including rehabilitation of the raw booster station building and rehabilitation of the instrumentation and controls within that building (both projects are to be constructed under WW-533 "Raw Water Booster Station Rehabilitation at Water Works Park"). Also underway is the design phase of a project to remodel the old administration building for use as the "Water Quality Investigators Administration Building."

It is recommended that an integrated UV/Ozone disinfection system be provided at the plant by 2013, since none was provided in the original construction contract.

SECTION 6

Summary of Recommended Improvements by Decade through 2050

6.1 Introduction

The Task C Water Supply and Service Management Plan (WSSMP) Report presents a phasing strategy of recommended system hydraulic improvements by decade, beginning with the decade ending in 2010. The 2050 Build Out model of the Hybrid Plan, as defined in Section 5, was used as the blueprint of the preferred system from which new pipelines and other facilities were chosen. Then, a phasing plan was developed to determine the potential for new customers to join the system on a decade-by-decade basis by examining hydraulic performance under anticipated MDDs for existing customers for the decade under consideration (refer to Section 5 of the Task C WSSMP Report for a detailed explanation).

The hydraulic performance improvements identified in the Task C decade plans include transmission main extensions, new piping loops, new parallel transmission mains, new booster pump stations and new equalization storage tanks. Capital cost estimates in current dollars are presented therein for each of these recommended improvements by decade.

In addition, the Task C decade modeling identified the WTP treatment capacities required to meet maximum day system demands for each decade, as summarized in Table 6-1.

TABLE 6-1

Required WTP Capacities to Meet Maximum Day System Demands (MGD)

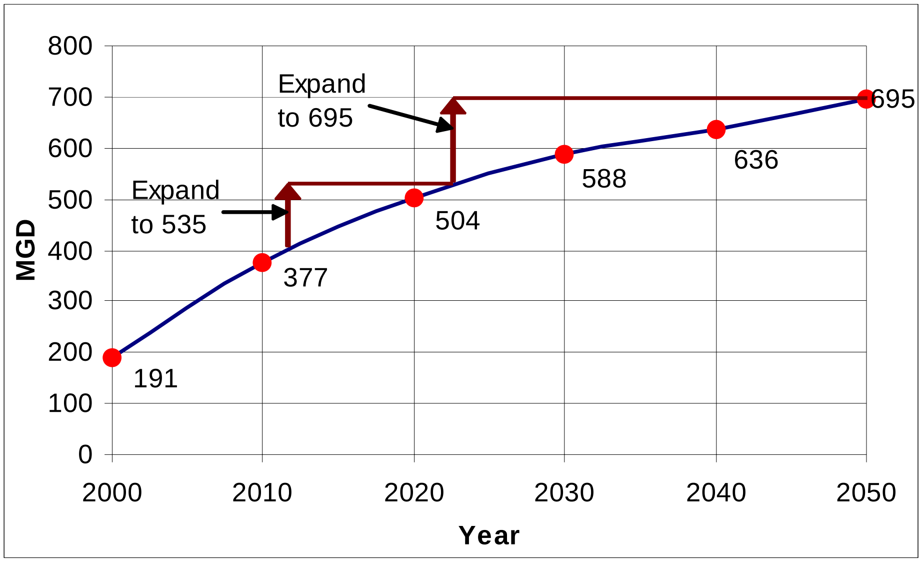
WTP	Treatment Capacity in 2004	Required Capacity to Meet System MDD					Planned Treatment Capacity in 2050
		2010	2020	2030	2040	2050	
Northeast	300	338	331	338	338	337	340
Springwells	540	495	473	472	472	530	540
Southwest	240[1]	196	201	201	202	203	240
Lake Huron	400	377	504	588	636	695	695
Water Works Park II	240	204	222	215	226	210	240
Total	1,720	1,610	1,731	1,814	1,874	1,975	2,055

[1]Reliable production is currently limited to 180 MGD.

The only WTP requiring significant expansion (beyond capacity increases gained by addressing the needed improvements identified by the Needs Assessment Reports) is the

Lake Huron WTP. To supply the projected demand increases of DWSD's growing service population over the planning period, the treatment capacity of the Lake Huron WTP (LHWTP) will need to be increased in two stages, to 535 MGD and 695 MGD, as indicated in Figure 6-1.

FIGURE 6-1
System Maximum-Day Demand Curve and Proposed Expansion Phases for LHWTP



Requirements for the phasing of other recommended system capital improvements not identified by the Task C hydraulic model are identified in other CWMP task reports. The Task D "Water Quality Management Plan" (WQMP) Report identifies phasing requirements for addressing the upgrading needs of DWSD's five WTPs; it also identifies 149 MG of additional system storage needed to reduce the impact of emergencies such as the power outage of 2003. Annual expenditures for replacing aging transmission mains are identified in Table A-7 of Appendix A of the Task C "R&R Program" Report.

This section presents decade-by-decade summaries of the system capital improvements recommended through 2050 in each of the CWMP task reports. The costs of these improvements are included in the CWMP Recommended CIP that is presented in the Task F "Financial Plan" Report, which is summarized in Section 8.

This section also identifies customer communities whose water supplies would be dependent on branched (unlooped) transmission lines during each decade of the plan, projected average water pressures at key locations throughout the system for ADD and MDD conditions for each decade and actions DWSD should take to protect its source water.

6.2 Water System Improvements by Decade

The decade plans which follow identify water system improvements recommended by the CWMP for each decade of the planning period based on serving the population projected for the final year of that decade. The improvements for each decade include the hydraulic upgrades recommended in Section 5 of the Task C WSSMP Report, additional emergency storage volume and water treatment plant upgrades/expansions recommended in the Task D WQMP Report, and the renewal and replacement program for transmission mains for that decade. The projects within each decade plan are listed randomly (in no particular order of priority).

It should be noted that in each case where a decade plan calls for the construction of a parallel main, consideration should be given, during design, to replacing the original, undersized main instead with a larger one (as explained in Appendix G of the Task C WSSMP Report).

Some of the pump station and storage tank projects listed in the decade plans will require the acquisition of land. DWSD should acquire the needed land during the decade before it is needed to avoid cost escalation due to land development competition.

6.2.1 Decade One Improvements

Table 6-2 and Figure 6-2 present the water system improvements recommended by the CWMP for Decade One of the planning period.

TABLE 6-2
Decade One Improvements

Map Key Figure 6-2	Facility/Pipe Route	Location	Description
1	Chesterfield Booster Pumping Station and Ground Storage Tank	Chesterfield Twp.	New booster station with 20 MG ground storage tank (incl. 13 MG new emergency storage), reservoir pumping only (26.4 MGD @ 350 ft.)
2	High Ground Storage Tank west of Newburgh Booster Station	8 Mile W of Sheldon	New 10 MG high ground storage tank (incl. 4 MG new emergency storage) and associated piping (2000 ft. of 36-inch diameter pipe)
3	Romeo Booster Pumping Station and Ground Storage Tank	Village of Romeo	New booster station with line pumping only (84.4 MGD @ 300 ft.; ultimate capacity will be 172.8 MGD); 20 MG new emergency storage tank
4	Springwells WTP	Springwells WTP	CIP upgrades per Table 2-35 of Task D WQMP Report, excluding Items SPW-2 and SPW-9[1]
5	Michigan Ave. Station upgrades	Michigan Ave. Booster Station - Wayne	Replace line pumps for additional head, add 4.2 MGD line pumping capacity (20 MGD @ 187 ft.)
6	Wick Station upgrades	Wick Rd. Booster Station - Romulus	Add 18-MGD line pumping capacity (54 MGD @ 250 ft.)
7	31 Mile Road new pipeline[2]	From Romeo to Springfield Twp.	Approximately 19 miles of 72-inch to 84-inch diameter pipe
8	Orion pipe loop[2]	From Independence Twp. to Orion Twp.	Approximately 7 miles of 54-inch to 60-inch diameter pipe
9	14 Mile Rd. extension[2]	Wixom to South Lyon	Approximately 2 miles of 72-inch diameter pipe

TABLE 6-2
Decade One Improvements

Map Key Figure 6-2	Facility/Pipe Route	Location	Description
10	8 Mile Road parallel main[2]	From WSC to Newburgh Station	Approximately 5 miles of 60-inch diameter pipe
11	24 Mile Road parallel main[2]	Chesterfield Twp. to Rochester	Approximately 13 miles of 36-inch to 42-inch to 48-inch diameter pipe.
12	Parallel main downstream of Newburgh Booster Station[2]	Livonia, 8 Mile Rd. from Newburgh Station to Newburgh Rd.	Approximately 0.4 miles of 60-inch diameter pipe
13	Parallel main in NW Detroit[2]	From Springwells WTP to WSC	Approximately 8 miles of 16-inch to 30-inch to 36-inch diameter pipe
14	14 Mile Road parallel main [2]	Between Franklin and Haggerty Stations	Approximately 5 miles of 36-inch diameter pipe
15	Wick Road parallel main[2]	From Wick Station Suction to Ypsilanti Station	Approximately 11 miles of 36-inch to 42-inch diameter pipe
16	Parallel Adams Road main[2]	Downstream of Adams Rd. Station	Approximately 1 mile of 30-inch diameter pipe
17	Parallel Warren main[2]	Edison/Schoenherr from 10 Mile to 14 Mile	Approximately 4 miles of 42-inch diameter pipe
18	Northeast WTP	Northeast WTP	CIP upgrades per Table 2-28 of Task D WQMP Report, excluding Item NE-14[2]
19	Southwest WTP	Southwest WTP	CIP upgrades per Table 2-42 of Task D WQMP Report, excluding Item SW-10[2]
20	Lake Huron WTP	Lake Huron WTP	CIP items per Task D WQMP Report: Expansion Items LH-1 through LH-7 per Table 2-51 and 2004-2010 non-expansion items per Table 2-52
21	Water Works Park II WTP	Water Works Park II WTP	Additional improvement under WW-534 (Item WWP-1 per Table 2-55 of Task D WQMP Report)
	Replacement of aging transmission mains	See Figure 4-6	Piping as identified in Appendix A, Table A-7 of the Task C R&R Program Report

[1]SPW-2 (Chemical Feed System and Mixing Improvements) has already been completed. SPW-9, NE-14 and SW-10 are for provision of ozone and UV disinfection, projected for completion during Decade Two.

[2] A detailed listing of these recommended new transmission system pipe segments can be found in Appendix G of the Task C WSSMP Report.

Table 6-3 identifies the new customers that are projected to be added to the system by 2010 and their expected MDD water usage. It should be noted that if Lyon Township and South Lyon do not join the system, the 14-Mile Road extension is not needed for 2010. Also, if Oxford and Oxford Township are not interested in service from DWSD, the Orion pipe loop would not be built by 2010, but a ground storage tank and reservoir pumps would be required at the Orion Pump Station to supply existing customers during peak periods.

6.2.2 Decade Two Improvements

Table 6-4 and Figure 6-3 present the water system improvements recommended by the CWMP for Decade Two of the planning period.

TABLE 6-3
2010 New Customers[1]

Community Name	2010 MDD (MGD)
Brandon Township	0.85
Clarkston	0.28
Franklin	0.86
Highland Park	8.62
Independence Township	6.50
Lyon Township	3.63
Oakland Township	2.36
Oregon Township	0.61
Oxford	1.53
Oxford Township	2.45
South Lyon	2.89
Wolverine Lake	0.82
TOTAL	**31.41**

[1] Casco Twp. and Rochester are also projected to become customers by 2010. They are not DWSD wholesale customers, but are considered as such for planning purposes, since they currently receive limited service through other communities.

TABLE 6-4
Decade Two Improvements

Map Key for Figure 6-3	Facility/Pipe Route	Location	Description
1	Second Feed from Lake Huron WTP[1]	Port Huron to Chesterfield Township	Approximately 40 miles of 42-inch, 54-inch, 96-inch, 108-inch and 120-inch diameter pipe
2	Lake Huron WTP	Lake Huron WTP	2014-2020 portion of structural and mechanical rehabilitation per Table 2-52 of Task D WQMP Report
3	High ground storage tank North of Orion Station	Brown East of Baldwin, Orion Township	New 20 MG high ground storage tank and associated piping (approximately 8 miles of 36-inch, 42-inch, and 48-inch diameter pipe)
4	Haggerty pipe loop[1]	Pontiac to north of Haggerty Pump Station	Approximately 16 miles of 54-inch, 60-inch, and 84-inch diameter pipe
5	Michigan Avenue pipe loop[1]	Hannan Rd. from Cherry Hill to Tyler	Approximately 6 miles of 36-inch diameter pipe

TABLE 6-4
Decade Two Improvements

Map Key for Figure 6-3	Facility/Pipe Route	Location	Description
6	Parallel main downstream of Haggerty Station[1]	14 Mile Rd. from Haggerty Station to Welch Rd.	Approximately 1 mile of 42-inch diameter pipe
7	Parallel main downstream of Michigan Ave. Station[1]	Michigan Ave. from Lamphere to Hannan	Approximately 2 miles of 24-inch to 30-inch diameter pipe
8	Joy Rd. Station upgrades	Joy Rd. Station	Additional 15.2 MGD line pumping added (line total 61.6 MGD @ 286 ft.)
9	WSC Station upgrades	West Service Center	Replace Intermediate Line Pumps (60 MGD @ 185 ft.)
10	Parallel main upstream of Wick Station[1]	Wick Rd. from Inkster Rd. to Wickham Rd.	Approximately 2 miles of 36-inch diameter pipe
11,12, and 13	Northeast, Springwells and Southwest WTPs	See Figure 6-3	UV and Ozone Disinfection Systems plus 2014-2020 portion of structural and mechanical rehabilitation per Tables 2-29, 2-36 and 2-43 of Task D WQMP Report
14	Water Works Park II WTP	See Figure 6-3	New UV disinfection system and 2014-2020 portion of structural and mechanical rehabilitation per Table 2-56 of Task D WQMP Report
15	Ground Storage Tank at Newburgh Pump Station	See Figure 6-3	New 20 MG ground reservoir for emergency storage
16	High Ground Storage southwest of Adams Booster Station	See Figure 6-3	New 10 MG high ground tank for emergency storage and associated piping (2.1 miles of 30-inch diameter pipe)
17	24-Mile Road extension[1]	Rochester Pump Station to Auburn Hills	Approximately 6 miles of 72-inch diameter pipe
	Replacement of aging transmission mains	See Figure 4-7	Piping as identified in Appendix A, Table A-7 of the Task C R&R Program Report

[1] A detailed listing of these recommended new transmission system pipe segments can be found in Appendix G of the Task C WSSMP Report.

Table 6-5 identifies twelve new customers that would be added to the system by 2020 and their expected MDD water usage. All of these communities are currently being served by other public water systems. Many of the communities listed are located near the route of the second feed from the Lake Huron WTP.

TABLE 6-5
2020 New Customers

Community Name	2020 MDD (MGD)
Algonac	1.51
Clay Township	2.18
China Township	0.09
Clyde Township	0.37
Cottrellville Township	0.36
East China Township	1.2
Fort Gratiot Township	2.2
Kimball Township	0.85
Marine City	1.19
Marysville	6.14
New Baltimore	4.46
Port Huron	11.94
Port Huron Township	1.88
Richmond	1.42
St. Clair	2.36
St. Clair Township	0.83
Waterford Township	19.28
White Lake Township	9.70
TOTAL	**68.0**

6.2.3 Decade Three Improvements

Table 6-6 and Figure 6-4 present the water system improvements recommended by the CWMP for Decade Three of the planning period.

TABLE 6-6
Decade Three Improvements

Map Key for Figure 6-4	Facility/Pipe Route	Location	Description
1	Continue second feed from Lake Huron WTP[1]	Chesterfield Station to NSC	Approximately 16 miles of 72-inch and 84-inch diameter pipe
2	Lake Huron WTP	Lake Huron WTP	CIP items per Task D WQMP Report: Expansion Items LH-8 through LH-13.2 per Table 2-51 and 2021 through 2030 non-expansion items per Table 2-52
3	Parallel main downstream of Haggerty Sta.[1]	14 Mile Road from Welch Road to Beck Road	Approximately 4 miles of 42-inch diameter pipe

TABLE 6-6
Decade Three Improvements

Map Key for Figure 6-4	Facility/Pipe Route	Location	Description
4	North Service Center capacity upgrades	North Service Center	Additional 110 MGD pumping capacity for line pumps (350 MGD @ 370 feet)
5	Michigan Avenue Station upgrades	Michigan Avenue Station	Replace reservoir pumps for additional head (17.28 MGD @ 250 feet)
6	Franklin Station upgrades	Franklin Station	Additional 30 MGD line pumping (120 MGD @ 250 ft.)
7	Parallel Orion Twp. main[1]	Giddings Road from Walton Blvd. to Green Rd.	Approximately 2 miles of 42-inch diameter pipe
8	Parallel main upstream of Joy Road Station[1]	Joy Road from Wayne Road to Joy Road Station	Approximately 4 miles of 36-inch diameter pipe
9	Transmission main to supply Brighton[1]	Pontiac Trail from West of Wixom to I-96 to Kensington Road to Buno Road	Approximately 12 miles of 42-inch, 48-inch, and 54-inch diameter pipe
10	Romeo Station upgrades	Romeo Station	Additional 33.6 MGD line pumping added (line total 120 MGD @ 300 ft.)
11	Haggerty Station upgrades	Haggerty Station	Additional 24 MGD line pumping added (line total 66 MGD @ 200 ft.)
12	Parallel main downstream of Newburgh Booster Station[1]	Livonia, 8 Mile Rd. from Haggerty Rd. to Meadowbrook Rd.	Approximately 1.0 miles of 30-inch diameter pipe
13,14,15 and 16	Northeast, Springwells, Southwest and WWP II WTPs	See Figure 6-4	2121 –2030 portion of structural and mechanical rehabilitation per Tables 2-29, 2-36, 2-43 and 2-56 of Task D WQMP Report
17	Ground Storage at Ypsilanti Pumping Station	See Figure 6-4	New 20 MG ground reservoir for emergency storage
	Replacement of aging transmission mains	See Figure 4-7	Piping as identified in Appendix A, Table A-7 of the Task C R&R Program Report

[1] A detailed listing of the recommended transmission system pipe upgrades can be found in Appendix G of the Task C WSSMP Report.

Table 6-7 identifies the new customers that can be added to the system by 2030 and their expected MDD water usage. Many of these communities cannot be served until the transmission main to Brighton is completed.

TABLE 6-7
2030 New Customers

Community Name	2030 MDD (MGD)
Brighton	2.76
Brighton Township	1.91
Bruce Township	0.73
Green Oak Township	3.43
Hamburg Township	5.20
Milford	1.30
Salem Township	0.67
TOTAL	**16.00**

6.2.4 Decade Four Improvements

Table 6-8 and Figure 6-5 present the water system improvements recommended by the CWMP for Decade Four of the planning period.

TABLE 6-8
Decade Four Improvements

Map Key Figure 6-5	Facility/Pipe Route	Location	Description
1	Columbus Pump Station and ground storage	Columbus Township	New station with line pumping only (294 MGD @ 300 feet). New 20 MG ground reservoir for emergency storage.
2	31 Mile Road new pipeline[1]	Casco Township to Romeo Station	Approximately 17 miles of 84-inch to 96-inch diameter pipe
3	Springfield pipe loop[1]	Independence Twp. to Wixom	Approximately 28 miles of 42-inch to 60-inch to 72-inch diameter pipe
4	Oakland Pump Station and ground storage	Oakland Township	New station with line pumps (78 MGD @ 260 feet; ultimate capacity). New 20 MG ground reservoir for emergency storage.
5	Parallel main in NW Detroit[1]	Midland from Evergreen to Pierson, Tireman from Central to Cloverlawn	Approximately 1 mile of 24-inch diameter pipe
6,7,8,9, and 10	Lake Huron, Northeast, Springwells, Southwest and WW P II WTPs	See Figure 6-5	2031 through 2040 portion of structural and mechanical rehabilitation per Tables 2-52, 2-29, 2-36,2-43, and 2-56 of Task D WQMP Report
11	High ground storage west of Springfield	See Figure 6-5	New 10 MG high ground tank for emergency storage
	Replacement of aging trans-mission mains	See Figure 4.7	Piping as identified in Appendix A, Table A-7 of Task C R&R Program Report

[1]A detailed listing of the recommended transmission system pipe upgrades can be found in Appendix G of the Task C WSSMP Report.

Table 6-9 identifies the new customers that can be added to the system by 2040 and their expected MDD water usage. All three communities will be served from the proposed Springfield pipe loop, which should only be constructed if Brighton elects to join the DWSD system.

TABLE 6-9
2040 New Customers

Community Name	2040 MDD (MGD)
Highland Township	0.26
Milford Township	0.66
Springfield Township	1.25
TOTAL	**2.17**

6.2.5 Decade Five Improvements

Table 6-10 and Figure 6-6 present the water system improvements recommended by the CWMP for Decade Five of the planning period.

TABLE 6-10
Decade Five Improvements

Map Key for Figure 6-6	Facility / Pipe Route	Location	Description
1	High ground storage tank in western grid[1]	Kensington South of Jacoby, Brighton Township	New 10 MG high ground storage tank (includes 2 MG emergency storage) and associated piping (approximately 1,700 feet of 42-inch dia. pipe)
2	Second feed to Flint[1]	Springfield Township to Genesee County	Approximately 12 miles of 36-inch diameter pipe
3	Salem Pumping Station and high ground storage tank	Salem Township	New station with line pumps (25.9 MGD @ 200 feet) and 10 MG high ground tank to the east of the pump station for emergency storage and associated piping (4.1 miles of 24-inch diameter pipe)
4	Joy Road pipeline extension[1]	Plymouth Township west to Ann Arbor	Approximately 8 miles of 36-inch diameter pipe
5	Brighton – Ann Arbor pipe loop[1]	From Milford Township to Brighton Township and from Green Oak Township to Ann Arbor	Approximately 22 miles of 48 inch to 72-inch diameter pipe
6	New West Chicago Road pipeline[1]	West Chicago Station to Stark Road	Approximately 4 miles of 36-inch diameter pipe
7	Lake Huron WTP	See Figure 6-6	2041 through 2050 portion of structural and mechanical rehabilitation per Table 2-52 of the Task D WQMP Report
8	North Service Center upgrades	North Service Center Station	Additional 50 MGD pumping capacity for line pumps (400 MGD @ 370 feet)

TABLE 6-10
Decade Five Improvements

Map Key for Figure 6-6	Facility / Pipe Route	Location	Description
9	Romeo Station upgrades	Romeo Station	Additional 52.8 MGD pumping capacity (172.8 MGD @ 300 feet)
10	Newburgh Station upgrades	Newburgh Station	Additional 12 MGD pumping capacity (64 MGD @ 200 feet)
11	Oakland Station upgrades	Oakland Station	Additional 126 MGD pumping capacity (204 MGD @ 260 feet)
12	Franklin Station upgrades	Franklin Station	Additional 61.2 MGD line pumping capacity (151.2 MGD @ 250 feet)
13	Parallel main in northwestern Detroit[1]	8 Mile Rd. from Evergreen to St. Marys, Schoolcraft from Lamphere to Schoolcraft Pump Station, Grand River from Bennett to WSC	Approximately 8 miles of 24-inch diameter pipe
14	Parallel main downstream of Joy Rd. Station[1]	Joy Rd. from Joy Station to Sheldon	Approximately 0.6 miles of 24-inch diameter pipe
15	Parallel main downstream of Wick Rd. Station[1]	Hannan Rd. from Wick to Huron River Dr. – Van Buren Twp.	Approximately 1.5 miles of 24-inch diameter pipe
16	Parallel main downstream of Franklin Station[1]	Inkster Rd. from Franklin Station to Maple Rd.	Approximately 1 mile of 24-inch diameter pipe
17	Parallel main downstream of Adams Rd. Station[1]	Squirrel Rd. from Walton Blvd. to South Blvd., Walton Blvd. from Squirrel Rd. to Avon Twp.	Approximately 5 miles of 24-inch diameter pipe
18	Parallel main Downstream of Newburgh Booster Station[1]	8 Mile Rd. from Meadowbrook Rd. to Sheldon Rd.	Approximately 3 miles of 24-inch to 30-inch diameter pipe
19, 20, 21, and 22	Northeast, Spring-wells, Southwest and WWP II WTPs	See Figure 6-6	2041 through 2050 portion of structural and mechanical rehabilitation per Tables 2-29,2-36, 2-43, and 2-56 of Task D WQMP Report
	Replacement of aging transmission mains	See Figure 4.7	Piping as identified in Appendix A, Table A-7 of the Task C R&R Program Report

[1] A detailed listing of the recommended transmission system pipe upgrades can be found in Appendix G of the Task C WSSMP Report.

Table 6-11 identifies the new customers that can be added to the system by 2050 and their expected MDD water usages. The communities are currently being served by the Ann Arbor system. Ann Arbor has not requested service from DWSD. If Ann Arbor does not request service for this decade, the Salem Station, Brighton-Ann Arbor loop and Joy Road pipeline extension would not need to be built.

TABLE 6-11
2050 New Customers

Community Name	2050 MDD (MGD)
Ann Arbor	38.00
Ann Arbor Township	1.07
Scio Township	4.05
TOTAL	**43.12**

6.3 Communities Served by Branched Transmission Systems

Transmission systems can be either looped or branched. In looped systems, there may be several different paths the water can follow to get from the source to a particular customer. In a branched system, the water has a single possible path to the customer.

The MDEQ has requested that the CWMP identify all communities connected to the DWSD water system by transmission piping which is not looped to provide more than one supply routing.

The current customer communities of Utica, Lapeer, Mayfield Township, Imlay City, Brownstown Township, Woodhaven, Gibraltar, Rockwood, South Rockwood, Sylvan Lake, Keego Harbor, the Ash Township System, the Berlin Township System and the Ypsilanti Community Utilities Authority (YCUA) are currently served by branched feeds and are projected to remain so throughout the 50-year planning period.

Table 6-12 identifies additional customer communities whose distribution systems will be served by a branched feed during one or more decades of the plan.

TABLE 6-12
DWSD Customer Communities Served by Branched Transmission Systems

Decade	DWSD Customer Communities Projected to be Served by a Branched Transmission System at Beginning of Decade[1]	Piping Loop Added During Decade	Branched System Communities Upgraded to Looped System by End of Decade	New Customers Projected to be Added by End of Decade and Served by Branched Transmission System
One	Wayne, Lake Orion, Orion Twp., Auburn Hills, Wixom, Commerce Twp., Walled Lake, Lenox Twp., Casco Twp, New Haven, Flint System[2]	Orion Loop	Lake Orion, Orion Twp. and Auburn Hills	Lyon Twp., Oregon Twp., South Lyon, and Wolverine Lake
Two	Wayne, Wixom, Commerce Twp., Walled Lake, Lenox Twp., Casco Twp., New Haven, Flint System[2], Lyon Twp., Oregon Twp., South Lyon, and Wolverine Lake	Haggerty Loop, Michigan Ave. Loop and 2nd Feed from Lake Huron WTP	Wayne, Commerce Twp., Lenox Twp., Casco Twp., and New Haven	None
Three	Wixom, Walled Lake, Flint System[2], Lyon Twp., Oregon Twp., South Lyon, Wolverine Lake	None	None	Brighton, Brighton Twp., Green Oak Twp., Hamburg Twp., and Milford
Four	Wixom, Walled Lake, Flint System[2], Lyon Twp., Oregon Twp., South Lyon, Wolverine Lake, Brighton, Brighton Twp., Green Oak Twp., Hamburg Twp. and Milford	Springfield Loop	Wixom, Walled Lake, Milford and Wolverine Lake	None
Five	Flint System[2], Lyon Twp., Oregon Twp., South Lyon, Brighton, Brighton Twp., Green Oak Twp. and Hamburg Twp.	Second Feed to Flint and Brighton-Ann Arbor Loop	Flint System[2], Lyon Twp., and South Lyon	None

[1] Note that the communities of Utica, Lapeer, Mayfield Twp., Imlay City, Brownstown Twp., Woodhaven, Gibraltar, Rockwood, South Rockwood, the Ash Twp. System (including Ash Twp. and Carleton), the Berlin Twp. System (including Berlin Twp. (Monroe) and Estral Beach) and the YCUA System (including Augusta Twp., Pittsfield Twp., Superior Twp., York Twp., Ypsilanti Twp. and Ypsilanti) are also currently served by branched feeds and will remain so throughout the planning period.

[2] The Flint System provides service to the City of Flint and the Genesee County Drain Commission (GCDC) System. The GCDC System serves Burton, Clayton Twp., Clio, Davison Twp., Flint Twp., Flushing, Flushing Twp., Gaines Twp., Genesee Twp., Grand Blanc Twp., Montrose, Montrose Twp., Mt. Morris, Mount Morris Twp., Mundy Twp., Richfield Twp., Swartz Creek, and Vienna Twp.

6.4 Projected System-Wide Pressures

Average water pressures at key locations throughout the DWSD water system have been projected by the models. These projections, for the average demand day and maximum demand day of each decade-ending year through 2050, are presented in Tables B-1 and B-2, respectively, of Appendix B. Reasons for some of the more significant changes in water pressures from existing pressure ranges at various locations in the system are presented in the introduction included in the appendix.

6.5 Source Water Protection

The Task D "Source Water Protection" Report has recommended short-term (within 3 years), intermediate-term (4 to 10 years) and long-range (beyond 10 years) actions toward developing and implementing a source water protection program.

Short-term actions will include monitoring of federal and state regulations and initiatives on source water protection and watershed issues and emphasize the further understanding and review of similar programs around the country, data collection of watershed conditions and planning, and contacting stakeholders in the USA and Canada for program organization activities.

Intermediate-term actions will emphasize the formation of a watershed alliance team to include all local governments and other stakeholders, the establishment of public support, the continuation of data collection, the beginning of information interpretation and the beginning of implementation of program activities.

Long-range actions will emphasize maintenance and refinement of program activities and the measurement of goals accomplishment.

The development of the source water protection program will be a dynamic process, and federal and state regulations are still developing. The watersheds containing the three DWSD drinking water intakes are large and international, and the multi-agency, multi-community programs involved in the source water protection program will require coordination and cooperation.

The CWMP has developed a recommended 50-year CIP for Source Water Protection. The activities included in the CIP and their suggested budgets are presented in Table 11-2 of the Task D "Source Water Protection" Report. These costs have been incorporated into the Task F "Financial Plan" Report.

SECTION 7

Human Resources Plan

7.1 Introduction

The CWMP makes a number of recommendations for both capital projects and management projects. The knowledge, skills and attitude of DWSD's workforce will affect the development and implementation of both types of projects, and will affect DWSD's ability to efficiently manage, operate and maintain the infrastructure and equipment recommended in the CWMP. As a result, the CWMP has assessed and recommended human resource strategies in the Task F "Human Resources Plan." Over the course of the planning period, it is hoped that these strategies will serve to optimize the performance of the recommended projects.

7.2 Plan Development

After reviewing background documents, CWMP staff conducted twenty nine management interviews at multiple management levels and at a variety of sites to develop an understanding of current and potential issues which could affect the performance of the projects identified in the CWMP.

Next, the results of the review were compared with a model for integrating people, projects and processes. Then gaps, or potential areas where a new or improved human resources strategy could improve the performance of CWMP projects, were identified.

Finally, a broad set of strategies was recommended which, if pursued, will help maximize the expected benefits of the projects implemented under the CWMP.

7.3 Recommendations

7.3.1 Performance Management

For a number of reasons, DWSD will face increasing demands for cost and process improvement. Support mechanisms such as those recommended below will need to be improved and new ones created to enable a change to an increasingly performance oriented work environment. The recommendations of the Task F "Human Resources Plan" Report in this area include:

- Build commitment to the review process used for measuring the performance of DWSD staff.

- Develop unit performance scorecards for DWSD staff.

- Strengthen progressive/positive discipline procedures.
- Improve legal and management support for dealing with substandard performance.
- Develop new recognition-reward processes and/or group incentive programs.
- Strengthen organization development section of the internal HR group.
- Encourage business and work process re-engineering projects.

7.3.2 Staff Development

An obvious yet very important element of successful capital project performance is the competence of those charged with managing, operating and maintaining the processes or equipment provided by the project. The Task F "Human Resources Plan " Report recommendations in this area include:

- Substantially strengthen the existing training and development function.
- Build on existing certification initiatives.
- Explore a pay for skill system.
- Create smart user involvement strategies as capital projects are designed and implemented.

7.3.3 Labor-Management Strategy

The cultivation and development, over the long term, of a favorable labor-management climate is critical to the ultimate performance and success of the projects that comprise the CWMP. The Task F "Human Resources Plan" Report recommends the incorporation of several specific elements into the development of a long-term management strategy for productive labor-management relations.

7.3.4 HR Support – HRIS System

DWSD does not have adequate information on very important HR measures. Contemporary Human Resources Information Systems (HRIS) are essential to improving organizational performance. HRIS functions particularly important to DWSD include staffing/workforce planning, staff development planning, and succession planning.

7.3.5 HR Support – Staffing/Workforce Planning

To deploy skills and human resources where needed, DWSD must develop an effective staffing planning process which will enable management to see where skills exist and how they can cost-effectively staff those skills in areas requiring additional resources. The Task F "Human Resources Plan" Report recommendations in this area include:

- Developing an accurate skills-resource inventory.
- Conducting an annual organizational requirements review including current status and gap identification.
- Developing appropriate acquisition and deployment strategies to fill identified gaps.
- Developing and implementing an on-going formal succession planning system.

7.3.6 HR Support – Recruitment Selection Process

It will be vital to DWSD as the CWMP projects unfold to recruit and hire those critical skills necessary for managing, operating and maintaining more sophisticated, complex technologies. The Task F "Human Resources Plan" Report recommendations include a complete re-engineering of the recruitment-selection process.

7.3.7 HR Support – Compensation

The Task F "Human Resources Plan" Report recommendations include:

- Build on a fundamentally sound current approach to compensation.
- Use a sophisticated workforce planning system to plan and identify critical human resources needs.
- Narrow salary survey activity to those areas identified as critical for DWSD.
- Develop targeted strategies for competitive salary adjustments or longer term strategies in those critical arenas.
- Work to "broadband," or flatten, the job titles and / or job categories for non-critical positions, creating broader jobs entailing multiple skill sets.
- Consider group incentive goal-sharing plans contingent on specific DWSD performance targets.

SECTION 8

Financial Plan

8.1 Introduction

The CWMP projects that DWSD will be required to make significant capital improvements to its water system over the next 50 years. The Task F "Financial Plan" Report presents a long-term financial plan that assesses the financial impacts of these projects. This section presents a summary of that plan.

8.2 Data Sources, Assumptions and Methodology

The financial plan is based on a number of data sources, which include documents identified in the Task F "Financial Plan" Report and interviews and discussions with DWSD staff.

The methodology used in the completion of the financial projections is directly based on the annual rate projection and documentation by DWSD's rate consultant, Black & Veatch. For the purposes of this analysis, actual unit rates are not presented, but rather the annual revenue requirement for the Department overall is projected. The total annual revenue requirement consists of the sum of the annual O&M expenses, annual rate-financed capital improvement expenses and annual debt service expenses resulting from the issue of long-term debt. In the development of the annual revenue requirements, the following are among the assumptions that were used:

- The Department is not expected to receive any state or federal grants in support of its capital improvement program.

- Starting in FY 2009, the Department is assumed to be eligible to finance a small portion of its annual unfunded capital needs through Drinking Water Revolving Fund (DWRF) loans. These loans are assumed to carry an interest rate of 2.5% over a term of 20 years.

- The Department will use both pay-as-you-go capital and debt financed revenue bonds for the balance of the CIP. The bond issues are assumed to have a term of 30 years with an interest rate of 6 percent starting in FY 2007. Debt issued in prior years carries an interest rate of 5.5 percent.

- Operating and maintenance costs are projected to inflate at a 3.0 percent average annual rate over the study period beginning in 2009, as DWSD's current five-year (FY 2004 through FY 2008) O&M and capital projections have inflation built into them.

8.3 Capital Improvement Program

Table 2 of the Task F "Financial Plan" Report presents the CWMP Recommended Capital Improvement Program as well as projected water system O&M costs throughout the 50-year planning period. The capital costs for the recommended improvements are separated into three categories as described below:

1. **New Infrastructure**

   Under this category, the capital costs of all the proposed new routings of transmission piping (including looping of piping to provide more secure feeds to customer communities), new equalization and emergency storage reservoirs, new pump stations, plant water quality improvement projects (including UV and ozonation systems at the WTPs and source water protection), and the expansion of the Lake Huron WTP are presented as line items.

2. **Rehabilitation and Replacement (R & R)**

   This category includes the replacement of existing transmission piping (both age-related and capacity related); the replacement of the City of Detroit's distribution piping, which was not specifically addressed by the CWMP but for which short – term cost projections (from the DWSD CIP) and long-term cost projections (from the CS-1332 "Detroit Model" project) have been included; all projects identified by the Needs Assessment Studies for the Northeast, Springwells and Southwest WTPs; other capital improvements identified for the water mains, pump stations and reservoirs in DWSD's CIP dated July 2003; unidentified structural and equipment rehabilitation and renovation at the WTPs, pump stations and reservoirs; capitalized maintenance; and the implementation of an overall water system asset management program.

3. **Technology**

   DWSD's CIP line item for computer systems is included under this category.

Table 8-1 summarizes the CWMP Recommended CIP presented in Table 2 of the Task F "Financial Plan" Report.

TABLE 8-1
Summary of CWMP Recommended CIP and O&M Costs for FY 2004-2050 by Decade (in Year 2003 dollars X 1000)[1]

Description	FY 2004 through FY 2010	FY 2011 through FY 2020	FY 2021 through FY 2030	FY 2031 through FY 2040	FY 2041 through FY 2050	Planning Period Sum by Category
CIP						
1. New Infrastructure	$507	$866	$386	$330	$209	$2,297
2. Rehabilitation & Replacement (R&R)	$1,118	$1,890	$1,133	$1,065	$1,077	$6,283
3. Technology	$147	$47	$47	$47	$47	$335
Total Capital Costs	**$1,772**	**$2,803**	**$1,566**	**$1,442**	**$1,333**	**$8,916**
O & M Costs	$1,138	$1,796	$1,903	$1,976	$2,067	$8,880
CIP + O & M Costs	**$2,909**	**$4,599**	**$3,469**	**$3,418**	**$3,401**	**$17,796**

[1]Though most of the capital costs were estimated in Year 2000 dollars, all costs are assumed to be in Year 2003 dollars for uniformity.

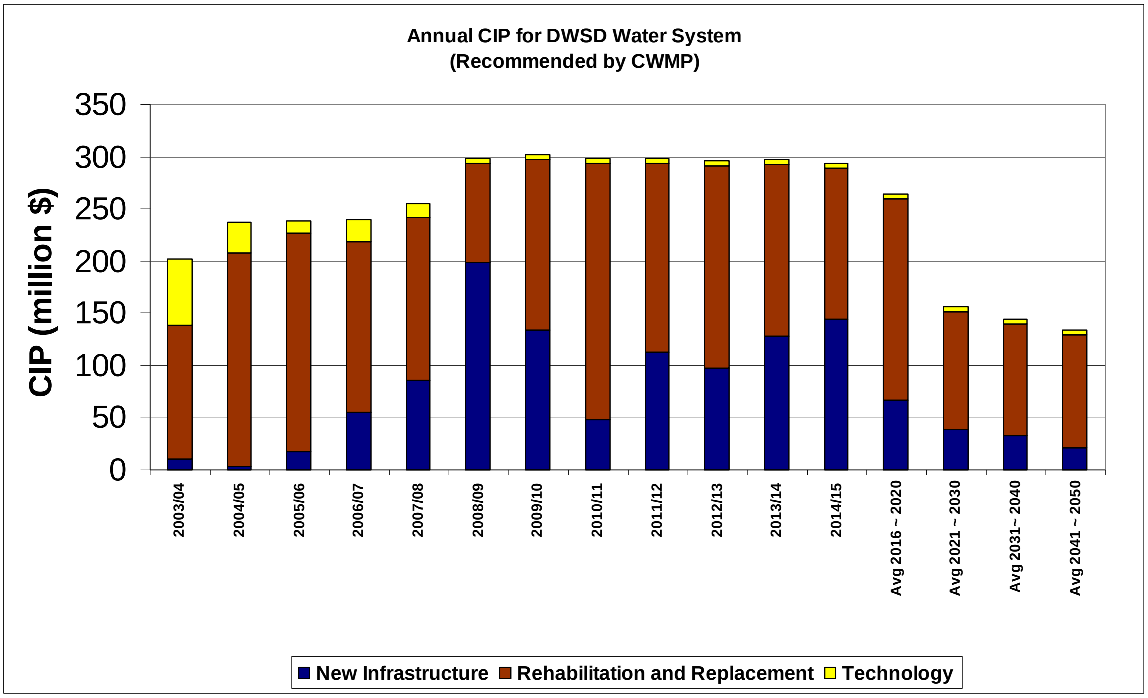
The CIP totals approximately $8.9 billion in Year 2003 dollars over the fifty-year planning period, of which approximately $4.6 billion is projected by the year 2020. Of the total amount, approximately 26% is designated for new or expanded water infrastructure; 70% on various water system R & R; and the balance of 4% on technology upgrades.

The CIP varies from approximately $200M per year to $250M per year for the period FY 2004 through FY 2008, and this is in accordance with the current DWSD published "Water Supply System Capital Improvement Program." From 2009 through 2020, the master plan projects an annual capital budget increasing to approximately $300M per year. From 2020 through 2050, the master plan projects that the capital budget will decrease to about $150M per year, approximately 70% to 80% of which is attributed to R & R of infrastructure. It must be recognized however that projections of need beyond 2020 cannot be determined with the same level of confidence as those for the shorter term up to 2020, and it is very likely that additional needs will be identified as this time frame approaches.

DWSD's R&R needs are not unusual. Renewal and replacement will be a major component of all water utilities' CIP needs over the upcoming decades. The EPA, in its 2002 report "*The Clean Water and Drinking Water Infrastructure Gap Analysis,*" reported that a 1999 EPA nationwide needs assessment survey identified a nationwide renewal and rehabilitation need of approximately $218 billion in 1999 dollars. For the DWSD system, the total R & R costs for the fifty-year planning period are projected to be approximately $6.3 billion in Year 2003 dollars.

The CIP as projected for the fifty-year planning period is shown graphically in Figure 8-1.

FIGURE 8-1
Recommended Annual CIP for the DWSD Water System -FY 2004-2050 (in Year 2003 dollars)



The CWMP task reports have recommended schedules for construction of the various components of the system based on a projected need that is generally driven by renewal, and/or growth needs. However, the scheduling of some of this work has been delayed or modified as part of the financial planning in order to maintain capital spending within the limits that have already been defined in the current DWSD CIP and a ceiling of $300 million per year from 2009 and beyond. This ceiling has been set using past DWSD experience in combination with engineering judgment, and is based on the maximum amount of construction that is considered reasonable to undertake in any one year in combination with the cumulative impact on the water rates structure. It should be noted that the affect of the slippage in the scheduling of some of the transmission main replacements has not been accounted for in the hydraulic modeling of the water system. Since replacement delays will impact the capacities of the mains, it is expected that the timing of the addition of new customers to the system will be delayed somewhat beyond the dates identified in Section 6 of this Summary Report.

8.4 Operations and Maintenance Costs

Operations and Maintenance (O&M) costs are those costs associated with the ongoing day-to-day water operations, including labor, power, chemicals, materials, etc. They include minor repairs to facilities and infrastructure but do not include major infrastructure rehabilitation or replacement costs as these are accounted for in the CIP.

O&M costs can be categorized so that comparisons or some basic "benchmarking" can be made with peer utilities to assess the validity of projecting these costs forward to future years for planning purposes.

Currently, the total O&M budget for the water department is about $150M. For comparison purposes, this has been categorized into three primary areas as follows:

- Production, including Source of Supply and Treatment
- Transmission and Distribution
- Administration

This categorization allowed comparison of DWSD O&M costs with a number of other large U.S. utilities using the AWWA Operating statistics for 1999, the latest year for which the data has been published. These data were compared graphically in the Task F "Financial Plan" Report with the DWSD data for the same year. A review of these graphs shows that, on an overall basis, the DWSD O&M costs for the water system operations compares favorably with other large utilities across the United States. In terms of overall system O&M cost, only two of the ten utilities surveyed were lower in overall system O&M costs than DWSD. The lowest-cost utility was New York City at $448/million gallons (MG). However, it must be recognized that New York City does not have the same level of treatment costs that the other utilities surveyed experience because its water is not filtered. Orlando ($544/MG) was marginally lower than Detroit at $617/ MG. The highest O&M cost utility was East Bay MUD at $1,559/MG.

DWSD production costs were found to be the lowest of all of the utilities surveyed, and overall administration costs are third lowest behind New York City and Milwaukee. However, the O&M costs for transmission and distribution are third highest at $367/ MG; this statistic may be attributed, at least in part, to the expanse of the service area and the long lengths of transmission mains and associated pumping costs included in the system operation.

Peak energy demands in the DWSD transmission system are expected to decrease over time due to the adoption of the hybrid mode of operation, which utilizes high ground storage to supply peak demands, as described in Section 5. Other advances in technology and improvements in operational efficiencies could lead to additional O&M cost savings. However, these savings may be offset by increasing O&M costs associated with increasingly stringent regulatory requirements, rising unit energy costs and the expansion of the system into areas having higher ground elevations and associated pumping requirements. For planning purposes in Table 8-1 for the period up to 2008, O&M cost projections used are the same as those provided by DWSD in their current rate projections. For 2009 and beyond, total O&M costs have been projected forward using the same unit costs per MGD as DWSD experiences today. As the water demand is projected to increase, the O&M costs have been projected to increase proportionally, using constant dollars per MGD of water produced.

8.5 Revenue Requirements

The annual revenue requirements have been determined by adding the projected expenses for operating and maintenance activities to debt service resulting from the master plan and the amount required to comply with the Department's debt service coverage requirements. The rate of increase in revenue requirements is therefore dependent on the capital financing assumptions, the rate of increase in existing expenditures and the annual volume of capital improvements. The result will be a range of annual financial requirements that can be used by the Department for planning purposes. However, considering the long time frame of the analysis, it is recommended that the department undertake a regular annual re-evaluation of the financial projections. This review should incorporate more detailed CIP planning schedules, updated cost estimates and more current customer allocation information. Updated projections should also reflect changes in the Department's cost allocation methodology, if any are approved and implemented.

Changes in the revenue requirements are summarized herein. Only a snapshot of the detailed financial projections is provided here. Again, it is important to view these projections as the results of a planning effort. As events unfold, the projections contained herein will be subject to significant modification. The Department and its customers will need to be cognizant of this over time and make adjustments as appropriate.

The projections described below are based on the assumption that the Department continues to set rates to generate a debt service coverage ratio of 40 percent consistent with current fiscal planning, which is over and above the legal covenant of 25 percent. Reduction of the debt service coverage requirement would lower the Department's annual revenue requirements over the short term. If the Department reduces targeted coverage, its amount of cash-funded capital would fall, but the amount of debt it must issue for a given capital improvement program would increase. The short-term reduction in the revenue requirement could be significant, but the benefit of the lowered target coverage would decline with time due to increasing annual debt service expenses.

The revenue requirement projections as shown in Table 8-2 are based on the CIP and O&M costs as presented in Table 2 of the Task F "Financial Plan" Report. In FY 2004, the revenue requirement is projected to be equal to approximately $283 million. In FY 2004, the Master Plan does not yet have an impact on the financial revenue requirement of the Department.

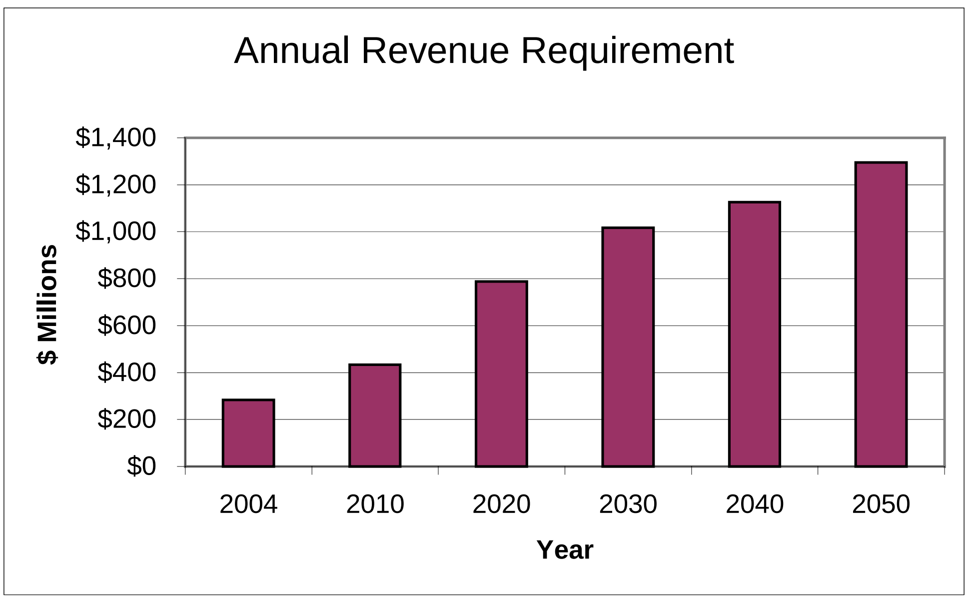
The composition of the revenue requirement changes over the 50-year timeframe. Overall, the annual revenue requirement, including the incremental expenses driven by the CWMP implementation, is projected to increase to approximately $1.3 billion in FY 2050, from the FY 2004 level of $283 million, as indicated in Table 8-2 and Figure 8-2.

TABLE 8-2
Projected Annual Revenue Requirements for DWSD Water System – FY 2004-2050 (X 1000 and adjusted to include 3% annual inflation)

	2004	2010	2020	2030	2040	2050
O&M	$150,400	$182,200	$261,000	$364,300	$508,600	$715,700
Debt Service	$ 92,400	$179,400	$376,600	$466,500	$395,700	$413,800
Capital from current revenue	$ 40,600	$ 71,800	$150,600	$186,600	$158,300	$165,500
Allowance for other revenue needs[1]					$ 62,400	
Totals	**$283,400**	**$433,400**	**$788,200**	**$1,017,400**	**$1,025,000**	**$1,295,000**

[1]Available due to assumption that revenue requirement remains level from 2034 to 2040. See text and Figure 8-3.

FIGURE 8-2
Projected Annual Revenue Requirements for DWSD Water System – FY 2004-2050
(adjusted to include 3% annual inflation)



In accordance with current financing, certain existing revenue bonds are due to be paid off in 2029, and a second set in 2034. This theoretically reduces DWSD's total revenue requirements, and although the calculated revenue requirements show a slight decline in the time period 2034 – 2040, it has been assumed for rate projection purposes that the revenue requirements will remain level during these time frames. It is assumed that refinancing or other revenue needs will make up the difference.

The Department uses a “cost-of-service” rate system, driven by elevation, distance and capacity factors in order to recover costs and charge its customers. Although this report does not attempt to project rates for individual customer communities, average rates of change in revenue requirements have been determined that will be roughly equivalent to the anticipated changes in rates (assuming no material change in the Department’s approved rate methodology).

A key aspect of this analysis is that the projected revenue requirement increases are front-loaded; that is, the revenue and rate increases are much greater in the shorter time frame than in the longer term. This reflects the need for the Department to catch up with its system rehabilitation, and then the system’s costs will stabilize as repair and replacement expenditures stabilize in latter years. The timing of the Department’s existing debt payments enhances the projected rate pattern. Eliminating this debt reduces the Department’s revenue requirements by a significant amount and provides room within the revenue requirement to support significant new debt without increasing rates.

Table 8-3 shows the anticipated average annual rate increases for customers in each of the 10-year intervals. Rate increases are projected to average 7.5 percent annually from 2004 through 2010; for the reasons described in the preceding paragraph, the average annual rates of change fall significantly toward the end of the analysis timeframe.

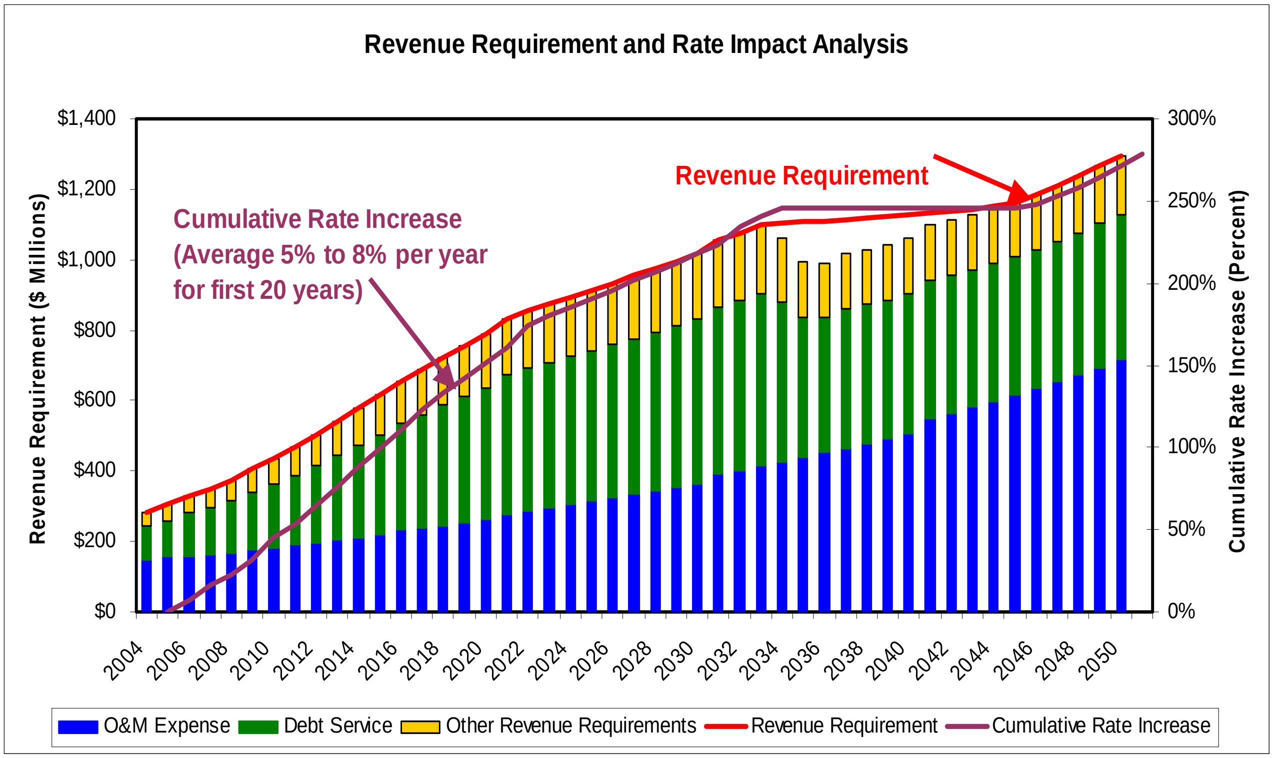
TABLE 8-3
Anticipated Average Annual Rate Increase (including adjustment for 3% annual inflation)

	2004-2010	2011-2020	2021-2030	2031-2040	2041-2050
Rate Increase	7.4%	5.4%	2.2%	0.7%	0.9%

Over the fifty-year planning period, rate increases are projected for all customers to increase at an average annual rate of about 3.4 percent. However, as noted earlier, projections are considered to be more reliable for the first twenty-year period and the rate increases are projected to increase at an average annual rate of between 5% and 8% during this time frame.

Figure 8-3 illustrates the financial projections graphically.

FIGURE 8-3
Projected Revenue Requirement and Rate Impact Analysis (adjusted to include 3% annual inflation)



8.6 Program Delivery

The CIP recommended by the CWMP is aggressive both in terms of the number of projects and the size of the annual budgets projected, particularly over the first twenty years of the planning period. The annual capital budget for the DWSD water system has grown substantially over the period of the past ten years. The CIP has grown from an annual budget of approximately $25M per year in the early 1990s to $200M in FY 2004. This is planned to grow to more than $250 M by FY 2008, and then to approximately $300M per year from FY 2009 through FY 2015.

The largest component of the recommended CIP relates to the rehabilitation and replacement (R & R) program for pipelines and other infrastructure. This component of the CIP is somewhat the result of a "catch up" process as many components of the DWSD system are aging and the R & R process has typically been under-funded in past years.

There are two individual components of the overall R & R program that can themselves be identified as major programs. The first is the rehabilitation program identified by the Needs Assessment Reports for the Northeast, Springwells, and Southwest water treatment plants. The rehabilitation work recommended for these three plants totals approximately $530 million in Year 2003 dollars, would be completed by FY 2015, and is needed both to bring the plants up to current standards for treatment and to allow their operation at the capacities for which they were initially rated.

The second major R & R program relates to the pipelines. The recommended CIP identifies the transmission system and the Detroit distribution system as two separate areas of pipeline replacement/rehabilitation. However, they could be viewed as one program for purposes of implementation. This program is scheduled to continue over the entire fifty-year planning period and beyond and represents a significant component of the CIP, amounting to approximately $2.0 billion in Year 2003 dollars.

DWSD has recently employed three different models for project delivery. The traditional design, bid, build (DBB) model has been and still is employed for the majority of the DWSD projects. Some of the larger projects have employed the design build (DB) model and examples of this model include the new Water Works Park II water treatment plant, the Lake Huron Residuals Management System and the Haggerty Road pumping station and reservoir, as well as others. In addition, the program management (PM) model has been employed for the very major ($550M) and long-term rehabilitation program at the wastewater treatment plant, PC-744.

There is no one model that is appropriate or “the best” to apply to all projects. Various projects within the long-term CIP will be appropriate for the application of all three of these delivery models. Many of the smaller projects will continue to utilize the DBB model. The DB model may be the best delivery model for some of the larger and stand-alone projects such as new reservoirs, new pumping stations, and perhaps some of the new transmission mains.

The two major R & R programs should be viewed as such for delivery through a PM model. This rehabilitation program for the Northeast, Southwest and Springwells WTPs identified in the Needs Assessment Reports contains a multitude of individual projects that are very closely interrelated. Scheduling of the work will be critical and dependent on a number of issues including such as seasonal variation in water demand. In addition, the nature of the work will require special skills in order to deal with the technical interrelationships. This program has a limited time frame of approximately ten years and should best be managed in a manner similar to the current program underway at the wastewater treatment plant using external expertise and resources.

The pipeline replacement/rehabilitation program will continue for the entire 50-year planning period of the CWMP. Its program approach will involve, firstly, a prioritization process, and then the initiation of the projects on an individual basis. There are a number of variations as to how this program can best be initiated. However, this ongoing program is of such a nature and with such a long and extended time frame that DWSD should organize and develop a dedicated in-house team to manage this important aspect of the CIP. Some external resources may be needed in the early stages to initiate the process. The CWMP recommends that DWSD give an early priority to the adoption of a formal “Asset Management Program” to assist in the prioritization process and to apply as a tool in the development of a long-term program.

The scope of the CIP, as projected, is such that the current resources within DWSD will need to be expanded or supported significantly to expedite the work as scheduled.

If DWSD does not establish the aggressive R & R program described in the CWMP, it can be anticipated that total costs for the recommended projects will increase as the infrastructure crumbles and R & R projects are conducted on an emergency basis.

SECTION 9

Customer Outreach Partnership Program

Through the CWMP efforts, DWSD has initiated a Customer Outreach Partnering Program. The outreach program began in March 2003, with two primary objectives. Firstly, the program seeks to identify customer related issues and incorporate these into the planning process of the CWMP. Secondly, the program provides a forum for DWSD to advise customers on the progress of the CWMP planning process and to keep them up to date on the study findings and recommendations.

The structure of the program involves a Technical Advisory Committee (TAC) made up of interested customer communities along with DWSD staff and representatives from the MDEQ and SEMCOG. The TAC is supported by DWSD's planning consultants. The TAC membership comprises approximately 26 of the 85 first-tier customers.

The mission statement established by the TAC membership for the outreach program is stated below:

Our mission is to provide a safe, secure and reliable potable water supply with sufficient quantities and pressures and in an efficient and cost effective manner that protects public health through proactive efforts to sustain communication, education, cooperation and a level of service acceptable to all customers.

Following formation of the TAC, customer issues were identified and workshops were conducted with customers throughout the DWSD service area to address these issues. All first tier and second tier customers were invited to these workshops. The primary issues that were identified include the following:

- Fair and equitable rates
- Emergency preparedness
- Contracts
- Customer service
- System pressures, and
- Metering accuracy

Following the work in 2003, the TAC has put together a work plan for 2004 to take these issues to the next step. This will involve efforts such as:

- An educational program dealing with the ratemaking process
- Communications protocols for coordinating between DWSD and its customers under emergency situations
- Preparation of a standardized customer service contract
- Identification of system pressure issues and how these need to be addressed
- Addressing metering issues of ownership, meter accuracy and maintenance

The DWSD envisions the Customer Outreach Partnering Program will continue beyond the current efforts of CWMP. The issues will likely change and evolve as the program progresses, but the communication with and involvement of the customer communities is now the focal point of the program.

Appendix A

Population Served by DWSD in Study Area and Water Usages by Community

Appendix B
Projected Average System-wide Water Pressures by Decade

Projected Average System-wide Pressures by Decade

Tables B-1 and B-2 present projected average water pressures at key locations throughout the DWSD water system, based on the decade computer models of the CWMP. In many cases, the projected pressures fall outside the existing operating pressure ranges established by DWSD for a given location. These changes in operating pressures will result from both higher water demands and the construction and connection of new infrastructure (i.e., transmission piping, pumps and storage tanks). The CWMP level-of-service criteria for pressures (minimums of 40 psi at demand takeoffs and 20 psi elsewhere throughout the system, maximums below design pressures of new and existing pipes) and head loss (average less than 3 feet / 1,000 feet) are met in all models. The most significant deviations from the existing pressure ranges and their causes are identified below:

Southwest WTP discharge: The average MDD pressure is expected to increase to approximately 103 psi by 2010 due to a higher MDD throughput resulting from an increase in the plant's firm low-lift pumping capacity.

Springwells WTP HPZ discharge: The average MDD pressure from the plant's HPZ pumps is projected to rise to 118 psi by 2010 due to the replacement of the pumps and resulting increase in MDD plant throughput.

Adams Road Pump Station suction: The average MDD pressure is projected to increase above the current range by 2020 because the discharge pressure from the NSC Pump Station will increase to enable that station to pump against the increased pressure in the 72-inch pipe to the south, which also ties into the Adams Road Pump Station suction. The flow in the 72-inch pipe is projected to increase due to redistribution of flows associated with the connections of the new Haggerty pipe loop, the new 24-Mile Road pipe extension and the new high-ground storage tank southwest of the Adams Road Pump Station.

Electric Avenue Pump Station suction: The average ADD and MDD pressures are expected to increase above their current ranges by 2010 because current Needs-Assessment-defined upgrades to the Southwest WTP, which feeds this station, will increase its throughput and enable it to raise the pressures in the transmission mains it feeds.

Ford Road Pump Station discharge: The average MDD pressure is projected to increase above the current range by 2010 because this station will be pumping against the increased discharge pressure of the new Springwells WTP HPZ pumps.

Franklin Pump Station suction: The average ADD pressure is projected to increase by 2010 because of the redistribution of flow caused by the new 31-Mile Road pipeline and Orion pipe loop and resulting anticipated increases in flow and pressure in the recently-installed 72-inch line from the North Service Center Pump Station to the Franklin Pump Station.

Haggerty Pump Station suction: The average ADD pressure is projected to increase significantly, to over 80 psi, by 2010 because the new 14-Mile Road parallel main will reduce the head losses in water pumped from the Franklin Pump Station. The average MDD pressure is projected to rise to 60 psi by 2020 because of the construction of the Haggerty pipe loop.

Michigan Avenue Pump Station discharge: The average MDD pressure is projected to increase to over 90 psi by 2010 to maintain adequate pressure at the end of Michigan Avenue. It is projected to rise to over 100 psi by 2020 due to the construction of the Michigan Avenue pipe loop, which will demand an increased pressure to feed the Joy Road Pump Station.

North Service Center (NSC) Pump Station discharge: The average MDD pressure is projected to increase significantly by 2020 due to the construction of the Haggerty pipe loop, which will raise the pressure in the mains the NSC will discharge to.

Northwest Pump Station suction and discharge: The average ADD and MDD pressures are projected to increase above their current ranges by 2010 because of the projected increase in the discharge pressure of the Springwells WTP's new HPZ pumps.

Rochester Pump Station discharge: The average ADD and MDD pressures are projected to increase to 171 psi and 165 psi, respectively, by 2020 because of the cumulative effects of the activation of the proposed 24-Mile Road pipe extension, the corresponding shift in pumping direction to the west exclusively and the installation of proposed high-ground storage tanks at Brown east of Baldwin and southwest of Adams Road Pump Station. The average MDD pressure is projected rise further, to 195 psi, by 2030 after the pumping capacities are increased at the Franklin, Romeo and North Service Center Pump Stations.

Rochester Pump Station suction: The average ADD pressure on the 96-inch line from the north is projected to increase to 117 psi by 2010 because a higher suction pressure is needed for the new Romeo Pump Station, which will pump uphill to Independence Township after the construction of the new transmission main along 31 Mile Road. The average MDD pressure at the suction is projected to rise to 106 psi by 2030 due to the required increase in discharge pressure.

West Chicago Pump Station suction: The average MDD pressure is projected to rise above its current operating range by 2010 because of the projected increase in the discharge pressure of the Springwells WTP's new HPZ pumps.

Wick Pump Station discharge: The average MDD pressure is projected to increase above its current range by 2010 due to the construction of the new Wick Road parallel transmission main.

Ypsilanti Pump Station suction: The average MDD pressure is projected to increase above the current operating range by 2010 due to the construction of the new Wick Road parallel transmission main. It is projected to decrease to 29 psi by 2050 if Ann Arbor becomes a customer.

Dorsey & Dickerson monitoring location: Reasons for increasing pressures at this location are the same as those for the Rochester Pump Station suction.

Eight Mile Road & Sheldon monitoring location: The average ADD and MDD pressures at this location will be slightly below the minimum current operating pressure of 65 psi due to the construction of the new high ground storage tank at this location. A minimum pressure of 40 psi will continue to be available at all demand nodes.

14 Mile Road & Lipke monitoring location: The average ADD and MDD pressures at this location will increase above the current range by 2004 due to the opening of the 42-inch Chesterfield loop (currently under construction).

Lake Huron to NSC Pump Station monitoring location: The average ADD pressure at this location is projected to increase above the current range by 2010, and the average MDD pressure is expected to increase markedly by 2030. The reasons for these increasing pressures are the same as those given above for the Rochester Pump Station suction.

Michigan & Hannan monitoring location: The average MDD pressure is projected to increase to about 85 psi by 2020 for the same reasons as given above for the Michigan Avenue Pump Station discharge.

Scottsdale Valve South monitoring location: The reasons for increasing pressures at this location are the same as those given above for the Franklin Pump Station suction.

Twelve Mile Road & Callahan monitoring location: The reasons for increasing pressures at this location are the same as those given above for the 14 Mile Road & Lipke monitoring location.

Tyler & Belleville monitoring location: The average MDD pressure is projected to increase to 84 psi by 2010 due to the opening of the Wick Road parallel main.