Chapter 9 - Water Resources Management Plan

Introduction

Purpose

The City of Hopkins (City) has developed this Water Resources Management Plan (WRMP) to meet regulatory requirements, and to plan for future alterations in the existing drainage system due to redevelopment activities. The City is within the Minnehaha Creek Watershed District (MCWD) and the Nine Mile Creek Watershed District (NMCWD). The MCWD is in the process of updating its Comprehensive Water Resources Management Plan, and the NMCWD updated its Water Management Plan in 2006. Minnesota Rules Part 8410.0160 states:

- Each local plan must, at a minimum, meet the requirements for local plans in Minnesota Statutes, Section 103B.235, except as provided by the Watershed Management Organization Plan under Part 8410.0110, Subpart 3.
- Each community should consider including its local water resources management plan as a chapter of its local comprehensive plan. Each local plan shall be adopted within two years of the board's approval of the last organization plan that affects local units of government.

The City of Hopkins will continue to work to ensure the City's Goals and Policies and Development Standards are consistent with both Watershed Districts as the Plans and Rules are revised.

The City is completely developed with a mix of commercial, industrial, residential and open space uses. Redevelopment activities within the City are also occurring as the population of surrounding area continues to grow.

Land Use

Location

The City of Hopkins lies in southeast Hennepin County. The City contains 2,760 acres of land and water resources within its corporate boundaries, and is bounded by the cities of Minnetonka, Edina, and St. Louis Park .

Existing Land Use

The existing land use of the City consists of a mix of industrial, commercial, residential, open space, and transportation corridors. Please see Figure 4.1 for the existing land use of the City.

A northern and eastern portion of the City drains to Minnehaha Creek, while the southern portion of the City drains to Nine Mile Creek, both through natural drainage and via storm sewer.

Future Land Use

As previously stated, the City of Hopkins is completely developed. The future land use as defined in the updated Comprehensive Plan is shown in Figure 4.2. The future land use changes will be a result of redevelopment activities. Future redevelopment activities should not have a significant impact on regional storm water systems.

Additional Land Use Control

Shoreland

The City of Hopkins has not adopted a shoreland ordinance. At this time, the Minnesota Department of Natural Resources (MNDNR) does not require a shoreland ordinance, and we do not see the need to implement one in the near future.

Floodplain

The City participates in the National Flood Insurance Program (NFIP). The City administers a floodplain ordinance based upon the effective Flood Insurance Study (FIS) for the City of Hopkins (dated June 16, 1992). There are two flooding sources (Minnehaha Creek and Nine Mile Creek) shown in the FIS. A request for a Letter of Map Revision (LOMR) has been submitted to the Federal Emergency Management

Agency (FEMA) for consideration. This LOMR is for a correction of an inconsistency found in the floodway version of the HEC-2 computer model that had been furnished by the MNDNR in August 1994. The roadway overflow section at 9th Avenue South had not been encroached to be consistent with the floodway width downstream and upstream of the crossing. This correction requires that a 'corrected duplicate model' be prepared and approved by FEMA.

Hydrologic Setting

Regional Climate

The climatology of Minnesota is described in the United States Geological Survey (USGS) Water-Supply Paper 2375 as follows:

Minnesota is affected by a variety of air masses. In winter, the weather is dominated by cold, dry, and polar continental air masses from northwestern Canada. In summer, the weather is dominated by dry, tropical continental air masses from the desert southwest or by warm, moist, tropical maritime air masses from the Gulf of Mexico. In spring and fall, the weather is transitional and is affected by alternating intrusions from these three air masses.

Almost 45 percent (about 12 inches) of Minnesota's annual precipitation is received from June through August, When moisture from the Gulf of Mexico is most available. Only 8 percent of the annual precipitation is received from December through February.

Cyclonic and convective storms are the two major types of storms that bring moisture into Minnesota. Cyclonic storms are large-scale, low-pressure systems associated with frontal systems that approach the State from the northwest or southwest. Cyclonic storms that approach from the northwest are common in winter and produce small quantities of precipitation. Cyclonic storms that approach from the southwest occur in the fall, winter, and spring and can bring substantial quantities of rain or snow by drawing moisture northward from the Gulf of Mexico. Cyclonic storms in combination with unstable conditions can produce severe weather and excessive precipitation.

In late spring and summer, thunderstorms are common. These small-scale convective storms typically form because of the presence of unstable, warm, tropical air near the surface and colder air above.

Floods in Minnesota are of two forms – large-scale floods in late winter and early spring, and small-scale flash floods in late spring and summer. Large-scale floods generally result from a combination of deep, late winter snowpack, frozen soil that prevents infiltration, rapid snowmelt due to an intrusion of tropical air, and widespread precipitation caused by cyclonic storms that approach the State from the southwest. Flash floods result from powerful, slow-moving thunderstorms.

Average annual values for various weather data components for the Hopkins area are listed below in Table 9.1:Average Annual Weather Data.

Table 9.1. Average Annual Weather Data

Weather Data	Value
Annual Normal Temperature	43 °
Annual Normal Precipitation	29 inches
Annual Runoff Depth	4.7 inches
Storm Duration	6 hours
Storm Intensity	1.4 inches per hour
Time Between Storm Midpoints	89 hours

Additional description of the climate of the area is provided in the MCWD Water Resources Management Plan.

Surface Water Resources

Wetlands

The National Wetland Inventory Map shows the location and type of wetlands within the City of Hopkins (see Figure 4.2). In addition to these basins, there are several storm water detention basins within the City limits which provide some of the benefits of a natural wetland basin.

There are four Minnesota Department of Natural Resources (MNDNR) Protected Waters and Wetlands (MNDNR Nos. 27-717W, 27-719P. 27-777P, and 27-779W) within the City. Part of MN/DNR No. 27-084P is located in the northern section of the City. This protected water is also shared by the cities of St. Louis Park and Minnetonka.

Creeks

Minnehaha Creek

Minnehaha Creek is a direct tributary to the Mississippi River. Lake Minnetonka is the headwater for the creek. It is a MNDNR watercourse and flows east at the north end of Hopkins and southeast on the east side of the City.

Nine Mile Creek

The headwater of the north fork of Nine Mile Creek is at the southern edge of Excelsior Boulevard in the southwest portion of Hopkins. Nine Mile Creek flows southeast to the Minnesota River, and is a MNDNR protected watercourse.

Ditches

Much of the surface water is routed through an existing storm sewer system within the City of Hopkins. This includes a system of storm sewer pipes, ponds, ditches, and culverts.

General Drainage Patterns

The City of Hopkins lies within the Minnehaha Creek Watershed District (MCWD) and the Nine Mile Creek Watershed District (NMCWD). The northern and eastern portions of the City drain to Minnehaha Creek, and the southern and central portions of the City drain to Nine Mile Creek. The City has been delineated into about 60 subwatersheds. The City of Hopkins has numerous points of discharge from and to the cities of Minnetonka, Edina, and St. Louis Park.

The City of Hopkins contains several land-locked areas. A land-locked area is one which will not drain naturally on the ground surface. An outlet for each of these areas should be considered to decrease the flooding potential.

Hydrologic Modeling

A HydroCAD™ model has been created for specific studies within the City of Hopkins, but there has not been a hydrologic model created for the entire City; however, detailed hydrologic information for each of the subwatersheds can be seen in Appendix A. The following paragraphs discuss areas of concern in the City.

Central District

Shady Oak Road Duck Pond

An existing pond along Shady Oak Road between 1st Street North and 2nd Street North has been a source for nuisance flooding along Shady Oak Road. No structural damage to residences has been documented. Presently, there is no outlet for this pond and during particular storms the pond will overflow onto Shady Oak Road. The Duck Pond receives runoff from both the cities of Minnetonka and Hopkins.

According to the Water Resource Management Plan for the City of Minnetonka, the Duck Pond can discharge 11 cfs to the City of Minnetonka through a 21-inch pipe culvert, with the remaining water discharging to the City of Hopkins.

Several concept designs were considered, but the preferred option as directed from City staff is to construct a gravity outlet.

This concept design includes two outlets for the pond, one that will discharge to Minnetonka and the other that will discharge to Hopkins. The Minnetonka outlet will be a 21-inch pipe that discharges to a wetland west of Shady Oak Road. The Hopkins gravity outlet will be through storm sewer on 1st Street North and down 18th Avenue North, which drains to Nine Mile Creek.

This project has been included in the Capital Improvement Plan. A formal feasibility study should be completed for this area to further define the issues, design options, and construction costs.

Van Buren Area

The Van Buren Area Drainage Study was completed by SEH in February 2004. The Minnehaha Creek Watershed District Engineer also completed a technical memorandum regarding this area. The purpose of both studies was to review storm water plans for the Plantation site, and to determine the effectiveness of replacing two 48-inch CMP culverts under Van Buren Avenue that ultimately drain a large drainage area, including Area 8 as mentioned above. The MCWD Engineer recommended replacing the two culverts due to the condition of the culverts. The ends are damaged and are nearly submerged during dry weather. According to the memorandum the culverts contain a foot or more of sediment. The City replaced these two culverts in the summer of 2007.

Southern District

Thermotech

The Thermotech building is located south of 5th Street South and west of 11th Avenue, and has experienced flooding problems in the past. These flooding problems include nuisance flooding of the parking lot, potential car flooding, and loss of use of the parking lot.

Approximately 140 acres of land drain to the low point west of the Thermotech building, which includes land in the City of Hopkins and the City of Minnetonka. There are two constructed storm water detention ponds upstream of the Hopkins corporate limit which capture most of the runoff from the City of Minnetonka. Outflow from the ponds enters a marsh area in Hopkins along the SOO line railroad tracks, and flows northeast. An existing 12-inch pipe allows high water in the marsh area to drain into Nine Mile Creek.

Much of the area will be flooded in a 100-year event. A proposed outlet for the marsh will reduce the high water levels near the existing buildings during a 100-year storm event that does not coincide with a 100-year flood on Nine Mile Creek. An improvement method considered to date included the excavation of additional storage in the ponds, surface restoration, and a 36-inch or 42-inch pipe. The ponds were reconstructed several years ago. The box culvert under the railroad tracks, along with the 36-inch stub for Thermotech has also been constructed. The construction was completed in 2000.

The following table is a list of important studies that have been completed in the City of Hopkins. For additional information, please see the listed studies and reports in Table 9.2: Summary of Water Resources Studieseasibility.

Table 9.2 - Summary of Water Resources Studieseasibility

Study Name	Study Type	Prepared By	Date
Oak Park Land Townhouses Flood Evaluation Calculations	Letter	RCM	July 1992
Hopkins Plaza/Hopkins Home Center Storm Water	Feasibility Report	RCM	July 1997
6th Avenue North and 3rd Street North Intersection	Feasibility Study and Report	RCM	November 1997
Nine Mile Creek Bank Stabilization/ Sediment Removal	Feasibility Report	RCM	December 1997
Area 2 Hilltop Park, Area 3-Alley Between 17th and 18th Avenues North, Area 4-13th Avenue North-Maetzold Field	Feasibility Report	RCM	March 1998
Area 5 - Alley between 8th and 9th Avenues North	Feasibility Report	RCM	September 1998
Super Valu Redevelopment	Drainage Calculations	Westwood Professional Services, Inc.	September 1998
Van Buren Avenue Drainage Study	Drainage Study	SEH, Inc.	January 2004

Design Criteria

Design Storm

The 24-hour duration, Natural Resources Conservation Service (NRCS) Type II rainfall distribution with average soil moisture conditions (AMC-2) will be used for overall subwatershed planning within the City of Hopkins. The rainfall depths for storms associated with various return periods is shown below in Table 9.3: Rainfall Depths for 24-Hr Event. This criterion is consistent with the MCWD Water Resources Management Plan, the NMCWD 509 Plan, and guidance from the NRCS. More recent data developed by Huff and Angel (1990) vary somewhat from these values.

Table 9.3 Rainfall Depths for 24-hr Event (USWB TP-40

Return Period	Rainfall Depth (inches)
1 - yr	2.3”
2-yr	2.7”
5-yr	3.5”
10-yr	4.1”
50-yr	5.3”
100-yr	5.9”

Rain Gages

The City of Hopkins has a rain gage on the public works building. There are four other rain gages in the surrounding area that can be used to obtain rainfall data; the Minneapolis National Weather Service Station and the cities of Crystal, St. Louis Park, and Eden Prairie have rain gages. The National Oceanic and Atmospheric Administration (NOAA) also has stations in the cities of Mound and New Hope.

Land Collection System

The minimum design storm for the future local collection system evaluation and design will be a 10-year return period event. Design of local storm sewer systems will generally be designed using the Rational Formula.

The choice of a design storm is largely an economic rather than a technical decision. The City should deliberately consider the level of service desired when it chooses the recurrence interval used in any construction project. Additional rainfall probability data are included in Appendix A.

Other City Requirements

Any new construction of development has the potential of increasing runoff rates and volumes.

The development or redevelopment must include facilities to provide water quality treatment and control runoff at existing or reduced rates. Variances from plan standards will be allowed if computations that demonstrate no adverse upstream or downstream effects will result from the proposed system can be provided to the City Engineer. A description of 'Development Standards' is included in Appendix F.

Geology and Hydrogeology

Soils

The superficial geology of the Hopkins area consists of unconsolidated sediments of glacial deposits derived from the Des Moines Lobe, Grantsburg Sublobe, and a small amount from the Superior Lobe. The glacial sediments were deposited during the most recent glacial event, the Late Wisconsinian, which ended about ten thousand years ago. These deposits consist of till and outwash deposits.

Surficial Hydrogeology

The unconsolidated glacial range has a thickness from 50 to 250 feet within the City of Hopkins. The water from the local groundwater table is most easily obtained from outwash deposits with broad areas of till acting as confining layers. Groundwater flow in the unconsolidated glacial deposits is generally east toward the Mississippi River. The water table is approximately 900 feet above mean sea level.

Bedrock Geology

As stated above, the depth to bedrock ranges from 50 to 250 feet in the City of Hopkins. The City sits on the western side of the Twin Cities basin, a bowl-like structure in the bedrock. At this location, the bedrock strata dips gently toward the east. The youngest and straitigraphically highest bedrock underlying the City consists of the Plateville and Glenwood Formations. Underlying the Plateville and Glenwood Formations is the St. Peter Sandstone, which along with the Plateville and Glenwood formations, make up almost all of the uppermost bedrock of the City.

Bedrock Hydrogeology

Four major bedrock aquifers underlie Hopkins. They are the St. Peter Sandstone, Prairie du Chien-Jordan, the Franconia-Ironton-Galesville, and the Mount Simon-Hinckley. These aquifers are separated by lower permeability confining layers. The first encountered confined bedrock aquifer is the St. Peter sandstone, the second aquifer is the Prairie du Chien-Jordan Aquifer. The St. Lawrence Confining Layer separates the Prairie du Chien-Jordan Aquifer from the underlying Franconia-

Ironton-Galesville Aquifer. The Eau Claire Confining Layer separates the Franconia-Ironton-Galesville Aquifer from the deepest aquifer, the Mt. Simon-Hinckley Aquifer. The groundwater flow direction in the bedrock aquifers is generally southeast in the Hopkins area.

The St. Peter Sandstone is the first encountered confined bedrock aquifer. The upper part of the formation consists of fine to medium grained friable quartz sandstone. The lower part of the St. Peter Sandstone contains multicolored beds of mudstone, siltstone and shale with interbedded very coarse sandstone. Many sand grains in the lower part are dark gray in color.

The Prairie du Chien-Jordan Auifer is made up of the Prairie du Chien group and the Jordan Sandstone. The Prairie du Chien Group consists of a sandy dolostone with minor amounts of shale. The Jordan Sandstone is a fine to coarse grained quartzose sandstone with minor amounts of shale. The Prairie du Chien is the most heavily used aquifer in Hennepin County, with potential yields of 1,000 to 2,000 gallons per minute. Underlying the Prairie du Chien-Jordan is the St. Lawrence Confining Layer. The St. Lawrence is comprised of lower permeability siltstone and dolostone and acts to hydrologically separate the overlying Prairie du Chien-Jordan from the underlying Franconia-Ironton-Galesville.

The Franconia-Ironton-Galesville Aquifer is made up of the Franconia Formation, comprised of glauconitic sandstone with some shale and dolomite; the Ironton Sandstone, and the Galesville Sandstone. This aquifer is commonly used for domestic water supply wells in the north and northwestern portions of Hennepin County. Underlying the Franconia-Ironton-Galesville is the Eau Claire Confining Layer. The Eau Claire consists of siltstone, shale, and silty sandstone and serves to hydrologically separate the overlying Franconia-Ironton-Galesville from the underlying Mount Simon-Hinckley.

The Mount Simon-Hinckley Aquifer is made up of the Mount Simon and Hinckley Formations. The Mount Simon Formation is a silty, fine-to-coarse-grained sandstone with thin beds of very fine-to-fine grained sandstone and minor shale beds. The Hinckley is absent in most places, but where it occurs it is in remnants only several tens of feet thick.

Recharge Zones

Recharge to the bedrock aquifers beneath the City of Hopkins occurs in two ways, vertically and laterally. Vertical recharge occurs through overlying glacial sediments and other bedrock aquifers. Lateral recharge occurs as groundwater moves laterally from outside the City or County, through the aquifer. The lateral recharge to the bedrock aquifers in Hopkins comes from the west.

Recharge to the Water Table Aquifer occurs primarily from precipitation and surface water groundwater interactions as well as laterally from outside the City.

Local Groundwater Models

The Hennepin County Conservation District (HCD), in cooperation with the Minnesota Department of Health, has developed a County-wide multi-layer groundwater model. This model may be a valuable tool in dealing with many of Hopkins' groundwater issues. This model could be useful with issues such as wellhead protection, storm water infiltration ponds, wetland issues, well siting, dewatering, etc.

The Minnesota Pollution Control Agency (MPCA) is currently developing a Metropolitan Groundwater Model. This model is a regional model focusing on the seven-County metropolitan area including Hennepin County. The focus of the MPCA model is more for evaluating groundwater contamination and remediation of the Quaternary and the Prairie Du Chien aquifers. The MPCA model and the HCD model utilize the Multi-Layer Analytical Element Model (MLAEW). The HCD model, however, is characterized as a single layer.

The City of Hopkins has prepared a water and sanitary sewer system update to its Comprehensive Plan for the period 2008 – 2030. This summary presents a profile of the existing conditions, needs assessment, and recommendations for improvements during the planning period.

Existing Water and Sanitary Sewer System Summary

The Hopkins water and sanitary sewer system has been continuously maintained with parts of the system dating before 1902. The system has been adapted by additions, modifications, and technological control advances as operational equipment and distribution methods have become

more sophisticated and efficient over the years. The city's population growth and new development has largely stabilized, allowing system needs to be incrementally diagnosed with improvements that could be funded and implemented over time.

Recently, the City of Hopkins has become poised for new growth that will add housing units near the downtown area and in the East Hopkins Redevelopment Area, as well as new commercial development adjacent to Highway 169 that will add new employment opportunities. The proposed developments will require some adjustments to the current system to accommodate the growth, accelerate needs that may be imminent to accommodate new development, and suggest that greater efficiencies can be obtained by planning to purchase replacement equipment and engaging neighboring communities in the implementation of plan recommendations.

Water and Sanitary Sewer System Analysis and Recommended Improvements

The following assessments and recommendations are outlined below and examined in greater detail in the contents of the 2008-2030 Comprehensive Utility Plan.

Water Supply

The City's water is supplied by four ground water wells (Well Nos. 1, 4, 5, and 6). Based upon the projected maximum day demands, Hopkins should plan for a reliable supply capacity of 5.9 million gallons per day (MGD) in 2007, 6.2 MGD in 2012, and 6.6 MGD in 2030. The design of supply facilities is based upon the maximum day demand requirements. Supply facilities should be able to meet the maximum day demand with the largest well out of service, which is referred to as "firm capacity." A new well should not be required to provide adequate firm capacity.

Well No. 1 is the City's only well that is not treated for iron and manganese contaminants. Use of Well No. 1 could result in "rusty" water complaints from customers due to the high iron levels in this well; therefore, polyphosphate and chlorine chemical feed systems should be added at Well No. 1 to help sequester and hold the iron minerals in solution.

The realiability of the City's wells is dependent on the availability of emergency power supplies. Generator hook-ups (manual transfer switches) are recommended for Well No. 5 and Well No. 6 to allow portable generators to power these wells during extended power outages.

Maintenance for the City's wells will be required on an ongoing basis. The city should plan to inspect and rehabilitate each well every ten years and replace each well pump every ten years for budgeting purposes.

Water Treatment

Hopkins is served by the Elmo Park Water Treatment Plant. The plant is effectively treating the raw water supply for iron and manganese contaminants in addition to providing disinfection and fluoride for dental care. Improvements are recommended for the Elmo Park plant including an emergency generator to operate the plant during extended power outages.

The existing treatment plant has a capacity of 4,800 gpm or 7.0 MGD. The reliable treatment capacity is 1,800 gpm (2.62 MGD) when one of the filter cells is removed from service.

The Elmo Park Water Treatment Plant has the potential to be expanded in the future to increase the reliable capacity of the plant. These improvements would increase the reliable capacity to 7.25 MGD. The City's reliable treated water capacity would increase to 8.4 MGD with use of Well No. 1. This capacity would be sufficient to meet the projected maximum day demand in 2030. A water treatment plant evaluation study is recommended for the Elmo Park plant in 2016 to assess the condition of the plant and provide recommendations for expanding the plant. The expansion of the Elmo Park plant is recommended in 2017.

Water Storage

The City currently has 1,000,000 gallons stored in elevated tanks and 2,200,000 gallons stored in ground water tanks. SEH conducted a storage analysis to determine the adequacy of the existing ground and storage capacities for the present and estimated future conditions. Based on the analysis, the City's total storage capacity is adequate if water can be pumped at all times from ground storage. The installation of emergency

generators at the Elmo Park Water Treatment Plant and the Moline pump house building are recommended to provide this capability.

The Moline tank was last recoated in 1999. The condition of the coating system appears adequate with no visible signs of peeling or rust spots. A properly applied coating system should last approximately 15 years; therefore, the City should plan to recoat the Moline tank in 2014. The coating system on the Blake tank was last recoated in 2001. The condition of the coating system also appears adequate with no visible signs of peeling or rust spots. The City should plan to recoat the Blake tank in 2016.

Water Distribution

With new residential and commercial developments in the downtown area, opportunities exist to extend a 12-inch trunk water main through the center of town to increase fire flows and provide greater redundancy in newly redeveloped areas. Currently, the City has an existing 12-inch stub extended north to the intersection of 10th Avenue South and Mainstreet. This 12-inch main should be extended north to an eventual connection with Highway 7.

The City has many hydrants that are very old and should be replaced to provide reliable fire protection. The City should plan to replace approximately 600 of these hydrants in the next ten years (60 hydrants per year).

Water Redundancy Analysis

To improve the City's emergency water supply, interconnections can be constructed with several neighboring communities. Currently, the City of Hopkins has one interconnection with the City of Minnetonka. Interconnections are recommended with the cities of Edina and St. Louis Park. These interconnections will provide additional insurance to help the City supply adequate volumes of water during maximum day and emergency conditions.

Sanitary Sewer Collection System

The City of Hopkins' sanitary sewer system consists of approximately 231,000 LF of sanitary sewer pipe ranging from 4 to 33 inches in diameter. Based on analysis on segments of the system serving the

proposed redevelopment in the downtown and east area there appears to be sufficient capacity for conveyance of additional future flow within the study period. Velocities in the majority of the segments analyzed also appear to be adequate with the exception of a sewer main located on Blake Road, north of Excelsior Boulevard. While this segment has the capacity to carry the estimated future flow, the current and future velocities within the sewer will continue to pose problems and require a higher level of maintenance to keep the sewer clear. The City should investigate the feasibility of reconstruction of this sewer at steeper slope to increase velocities in the pipe. Some consideration should also be given to redirecting the sewer to the north for discharge into the 33-inch trunk sewer in Lake Street.

The City should initiate a city-wide CCTV televising inspection program for all sanitary sewer lines. This proactive measure would be phased to complete different areas of the City over a 5-year period. After the complete sewer system is televised, the City would then review the need for a continued CCTV sewer inspection program. Information gathered from CCTV televising inspections is vital in determining the condition of the sewer and service connections. It is also an important tool in identifying and resolving infiltration and inflow (I/I) issues.

The City has programmed the elimination of Lift Station No. 1 into the 2009 street reconstruction project. The lift station will be demolished and replaced by a gravity sewer line that will be constructed from the corner of Second Street North and 21st Avenue North (the current location of Lift Station No. 1) west to Shady Oak Road.

Sanitary Sewer Lift Stations

The City of Hopkins owns and operates seven sanitary sewer lift stations. Pump down tests were preformed at all lift stations, and pump cycle times were reviewed and provided to the City. A visual inspection was also performed. All of the lift stations, based on available data and information gathered from the pump down tests, appear to be operating at adequate levels pumping capacity. The pump cycle times provided by the City appear to be high at some stations. High cycling results in more pump starts and subsequently higher operation costs. The lift stations with high numbers of cycle ("pump on" less than 3-minute intervals) should be investigated to verify if floats or other level sensors should be adjusted.

The City should continue routine maintenance of the lift stations including bi-annual inspections and cleaning, which includes: wet-well cleaning, pump impellor, bearing and seal inspection, and float resets if necessary. Check valves and isolation valves should also be inspected.

A prioritized lift station rehabilitation program should also be implemented. The rehabilitation program would provide the City a means of strategically managing its sewer in a cost effective and efficient manner. The program allows for an operation and maintenance approach in a proactive rather than a reactive manner.

Over the study period the recommended individual lift station rehabilitation items were divided into short (0-5 years), medium (5-10 years), and long-term (over 10 years). For pump replacement purposes a pump service life of 15 years was used. In the short term, Lift Station Nos. 2, 3 and 4 should have pumps replaced due to length of service life. In addition, Lift Station No. 4 should be additionally rehabilitated including the following: grouting and sealing the wet well, and installation of a new hatch and concrete cover. With these substantial improvements it is also recommended that a separate valve vault be constructed.

Medium range recommendations include pump replacement at Lift Station Nos. 5 and 6. Long range items include pump replacement at Lift Station No. 7.