CHAPTER 6

SYSTEM ANALYSIS AND RECOMMENDATIONS

6.1 GENERAL

This section of the Plan discusses existing system analysis and provides recommendations for future system improvements, extensions and operational improvements. It is based on the population and flow projections, existing system data and minimum design criteria presented in previous sections and includes system analysis information described in this section. Included are discussions and recommendations pertaining to: resolving existing limitations in the system, meeting projected system requirements in terms of capacity, improving system operation by rerouting flows, reconfiguring drainage basins and eliminating pump stations and extending service to currently unserved areas. A summary of recommended improvements, their estimated costs, proposed schedule and financing is included in Chapter 7 and Chapter 9.

6.2 SYSTEM ANALYSIS

This section describes the analysis of the collection system's ability to meet the needs of the existing and projected customers of the District's ultimate sewer service area. The analysis was performed using various tools; including a spreadsheet analysis accomplished using Microsoft Excel™ and a computer model that was constructed to simulate how the sewer system operates under various flow and growth projections. The computer software used in modeling the system is InfoSWMM® by Innovyze of Monrovia, California.

InfoSWMM® is an ArcGIS-centric hydraulic, hydrologic, and water quality simulation model for urban drainage and sewer networks. It provides analysis for the planning and management of sanitary sewer networks. The model utilizes various interfaces with GIS and utilizes the Innovyze tool GIS Gateway to exchange relevant system database files from the District's GIS to be used by the InfoSWMM® model data and user interface. The information exchanged from the District's GIS includes conveyance system facility data and layers for parcels, streets, and drainage basin boundaries. The model utilizes all of these layers to determine flows in various portions of the system and identifies potential problem areas under a given set of development conditions. Detailed descriptions of the data developed for the model is included in the following subsections.

6.2.1 Data Input

In developing the InfoSWMM model's Conveyance System layer (pipes and manholes), existing system mapping developed for the District's GIS was utilized. GIS data was brought into the InfoSWMM® model inclusive of all District trunk line mains, side street pipelines, and their connected manholes. All associated pipe material, diameter, and lengths along with manhole rim and invert elevations were incorporated into the

InfoSWMM® modeling program. PACE evaluated the existing system and determined for ease of modeling to eliminate all cleanouts as these are not considered to contribute a significant amount of wastewater flow. Updated pump station data was also used to modify the Conveyance System layer of the model. This information was provided by the District and is summarized in Table 4-1. The final component of the system analysis is the infiltration and inflow rates established for various areas of the District. These rates were estimated based on District and King County flow measurements and modeling and entered into the model as described in Section 6.2.2.2 below and in Section 3.5.

6.2.2 Development of System Flows

Municipal wastewater consists of base wastewater flow, groundwater infiltration and surface water inflow. These types of flow are included in both the InfoSWMM® and spreadsheet modeling processes. A more detailed discussion of these flows and how they were considered in the analyses is presented below.

6.2.2.1 Wastewater Flows

Population data from the Puget Sound Regional Council (PSRC) was used to develop modeling scenarios for the twenty-year planning horizon starting with year 2020 and increasing in five-year increments until 2040. The data received from PSRC contained estimates for both residential and commercial populations within the District's boundaries. These estimates were allocated per parcel within the District's sewered service area. All residential and commercial populations associated with parcels outside of the District's sewered service area were excluded from the model. Existing flow conditions as well as projected flow conditions based on the District's population growth were analyzed. A peaking factor of 2.5 was applied to residential and commercial base flows to determine peak wastewater flow.

Flow contributions per capita were used for residential and office/commercial populations.

6.2.2.2 Infiltration and Inflow

Infiltration occurs as a result of groundwater unintentionally entering the wastewater system through joints and cracks in pipes and manholes. The volume of infiltration is mainly influenced by age and condition of the system and by the amount of rainfall. Infiltration is also affected by system proximity to larger bodies of water and by tidal influences near low lying seashores.

Inflow is the water that unintentionally enters the sanitary system directly. Inflow might occur due to overflowing storm drain systems or might result from illegal connections to the sanitary sewer system (typically from area, roof or footing drains).

Typical values to compensate for I & I in system evaluation and design are 600 gpad for infiltration and 500 gpad for inflow. These typical values must be adjusted accordingly to suit local conditions. For example, older facilities are determined on a case-by-case basis and can be as high as 1,100 gpad for infiltration and 2,500 gpad for inflow.

Specific data regarding actual I & I rates were calculated prior to this Plan update are available from both the District's flow monitoring efforts as well as monitoring performed by King County in the past. In order to accurately estimate I & I flow within the sub-basins, a number of sub-basin characteristics are considered. These factors included pipeline age and materials, land use, concentrations of on-site disposal systems, open space, lakes and surface water, significant portions of sub-basins situated adjacent to the Puget Sound, and pump stations which have exhibited higher levels of I & I flows. Based on this information, average I & I was adjusted for each sub-basin and considered in the analyses. I & I ranged from 1,100 gallons per acre per day (in accordance with The District's contract with King County) to a small area of the Rainier Vista Basin where I & I rates are thought to be in excess of 13,200 gallons per acre per day (gpad). The weighted average of I & I in the District at the present time is estimated at just over 2,500 gallons per acre per day. For reference, it is noted that if the District were able to reduce I & I in the aforementioned area where it currently exceeds 13,000 gpad, the District-wide average could be reduced to less than 2,000 gpad.

For modeling purposes in InfoSWMM, the I & I rates were allocated per sewered parcel by multiplying the associated basin's I & I by the parcel's total area to obtain gallons per day. This I & I was then added to the peak residential and peak commercial flows to determine the total peak wastewater flow per parcel.

6.2.2.3 Pattern of Usage

Diurnal curves for various types of connections represent typical flow patterns within the service area. The diurnal curves reflect the relative use of unit flow of water throughout the day and assist in analysis of facilities under peak flow conditions. The various diurnal curves used to reflect usage patterns for different populations in the analysis are presented in Figures 6-1.

The residential curve in Figure 6-1 shows peak usage in the early morning hours. A smaller peak starts to develop in the late afternoon/early evening. The unit diurnal curve used to represent office/retail/industrial consists of several peaks. Water usage increases in the morning as people arrive at work and a peak occurs during lunchtime. Water usage then declines and rises again as the workday ends and reaches the highest peak during the day. The hospital diurnal curve was estimated to fall somewhere between the residential and the office/retail/industrial curve. Water usage in the hospital at night remains fairly consistent compared to the other two curves. It is assumed that an additional small peak occurs around midnight as shift change occurs.

In the InfoSWMM model, the peak flow scenario was the only scenario modeled for residential and commercial populations. The output from the model presents sewer flows at the peak condition (which based on the diurnal curves is in the morning hours between 8am and 10am). The InfoSWMM model output can be considered a snapshot in time for peak flows throughout the system. The InfoSWMM model can be fine tuned and calibrated, if deemed necessary, to show sewer pipe capacities and flows for different times of the day. However, when selecting areas to be considered for capital improvements the most important factor is available pipe capacity during peak events. Thus the peak flow scenarios as modeled by InfoSWMM are considered sufficient to identify areas where it is necessary to, firstly, resolve existing limitations in the system and, secondly, meet projected system requirements in terms of residential and commercial population growth.

The diurnal curves show unit flows. The peak is 100 percent of the unit flow. These curves are used to distribute the daily flows throughout the day. The peak flows contributed to the system occur based on the peak in the curve. As described above, the InfoSWMM model calculates the peak sewer flows based on residential and commercial population peak flows plus I & I contributions to sewer flow. These flows can then used to determine the peak hour, the peak day and the average day flows.

It is important to note that while there has been flow monitoring in the past, there has not been recent monitoring done to confirm peak flows that are shown within the hydraulic model.

Figure 6-1

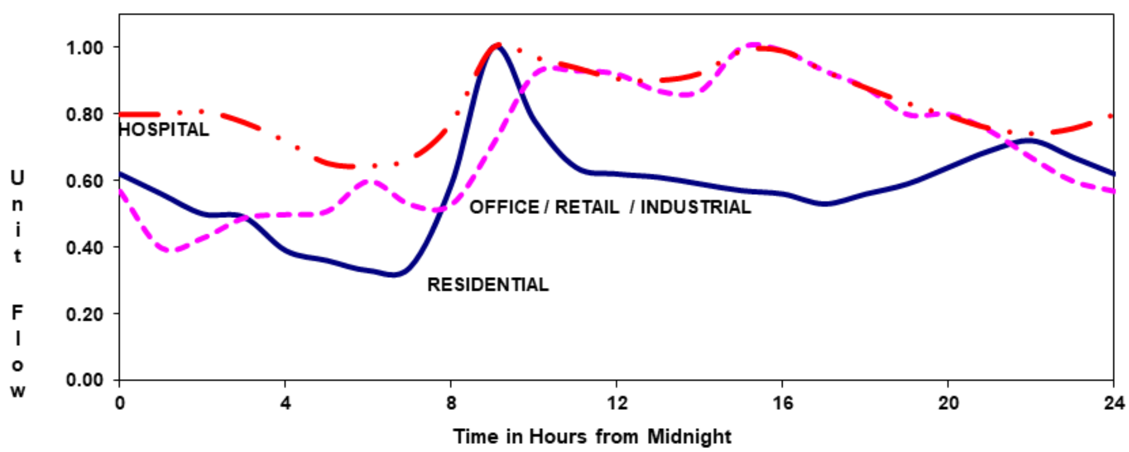

Figure 6- 1: Diurnal Curve - Residential Usage

6.3 DRAINAGE BASIN ANALYSIS

The estimated I & I per basin serves as the starting point for the system analyses and determination of recommended improvements to the existing system and I & I rates were presented in detail in Chapter 5 of this Plan. This data combined with review of historical repair records and viewing of video inspection tapes of specific pipe runs provided a realistic view of existing facilities and opportunities for system improvements and/or extensions to provide service to parcels that are currently undeveloped or rely on on-site septic tanks for wastewater treatment and disposal. Detailed system improvements recommendations are presented in Chapter 7.

A primary goal of the system analysis was to identify unsewered areas that could be directed to the least expensive treatment provider without creating exorbitant pumping costs. Although no significant changes in the previously aligned basins between King County WWTFD served areas and those areas that flow to other jurisdictions for treatment, it is recommended that the District continue to review opportunities for directing flows westerly to SWSSD on a case by case basis.

The InfoSWMM model was run for the entire twenty-year planning horizon in five year increments (ie. 2020, 2025, 2030, 2035, and 2040). The results produced by the model represent a one day snapshot for peak wastewater flows for all pipes and manholes in the District’s system. Pipe capacity was the main component analyzed when evaluating potential system improvements. The model results provide pipe capacity (d/D) as the percentage of the used capacity over the total available capacity, where d represents the actual wastewater flow depth through the pipe and D is the maximum available depth. If d/D exceeded 75%, then the pipe is considered under capacity and it is recommended to evaluate system improvement options to provide the additional required capacity.

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