Memorandum
City of Lawrence
Utilities Department

TO: **David L. Corliss – City Manager**
Cynthia Wagner - Assistant City Manager
Diane Stoddard - Assistant City Manager
FROM: **Mike Lawless – Asst. Director of Utilities**
CC: **Dave Wagner – Director of Utilities**
Philip Ciesielski – Asst. Director of Utilities
Date: **May 24, 2012**
RE: **Wastewater and Water Master Plan Summary**

Project Background:

The 2003 Wastewater and Water Master Plans estimated the population growth rate for the City to be between 2.2 percent and 2.7 percent per year resulting in an expected population of 149,278 by 2025. It was necessary to update the master plans due to their age and because recent growth rates have been at or below 1 percent.

Wakarusa Wastewater Treatment Plant

The 2003 Wastewater Master Plan recommended the construction of the Wakarusa Wastewater Treatment Plant (Wakarusa). The initial size of the Wakarusa was a 7 million gallons per day (mgd) treatment plant, which, in combination with the City's existing wastewater treatment plant would accommodate a population of 150,000. The cost of the 7 mgd facility was estimate to be $88 million in 2007 dollars. In late 2007 the City decided to hold on the design and construction of the Wakarusa until the changing conditions of the economy and population growth could be analyzed.

The 2012 Wastewater Master Plan recommends construction of the Wakarusa and that it needs to be in operation by 2018. Because of the reduction in the population forecast, the implementation of a rapid inflow/infiltration (I/I) reduction program, and other measures the initial size of the facility can be reduced to 2 mgd. Together with the existing plant, wastewater treatment capacity would to be able to accommodate a population of 120,000 which is forecasted to be 2030. The cost of the 2 mgd facility, pumping, and conveyance is estimated to be $54.7 million in 2012 dollars.

Preparation for Master Plans

Since the completion of the 2003 Master Plans, the Utilities Department has invested in an extensive rainfall and flow monitoring program in the sewer collection system. Also the Department has better defined the layout of the sewer collection and water distribution systems in the Geographical Information System (GIS). Both of these efforts provide information for the building of the collection and distribution system models that is significantly better than the basis for previous plans.

Burns & McDonnell was selected to prepare the update of the master plans. The scope of the project is to prepare collection and distribution system models using this new data, review current treatment plant capacities, and prepare wastewater and water capital improvement programs (CIP) based on growth triggers, regulatory demands, and infrastructure maintenance needs. Burns and McDonnell was also tasked with training

City staff on the process to use and maintain the new generation system models that will allow staff to adjust project timing and scope based on changing population locations and growth rates.

Wastewater Facilities Master Plan Summary:

The Wastewater Plan incorporated some tasks common to both master plans including defining the geographical plan boundary, developing time based population projections, and selection of the collection and distribution system modeling software.

The master plan boundary area is shown on Figure 1.1. The population forecast used for the master plan area was provided by the City using Horizon 2020 population projections between the medium and low projections and is summarized as follows:

Population Forecasts

Year	Utility Service Area	Master Planning Area
2010	92,727	94,564
2020	106,667	113,051
2030	119,529	129,176
Buildout	251,971	251,971

The modeling software selected for the master plans are SewerGEMS and WaterGEMS from Bentley. SewerGEMS was calibrated to mimic flows for wet weather events using data from the flow meters and rainfall gauges from the Flow Monitoring Program using a 10-year storm event as the "design storm". The large amount of field and operational data provides an exceptionally accurate model.

Model Results

After model calibration, multiple scenarios of the design storm were run to determine existing system deficiencies and the capacities needed to support projected system growth. The model runs indicated the following major concerns:

1. The instantaneous peak flow rate of 81 million gallons per day (MGD) at the Kansas River Wastewater Treatment Plant (KRWWTP) exceeds the firm capacity of 65 MGD.
2. Many "overloaded or surcharged" sewers are upstream of pumping stations that have inadequate firm pumping capacity.
3. Some surcharging of sewers downstream of Pumping Stations 5A/5B (Haskell) and 8 (22nd and Alabama) are due to peak flow rates that exceed the downstream sewer capacity.
4. There is a very short period from the beginning of a storm until peak flows arrive at the KRWWTP. This quick increase in flow indicates there are appreciable I/I sources close to the KRWWTP that should be reduced.

The following measures are recommended to address these concerns:

1. Increase pumping capacities for stations that have inadequate firm pumping capacities.
2. Implement a rapid I/I reduction program to reduce I/I that is in close proximity to KRWWTP. Overall reduction of I/I should be about 35%.

3. Divert a portion of both dry and wet weather peak flow to the future Wakarusa Wastewater Treatment Plant by 2018.

Running the model with these improvements in place indicates many of the overloaded or surcharged issues in the existing system would be eliminated. Figure 2.13 shows the current system conditions and Figure 2.15 shows the system after the measures above are implemented. The design year model runs were also made with the implementation of these measures. Figure 3.1 shows the 2020 Recommended Improvements and Figure 3.3 shows 2030 Recommended Improvements.

Wastewater CIP

A recommended Capital Improvement Program (CIP) was developed based on the model's indication of existing system deficiencies, the capacity needs for future growth, expected or known regulatory requirements, and infrastructure maintenance needs. The attached table lists CIP projects for the existing system and design years of 2020 and 2030 based on projected growth. For each project, the driver for the improvement (growth, regulatory, or system reliability (age and or condition)), cost in 2012 dollars, and the project's current, estimated timing are presented.

Water Facilities Master Plan Summary:

The Water Master Plan used the same population projections and master plan boundary as the Wastewater Master Plan. WaterGEMS models the distribution system based on maximum day and maximum hour customer demands during a dry year. Water demands, water rights, and treatment capacity were evaluated for the plan design years. There are no predicted deficiencies in water right quantity or treatment capacity until 2027 when treatment capacity is projected to equal demand. If the Clinton WTP filters are shown to be able to treat 25 MGD (5 MGD above the current rating of 20MGD) and the firm pumping capacity of the Clinton Intake is increased to 25 MGD, overall treatment capacity is predicted to be adequate until about 2038.

WaterGEMS was calibrated to mimic flows in the water distribution system using data collected during summer peak demands. The field and operational data provided a well-calibrated model.

Model Results

After calibration, multiple scenarios of maximum day and maximum hour conditions were run to determine adequacy of the distribution system, water age, fire flows, and the future main capacities needed to support expected system growth. The results indicate:

1. There are only minor system deficiencies due to capacity limitations.
2. To address an aging water system infrastructure and past deferred maintenance two pipe replacement programs are recommended.
    a. The first program targets 8" and larger water mains based on age, material, service location, and interior roughness of the pipe.
    b. The second program targets 6" and smaller mains to be replaced with 8" mains to improve system reliability, system fire flows, and service pressures while reducing water loss.

3. A booster pump station at the Harper tower is recommended to help maintain system pressure east and south of the tower and assist with water turnover in the tower.
4. Improvements recommended for 2020 and 2030 include:
    a. A pressure reducing valve between West Hills and Central Service pressure zones to improve system pressures and fire flows in the northwest portion of the Central Service Zone.
    b. Extensions of the transmission system to serve future growth including the Kaw Transmission Main. Figure 9.4 shows the 2020 Recommended Improvements and Figure 9.7 shows 2030 Recommended Improvements.

Water Age

A 14-day extended period simulation (EPS) was run with average day demand for the design years to evaluate water age. Water age is associated with the formation of disinfection by products that are regulated by the EPA. Results of the EPS indicated the average age of water in the system is adequate at 27 to 34 hours. There are high water age issues localized at end of the distribution system and at dead-end mains with low water usage. The average water age is consistent with growth through year 2030 and does not vary from year 2010 scenarios. Dead-ends mains that are unlikely to be extended can be looped. If not looped, they should be evaluated on a case-by-case basis and should include a combination of the following: routine residual monitoring, seasonal auto-flushing, or year round auto-flushing.

Fire Flows

Fire flows were analyzed under maximum day demand with a fire flow added to each node one node at a time. Fire flows are calculated for a residual distribution system pressure of 20 psi. Results of the fire flow analysis indicated fire flows ranging from under 750 gallons per minute (gpm) to in excess of 4,500 gpm. The lower fire flows are generally associated with residential areas or dead-end mains. The Pipeline Replacement Program and the Small Main Replacement Program greatly improve the available fire flows in 2020 and 2030. Similar to water age, dead-end mains that are not going to be extended could be looped to provide improved fire flows in those areas.

Water CIP

The Water CIP was developed based on the model's indication of existing system deficiencies, the capacity needs for future growth, expected or known regulatory requirements, and infrastructure maintenance needs. Other tasks completed with this master plan include review of the Oread Storage Tank replacement project and an evaluation of the Kaw WTP for structural, electrical and process needs. The attached table presents the recommended Water CIP Projects for the existing system and design years 2020 and 2030 based on projected growth. For each project, the driver for the improvement (growth, regulatory, or system reliability (age and or condition)), cost in 2012 dollars, and the project's current, estimated timing are presented.