City of Flint
Water Reliability Study
Distribution System

December 2013

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Executive Summary

Reliability Plan Purpose & Scope

The purpose of this Reliability Plan is to conduct an evaluation of the City of Flint water distribution system. This study includes analyzing the water distribution system's ability to address the existing and projected future water demands. The *City of Flint Water System Review* performed by the Michigan Department of Environmental Quality (MDEQ) Drinking Water & Radiological Protection Division in 2008, rated the water distribution system as "deficient", citing key improvements being necessary to the water supply including:

- Distribution system improvements
- Transmission system improvements
- Improvements to pumping stations
- Develop the necessary rate structures to operate and maintain the water system and construct the necessary infrastructure to meet the 20-Year Capital Improvement Program.

With this information, the city will be able to identify necessary improvements to the existing water distribution system and plan for additional capacity at water storage facilities and booster pump stations. Furthermore, they will be able to implement and financially plan for the proposed water infrastructure improvements in the future.

Reliability Study Major Tasks Completed

- City of Flint water system model ported to GIS-based modeling software and model updated to reflect current demands and conditions.
- City of Flint General Plan updated to reflect existing conditions and show all valves and hydrants.
- Genesee County demands added to model.
- Annual Average Day (AAD), Maximum Day (MD), and Peak Hour (PH) scenarios developed.
- Six-Year Capital Improvement Program
- Valve and hydrant assessment
- Calibration of Model
- Calculation of unaccounted for water
- 20-year operational alternatives evaluated
- 20-year demands evaluated and modeled for AAD, MD, PH
- 20-Year Capital Improvement Program
- Water System Asset Evaluation
- Water System Recommendations
- Preliminary Asset Management Plan

upgrading and expanding. The review of the SCADA system was not in the scope of this study, but it should be evaluated and upgraded.

G. GIS Based Asset Management

The city has established a GIS Department that is working on inventorying the water and sewer assets of the city. Some of this information was used in the preparation of this report. Given the size and age of the city's water and sewer assets, it would be prudent to incorporate a GIS-based asset management program. There are several packages on the market that can be customized to fit the city's needs.

Table 1: 6-Year Capital Improvement Table

Project Number	Capital Improvement Program	Design Status	Construction Status	2010 Construction Costs	Contingencies, Engineering, Management and Legal (CEM&L @ 47%)	Total CIP Project Cost
	Major Booster Station Improvement Projects					
Project 1	Torrey Road Booster Upgrades (In-house)	Design Complete	Construct 2010	$300,000	$141,000	$441,000
Project 2	Water Pumping Station 3 Electrical and Controls Upgrade	Design in Progress	Construct 2010	$900,000	$423,000	$1,323,000
	Sub Total			**$1,200,000**	**$564,000**	**$1,764,000**
Project 3	**Major Transmission System Improvement Projects**					
Project 4	28,000 LFT of 24" & 30" watermain, WTP to Dupont; South to University	Design Complete	Construct 2011	$10,000,000	$4,700,000	$14,700,000
Project 5	Water Meter Replacement Program 3,000 meters/year		2010-2015	$1,000,000		$5,000,000
Project 6	15,500 LFT of 12" & 24" watermain; Saginaw Street, Flint River to Pierson Road	2010	2012	$3,800,000	$1,786,000	$5,586,000
Project 7	16,100 LFT of 16" watermain; Atherton Road, Van Slyke to Dort	2010	2013	$4,000,000	$1,880,000	$5,880,000
	Sub Total			**$18,800,000**	**$8,366,000**	**$31,166,000**
	Minor Transmission System Improvement Projects					
Project 8	500 LFT of 6" watermain; Hamilton Avenue, Mason Street to MLK Boulevard.	2010	2011	$50,000	$23,500	$73,500
Project 9	1,650, LFT of 6" watermain; Sonny Avenue, Dupont to Lawndale	2010	2011	$165,000	$77,550	$242,550
Project 10	1500 LFT of 6" watermain; Walton Street, Clairmont to Augusta	2010	2012	$150,000	$70,500	$220,500
Project 11	1500 LFT of 6" watermain; East Boulevard, Farmers Market to Park	2011	2013	$150,000	$70,500	$220,500
Project 12	325 LFT of 6" watermain; Alexander Street, Taylor to Rankin	2011	2014	$32,500	$15,275	$47,775
Project 13	1075 LFT of 6" watermain; Mack Street, Clio Road to Winona	2011	2015	$122,500	$57,575	$180,075
	Sub Total			**$670,000**	**$314,900**	**$984,900**
	Total CIP Costs			**$20,670,000**	**$9,244,900**	**$33,914,900**

Section 2 - Introduction

2.0 Background

The City of Flint currently provides water service to a population of approximately 118,000 through an extensive network of transmission and distribution mains. Many of these mains are aging and are in need of replacement. The city also operates several booster pumping stations and storage facilities to boost pressures and enhance service. The *City of Flint Water System Review* performed by the Michigan Department of Environmental Quality, Drinking Water & Radiological Protection Division in 2008, rated the water distribution system as "deficient", citing key improvements being necessary to the water supply including:

- Distribution system improvements
- Transmission system improvements
- Improvements to pumping stations
- Development of an Asset Management System

The review also states that much of the piping within the City of Flint is more than 70 years old and is in serious need of replacement. The City of Flint Water Service Center, which operates and maintains the water system, spends a significant amount of time repairing mains that are in poor condition. Each winter, a large number of watermain breaks occur due to the aging condition of the watermains. These breaks result in interruptions in water service and potential public health risks to city customers.

In response to this deficiency rating, the city retained ROWE Professional Services Company to develop a Water System Reliability Study to correct these deficiencies.

Before beginning the Water Reliability Study process, ROWE Professional Services Company met with City of Flint officials and Michigan DNRE staff to determine the goals of the study. These discussions produced a three-phase approach to addressing the issues raised by the DNRE. This study completes the first two phases; Phase 3 includes the treatment plant and will be analyzed in a future study.

A. Phase 1 – Model Update and Short Term CIP

Key tasks include:

- Update the city's water model including demand allocations, pumping and storage facilities, piping changes, and other associated infrastructure
- Update the city's General Water Plan
- Evaluate existing conditions and develop a short-term (6-year) Capital Improvement Plan
- Update the Contingency Plan
- Calibrate the city water model
- Analyze valve and hydrant deficiencies

B. Phase 2 – Distribution System Asset Management and 20-Year Capital Improvement Plan

Key tasks include:

- Develop modeling scenarios for 20-year water system plan
- Develop 20-year plan for the water system
- Prepare cost opinions for 20-year plan
- Analyze rate structure to support 20-year plan
- Develop an asset management plan
- Inventory water distribution system assets

2.1 Existing Conditions

A. Source Facilities

The City of Flint purchases treated water from the City of Detroit through the DWSD. The treated water is supplied to Flint via a 72-inch transmission main. This transmission main also provides water service to Genesee County and several other communities between Flint and Detroit. The flow to the City of Flint is metered to provide accurate water use records.

The city also maintains a water treatment plant as a backup supply in the event that the City of Detroit water supply is interrupted. Work to upgrade the City of Flint Water Treatment Plant (WTP) began several years ago and is progressing to completion. A number of test runs were initiated in 2006, 2007, and 2008. Additional test runs are planned for the future. The majority of the improvements at the plant have been implemented as a result. The plant is generally ready for use in a standby capacity, in the event that service from the City of Detroit water supply is interrupted. Long-term plans include provisions for expanding the capacity of the plant and implementing a softening system.

B. Water Treatment

The water purchased from the DWSD is already treated prior to reaching the City of Flint system; typically, no further treatment is required. The City of Flint also owns and operates a water treatment plant located at 4500 North Dort Highway, which serves as a backup supply in the event of a major service disruption from the DWSD water supply. The source for the City of Flint water treatment plant is the Flint River. The city has made significant improvements to the plant over the past five years and operates the water treatment plant on a quarterly basis to ensure proper operation of the plant. According to the contract with the DWSD, this water is isolated from the DWSD supply to prevent water from the two different supplies from mixing.

While the treatment plant is considered a viable backup water supply for the system, the plant is not currently operating. There are additional issues that will require a significant amount of capital investment in the future. The City of Flint estimates that the upgrades to the water treatment plant will cost approximately $25,000,000.

C. Evaluation of Storage and Pumping Facilities

The City of Flint owns and operates several water storage facilities and pumping stations. The *City of Flint Water System Review,* prepared by the MDEQ, includes a detailed review of these facilities. This review states that adequate storage and pumping facilities are currently in place; however, most of the systems are nearing their useful life and are in need of repair or replacement. A brief overview of each facility follows.

1. Dort Reservoir and Pumping Station No. 4 (P.S. No. 4)

   The Dort Reservoir is located at the City of Flint WTP and is a 20-million gallon (MG) ground storage facility. This facility was constructed in 1966 and is used primarily for emergency water storage and for use during peak water demand periods.

   Pumping Station No. 4 is equipped with three 20 mgd turbine pumps, one 25 mgd turbine pump, and one 6 mgd turbine pump. Pumps 7, 8 and 9 were installed in 1994 and Pumps 1 and 2 were installed in 1949. Pumps 1 and 2 are both considered inoperable and there are no plans to replace or repair the inoperable pumps at this time. The total pumping capacity of this station is 46 mgd, with a firm pumping capacity of 26 mgd. In 1994, the pumping station was rehabilitated with two new 20 mgd pumps and one 6 mgd pump to induce turn-over of the Dort Reservoir. This pumping station is primarily used to provide a supply from the 20 MG Dort Reservoir during emergency situations and peak demand events.

2. WTP Elevated Tank

   A 2.0 MG elevated water storage tank is located at the WTP. This tank was constructed in 1952 and is used primarily for emergency water storage and as a pressure buffer. The elevated tank fills and drains as system demands and pressures dictate. The tank was inspected and repainted in 2009.

3. WTP Ground Storage Facility

   A 3.0 MG ground storage tank is also located at the WTP complex. This storage tank was constructed in 1954 and is used primarily as an emergency water supply and pumping source during peak demand events.

4. Cedar Street Reservoir and Pumping Station (P.S. No. 3)

   The Cedar Street Reservoir is a 20 MG ground storage facility located between 1-69 and Swartz Creek, off of Cedar Street. This facility was constructed in 1948 and is primarily used as an emergency water supply and pumping source during peak demand events. The pumping station electrical controls have not been updated since the original construction. The station requires significant upgrades to bring the station up to current automatic operation standards.

The pumping station located at the Cedar Street facility is equipped with three single-stage horizontal centrifugal pumps rated at 12 mgd, 9 mgd, and 9 mgd, respectively. These pumps were installed in 1948 and are primarily used to supply water from the Cedar Street reservoir during emergency events and peak demand periods. This pumping facility has a total pumping capacity of 30 mgd and a firm pump capacity of 18 mgd.

Pump operation and filling of the reservoir can be controlled from the WTP or manually at the pumping station. Typically, the reservoir is refilled at night during low demand periods. The pumping station is equipped with chlorination facilities to provide additional chlorine residual as needed.

5. West Side Reservoir and Pumping Station (P.S. No. 5)

   The West Side Reservoir is a 12 MG ground storage facility located near Mackin Road and Jean Avenue. This facility was constructed in 1970 and is primarily used as an emergency water supply and a pumping source during peak demand events.

   The West Side Pumping Station is equipped with 2 three-stage turbine pumps and 2 two-stage turbine pumps, all installed in 1970. Pumps 1 and 2 have a capacity of 8 mgd each, and Pumps 3 and 4 have a capacity of 4 mgd each. The total pumping capacity of P.S. No. 5 is 24 mgd with a firm pump capacity of 16 mgd.

   Pump operation and filling of the reservoir can be controlled from the WTP or manually at the pumping station. Typically, the reservoir is refilled at night during low demand periods. The pumping station is equipped with chlorination facilities to provide additional chlorine residual as needed.

   It is recommended that the existing swing check valves on two of the pumps at this station be replaced to allow for proper operations of the station, and to eliminate water hammer caused by the spring check valves upon start up and shut down of the pumps. This work was budgeted for 2006 and 2007, but never implemented. The city is currently working to implement these upgrades in 2012.

6. Torrey Road Pumping Station

   The Torrey Road Pumping Station is equipped with two centrifugal pumps rated at 2.8 mgd and 4 mgd, respectively. Both pumps were installed in 1954. The station has a total pump capacity of 6.8 mgd and a firm pump capacity of 2.8 mgd. The primary function of this station is as an in-line booster pumping station to provide increased pressures to the southwest portion of the city. This pumping station takes suction from the 24" transmission main along Hammerburg Road and discharges to the 18" transmission main supplying the southwest pressure district. There is no standby power provided to this pumping station.

The City of Flint has made plans to replace the existing pumps and piping in the station. The existing pumps have exceeded their useful life and the piping and valves are in poor condition. The station is scheduled for upgraded pumps and interior piping in 2012. Permit applications were submitted to the DNRE in April 2010.

D. Condition of Service Lines

Service lines appear to be in adequate condition, with typical repairs made by city staff, depending on the age of the existing watermain and water services connected to it. The city does experience problems with a number of existing valves. The long-term needs for the system include replacement of the existing valves over the next 20 years. The total estimated cost to replace the valves is approximately $2,000,000.

E. Type of Conveyance System

The conveyance system of the City of Flint consists of water distribution and transmission main ranging in size from 4" to 72" in diameter. Many of these mains exceed 70 years old, and the majority are constructed of cast iron or ductile iron pipe up to 24" in diameter. Transmission mains larger than 24" are primarily constructed of steel piping.

The majority of the city's system has adequate transmission piping to convey sufficient flows and pressure for fire protection. However, the distribution and transmission systems are old and in serious need of replacement. Every year, a large number of watermain breaks occur within the city. These breaks, which are repaired by city staff, result in serious water service disruptions and potential water quality problems to customers of the City of Flint. The Six-Year Capital Improvement Program (CIP) in Table 1 is intended to remedy the most pressing of these infrastructure problems and the 20-Year CIP in this study will take a long term look at system-wide problems and solutions. Recent improvements to the distribution system are shown in Appendix 2.

F. Appurtenances

The City of Flint system appurtenances, similar to the conveyance system, are in general over 50 years old and in constant need of repair or replacement.

1. Valves

   The City of Flint distribution system currently has 3,931 gate valves and 3,327 gate well valves for total valve count of 7,258 valves to be operated and maintained. A breakdown of the valves by size is shown in Table 2 below.

Table 2: Valves by Size

72"	20
24" and >	661
16 - 20	737
12	1398
<12	4462

The development of an asset management plan for the valve system would include a process to move from reactionary valve maintenance to planned preventative maintenance and replacement. Given the size and age of the city system, this will take some time to transition and the following is a general outline of a plan to accomplish this over a 20-year period while addressing the critical valves within two years. In general, the asset management plan for the operation and maintenance of the valve system has been divided into three categories: critical; subcritical; and normal.

Critical valves are 16" and larger that are on the primary transmission mains around the city, and in the event of a break in a major transmission main, valve failure, or multiple valve failures, could result in shutting down a significant portion of the city. A preliminary evaluation indicates that there are 1,398 critical valves in the system and these valves should receive primary attention. Primary attention would consist of operating the valves on a rotating two-year basis and making all repairs and replacements that are necessary. Approximately 700 critical valves would be operated and maintained each year.

Subcritical valves are the 12" valves on minor transmission mains and the failure of one or more of these valves could result in shutting down a residential area. There are 1,398 subcritical valves in the system. These valves should receive secondary attention which would consist of a 5-year plan for operation and maintenance. This would require that approximately 280 valves be operated and maintained each year.

Normal valves are any valve smaller than 12" and the failure of one or more of these valves would shut down a small residential area. There are 4,462 of these valves in the system and these valves should receive operation and maintenance attention on a 10-year rotating basis. Approximately 450 valves would require attention each year.

The total valve operation and maintenance program would require that approximately 1,430 valves receive routine maintenance each year, in addition to any emergency repair and replacement that is required during the course of a year. Appendix 3 includes a map of the water system valves.

2. Hydrants

The City of Flint has 3,605 hydrants in the water system and as with the watermains and valves; many of these hydrants are in excess of 50 years old. In the spring of 2010, the city purchased 80 hydrants to begin replacing old hydrants while the Reliability Study was completed.

Similar to the asset management approach to the valve maintenance, the plan for hydrants would include a transition from reactive maintenance to planned maintenance and replacement. Here the goal would be to analyze the hydrant age in the system and begin to change out hydrants in excess of 50 years old, and then over a period of twenty years create a system where hydrant age did not exceed 25 years. Appendix 4 includes a map of the water system hydrants

G. Method of Residuals Handling

The WTP is a back-up facility and does not currently generate significant residuals. If the WTP becomes the primary water source for the city, a residuals management plan will need to be submitted to the MDEQ.

H. Design Capacity of the System

The design capacity of the waterworks system, in the form of the maximum day demand, is 36.0 mgd. The total source capacity from the DWSD exceeds 70 mgd, with a firm source capacity of 36 mgd.

The City of Flint has completed the WTP rehabilitation project, which was partially funded through the DWRF program. The city has already conducted several trial runs and is expected to complete the project in the near future. The improvements result in a firm capacity of 36 mgd.

I. Operation and Maintenance of the System

The City of Flint operates the system manually, using trained personnel with the experience and knowledge to assure proper and adequate control of the system. City personnel estimate the daily water demand anticipated to service the City of Flint and surrounding Genesee County communities and communicate such needs to personnel at the DWSD, who ensure delivery. City staff usually communicates with DWSD staff twice daily.

Water is supplied from the DWSD at an approximate pressure of 103 psi. Water demands of Genesee County communities are taken off the distribution system between the location of the DWSD water supply meter and Control Station 2 (CS 2) at the City of Flint WTP. CS 2 has a pressure reducing valve which regulates and lowers the supply pressure from 103 psi to approximately 75 psi.

If the supply pressure from the DWSD is greater than 105 psi, the valve to the Dort Reservoir at Control Station 3 (CS 3) is opened. The valve at CS 3 is also operated when the water level in the elevated tank is more than 33 feet. The Dort Reservoir is kept at a 16 foot level to have available volume for water demand fluctuations.

The Dort Reservoir is connected to Clear Well No. 3 through a valve at Control Station 5 (CS 5). The 6 MG pump located in P.S. No. 4 is used to turn over the water stored at the Dort Reservoir. The other pumps are used, as necessary, to increase distribution system low pressures due to fire flow, main breaks, and high demands.

The elevated tank fills and empties based on system pressure. If the elevated tank level drops below 20 feet during the hours of 7:00 a.m. and 3:00 p.m., P.S. No. 3 at the Cedar Street Reservoir or P.S. No. 5 at West Side are placed on-line to supply additional water to the system. Typically only one of the two stations is used at a time, and station use is alternated in order to ensure proper operation of the system.

The Cedar Street and West Side Reservoirs are filled during the night between the hours of 11:00 p.m. and 7:00 a.m., after the elevated tank is full. The West Side Reservoir is filled first; when its level is 16 feet, the filling of Cedar Street Reservoir begins.

Pump Stations 3, 4, and 5 are controlled remotely from the Water Plant Facility. The filling operation of the reservoirs is based on opening the fill valves remotely. The fill rates are controlled by opening the valve a certain percentage.

The Torrey Road Booster Pumping Station is controlled utilizing a pressure sensing station at Brown Street and Bradley Avenue (B&B). The booster pumping station has two pumps. Pumps 1 and 2 are normally operated to maintain pressure at B&B between 40 & 50 psi. This pump station does not have a secondary power source (auxiliary power) in case of power interruption.

2.2 Water Master Plan References

Several studies, reports, maps and publications were used as reference material in completing the City of Flint Water Reliability Study, including the following:

1. 2009 City of Flint DWRF Plan
2. *Modeling, Analysis, and Design of Water Distribution System*, Lee Cesario, American Water Works Association, 1995
3. *Recommended Standards for Water, Great Lakes Upper Mississippi River, Board of State Public Health and Environmental Managers (Ten State Standards)*, 2003
4. City of Flint website
5. U.S. Census Bureau surveys

2.3 Abbreviations

AADD – Annual Average Day Demand
AWWA - American Water Works Association
DIP - Ductile Iron Pipe
DPW - Department of Public Works
DWSD - Detroit Water & Sewerage Department
FWS – Flint Water System
GCDC - Genesee County Drain Commissioner
GCDC-WWS - Genesee County Drain Commissioner, Division of Water & Waste Services
gpd - gallons per day
gpcd - gallons per capita per day
MGD - Million Gallons per Day
gpm - gallons per minute
HGL - Hydraulic Grade Line
Hp - Horsepower
ISO - Insurance Services Office
MG - Million Gallons
MDD - Maximum Day Demand
MDEQ - Michigan Department of Environmental Quality
DNRE – Department of Natural Resources and Environment
MDOT - Michigan Department of Transportation
O&M - Operation and Maintenance
ROW - Right-of-Way
ROWE – ROWE Professional Services Company
PHD - Peak Hour Demand
psi - pounds per square inch
REU - Residential Equivalent Unit
TDH - Total Dynamic Head
USEPA - United Stated Environmental Protection Agency
USGS - United States Geological Survey
VFD - Variable Frequency Drive
WTP - Water Treatment Plant

2.4 Staffing

Operation of the City of Flint water system is provided by the WTP staff and maintenance of the distribution system is provided by the Water Service Center. The organizational charts for the two entities are included in Appendix 5.

The Water Treatment Center currently has 28 budgeted positions with five vacancies. The city is currently interviewing for three of the vacant positions and will evaluate staffing needs after these three positions are filled. Due to economic conditions in the city, it is unknown whether the remaining vacancies will be filled.

The Water Service Center has 48 full-time equivalent positions with 5 vacancies. Due to economic conditions, there are no current plans to fill the vacancies. In early 2010, crew levels were reduced and overtime was eliminated curtailing the Water Service Center's ability to maintain the system.

2.5 Existing Capital Improvement Plan

In 2009, ROWE prepared a DWRF Project Plan for the city outlining a number of projects, including replacement of the Torrey Road Booster Station and the construction of 28,000 feet of 24" watermain. Due to economic conditions these projects have not been constructed. A revised 6-Year City of Flint CIP is shown in Table 1 in the Executive Summary. The city is currently moving forward with the replacement of key equipment at the Torrey Road Station and electrical and control improvements at the Cedar Street Station. The city is currently seeking funding for the 24" watermain and hopes to begin construction in 2012.

2.6 Existing and Proposed Water Service Area

The City of Flint is the service area for the purpose of the Reliability Study. However, the city provides water to Genesee County from several metered connection points along the city's 72" feed from the DWSD (see general plan). The city does not operate or maintain the county system.

The City of Flint, along with Genesee County, Lapeer County, and the City of Lapeer, formed the Karegnondi Water Authority for the purpose of exploring the possibility of developing a Lake Huron water intake and providing raw water to the member communities. The member communities would then treat the raw water at plants located within their jurisdiction.

The City of Flint has also entered into discussions with Genesee County to provide emergency backup water supply to a portion of the county system. At this writing, the volume under discussion was 8 MGD to be delivered at a connection point to be determined, on the north side of the City of Flint water system. This is discussed further in Section 3.6.

2.7 General Plan

The general plan of a water system is essentially a map of the system showing watermains, valves, hydrants, and major pumping and storage facilities of the system. The general plan can also include such items as pressure districts; however, the Flint Water System (FWS) operates as one pressure district. The general plan has been updated as part of this report and is included in Appendix 6. Areas that were updated are highlighted and labeled.

2.8 Cross-Connection Program

The city operates a cross-connection plan through the wastewater plant. The cross connection program is in compliance and a copy of the program is on file at the city.

2.9 Water Shortage Response Plan

There are several potential situations that could result in a water shortage in the City of Flint. In each case, the city has sufficient infrastructure, equipment, and redundancy to resolve any water shortage situation that may arise. In each case, a press release outlining the nature of the water shortage and a request to limit water usage would be issued by the city. The following are representative of these potential situations:

A. Loss of Service from the DWSD

In the event that the city loses water service from the DWSD, the city would run off the 57 MG of existing storage, while implementing its EOS by putting the back-up water plant in service to feed the system, until such time as water service from the DWSD is restored.

B. Loss of Elevated Tower

The city currently has one elevated tower located on the treatment plant grounds. In a case where the elevated tower was out of service for repairs or painting, the system would run off the DWSD pressure with peak flows supplied by the West Side Station, Cedar Street Station or Torrey Road Booster Station. DWSD pressure would refill the storage at Cedar and West Side each night.

C. Loss of Pumping Facility

The City of Flint water system is supplied by DWSD water pressure. The city has three pumping facilities in addition to P.S. No. 4 at the plant. West Side Pumping and Storage Facility, and Cedar Street Pumping and Storage Facility, are alternated each day to supply peak flows to the system. In the event that either of the stations were out of service, the other could supply all the needs of the city. In the event that both stations were out of service, the system could run off the DWSD pressures. The Torrey Road Booster Station supplies peak flows to the Hospital Hill area. In the event that Torrey Road Booster Station was out of service, the Cedar Street Station could be used to supply peak flows to the hospital area.

D. Watermain Break on Major Transmission Main

The city has a well-designed system with significant looping of major supply lines. Extensive modeling was done with various sections of the key transmission mains out of service and in all cases the impacts were minimal. This analysis assumes that system valves will operate as intended.

2.10 Contingency Plan

The contingency plan outlines the emergency measures that can be taken in the event of a major infrastructure failure or local disaster. The plan includes emergency notification procedures, emergency contact numbers for city employees, contractors, neighboring municipalities, and other information related to managing water system emergencies. The contingency plan was updated in 2010 and a copy is on file at the city.

2.11 Historical Water Use

Water use is determined primarily by the total of residential, commercial and industrial use. Historical purchases and sales records can be very useful in determining future system improvements. Meter records indicate the amount of water supplied to the City of Flint. City records show the metered sales for residential, commercial and industrial customers. Table 3 below summarizes the city's historical water use, including Genesee County, for the past eight years. Table 4 shows the city's usage during the same period.

Table 3: City of Flint Flows from the DWSD (MG)

Year	AADD
2004	30.76
2005	31.80
2006	29.05
2007	31.35
2008	28.56
2009	24.5
2010	26.9
2011	24.4
Source: City of Flint	

Table 4: City of Flint Usage (MG)

Year	AADD
2004	17.8
2005	18.2
2006	17.0
2008	15.23
2009	14.04
2010	6.9
2011	8.2
Source: City of Flint	

2.12 Water Distribution System Master Metering – Genesee County

Genesee County is the city's largest customer and takes water off the 72" pipeline at a number of locations, and has the ability to take water from the Flint distribution system. The following Table shows the Genesee County meter locations and AADD for each meter location.

Table 5: Water Distribution System Master Metering – Genesee County

Meter Location	Meter Size	2011 AADD (MG)
West Carpenter	6"	Inactive
G3000 Flushing Road	6"	Inactive
G3348 Flushing Road	6"	0.1
G3167 West Pierson	6"	Inactive
G3376 North Genesee	10"	Inactive
Kearsley Circle	24"	4.4
Potter and Belsay	10"	1.7
Potter and Irish	10"	2.1
Oak and Potter	10"	0.6
Henderson and Potter	36"	3.4
M-15 and Potter	10"	0.3
Total		12.6

Source: City of Flint

2.13 Unaccounted for Water Use

The difference between the quantity of water supplied to the City of Flint and the quantity sold to customers is referred to as "unaccounted for" water. Water in a public system can be unaccounted for due to a number of reasons. Water withdrawn from a fire hydrant, whether it is to fight a fire or flush a water main, is un-metered and therefore "unaccounted for". Leaks and watermain breaks, faulty or inaccurate meters, unauthorized connections and un-metered municipal water use also contribute to "unaccounted for" water.

Water system efficiency analysis indicates that the City of Flint system averages 63 percent over the last five years. This indicates that the city has significant leaks, inaccurate meters and/or illegal connections to the system. A high priority should be placed on implementing a program to reduce the "unaccounted for" water. The program should include: testing high volume meters, leak detection analysis, residential meter replacement, billing system review, and fire flow estimates.

Table 6 and 7 below show the historical "unaccounted for" water.

Table 6: FWS and GCDC-WWS Combined "Unaccounted for" Water

Year	DWSD Flow Ccf	City of Flint Total Ccf	Efficiency %
2004	15,008,384	12,599,895	83.95%
2005	15,514,886	12,959,400	83.53%
2006	14,174,832	11,208,001	79.07%
2007	15,295,449	12,575,645	82.22%
2008	13,934,327	11,204,322	80.41%
2009	11,943,960	10,027,390	83.95%
2010	13,108,730	10,140,121	77.35
2011	11,926.870	9,650,632	80.92

Table 7: City of Flint Efficiency 2007 - 2011

Year	DWSD Purchased Ccf	GCDC Billed Ccf	DWSD - GCDC Ccf	City Of Flint Billed Ccf	City Only	Efficiency
2007	15,295,449	6,907,946	8,387,503	12,575,645	5,667,699	0.68
2008	13,934,327	6,418,120	7,516,207	11,204,322	4,786,202	0.64
2009	11,943,960	6,069,843	5,874,117	10,027,390	3,957,547	0.67
2010	13,108,730	6,263,618	6,845,112	10,140,121	3,876,503	0.57
2011	11,926,870	6,121,590	5,805,280	9,650,632	3,529,042	0.61
Totals	**66,209,336**	**31,781,117**	**34,428,219**	**53,598,110**	**21,816,993**	**0.63**

2.14 Demographics

A. Population

Flint lost almost 18,000 people between the 2005 mid-decade census and the 2010 census. Given the current economic situation, this trend is anticipated to continue over the next twenty years. See Appendix 7 for full Genesee County population data.

Table 8: Population Figures

Date	Population	Residential Customers	Commercial Customers	Total Customers	System Demand (gpm)		
					Average Day	Maximum Day	Peak Hour
2005	120,283	41,026	1,500	42,526			
2010	102,400	35,052	1,686	36,738	7,851	18,319	23,552
2015	100,000	34,230	1,647	35,877	7,667	17,890	23,000
2020	98,000	33,546	1,614	35,159	7,513	17,532	22,540
2025	96,000	32,861	1,581	34,442	7,360	17,174	22,080
2030	94,000	32,176	1,548	33,724	7,207	16,817	21,620

Population projections from Regional Planning Agencies for the 2010 Census are not available as of this writing.

Genesee County, which accounts for approximately 57% of the water usage, is the largest purchaser of water from the City of Flint. For the purpose of the table below, the water usage by Genesee County has been removed from the calculations. The following table lists the major water users among the commercial and industrial operations in the City of Flint.

Table 9: Major Water Users

Water User	Location	Demand Estimate (CCF/Yr)
Beecher Metro District	Carpenter Road	907,896
General Motors (South Complex)	3100 Van Slyke	696,132
Beecher Metro District	Premier Street	200,016
Thomas Raymond	1402 Davison Road	119,928
McLaren Regional Medical Facility	401 Ballenger	113,772
Country Fresh Dairy	158 Genesee	75,276
Genesee County Jail	1100 Saginaw Street	60,432
Buick Motor Division	Stewart Avenue	47,868
Evergreen Regency	2622 Trout Drive	45,300
Delphi	1101 Center Road	42,000
U of M Flint	502 Mill Street	38,616
Country Fresh Dairy	609 Chavez	37,236
Hurley Medical Center	6th & Begole	37,176
Buick Motor – Industrial Waste	St. John Street	33,912
Evergreen Regency	2102 Trout Drive	32,424
Delphi	Robert T Longway	30,096
Hurley Medical Center	1 Hurley Plaza	26,856
Country Club Manor	1901 Woods Leaf	23,616
Flint Odyessy House	529 M L King Avenue	23,436
Hurley Medical Center	1001 Begole Street	23,268
American MHP	2701 Branch Road	22,428
Kettering University	501 Chevrolet Drive	21,216
Lockhart Chemical	4701 Thetford Drive	20,400
Country Fresh Dairy	158 Genesee	19,872
Genesee Forest Estates	1806 Webster Road	19,440

(Source: City of Flint Department of Public Works and Utilities, March 2009)

2.15 Land Use

The zoning map shows the city remaining relatively constant over the next five years, as there is little pressure for growth into vacant, open or wooded areas. It is difficult to predict land use over the next 20 years, except to say that most of the industrial urban cities along the I-75 corridor in Michigan have experienced very little growth pressure over the last 10 years and reported a loss in population with the 2010 census. Both of these are true for the City of Flint, and population loss has increased since the 2010 census. It is likely that this trend will continue in the near future. The map in Appendix 8 shows the general location of existing land uses in the area.

2.16 Modeling Conditions & Scenarios

For purposes of this study, four conditions were analyzed. These conditions include the following:

A. Existing System and Future System

The existing water distribution system was analyzed with the current demands from the existing developments to identify potential capacity problems within the existing water infrastructure. The existing demands were developed from City of Flint billing records, Genesee County meter pit data, and DWSD data.

1. Annual Average Day Demands (ADD)
2. Maximum Day Demand (MDD)
3. Peak Hour Demand (PHD)
4. Fire Flow Demands (FFD)

Section 3 - Water Demands

System demands were developed from City of Flint billing records and water plant records. Demands for Genesee County meter pits were developed from Genesee County data. Residential demands were spread evenly across the system. Commercial demands were evaluated individually and attributed to the nearest node in the model. Genesee County demands were input at master meter pit locations.

3.0 Annual Average Day Demand (AADD)

The AADD is the total annual water use divided by 365 days/year. In the case of the City of Flint, the AADD's were developed using City of Flint billing records, water plant information, master meter readings, commercial meter analysis and the modeling process. A summary of that data is provided in Table 10 below. Annual Average Day Demand contours are shown in Appendix 9.

Table 10: City of Flint Annual Average Day Demands

Account Class	Number of Sites	Water Usage				System Demand (gpm)
	All Sites With Active Accounts	Average (Ccf/month)	Total (Ccf/year)	Average Per Account (gpd)	Annual Average Day (gpd)	
Residential	32,604	162,937	1,955,248	123	4,006,919	2,783
Commercial	1,768	292,701	3,512,417	4,128	7,198,049	4,999
City Totals	38,184	475,788	5,709,456	4,404	11,700,474	7,781
GCDC Meter Pits	10	510,133	6,121,590	1,254,506	12,545,067	8,712
All	72,566	1,441,559	17,298,711	492	35,450,509	24,275
2011 Data						

3.1 Maximum Day Demands (MDD)

Maximum day demand (MDD) is the highest daily usage that occurs during the course of a year. Public water systems typically experience a variety of demands generated by the community. Water usage can vary from season to season, day to day, and even hour to hour. Water usage is usually higher during certain times of the week and certain times of the day. Water usage is also typically higher in summer months and lower during the winter months. A water system must be able to meet the wide range of demands expected to occur.

A public water distribution system should have adequate water supply to meet the MDD. Generally, system storage and system pumping facilities should be sized to buffer the difference between AADD and MDD. The MDD is the greatest amount of water used over a 24-hour period. The observed MDD from the city in the last five years is 26.38 MGD and occurred in 2007. Typically MDD are 2-3 times average day demands. The City of Flint's MDD is approximately 1.5-2.0 times average day and this would be typical of an older system with minimal lawn sprinkling demand.

Maximum day pressure contours are shown in Appendix 10. There is a small area that the model projects Maximum day pressure at 35 psi. It is recommended that the city perform some pressure tests in this area to determine the whether the field conditions mimic the model conditions.

3.2 Peak Hour Demands (PHD)

The PHD is the greatest amount of water used during any 60-minute period of time. Generally, storage should be available to provide the difference between the PHD and MDD. The water distribution system must be able to deliver the PHD. Peak hour demands are not available from the city and are estimated to be three times the average hour.

3.3 Future Demands

Genesee County Metropolitan Alliance and Genesee County Planning Commission Table in Appendix 7 indicates that the population in the City of Flint will continue to shrink through the period of the study 2010 through 2030. Figures 1 and 2 below illustrate the declining population, customers, and declining water use projections for the city.

Figure 1: City of Flint Water Customers - Future Estimates

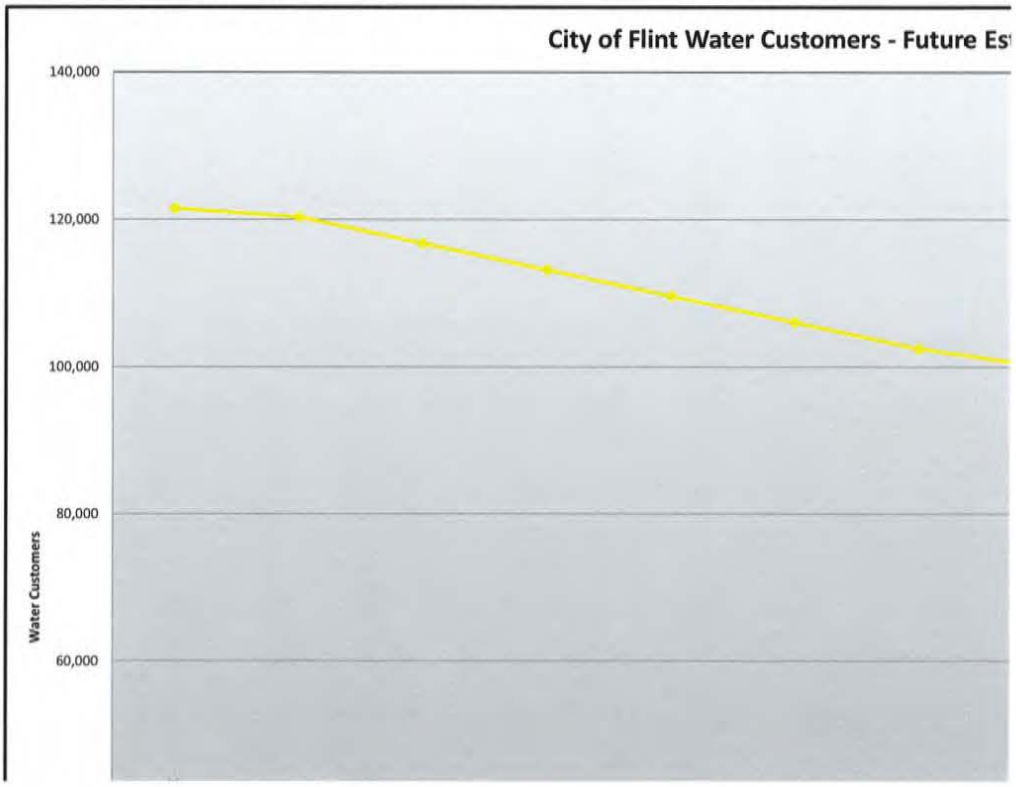
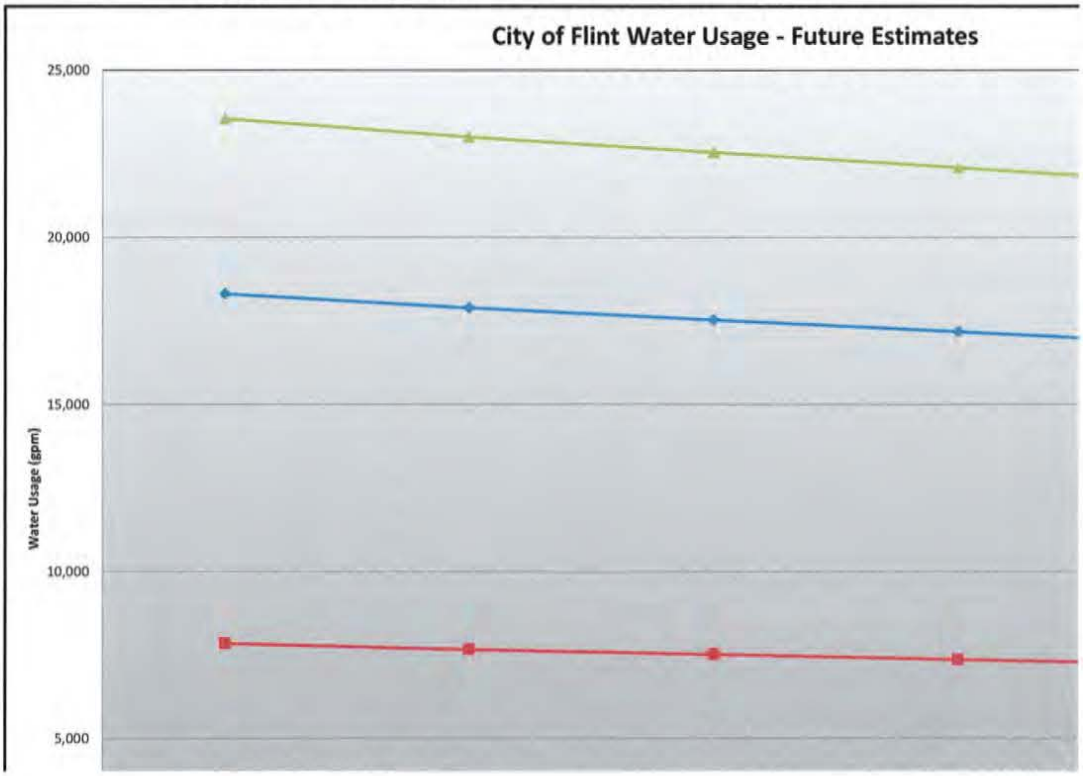


Figure 2: City of Flint Water Usage - Future Estimates



3.4 Fire Flow Demands (FFD)

In the event of a fire, it is desirable that a public water distribution system be capable of meeting certain flow and pressure guidelines established by the AWWA and ISO for public water systems. The actual recommendations for fire protection vary depending on factors such as building use, construction materials, fire suppression regulations, and proximity to hydrants. The following fire flow criteria were developed using ISO and AWWA guidelines. Areas of the city that have 4" pipe will not meet these standards in some cases, and the following are goals to be taken into consideration when planning and designing upgrades for the FWS.

A. Residential Fire

In the event of a residential fire, a water demand of 1,000 gpm should be available for firefighting for a period of four hours. The system should maintain a minimum pressure of 20 psi throughout the remainder of the water distribution system during the time the fire is being fought. The areas of the city that are unable to meet the fire flow goal are located where 4" watermains are present. The 4" watermain replacement plan will remedy the fire flow deficiencies in these areas.

B. Commercial or Industrial Fire

In the event of a school, commercial, or industrial building fire, a water demand of 1,500 gpm should be available for firefighting for a period of four hours. The water distribution system should maintain a minimum pressure of 20 psi throughout the remainder of the water distribution system during the

time the fire is being fought. A representative number of locations were modeled and in cases where the watermain was at least 8", the system met the above criteria. ISO recommendations for commercial and industrial facilities vary significantly and can be as high as 5,000 gpm. Interior sprinkling systems for these types of facilities are highly desirable.

Section 4 - 20-Year Water Supply, Distribution and Storage

4.0 Water Supply Planning Criteria

The following were used as planning standards for this study:

1. System pressures not lower than 20 psi and not higher than 100 psi
2. Normal operating pressures between 40 psi and 75 psi
3. System storage requirements of 2 times Average Day Demands, plus storage for fire flows
4. Firm pumping capacity to meet Maximum Day Demands
5. Future fire flow capability of 1,000 for residential and 1,500 for commercial

4.1 Water Supply

The city faces three potential scenarios for water supply in the near future. 1) Remain with the City of Detroit system; 2) complete the upgrades to the city water plant and use the Flint River as the water source; or 3) participate in the Karegnondi Water Authority, which will use water from a new Lake Huron intake near Sanilac, Michigan and supply raw water to several communities including Flint and Genesee County. The city has determined that the long-range plan for water supply will either be scenario 2 or 3 above, which will require the operation of the water plant on a full-time basis. The reliability study will analyze the needs of the distribution system including P.S. No. 4, the high service pumping facility located on the water plant grounds.

4.2 Water Storage Facilities

There are several ways to evaluate water system storage. One commonly accepted method is that the system should have two times average day flow, plus fire flow storage. The city's current average day flow is 14.04 MGD, therefore the calculated system storage requirement would be 28.1 MG plus fire flow storage. Assuming simultaneous residential and industrial fires at 1,000 gpm and 1,500 gpm respectively, and a fire duration of four hours, fire storage calculates to an additional 600,000 gallons of storage. Required system storage would be 28.7 MG.

The table below shows the existing storage facilities in the City of Flint. The total storage available in the system is 57 MG located in three different areas of the city. The total system storage exceeds the required storage by just over 28 MG. While excess storage is sometimes advantageous from an operational stand point, the city currently has two times the required storage and is facing declining population, declining water use and declining revenues.

Table 11: City of Flint Storage Facilities

Location	Type	Size (Gallons)	Overflow Elevation
Dort Reservoir	Ground	20,000,000	774.3
Cedar Street Reservoir	Ground	20,000,000	757
West Side Reservoir	Ground	12,000,000	779
Clear Well 3	Ground	3,000,000	724
Plant	Elevated	2,000,000	898

4.3 Water Pumping Facilities

The Ten State Standards requires that at least two pumping units be provided at each facility. With any pump out of service, the remaining pump or pumps shall be capable of meeting the maximum pumping demand of the system. Therefore we have used the following criteria in evaluating the system:

- The firm pumping capacity should provide projected Maximum Day Demand and fire flow of 2,500 gpm for four hours.

A. Pump Station 4

Pump Station 4 is located at the Dort Reservoir on the WTP grounds. The station currently has a total of five pumps, two of which are inoperable. The station's total capacity is 46 MGD with firm capacity of 26 MGD. Table 12 shows the pump characteristics for the operable pumps. The operable pumps were installed in 1994 and are now 19 years old.

Table 12: Pump Station 4 Facility

Pump No.	Design Capacity (MGD)	Type	Design Head (Feet)
7	20	Turbine	185
8	20	Turbine	185
9	6	Turbine	185

B. Cedar Street Pumping Facility

Cedar Street Pumping Facility is located in the southern portion of the city on Cedar Street near Court Street. The station consists of three pumps, with a total capacity of 30 MGD and a firm capacity of 18 MGD. The station was constructed in 1948 and the existing equipment is all 1948 vintage. The station has exceeded its design life and has been scheduled for rehabilitation for several years. Table 13 shows the pump characteristics of the Cedar Street Pumping Station.

Table 13: Cedar Street Pump Facility

1	12	Centrifugal	160
2	9	Centrifugal	160
3	9	Centrifugal	160

C. West Side Pump Station

West Side Pump Station is located on the west side of the city on Pershing Street. The station consists of four pumps, with a total capacity of 24 MGD and a firm capacity of 16 MGD. The pump station's four pumps were installed in 1970 and are now 40 years old. The pumps are approaching their design life of 50 years. The pump station has been scheduled for check valve upgrades for several years. Table 14 shows the pump characteristics of the West Side Pumping Station.

Table 14: West Side Pumping Station

1	8	Turbine	142
2	8	Turbine	142
3	4	Turbine	142
4	4	Turbine	142

D. Torrey Road Booster Station

Torrey Road Booster Station is located on Hammerberg Road south of the Cedar Street Facility. The station consists of two pumps, with a total capacity of 6.8 MGD and a firm capacity of 2.8 MGD. The station is vintage 1954 and at 56 years of age, has exceeded its design life. The station has been scheduled for rehabilitation or replacement for several years. Table 15 shows the pump characteristics of the Torrey Road Pumping Station.

Table 15: Torrey Road Pump Facility

1	4	Centrifugal	65
2	2.8	Centrifugal	100

Table 16: City of Flint Total Pumping Capacity Analysis

Pump Station	Number of Pumps	Design Capacity (MGD)	Firm Capacity (MGD)
Dort (P.S. No. 4)	3	46	26
Cedar Street (P.S. No. 3)	3	30	18
West Side (P.S. No. 5)	4	24	16
Torrey Road	2	6.8	2.8
Total Pump Capacity		106.8	62.8

The City of Flint currently has a total pumping capacity of 106.8 MGD and a firm capacity of 62.8 MGD. Typically water systems have sufficient firm capacity to meet projected maximum day and the necessary storage to meet peak hour. The City of Flint currently has an observed maximum day of 26.38 MGD, which occurred in 2007. The observed maximum day for 2008 and 2009 were 18.66 MGD and 21.57 MGD respectively, and are significantly less than the 2007 figure. Based on projections shown in Table 17 below, the maximum day demand will continue to decline for the foreseeable future. The projected maximum day for 2010 is 26.2 MGD and based on that, the city has almost two and half times the firm capacity required to meet the needs of its customers.

Table 17: City of Flint Future Population and Water Usage Projections

					System Demand (gpm)					
Date	Population	Residential Customers	Commercial Customers	Total Customers	Avg. Day	% Change	Max. Day	% Change	Peak Hour	% Change
2010	118,465	36,067	1,735	37,802	8,078		18,319		24,235	
2015	115,481	35,159	1,691	36,850	7,875	0.975	17,858	0.975	23,624	0.975
2020	112,234	34,170	1,644	35,814	7,653	0.972	17,356	0.972	22,960	0.972
2025	109,865	33,449	1,609	35,058	7,492	0.979	16,990	0.979	22,475	0.979
2030	107,663	32,778	1,577	34,355	7,342	0.980	16,649	0.980	22,025	0.980

Population projections from Genesee County Metropolitan Alliance
Information shown is for City of Flint only

4.4 Water Distribution System

As noted in Section 1.1 E, much of the City of Flint water distribution system is over 70 years old and is in need of rehabilitation or replacement. In addition, there is a significant amount of 4" watermain in the system that is over 70 years old, prone to watermain breaks, and unable to provide modern pressures and fire flows. The 20-year plan for the water distribution system is twofold: 1) rehabilitate or replace the primary transmission system that serves the city and 2) abandon 4" watermains where there is a suitable parallel main, or replace the 4" watermains with 8" in other cases.

4.5 System Pressures

The Ten States Standards recommends the following criteria for water systems:

- A minimum working pressure of 20 psi
- A normal working pressure of 60 to 80 psi
- Pressure reducing valves are to be provided when static pressures exceed 100 psi

In general, accepted minimum and maximum working pressures are 20 and 100 psi, respectively. Pressures below 20 psi do not provide adequate working pressure for firefighting needs and pressures in excess of 100 psi increase the risk of watermain breaks, and can cause issues in residential plumbing installations.

The city system generally operates between 40 and 75 psi and provides all customers with adequate flows and pressures to meet normal demands. Fire flow and pressure are substandard in some areas due to undersized mains and this has been addressed in the water distribution 20-Year Capital Improvement Program.

4.6 Emergency Back-up Water Supply

As discussed in Section 1.1 B, the City of Flint emergency backup water supply system is provided by the 36 MGD Water Treatment Facility located at Dort and Stewart. The facility has been recently rehabilitated and upgraded and can meet the city's current maximum day of 26.4 MGD and projected maximum day demands for the 2010 – 2020 study period. However, an estimated $25,000,000 of upgrades are planned to provide additional capacity and water softening.

In addition, Genesee County has requested 8 MGD in emergency backup water supply that would be delivered from Pump Station 4 to a point on the northern limits of the city, most likely in the Dort and Carpenter area. From that point the county would construct watermain and pressure boosting facilities to supply water to the GCDC-WWS system.

A. Standby Power Availability

The Flint Water System includes three pumping facilities that provide additional pumping to meet daily peak flow demands. These facilities are Cedar Street, West Side, and Torrey Road and the pumping capacities are listed in Tables 12, 13, and 14. The facilities currently do not have any standby power. The goal is to provide sufficient standby power to meet average day demands of the city in the most cost-effective manner.

West Side Station has a firm capacity of 26 MGD; Cedar Street Station has a firm capacity of 18 MGD; and Torrey Road has a firm capacity of 2.8 MGD. The current average day demand is 14.04 MGD and Cedar Street most closely matches firm capacity to average day demand. Therefore, it is

recommended that a standby generator be provided at the Cedar Street Facility in the event that the city remains on the DWSD system.

4.7 Distribution Model

The distribution model developed for this study was created from City of Flint GIS data using MWHSoft's InfoWater modeling software, an ESRI ArcView, GIS-based water modeling package. The model was updated to include water infrastructure improvements that have been completed since the previous model update in 1999-2000. The GIS-based model also provides the ability to include additional geographical information in the model such as valve locations, streets, parcel maps, contours, etc.

4.8 General

Water modeling is a computer simulation of water system infrastructure and demands. Water modeling can identify deficiencies in a system and evaluate the impact of alternatives for improvements. The parameters used for determining improvements include such items as providing adequate fire flows, increasing system reliability, serving future customers, maintaining a residual pressure of 40 psi or greater during PHD conditions, and evaluating system pumping and storage needs.

Water systems are analyzed, planned and designed through the application of basic hydraulic principles. Some important factors which must be considered when performing this analysis include:

- The location and size of supply facilities
- The location, size, and design of storage facilities
- The location, type, magnitude and variability of customer demands
- Water system geometry and geographic topography
- Minimum and maximum pressure requirements
- Anticipated fire flow requirements
- Land use

4.9 Hydraulic Water Model

The model is set up to simulate the existing City of Flint Water System as accurately as possible within the frame work of the software. Because the city operates the water system manually, the control schemes included in the model are limited and each run should be set to mimic specific boundary conditions including: pressure from Detroit; which pumps are on or off; GCDC demands; and appropriate tank and reservoir levels. The water model includes demand scenarios for the existing AAD, MDD, and PHD and projected demands for every five year increment from 2010 to 2030.

4.10 Physical Characteristics

The existing water distribution system facilities have been modeled using design information provided by the city. The model includes detailed information about the water system infrastructure including pipe

size, pipe length, c-factor, node elevations, pump curves, and tank and reservoir sizes. This information was collected from the city's GIS, City of Flint blue prints, and meetings with city staff.

4.11 Demand Allocation

The City of Flint demands were allocated in several ways depending on the information available and the level of potential impact on the accuracy of the model. Six sets of demands are included in the model:

1. Residential demands were developed from residential billing data and divided across the model;
2. Commercial/Industrial accounts with meters 2" and larger were analyzed for one year of data and the demand placed at the closest node to the account;
3. GCDC demands were developed using actual meter data from GCDC and City of Flint;
4. Small commercial demands were developed from billing data and spread across the system;
5. Unaccounted for water was analyzed in Table 6 and applied across the system.

4.12 Water Model Calibration

Model calibration is the process of evaluating the data incorporated into the model against real world flows and pressures in the water system. The accuracy of the process will vary depending on the accuracy of the information input to the model; the age and complexity of the water system; the accuracy of the boundary conditions; and the accuracy of the field data that is collected for calibration. The level of calibration accuracy that is required varies with the type of analysis being carried out. For the purposes of this study, values plus or minus 10 percent of field values were considered acceptable. The water model was calibrated using flow test information from the City of Flint conducted in the fall of 2009. The flow test sites were spread geographically across the system.

4.13 System Configuration Alternatives

A. Water Supply

Water supply and the water plant will be evaluated in a separate report.

B. Water Pumping and Storage Facilities

The existing City of Flint water system was designed to service a much larger population and significantly more industry than is currently being served. Steadily declining population, declining water demands, a much smaller General Motors presence, and GCDC-WWS's construction of out-county pumping and storage facilities have gradually reduced the demands on the city's water infrastructure. In addition, many of the city facilities are at or are reaching their design life and are poised to impact the water system budget and fund balance. There is significant excess pumping and storage in the system and some of this can be eliminated without impacting flows and pressures while lessening the burden on the budget and maintenance staff. The pump and fill ground storage system that the city operates is energy-intensive and additional elevated storage, that does not require additional pumping, is included in one of the scenarios. Based on these factors, three alternatives were

developed for the 20-Year Capital Improvement Program. The first alternative would keep the city water system as it is currently and provides a number of potential future configurations. The second alternative examines operating the system with the water plant as the source of water. The third alternative provides a preliminary view of the city and county combining the water systems and operating as one system.

1. Existing System Configurations

   In the existing mode of operation, the city operates off DWSD line pressure to feed the round storage tanks in the system and then pumps from Cedar Street and West Side to meet peak demands. The City of Flint water system currently has excess pumping and storage capacity that is reaching its design life, costly to maintain, and not required in order to meet the design standards for the system. The following five tables show various configurations that would meet the system demands while reducing operating costs and facility upkeep costs.

Table 18: City of Flint Existing System Analysis

Average Annual Day	14.04	MGD		
Max Day	26.38	MGD		
Peak Hour	42.12	MGD		
Fire Flow	0.60	MG		
System	28.08	MG		
Total	**28.68**	**MG**		
Dort Reservoir	20	MG		
Clear Well 3	3	MG		
Elevated	2	MG		
Cedar Street	20	MG		
West Side	12	MG		
Total Storage	**57**	**MG**		
Dort (P.S. No. 4)	46	MGD	26	MGD
Cedar Street	30	MGD	18	MGD
West Side	24	MGD	16	MGD
Torrey Road	6.8	MGD	2.8	MGD
Total Pumping	**106.8**	**MGD**	**62.8**	**MGD**

Table 19: City of Flint Existing System Analysis Cedar Street out of Service

Average Annual Day	14.04	MGD		
Max Day	26.38	MGD		
Peak Hour	42.12	MGD		
Fire Flow	0.60	MG		
System	28.08	MG		
Total	**28.68**	**MG**		
Dort Reservoir	20	MG		
Clear Well 3	3	MG		
Elevated	2	MG		
West Side	12	MG		
Total Storage	**37**	**MG**		
Dort (P.S. No. 4)	46	MGD	26	MGD
West Side	24	MGD	16	MGD
Torrey Road	6.8	MGD	2.8	MGD
Total Pumping	**76.8**	**MGD**	**44.8**	**MGD**

Table 20: City of Flint Existing System Analysis West Side out of Service

Average Annual Day	14.04	MGD		
Max Day	26.38	MGD		
Peak Hour	42.12	MGD		
Fire Flow	0.60	MG		
System	28.08	MG		
Total	**28.68**	**MG**		
Dort Reservoir	20	MG		
Clear Well 3	3	MG		
Elevated	2	MG		
Cedar Street	20	MG		
Total Storage	**45**	**MG**		
Dort (P.S. No. 4)	46	MGD	26	MGD
Cedar Street	30	MGD	18	MGD
Torrey Road	6.4	MGD	2.9	MGD
Total	**82.4**	MGD	**46.9**	MGD

Table 21: City of Flint Existing System Analysis Cedar Street and Torrey out of Service

Average Annual Day	14.04	MGD		
Max Day	26.38	MGD		
Peak Hour	42.12	MGD		
Fire Flow	0.60	MG		
System	28.08	MG		
Total	**28.68**	**MG**		
Dort Reservoir	20	MG		
Clear Well 3	3	MG		
Elevated	2	MG		
West Side	12	MG		
Total Storage	**37**	**MG**		
Dort (P.S. No. 4)	46	MGD	26	MGD
West Side	24	MGD	16	MGD
Total Pumping	**70**	**MGD**	**42**	**MGD**

Table 22: City of Flint Existing System Analysis West Side and Torrey out of Service

Average Annual Day	14.04	MGD		
Max Day	26.38	MGD		
Peak Hour	42.12	MGD		
Fire Flow	0.60	MG		
System	28.08	MG		
Total	**28.68**	**MG**		
Dort Reservoir	20	MG		
Clear Well 3	3	MG		
Elevated	2	MG		
Cedar Street	20	MG		
Total Storage	**45**	**MG**		
Dort (P.S. No. 4)	46	MGD	26	MGD
Cedar Street	30	MGD	18	MGD
Total	**76**	MGD	**44**	MGD

2. Full-Time Water Plant Operation

This alternative examines the system configuration with the water plant operating as the main supply source for the city. The two alternatives for water supply are either from the Flint River or raw water from the Karegnondi Water Authority (KWA). In this alternative, the city would use the high service pumps at Pump Station 4 located on the water plant grounds to feed the system. Two of the existing pumps have been abandoned, and the remaining three are over 16 years old and are not sized to efficiently supply the system with water. The five pumps at Pump Station 4 should be replaced with appropriately sized pumps to meet current and future demands and the associated piping and electrical equipment upgraded as necessary.

As noted in Section 1 above, West Side Storage and Pumping Facility and Cedar Street are operated on alternative days to meet peak demands. This operating configuration is reasonable with the existing water supply system operating off DWSD pressure during nonpeak periods. However, with the water plant operating full-time re-pumping water from Cedar and West Side to meet peak demands this may not be the most efficient way to operate the system. Proposed elevated storage located on the south end of the city allows the water to be pumped from Pump Station 4 through the system, filling the tanks and the elevated storage tanks and providing peak hour supply and fire protection without additional pumping.

Table 23: West Side, Torrey, and Cedar out of Service - 2 New Elevated

Average Annual Day	14.04	MGD	
Max Day	26.38	MGD	
Peak Hour	42.12	MGD	
GCDC Backup			
Fire Flow	0.60	MG	
System	28.08	MG	
Total	**28.68**	**MG**	
Dort Reservoir	20	MG	
Clear Well 3	3	MG	
Elevated	2	MG	
Proposed Elevated	2	MG	
Proposed Elevated	2	MG	
Total Storage	**29**	**MG**	
Proposed Dort (P.S. No. 4)	64	MGD	48

3. Combine the city system with the GCDC-WWS system.

   Genesee County surrounds the City of Flint and has significant water infrastructure in place. There have been discussions between the parties regarding interconnects for the mutual aid of both water systems during emergencies. Interconnecting the systems for daily use could also have mutual benefit to both parties. The county has 3 MG of elevated storage with overflow elevations at 930 and 940, and a pumping facility in close proximity to the hospital district which could meet peak demands and aid in the elimination of the Torrey Booster. The city has the backup water plant that is capable of providing 36 MGD in the case of an extended shut down of the 72" transmission main from Port Huron. There are numerous configurations for combining the two systems, and an in-depth analysis of the two systems could result in capital and operating savings to both systems. The following table illustrates one possible configuration.

Table 24: West Side, Torrey, and Cedar out of Service - Use County Houran Facility

Average Annual Day	14.04	MGD		
Max Day	26.38	MGD		
Peak Hour	42.12	MGD		
Fire Flow	0.60	MG		
System	28.08	MG		
Total	**28.68**	**MG**		
Dort Reservoir	20	MG		
Clear Well 3	3	MG		
Elevated	2	MG		
Houran	2			
Total Storage	**27**	**MG**		
Dort (P.S. No. 4)	46	MGD	26	MGD
Houran	9	MGD	6	MGD
Total	**46**	MGD	**26**	MGD
Upgrade P.S. No. 4 for flexibility and reliability (2 - 8 mgd and 3 - 16 mgd)				
Use County Houran Storage Facility and Pumping				

C. Water Distribution System

There are a number of improvements identified in the 20-Year Capital Improvement Plan. Water modeling and discussions with the city resulted in the following 20-year CIP.

	Major Booster Station Improvement Projects					
1	Torrey Road Booster Upgrades (In-house)	Design Complete	Construct 2010	$300,000	$141,000	$441,000
2	Water Pumping Station 3 Electrical and Controls Upgrade	Design in progress	Construct 2010	$900,000	$423,000	$1,323,000
3	Pump Station 4 Improvements	Design 2012	Construct 2013	800,000	$376,000	$1,760,000
	Sub Total			**$2,000,000**	**$940000**	**$2,940,000**
	Major Transmission System Improvement Projects					
4	28,000 LFT of 24" watermain, WTP to Dupont; South to University	Design Complete	Construct 2011	$10,000,000	$4,700,000	$4,410,000
5	15,500 LFT of 12" watermain; Saginaw Street, Flint River to Pierson Road	2010	2012	$3800,000	$1,786,000	$5,586,000
6	16,100 LFT of 12" watermain; Atherton Road, Van Slyke to Dort	2010	2013	$4,000,000	$1,880,000	$5,880,000
	Sub Total			**$18,800,000**	**$8,366,000**	**$31,166,000**
	Minor Transmission System Improvement Projects					
7	500 LFT of 6" watermain; Hamilton Ave, Mason St to MLK Blvd.	2010	2011	$50,000	$23,500	$73,500
8	1,650, LFT of 6" watermain; Sonny Ave, Dupont to Lawndale	2010	2011	$165,000	$77,550	$242,550
9	1500 LFt of 6" watermain; Walton St, Clairmont to Augusta	2010	2012	$150,000	$70,500	$220,500
10	1500 LFt of 6" watermain; East Blvd, Farmers Market to Park	2011	2013	$150,000	$70,500	$220,500
11	325 LFT of 6" watermain; Alexander Street, Taylor to Rankin	2011	2014	$32,500	$15,275	$47,775
12	1075 LFT of 6" watermain; Mack Street, Clio Road to Winona	2011	2015	$122,500	$57,575	$180,075
	Sub Total			**$670,000**	**$314,900**	**$984,900**
	System Maintenance Improvements					
13	Water Meter Replacement Program 3,000 meters/year		2010-2015	$3,000,000		$15,000,000
14	Hydrant Replacement Program 3,000 meters/year		2010-2030	$500,000		$10,000,000
15	Valve Replacement Program 3,000 meters/year		2010-2030	$250,000		$5,000,000
15	SCADA Improvements	2011	2012-2013	$250,000		$250,000
	Total CIP Costs			**$25,470,000**	**$9,620,000**	**$35,090,900**

4.14 Construction Costs

ROWE has compiled "Engineer's Opinion of Probable Construction Costs" for the water system improvements. The following considerations were made in compilation of the costs.

- ROWE assumed the cost estimates for all watermain also included the costs for installing:
  - < Hydrants
  - < Valves
  - < Gate wells
  - < Taps
  - < Corporations, curb stop and boxes
  - < All fittings (bends, tees etc.)
- ROWE assumed the water service leads were not included in the cost estimates. The cost for the service leads should be included in the proposed development construction costs.
- ROWE assumed pavement removal and replacement would occur for 60% of the watermain installed, while 40% would be installed in non-paved areas.
- ROWE assumed a 20% contingency of the total construction costs to account for any unforeseen construction costs including, but not limited to, bore and jack installations, de-watering, and poor soil conditions.
- ROWE assumed the surveying, engineering, legal and administration costs would be 20% of the total construction costs.
- ROWE completed cost estimates using 2004 dollars, and applied an inflation rate of 2% per year.
- ROWE did not include costs for obtaining easements, since there was no consideration of detailed watermain routing in this study. This should be performed during the design phase of the proposed improvements.
- ROWE did not include costs for time and effort by City of Flint personnel.
- ROWE assumed the DWSD could provide an adequate amount of water to meet all Flint water demands for all conditions.
- ROWE did not include costs for 3-phase electrical service

Section 5 - Recommendations

The City of Flint has indicated that its goal is to operate the system with the Flint Water Plant as the source of water and withdraw from the DWSD system. The water source for the treatment plant may be the Flint River or raw water from KWA. The following recommendations are based on this decision and are listed in order of importance.

5.0 Water Efficiency

The city's current water efficiency is 65%. Typically water utilities operate at 85-90% efficiency. An increase to 85% efficiency would result in increased revenues in the range of $1.5 million to $3.0 million annually.

Key tasks:

- Large meter testing program
- Meter replacement program
- Water billing system audit
- Watermain break and leak analysis study
- Repair, replacement, or reconditioning of those assets found to be in disrepair

5.1 Water System Storage and Pumping Capacity

The current water system has twice the storage and pumping capacity that is needed to operate the system. A number of options to reduce pumping and storage have been identified. Implementing these operational changes going forward will allow the city to operate more cost effectively and concentrate on upgrading and maintaining key infrastructure.

Key Tasks:

- Review scenarios and reduce pumping and storage
- Upgrade those facilities that are retained to operate more efficiently

5.2 Capital Improvement Programs

The Water Reliability Study outlines a number of potential capital improvements that may be constructed over the next 20 years. These capital improvements should be evaluated more closely as the city moves forward with changing water supplies. The priority of the capital improvements will change depending on the direction that the city chooses for water supply.

Key Tasks:

- Revise and reprioritize CIPs based on outcome of water supply decision

5.3 Valve Replacement Program

A $500,000 annual valve replacement program has been outlined in the Water Reliability Study. The replacement program concentrates on the most critical valves and putting in place a system to upgrade all valves over time.

Key Tasks:

- Implement Valve Replacement Program

5.4 Hydrant Replacement Program

A $250,000 annual Hydrant Replacement Program has been outlined in the Water Reliability Study. The program concentrates on the oldest hydrants first, and puts in place a long term program to upgrade all hydrants in the system over time.

Key Tasks:

- Implement Hydrant Replacement Program

5.5 Water System Automation

Supervisory Control and Data Acquisition (SCADA) - Modern water utilities operate more efficiently and with lower labor costs by using SCADA to operate and analyze the water system and its operation.

Key Tasks:

- Evaluate and upgrade water system SCADA system
- Develop CIP costs to upgrade SCADA system
- Look at interoperability with GCDC-WWS SCADA system

5.6 GIS-Based Asset Management

One key to operating and maintaining a water system is identifying which assets are fundamental to operating the system, which require the most maintenance, and which are most likely to fail and what the effect of that failure will be. GIS-based work management and asset management systems provide the tools to easily perform these types of analyses and apply them to the system to make the most cost-effective capital improvements. The city has the basic GIS tools and water and sewer modeling software.

Key Tasks:

- Evaluate the various software packages
- Purchase software
- Implement software