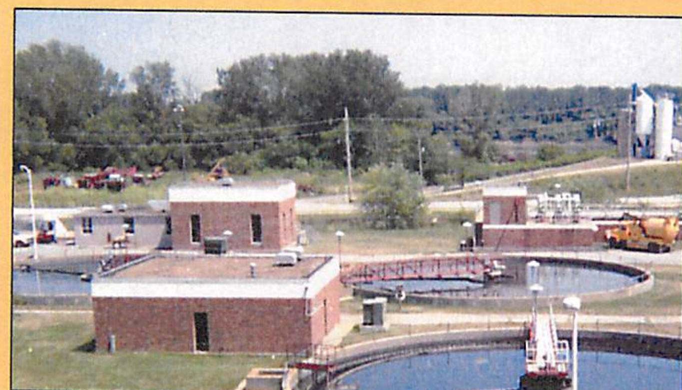
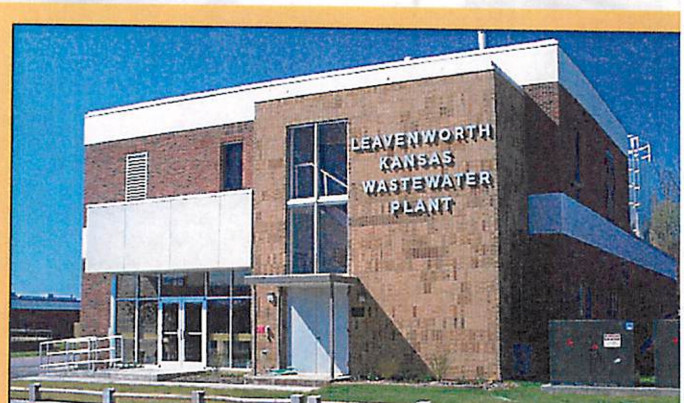
FINAL REPORT

Wastewater Master Plan for The City of LEAVENWORTH KANSAS





JANUARY 2002

building a world of difference™ BLACK & VEATCH

TABLE OF CONTENTS

Appendices

Glossary of Terms and Abbreviations

Tables

Figures

Executive Summary

A. Introduction

The primary purpose of the Wastewater Master Plan is to identify the most efficient, cost-effective, and appropriate collection system and facility improvements to accommodate existing and future wastewater flows through the year 2020. The principal objectives of this study are to determine process design capacities, inspect and make recommendations concerning existing facilities, provide recommendations for expansion or diversion of WWTP flows, and prepare an evaluation of alternatives. Evaluation of alternatives will consider cost and non-cost factors.

This Master Plan includes flow and rainfall monitoring in the collection system, hydraulic modeling of the collection system interceptors, consideration of wet weather equalization/holding, identification of needed rehabilitation and repair of existing facilities and equipment at the WWTP, and analysis of expansion alternatives at the WWTP. Recommendations are included to maximize treatment efficiency of existing processes, automate treatment operations, and minimize impacts on the surrounding community.

B. Wastewater Collection System Findings

1. Flow and Rainfall Monitoring

As indicated in Chapter II, a sanitary sewer flow and rainfall-monitoring program was conducted for the Leavenworth collection system to determine system flow rates and to evaluate infiltration/inflow (I/I) into the collection sewers. Rainfall monitoring was performed to develop a correlation between wet weather system flows and rainfall. A significant number of storms were observed. Flow monitoring was performed simultaneously with the rainfall monitoring to obtain collection system flow rates during both dry and wet weather conditions in an attempt to identify the portions of the wastewater system that may contribute significant amounts of I/I.

2. Population and Land Use

For analysis of the flow monitoring results, the developed acreage in each monitored area was determined by data supplied by the City. The total developed area of the City of Leavenworth and Fort Leavenworth covered by the monitoring program was 8,399 acres.

Developed acreage within the service area is directly related to population growth. The year 2000 population of Leavenworth including Fort Leavenworth was estimated to be 40,000. Population projections provided by the City through the year 2020 are given below and are based on an estimated 1.5% growth rate:

Year	Projected Population
2000	40,000[1]
2010	46,400
2020	54,000

Land use in Leavenworth is divided into eight categories that include three residential categories, two industrial categories, commercial development, public development, and parks. Future land use was based on the City's current development, available area for growth, and the future projected population. A projection of future land use is shown in Figure VI-6.

Various flow rates important to the operation and evaluation of the wastewater treatment plant (WWTP) were estimated. Flow rates estimated included average daily dry weather flow (ADDF), average annual daily flow (ADF), peak month flow, peak day flow, and peak hour flow. Table ES-1 shows the estimated current system flows based on the flow, population, and land use analysis.

Table ES-1
Projected Flow Summary

Parameter	Value
Average Daily Dry weather Flow (ADDF)	3.9 mgd
Average Daily Flow (ADF)	4.5 mgd
Peak Month (PM)	5.3 mgd
Peak Day (PD)	8.9 mgd
Peak Hour (PH)	33.7 mgd
Peaking Factors	
ADF/ADDF	1.13
PM/ADF	1.20
PD/ADF	2.00
PH/ADF	7.57
Note: ADF, PM, PD, PH based on 5 year design storm.	

[1] It should be noted that just prior to submitting the final copy of this study, the U.S. Census data for the City of Leavenworth revealed that the actual population was 35,420. The actual population figures were determined to not appreciably change the findings of this study.

3. *Collection System Evaluation*

System analyses were performed to evaluate the existing collection system capacity against peak flow rates and the impact of infiltration and inflow (I/I) removal. Analyses were performed for existing and future population and developed area conditions. A computer model of the City's trunk sewer network was used for the analyses.

The objectives of the system evaluation were to:

- Identify existing system improvements required to serve current and future sewered customers.
- Define the I/I reduction plan.

An inventory and definition of the City's existing trunk sewer system was completed. The inventory only included trunk facilities and did not include collector sewers or private sewer laterals. Data was obtained from the Engineering Department and selective field investigations. The model included all trunk sewer pipes 10 inches in diameter and larger.

The study area consists of five monitored subsystems. The monitored subsystems include flows received from both the City of Leavenworth and Fort Leavenworth. The total length of trunk sewers included in the sanitary sewer model is approximately 113,500 feet or 21 miles. The trunk sewers were identified through a review of various maps and documents related to the study area, interviews with City personnel, and surveys and field investigations performed for this project.

The model was calibrated against actual field data to insure accurate simulation. The results of the calibration provided satisfactory agreement between computer-generated and monitored flow.

Results of the analysis show that none of the system is overloaded during dry weather conditions, but a significant number of trunk sewer segments are overloaded during wet weather conditions. This observation was confirmed through review of overflows observed in the system. The status of the collection system under current flows is summarized on Figure VI-2 of Chapter VI.

Land use projections were used to estimate future flow conditions in the model to determine the impact on the existing system for the design years 2010 and 2020.

4. Collection System Recommendations

The Implementation Plan in Chapter VI was prepared using information from flow monitoring, sewer system inventory, growth and development projections, and computer modeling described in this report. The Implementation Plan for the sanitary sewer collection system includes the following components:

- Conducting detailed sewer system evaluation surveys to provide better focus of priority areas.
- Removing I/I sources through continuation of sewer rehabilitation efforts.
- Constructing relief sewers.

The capital improvements recommended in the Implementation Plan are based on the following criteria:

- Sewer capacity and flow containment for peak flow conditions under a 5-year storm event.
- 30 percent I/I reduction in Subsystem SUB01 as recommended in Chapter III.

The recommended improvements are grouped into three priorities. Priority I improvements are recommended to address immediate or near term needs and are estimated to cost approximately $3.8 million. Priority II improvements are recommended within the next ten years and are estimated to be approximately $2.1 million. Priority III improvements are recommended within the next 20 years and are estimated to be approximately $4.4 million. These improvements are summarized in Table ES-2.

Table ES-2
Summary of Recommended Collection System Improvements

Description	Capital Cost (year 2001 dollars)
Priority I – address near term needs	$3.8 million
Priority II – implement within next 10 years	$2.1 million
Priority III – implement within next 20 years	$4.4 million
Total	$10.3 million

Sewer system evaluation surveys (SSES) are recommended as part of Priority I improvements to locate and prioritize I/I sources in the subsystem that makes up the oldest part of the City of Leavenworth. It is recommended that a field inspection program be implemented to confirm assumed sewer system inventory information and to quantify sources of extraneous flow to the system. Then, a cost-effectiveness analysis should be carried out to identify which sources of I/I are cost-effective to remove. Inspections are only needed in subbasin SUB01, which represents the oldest portions of the collection system, primarily in the central downtown corridor of the City along 3-Mile Creek. It is recommended that field investigations be conducted to locate sources of I/I, confirm structure locations, verify key capacity data, and address routine maintenance including:

- Manhole inspections
- Sewer line lamping
- Smoke testing
- Dyed-water testing
- Television inspections

The results of the flow analysis reveal that the ultimate capacity at the wastewater plant is not adequate to handle the 5-year design flow without I/I removal. This is shown in Figure VI-4.

Further analyses indicate that the flow from the collection system sewers remains at or below the Wastewater Treatment Plant hydraulic capacity at the influent pump station provided that at least 30 percent I/I removal is completed before the year 2010.

It is also recommended that a preventive maintenance program be established to implement the pending EPA CMOM (Capacity, Management, Operations, and Maintenance) requirements to evaluate and implement planned maintenance/rehabilitation activities. The program would optimize maintenance operations and assist in addressing pending CMOM requirements that are expected to be issued by the EPA by the year 2003. These requirements for eliminating sewer overflows are expected to be much more stringent than currently required and will require extensive evaluation of sewer overflows once the EPA officially adopts these requirements.

C. Wastewater Treatment System Findings

1. Physical Condition of Existing Facilities

An evaluation of the existing WWTP is included in Chapter IV. The WWTP has undergone many expansions and upgrades, with the last major solids processing expansion in 1994. This expansion included a rehabilitation of facilities damaged during the flood of 1993 and an expansion of the administration building to house a belt filter press and a lime stabilization system for processing EPA 501 Class B biosolids. A chemical feed system for feeding ferrous chloride, and new influent screens were provided in 1996 and 1998, respectively.

A plant inspection was conducted in August 2000 and results of the inspection were compiled into report forms included in this document. These reports present additional details on condition of equipment and structures.

The plant staff is adequate for its size. The overall appearance and condition of the WWTP is good. Maintenance procedures are followed and tracked through a maintenance management system to final resolution.

Physical improvements recommended include the immediate expansion of the influent pump station with additional pumping capacity, improvements to the aerated grit basin to correct inefficient performance and improved grit capture, and improvements to the primary clarifiers to improve solids capture and reduce the load to the trickling filters downstream. The total estimated cost of all recommended physical improvements to the WWTP is $4.3 million.

Staged implementation of plant-wide odor control was also considered. Additional odor control should be implemented as development of surrounding properties becomes pressing. The estimated cost of the recommended first phase of plant-wide odor control is $1.7 million.

2. Wastewater Treatment Process Expansion Analysis

The process evaluation of the WWTP is summarized in Chapter V. The WWTP was designed for the following parameters, which were expected to be reached in 1990:

- 55,000 population equivalents.
- 6.88 mgd annual average flow.
- 20 mgd peak hydraulic capacity through secondary treatment.
- 86% five-day biochemical oxygen demand (BOD_5) removal, resulting in an effluent BOD_5 of 42 mg/l.

The current NPDES permit conditions are listed below.

- BOD_5 - 45 mg/l weekly average, 30 mg/l monthly average.
- Total suspended solids (TSS) – 45 mg/l weekly average, 30 mg/l monthly average.
- pH – 6 – 9.

The current permit limit of 30 mg/l BOD_5 represents a significant reduction from the original design basis of 42 mg/l. The following Table ES-3 shows that the projected BOD_5 loading for 2020 is just under the original design basis, while the projected TSS loading is just over the original design basis.

Table ES-3
Basis of Evaluation

Year	Original Design	Existing Conditions (2000)	Future Conditions (2020)
Flow, average day (mgd)	6.88	4.0	5.4
Max month (mgd)	--	5.11	6.88
Peak day (mgd)	13.76	8.91	10.8
Peak hour (mgd)	--	33.7[1]	35[2]
BOD_5, average (ppd)	--	7,072	9,525
(mg/L)	--	212	212
BOD_5, max month (ppd)	17,200	11,576	15,591
(mg/L)	300	272	272
TSS, average (ppd)	--	12,076	16,265
(mg/L)	--	362	362
TSS, max month (ppd)	20,000	18,415	24,802
(mg/L)	350	432	432
Monthly Avg. Effluent BOD_5/TSS	42/-	30/30	30/30

Notes: 1. Based on current peak hour flows as discussed in Chapter II and VI without any I/I removal.
2. Based on future peak hour flows as discussed in Chapter VI and assumes 30% I/I removal from subsystem SUB01. Without 30% I/I removal, peak hour flows approach 43 mgd.

The Wastewater Treatment Plant unit processes were evaluated for the adequacy of both existing hydraulic capacity and pollutant treatment capacity. Figure ES-1 shows the unit processes that are rated based on the required hydraulic capacity. This figure indicates the need for the expansion of influent pumping facilities, primary clarification facilities, and settled sewage pumping facilities. Peak hour flows through the plant could approach 35 mgd by year 2020. Influent pumping capacity should be expanded to accommodate this flow rate. In addition, to accommodate this large peak flow without exceeding the recommended capacity of the primary clarifiers, an additional primary basin should be constructed. Space already exists for the installation of a fourth primary clarifier. If a fourth clarifier were constructed, the total hydraulic capacity would increase to 16 mgd on a maximum month basis. It is recommended that a fourth primary clarifier be constructed in order to accommodate the peak flows from the influent pumping station. Construction of a fourth primary clarifier will increase the peak flow capacity to 32 mgd. Peak flows between the estimated 35 mgd in year 2020 and the recommended peak flow capacity of 32 mgd in the primary clarifiers would be less common but would indicate the need for further expansion after the year 2020. Settled sewage pumping capacity should also be expanded to handle the higher flows.

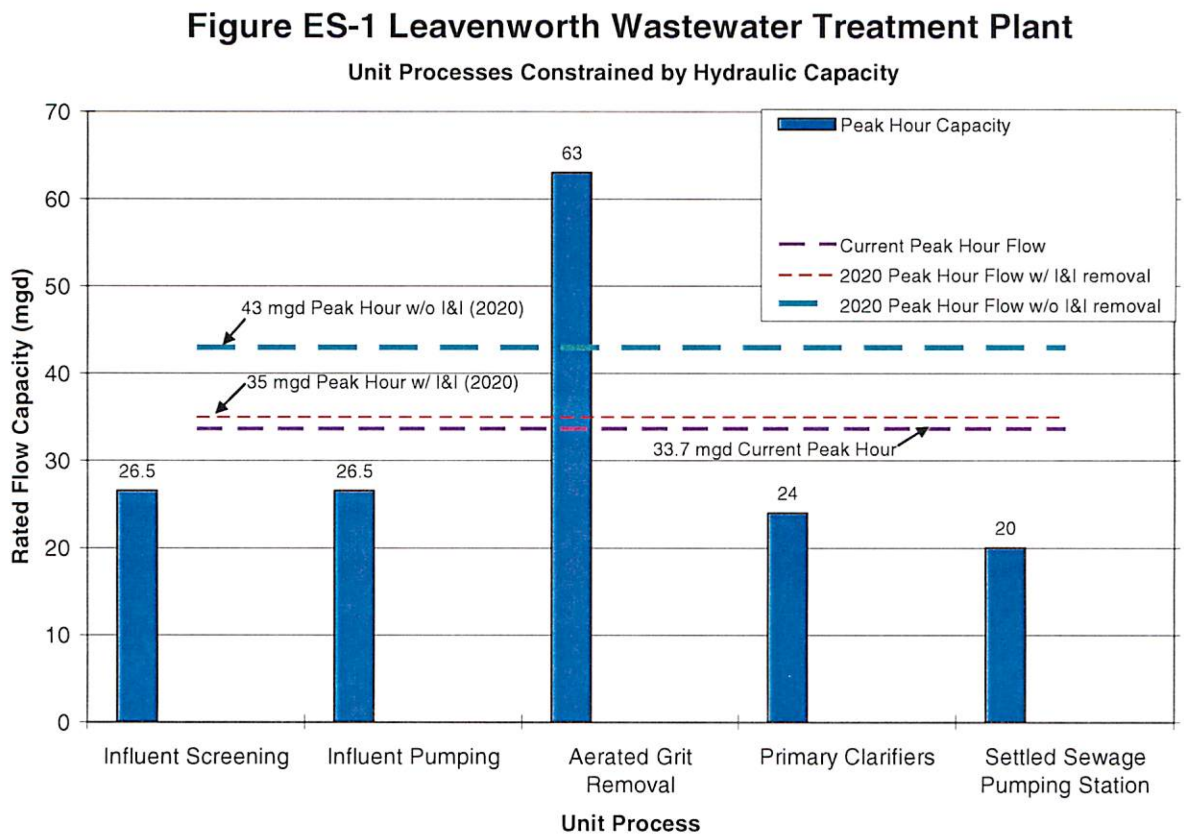
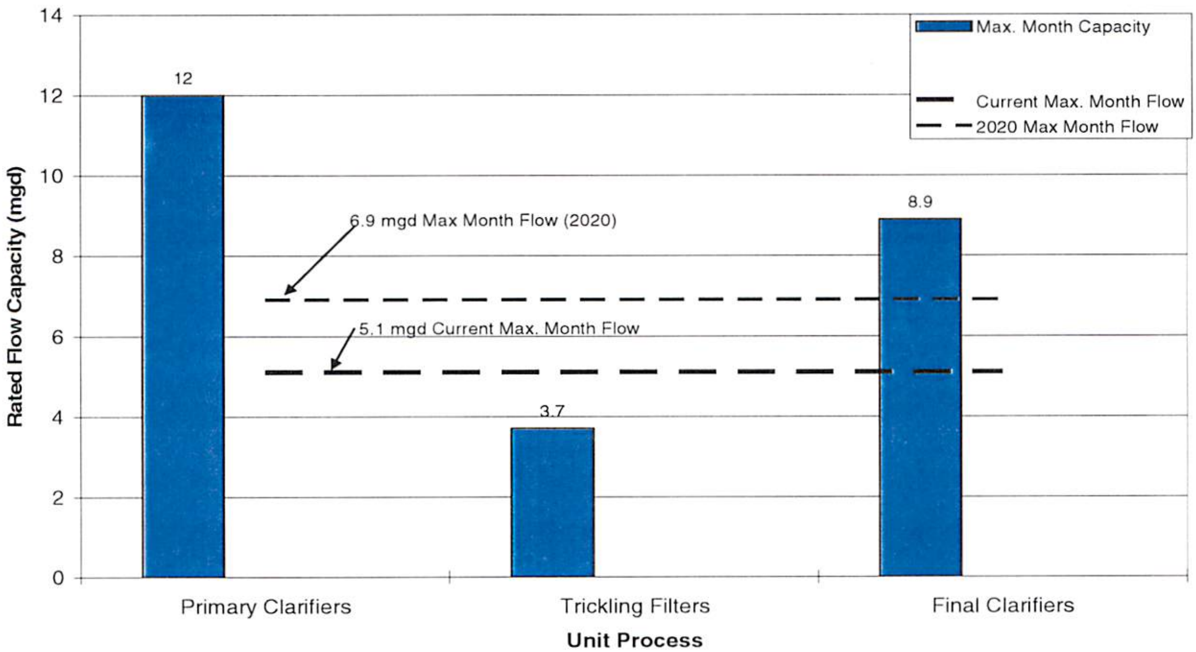


Figure ES-2 shows the unit processes that are rated based on the required pollutant treatment capacity. This figure indicates the need for the expansion of the trickling filter towers. A trickling filter process model was calibrated using the historical plant data. The results from this model were used to determine the existing biological treatment capacity of the plant to meet the current 30 mg/L effluent BOD_5 permit limit with current and future loading conditions. Results indicate that the Leavenworth trickling filters are at risk of exceeding their recommended loading limit at certain combinations of temperatures and loading conditions. The risk to violate effluent limits is imminent and will result when high loads and low temperatures occur in combination. If violations become frequent state action or consent orders will occur. It is therefore in the best interest of the City to build additional treatment capacity as soon as possible.

Figure ES-2 Leavenworth Wastewater Treatment Plant

Unit Processes Constrained by Physical or Biological Treatment Capacity



There are many potential options to increase the treatment capacity of the WWTP. Five options were identified for improving the effluent at Leavenworth's WWTP to meet compliance with the permit limits at current and future design conditions.

- Add two additional trickling filters.
- Add Chemically Enhanced Primary Treatment (CEPT) capability and one trickling filter.
- Add effluent filters after final clarification.
- Add CEPT capability and intermediate clarification to allow true two-stage operation.
- Convert to a Trickling Filter/Solids Contact (TF/SC) treatment system.

Space was allocated under the original design for two additional trickling filters and two additional final clarifiers for future increases in flow and load. Constructing two additional trickling filters would provide sufficient treatment through 2020.

Construction of one trickling filter in conjunction with the addition of CEPT capability would allow for adequate treatment through the year 2015. After 2015 additional treatment capacity may be required and the second trickling filter may be required. However, this alternative may represent a cost advantage to the City if growth or load increases at a slower rate than estimated.

Black & Veatch recommends constructing one additional primary clarifier, installing chemically enhanced primary treatment, and constructing one new trickling filter as the best option to the City for achieving permit compliance. The present worth costs are essentially equal to adding two trickling filter and this alternative has a favorable non-economic rating. This alternative offers the benefit of reduced capital costs, but higher operations costs due to chemical use and increased solids production. It may be necessary to construct the second trickling filter in 2015. It is possible that growth may be less than predicted in this Master Plan as was the case during the previous major facility upgrade in the early 1970's. If this is the case, it is possible that the construction of the second trickling filter could be delayed beyond the predicted year 2015.

Costs to implement the recommended additions at the WWTP are $4 million in year 2001 dollars which includes the installation of a new primary clarifier. The recommended improvements are summarized in Table ES-4.

Table ES-4
Summary of Recommended WWTP Improvements

Description		Capital Cost (year 2001 dollars)
Priority I Physical Improvements	(2002-2004)	$2.1 million
Priority II Physical Improvements	(2004-2006)	$0.5 million
Priority III Physical Improvements	(2006-2008)	$2.6 million
Process Expansion	(2002-2008)	$4.0 million
Total		$9.2 million

D. Conclusion

The costs for the various recommendations described in this report were loaded into a Capital Cost Model, which is included in Appendix N. Costs were allocated in the model based on the time frames discussed in each chapter of this report. Actual timing of the recommended alternatives will depend on the City's actual population growth, project prioritization, and funding.

I. Introduction

A. Purpose

The primary purpose of the Wastewater Master Plan is to identify the most efficient, cost-effective, and appropriate collection system and facility improvements to accommodate existing and future wastewater flows through the year 2020. The Master Plan will include flow and rainfall monitoring in the collection system, hydraulic modeling of the collection system interceptors, identification of needed rehabilitation and repair of existing facilities and equipment at the WWTP, and analysis of expansion alternatives at the WWTP. The facility plan will include recommendations to maximize treatment efficiency of existing processes, automate treatment operations, and minimize impacts on the surrounding community.

B. Scope

The principal objectives of the study are to determine process design capacities, inspect and make recommendations concerning existing facilities, provide recommendations for expansion or diversion of WWTP flows, and prepare an evaluation of alternatives. Evaluation of alternatives will consider cost and non-cost factors. Key elements within the scope of this project include the following:

1. Wastewater Collection System

- Define the sewer service area.
- Review existing collection system and land use data.
- Use current and development population data and land use projections provided by the June 1998 Leavenworth Comprehensive Plan for the period to the year 2020.
- Conduct a 12-week flow and rainfall monitoring program to analyze the impacts of infiltration and inflow on collection system flows.
- Determine wet weather conditions in sewer watersheds to the extent allowed by the flow and rainfall monitoring program.
- Prepare a hydraulic model of the existing collection system, including major trunk sewers.
- Analyze the existing collection system under dry weather flow and selected peak flow conditions to determine currently available system capacity and level of storm protection.

- Evaluate collection system alternatives to relieve hydraulic constraints and to provide adequate capacity for future growth.
- Determine alternatives for correcting deficiencies including rehabilitation, replacement of existing collection system components.
- Identify expansions to the collection system to accommodate projected growth for the years 2010 and 2020.
- Provide a staged capital improvements plan for the collection system to assist the City with sizing, budgeting, and scheduling future projects.

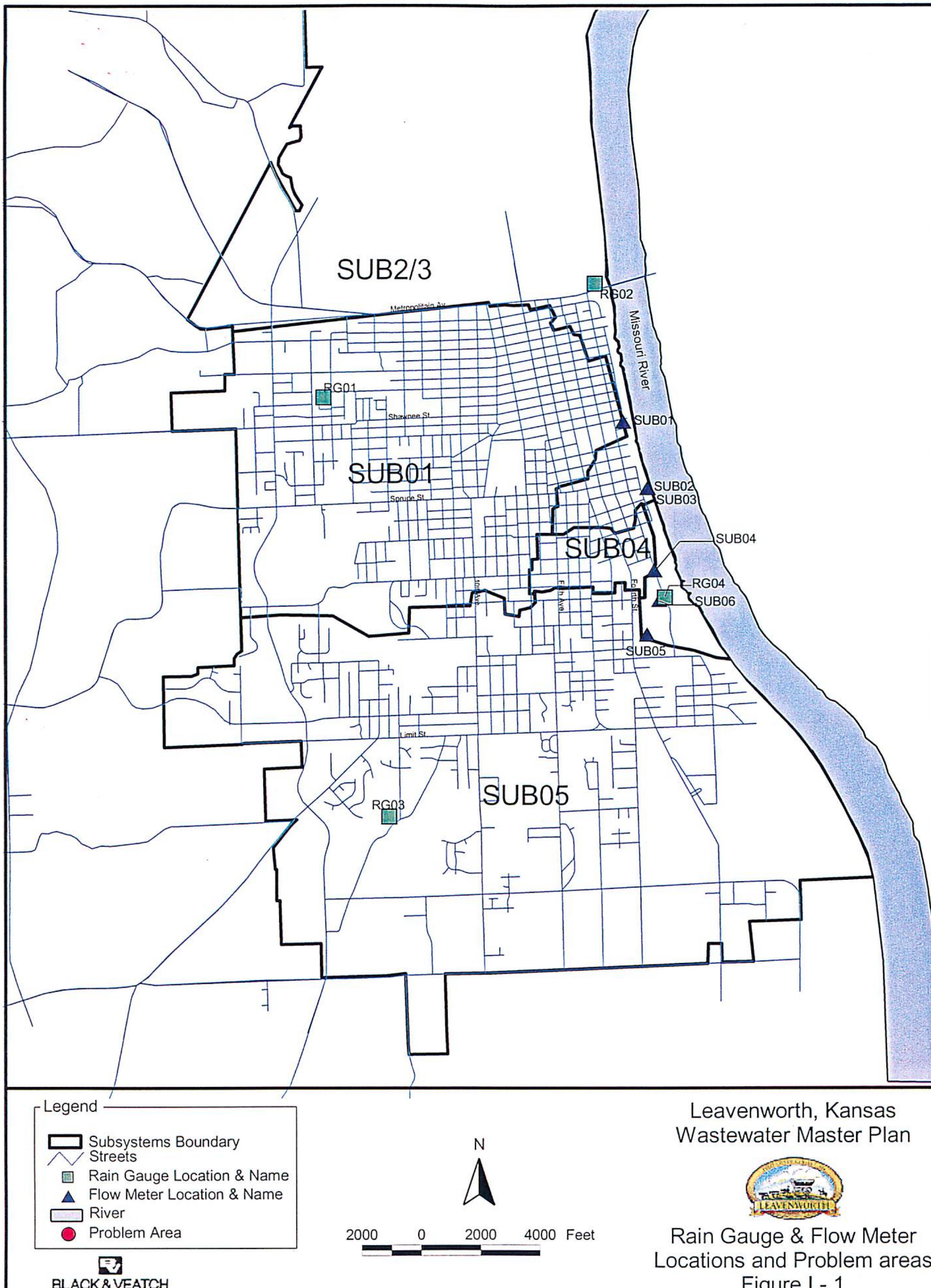
2. *Wastewater Treatment System*

- Summarize and evaluate plant operating data.
- Evaluate the existing WWTP facilities and determine the treatment capacity and life expectancy.
- Identify feasible alternatives for increasing the treatment capacity or reliability of inadequate unit processes.
- Determine additional treatment capacity needed to handle projected flows through the year 2020.
- Provide economic analyses of alternatives utilizing present worth and equivalent annual cost methods for the recommended facility plan.
- Provide a staged capital improvements plan for the WWTP to assist the City with sizing, budgeting, and scheduling future projects.

The study area is shown in Figure I-1. The study area consists of five subsystems. The subsystems include flows received from both the City of Leavenworth and Fort Leavenworth. The total length of all significant trunk sewers included in this Master Plan is approximately 113,500 feet or 21 miles.

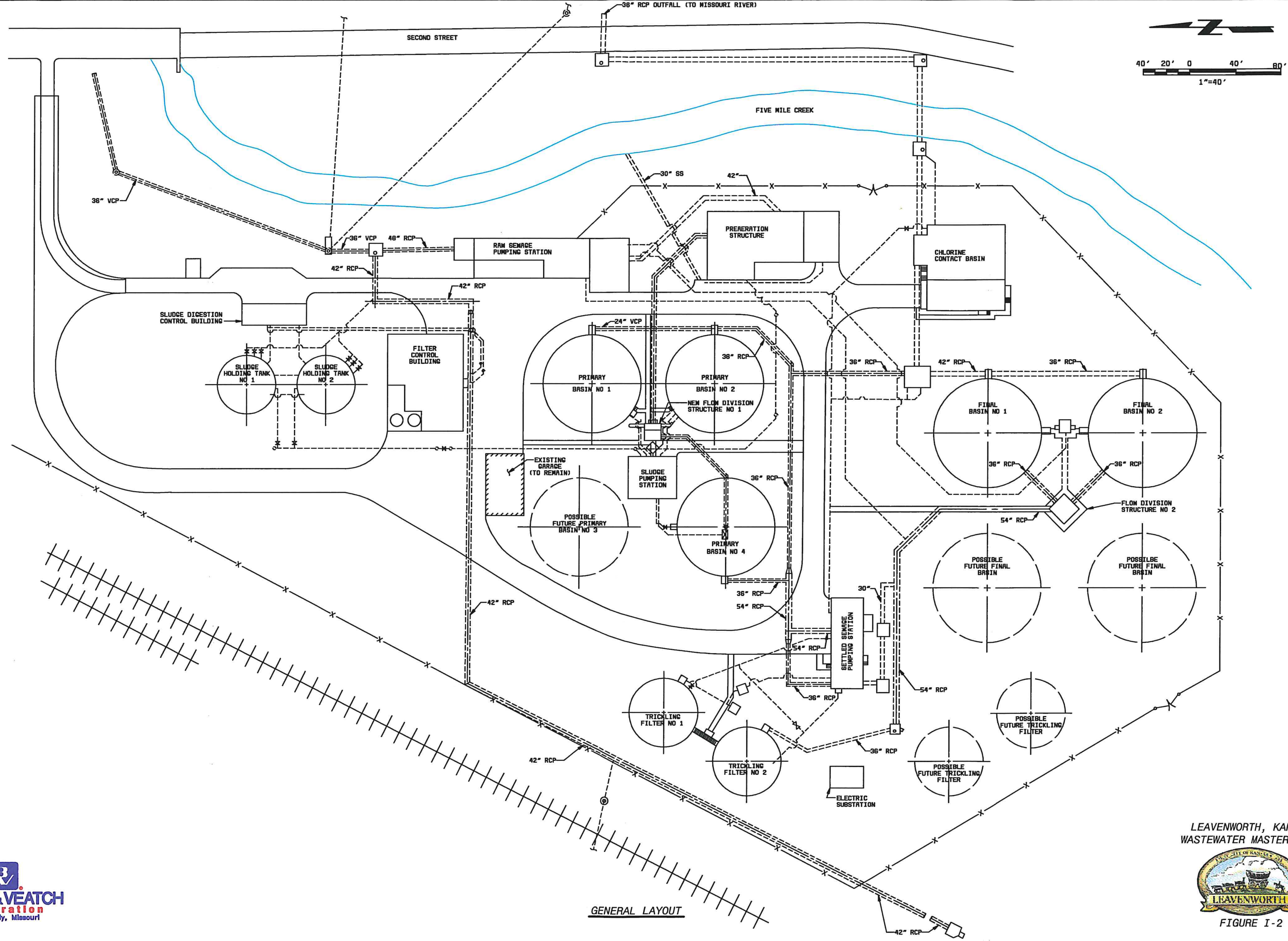
Overall collection system operations were reviewed. The 2000 budget for the collection system operation and maintenance was approximately $391,000. The collection system staff includes 5 full-time employees. Historical operating budgets are included in Appendix A.

The WWTP is located on the west bank of Five-Mile Creek near the central-east part of downtown Leavenworth. A site plan for the existing WWTP is presented in Figure I-2. The WWTP treats influent wastewater from the collection system using a combination of influent screening, preaeration and grit removal, clarification, and biological treatment with trickling filters before discharging into the Missouri River. The facility has undergone many expansions and upgrades, with the last major solids processing expansion in 1994. This expansion included a rehabilitation of facilities



Leavenworth, Kansas
Wastewater Master Plan

Rain Gauge & Flow Meter
Locations and Problem areas
Figure I - 1



GENERAL LAYOUT

BLACK & VEATCH Corporation
Kansas City, Missouri

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

LEAVENWORTH

FIGURE I-2

37372-3000-247-C-H00001XC5 6-4-01

damaged during the flood of 1993 and an expansion of the administration building to house a belt filter press and a lime stabilization system for processing EPA 501 Class B biosolids. A chemical feed system for feeding ferrous chloride, and new influent screens were provided in 1996 and 1998 respectively.

Overall WWTP operations were reviewed. The 2000 budget for the WWTP operation and maintenance was approximately $896,000. The WWTP includes 10 full-time employees: 2 administrative positions, 7 operators, and 1 laboratory technician. Historical operating budgets are included in Appendix A.

The wastewater flow projections in this study were developed using the current land use information, projected land uses, and population figures provided by the City. Significant changes to these land use and growth projections would affect the flow and load projections used in this study. Recommendations for capital improvements to the collection system and WWTP should be re-evaluated if actual growth exceeds the growth projections presented in this report.

II. Flow and Rainfall Analysis

A. Flow and Rainfall Monitoring Program

A sanitary sewer flow and rainfall-monitoring program was conducted for the entire Leavenworth collection system to determine system flow rates and to evaluate infiltration/inflow (I/I). Five open channel flowmeters and four rain gauges were installed in the study area during April and June 2000. In addition, flow data was gathered from the permanent influent flow meter located at the headworks of the WWTP.

The flow monitoring and rain gauge locations are shown on Figure II-1. The figure shows the boundaries of the areas tributary to each flow meter.

1. Rainfall Monitoring

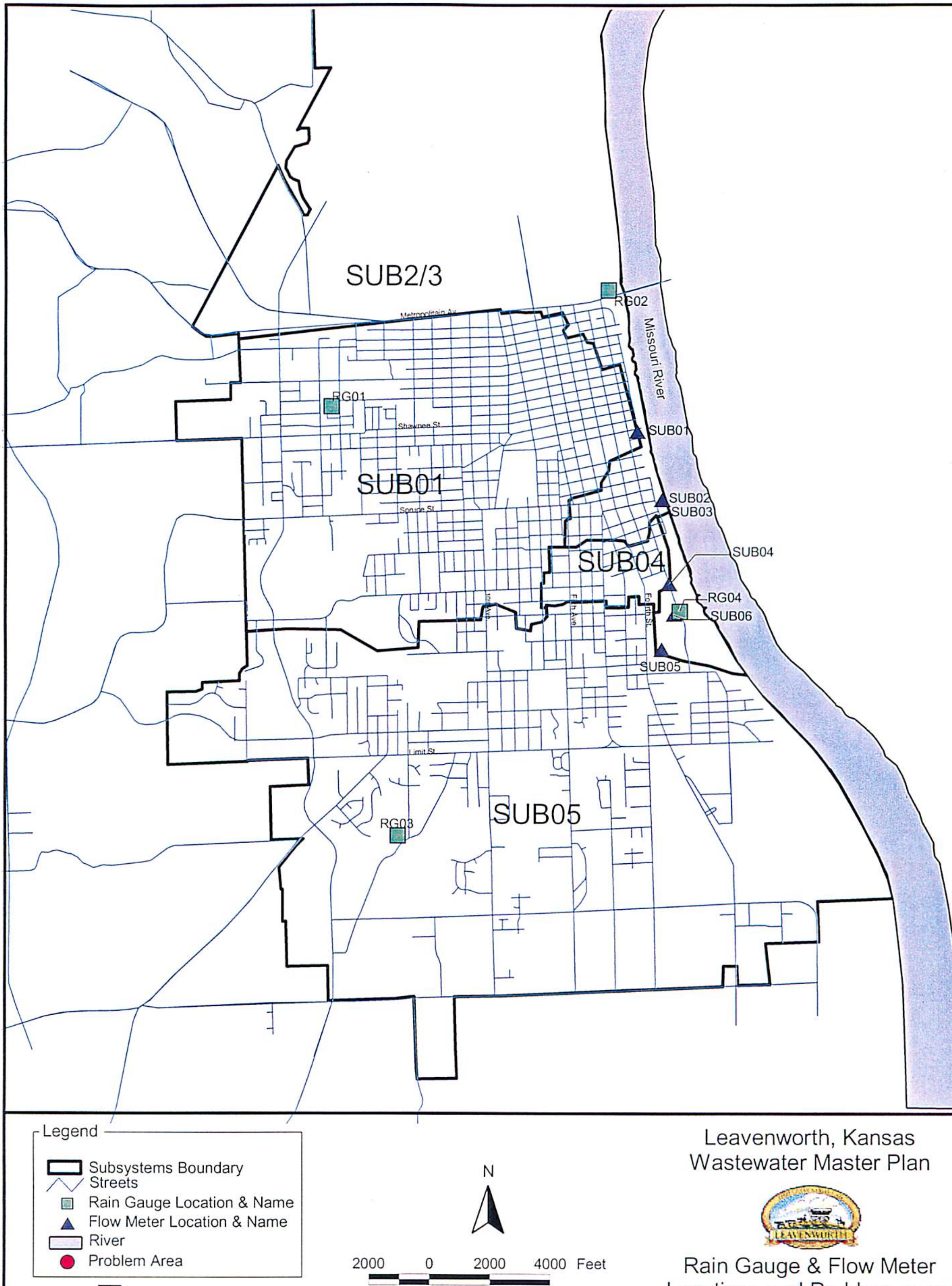
Rainfall monitoring was performed to develop a correlation between wet weather system flows and rainfall. Rainfall gauges were installed in clear open spaces and were serviced at least weekly to ensure proper operation. The gauges were continuously recording, tipping-bucket type, with electronic recorders, that record each 0.01 inch increment of rainfall. The continuous data record was processed to define each rainfall event and to determine the amount of rainfall over 15-minute intervals.

Daily rainfall totals and distributions were developed for each gauge site and compared against the known rainfall intensity-duration-frequency relationship for the Leavenworth study area to determine the return interval of each storm event. A Thiessen analysis was performed to relate the point rainfall recorded at the rain gauge locations to the average rainfall in the area tributary to each flow monitoring site.

2. Flow Monitoring

Flow monitoring was performed to obtain system flow rates during both dry and wet weather conditions in an attempt to identify the portions of the wastewater system that may contribute significant amounts of I/I.

a. Flow Components. For purposes of this report, wastewater production (WWP) is defined as wastewater exclusive of infiltration and inflow. The daily WWP flow rate can be approximated by using (1) winter month water consumption data or (2) direct measurement during dry weather/low groundwater conditions (average daily dry weather flow, ADDF). The WWP flow rate varies throughout the day, with the highest rate normally occurring between 8:00 and 11:00 a.m. The ratio of peak 60-minute flow to total average daily flow is defined as the WWP flow peaking factor.



Leavenworth, Kansas
Wastewater Master Plan

Rain Gauge & Flow Meter Locations and Problem areas
Figure II - 1

Infiltration is groundwater that enters the wastewater collection system and private building lines through defective pipes, pipe joints, and manhole structures below the manhole cone. The rate of infiltration depends on the depth of groundwater above the defect, the size of the defect, and the percentage of the collection system that is submerged. Groundwater levels and the associated infiltration varies seasonally and depending on weather. Dry weather infiltration occurs year-round and is measured during dry weather when the previous rainfall no longer has an effect on flows. High groundwater/dry weather infiltration is additional infiltration, which is caused by higher groundwater following rain events.

Inflow is rainfall-related water which enters the collection system from sources such as private sewer laterals, downspouts, foundation drains, yard and area drains, storm water sump pumps, manholes, defective piping, and cross-connections with storm drains. Inflow is directly influenced by the intensity and duration of a storm event, and therefore is not a fixed quantity.

Figure II-2 illustrates the flow components.

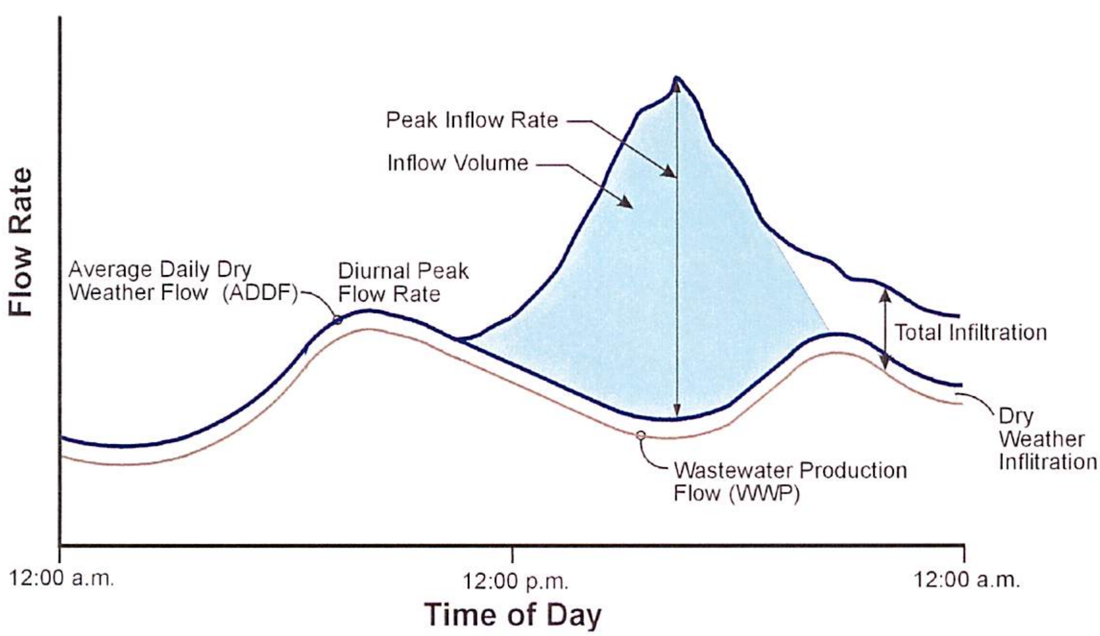


Figure II-2. Typical Flow Components

b. ***Equipment.*** Temporary flow meters that were installed throughout the City were American Sigma Model 910 open channel flow meters. Each flow meter includes sensors that measure depth and velocity. The depth of water is determined by pressure measurement. The velocity is measured using an electromagnetic field. The sensors are mounted on an expandable aluminum ring installed in the sewer pipe, normally upstream from the manhole invert. The signal from the sensors is transmitted to the monitor through a communication cable.

The one permanent influent flow meter located in the headworks of the WWTP is an American Sigma model 950 with an ultrasonic level sensor and an area velocity probe. This flow meter includes sensors that measure depth and velocity. An ultrasonic device that measures the distance from the top of a pipe to the surface of the water determines the depth of the water. The velocity is measured using an electromagnetic field. The ultrasonic sensor is mounted on the crown of the pipe and the velocity sensor is mounted six feet upstream of the ultrasonic sensor. The signal from the sensors is transmitted to the monitor through a communication cable.

The temporary monitoring units were suspended from brackets mounted in the manhole wall near the top of each manhole and were set to collect and store depth of flow and velocity readings at 15-minute intervals. The permanent meter was also set to read flow and velocity at 15-minute intervals. Data from the monitors were retrieved using a portable laptop computer.

c. ***Flow Monitoring Methodology***. All equipment was calibrated before installation to ensure depth sensor accuracy and proper operation of the velocity sensor.

After completion of the site investigations and monitor calibration, the flowmeters were installed. After installation, the sensors were tested to ensure that the monitors were working properly. A site report was completed during installation and updated each time the site was visited.

During the monitoring, certain steps were taken to assure the integrity of the data collected at each metering location. The quality of the field data was analyzed throughout the project. Regular field visits to each flow monitor included the following tests:

- Download Data. The time, depth, and velocity data accumulated in the monitor's memory were downloaded to a laptop computer.
- Measure Power Supply. Power levels were recorded and batteries replaced if necessary. A 6-volt battery powers the monitor. A backup battery permits servicing to the primary battery without data loss.

- Verify Velocity and Depth of Flow. During about half of the site visits, a member of the field crew descended into the manhole to measure the depth and velocity of flow at the sensor for comparison with the monitor readings. The depth-velocity profiles were used to verify that each monitor was properly calibrated.
- Measure Silt Level. The depth of silt at the sensor was measured.

The downloaded data were processed in the office each week, and reviewed to ensure accuracy and consistency. Any deviations from expected value ranges were addressed by additional field checks. In the office, the monitor manufacturer's software was used to convert the sensed velocities to the average cross section velocities, calculate flows from the average velocities and depth/diameter data, and prepare flow data printouts and plots.

d. Preliminary Data Analysis. After sufficient data was collected, preliminary analysis was initiated, which included the following:

- Verification. Digitized flow data were checked against field documentation to ensure accuracy. Key values such as pipe diameter, flow depth, sewer line calibration results, and silt depth were also checked for accuracy.
- Review of Hydraulic Calibration Data. Calibration data were collected for each site to develop the relationship of depth to discharge. The calibration tasks included the following steps:
  - A hand-held portable velocity meter was used to obtain average flow velocities through velocity profiling. The flow depth was recorded and the instantaneous flow rate determined from the Continuity Equation (Q=AV). These values were entered into software provided with the equipment, which then output a "site coefficient" value. The Manning formula was solved for the energy gradient ($s^{1/2}/n$), which is the actual slope of the water surface at the monitoring point. (The as-built pipe slope was obtained from computer model inventory tables.)

  - After several site visits, statistical analyses were performed to evaluate the quality of the calibration data and to determine the final site coefficient to be used for final flow data processing.

- Flow tables and graphs at 15 minute and daily intervals were printed using the manufacturer's software. Flow quantities were calculated using the depth and velocity of flow (Continuity Equation {Q=AV}). Since velocity probes may sometimes be inaccurate, (such as during extremely low nighttime flows or if a meter has temporarily fouled), flows were also calculated using the depth and the calibrated energy gradient (Manning equation). Close agreement between the results of the two methods is evidence of proper flowmeter operation.

The most representative days of data were selected for use in determining dry and wet weather flow parameters. Seven days, one for each day of the week, were identified for the analysis of dry weather flows. All of the days with rainfall that produced a measurable increase in wastewater flow were used for the I/I analysis.

Flow monitors' identification numbers, location, and monitoring periods are summarized in Table II-1.

Table II-1
Monitoring Sites

Subsystem	Monitor	Manhole Number	Meter Type[1]	Pipe Size at Meter (in)	Installation Date	Removal Date
Temporary						
SUB01	01	311	D/V	25	04/11/00	06/26/00
SUB02_03	02	K	D/V	36	04/11/00	06/26/00
SUB02_03	03	2118	D/V	36	04/11/00	06/26/00
SUB04	04	630A	D/V	12	04/11/00	06/26/00
SUB05	05	2105	D/V	42	04/11/00	06/26/00
Permanent						
SUB06	06	WWTP	D/V	48	N/A	N/A

(1) D/V = depth and velocity meter open channel.

B. Rainfall Data Analysis

1. Design Flow and Probability

The design flow for a sewer is defined as the maximum flow that a specified structure can pass without exceeding selected loading criteria. Since a significant portion of the peak flow in sanitary sewers is inflow resulting from rainfall, the design flow that the sewer must convey is related to the probability of occurrence of a design storm event.

Design flow for a selected rainfall event is the sum of three components: (1) wastewater production multiplied by the diurnal peaking factor; (2) infiltration; and (3) inflow. As presented later, inflow is a function of the local intensity-duration-frequency relationship for rainfall. This relationship includes a probability consideration to the design flow.

A summary of the probability that a storm event having a prescribed recurrence interval will not be equaled or exceeded during a specified period is given in Table II-2. For example, a design based on a 10-year storm event has a 59 percent chance of not being exceeded during a 5-year period.

Table II-2
Probability of Non-Exceedance

Design Storm (years)	Period, years							
	1	5	10	20	50	100	200	500
1	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
2	0.50	0.03	0.01	(1)	(1)	(1)	(1)	(1)
5	0.80	0.33	0.12	0.01	(1)	(1)	(1)	(1)
10	0.90	0.59	0.35	0.12	(1)	(1)	(1)	(1)
50	0.98	0.90	0.82	0.67	0.36	0.13	0.02	(1)
100	0.99	0.95	0.90	0.78	0.61	0.37	0.13	0.01
200	0.995	0.975	0.95	0.90	0.78	0.61	0.37	0.08
500	0.998	0.989	0.98	0.96	0.90	0.82	0.67	0.37

(1) Values are near 0.

2. *Analysis of Rainfall Data*

The normal annual average rainfall for the Leavenworth area is 40.54 inches. Historical data on average monthly rainfall amounts and rainfall intensity-duration relationships are presented in Tables II-3 and II-4 and shown graphically on Figure II-3. The annual and monthly normal rainfall values were obtained from the National Weather Service, San Francisco, based on 1961 to 1990 data for Leavenworth, Kansas.

Rainfall intensities were evaluated to allow correlation of peak rain intensity to the peak flow rate in the sewers. The highest flow for a given storm event is generated when the storm duration has reached the travel time from the farthest point in the system to the flow monitor location.

A significant number of storms were observed. During the flow monitoring period of April 11, 2000 to June 26, 2000, the recorded total average rainfall was 10.75 inches, as shown in Table II-5. The actual rainfall that occurred during the monitoring period was lower than the historical April, May, and June average of 14.02 inches. The importance of using a network of rainfall gauges is evidence of the varying amounts of total rainfall between gauges shown in Table II-5.

Rainfall was recorded on 29 of the 77 days in the monitoring period. A storm event was defined as continuous recorded rainfall separated by a minimum of four hours of no rain. During the eight-week monitoring period, 11 significant storm events occurred, with at least 0.25 inch total depth each. Two storms of approximately 1.0 inches of total depth occurred, plus 1 storm of more than 2 inches in depth. The events for which a definable flow response occurred were selected for flow analysis to determine inflow into the system.

Table II-3
Historical Average Rainfall
For Leavenworth, Kansas

Month	Average Precipitation (in)	Cumulative Precipitation (in)
January	1.14	1.14
February	1.12	2.26
March	2.63	4.89
April [1]	3.61	8.50
May [1]	5.28	13.78
June [1]	5.13	18.91
July	4.62	23.53
August	4.32	27.85
September	5.14	32.99
October	3.82	36.81
November	2.25	39.06
December	1.48	40.54

(1) Flow and Rain gauge monitoring period.

Table II-4
Rainfall Depth-Duration-Frequency Relationship for Leavenworth, Kansas

Return Period	Total Rainfall (inches) for Duration Indicated				
Yrs	30 Min	60 Min	2 Hrs	3 Hrs	12 Hrs
1	1.12	1.44	1.70	1.86	2.42
2	1.30	1.70	2.00	2.25	3.24
5	1.70	2.20	2.74	3.00	4.20
10	1.95	2.52	3.18	3.45	4.86
25	2.25	2.90	3.60	4.02	5.64
50	2.50	3.20	4.08	4.56	6.21

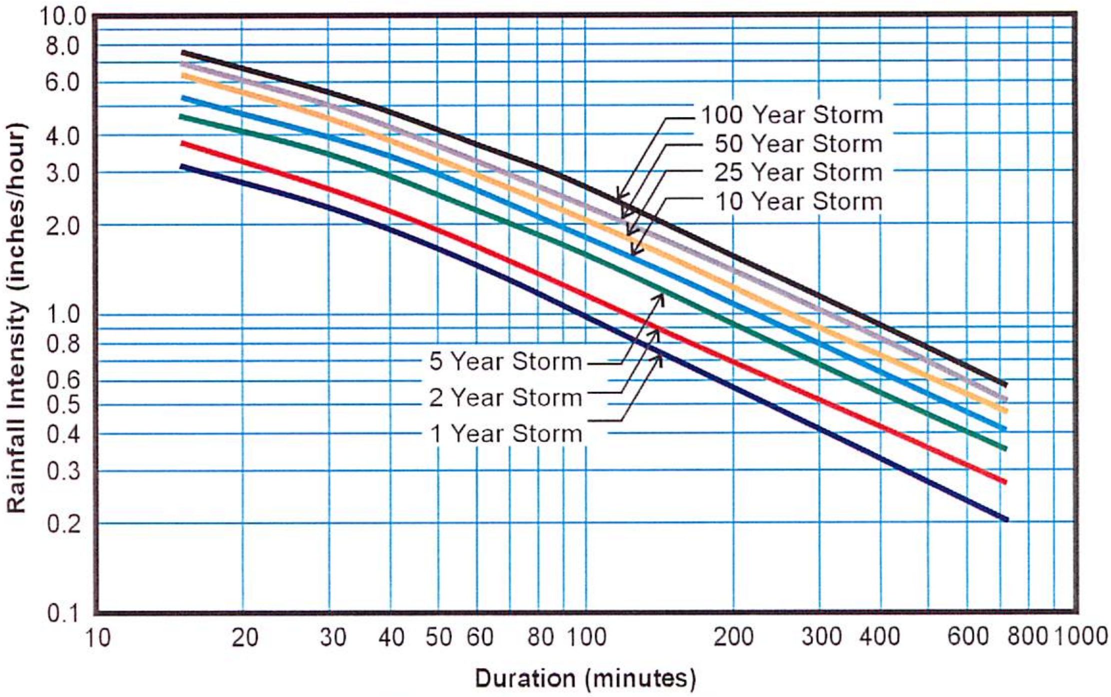


Figure II-3. Rainfall History

Table II-5 Total Monitoring Period Recorded Rainfall, 4/1/00 to 6/1/00		
Rainfall Gauge No.	Gauge Location	Rainfall (inches)
RG01	17th Street and Miami	10.95
RG02	Dakota St.	10.65
RG03	14th Street and New Lawrence Road	10.35
RG04	2nd Street and Poplar Road	11.03
Average		10.75

For the analysis of inflow versus rainfall (Q vs. i relationship), it was necessary to determine the rainfall pattern for each rain event applicable to each flow monitor's tributary area. Thiessen polygons were drawn around each rainfall gauge to indicate the areas most influenced by each gauge, and the percentage of the total area tributary to each metering site within each rainfall gauge polygon was determined. For each flowmeter, these percentages were applied to the rainfall data recorded at each rainfall gauge. This procedure resulted in a rainfall pattern specific to each flow monitor and each storm event, in 15-minute intervals, based on the data collected at the four rain gauges. Table II-6 shows the rainfall gauge allocations used in the Thiessen analysis. Each rainfall event was further analyzed to determine the return interval for the selected rainfall duration by comparing the recorded data with the rainfall intensity-duration-frequency curves for Leavenworth.

Table II-6
Rain Gauge Assignment to Subsystems
(Theissen Analysis)

Flow Monitoring Subsystem	Recorded Rainfall Assignment			
	RG01	RG02	RG03	RG04
SUB01	64%	20%	2%	14%
SUB02	20%	70%	0%	10%
SUB04	20%	70%	0%	10%
SUB05	0%	0%	0%	100%
SUB06	0%	0%	63%	37%

Summaries of the observed daily total rain at each rain gauge, and the peak rainfall intensity/duration relationship during each storm event are given in Tables II-7 and II-8.

Table II-7
Monitored Daily Rainfall Totals

Rain Date	Total Rain at Rain Gauge (in)			
	RG01	RG02	RG03	RG04
04/11/00	0.00	0.05	0.05	0.05(1)
04/19/00	0.21	0.12	0.00	0.12(1)
04/20/00	0.29	0.28	0.24	0.28(1)
04/23/00	0.07	0.04	0.05	0.04(1)
04/25/00	0.08	0.05	0.02	0.05(1)
04/26/00	0.03	0.01	0.01	0.00
04/27/00	0.00	0.00	0.00	0.05
04/30/00	0.09	0.20	0.19	0.27
05/01/00	0.00	0.00	0.01	0.00
05/06/00	0.00	0.01	0.00	0.00
05/09/00	0.39	0.37	0.38	0.38
05/11/00	0.43	0.40	0.91	0.79
05/12/00	0.26	0.26	0.10	0.09
05/21/00	0.01	0.00	0.14	0.01
05/26/00	1.52	1.80	1.06	1.17
05/27/00	0.02	0.02	0.03	0.02
06/01/00	0.97	1.05	0.97	1.14
06/02/00	0.01	0.03	0.03	0.04
06/10/00	0.03	0.01	0.01	0.03
06/11/00	0.25	0.15	0.09	0.04
06/12/00	0.00	0.00	0.00	0.01
06/13/00	2.12	1.76	1.93	1.91
06/14/00	0.54	0.49	0.58	0.58
06/16/00	0.02	0.01	0.01	0.01
06/20/00	2.28	2.31	2.49	2.50
06/23/00	0.00	0.00	0.03	0.00
06/24/00	1.13	0.80	0.74	1.06
06/25/00	0.19	0.42	0.28	0.39
06/26/00	0.01	0.01	0.00	0.00
TOTAL	10.95	10.65	10.35	11.03

(1) Gauge 4 was not operating during data shown. Rainfall during this period was estimated from data recorded at gauge 2.

Table II-8 Monitored Peak Rainfall Depth vs. Duration						
Storm Event	Peak Rainfall Depth (in.) For Duration Indicated (1-Year Storm)					
	30 (min)	60 (min)	120 (min)	180 (min)	240 (min)	600 (min)
-	1.12	1.44	1.70	1.86	1.96	2.35
05/09/00	0.02	0.05	0.27	0.32	0.33	0.36
05/11/00	0.12	0.42	0.79	0.79	0.79	0.88
05/26/00	0.00	0.53	0.79	0.94	0.95	0.95
06/01/00	0.28	0.78	0.91	1.06	1.14	1.17
06/13/00	0.36	0.91	1.10	1.21	1.24	1.32
06/20/00	0.33	0.97	1.33	1.93	2.35	2.44
06/24/00	0.01	0.26	1.01	1.06	1.06	1.06
06/25/00	0.22	0.38	0.39	0.39	0.39	0.39
Note: Only the significant rain dates selected for the inflow analyses are listed. This table shows representative data for RG04. Some rain events continued into the next date, but were considered one storm event. That is why some high rainfall dates are not included in this list. The actual rain distribution applied to the flow analysis for a given flow monitor utilizes the data observed at the rain gauges assigned as listed in Table II-6, Theissen Analysis.						

C. Wastewater Flow Data Analysis

1. Service Area Background Information

a. Flow Monitoring Program Subsystem Schematic. Continuous flow monitoring was performed at 6 sites. Each subsystem was assigned an identification number corresponding to the flow monitor number. The meter locations were selected to determine flow rates within the city limits of Leavenworth and to identify the subsystems that contribute large amounts of I/I. Figure II-4 is a schematic drawing ("bubble diagram") of the relationship between the monitored areas or subsystems.

b. Monitoring Area Data. For analysis of the flow monitoring results, the developed acreage in each monitored area was determined. Using the ArcView GIS program and the GIS street outlines of Leavenworth, the subsystem boundaries were constructed. The total city acreage and the monitored subsystem acreage were determined from the GIS data. The monitored area acreage is listed in Table II-9.

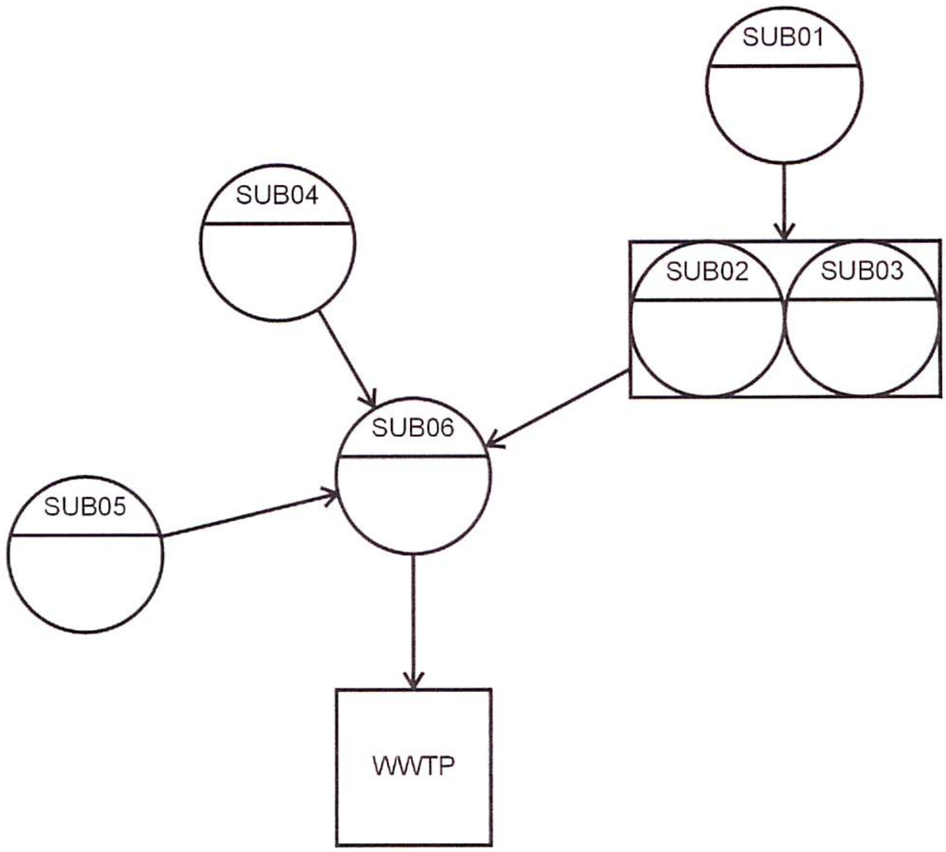


Figure II-4. System Flow Schematic

Table II-9 Monitored Area by Subsystem				
Subsystem Designation	Meter Number	Estimated Subsystem Population for Year 2000 (Persons)	Subsystem Area (acres)	Cumulative Tributary Area (acres)
SUB01	01	15,300	2,344	2,344
SUB02_03	02 and 03	9,533	2,264	4,608
SUB04	04	792	190	190
SUB05	05	12,944	3,461	3,461
SUB06	06	1,431	140	8,399
Total		40,000[1]	8,399	

[1] It should be noted that just prior to submitting the final copy of this study, the U.S. Census data for the City of Leavenworth became available and revealed that the actual population for the year 2000 was 35,420. The actual population figures were determined to not appreciably change the findings of this study.

The estimated developed area for Fort Leavenworth is 1,892 acres. Fort Leavenworth comprises 84 percent of the total developed monitored area of SUB02_03. The total developed area of the City of Leavenworth and Fort Leavenworth covered by the monitoring program was 8,399 acres.

c. Population Data. The estimated year 2000 population of Leavenworth including Fort Leavenworth used for planning purposes was 40,000. Given the estimated population and the total developed area within the City boundaries, the estimated average number of persons per acre is 4.76.

The adopted year 2000 population of Leavenworth including Fort Leavenworth was 35,420 based on U.S. Census figures. Given the current population and the total developed area within the City boundaries, the average number of persons per acre is 4.22.

2. Determination of Average Daily Dry Weather Flow

Daily fluctuations in flow are attributable to variations in domestic, industrial, and commercial wastewater production. Average Daily Dry Weather Flow (ADDF) is measured directly by flow monitoring and includes wastewater production (WWP) plus the portion of total infiltration that occurs during low groundwater conditions. The ADDF for each monitoring location was determined using the average flow at the monitor for the selected 7 days. The days selected for determining the ADDF were preceded by several days of no significant rainfall.

A mass balance was performed using the ADDF recorded at each metering site. The mass balance is an accounting procedure for balancing flows recorded throughout the system. At the same time, flows were checked against the population tributary to each meter (to determine the per capita use rate (gpcd) for each subsystem). Any metering site for which unrealistic per capita rates were obtained from the preliminary data was rechecked.

Appendix B shows a representative example of ADDF flows in a subsystem (SUB 01) at a particular point in time. To illustrate the impact of wet weather flows, the ADDF flow is compared to the amount of rainfall received during a particular storm event and to the measured wet weather flow during the storm event. As can be seen, there is a dramatic increase in the amount of flow. The components of the measured wet weather flow are discussed in detail later in this chapter.

A final adjustment was needed for Flow Meter 06 (SUB 06), which is the permanent meter located at the influent of the WWTP, to achieve the mass balance. This monitor recorded an excessively high flow relative to the tributary area. Before adjustment of data for SUB 06, the total subsystem ADDF flow was 1.449 mgd, based on the mass balance, which is inconsistent with residential area tributary of only 140 acres. Field logs indicated a deposition depth at the site ranged from 3 inches to 10 inches. Since SUB06 uses an ultrasonic depth measuring sensor, it is likely that the effective depth of flow was inaccurate due to the deposition depth. By adjusting the flow depth for an average deposition depth of 4 inches, the flow information was reevaluated, resulting in an average subsystem flow of 0.141 mgd and the total ADDF recorded at the WWTP of 3.940 mgd.

Dry weather peaking factors (the ratio of the peak 60-minute flow to average daily flow measured during dry weather/low groundwater conditions) were determined for each monitor as the average of the factors observed for each day of the selected period. The system-wide average was about 1.493 based on total ADDF and peak dry weather flow. A summary of the monitored ADDF by flow monitor location, dry weather flow peaking factor, and peak ADDF is given in Table II-10.

Table II-10
ADDF and Peak Flow Summary

Subsystem Area	Measured Subsystem ADDF (mgd)	Peaking Factor[1] (Qp/Qa)	Peak Dry Weather Flow[2] Subsystem (mgd)	Peak Dry Weather Flow[2] Cumulative (mgd)
SUB01	1.507	1.625	2.449	2.449
SUB02_03	0.939	1.486	1.395	3.634
SUB04	0.078	1.675	0.131	0.131
SUB05	1.275	1.298	1.655	1.655
SUB06	0.141	1.381	0.195	5.441
TOTAL	3.940		5.825	

(1) Peaking factor is the ratio of peak flow rate to average flow rate.
(2) Average base times peaking factor.

3. Determination of Total Infiltration

Total infiltration consists of dry weather-low groundwater infiltration and dry weather-high groundwater infiltration (as indicated on Figure II-2). The two components of total infiltration are assigned individually in the computer model.

Base infiltration can be determined by the difference between monitored ADDF and the WWP flows determined from an analysis of water consumption data. This analysis was beyond the scope of this study. For this analysis, therefore, WWP was considered equal to ADDF.

Infiltration during high groundwater is observed on the days after the end of significant rainfall events. The total flow measured during these periods includes ADDF flow plus high groundwater infiltration flows. High groundwater infiltration flow is determined from flow monitoring data by subtracting the minimum nighttime flow during dry weather/low groundwater periods from the minimum nighttime flow during high groundwater periods. Using night-time flow readings is the most reliable method for determining these infiltration flows.

The system-wide total infiltration flow rate for the area is 0.429 mgd, which is equivalent to 51 gpd per acre. The infiltration rate ranged from 30 gpd per acre to 88 gpd per acre. A summary of total infiltration, including a ranking of the subsystems on this parameter is given in Table II-11.

Table II-11
Subsystem Infiltration Rate

Subsystem	Subsystem Area (acres)	ADDF (mgd)	Population Density[1] (Persons per acres)	Total [2] Infiltration (mgd)	Subsystem Infilt. Rate (gpd/acre)	Rank[3]
SUB01	2,344	1.507	6.5	0.206	88	1
SUB02_03	2,264	0.939	4.2	0.069	30	5
SUB04	190	0.078	4.2	0.016	84	2
SUB05	3,461	1.275	3.7	0.130	38	4
SUB06	140	0.141	10.2	0.008	57	3
	8,399	3.940		0.429		

[1] Population Density based on total population of 40,000 for year 2000 planning purposes.
[2] Total infiltration is dry weather infiltration plus wet weather infiltration.
[3] Ranking from highest to lowest infiltration rate, with 1 being the highest rate.

4. Determination of Inflow

Inflow for a specific storm event includes all rainfall-induced flow, direct storm water inflow, and rapid infiltration. Flow data for each significant rainfall event were analyzed for inflow. The total peak flow measured during inflow periods includes wastewater production flow, infiltration, and inflow. Inflow for a particular rainfall event is determined by subtracting the wastewater production and infiltration flow from the measured peak flow. Normally, the wastewater production and infiltration flows at the time of peak inflow are estimated as the dry weather flow data 24 hours previous.

The magnitude of peak inflow depends on rainfall distribution, intensity, antecedent groundwater conditions, types and locations of inflow sources, and time of concentration of the system to the monitoring point. The time of concentration is the time from initiation of peak rainfall to the time of peak inflow. An inflow coefficient "K" was determined for each rainfall event for each monitoring location. The inflow coefficient is an attempt to combine all system variables into a single parameter, and is analogous to the runoff coefficient in the rational formula for storm water flow. The cumulative inflow coefficient for each monitoring point was determined by dividing the peak inflow rate by developed tributary land area and by the peak rainfall intensity corresponding to the system time of concentration as determined from field measurements. Generally, the time of concentration increases as the total tributary area increases and the inflow coefficient increases with the age of the system.

An average "K" based on specific inflow coefficients calculated for each monitored storm event was used for analysis. The average inflow coefficient is used to determine inflow for any storm event with a selected recurrence interval using the following relationship:

$$Q = KiA$$

where: Q = peak inflow (cfs)
K = inflow coefficient
i = rainfall intensity for selected recurrence interval and time of concentration (in/hr)
A = developed area (acres)

The inflow coefficient for interior subsystems can be calculated using measured cumulative flow, tributary subsystem inflow coefficients, and tributary area. The inflow generated within an interior subsystem must be calculated because measured flow includes the dynamic cumulative effect from all tributary subsystems. System dynamics considers the time of travel through the sewer system. Each interior subsystem inflow coefficient was determined using the following weighted coefficient formula:

$$K_t = K_1A_1 + K_2A_2 \ldots K_iA_i / A_t$$

where: K_t = cumulative inflow coefficient
K_i = tributary subsystem inflow coefficient
A_i = tributary subsystem area
A_t = total tributary area

A summary of tributary areas, times of concentration, and inflow coefficients are presented in Table II-12. Inflow for a storm with any selected recurrence interval can be determined from this data using the above equations. Typical inflow coefficients for a collection system are in the range of 0.004 to 0.008.

Cumulative inflows and subsystem inflows were determined for each monitoring point in the system for a one-year storm event, as shown in Table II-13. A comparison of cumulative inflow and subsystem-generated inflow rates shows that the cumulative inflow for interior subsystems is less than the sum of individual subsystem-generated inflows. This fact is consistent with expected system dynamics and is critical for any comparison of projected I/I source flow with monitored flow.

Table II-12
Summary of Inflow Parameters

Subsystem	Area (acres)		Time of Concentration, tc (min)		Inflow Coefficient "K"	
	Subsystem	Cumulative	Subsystem	Cumulative	Subsystem	Cumulative
SUB01	2344	2344	175	175	0.01417	0.01417
SUB02_03	2264	4608	100	180	0.00096	0.00768
SUB04	190	190	30	30	0.00475	0.00475
SUB05	3461	3461	240	240	0.00232	0.00232
SUB06	140	8399	30	185	0.00522	0.00522

Table II-13
Inflow Summary

Subsystem	5-Yr. Inflow (MGD)		Area (acres)	Subsystem 5-Yr. Inflow Rate (gpd/acre)	Ranking
	Subsystem	Cumulative(1)			
SUB01	21.90	21.90	2,344	9,343	3
SUB02_03	2.25	22.88	2,264	1,000	5
SUB04	1.98	1.98	190	10,421	2
SUB05	4.15	4.15	3,461	1,200	4
SUB06	1.60	28.35	140	11,428	1

(1)5-Yr. Cumulative inflow based on cumulative time of concentration, cumulative "K", and cumulative acres.

5. Subsystem Distribution of I / I

The distribution of I/I based on a 5-Year storm event is summarized in Table II-14. Figure II-5 is a graph of the system I/I versus the total system acreage. Figure II-6 shows the I/I rate by subsystem. It is greatest in the case of the service area in subsystems 01, 04, and 06. The lowest I/I occurs in the southern part of the system in Subsystem 5. The data indicates that 76 percent of the total I/I is produced in 32 percent of the area.

Table II-14 Subsystem Distribution of I / I							
Flow Monitor	5-Yr. Storm I/I (mgd)	Area (acre)	5-Year I/I Rate (gpd/acre)	Percent Total I/I By Subsystem		Percent Total Size By Subsystem (acre)	
				Subsystem	Cum.	Subsystem	Cum.
SUB06	1.61	140	11,500	4.5	5.0	1.7	1.7
SUB04	2.00	190	10,536	6.2	11.2	2.3	4.0
SUB01	22.11	2,344	9,432	68.4	76.6	27.9	31.9
SUB05	4.28	3,461	1,236	13.2	92.8	41.2	73.1
SUB02_03	2.32	2,264	1,024	7.2	100.0	26.9	100
	32.32	8,399					
Note: Table sorted based on 5-year I/I rate.							

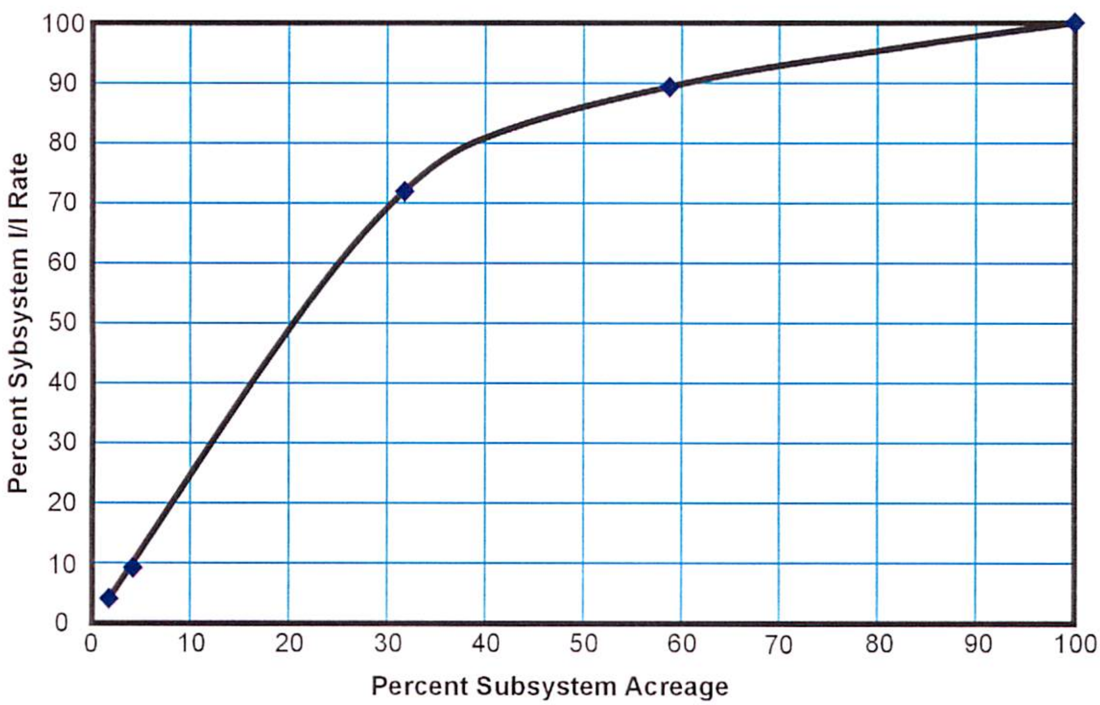
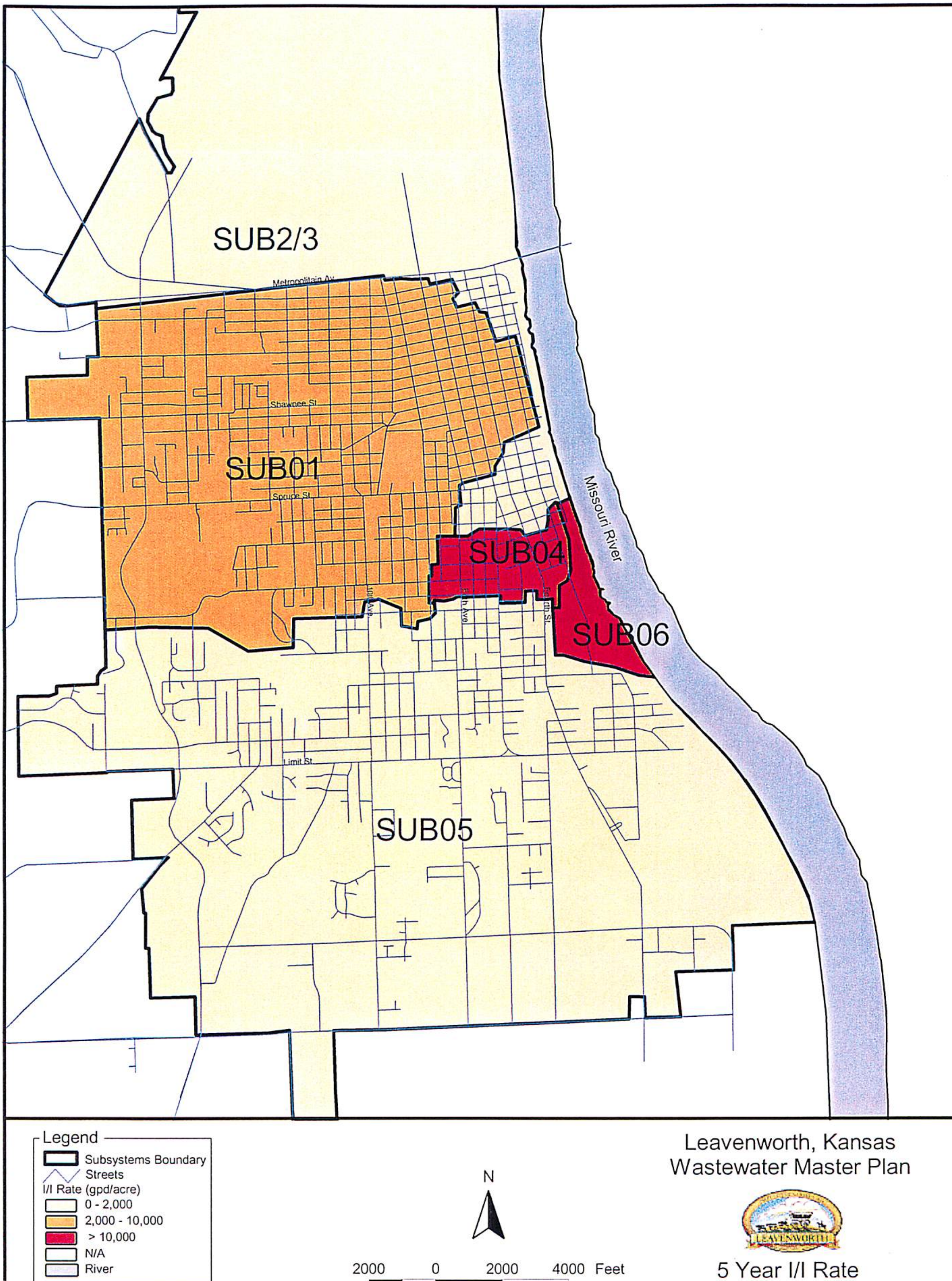


Figure II-5. Percent Infiltration vs Percent System Acreage



Leavenworth, Kansas
Wastewater Master Plan

5 Year I/I Rate

Figure II - 6

6. *Summary of Projected Year 2000 Flow at WWTP*

Various flow rates important to the operation and evaluation of the wastewater treatment plant (WWTP) were estimated using the flow parameters previously presented in this report. Flow rates estimated included average daily dry weather flow, average annual daily flow, peak month flow, peak day flow, and peak hour flow.

ADF flow data at the WWTP is reviewed in Chapter IV. The following typical peaking factors for collection systems are offered for comparison of peak month and peak day. It is recommended that the average annual, peak month, and peak day flows be confirmed prior to any modifications to the WWTP based on the magnitude of the flows.

Table II-15
Projected Flow Summary

Parameter	Value
ADDF	3.940 mgd
ADF	4.454 mgd
Peak Month (PM)	5.340 mgd
Peak Day (PD)	8.910 mgd
Peak Hour (PH)	33.689 mgd
ADF/ADDF	1.13
PM/ADF	1.20
PD/ADF	2.00
PH/ADF	7.57

Note: ADF, PM, PD, pH based on 5 year design storm.

III. Collection System Evaluation

A. Introduction

System analyses were performed to evaluate the existing collection system capacity against peak flow rates and the impact of Infiltration and Inflow (I/I) removal. Analyses were performed for existing and future population and developed area conditions.

A computer model of the City's trunk sewer network was used for the analyses. The system model allows evaluation of system performance for selected growth, storm events and different I/I removal conditions.

The objectives of the system evaluation were to:

- Identify existing system improvements required to serve current and future sewered customers.
- Define the I/I reduction plan.

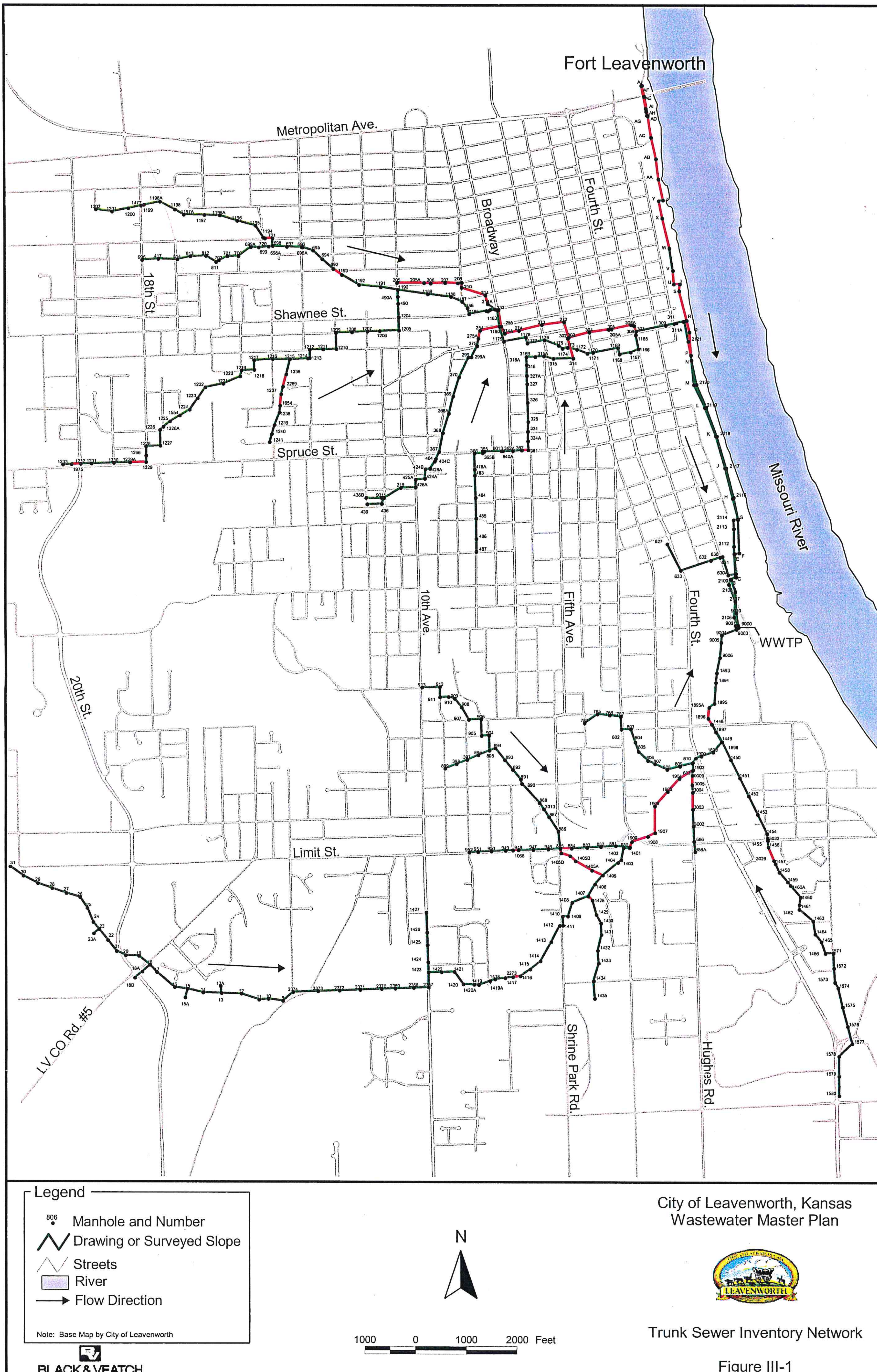
B. Collection System Definition

An inventory and definition of the City's existing trunk sewer system was completed. The inventory only included trunk facilities and did not include collector sewers or private sewer laterals. Data was obtained from the Engineering Department and selective field investigations.

The Wastewater Treatment Plant is located on the east side of the City along the Missouri River. The major trunk sewer system flows to the plant along the river from the north and additional flows are received from the south. Although the collection system does include minor pump stations, none of the pump stations are considered part of the trunk sewer collection system and therefore were not included in the model.

The study area consists of five monitored subsystems. The monitored subsystems include flows received from both the City of Leavenworth and Fort Leavenworth. While Fort Leavenworth flows are included, the Fort Leavenworth collection system is not part of the model. The total length of trunk sewers included in the sanitary sewer model is approximately 113,500 feet or 21 miles. Table III-1 shows the total modeled length of the trunk sewers by pipe diameter.

The trunk sewers were identified through a review of various maps and documents related to the study area, through interviews with City personnel and field investigations. The currently planned Ironmoulders relief sewer project was included as part of the future collection system. Generally, the trunk sewers included in the model were pipes 10 inches in


Fort Leavenworth
Missouri River
WWTP
Metropolitan Ave.
Broadway
Fourth St.
18th St.
Shawnee St.
Spruce St.
10th Ave.
Fifth Ave.
Fourth St.
20th St.
Limit St.
LV CO Rd. #5
Shrine Park Rd.
Hughes Rd.
Legend
806 Manhole and Number
Drawing or Surveyed Slope
Streets
River
Flow Direction
Note: Base Map by City of Leavenworth
BLACK & VEATCH
N
1000 0 1000 2000 Feet
City of Leavenworth, Kansas
Wastewater Master Plan
Trunk Sewer Inventory Network
Figure III-1

diameter and larger. Some pipes less than 10 inches in diameter were added to the model if they were required for connectivity.

Data for pipe slopes plays a critical role in modeling the hydraulic capacity of sewage collection systems. Slope data is gathered from a variety of sources including record drawings, field surveys, and assumptions based on surface topography or other factors. Inaccurately modeled pipe slopes can lead to inaccuracy in model results and poor planning recommendations. For this reason Figure III-1 was developed to show the modeled inventory and the source of slope data for each modeled pipe. Pipes that are marked as assumed slope means the slopes have been estimated based on interpolation of known pipe slopes either upstream or downstream of the assumed slope pipe. There is approximately 19,000 ft (17% of the total) of assumed slope pipe in the model.

Table III-1
Gravity Trunk Sewer Inventory

Diameter (inches)	Length (feet)
8	8,461
10	15,884
12	21,271
15	16,196
18	10,165
24	17,259
30-36	15,336
42–60	8,891
Total	113,463

C. Description of Hydraulic Model

The computerized capacity model of the sanitary sewer system was developed utilizing sewer network data, flow data, and a flow routing computer program. The model incorporated measured system parameters such as travel time, time of concentration, tributary acres, rainfall duration and intensity to determine peak system flow rates. The capacity model was developed using HYDRA software as the hydraulic engine. Data was processed using Black & Veatch-developed support modules (SSMS) to write to and read from HYDRA.

The drainage areas tributary to each monitoring point in the system were established from existing maps. The developed acres for each drainage area were obtained from Geographical Information Systems (GIS). The average daily dry weather flow (ADDF) obtained from the flow monitoring was used as the "base" flow component and was input into the model using the monitored diurnal flow variation observed at each metering site.

Infiltration flow was considered as a constant flow during high groundwater conditions due to the fact that observed infiltration flows were relatively constant over several days.

The inflow flow component was observed to be highly variable over short periods of time requiring dynamic analysis and modeling for accurate measurement and simulation. The inflow component was input into the model in such a manner as to reflect the dynamic nature of the flow. Input required to generate the inflow included the following:

- Inflow coefficient determined from flow monitoring data.
- Developed acres for each drainage area.
- Historical rainfall intensity-duration curves for selected storm events.
- Estimated inlet time for each drainage area.

As flow was routed through the system, the model added the dry weather flow, infiltration flow and the calculated inflow. Inflow was calculated at each line segment in the system using the inflow coefficient method of inflow analysis. The model used the estimated inlet time, added computed system travel time to determine time of concentration, and selected the appropriate rainfall intensity to calculate inflow. The model evaluated tributary areas at junction points and selected the critical rainfall intensity considering travel time, inflow coefficient, and area from each contributing area.

Total flow routed through each sewer segment was compared to line capacity. For sewer segments or pump stations where total flow exceeded capacity by a selected amount, a replacement relief sewer or replacement relief sewer or expanded pumping facilities was sized and simulated so that flow continued to be routed downstream.

D. Review of Model Calibration

Prior to performing an analysis, the model was calibrated against actual field data to insure accurate simulation. The model was calibrated against the projected 1-year flow rate determined from the adjusted flow monitoring data discussed in Chapter II. The results of the calibration provided satisfactory agreement between computer-generated and monitored flow. A summary of model calibration data is given in Table III-2.

Table III-2 Model Calibration				
		1-year Total Flow (mgd)		
Monitor	Monitor Location	Adjusted Metered	Model	% Diff.
SUB01	311	16.18	16.75	3.5
SUB02_03	K/2118	18.09	18.15	0.3
SUB04	630A	1.45	1.44	-0.5
SUB05	9003	4.28	4.16	-2.6
SUB06	WWTP	23.44	21.52	-8.3

E. Capacity Analysis for Existing Flow Conditions

1. Introduction

The purpose of modeling the existing system using existing land use data was to determine how the existing system would react to a variety of storm events. All analyses were performed using the calibrated model.

2. Collection System Improvement Criteria

The collection system improvement criteria are included in Appendix C. This contains parameters which were used in the model for all of the peak flow analyses. The model improvement criteria include evaluation information on existing sewers and relief sewers. It also includes I/I flow duration by design storm, for a 1-year and 5-year storm event. For the analysis, an allowable peak flow to capacity ratio of 1.0 was used for existing sewers. Relief sewers were sized and costs assigned for any pipe with a peak flow greater than 100 percent of the pipe capacity. Relief sewers were designed for a peak flow to capacity ratio ranging from 0.65 to 0.78. Proposed relief sewers greater than or equal to 18 inches in diameter were sized for a design flow-to-capacity ratio of 0.78. Proposed relief sewers less than 18 inches in diameter were sized for a design flow-to-capacity ratio of 0.65. For planning, improvements were sized as replacement relief sewers however the decision to parallel or replace the sewer should be made during design.

3. Improvement Cost Basis

The improvement cost basis information is also included in Appendix D. This information includes planning level costs for relief sewers. The cost figures are planning level construction costs only and do not consider construction contingencies, legal, administrative, and engineering costs. The costs are considered to be averages for the Leavenworth area based on average restoration costs and average construction complexity. In the future, these costs could be updated based on an Engineering News Record (ENR) Construction Cost Index of 6,288.

4. *Dry Weather Analysis – Existing Conditions*

The initial peak flow analysis consisted of the dry weather condition. Peak wastewater production and dry weather infiltration was included in the analysis. Inflow and wet weather infiltration was not included in the analysis. Accordingly, this analysis was independent of any rainfall event.

The dry weather condition was simulated to determine whether or not any of the existing pipes were undersized for dry weather conditions. The modeling indicated that no modeled trunk sewers were surcharged under dry weather conditions.

5. *Wet Weather Analysis – Existing Conditions*

In order to evaluate system performance under various storm events for existing conditions, the following capacity analyses were performed:

- 1-year storm event
- 5-year storm event

Following analysis, replacement relief sewers were sized and costed for those facilities which had peak flows exceeding 100 percent of the capacity. Figure III-2 shows the existing pipe network indicating surcharged pipes for a 5-year storm.

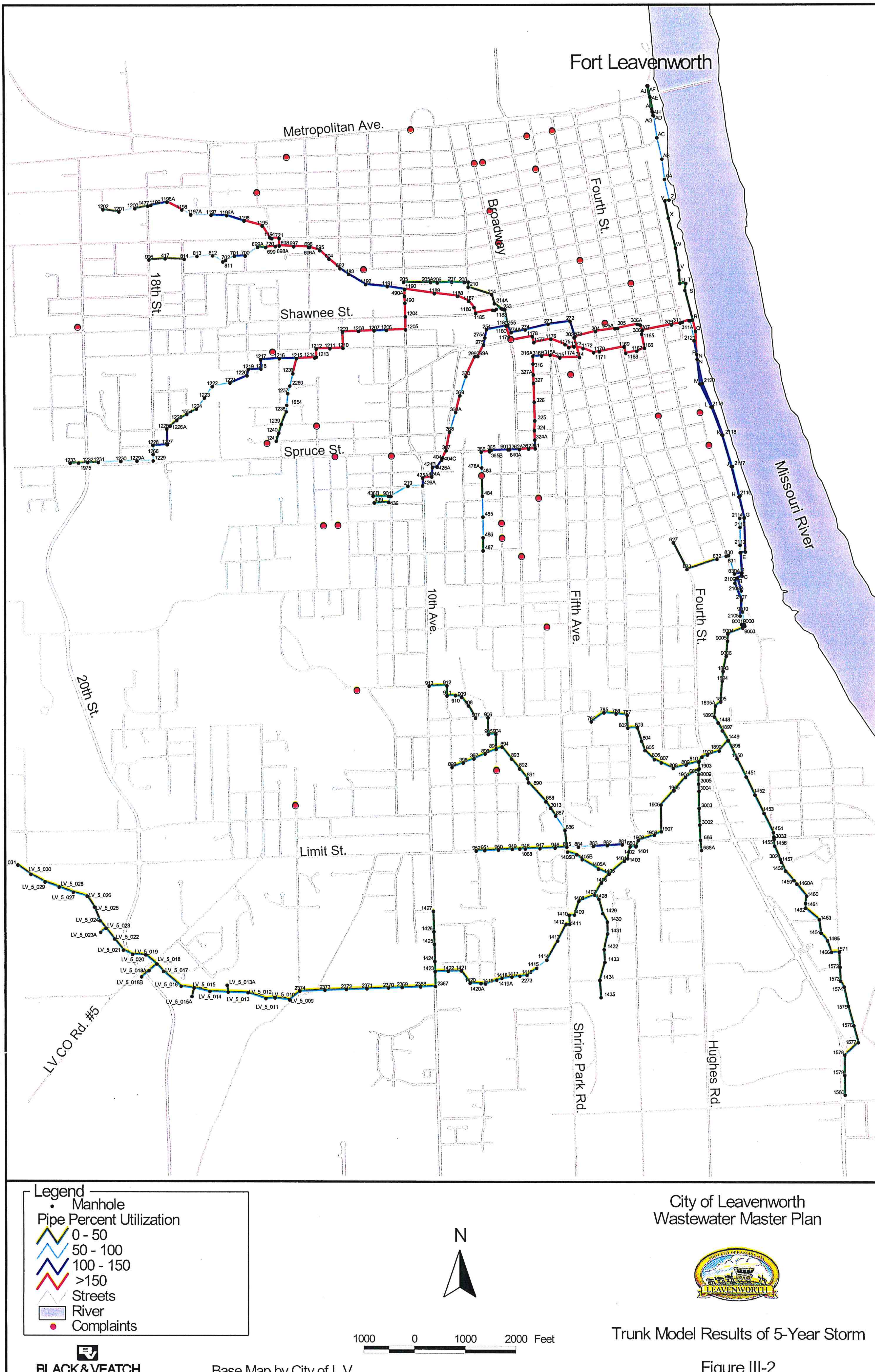
6. *Surcharged Pipes and Relief Sewers - Existing Condition*

A summary of the surcharged sewer and relief sewer capital costs for various design storms is presented in Table III-3.

Table III-3
Design Storm Comparison Cost for Relief Sewers

Year Storm	Length of Surcharged Pipe (Ft)	Total Length Of Pipe (Ft)	Percent of Surcharged Pipes Based on Length	Number of Surcharged Pipes	Total No. of Modeled Pipes	Percent of Surcharged Pipes Based on No. of Modeled Pipes	Total Construction Cost for Relief Sewers ($)
DW/HG	0	113,463	0.0	0	447	0.0	0
1	21,950	113,463	19.3	89	447	19.9	3,000,000
5	38,114	113,463	33.1	143	447	32.0	6,200,000

DW/HG – Dry weather high ground water.



City of Leavenworth
Wastewater Master Plan

Trunk Model Results of 5-Year Storm

Figure III-2

Results of the analysis show that none of the system is overloaded during dry weather conditions, but a significant number of trunk sewer segments are overloaded during wet weather conditions. As expected, the number of overloaded lines increases with increasing storm return intervals. Appendix E and F lists the overloaded pipes during a 1-Year and 5-Year Storm event. Table III-4 shows that subsystem SUB01 has the highest percentage of overloaded lines in comparison to the other subsystems.

Table III-4
Percentage of Overloaded Sewer for a 5-Year Storm Event

Subsystem	Total # of Sewer Lines	Number of Surcharged Pipes	Subsystem Percent of Trunk Pipes Overloaded (%)	Total System Percent of Trunk Pipes Overloaded (%)
SUB01	187	116	62.0	80.0
SUB02_03	34	13	38.2	9.0
SUB04	6	2	33.3	1.4
SUB05	192	2	1.0	1.4
SUB06	28	12	42.9	8.3
Total	447	145		100.0

F. Capacity Analysis for Future Flow Conditions

Future flow conditions were incorporated into the City of Leavenworth model to establish system flows and the impact on the existing system for the design years 2010 and 2020. The systems flows are projected based on the design years population and developed area. The existing collection system capacity, with the addition of the new Ironmoulders relief project and Central Avenue Tie-ins, was evaluated under 2010 and 2020 future flow conditions using a 5-year storm event.

1. Population Projections

The City provided population projections for the Study Planning Years. The population projections were developed using a 1.5% growth scenario that include the population of Fort Leavenworth. Population projections for the Study Area are presented in Table III-5.

Table III-5 Population Data for the Study Area		
Year	Population	Increase
Existing	40,000[1]	0
2010	46,400	6,400
2020	54,000	7,600

2. *Future Service Area*

The 2020 Sewer Service Area was defined as an interim area where development would be permitted through the use of appropriate planning and land use control tools. The areas identified for residential and commercial/industrial growth, which are likely to develop through the planning years 2010 and 2020 are shown on Figure III-3. During conversations with the City's planning and engineering staff, the percentage of population increase to be applied to the new growth areas was determined.

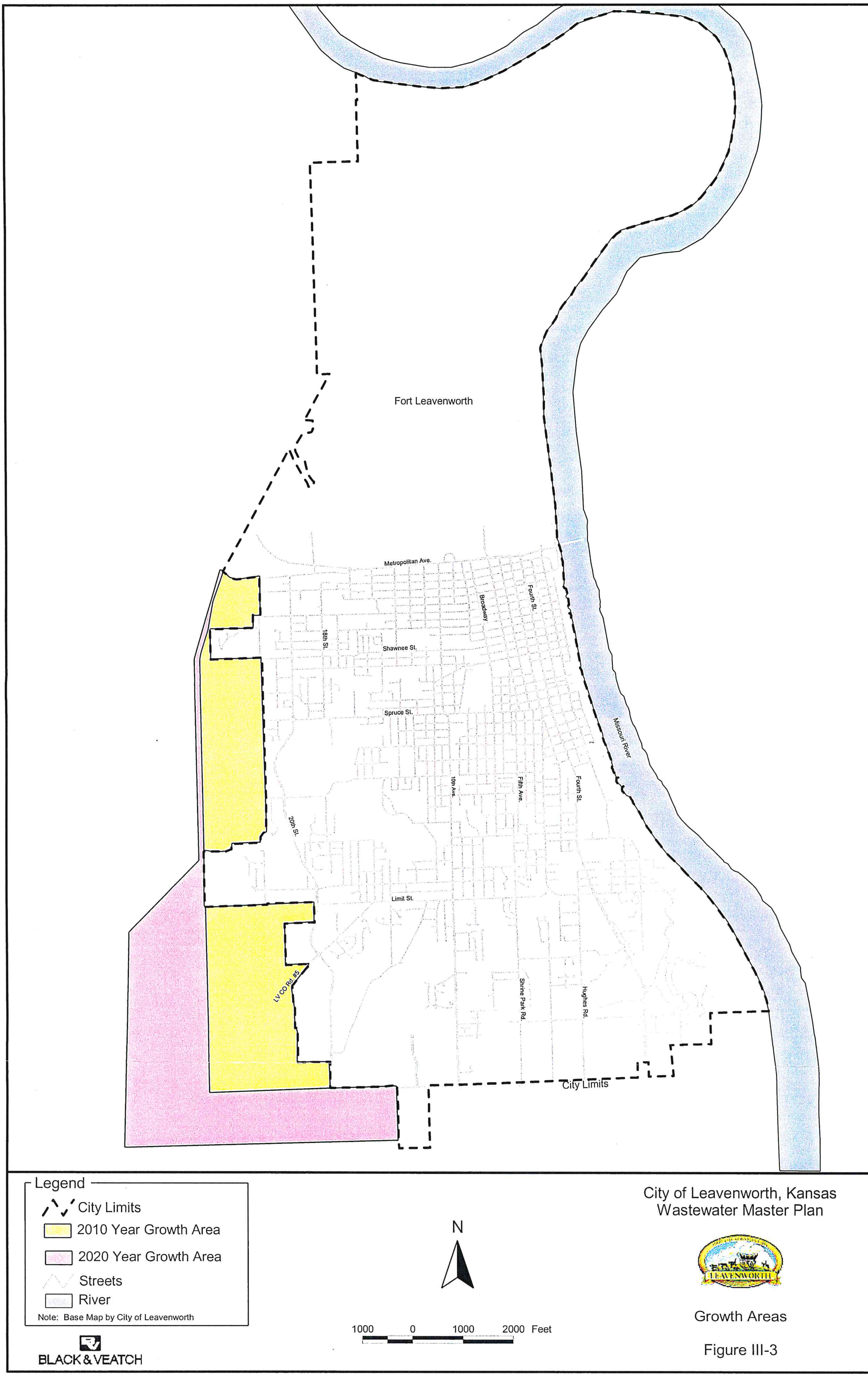
3. *Future Land Use*

The future land use was based on the City's current development, available area, and future projected population. Table III-6 lists the estimated developed area by general land use type for the planning years 2010 and 2020.

Table III-6 Future Growth Area by Land Use		
Land Use Description	2010 Est. Growth Area (Acres)	2020 Est. Growth Area (Acres)
Low Density Residential	261.65	303.62
Medium Density Residential	713.58	828.06
High Density Residential	0.00	0.00
Office & Commercial	130.82	151.81
Light/Medium Industry	59.47	69.01
Heavy Industry	0.00	0.00
Public	23.79	27.60
Agricultural/Park	0.0	0.00
Total	1189.31	1380.10

A flow design curve was constructed based on the future land use and population that estimated the future flows. The design curve and the allocation percentages are listed in

1 It should be noted that just prior to submitting the final copy of this study, the U.S. Census data for the City of Leavenworth became available and revealed that the actual population was 35,420. The actual population figures were determined to not appreciably change the findings of this study.



BLACK & VEATCH

City of Leavenworth, Kansas
Wastewater Master Plan

Growth Areas

Figure III-3

Appendix G. Table III-7 lists the manholes that the future flows have been allocated to in the existing model.

Table III-7 Connection Points		
Contributing Subsystems	Manhole Where Future Flow Enters Existing System	Diameter of Existing Pipe at Connection Point (inches)
SUB01 – Dakota Street Ext.	1202	8
SUB01 – Spruce Street Ext.	1233	10
SUB05 – Highway 5 Ext.	LV_5_018B	18

4. Surcharged Pipes and Relief Sewers – Future Condition

A summary of the surcharged sewer and relief sewer capital costs for various design storms with future flow allocated is presented in Table III-8.

Table III-8 5-Year Design Storm Cost for Relief Sewers							
Design Year	Length of Surcharged Pipe (Ft)	Total Length Of Pipe (Ft)	Percent of Surcharged Pipes Based on Length	Number of Surcharged Pipes	Total No. of Pipes	Percent of Surcharged Pipes Based on No.	Total Construction Cost for Relief Sewers ($)
	0	113,463	0.0	0	447	0.0	0
2010	38,946	113,463	34.3	143	447	31.9	8,400,000
2020	48,709	113,463	42.9	184	447	41.1	10,900,000

As expected, the number of overloaded lines increases with increasing population. Table III-8 shows the number of overloaded pipes without any Infiltration and Inflow (I/I) removal. Appendix H and I lists the overloaded pipes during a 5-Year Storm event for 2010 and 2020 planning years.

G. Reduction of I/I

Analyses were performed to determine a cost-effective level of I/I reduction for use in future design year model analyses. The hydraulic capacity at the WWTP was used as a goal to determine the minimum level of I/I reduction to be used in the model runs.

Peak flows at the plant during the 5-year design storm were developed for each design year (Existing, 2010, 2020) for comparison with the plant hydraulic capacity. The peak 5-year plant flow for each of the design years was based on population estimates provided by the City. In addition, flows for different levels of I/I reduction were calculated. After some initial model runs it was determined that I/I would be removed from subsystem SUB01 only. As discussed in Chapter II, subsystem SUB01 has the largest inflow coefficient and contributes 73 percent of the total flow during a 5-Year storm event. While the other subsystems contribute to I/I, the percentage is low and does not warrant an I/I removal program. In contrast, subsystem SUB01 contributes the largest amount of I/I and has the largest number of overloaded pipes.

For the purposes of planning it is assumed that the I/I removal will be completed within a 10-year planning period (by 2010). Flows for 0, 20, 30, and 40 percent I/I reduction in subsystem SUB01 are shown by year in Figure III-4. The existing and proposed hydraulic capacity of the plant is also shown. The existing hydraulic capacity of the plant is 26 mgd and will need to increase to 31 mgd with a plant expansion around the year 2010. Additional discussions of this necessary plant expansion are discussed in Chapters IV and V.

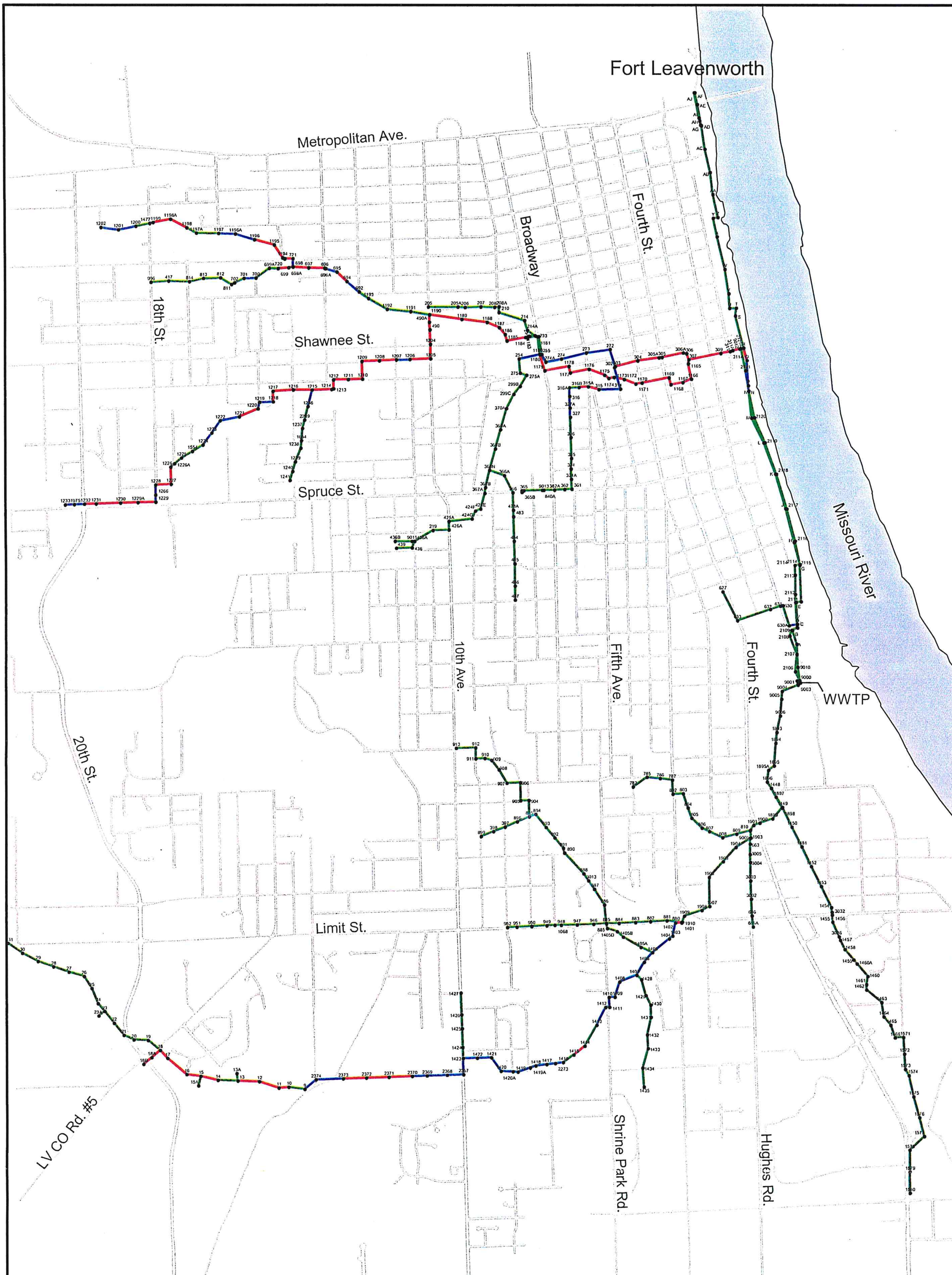
The ultimate capacity at the plant is not adequate to handle the 5-year design flow without I/I removal. The flow with 30 percent I/I removal remains at or below the plant hydraulic capacity until the year 2010. Considering the relief costs and potential capacity benefits at the WWTP, the 30 percent I/I reduction level in subsystem SUB01 was selected for use in sizing and costing the CIP projects.

Further analyses indicate that the 30 percent I/I removal should be complete by the beginning of planning year 2010. Table III-9 is a comparison of relief lengths between the 0 percent I/I reduction and the 30 percent I/I reduction form subsystem SUB01. The lengths are for existing trunks over 100 percent utilized.

Table III-9
Relief Lengths Comparison of 0% I / I Reduction
Versus 30% I / I Reduction in Subsystem SUB01

Design Year	0% I / I Reduction		30% I / I Reduction from SUB01	
	Incremental Length of Relief Sewers (ft.)	Cumulative Length of Relief Sewers (ft.)	Incremental Length of Relief Sewers (ft.)	Cumulative Length of Relief Sewers (ft.)
Existing	---	37,539	---	23,607
2010	1,407	38,946	2,937	26,544
2020	9,763	48,709	10,882	37,426

A relief cost comparison is shown in Table III-10 between 0% I/I removal and 30% I/I removal in subsystem SUB01. Figure III-5 shows the overload pipe for 2020 design year and a 5-Year storm event with 30% I/I removal from subsystem SUB01. A detailed cost comparison of the construction costs for I/I removal is included in Appendix J.



Legend
806 Manhole
Pipe Percent Utilization
<100%
100%-150%
>150%
Streets
River
Note: Base Map by City of Leavenworth

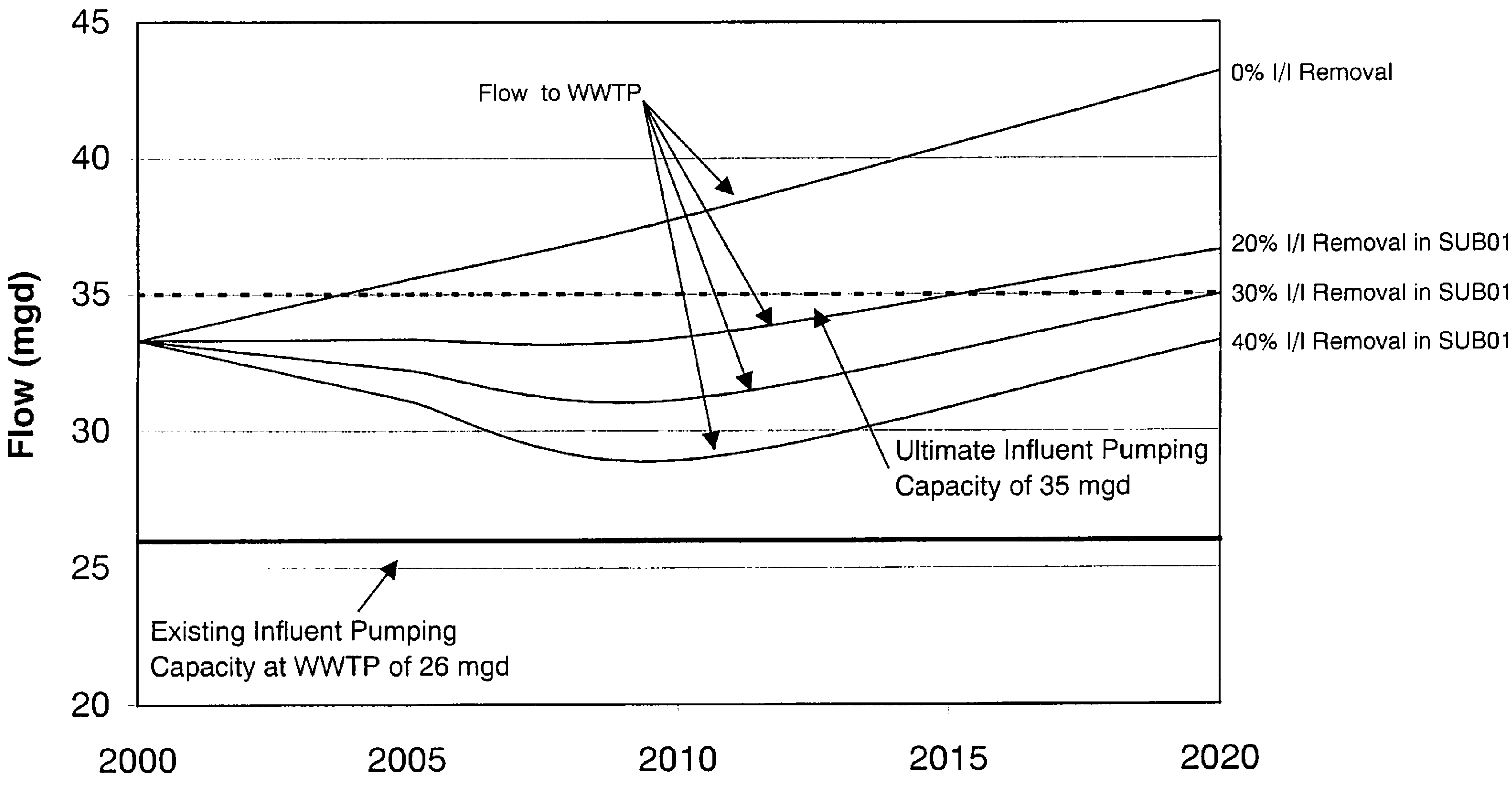
BLACK & VEATCH

City of Leavenworth, Kansas
Wastewater Master Plan

Trunk Model Results of 2020 Flow
5-Year Storm with 30% I/I Renewal

Figure III-5

5-Year Storm Peak Flows and WWTP Capacity



City of Leavenworth, Kansas

Figure III-4

Table III-10
Cost Comparison for a 5-Year Storm Event

Design Year	Construction Costs 0% I/I Removal ($)	Construction Costs 30% I/I Removal From SUB01 ($)
2010	8,400,000	5,000,000
2020	10,900,000	7,460,000

PROCEDURES, POLICIES, AND SOP'S IN PLACE

At a central location I have position a book with the following operational instruction for maintenance and for locates. As task are being accomplished I have the operators write these instruction and have other operators review them for accuracy, then I review these instructions. Also individual operational instruction is placed in areas where these tasks are accomplished frequently, (ex: controlling timers on primary sludge pumps).

Operational Instruction for Maintenance:

Belt Press Start-up

Mixing of Polymer

Back flushing Grit Pump

Unplugging Grit Screw

Belt Press Shut Down

Belt Press Wash down Checklist

Checking Sludge Blankets in Clarifiers

Controlling Sludge Pumps

Draining Clarifiers

IV. Physical Condition of Existing Facilities

A. Existing Wastewater Treatment Facilities

The WWTP is located on the west bank of Five-Mile Creek near the central-east part of downtown Leavenworth. The facility has undergone many expansions and upgrades, with the last major solids processing expansion in 1994. This expansion included a rehabilitation of facilities damaged during the flood of 1993 and an expansion of the administration building to house a belt filter press and a lime stabilization system for processing EPA 501 Class B biosolids. A chemical feed system for feeding ferrous chloride, and new influent screens were provided in 1996 and 1998 respectively.

Figure IV-1 is a site plan for the existing system. A schematic of the existing treatment processes is presented in Figure IV-2. Each treatment process is discussed in the following sections together with an evaluation of the physical condition and the rate capacity of each process.

Reports from plant inspections conducted in August 2000 are included in Appendix K. These reports present additional details on equipment such as year of installation or most recent renovation.

B. Operation and Maintenance

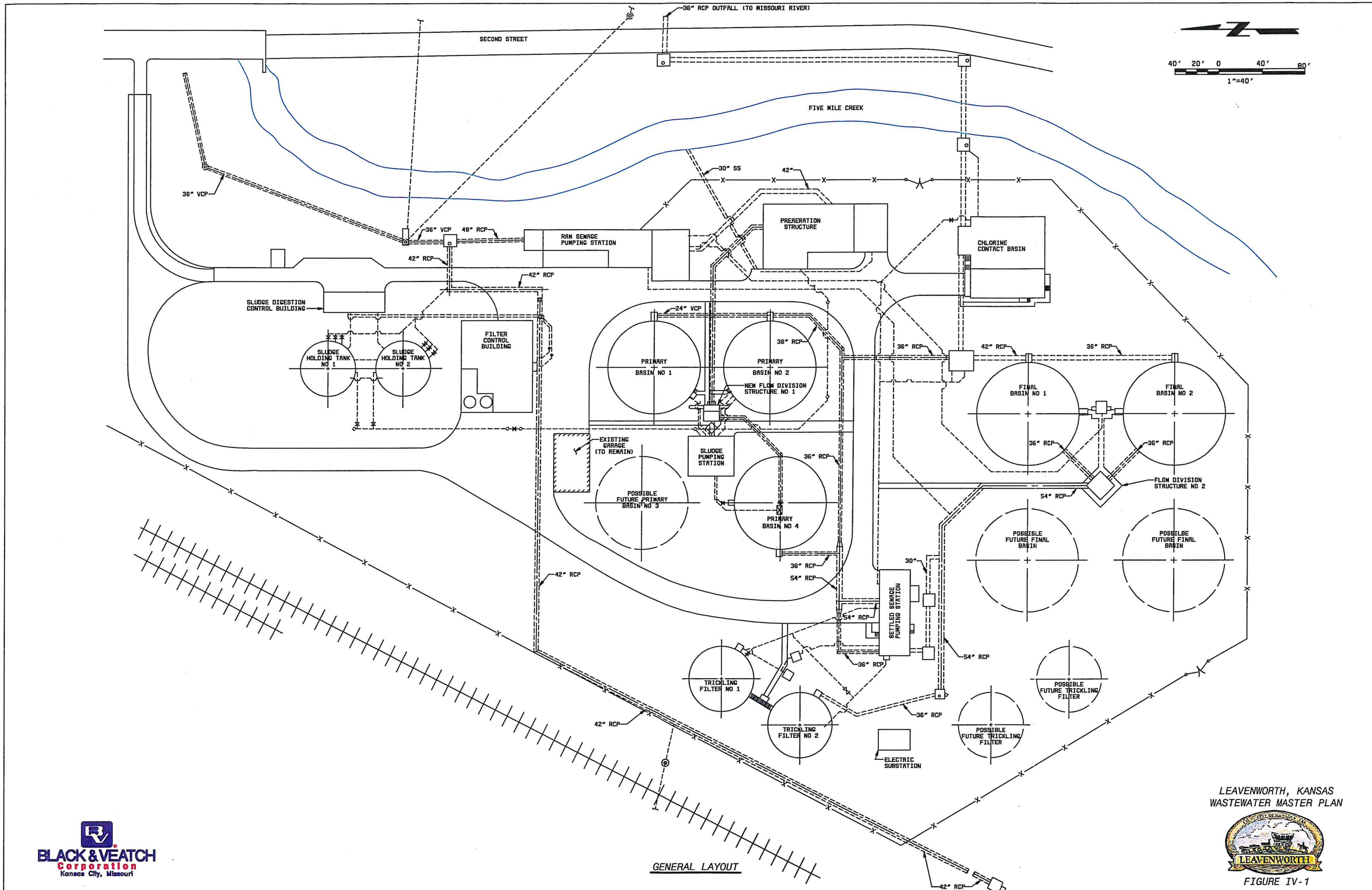
The WWTP includes 15 full-time employees: 2 administrative positions, 7 operators, and 1 laboratory technician, and 5 collections system personnel.

The plant staff is adequate for its size. Because of the reliability and stability of the trickling filter process and the degree of automation, no operators are required to be present overnight or during weekends. If a problem occurs during evenings or weekends, as many as three on-call operators are notified. If a problem with equipment occurs, the operator turns on redundant equipment and fills out a work order.

Most plant maintenance is performed Monday through Friday. The overall appearance and condition of the WWTP is good. Housekeeping is important to the staff and helps extend the life of structures and equipment. Maintenance procedures are followed and tracked through a maintenance management system. As a result of effective maintenance, several equipment items installed in 1971 are still in operation. A summary of historical O&M budgets for the WTP is included in Appendix A.

C. Influent Flow Monitoring

An influent flow meter is located in the flow-metering vault at the WWTP upstream of the headworks. The flowmeter is an American Sigma model 950 with an ultrasonic level

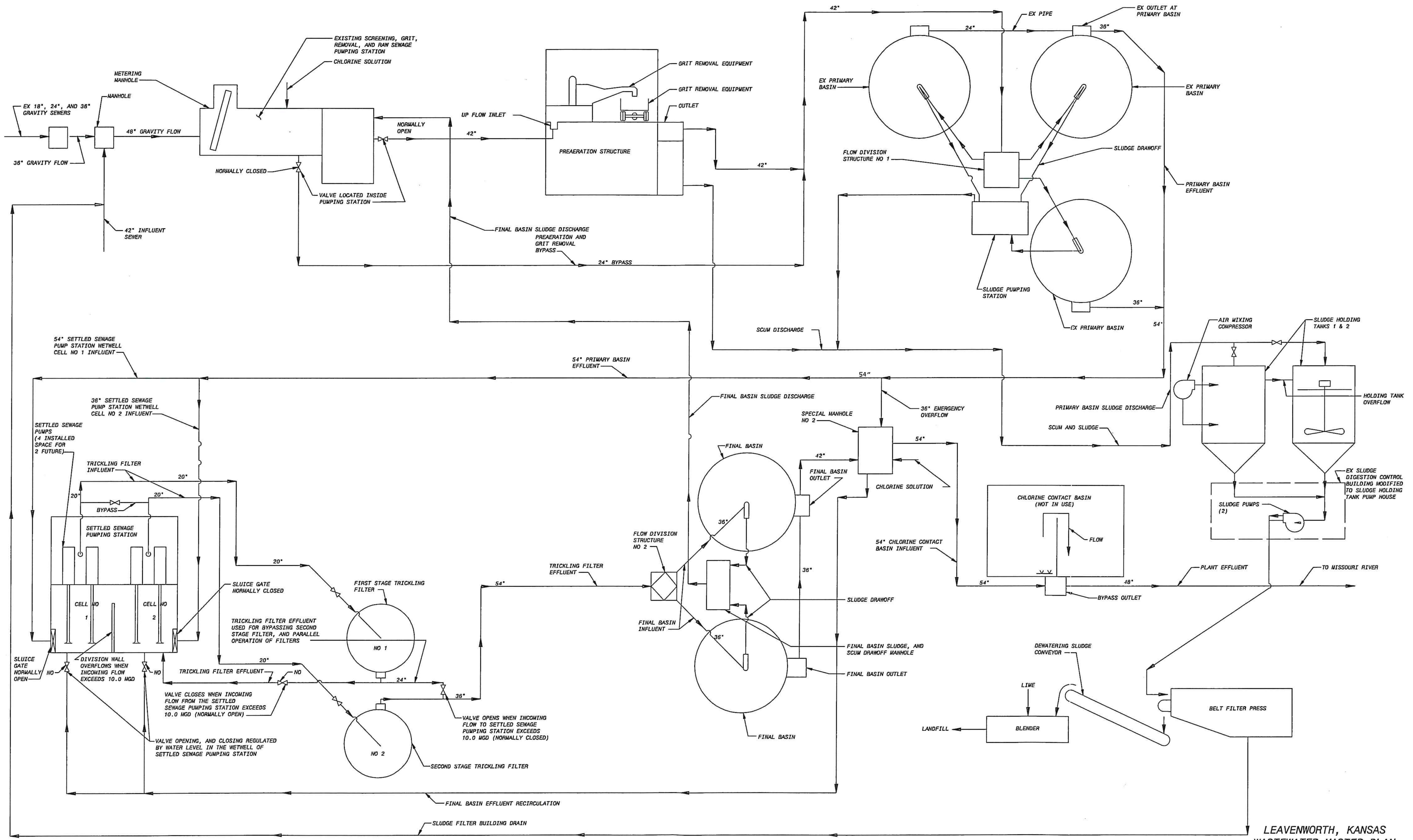


GENERAL LAYOUT

BLACK & VEATCH Corporation
Kansas City, Missouri

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

FIGURE IV-1



LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

NOTE:

NOT ALL PIPING AND VALVES ARE SHOWN IN THIS SCHEMATIC.

BLACK & VEATCH Corporation
Kansas City, Missouri

EXISTING PROCESS SCHEMATIC

NO SCALE

FIGURE IV-2

37372-120-324-C-H000009A1 6-4-01

sensor and an area velocity probe. An ultrasonic device that measures the distance from the top of a pipe to the surface of the water determines the depth of the water. The velocity is measured using an electromagnetic field. The ultrasonic sensor is mounted on the crown of the pipe at the entrance to the flow-metering vault and the velocity sensor is mounted six feet upstream of the ultrasonic sensor.

As discussed in Chapter II, the influent flow meter is reporting excessively high flow data due to non-ideal flow conditions immediately upstream and downstream of the meter. The meter vault and the influent pipe immediately upstream cannot be modified to improve the flow characteristics through the meter.

It is recommended that a flow meter be installed immediately downstream of the influent pump station. A description of this recommended installation is included with the improvements to the influent pump station described later in this chapter. By installing an additional flow meter, the influent flow meter could be better calibrated with the amount of flow being pumped to the aerated grit basins and would also provide more reliable flow data in the future.

D. Raw Influent Screening

Raw wastewater is screened before it enters the influent pumping station wetwell. Screening facilities include two, 4-foot bar screens with 5/8-inch spacings equipped with front-cleaned climber rakes. The peak hydraulic flow through the screens is 26.5 mgd. Screenings are discharged onto a belt conveyor and transported to a dumpster.

The influent screening facilities were last updated in 1998 and are in good condition. During extreme wet weather conditions, influent pumping cannot keep up with inflow, and the water level rises above the screen channels causing large solids and abrasive material to bypass the screening process and be transplanted into downstream unit processes.

E. Influent Pumping

Screened influent wastewater flows through the influent screens to the influent wetwell. Normally two pumps with 5 mgd capacity each discharge the wastewater to the pre-aeration basin.

The influent pumping capacity is 26.5 mgd, with four constant speed and one variable speed pump operating. The wetwell basin is capable of handling 35 mgd of influent flow with the installation of an additional variable speed pump.

An analysis of year 2000 flows indicated that the wetwell is occasionally experiencing peak hour flows of nearly 34 mgd. Therefore, the existing pumps are insufficient for pumping the peak hour flow while keeping the water levels from overtopping the screen channels. Additional pumping capacity should be added. The influent pump station was originally designed for one additional variable speed pump and drive. When an additional pump is installed, the maximum pumping capacity would be increased to approximately 35 mgd.

The existing influent pumping facilities are in fair condition. Pumps 1 through 4 are constant speed pumps and were installed in 1974. Pump 6 is a variable speed drive and was also installed in 1974. Pump 6 contains an antiquated magnetic variable speed drive that is becoming obsolete and is increasingly difficult to obtain parts. The drive should be replaced with an electronic adjustable frequency drive.

The existing control system for the pumps relies on an old pump sequencing scheme that is not very efficient and should be upgraded to programmable logic controller (PLC) technology. If the new control system were tied in with signals from the new flow meter the combined installation would allow tighter and better pump control at high flows. This could extend the life of the existing wetwell before additional pump station expansion would be required.

It was noted that the lower flight of stairs to the basement of the influent pump station is corroded. The last tread on this flight of stairs is missing and creates a possible trip hazard. In addition the last riser on this flight of stairs is corroded completely away. It is recommended that the entire lower flight of stairs be replaced.

The floor in the basement of the influent pump station was corroded. The slab appeared to be susceptible to ground water seepage causing the concrete to crack and spall. A new floor sealer should be installed to prevent additional moisture from coming through the slab and ponding on the floor.

Access to the wetwell is accomplished through a hatch on the south side of the influent pump station. The hardware and cable tie hold-downs were completely corroded, eliminating the ability of this hatch to lock in the fully open position. This is a hazardous condition that should be repaired.

There are two power roof ventilators (PRVs) mounted over the wetwell. The hoods covering the motors for these PRVs are corroded and should be replaced.

Installation of a flow meter on the pump header discharge is recommended. Because of insufficient room for this flow meter in the basement of the influent pump station, a flow meter vault will be required to be constructed in the yard between the influent pump station and the aerated grit basin.

A summary of recommended improvements to the influent pump station is presented in Table IV-1. The costs include 10% for general requirements, 25% for contingencies and 20% for engineering, legal, and administrative costs.

Table IV-1 Influent Pump Station Improvements		
Description	Implement	Cost (in 2001 dollars)
Install new 7,500 gpm pumping unit	Immediate	$157,800
Replace old magnetic drive on Pump 6 with new AFD.	Immediate	$59,500
Upgrade pump controls	Immediate	$51,100
Replace lower flight of stairs	Immediate	$1,700
Install floor sealer	Immediate	$6,100
Install new hardware on south access hatch	Immediate	$500
Replace PRV hoods	Immediate	$1,700
New flow meter vault	Immediate	$203,000
Total		$481,400

F. Preaeration and Grit Removal Facilities

From the influent pump station, the wastewater is conveyed to the pre-aeration facility. The pre-aeration facility consists of two basins, 78 feet long by 20 feet wide. Air is introduced into the basins through three, 600 cubic feet per minute (cfm) blowers to condition the wastewater and to help settle out grit. Total unit process capacity for the pre-aeration basin is 62.8 mgd per basin based on minimum detention time.

The purpose of preaeration of wastewater prior to primary settling is to improve grease separation and grit removal, to provide better five-day biochemical oxygen demand (BOD_5) removal, and to reduce odors. Some improvements to the overall treatability of wastewater have also been noted with some preaerated wastewaters. The state of Kansas acknowledges an additional 10 percent treatment removal credit for facilities with preaeration provided that the detention time is greater than 45 minutes. These requirements are discussed further in Chapter V.

As part of this Master Plan effort, data on the preaeration facility was obtained for a two week period in late November and early December of 2000. During the second week of December, the blowers were switched off and data collected on hydrogen sulfide in the preaeration basin and primary clarifier weirs and BOD_5 and total suspended solids (TSS) loadings at the primary clarifiers. A copy of the data from this test is included in Appendix L. With the limited data available, there was little discernable effect on BOD_5 and TSS at the primary clarifiers whether or not preaeration was being used. In order to assess the long-term effects of preaeration on BOD_5 and TSS, a lengthier study is necessary. Airborne hydrogen sulfide immediately doubled when preaeration was turned off, and plant staff received odor complaints from surrounding property owners during this time. It is clear that preaeration should be maintained for the purposes of odor reduction in the future. Failure to maintain adequate preaeration will result in odor complaints and further cost to contain odors under a plant-wide odor control system. Odor control is addressed later in this chapter.

The preaeration basins are equipped with rarely used scum removal weirs that are badly corroded and in poor condition. Scum is intended to be transferred from the removal weirs to a wetwell and pumped by a progressing cavity pump to the sludge storage tanks. The scum pump is in good condition due to little use.

The blowers were replaced in 1993, and are in good condition.

Grit is settled out of the bottom of the basin and transported to grit pumps. The plant experiences poor grit removal from these basins, with most of the grit settling to the bottom of the basin without transporting to the grit suction piping. As a result, the basins must be taken out of service approximately every 12 months and cleaned. Cleaning involves dewatering the basin and employing laborers to hand shovel out the settled and compacted grit. This is expensive and time consuming.

Grit is pumped through grit pumps to two grit classifiers and grit cyclones. The grit classifiers and cyclones dewater the grit and discharge into dumpsters. Current grit capture is extremely low with only 1 dumpster of grit being removed every couple of weeks. The grit equipment is in fair condition. Grit capture is low due to the lack of effective grit transport to the suction piping. If the grit basin performance is improved, grit capture through the cyclones and classifiers should improve dramatically.

The physical condition of the pre-aeration and grit removal facilities is mixed. The portions that are in good condition such as the blowers are in very good condition, while the portions that are in poor condition such as the scum removal weirs and the grit removal facility are in very poor condition.

The pre-aeration and grit removal system should be modified for more efficient operation. This can be accomplished by removing the current inefficient grit removal basins from service and installing improved grit transport screws within the existing basin structure. Sloped concrete fill would be provided to minimize grit deposits in the channel.

The concrete slab in the grit loading room is in fair condition. There are areas of the slab that are spalling and deteriorating and should be retopped with new concrete.

A summary of necessary physical improvements to the pre-aeration and grit removal facilities are presented in Table IV-2.

Table IV-2
Preaeration and Grit Removal Facility Improvements

Description	Implement	Cost (in 2001 dollars)
Replace scum skimmer and weirs	Immediate	$28,000
Install new grit transport screws and appurtenances including concrete work	Immediate	$805,000

Install new concrete topping in grit loading room	Defer	$9,000
Total		$842,000

G. Primary Clarifiers

Flow is conveyed from the pre-aearation and grit removal basins to the primary clarifier flow splitter and into the primary clarifiers. The primary clarifier flow splitter divides the flow evenly between the three installed primary clarifiers. Space exists for the installation of a fourth, future primary clarifier if needed. Rated capacity for the primary clarifiers is currently 12 mgd based on a surface overflow rate of 800 gpd/ft^2. If a fourth clarifier were constructed, the total hydraulic capacity would increase to 16 mgd on a maximum month basis. It is recommended that a fourth primary clarifier be constructed in order to accommodate the peak flows from the influent pumping station. Construction of a fourth primary clarifier will increase the peak flow capacity to 32 mgd. Because construction of a fourth primary clarifier is also closely related to the WWTP pollutant treatment capacity, the analysis and costs for this additional clarifier are discussed in Chapter V.

It appears that there is an uneven flow split occurring in the flow splitter structure that may be due to less than ideal flow characteristics or an uneven weir height. The weir height should be checked and reset if necessary. Improving the flow split will improve the performance of the primary clarifiers.

Two primary clarifiers were installed in 1960. These two clarifiers are 80 feet in diameter and have a side water depth of 6.5 feet. This side water depth is considered shallow by today's standards and does not provide for optimal clarifier performance. The third primary clarifier was installed in 1974. It is also 80 feet in diameter but has a side water depth of 10 feet which is the minimum recommended depth.

Wastewater influent enters the primary clarifiers, allowing primary sludge to settle to the bottom, scum to rise to the top and be skimmed off, and primary clarifier effluent to flow into the effluent launders to receive further treatment.

Scum that floats to the top of each clarifier is skimmed off the water surface to a scum wetwell and subsequently pumped to the sludge holding tanks.

The primary clarifiers contain sections of extremely rusted and corroded handrail and walkway. The handrail that surrounds the circumference of the primary clarifiers is in poor condition and is not currently in compliance with building codes for handrail. This handrail should be evaluated and replaced.

The effluent launder and weirs are constructed of galvanized steel. The launders are inset type launders allowing flow to travel over the weir from both the inboard and outboard edge. Clarifiers with shallow side water depths and inset launders may be subject to short circuiting and reduced performance. The short circuit mechanism is caused by velocity currents. Velocity currents can sweep across the clarifier floor from the center influent column to the wall, re-suspending settled sludge in the process. When the current reaches the wall, it can travel up the wall and over the outboard weir into the launder, carrying with it a high suspended solids load into the launder and into the next phase of treatment.

During the plant site investigation, one grab sample was taken at the inboard and outboard weir to see if short-circuiting may be occurring. Results from this single grab sample did not indicate that short-circuiting was occurring at that particular time, although it is possible that short-circuiting could occur in the future as plant flows increase.

The effluent weirs are badly corroded and in poor condition. The weirs should be replaced as part of any other enhancements of the clarifiers. These steel weirs could be replaced with fiberglass reinforced plastic weirs that are commonly available.

Optimizing the existing primary clarifiers may be possible to maximize their performance and increase the capacity of this unit process, improve TSS and BOD_5 removal, reduce the load to downstream plant components, and reduce the biological load to the trickling filters downstream. Reducing the load sent to the trickling filters is an important component of extending the life of the existing trickling filters as described in Chapter V.

Maximizing performance would involve replacing the influent distribution chamber to a more efficient energy dissipating inlet (EDI), installing spiral sludge rake arms to improve sludge collection and providing effluent peripheral baffles. Velocity current baffles around the perimeter of the tank would prevent the future possibility of solids carry over into the effluent launders.

A summary of recommended improvements to the primary clarifiers is presented in Table IV-3.

Table IV-3
Primary Clarifier Improvements

Description	Implement	Cost (in 2001 dollars)
Replace scum baffle and effluent weirs	Immediate	$225,000
Install new stairs, walkway, and handrail	Immediate	$119,200
Replace receptacles and junction boxes	Defer	$8,300
Optimize existing primary clarifier performance	Immediate	$499,000
Total		$851,500

H. Primary Sludge Pump Station

Settled sludge from the primary clarifiers is pumped to the sludge holding tanks by the sludge pumps in the Primary Sludge Pumping Station. The Primary Sludge Pumping Station contains three constant speed progressing cavity sludge pumps, one for each clarifier, and space for an additional, fourth pump. The total primary sludge pumping capacity is 300 gpm.

Scum collected from the surface of the primary clarifiers is pumped to the sludge holding tanks by the scum pumps housed in the Primary Sludge Pump Station. There are two variable speed progressing cavity scum pumps currently installed with no room for additional scum pumps. Both sludge and scum pumping equipment are interconnected so that sludge or scum removal can be accomplished when pumps are out of service. The total primary scum pumping capacity is 100 gpm.

All five sludge and scum pumps were replaced in 1993 and are in good condition.

The stairway to the basement was missing part of the last tread and riser and needs to be replaced. Heavy corrosion was noticed on the lower flight of stairs including the stair stringers and should be replaced. Door and window frames in the upper level of the pump station were similarly corroded. Sandblasting and repainting of these door and window frames should be considered before the corrosion becomes excessive.

The roof of the pump station is in poor condition. The existing roof is a built-up bituminous roof with a gravel surface. The roof was observed to contain many cracks, bubbles, and soft spots, and has reached the end of its expected service life. The roof should be replaced soon.

The pump station is in overall good condition, with the exception of the roof.

A summary of necessary physical improvements to the primary sludge pump station is presented in Table IV-4.

Table IV-4
Primary Sludge Pump Station Improvements

Description	Implement	Cost (in 2001 dollars)
Replace stair section	Immediate	$8,300
Replace existing roof	Immediate	$33,700
Total		$42,000

I. Settled Sewage Pump Station

Primary clarifier effluent flows from the primary clarifier effluent launders to the Settled Sewage Pump Station wetwell. The Settled Sewage Pump Station houses four constant speed pumps that draw water from the wetwell and pump it to the top of the trickling filters. The pump station is designed to send flow to the trickling filters in series at flows below 10 mgd. When flows exceed 10 mgd but are less than 20 mgd, the pump station is designed to automatically switch from series operation of the trickling filters to parallel operation of the trickling filters. Flows above 20 mgd are designed to bypass directly to the chlorine contact basin. Flows above 20 mgd would only occur during extreme flooding conditions and bypassing secondary treatment should not normally be permitted.

The pump station was designed to deliver a total flow of 10 mgd to each trickling filter regardless of plant flow. During periods of low flow, a portion of the trickling filter effluent is returned to the Settled Sewage Pump Station wetwell for recycle pumping so that a constant flow of 10 mgd is maintained to each trickling filter. Supplying a constant flow to each trickling filter allows for uniform and consistent performance from the trickling filters.

The settled sewage pumps are in fair condition. All of the pumps, motors, and controls are original equipment installed in the early 1970s. The pumps operate on a manual pumping cycle that must be switched over by the plant staff in order to even out the wear on the duty and stand-by pumping units. More modern controls could be installed to automate this function and improve overall performance.

The pump controls rely on a pressure indicator to determine whether flows are pumped to the trickling filters either in series or in parallel. This pressure indicator is in poor condition and has been a high maintenance item. Installation of a different type of sensor, perhaps an ultrasonic level sensor or a bubbler tube, would provide more reliable service.

The Settled Sewage Pump Station also houses the non-potable water system for the plant. Water from the wetwells is pumped through a strainer and into a pressurized tank. There are two horizontal centrifugal pumps with a total unit process capacity of 250 gpm. At the time of the inspection, one non-potable pump was inoperable and in need of service. The entire non-potable water system inside the pump station building is in need of a new coating system. The existing pumps, piping, strainer, and pressurized tank are badly corroded and need to be cleaned and painted. At the time of cleaning, a close inspection should be made of the amount of damage that has been caused by corrosion and if this corrosion is impacting the structural integrity of the system components.

Plant staff reports difficulty with the existing HVAC system inside the settled sewage pump station. In the summertime, temperatures inside the facility get extremely warm, while in the wintertime, it is difficult to keep the room warm enough to work in. A complete replacement of the existing HVAC system is recommended to improve these conditions.

A summary of necessary physical improvements to the settled sewage pump station are presented in Table IV-5.

Table IV-5
Settled Sewage Pump Station Improvements

Description	Implement	Cost (in 2001 dollars)
Install new pump controls	Immediate	$34,600
Repair non-potable water system paint coatings	Immediate	$4,300
Install new HVAC system	Immediate	$190,900
Total		$230,000

J. Trickling Filters

Flow is pumped from the Settled Sewage Pump Station wetwells to the trickling filters. There are two trickling filters that are operated either in series or parallel depending on the influent plant flow. The unit process capacity for the trickling filters is 20 mgd when operated in parallel. Normal operation of the trickling filters is limited to a process capacity of 10 mgd when operated in series.

Wastewater is pumped to the top of each trickling filter through a rotary distributor that distributes flow evenly over the trickling filter media. Each trickling filter is packed with trickling filter media that is in good condition. During the inspection, the surface of the media was examined for signs of delamination and deterioration. With the exception of isolated places along the surface of both filters near the rotary distributors, the media appears to be in good condition. The isolated places of deterioration appear to be minor and are not impacting the overall performance.

The trickling filters are constructed of a concrete base that collects the treated water and a structural steel frame and fiberglass panels that contain the media. The panels are in good condition. No signs of cracking, loss of section, or deterioration due to ultraviolet light exposure were noted. The panels did not appear brittle, although a small hole was noted near the top of one panel on trickling filter No. 2. This hole is above the wetted surface of the trickling filter and does not appear to be causing problems to the panel performance, but should be monitored to make sure that cracks do not propagate. Panel replacement would be expected to cost around $200,000 per filter, but does not appear to be necessary in the foreseeable future.

The rotary distributors appear to be performing well. The distributor on trickling filter No. 1 appears to have surface corrosion while very little corrosion was seen on the distributor for trickling filter No. 2. Both distributors should be thoroughly cleaned and inspected to determine the full extent of any damage from corrosion.

The spiral stair tower to the top of each trickling filter was replaced in 1985. At the time of inspection, there was a missing section of handrail on the stairs that causes a dangerous situation for operations staff and should be replaced.

The media appears to be in good condition. If the media delaminates or fails, it is expected to cost approximately $320,000 per filter to replace. Replacement of the media does not appear to be necessary in the foreseeable future.

Beyond routine cleaning and maintenance, no improvements appear to be warranted at this time.

Trickling filter treatment capacity is limited and expansion to the trickling filters is required to achieve the required permit limitations. This necessary process expansion is described in Chapter V.

K. Final Clarifiers

Once the wastewater has passed through the trickling filters it flows by gravity to the final clarifier flow splitter and into the final clarifiers. The final clarifiers collect suspended solids and trickling filter humus that has sloughed off from the filter media. Final sludge is a thin sludge that is collected at the center of each clarifier and is drained by gravity back to the Influent Pump Station. The unit process capacity for the final clarifiers is 8.9 mgd when both clarifiers are in service, based on a recommended surface overflow rate of 700 gpd/ft^2.

The final clarifiers are in good condition. The influent launders are the inset launder type similar to the primary clarifiers. Although also subject to short-circuiting, final clarifiers are affected less than are primary clarifiers. The final basins are dewatered once a year for maintenance and plant staff reports that the rake arms below the water level are in good condition.

The condition of the concrete at the final clarifiers is in good condition. No cracking or spalling was noted.

The effluent weirs are in poor condition. The weirs are made from galvanized steel and are delaminating due to very advanced corrosion. The weir plates should be replaced with fiberglass reinforced plastic weirs that are not subject to corrosion.

Electrical conduit and junction boxes are also heavily corroded. The electrical system continues to function satisfactorily, however at a minimum, junction boxes and conduit should be replaced.

A summary of necessary physical improvements to the final clarifiers are presented in Table IV-6.

Table IV-6
Final Clarifier Improvements

Description	Implement	Cost (in 2001 dollars)
Replace effluent weirs and scum baffle	Defer	$75,000
Replace junction boxes and conduit	Immediate	$9,200
Total		$84,200

L. Chlorine Contact Basin

Because the plant effluent is discharged directly into the Missouri River, the City has not been required by the state of Kansas to disinfect its treated effluent for many years. As a result, the chlorine contact basin is not being utilized. If placed in service, the total unit process capacity for the chlorine contact basin is 10.6 mgd at a maximum month flow detention time of 30 minutes and 21.2 mgd at a peak hour flow detention time of 15 minutes.

The chlorine contact basin is comprised of the chlorine storage facility and the chlorination basin. The concrete structure of the chlorination basin is in good condition with no spalling or significant cracking noted. The basin is surrounded on the north side by handrail for safety. A large section of handrail is missing and is replaced with a chain across the opening. The chain does not meet OSHA requirements for fall protection and should be replaced with a new section of handrail. This work could be accomplished as part of the overall plant O&M and is not included in the rehabilitation costs in this report.

The chlorine storage facility was previously used to house bulk chlorine storage containers. It is currently used to store spare parts for maintaining the wastewater plant equipment. Most of the original equipment has been removed from service, including all of the chlorine dosing equipment. The lights inside the storage facility do not appear to function properly. The unit heaters in the main storage facility are old and in poor condition. A relatively new unit heater is located in the old chlorinator room and appears to be in good condition. All of the doors into the chlorine storage facility are in poor shape and should be replaced. The double doors at the truck unloading dock were unable to be opened due to broken mechanisms and corrosion. There is a windowpane missing from the south door that should be replaced or new doors installed.

A summary of necessary physical improvements to the chlorine contact basin is presented in Table IV-7.

Table IV-7
Chlorine Contact Basin Improvements

Description	Implement	Cost (in 2001 dollars)
Replace existing doors	Defer[1]	$17,400
Replace handrail	Defer[1]	$1,600
Replace interior lighting	Defer[1]	$33,000
Replace interior gas unit heater	Defer[1]	$1,600
Total		$53,600

Notes: 1. Consider deferring until facility is used for chlorination or another purpose.

M. Sludge Storage Tanks

The Sludge Storage Tanks accept scum from the pre-aeration basin and sludge and scum from the primary clarifiers. Sludge is decanted from these covered storage tanks for dewatering on the belt filter press housed in the filter control building. The total storage volume of the sludge storage tanks is 568,000 gallons. Normal operation utilizes only the north sludge storage tank, reserving the south tank as an emergency holding tank.

The north sludge holding tank utilizes an impeller type mixer for maintaining a uniform concentration of sludge. The impeller mixer was not examined at time of inspection due to stored sludge in the tank and a hazardous atmosphere of hydrogen sulfide inside the structure. Plant staff reports that the impeller mixer is in fair condition. A gas meter is installed inside the tank to detect hazardous levels of hydrogen sulfide. Plant staff reports that this meter is a high maintenance item that is in fair condition.

The north holding tank has a walkway bridge from the entrance door to the center of the tank. The impeller mixer is supported from the center of this walkway. The condition of this walkway is very poor. Because of the heavy hydrogen sulfide atmosphere in the tank, the walkway is badly corroded and needs to be replaced or the walkway and mixer will fail.

The south sludge storage tank uses air to mix the sludge. Air is introduced into the storage tank by a blower located between both storage tanks. The blower is located in an enclosure intended to reduce noise when the blower is running. Both the enclosure and the blower are in poor condition. The south sludge storage tank should be retrofitted with an impeller mixer similar to the north tank if it is to be used for continuous service.

Odorous air is drawn off the tanks and sent to an odor control system utilizing activated carbon. The odor control system is in good condition. Vibration was noticed on the odor control duct coming from the south tank. This vibration was causing a loud noise from the duct vibrating against the tank cover. Vibration isolators should be installed to prevent damage to this ductwork.

The local electrical hand-stations used to start the impeller mixer or the blower are badly corroded and are in poor condition. Sludge level sensors should be added to these tanks so that level can be monitored remotely. These sensors should be optical or ultrasonic type detectors.

All hazardous atmosphere signage around the storage tanks was either missing or badly corroded. Safety signs indicating the presence of a hazardous atmosphere should be replaced.

A summary of necessary physical improvements to the sludge storage tanks is presented in Table IV-8.

Table IV-8
Sludge Storage Tank Improvements

Description	Implement	Cost (in 2001 dollars)
North Tank mixer replacement	Immediate	$38,800
Demo and install new walkway and handrail in North Tank	Immediate	$62,000
Install new walkway and handrail in South Tank	Defer[1]	$52,200
Install new mixing system and demo the existing blower system in South Tank	Defer[1]	$57,100
Install new local hand stations and level sensor	Immediate	$2,600
Total		$207,200

Notes: 1. Defer to a time when the South Tank is needed.

N. Sludge Pump House

The Sludge Pump House contains two, 150 gpm progressing cavity sludge pumps for transferring sludge from the storage tanks to the Filter Control Building for dewatering. One pump functions only when sludge is being dewatered, typically about 24 hours per week, and the other is a standby pump.

The pumps were installed in 1993 and are in good condition. The rotors and stators have been replaced once in the past seven years.

The pump house also contains a ferrous chloride feed system for controlling odor during the sludge dewatering process. The ferrous chloride is stored in a 6,000 gallon bulk storage tank outside of the building and ferrous chloride is injected into the sludge with a diaphragm pump to either the sludge storage tanks, directly into the sludge pumps, or to the head of the plant.

The ferrous chloride feed system was installed in 1996 and is in good condition. One diaphragm on one of the diaphragm pumps has been replaced in the past four years.

The pumping equipment inside the pump house is in good condition; however the pump house itself is in fair condition. Concrete spalling was noted on the floor of the pump house and there was staining of the concrete floors and walls due to ferrous chloride. The air-handling system was checked and it appeared that there was inadequate air flow out of the building. Power roof ventilator PRV-9 was not operational when manually started. The electric lights in the building had lamp ballasts that were badly corroded and should be replaced. Maintaining PRV-9 and replacing the lamp ballasts are considered general maintenance items and are not included in an analysis of recommended capital costs. Beyond routine maintenance, no improvements appear to be warranted at this time.

O. Filter Control Building

The Filter Control Building contains the administrative offices for the Wastewater Treatment Plant and the sludge dewatering unit processes for processing sludge. These facilities were renovated in 1993 when a complete retrofit of the existing building occurred.

The Filter Control Building is divided into different areas as follows:

- Filter Room. The filter room houses the belt filter press for sludge dewatering and the sludge blender for processing EPA 504 Class B lime stabilized sludge. The facilities are in good condition. Only a few items of concern were noted.

  There was a high amount of corrosion on the potable water piping located adjacent to belt filter press. This piping should be cleaned and repainted to prevent further corrosion.

The rollers on the conveyor belt transferring dewatered sludge to the blender were mildly corroded. These rollers should be monitored for further corrosion before replacing.

There was some corrosion noted on the air handling duct over the belt filter press. This duct should be cleaned and recoated. There was also some corrosion noted on the belt filter press control panel.

The entrance to the electrical room is through double doors from the filter room. These double doors are corroding and allowing washdown water from the belt filter press to leak across the door threshold. The double doors should be replaced with fiberglass doors to prevent further corrosion. In addition, a sill should be installed at the door threshold to raise the door out of the water that flows by during washdown of the press.

- Administration area. The administration area houses the offices of plant staff, the plant superintendent, the training room, the lab, and bathroom facilities. These areas are well maintained and are in good condition.

  The composite tile flooring in the hallway near the west exit is loose and cracking. Some portions are missing. Replacement of this flooring with seamless flooring similar to what is installed in the lab should be considered.

  Plant staff reports that air flows in the main entrance lobby aren't balanced and poor air flow is the result. The supplier of the air handling systems has been to the plant on two separate occasions to investigate without determining a solution.

- Sludge Loading Station. The sludge loading station allows sludge hauling trucks to load lime stabilized sludge from the dewatering process for transport to a landfill. These facilities are in good condition. There was minor damage to some of the painted surfaces in the loading area that should be touched up. The gas meter used to detect high levels of hydrogen sulfide needs the sensors replaced often.

- Polymer Feed Room. The polymer feed room houses the polymer feed mixing and feed equipment for preparing polymer solution for injection into the sludge prior to dewatering. These facilities are in good condition. One polymer pump transmission was replaced within the past year. There was minor paint damage noted on the ceiling of the room.

- Scrubber Room. The scrubber room houses the odor control packed tower scrubber used for treating odors from the dewatering process. These facilities are in good condition. There was minor corrosion noted on the air louver and on the emergency eyewash within the room.

- Odor Control Chemical Feed Room. The odor control chemical feed room houses the feed equipment that dose sodium hypochlorite and sodium hydroxide to the packed tower scrubber. Pumps installed in the 1993 project have been replaced with less maintenance-intensive pumps. These facilities are in good condition. The chemical scales for both hypochlorite and caustic are in fair condition due to corrosion. These scales should be re-evaluated annually to determine if replacement is warranted.

- Lime Feed Room. The lime feed room houses the lime transfer equipment that sends quicklime to the sludge stabilization blender. Overall this facility is in good condition. Only a few items should be investigated for improvements.

  The roof of this room should be cleaned of the spilled lime that has occurred during lime transfer. Over time, this lime will damage the condition of the roofing and require the roof to be replaced. One of the lime transfer pipes should be painted before corrosion sets in. The lime storage silos were reused during the 1993 improvements and are in overall fair to good condition. The dust collectors mounted on top of the lime silos are in poor condition and should be replaced. These dust collectors use a shaker to clean the filter bags which is in poor condition. Consideration should be given to replacing these dust collectors with reverse air jet type dust collectors which use compressed air to clean the filter bags.

A summary of recommended improvements to the filter control building are presented in Table IV-9.

Table IV-9 Filter Control Building Improvements		
Description	Implement	Cost (in 2001 dollars)
Filter room improvements (painting and installation of new FRP doors)	Immediate	$43,500
Administrative area improvements (seamless flooring)	Immediate	$17,200
Sludge loading area improvements (painting)	Immediate	$2,600
Lime feed room improvements (painting)	Immediate	$500
Total		$63,800

P. Garage

The plant garage is located to the southwest of the Filter Control Building. The garage is used to house some of the plant job trucks and sewer maintenance trucks and to perform maintenance of some of the equipment. It is a prefabricated metal building that was erected by City staff. The year of construction is unknown.

Currently, the garage is laid out inefficiently and cannot house more than one plant vehicle. Parts of the foundation are cast concrete, while others are concrete block. The foundation is suspect and should be demolished and rebuilt. The exterior walls of the garage are damaged in more than one location due to vehicles backing into the structure.

The garage is in poor condition and should be replaced with a more space efficient building and an improved foundation. It appears that three vehicles could be parked in a new garage with a more efficient layout with increasing the footprint of the existing garage.

Completely demolishing the garage and the foundation and constructing a new 30 feet by 50 feet foundation slab and prefabricated metal building with improved parking access would cost $300,000.

Q. Site Needs

The site experiences poor drainage on the south end of the plant. During and immediately after storms, water tends to pond in the areas near the final clarifiers. There is also poor drainage between Primary Clarifier No. 3 and the Primary Sludge Pump Station. A stormwater plan for the site should be investigated to examine methods of improving drainage.

The perimeter fence is in good condition. The plant site is not completely surrounded by fencing and consideration should be given to completing the perimeter fence. The current fence ends in the vicinity of the screening chamber.

There are no water hydrants for fire suppression currently on site. Extending the water lines inside the plant perimeter and installing fire hydrants, or increasing the extent of the non-potable water system and installing fire hydrants inside the plant perimeter should be considered.

The plant access roads are in fair condition in front of the Filter Control Building, but are in poor condition elsewhere in the plant. The access road to the Primary Sludge Pump Station is in very poor condition and should be demolished and rebuilt with a suitable subbase. Consideration should be given to milling all plant roads and repaving.

One influent manhole west of the trickling filters is in poor condition and should be repaired or replaced. The existing manhole is constructed of brick and mortar and has several bricks missing from around the manhole ring. It is not water tight and is a source on inflow. This manhole should be repaired or replaced with a precast manhole.

There is currently a conceptual evaluation underway for the construction of a flood levee around the WWTP to protect the site from flooding on Five-Mile Creek or the Missouri River. The levee would consist of a combination of earth berms and concrete flood walls with a removable gate structure at the plant entrance.

A summary of necessary physical improvements to the site are presented in Table IV-10.

Table IV-10
Site Improvements

Description	Implement	Cost (in 2001 dollars)
Milling and repaving plant roads	Defer	$119,000
Extend perimeter fencing	Defer	$6,600
Extend fire hydrants	Defer	$223,000
General grading improvements	Defer	$165,000
Total		$513,600

R. Odor Control Systems

The WWTP currently employs four different types of odor control systems to handle odors generated at three different locations. The following odor control systems are in place:

- Influent Headworks. Ferrous chloride is injected into a manhole upstream of the flow meter vault at the influent headworks. Ferrous chloride reacts with the liquid phase sulfide contained in the influent wastewater and prevents it from volatilizing into gaseous hydrogen sulfide. Airborne hydrogen sulfide smells like rotten eggs and is a major contributor to odors at the plant. Injecting ferrous chloride upstream of the headworks lowers the airborne sulfide through the influent screens and the influent pump station wetwell. As discussed previously, the headworks contain the influent flow meter and the influent screens and is a confined space that operators are required to enter to perform occasional maintenance. Reduction of odors in the headworks is important for operator health and safety. The ferrous chloride has fully reacted with the influent wastewater by the time the influent is pumped to the aerated grit basin. Installation of the ferrous chloride system has reduced off-site odor complaints.

- Sludge Storage Tanks. Air from the sludge storage tanks is sent through an activated carbon odor control unit for treatment. Activated carbon removes airborne hydrogen sulfide, but the carbon media must be regenerated or replaced once it has reached the end of its usable life.

  In order to extend the life of the activated carbon unit, ferrous chloride is also injected into the sludge storage tanks for controlling hydrogen sulfide odors.

- Filter Control Building. Prior to dewatering of sludge in the Belt Filter Press room in the Filter Control Building, the sludge is injected with hydrogen peroxide (H_2O_2) to oxidize odors. Treating odors in the liquid state is more cost effective than treatment after odors have volatilized into the air and makes the room atmosphere safer for operators. The hydrogen peroxide is effective in reducing the volume of odor that must be treated after the sludge has been dewatered on the Belt Filter Presses. Odors from the sludge dewatering and lime stabilization process in the Filter Control Building are treated with a wet chemical scrubber. Wet chemical scrubbing utilizes sodium hydroxide (NaOH) and sodium hypochlorite (NaOCl) to oxidize the remaining odors from the sludge dewatering operation. Both the wet chemical scrubbing and hydrogen peroxide systems are discussed in Filter Control Building section of this chapter.

Although these three areas of the WWTP utilize odor control, they are insufficient to treat all odors generated by the treatment operation across the plant. A plant-wide odor control system is beneficial for the following reasons:

- Reduces opportunity for odor complaints from property owners adjacent to the WWTP.
- Encourages development of properties surrounding the WWTP that would otherwise be impacted by odors.

Establishment of a plant-wide odor control system would involve the following structures:

1. Influent Headworks and Influent Pump Station. The influent headworks and influent pump station are already receiving some level of odor control with ferrous chloride. Both the headworks and wetwell are well covered and sealed off from surrounding facilities. In order to treat the remaining odors in these two facilities, the air exhaust PRV's would need to be replaced with odor control ductwork to a plant wide odor control system.

2. Aerated Grit Basin. The aerated grit basin is a significant source of odors, especially when the aeration blowers are not operating as previously discussed. This facility should be covered with an aluminum or fiberglass cover and the odorous air should be ducted to the plant-wide odor control system.

3. Grit Building. Dewatered grit is a major source of odor. With an improved grit capture system as described in Chapter IV, odors will increase inside this building. Exhaust air ductwork should be installed and connected to the plant-wide odor control system.

4. Primary Clarifier Flow Splitter. The flow splitter is a contributor to plant odors due to the turbulence generated by the water as it enters this structure. The flow splitter should be covered with an aluminum cover and exhaust air duct should be connected to the plant wide odor control system.

5. Primary Clarifiers. The primary clarifiers generate odors from both the clarifier influent feed well and the effluent weirs due to turbulence of the water as it enters and leaves the basin. The clarifiers should be covered and exhaust air should be ducted to the plant-wide odor control system. In order to prevent a vacuum on the clarifier covers, air inlet valves should be installed in the covers.

6. Trickling Filters. The trickling filters typically do not generate objectionable amounts of hydrogen sulfide, but can be major odor contributors under the right conditions. Typically, during spring and autumn periods of warm weather days followed by cool evenings and nights can result in air inversions

through the trickling filters and the volatilization of hydrogen sulfide. When this occurs, odors can be extremely objectionable.

Trickling filter odor control would be recommended for a second odor control project after the prior processes are treated and off-site odor generation assessed. Covering the trickling filters with an aluminum or fiberglass dome and connecting both supply and exhaust ductwork would be required. Because trickling filters require oxygen to properly function, providing odor control to a filter requires an air supply system as well. The required air supply to the filter requires a separate supply fan and separate air supply duct. This air supply system is required regardless of the type of odor control system employed.

The odor control system would collect exhaust air from the influent headworks through the primary clarifiers with a large exhaust fan and draw the air through an odor control system for treatment. There are three types of odor control systems typically employed to treat odorous air at wastewater treatment facilities. These systems are described as follows:

1. Wet chemical scrubbing. Wet chemical scrubbing utilizes a stack of plastic media contained in an odor control tower. Air is sent through the bottom of the tower and sodium hypochlorite and sodium hydroxide are introduced in the top of the tower and trickle over the media, oxidizing the odorous air in the process. Advantages to wet chemical scrubbing include wide process control, the ability to handle large, sudden changes in odor concentrations without upsetting the process, and automation of control. Disadvantages include the need to handle large volumes of highly concentrated and dangerous sodium hydroxide and sodium hypochlorite.

2. Activated carbon scrubbing. Activated carbon scrubbing utilizes porous carbon media in a fiberglass container to remove odors from the air. Air is sent through the bottom of the scrubber and passes through a bed of carbon media before exiting from the top of the container. Advantages to activated carbon scrubbing include no requirements for handling dangerous chemicals. Disadvantages include the necessity to replace the media after it has been depleted and the possibility of spontaneously generated fires in the media bed under high sulfide and low air flow conditions.

3. Biofilter. Biofilters for odor control consist of a large volume of organic material, typically wood chip mulch that the odorous air passes through. Bacteria on the organic material utilize the sulfide-laden air as a food source and slowly break down the organic media over time. Advantages to biofilters include utilization of renewable "environmentally friendly" media, and no requirements for handling dangerous chemicals. Disadvantages include difficulty in obtaining good odor removal over a wide range of or sudden change in airflows and sulfide concentrations, and a relatively large amount of space required to contain the necessary volume of media.

For the purposes of this report, it is assumed that wet chemical scrubber type odor control treatment will be utilized. Wet chemical scrubbing treats odors over the widest range of fluctuating concentrations and is the most flexible method to treat odors as additional plant processes are phased in over time. During implementation, odor sampling and characterization should be performed to confirm the scope of the odor control improvements and the cost effectiveness of each odor control system should be reevaluated.

A summary of the costs of odor control for the various structures is given in Table IV-11.

Table IV-11
Odor Control

Description	Implement	Cost (2001 dollars)
Plant-wide Odor Control	Defer until required	$1,650,000
Total		$1,650,000

S. Summary

The total estimated cost of all of the recommended physical improvements at the WWTP is $6.1 million. However, not all recommended projects require immediate implementation.

Recommended improvements are divided into three levels of priorities. The first priority includes improvements that affect the overall plant performance and reliability and include the influent pumping station improvements, the aerated grit facility improvements, and the primary clarifier improvements.

The second priority includes improvements that require rehabilitation to remain in service, however do not limit the ability of the WWTP to meet its permit requirements.

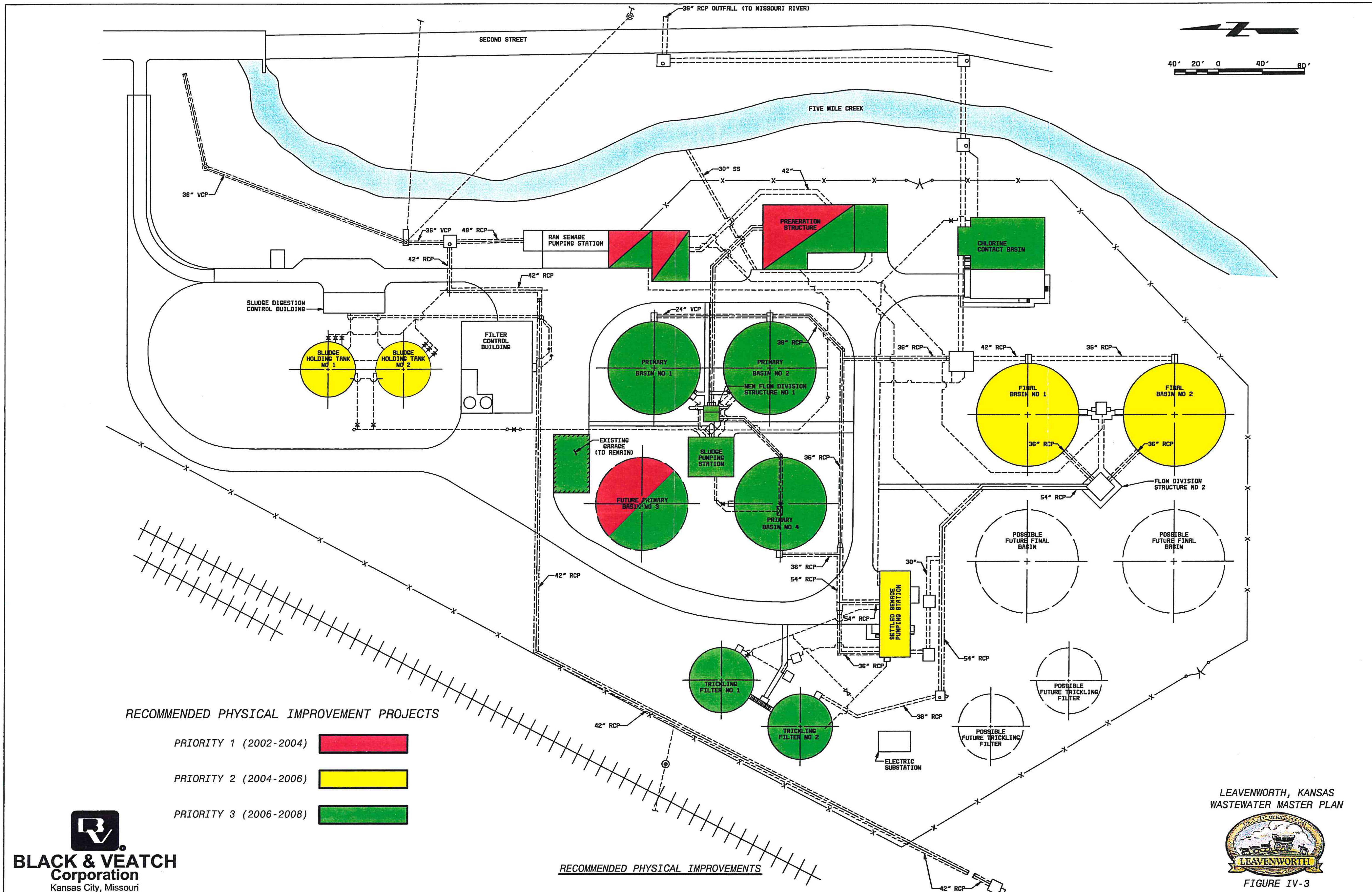
These improvements include the settled sewage pump station, final clarifiers, and sludge storage tanks improvements.

The third priority includes improvements that may be desirable to implement for operator comfort, property-wide site development, and the consideration of property development adjacent to the WWTP. These improvements include the primary sludge pump station, chlorine contact basin, filter control building, the new garage, sitework, and odor control improvements.

A breakdown of these priorities and the recommended year of implementation are included in Table IV-12 and Figure IV-3.

Table IV-12
Summary of Physical Improvements

Description	Implement and Complete	Cost (2001 dollars)
Priority 1 –Influent Pumping Station, Grit Facility Primary Clarifier Improvements	2002-2004	$2,120,000
Priority 2 – Settled Sewage Pump Station, Final Clarifiers, Sludge Storage Tanks,	2004-2006	$520,000
Priority 3 – Primary Sludge Pump Station, Chlorine Contact Basin, Filter Control Building, New Garage, Sitework, and Odor Control	2006-2008	$2,560,000
Total		$5,200,000


36" RCP OUTFALL (TO MISSOURI RIVER)
SECOND STREET
FIVE MILE CREEK
40' 20' 0 40' 80'
36" VCP
36" VCP
48" RCP
42" RCP
42" RCP
RAW SEWAGE PUMPING STATION
PREAERATION STRUCTURE
CHLORINE CONTACT BASIN
30" SS
42"
SLUDGE DIGESTION CONTROL BUILDING
SLUDGE HOLDING TANK NO 1
SLUDGE HOLDING TANK NO 2
FILTER CONTROL BUILDING
24" VCP
36" RCP
PRIMARY BASIN NO 1
PRIMARY BASIN NO 2
NEW FLOW DIVISION STRUCTURE NO 1
36" RCP
42" RCP
36" RCP
FINAL BASIN NO 1
FINAL BASIN NO 2
36" RCP
36" RCP
EXISTING GARAGE (TO REMAIN)
SLUDGE PUMPING STATION
FUTURE PRIMARY BASIN NO 3
36" RCP
PRIMARY BASIN NO 4
FLOW DIVISION STRUCTURE NO 2
54" RCP
POSSIBLE FUTURE FINAL BASIN
POSSIBLE FUTURE FINAL BASIN
42" RCP
36" RCP
54" RCP
30"
SETTLED SEWAGE PUMPING STATION
54" RCP
36" RCP
54" RCP
TRICKLING FILTER NO 1
TRICKLING FILTER NO 2
36" RCP
POSSIBLE FUTURE TRICKLING FILTER
POSSIBLE FUTURE TRICKLING FILTER
ELECTRIC SUBSTATION
42" RCP
42" RCP
RECOMMENDED PHYSICAL IMPROVEMENT PROJECTS
PRIORITY 1 (2002-2004)
PRIORITY 2 (2004-2006)
PRIORITY 3 (2006-2008)
BLACK & VEATCH Corporation
Kansas City, Missouri
RECOMMENDED PHYSICAL IMPROVEMENTS
LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN
LEAVENWORTH
FIGURE IV-3

V. Wastewater Treatment Process Expansion Analysis

A. Original Design Basis

The existing Leavenworth, Kansas Wastewater Treatment Plant (WWTP) largely dates back to the secondary treatment expansion in the early 1970's. According to the 1973 Operation & Maintenance Manual, it was designed for a 1990 basis of:

- 55,000 population equivalents.
- 6.88 mgd annual average flow.
- 20 mgd peak hydraulic capacity through secondary treatment.
- 17,200 pounds per day (ppd) raw influent five day biochemical oxygen demand (BOD_5).
- 20,000 pounds per day raw influent total suspended solids (TSS).
- 86% BOD_5 removal, resulting in an effluent BOD_5 of 42 mg/l.

The current NPDES permit conditions are listed below. A copy of the permit is provided in Appendix M.

- BOD_5 - 45 mg/l weekly average, 30 mg/l monthly average.
- TSS – 45 mg/l weekly average, 30 mg/l monthly average.
- pH – 6 – 9.

A wastewater treatment plant capacity is commonly referenced to an annual average daily flow rate. However, it also has a pollutant load limitation, which is a function of flow, pollutant concentration, and discharge requirements. It is noted that the permitted monthly average effluent BOD_5 of 30 mg/l is approximately one third less than the design basis. Leavenworth's WWTP has largely been able to meet the lower permit requirement due to flow and loading conditions below the original design basis. However, in 1997 two monthly average BOD_5 values exceeded 30 mg/l and two other values equaled 30 mg/l as seen in Figure V-1. These exceedances were attributed partially to mechanical problems (trickling filter pumping), but are also a result of higher influent loadings compared to other historical data as seen in Figure V-2. Also in 1997, one monthly average TSS value exceeded 30 mg/l. However, this appears to be related to nearly no influent flow for several preceding days. During this same time period of 1997

Figure V-1 - Leavenworth, KS
Historical Effluent BOD_5 & TSS Concentrations
(Monthly Average Jan '97 to Jan '00)

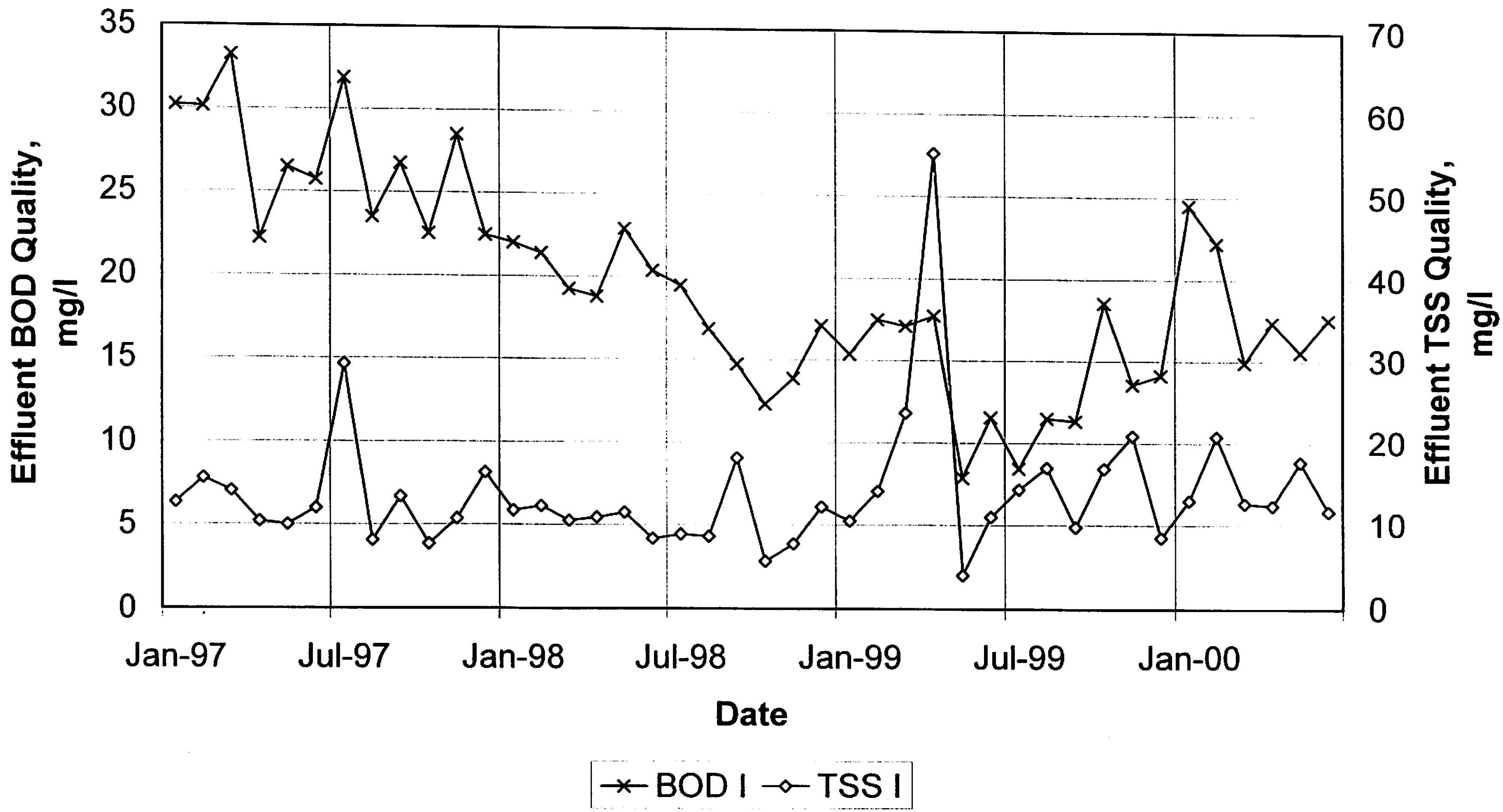
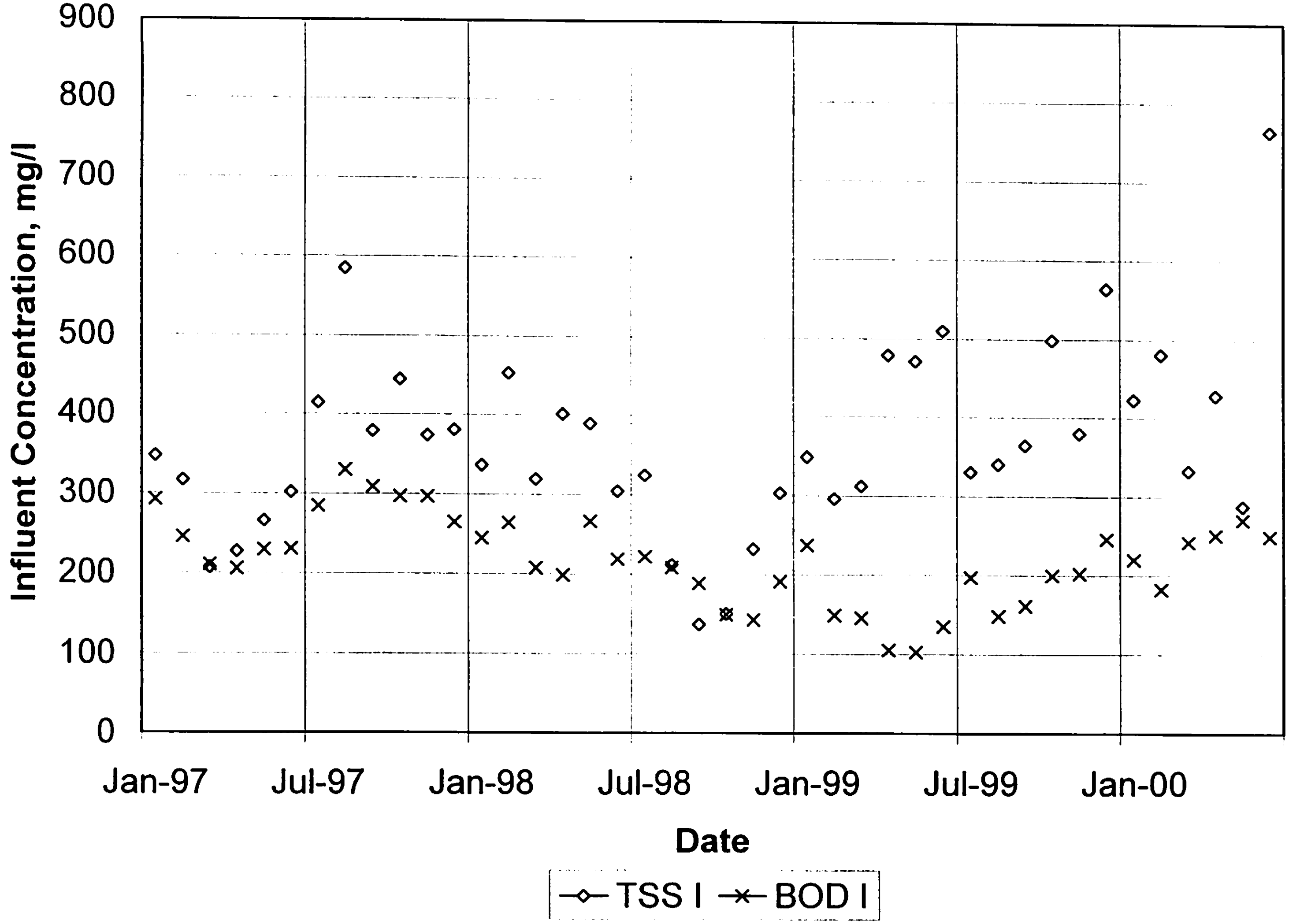


Figure V-2 Leavenworth, KS 1/97-6/00 Monthly Avg



- 2000, only one weekly average BOD_5 and two weekly average TSS values exceeded the allowable 45 mg/l.

The original design basis of 55,000 population equivalents and 6.88 mgd results in a per capita flow rate of 125 gallons per day (gpd). This is within the range of a typical design basis of 100 to 150 gpcd for domestic wastewater production and normal infiltration and inflow (I/I) if no historical information is available.

The original raw BOD_5 design basis was 0.313 pounds per capita per day (ppcd) at 55,000 population equivalents, resulting in 17,200 pounds per day (ppd). At the average design flow rate of 6.88 mgd, this is equivalent to 300 mg/l raw BOD_5. Likewise, the original raw TSS design basis was 0.37 ppcd, resulting in 20,000 ppd. At the average design flow rate, this is equivalent to 350 mg/l raw TSS. Both the per capita loading factors and the resultant concentrations would be considered relatively high. Although stated as design loads, it is assumed that these values represent maximum month conditions.

The Operation & Maintenance Manual indicates design primary clarifier removal efficiencies of 36 percent BOD_5 and 67 percent TSS. This means that the trickling filters were designed for 11,000 pounds per day of BOD_5 with a resulting unitary loading rate of approximately 100 ppd/1,000 ft^3 of media. According to Water Environment Federation's Manual of Practice 8 & 11, the filters are on the border between high rate and roughing filter classification. Additionally, the Manual confirms that additional treatment would be required for either classification of these filters to meet traditional "secondary treatment" levels of 30 mg/l BOD_5 and TSS.

B. Recent Data

The influent and effluent flow meter readings at the WWTP are questionable. This is due to non-ideal flow meter installation locations. As a part of this Wastewater Master Plan, temporary flow meters were installed in the collection system in an attempt to verify the accuracy of the plant meters.

Chapter II, Flow and Rainfall Analysis, developed an estimate of the influent wastewater based upon collection system and rainfall monitoring. The analysis determined that the influent flow meter was reading high due to depositions in the location of the ultrasonic meter. The annual average daily influent flow, adjusted for deposition, was estimated to be 4.5 mgd.

Of the two plant meters, the effluent flow meter is considered to be more accurate than the influent meter. Since effluent and influent flow should be nearly equivalent on a daily basis, the effluent flow meter readings are recorded for reporting purposes. The annual average daily flow rate of the effluent flow meter has been 3.2, 3.2, and 3.3 mgd in 1997, 1998, and 1999 respectively. The estimated flow in Chapter II is nearly 40 percent higher than the recorded averages.

At an estimated connected population equivalent of 40,000[1], the recorded effluent average results in a per capita flow rate of approximately 80 gpd. This is extremely low, especially compared to the original design basis of 125 gpcd. This is additional evidence that the plant flow meters are inaccurate on the low side. An inaccurate (and probably low) effluent flow meter reading indicates that the WWTP is experiencing higher flows and loads than recorded.

While the estimated flow in Chapter II results in an average per capita flow rate of 111 gpd, a more typical minimum per capita flow rate would be 100 gpd. Combining the likely minimum flow rate with the year 2000 connected population equivalents of 40,000, it is likely that the WWTP is experiencing at least 4.0 mgd on an annual average basis. This is approximately 25 percent higher than recorded by the effluent meter. An upper bound of 125 gpcd, as in the original design, the WWTP could be experiencing 5.0 mgd on an annual average basis. This is close to the adjusted flows estimated in Chapter II, and 60 percent higher than the effluent meter readings.

Without further field measurements, it is difficult to confirm how far off the effluent meter is from actual readings. It is proposed to use a 25 percent error in recorded flows for further investigation. This flow assumption is primarily to assess influent pollutant loadings. A conservative peaking factor will be applied when considering hydraulic loadings.

A 25 percent increase in flow and thus influent load was applied to the recorded data and compared to the original design basis for calibration. Influent BOD_5 loadings were estimated by multiplying the assumed flow by the recorded pollutant concentrations. A summary of this adjusted historical data is presented in Table V-1.

Table V-1
Adjusted Historical Data

	Influent BOD_5		Influent TSS	
Flow (mgd)	Concentration (mg/L)	Load (ppd)	Concentration (mg/L)	Load (ppd)
4.0 ADF	212 ADF	7,100	362 ADF	12,100
5.11 MM	272 MM	11,600	432 MM	18,400

[1] It should be noted that just prior to submitting the final copy of this study, the U.S. Census data for the City of Leavenworth became available and revealed that the actual population was 35,420. The actual population figures were determined to not appreciably change the findings of this study.

C. Projection of Flows and Loads

The current connected population equivalent of 40,000 was estimated to grow at 1.5 percent per year. Therefore 2020 design population equivalents agreed on by the City for this Wastewater Master Plan are 53,900. This is approaching the original design basis of 55,000 which was projected to occur in 1990.

The current connected population equivalent of 40,000 and the adjusted annual average daily flow of 4.0 mgd, results in a per capita flow rate of 100 gpcd. For the process analysis, the current per capita flow rate of 100 gpcd was used to determine the projected annual average flows and loads. Multiplying the 2020 design population equivalents by the current per capita flow rate, results in an annual average dry weather daily flow of 5.4 mgd.

The estimated 2020 average daily flow of 6.0 mgd as discussed in Chapter II is also below the original plant design capacity. Therefore, it is concluded that the WWTP is not expected to experience flows greater than 6.88 mgd on an annual average basis over the next 20 years. However, peak hour flows through the plant could approach 35 mgd. To accommodate this large flow without exceeding the recommended capacity of the primary clarifiers an additional primary basin should be constructed. Space exists for the installation of a fourth, future primary clarifier if needed. Rated capacity for the primary clarifiers is currently 12 mgd based on a surface overflow rate of 800 gpd/ft^2. If a fourth clarifier were constructed, the total hydraulic capacity would increase to 16 mgd on a maximum month basis. It is recommended that a fourth primary clarifier be constructed in order to accommodate the peak flows from the influent pumping station. Construction of a fourth primary clarifier will increase the peak flow capacity to 32 mgd. Peak flows between the estimated 35 mgd in year 2020 and the recommended peak flow capacity of 32 mgd in the primary clarifiers would be less common but would indicate the need for further expansion after the year 2020.

Improvements that are necessary because of age or deterioration are discussed in Chapter IV. Hydraulic capacities of the WWTP structures are entirely dependent on the amount of I/I that is removed from the collection system prior to entering the treatment process. This report assumes the hydraulic capacity of the WWTP facilities will be managed through I/I removal as recommended in Chapter III.

The adjusted historical influent TSS and BOD_5 loadings shown in Table V-1 and the 1.5 percent per year growth rate were used to estimate the projected annual average and maximum month TSS and BOD_5 loadings. A maximum month to annual average ratio (MM/AA) of 1.27 was used to determine the maximum month flow rate in the future. The MM/AA ratio was obtained by dividing 6.88 mgd, which is the original design basis of the plant, by 5.4 mgd, the projected annual average flow for the year

2020. Since the plant data indicates a MM/AA ratio of 1.22, the 1.27 ratio was considered appropriate for the process evaluation and is in close agreement with the flow peaking factors described in the flow and rainfall analysis discussed in Chapter III. Table V-2 summarizes the current and projected flows and waste loads and compares the results with the original design basis.

Table V-2
Basis of Evaluation

Year	Original Design	Existing Conditions (2000)	Future Conditions (2020)
Flow, average day (mgd)	6.88	4.0	5.4
Max month (mgd)	--	5.11	6.88
Peak day (mgd)	13.76	8.91	10.8
Peak hour (mgd)	--	33.7[1]	35[2]
BOD_5, average (ppd)	--	7,072	9,525
(mg/L)	--	212	212
BOD_5, max month (ppd)	17,200	11,576	15,591
(mg/L)	300	272	272
TSS, average (ppd)	--	12,076	16,265
(mg/L)	--	362	362
TSS, max month (ppd)	20,000	18,415	24,802
(mg/L)	350	432	432
Monthly Avg. Effluent BOD_5/TSS	42/-	30/30	30/30

Notes: 1. Based on current peak hour flows as discussed in Chapter II and VI without any I/I removal.
2. Based on future peak hour flows as discussed in Chapter VI and assumes 30% I/I removal from subsystem SUB01. Without 30% I/I removal, peak hour flows approach 43 mgd.

Table V-2 shows that the projected BOD_5 loading for 2020 is just under the original design basis, while the projected TSS loading is just over the original design basis.

D. Existing Treatment Capacity

A process model for the trickling filter was developed and calibrated using the historical plant data from January 1997 through June 2000. The results from this model were used to determine the existing biological treatment capacity of the plant to meet the 30 mg/L effluent BOD_5 limit.

Figure V-3 indicates the performance of the existing trickling filters by plotting monthly average BOD_5 effluent values against the calculated trickling filter influent

BOD_5 loading rates. The influent BOD_5 loading was determined by assuming a 30 percent removal rate in the primary clarifiers. Thirty percent BOD_5 removal is typical of primary treatment and is acknowledged by the KDHE minimum standards. A unitary loading rate was calculated by dividing the BOD_5 load by the volume of trickling filter media in operation. The unitary BOD_5 loading was used to normalize the performance of the WWTP during one trickling filter operation during four months of 1997. As can be seen, the four months of one filter operation result in higher unit loadings and understandably result in higher effluent BOD_5 reading. The remaining loading rates have been less than or equal to 65 ppd/1,000 ft^3.

The trickling filter model was calibrated to simulate the biological performance of the plant during maximum month conditions; therefore, a temperature of 15°C and a hydraulic recirculation rate of 1 gpm/sf were selected for the model. The model results are presented in Figure V-3. The model line coincides with the upper boundary plant data, indicating the accuracy of the model to represent the existing performance of the trickling filters during maximum month conditions. The data at higher loadings appears to show better performance than projected by the model; however, this was for short-term operation only (four months) and does not represent long-term performance. Therefore, for design purposes, the model line, rather than a trendline of the plant data, should be used.

According to the model line, the Leavenworth WWTP could exceed the permit limit of 30 mg/L when the trickling filter influent BOD_5 unitary loading is 55 ppd/1000 ft^3. This corresponds to a trickling filter unit process capacity of 3.7 mgd of plant flow. Plant BOD_5 loadings are currently at and beyond this loading. Failure of the trickling filters is imminent and will result when high loads and low temperatures occur in combination. Repeated violations may result in state action or consent orders. It is therefore in the best interest of the City to build additional treatment capacity as soon as possible.

The remaining WWTP processes were also evaluated for their capacity to determine other limiting factors in the ability of the plant to make permit. The results of this evaluation are presented in Table V-3.

Figure V-3
Trickling Filter Performance (Monthly Avg) and Model Results

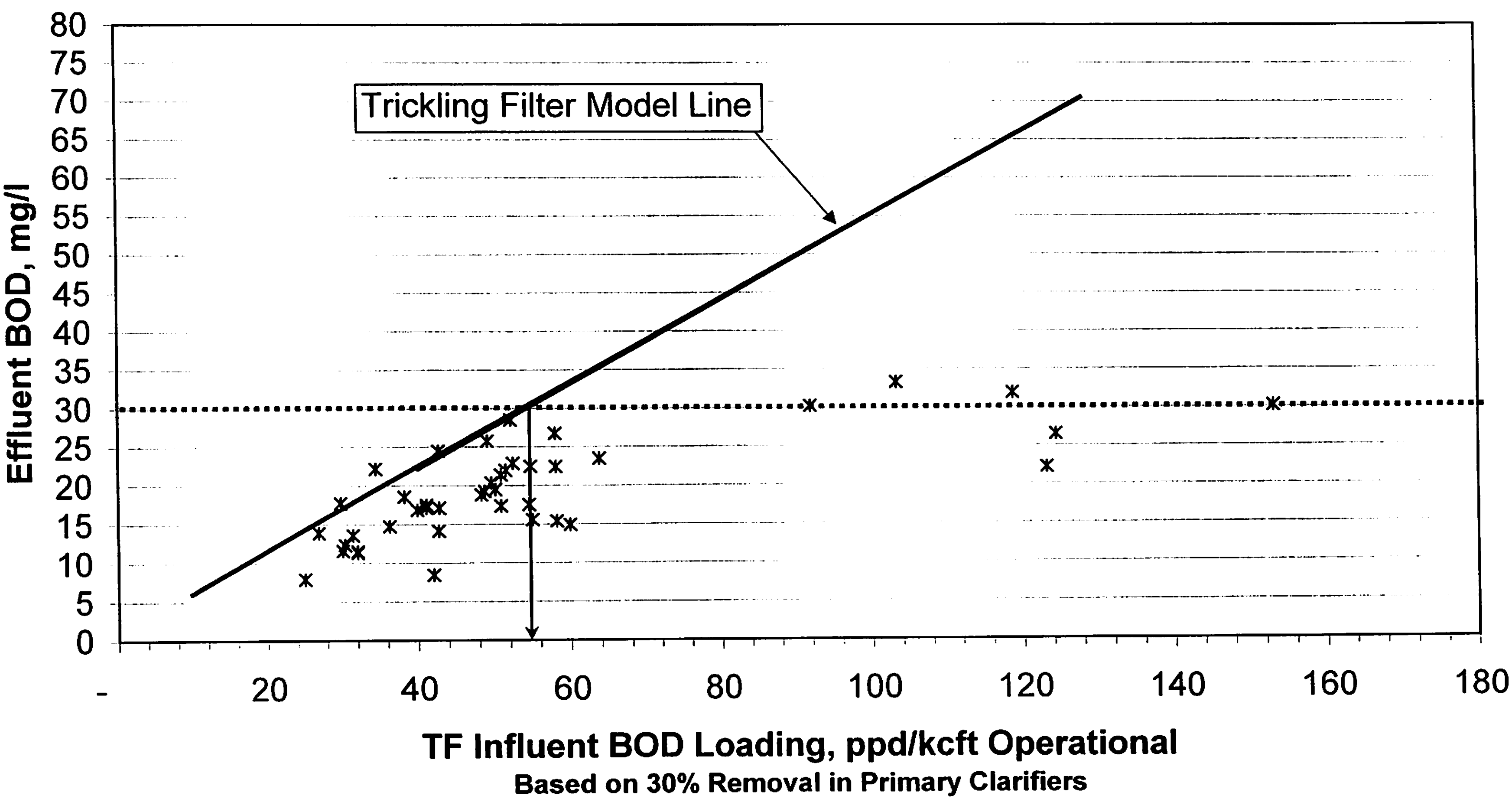


Table V-3
Leavenworth WWTP
Capacity Analysis Summary

Process	Description	Rating Criteria	Operating Condition at Rated Capacity[a]	Summary Process Capacity[b]
Liquid Treatment				
Influent Screening	Two 3 ft. wide bar screens 5/8-inch spacing.	**Design capacity**[5]	Design capacity at maximum influent raw sewage pumping capacity. 26.5 mgd total	**26.5 mgd**
Influent raw sewage pumping Wetwell No. 1 Wetwell No. 2 Total	Three constant speed pumps @ 5.0 mgd One constant speed pump @ 5.3 mgd One variable speed pump @ 10.8 mgd Four pumps in service	**Firm capacity at peak flow** **Limited to six starts per hour** [1] Limited to twelve starts per hour [2]	10.0 mgd firm 5.3 mgd firm 10.8 mgd firm 26.5 mgd firm. 31.9 mgd total	**26.5 mgd firm** 31.9 mgd total
Aerated Grit Removal Grit basins Blowers	Two basins 78 ft. x 20 ft. x 12 ft. SWD Three blowers 600 cfm each 60 Hp. 3,600 rpm	**Minimum detention time 3 minutes** [2] Minimum air supply 3 cfm/ft basin length [2]	63 mgd firm @ 3 minutes detention time per basin. 126 mgd total	**63 mgd firm.** 126 mgd total
Grit removal equipment	Grit removal equipment 1&2	2-10 cf/mg [4]	Adequate at peak flow	53 cfd minimum at peak flow [c]
Primary clarification	Two clarifiers 80 ft. diameter., 6.5 ft. SWD One clarifier 80 ft. diameter., 10 ft. SWD	**Surface overflow rate** **MM<800 gpd/ft² [1]** **Peak<1600 gpd/ft² [1]** AA<1000 gpd/ft² [2] Minimum detention time of 2 hours. [2] Avg.<1000 gpd/ft² [3] Peak<1500-3000 pd/ft² [3]	12.0 mgd MM total 24 mgd Peak	**12.0 mgd total** [d] 24 mgd Peak
Settled sewage pumps (to trickling filters)	Four constant speed pumps @ 7,000 gpm	**Firm capacity at peak flow**	**10 mgd firm each cell**, 20 mgd total each cell.	20 mgd
Non-potable water pumps	Two constant speed pumps @ 250 gpm	None	Adequate capacity	**250 gpm firm**, 500 gom total
Trickling filters	Two 56 ft. diameter x 21.5 ft. depth	Hydraulic capacity 4,200 gal/day/ft² maximum. [4] BOD_5 removal capacity >100 lbs BOD_5/1000 ft³ [4] **BOD_5 removal capacity 55 lbs BOD_5/1000 ft³ at MM loads, 15°C**[1]	10 mgd when trickling filters operated in series. 20 mgd when trickling filters operated in parallel **3.7 mgd total**	3.7 mgd total at MM conditions

Final clarifiers	Two clarifiers 90 ft. diameter, 10 ft. SWD	**MM SOR<700 gpd/ft^2 [1]** MM SLR<33 ppd/ft^2 [1] Avg. SOR<800 gpd/ft^2 [2] Peak SOR<1000 gpd/ft^2 [3]	**4.5 mgd firm**, 8.9 mgd total [f]	8.9 mgd
Chlorine contact basin	One basin 64 ft x 46 ft. x 10 ft. depth.	**Thirty minute detention at average daily flow. Fifteen minutes detention at peak hour flow.** [2]	**10.6 mgd firm** for 30 minutes detention time	10.6 mgd [e]
Solids Processing				
Primary sludge pumps	Three constant speed pumps @ 100 gpm.	None	Adequate capacity	**200 gpm firm**, 300 gpm total
Primary scum pumps	Two variable speed pumps @ 50 gpm.	None	Adequate capacity	**50 gpm firm**, 100 gpm total
Sludge storage tanks	Two tanks	None	284,000 gallons firm capacity each tank. Provides 22 days firm storage. **Practical limit of 3-4 days storage. Capacity adequate.**	568,000 gallons
Sludge Feed Pumps	Two variable speed pumps @ 150 gpm.	None	Adequate capacity	**150 gpm firm**, 300 gpm total
Belt Filter Press	One 2-meter wide belt press.	**75 gpm/meter belt width** [1]	150 gpm firm @ three 8 hour shifts/week at 4 mgd, could handle up to 6.6 mgd with five 8 hour shifts.	**150 gpm firm**

Rating Criteria

(1) Black & Veatch recommendations

(2) KDHE Minimum Standards of Design for Water Pollution Control Facilities

(3) Ten States Standards

(4) Manual of Practice 8, WEF

(5) Equipment specification

Notes

(a) Value shown in bold type controls unit process capacity.

(b) Unit process capacity as an equivalent plant flow based on historical raw wastewater characteristics, peak or maximum month as noted.

(c) Plant currently does not achieve this level of grit removal.

(d) Based on maximum 800 gpd/sf criteria.

(e) Not currently required by NPDES permit or KDHE for discharge into Missouri River.

(f) Based on maximum 700 gpd/sf criteria.

The most limited process at the WWTP is the trickling filters, with a cold weather maximum month capacity of 3.7 mgd. Immediate expansion is recommended to ensure the ability to meet permit requirements. The next limiting unit process is the final clarifiers at a maximum month plant flow of 8.9 mgd. However, this flow rate is still greater than the maximum month flow conditions. No expansion to the final clarifiers should be necessary throughout the study period. All other unit processes have acceptable capacity.

Wastewater treatment processes may be limited by the monthly average flows or the peak hour flows. Flows in excess of 20 mgd are bypassed after primary clarification. Thus, processes from the headworks through primary clarification must be able to handle peak hour flows up to the pumping capacity of the influent pump station, which is proposed for expansion to 35 mgd. The primary clarifiers are currently limited to a peak hour flow of 24 mgd as described in Chapter IV. Therefore, construction of a fourth clarifier is recommended to meet current and future peak hour flows.

E. WWTP Process Expansion Alternatives

There are many potential options to increase the treatment capacity of the WWTP. Five options were identified for increasing the treatment capacity at Leavenworth's WWTP to meet compliance with the permit limits at current and future design conditions.

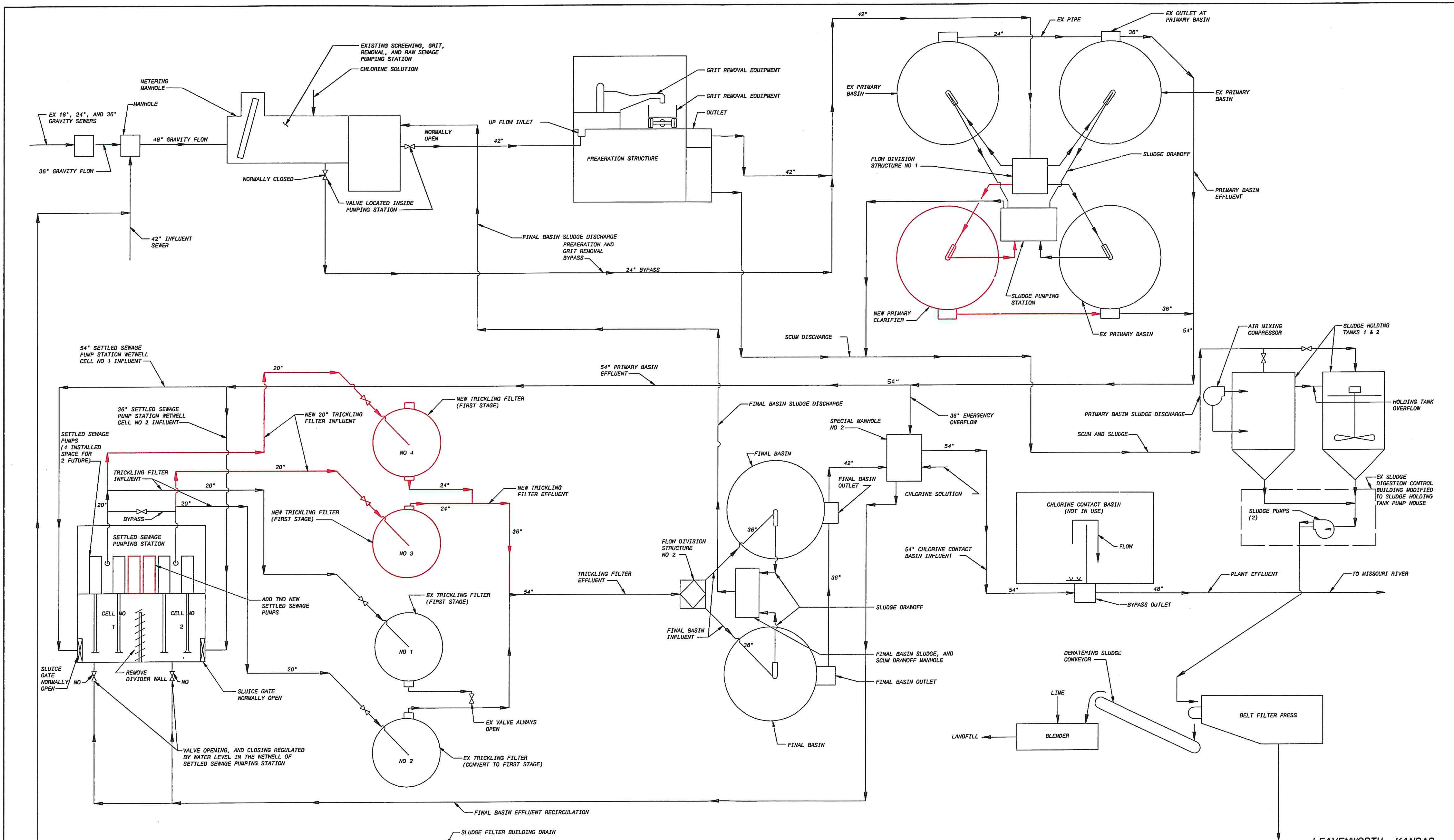
- Add two additional trickling filters.
- Add Chemically Enhanced Primary Treatment (CEPT) capability and one trickling filter.
- Add effluent filters after final clarification.
- Add CEPT capability and intermediate clarification to allow true two-stage operation.
- Convert to a Trickling Filter/Solids Contact (TF/SC) treatment system.

Some of the options may be stand alone solutions, while others may be cost effective to implement now, but possibly require the addition of one of the other options at a later date. All options would include a fourth primary clarifier to meet projected peak hour flows. A discussion of each option follows:

<u>Alternative 1 - Add Two Additional Trickling Filters</u>

Space was allocated for two additional trickling filters and two additional final clarifiers for future increases in flow and load. Constructing two additional trickling filters would provide sufficient treatment through 2020. Adding two trickling filters would adequately treat the wastewater effluent down to a BOD_5 of 25 mg/l and a TSS concentration of 30 mg/l. Trickling filter models that have been calibrated to existing trickling filter performance data have indicated little additional benefit to continue to operate the trickling filters in series. Therefore, under this alternative, all four trickling filters would be operated in parallel under all conditions. A schematic of this alternative is shown in Figure V-4. Required modifications to the existing facilities include:

a. Installation of two new settled sewage pumps in the settled sewage pump station.



NOTE:

NOT ALL PIPING AND VALVES ARE SHOWN IN THIS SCHEMATIC.

PROCESS SCHEMATIC
ALTERNATIVE 1
TWO TRICKLING FILTERS
ONE PRIMARY CLARIFIER

BLACK & VEATCH Corporation
Kansas City, Missouri

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

LEAVENWORTH

FIGURE V-4

37372-120-324-C-H00000UJ0 6-4-01

b. Modifications to the existing settled sewage pump controls for true parallel operation.

c. Construction of two 56 foot diameter by 21 foot side water depth trickling filters with plastic filter media and non-motorized rotating distributors.

d. Additional piping from the settled sewage pumping station to the new trickling filters.

Recommended locations for these new facilities are shown on Figure V-5.

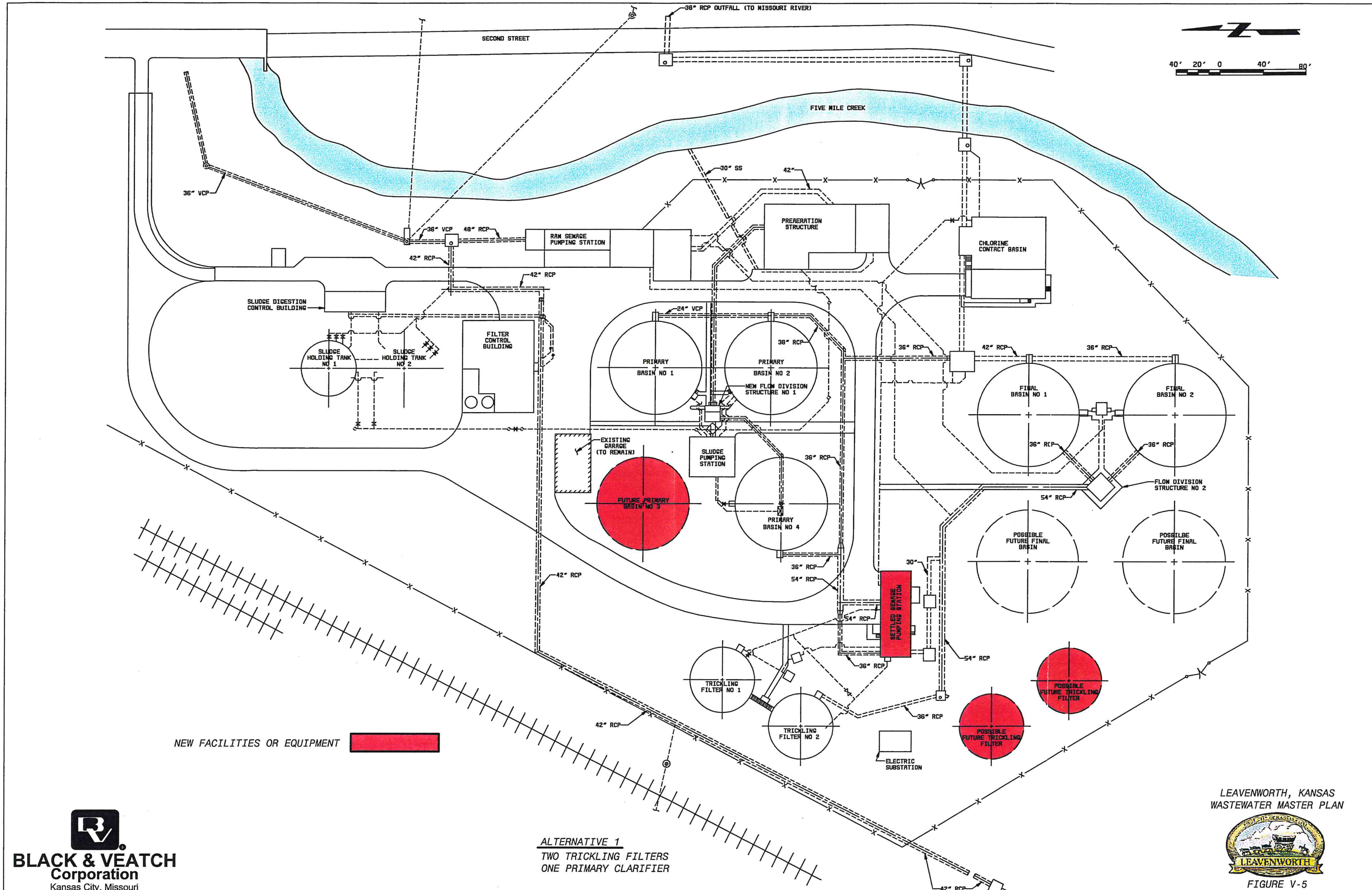
Flow from all four filters would be settled in the two existing final clarifiers. Since there is no increase in the original design flow, additional final clarifiers would not be necessary at this time.

The estimated present worth cost for the construction, operation, and maintenance of Alternative 1 is $3,800,000. A breakdown of the costs associated with this alternative is contained in Appendix N.

Alternative 2 - Add Chemically Enhanced Primary Treatment (CEPT) Capability and One Trickling Filter

Chemically enhanced primary treatment (CEPT) is usually used as a temporary measure to improve treatment. Flocculants, such as ferric chloride (ferric) or aluminum sulfate (alum), are added to the raw wastewater prior to the primary clarifiers to increase the amount of BOD_5 and TSS removed by settling. This reduces the load on the downstream trickling filters and thus improves the effluent quality from the trickling filter process. This is typically employed as a temporary measure due to high annual costs. However, the economics of chemical enhancement should be evaluated in more detail if a delay in capital expenditures is desired. Chemically Enhanced Primary Treatment by itself is not sufficient to meet the permit requirements. However, when used in conjunction with other alternatives, it can help meet short to medium term effluent quality goals. One possibility for adding CEPT capability is to install the CEPT system and to construct only one trickling filter. A schematic of this alternative is shown in Figure V-6.

Construction of one trickling filter in conjunction with the addition of CEPT capability would allow for adequate treatment to 30 mg/l BOD_5 and 20 mg/l TSS through the year 2015. After 2015 additional treatment capacity may be required and the second trickling filter would be added. However, this alternative may represent a cost advantage to the City if growth or load increases at a slower rate than predicted.

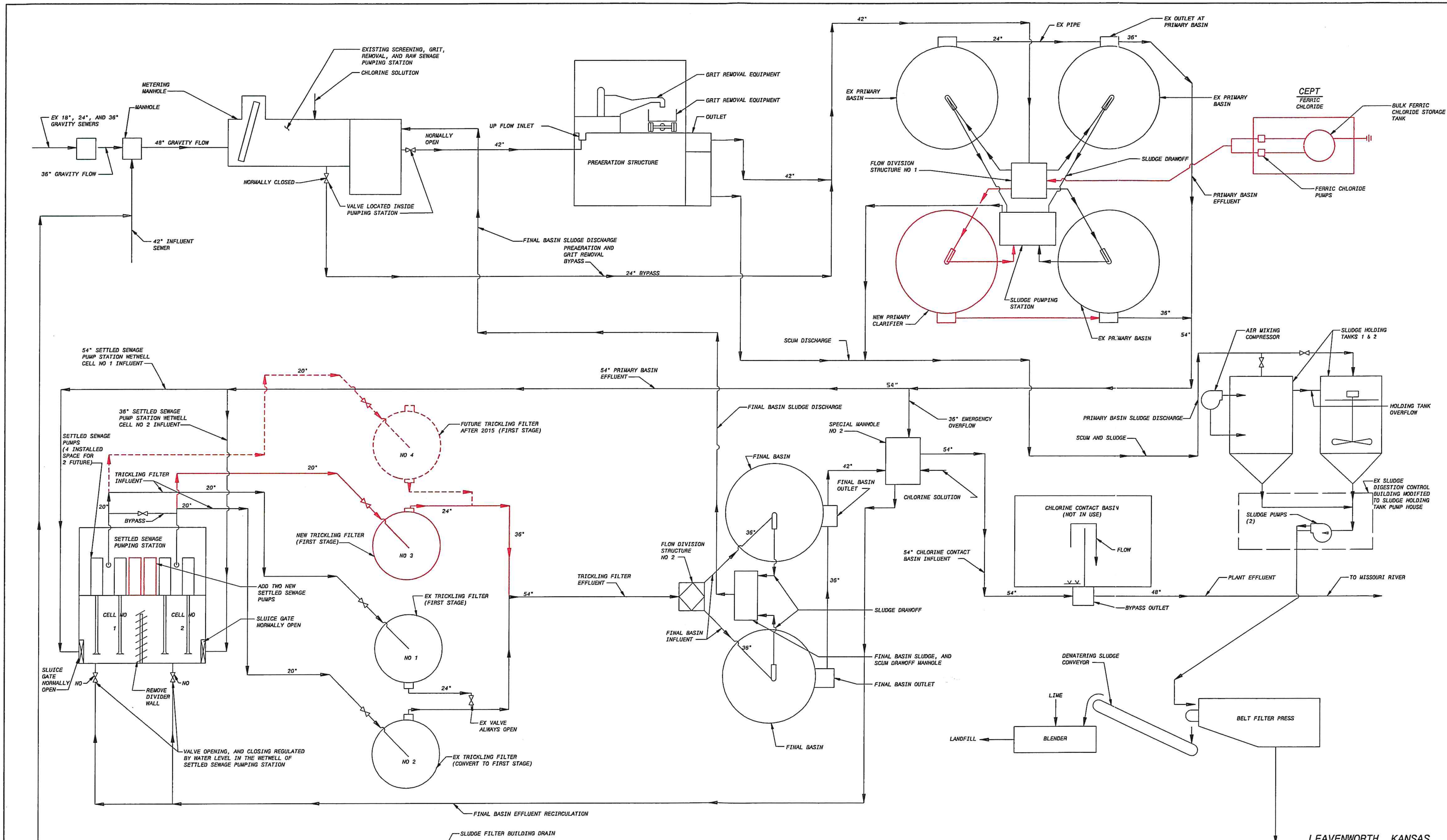


BLACK & VEATCH Corporation
Kansas City, Missouri

ALTERNATIVE 1
TWO TRICKLING FILTERS
ONE PRIMARY CLARIFIER

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

FIGURE V-5



PROCESS SCHEMATIC

ALTERNATIVE 2

1 TRICKLING FILTER
1 TRICKLING FILTER (AFTER 2015)
CEPT
ONE PRIMARY CLARIFIER

NOTE:

NOT ALL PIPING AND VALVES ARE SHOWN IN THIS SCHEMATIC.

BLACK & VEATCH Corporation
Kansas City, Missouri

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

FIGURE V-6

37372-120-324-C-H00000UJ1 6-4-01

Iron salts such as ferric chloride require some reaction time in order to be fully effective in removal of BOD_5 and TSS by coagulation and settling in the primary clarifiers. Therefore, it is recommended that ferric chloride be introduced into the wastewater in the primary clarifier flow splitter to allow enough reaction time to realize the full advantage of the CEPT. Required modifications to the existing facilities include:

a. Installation of one trickling filter as described above.

b. Installation of a ferric chloride feed system including:

   (1) Two 1/2-horsepower ferric chloride pumps capable of dosing 303 gpd under maximum month conditions and 237 gpd under annual average conditions with a motor capable of a 5:1 turn-down. One pump would be installed as a duty pump and the other would be for standby service.

   (2) A 7,200 gallon heated, outdoor bulk storage tank for storing a 30 day supply of ferric chloride.

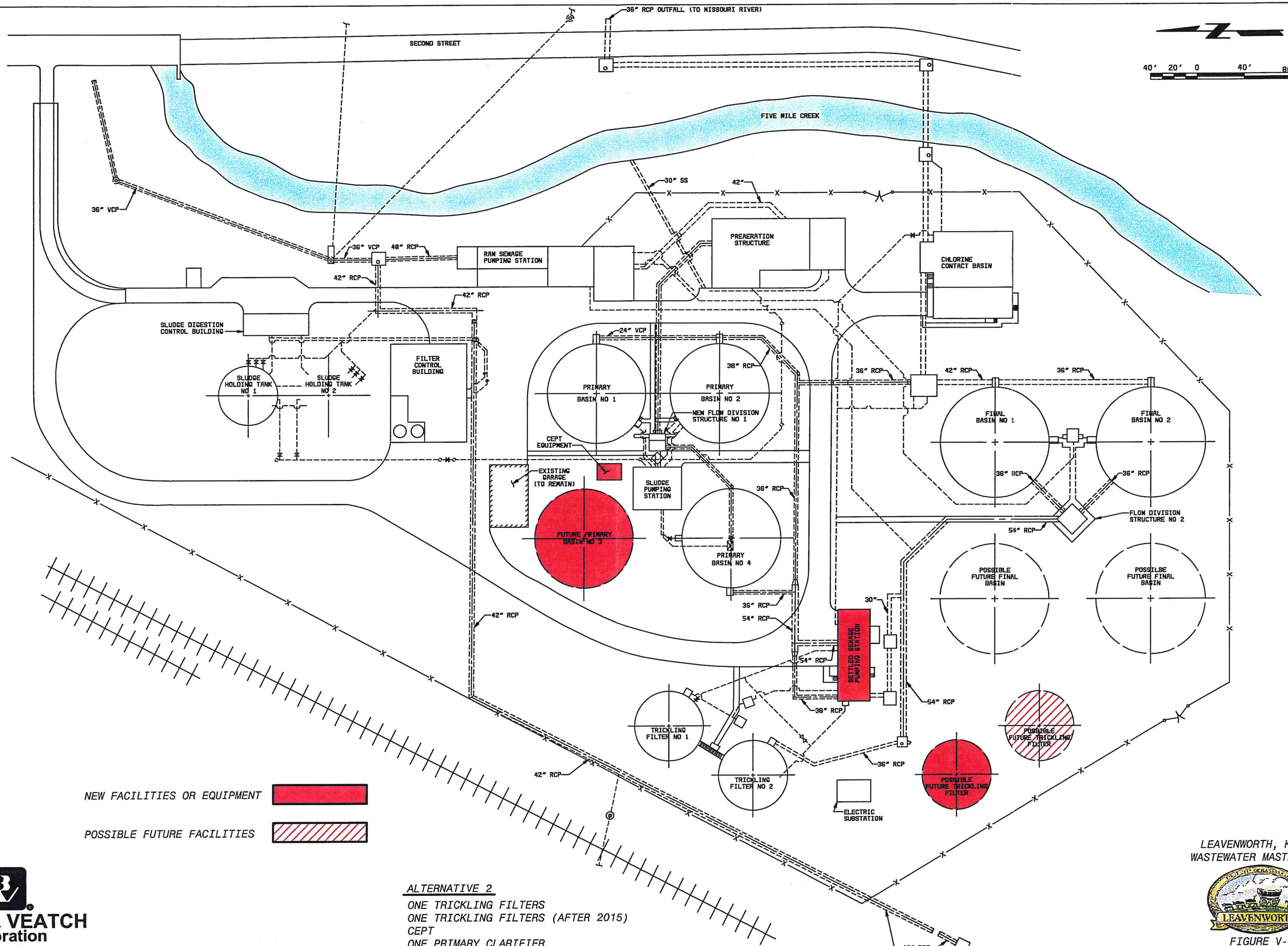
   (3) Associated electrical and remote control and monitoring equipment.

   (4) Installation of additional piping and a chemical diffuser near and in the primary clarifier flow splitter structure.

c. Installation of one additional trickling filter in year 2015 if growth and load warrants.

Recommended locations for these new facilities are indicated on Figure V-7.

CEPT may be used on a short-term basis when effluent violations become more common. Modifications to the City's existing ferrous chloride odor control feed system may be possible by installing larger capacity pumps and piping. The existing ferrous chloride storage tank could be emptied and reused to store ferric chloride. Reusing this existing 6,000 gallon tank would reduce the bulk storage capacity from a 30 day supply to a 20-25 day supply. In addition, odors associated with sulfide gas at the headworks would once again become a problem. If the ferric chloride were added at the headworks instead of at the primary clarifier flow splitter, coagulation and higher solids deposition could be expected to occur in the pump station wet well or in the preaeration basin. This



BLACK & VEATCH Corporation
Kansas City, Missouri

ALTERNATIVE 2
ONE TRICKLING FILTERS
ONE TRICKLING FILTERS (AFTER 2015)
CEPT
ONE PRIMARY CLARIFIER

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

FIGURE V-7

could result in increased maintenance of these structures due to the need for periodic cleaning. Due to the high amount of turbulence in these two structures, settling performance in the primary clarifiers could also be expected to be poorer and the full benefit of CEPT would not be seen.

The estimated present worth cost for the construction, operation, and maintenance of Alternative 2 is $3,500,000. A breakdown of the costs associated with this alternative is contained in Appendix N.

Alternative 3 - Add Effluent Filters After Final Clarification

Trickling filters inherently produce a higher effluent TSS concentration than activated sludge due to the type of biological solids. Therefore, in order to remove these solids, which result in higher effluent TSS and BOD_5, effluent filters could be added. There are several types of effluent filters possible, traveling bridge, deep bed, moving bed, and disk, among others. Effluent filtration should occur as one of the last treatment processes prior to discharge to the receiving stream. The existing chlorine contact basin provides enough footprint area for most filter types. Therefore, it would be possible to modify the basin to serve as the effluent filter area. The contact basin is also located in the correct process order for conversion to effluent filtration. If effluent disinfection were required in the future, it is possible that ultraviolet (UV) light would be selected, and it could be placed in the remaining portion of the chlorine contact basin or in a much smaller basin downstream of the existing chlorine contact basin. UV light disinfection is usually more difficult to achieve on trickling filter effluent, but filtration would help.

However, effluent filtration by itself is not sufficient to meet the permit requirements. When used in conjunction with other alternatives, it can help meet short to medium term effluent quality goals. A schematic of this alternative using disk filters is shown in Figure V-8.

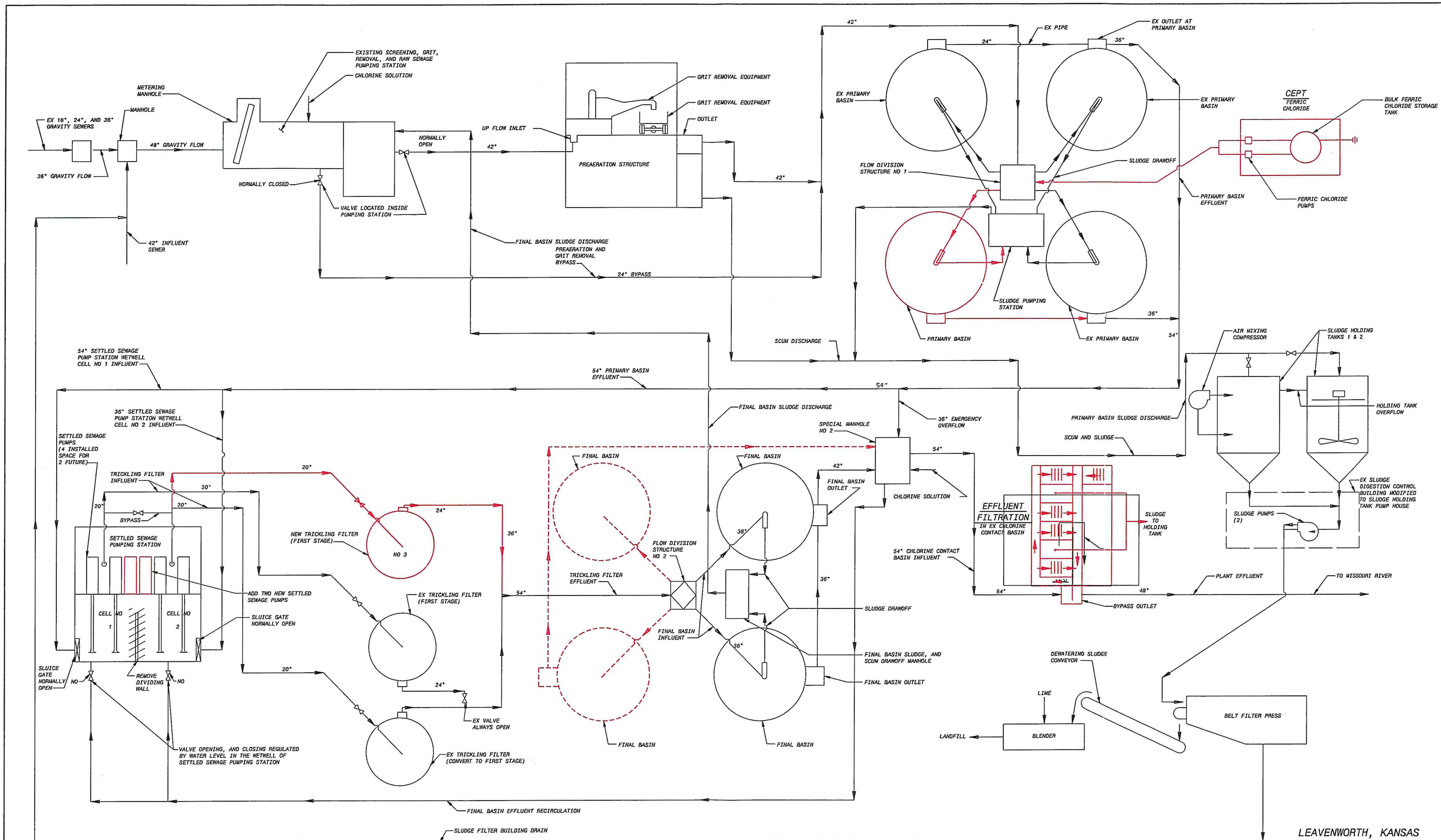
Effluent quality can be treated down to 25 mg/l BOD_5 and 2 mg/l TSS through the 2020 design year by using a combination of trickling filters, CEPT, and by filtering the effluent. Required modifications to the existing facilities include:

a. Modifications for adding one trickling filter as described in Alternative 1.

b. Modifications for adding CEPT.

c. Adding effluent filtration as described above.

Recommended locations for these new facilities are indicated on Figure V-9.



PROCESS SCHEMATIC

ALTERNATIVE 3

1 TRICKLING FILTER
CEPT
EFFLUENT FILTRATION
ONE PRIMARY CLARIFIER

NOTE:

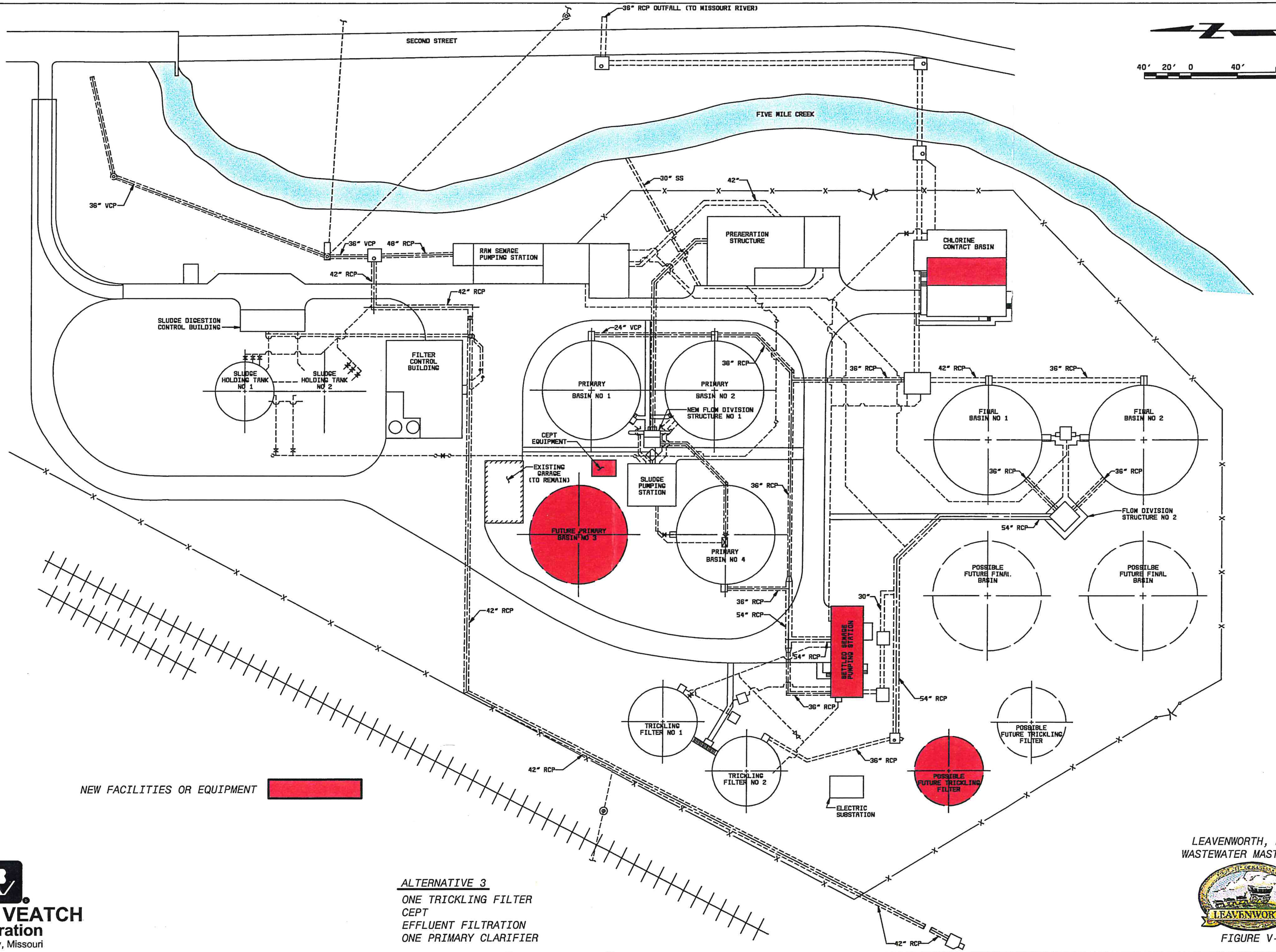
NOT ALL PIPING AND VALVES ARE SHOWN IN THIS SCHEMATIC.

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

FIGURE V-8

BLACK & VEATCH Corporation
Kansas City, Missouri

37372-120-324-C-H00000UJ4 6-4-01



NEW FACILITIES OR EQUIPMENT

BLACK & VEATCH
Corporation
Kansas City, Missouri

ALTERNATIVE 3
ONE TRICKLING FILTER
CEPT
EFFLUENT FILTRATION
ONE PRIMARY CLARIFIER

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

LEAVENWORTH

FIGURE V-9

The estimated present worth cost for the construction of Alternative 3 is \$5,700,000. A breakdown of the costs associated with this alternative is contained in Appendix N.

Alternative 4 - Add CEPT Capability and Intermediate Clarification to Allow True Two-Stage Operation

The existing trickling filters are operated in series by first pumping to filter number 1 and then to filter number 2. To enhance performance, an intermediate clarification step could be added between the existing two trickling filters. Intermediate clarification would reduce the load onto the existing second filter and thus improve effluent quality. The intermediate clarifier(s) could be added where the two final units were planned. The new clarifier(s) should also be placed at the hydraulic elevation of the existing two final units, such that it could serve as either an intermediate or final clarifier with piping additions. CEPT capability would also be necessary to meet the required effluent limits. A schematic of this alternative is shown in Figure V-10.

Effluent quality can be treated down to 30 mg/l BOD_5 and 6 mg/l TSS through the 2020 year design period by using a combination of CEPT and the construction of two intermediate clarifiers. Required modifications to the existing facilities include:

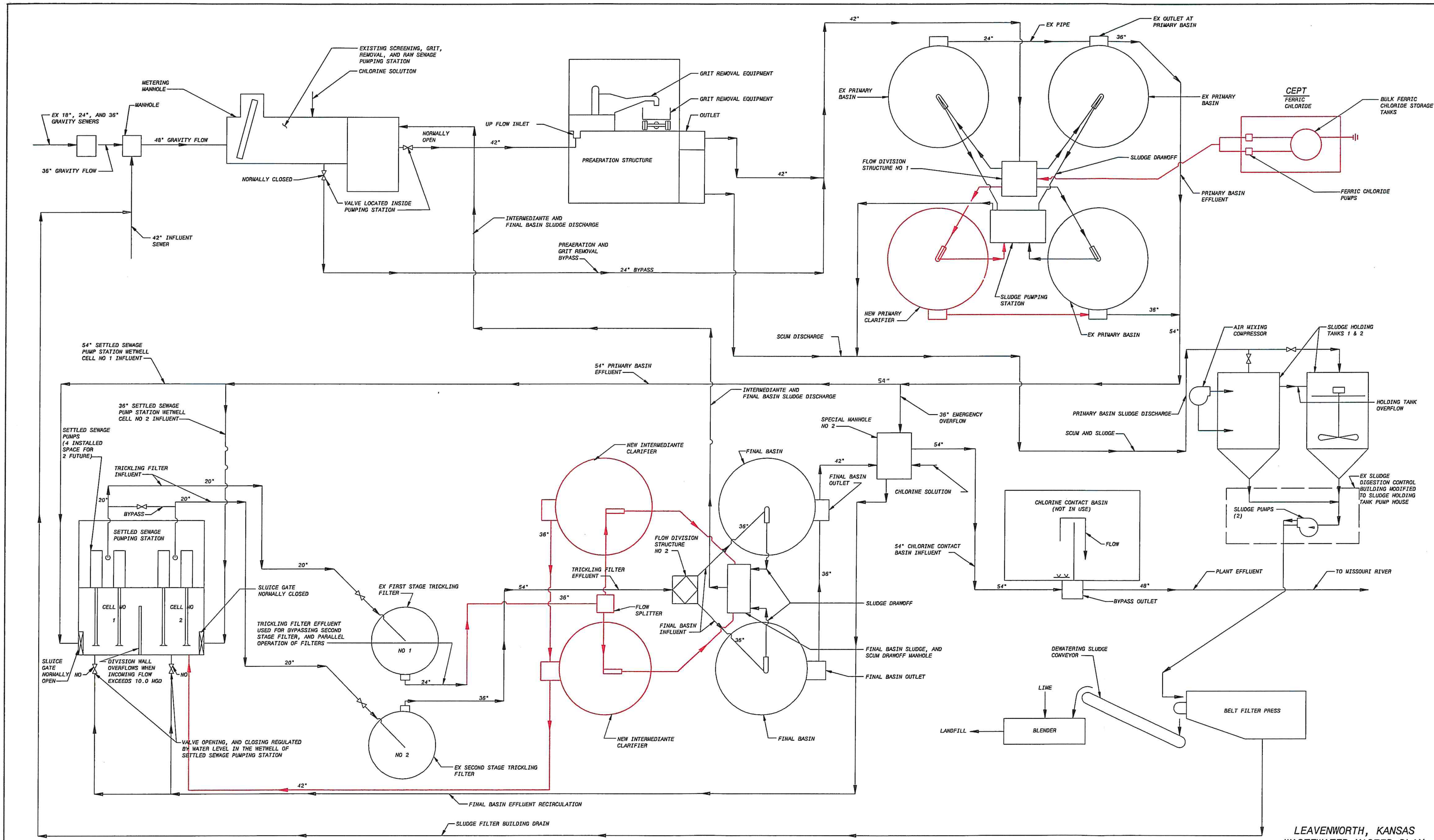
a. Modifications for adding CEPT.

b. Installation of two 80 foot diameter by 12 foot side water depth intermediate clarifiers. These two clarifiers would be constructed in the location reserved for two future final clarifiers. There appears to be enough available head in order to allow intermediate clarifier effluent to drain by gravity back to the settled sewage pump station.

c. Installation of an intermediate clarifier flow splitter structure to divide the flow equally between the two basins.

d. Modifications to plant piping from the trickling filters to the new intermediate clarifiers and from the new intermediate clarifiers to the settled sewage pumping station.

Recommended locations for these new facilities are indicated on Figure V-11.



PROCESS SCHEMATIC

ALTERNATIVE 4

CEPT
INTERMEDIATE CLARIFICATION
ONE PRIMARY CLARIFIER

NOTE:

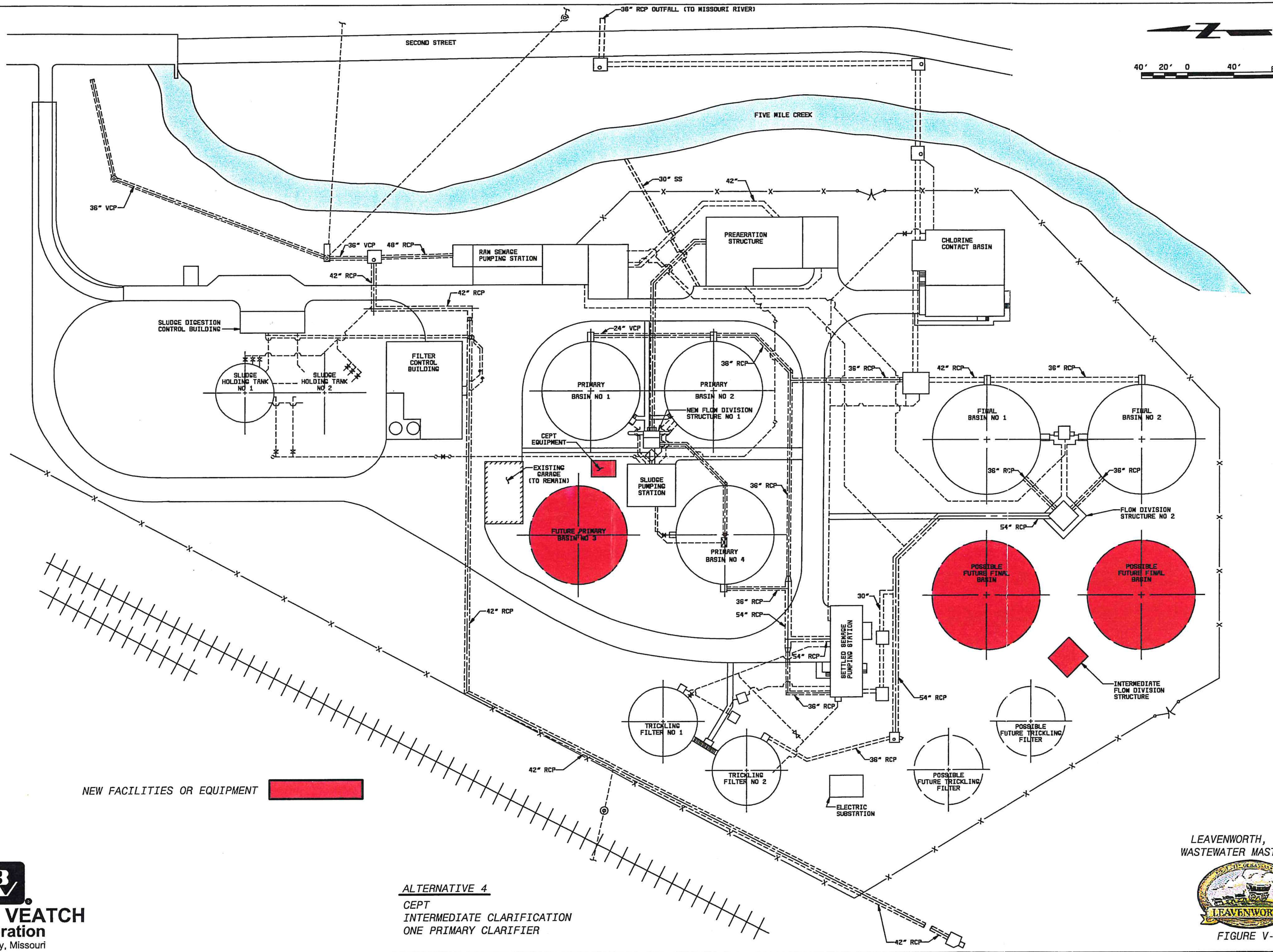
NOT ALL PIPING AND VALVES ARE SHOWN IN THIS SCHEMATIC.

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

FIGURE V-10

BLACK & VEATCH Corporation
Kansas City, Missouri

37372-120-324-C-H00000UJS 6-4-01



ALTERNATIVE 4

CEPT
INTERMEDIATE CLARIFICATION
ONE PRIMARY CLARIFIER

BLACK & VEATCH Corporation
Kansas City, Missouri

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

LEAVENWORTH

FIGURE V-11

The estimated present worth cost for the construction of Alternative 4 is $5,550,000. A breakdown of the costs associated with this alternative is contained in Appendix N.

Alternative 5 - Convert to Trickling Filter/Solids Contact

As discussed above, trickling filters typically produce slightly higher effluent TSS concentration than activated sludge due to the type of biological solids. In order to compensate for this fact, trickling filters have been followed by a small activated sludge basin prior to clarification. The trickling filter solids are incorporated into the activated sludge floc for better settleability. This flow scheme has been termed trickling filter/solids contact (TF/SC). This option would require the addition of an activated sludge basin, new final clarifiers and modification to the solids handling operation which would be better equipped to handle the waste activated sludge. Due to the high capital and operating costs required, and the increased operational complexity, the TF/SC concept is likely not a candidate for future consideration.

F. Economic Evaluation of Alternatives

The process expansion alternatives were compared on an economic basis. Capital and O&M costs were included for the process expansion alternatives. Detailed economic evaluations are included in Appendix N.

A summary of all combinations and alternatives is provided in Table V-4. The results of the cost evaluation are also shown. This table shows the different components of the total present worth. Alternatives 1 and 2 are very close on a present worth basis. Present worth cost differences of 10 percent or less are usually considered insignificant at the level of confidence of cost estimates at the conceptual design. Alternative 2 is the lowest present worth cost alternative, however it has slightly higher O&M costs due to the cost of hauling larger volumes of sludge. Alternatives 3 and 4 are also very close to each other on a present worth basis, but represent a second tier of higher cost process alternatives.

G. Non-Economic Evaluation

A non-economic analysis of the process expansion alternatives was performed in conjunction with City staff. The relative benefits or disadvantages of each alternative are presented in this section. The factors considered were:

- Effluent Quality

- Reliability
- Redundancy
- Lab/Operations/Maintenance Labor
- Quantity of Solids Production
- Flexibility

1. **Effluent Quality**. All five alternatives considered would meet the required NPDES permit limit of 30 mg/l BOD_5 and TSS. Each process provided a different effluent quality, and some were able to provide treatment to extremely low discharge concentrations as indicated in Table V-5. It was agreed that, when compared to other alternatives that also met the permit requirements, there was no real benefit to the additional treatment provided by these alternatives. Therefore, the process given the highest rating was Alternative 5.
2. **Reliability**. The reliability of an alternative is assessed by the ability of the process to continuously meet the level of treatment stipulated by the NPDES permit. Both Alternatives 1 and 5 were rated the most reliable and have long records of reliable performance. Alternative 2 was rated the lowest due to the chance of delayed chemical shipments for CEPT treatment and the construction of only one of the trickling filters in the near future.
3. **Redundancy**. The redundancy of an alternative is determined by the number of unit processes in service and the ability to meet the required effluent quality if one of those processes is out of service. Alternative 1 was rated the highest due to the ability of the plant to continue treating effluent if one trickling filter was inoperable. Alternative 4 was rated the lowest because if one of the processes were out of service, the effluent quality would not meet the permit.
4. **Lab/Operations/Maintenance Labor**. The amount of labor required for each alternative is determined by the relative complexity of each process, the familiarity of the processes by operations staff, and the amount of new mechanical equipment required. Alternatives 1 and 2 were ranked the highest due to the relatively simple function of trickling filters and the familiarity of the process by staff. Alternative 5 was ranked the lowest due to the higher complexity and the use of more mechanical equipment.

Table V-4
Summary of Process Alternatives

Alternative	1-Add Two Additional Trickling Filters	2 –Add CEPT and One Trickling Filter	3 – Add Effluent Filters	4 – Add CEPT and Intermediate Clarifiers	5 – Convert to Trickling Filter/Solids Contact
Add Two Additional Tricking Filters	●				
Add One Additional Tricking Filter		●[1]	●		
CEPT		●	●	●	
Effluent Filtration			●		
Intermediate Clarification				●	
Trickling Filter/Solids Contact					●
BOD_5/TSS (mg/l)	25/30	30/20[2]	25/2	30/6	20/20
Present Worth Capital Cost	$2,800,000	$2,400,000	$4,500,000	$4,900,000	NA
O&M Cost	$1,000,000	$1,100,000	$1,100,000	$650,000	NA
Total Present Worth	$3,800,000	$3,500,000	$5,700,000	$5,550,000	NA
Equivalent Annual Cost Capital Cost	$218,000	$187,000	$348,000	$376,000	NA
O&M Cost	$77,000	$88,000	$88,000	$50,000	NA
Total EAC	$295,000	$275,000	$436,000	$426,000	NA
Percent Difference	7.3%	Lowest Present Worth	59%	55%	NA

Notes:
1. Plus adding an additional Trickling Filter in 2015
2. Prior to construction of the second Trickling Filter

5. **Quantity of Solids Produced**. The relative amount of additional solids that would be disposed of was compared with the lowest increase in solids production receiving the highest rank. It was determined that Alternatives 1 and 3 would result in the lowest amount of additional solids that would need to be processed and therefore received the highest rank. The lowest rank was Alternatives 2 and 4 due to the additional solids in the primary clarifiers as a result of CEPT.

6. **Flexibility**. The degree of process flexibility was considered. The highest ranking for process flexibility was given to Alternative 1 due to the ability to recycle flows through the process to achieve the desired level of treatment. Alternatives 3 and 4 were ranked the lowest due to the limited ability to improve treatment if flows are sent through effluent filtration or intermediate clarification more than one time.

Table V-5 presents a summary of the alternatives, with higher scores being assigned to the more favorable alternatives. Alternative 1, received the highest overall ranking. Alternatives 2 and 5 were considered essentially equal and also favorable.

Table V-5
Non-economic Evaluation

Alternative	1-Add Two Additional Trickling Filters	2 –Add CEPT and One Trickling Filter	3 – Add Effluent Filters	4 – Add CEPT and Intermediate Clarifiers	5 – Convert to Trickling Filter/Solids Contact
Criterion					
Effluent Quality	0	-	+	0	++
Reliability	++	+	-	0	++
Redundancy	++	+	0	-	0
Lab/ Operations/ Maintenance Labor	++	++	0	+	--
Quantity of Solids Production	++	0	++	0	+
Flexibility	++	+	-	-	+
Total	10	4	1	-1	4

Legend: ++ = very desirable, 2 points, + = desirable, 1 point, 0 = neutral, no points, - = undesirable, -1 point, -- = very undesirable, -2 points

H. Discussion

Table V-4 summarizes the capacities and limiting criteria for each unit process at the Leavenworth WWTP. The plant capacity is limited by the trickling filters at a maximum month flow of 3.7 mgd, which is critical to the overall plant performance.

If the load concentrations do not change, additional trickling filter capacity will be required at a maximum month flow and load of 3.7 mgd. This indicates a need for at least one additional trickling filter immediately. Without the additional trickling filter, failure of the secondary treatment processes could occur anytime maximum month loads reach the plant and the wastewater temperature drops below 15°C (59°F).

Expansion of the secondary treatment processes is recommended immediately to ensure reliable plant performance under identified loading conditions. The evaluation of the alternatives leads to the following recommendations for achieving permit compliance through the year 2020.

- Alternative 1. This alternative offers acceptable treatment with present worth costs essentially equal to Alternative 2. It has a higher initial capital cost, but offers substantial annual cost savings due to less sludge hauling. In addition, installing two new trickling filters does not represent new technology or new equipment. O&M costs should be minimized due to operator familiarity. This alternative has the highest non-economic rating due to the highest rated reliability, redundancy, and flexibility, and the least operations/maintenance labor requirements and sludge production. Operations/maintenance on two additional trickling filters would be identical to the plant's current operations and maintenance. No additional training should be required to operate the new trickling filters. Sludge production should essentially be the same as current sludge production. Each of the four filters would be loaded less than the existing two trickling filters, but total sludge produced should not increase due to more filters in service.
- Alternative 2. This alternative offers the benefit of reduced capital costs, but higher operations costs due to chemical use and increased solids production. It may be necessary to construct the second trickling filter in 2015. It is possible that growth may be less than predicted in this Master Plan as was the case during the previous major facility upgrade in the early 1970's. If this is the case, it is possible that the construction of the second trickling filter could be delayed beyond the predicted year 2015. It also has an acceptable non-economic ranking.
- Alternatives 3, 4, and 5 These alternatives represent departures from the more familiar treatment methods currently employed at the WWTP. Because of the higher

cost of these alternatives, they have been ruled out. The non-economic factors of Alternatives 3 and 4 were undesirable. Alternative 5 had a non-economic ranking equal to Alternative 2, however the advantages are still not great enough to warrant further consideration.

I. Recommendations

Alternative 2 is recommended because of its lower present worth cost and lower capital costs. It would involve the addition of one primary clarifier, one trickling filter, and chemically enhanced primary treatment (CEPT). The primary clarifier should be added at the same time as the pumping station expansion discussed in Chapter IV. This alternative also has the flexibility to implement the chemical feed system for CEPT initially, with addition of the trickling filter later. CEPT could be installed very quickly within a few months. The installation of the CEPT or trickling filter expansion could then be added when permit violations occur.

A possible staging of these expansion alternatives and their year of implementation is included in Table V-6. The timing for this work should be reviewed annually upon examination of influent flows and loadings and the performance of the treatment plant. Additionally, it should be noted that construction of a fourth primary clarifier as recommended below is also described in Chapter IV, but only accounted for in the cost model once, as indicated in Table V-6.

Table V-6
Implementation of Recommendations

Description	Implement and Complete	Cost (2001 dollars)
Construct new primary clarifier	2002-2004	$792,200
Construct chemically enhanced primary treatment (CEPT)	2004-2005	$275,000
Construct third trickling filter	2006-2008	$1,500,000
Subtotal		$2,100,000
Construct fourth trickling filter	2015-2020	1,500,000
Total		$4,070,000

VI. Collection System Recommendations

A. Introduction

The Implementation Plan was prepared using information from flow monitoring, sewer system inventory, growth and development projections from the City, as well as the computer modeling described in this report. The Implementation Plan for the City of Leavenworth sanitary sewer collection system includes the following components:

- Removing I/I sources.
- Constructing relief sewers.
- Conducting additional Sewer System Evaluation Surveys.

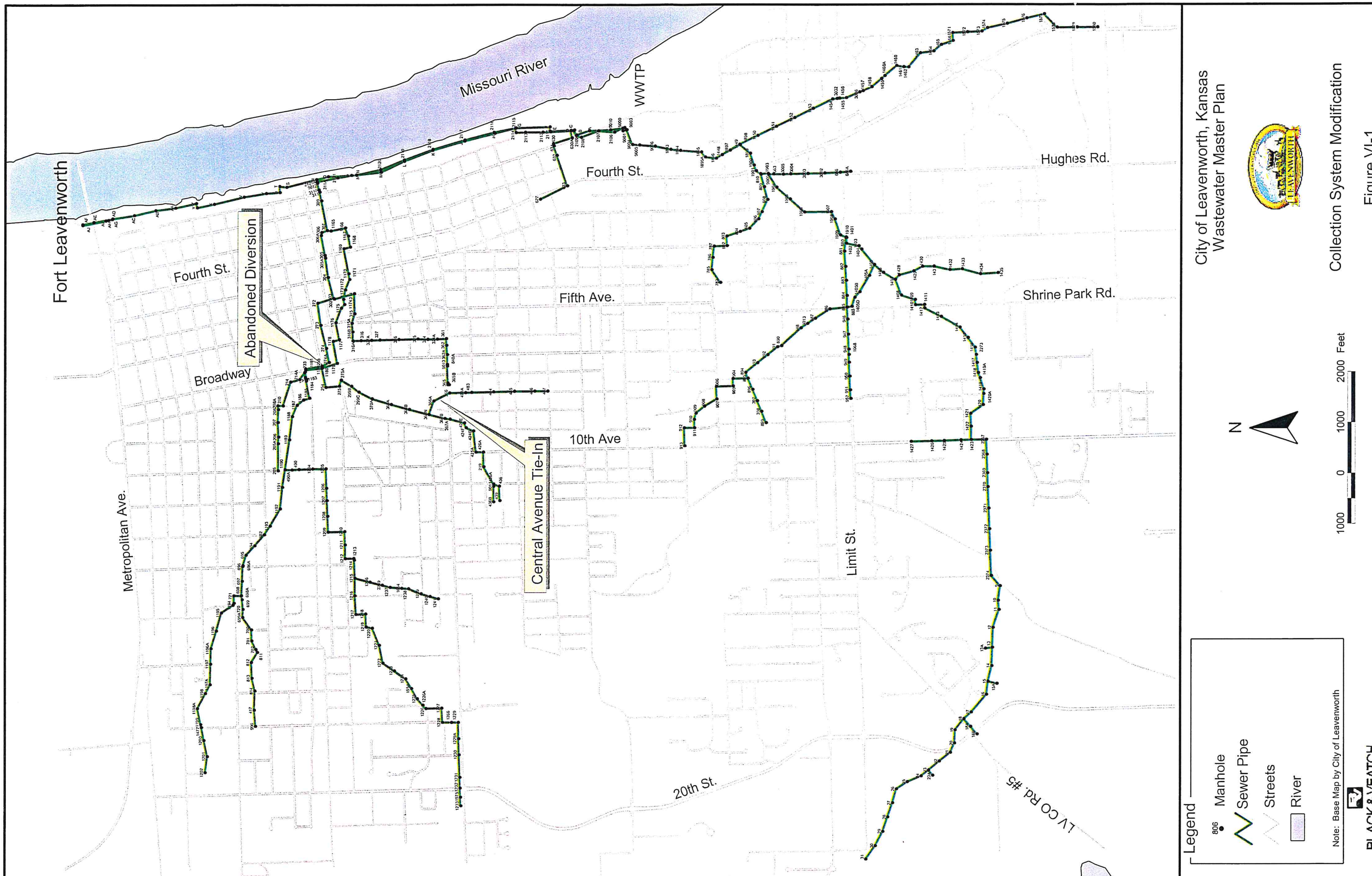
The capital improvements recommended in the Implementation Plan are based on the following criteria:

- Sewer capacity and flow containment for a 5-year storm event - peak flow conditions.
- 30 percent I/I reduction in Subsystem SUB01 as recommended in Chapter III.

The recommended improvements are grouped into three priorities. Priority I improvements are recommended to address immediate or near term needs (next 5 years). Priority II improvements are recommended by 2010. Priority III improvements are recommended by 2020. Each improvement should be reviewed prior to implementation, based on the actual growth and flow that occurs.

B. Modifications to Collection System

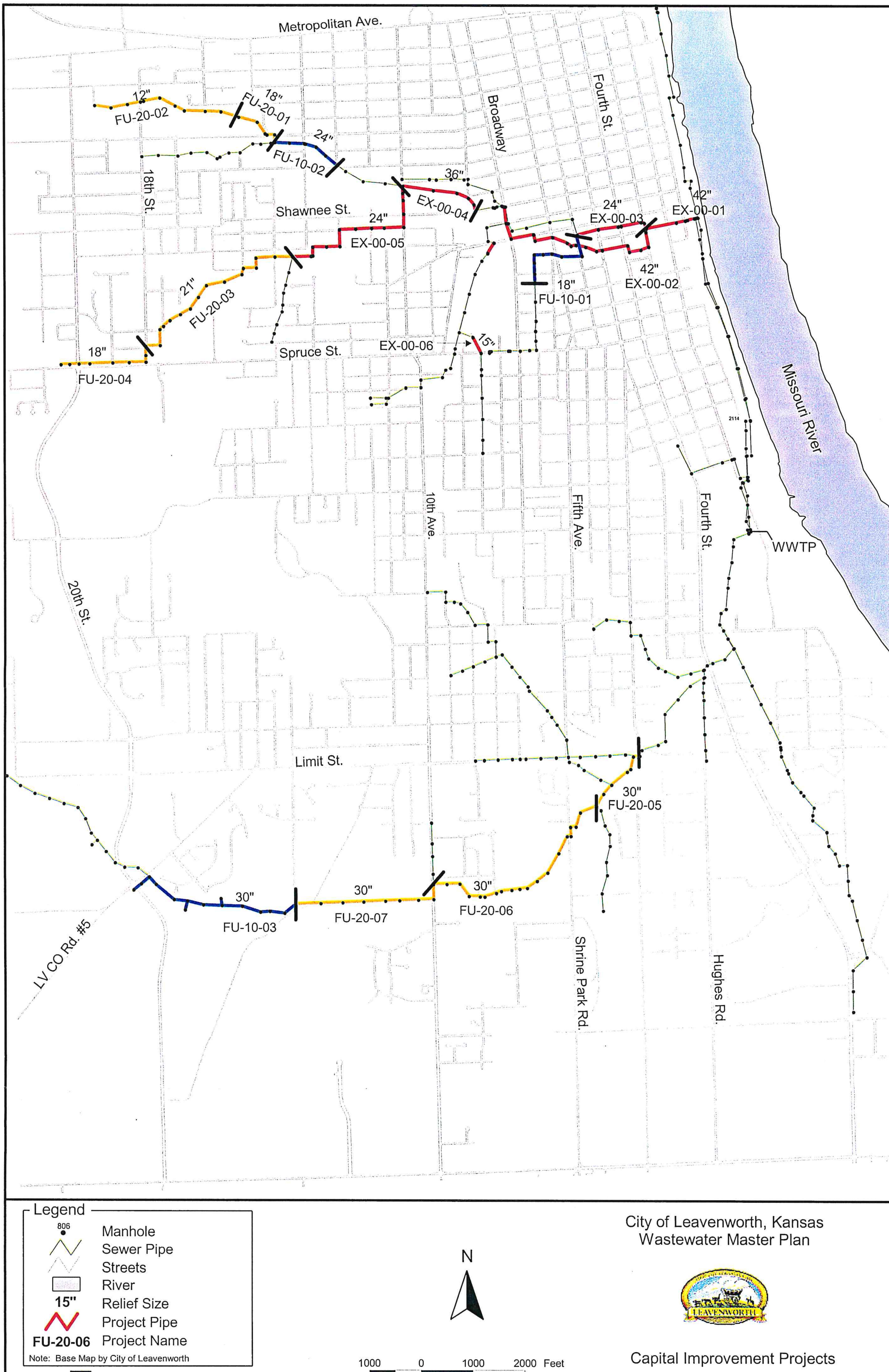
As part of the collection system analysis, alternative system configurations were analyzed to correct the capacity deficiencies identified. The analyses identified potential cost savings that could be achieved by reconfiguring the collection system at two locations as shown on Figure VI-1.



City of Leavenworth, Kansas
Wastewater Master Plan

Collection System Modification

Figure VI-1



City of Leavenworth, Kansas
Wastewater Master Plan

Capital Improvement Projects

Figure VI-2

The recommended two system reconfigurations are as follows:

- The first reconfiguration considered the completion of the Central Avenue tie-in to the new Ironmoulder's sewer. The Central Avenue tie-in reduces the number of overloaded sewers along Sixth Avenue. This connection should be constructed only after the Ironmoulder's sewer improvements are completed.
- The second reconfiguration considered abandoning or closing the diversion line between Manhole 1180 and 255 which is located on Broadway between Delaware and Cherokee Streets. This allows a reduction of about 1,000 lineal feet of sewer projects in downtown Leavenworth.

These two system reconfigurations reduce the relief construction cost by approximately $250,000 compared against their alternatives. The comparison is shown in Appendix P.

C. Relief Sewers

This component of the implementation plan consists of constructing relief trunk sewers to increase the capacity of the existing collection system and includes the collection system reconfiguration. The Capital Improvement Projects (CIPs) are numbered and include a prefix, the planning year, and a project identifier. Several sewers that were slightly overloaded or in isolated segments where the short term surcharge is not expected to result in system performance problems were not scheduled as relief projects.

1. Relief Sewers for Year 2000 Conditions

The collection system currently experiences overloaded sewers during storm events due to excessive I/I entering the system. To address these problems, replacement relief sewer projects were defined that would provide additional capacity for currently overloaded sewers. The relief sewers were sized to safely convey peak flows for future 2020 conditions and 30 percent I/I removal from Subsystem SUB01. The projected capital cost of relief sewers required to alleviate existing hydraulic deficiencies is $3.87 million, as shown in Table VI-1. These projects are shown on Figure VI-2.

Table VI-1 Capital Improvement Projects – Existing								
CIP Name	Up Manhole	Down Manhole	Priority	Existing Size (in.)	Relief Size (in.)	CIP Length (ft)	Construction Cost(3) ($)	Capital(2)(3) Cost ($)
EX_00_01	307	2121A	2	24-30	42	967	315,000	442,000
EX_00_02	1180	307	3	24	42	3,625	1,129,000	1,580,000
EX_00_03	303	307	4	18	24	1,435	207,000	290,000
EX_00_04	1190	1180	5	24	36	1,921	420,000	588,000
EX_00_05	1215	1190	6	15	24	3,855	600,000	840,000
EX_00_06(1)	366	367A	1		15	348	90,000	126,000
Total						12,151	$2,761,000	$ 3,866,000

(1) EX_00_06 is the Central Ave Tie-in to Ironmoulder's new sewer including tunneling under Spruce Street.
(2) Capital Cost includes construction costs plus 40 for percent contingencies, legal, engineering, and administration cost.
(3) Year 2001 Dollars

2. *Future Relief Sewers*

As the City's growth continues, the demands on the collection system will increase. Population and land use data were used as a basis for estimating peak flows throughout the system for each design year (2010 and 2020). System analyses were conducted to determine additional relief required for each design year. Relief requirements considered a 30 percent I/I reduction in Subsystem SUB01 as discussed in Chapter III. The Ironmoulder's replacement sewer project and the Central Avenue tie-in were included in the 2010 and 2020 analyses. The cost for the Ironmoulder's sewer project is not included in the CIP relief projects in the report. The capital cost of relief sewers required to alleviate future hydraulic deficiencies is estimated at $6.56 million, as shown in Table VI-2.

For planning purposes, relief sewers were sized as replacement sewer lines with similar alignment and slope as the exiting sewer. The preliminary alignments and pipe diameters indicated in this report should be used as a guide in planning. More precise alignments and sizes should be determined during design. The location of each CIP project is shown on Figure VI-2. The CIP project details are provided in Appendix P.

Table VI-2 Capital Improvement Projects – Future								
CIP Name(1)	Up Manhole	Down Manhole	Priority	Existing Size (in.)	Relief Size (in.)	CIP Length (ft)	Construction Cost ($)	Capital(1) Cost ($)
10 Year Projects								
FU_10_01	327	303	1	10-12	18	1,961	235,000	329,000
FU_10_02	698	692	2	18	24	1,347	190,000	266,000
FU_10_03	18B	2379	3	15-24	30	3,471	1,109,000	1,552,000
20 Year Projects								
FU_20_01	1196A	698	4	10-12	18	1,350	172,000	240,000
FU_20_02	1202	1196A	5	8-10	12	2,510	277,000	387,000
FU_20_03	1228	1215	6	12-15	21	3,851	569,000	796,300
FU_20_04	1233	1228	7	10-12	18	1,940	237,000	332,000
FU_20_05	1407	880	8	24	30	1,362	260,000	364,000
FU_20_06	1423	1407	9	24	30	4,235	903,000	1,264,000
FU_20_07	2374	1423	10	24	30	2,628	735,000	1,029,000
Total						24,655	$4,687,000	$ 6,559,000

(1) Capital Cost include construction costs plus 40 percent for contingencies, legal, engineering, and administration cost.
(2) Year 2001 Dollars

D. Sewer System Evaluation Surveys

Future Sewer System Evaluation Surveys (SSES) are recommended to control I/I in Subsystem SUB01. It is recommended that a field inspection program be implemented to identify and quantify sources of extraneous flow to the system, and that a cost-effectiveness analysis be carried out to identify which sources of I/I are cost-effective to remove. It is recommended that inspections should be conducted in Subsystem SUB01.

It is recommended that field investigations be conducted to locate sources of I/I in Subsystem SUB01, confirm structure locations, verify key capacity data, and address routine maintenance including:

- Manhole inspections
- Sewer line lamping
- Smoke testing
- Dyed-water testing
- Television inspections

These inspections will provide information on the condition of manholes and sewer lines. Private sector inspections for sources of inflow are difficult to implement and not considered necessary at this time. However, private sector inspections could be required depending on results of the recommended activities.

E. Rehabilitation

Rehabilitation should be carried out following analysis of the field inspection data in order to reduce infiltration and inflow and extend the life of the sewer system.

Costs have been estimated for manhole inspections, line lamping, dyed water testing, smoke testing and television inspections. The City's inspection crews could conduct these inspections as part of the routine maintenance of the sewer system. Even if City crews conduct inspections, it is recommended that some consulting support be provided to ensure maximum benefit from the inspection program. The recommended I/I management activities and estimated costs are listed in Table VI-3.

F. Sewer System Management Plan

It is recommended that a sewer system management plan be developed to improve the performance of the sewer system. This plan should include the following components:

- Evaluation of flow and rainfall data.
- Updating and completing system inventory
- Updating capacity analyses
- A program for cleaning and televising sewer lines, and other system inspections as needed.

1. Permanent Flow and Rainfall Data Collection

At least one rain gauge should be permanently installed in the study area. Flow data collected from the permanent WWTP meter should be analyzed in conjunction with the rain gauge data for post-rehabilitation evaluation of I/I rates and for subsequent modeling and planning.

The WWTP meter showed to be inaccurate during the flow monitoring program. Efforts need to be made to calibrate the meter or purchase additional meters to track wastewater flows prior to being received at the WWTP. This allows the City to monitor of the collection system performance and perform model updates.

2. *Update and Complete System Inventory*

There is approximately 19,000 ft of the modeled trunk sewer (17 percent of the total modeled inventory) where the slope information was assumed. Trunk sewers that have assumed slopes, which were identified in Chapter III, should be surveyed and the inventory database updated.

A complete system inventory database should be completed to incorporate sewers eight-inches and larger. The database would contain the physical inventory information such as pipe invert information, pipe sizes, manhole depth, manhole and sewer pipe material, plus sewer line lengths. It is estimated that only 16 percent of the inventory is currently modeled. The inventory update should include efforts to accurately locate and record the inventory information in an electronic format.

3. *Update Capacity Analysis (2006)*

The model should be updated with new inventory information and population projections every five years, with the first update in 2006. This allows the model to be used as a functional planning tool to aid in City growth demands. An updated model would also allow the City to evaluate development as is occurs and to refine potential expansion areas.

4. *Develop Preventive Maintenance Program/CMOM Program*

It is recommended that a preventive maintenance program be established to evaluate and coordinate manpower and equipment with planned maintenance/rehabilitation activities. The program would optimize maintenance operations and assist in addressing pending EPA CMOM (Capacity, Management, Operations, and Maintenance) requirements. Some key components for establishing a preventive maintenance program include:

- Review staff requirements versus maintenance activities
- Complete inventory database
- Purchase software with work order and scheduling abilities.

This program should be implemented by City Staff or by a consultant when required by the EPA. This program is currently expected to be required in 2002 or 2003. A detailed discussion of the CMOM program elements is included in Appendix Q.

G. Summary of Costs

The total projected capital cost (excluding inspection and rehabilitation costs) of the Implementation Plan plus Management Activities is $10.4 million in 2001 dollars. The I/I Management and Rehabilitation Activities estimated costs are $3.2 million. Table VI-3 lists the management activities and estimated costs. The projected capital costs listed in Table VI-4 for capital projects include construction cost plus allowances of 20 percent for contingencies and 20 percent for engineering, legal, and administrative costs. Table VI-5 lists the summary of the recommended management activities and estimated costs.

Table VI-3
I/I Management and Rehabilitation Activities

Work Tasks	Purpose/Benefit	Estimated Cost ($)	Year Of Implementation
SSES Activities			
1. Manhole inspection	To identify I/I sources and determine the structural condition of manholes in subsystem SUB01. (Based on 1280 Manholes)	120,000	2002-2003
2. Smoke and dye testing	To locate potential I/I sources in subsystem SUB01 (Based on 256,000 ft of sewer)	90,000	2002-2003
3. Television inspection	To identify I/I sources and determine the condition of sewers sources in subsystem SUB01 (Based on 128,000 ft of sewer)	250,000	2002-2003
Subtotal		$460,000	
Rehabilitation Activities			
4. Rehabilitation	To reduce infiltration and inflow and extend the life of the sewer system. Estimated 2-3 Million (Assumed 2.5 Million)	$2,500,000(1)	2004-2005
Planning Activities			
5. Flow Meter Calibration and rain gauge installation	To collect rainfall data which will result in improved understanding of system reaction to rainfall and effectiveness of I/I removal	20,000	2006
6. Complete and Update System Inventory	To improve the database of existing sewer information. (Based on 2,781 Manholes)	70,000	2006
7. Model Update (Year 2006)	To improve CIP project accuracy and priorities by updating the system plan based on new information.	80,000	2006
Subtotal		$170,000	
Maintenance Activities			
8. Develop preventive maintenance program	To evaluate and coordinate manpower and equipment with planned maintenance/rehabilitation activities to maximize the benefit of maintenance operations. Address pending EPA C-MOM requirements	$50,000	When Required
Total	-	$3,180,000	

(1) Planning estimate which requires updating after SSES activities
(2) 2001 Dollars

Table VI-4 Summary of Probable Improvement Capital Costs		
Cost Item	Construction Cost ($)	Total Capital Cost ($)
Relief Sewers		
-2000 Conditions	2,761,000	3,866,000
-Future	4,687,000	6,559,000
Total Relief Sewer Cost	**$7,448,000**	**$10,425,000**
Rehabilitation		
-Manhole and Sewer Line Rehabilitation(1)	2,500,000	2,500,000
Total Capital Improvement Costs	**$9,948,000**	**$12,852,000**
(1) Total estimated cost is 2.5 million. (2)2001 Dollars		

Table VI-5 Summary of Management Activity Costs	
	Total Estimated Cost ($)
System Management Activities	
- Physical Inspection Activities	460,000
- Flow Meter Calibration and Rain Gauge Installation	20,000
- Update and Complete System Inventory	70,000
- Model Update (2005)	80,000
- Develop Preventive Maintenance Program/CMOM Program	50,000
Total Cost	**$680,000**

APPENDIX A

HISTORICAL OPERATING BUDGETS

Leavenworth, Kansas WWTP
Annual Operating Cost Information

Based on 1995-2000 WWTP Expenditures, Year 2000 & 2001 Budget

	1995	1996	1997	1998	1999	2000 Budget	2000	2001 Budget
Number of Employees	10	10	10	10	10	10	10	10
Personal Service Cost	$ 381,997	$ 343,050	$ 354,817	$ 337,673	$ 353,449	$ 399,105	$ 354,253	$ 405,980
Average cost/hr, 2080 hr/yr	$ 18.37	$ 16.49	$ 17.06	$ 16.23	$ 16.99	$ 19.19	$ 17.03	$ 19.52
Contractual Services								
Utilities								
Electricity	$ 134,484	$ 118,013	$ 131,022	$ 111,520	$ 130,244	$ 127,000	$ 101,433	$ 118,000
Natural Gas	$ 22,838	$ 24,336	$ 34,075	$ 18,728	$ 19,410	$ 20,000	$ 12,534	$ 22,000
Water	$ 14,295	$ 17,061	$ 18,256	$ 17,724	$ 18,711	$ 20,000	$ 22,629	$ 21,000
Trash Hauling/Sludge	$ 66,928	$ 62,570	$ 68,576	$ 75,375	$ 78,133	$ 70,000	$ 67,908	$ 82,500
Total Utilities	$ 238,545	$ 221,980	$ 251,929	$ 223,347	$ 246,498	$ 237,000	$ 204,504	$ 243,500
All Other Contractual Services	$ 171,153	$ 134,819	$ 102,365	$ 107,488	$ 119,286	$ 122,800	$ 471,275	$ 224,905
Commodities	$ 152,297	$ 126,485	$ 120,343	$ 89,892	$ 99,941	$ 124,100	$ 138,420	$ 152,370
Capital Outlays	$ 21,889	$ 19,437			$ 21,585	$ 13,160	$ 5,745	$ 55,210
Total Cost	$ 965,881	$ 845,771	$ 829,454	$ 758,400	$ 840,759	$ 896,165	$ 1,174,198	$ 1,081,965

Notes for budget Items

Personal Services: Full Time, Overtime, Longevity, FICA, Life Insurance, Health Insurance, KPERS, Worker's Compensation, Unemployment Insurance, Vacation Leave Reimbursement, Corporate pass

All Other Contractual Items: Telephone, Postage, Commerical Travel, Lodging, Meals, Mileage Reimbursement, Tuition, Registration, Classified and Legal Advertising, Insurance, Dues/Memberships, Medical services, Janitorial services, Delivery/Courier services, Printing/Copying services, Laboratory services, Film processing, Other Professional services, Equipment rental, Uniform rental, Other rental, Building & Grounds M&R, Office equipment M&R, Sewer System Equipment M&R, Vehicle M&R, Other Equipment M&R, Vehicle license fees

Commodities: Office supplies, Books/magazines, Educational materials, Protective/safety apparel, Food, Medical supplies, Gasoline, Diesel fuel, Oil/grease/lubricants, Chemicals, Concrete, Gravel/sand, Safety Materials, Equipment repair, Sewer System Materials, Tools, Janitorial supplies, Operating supplies, Non-capital pumps/motors, Non-capital Lab equipment

Total Capital Projects: Data processing Equipment, Generators/pumps/motors, Lab equipment, Sewer monitoring equipment, Sewer equipment, Other operating equipment

Leavenworth, Kansas WWTP
Annual Operating Cost Information

Based on 1995-2000 Sewer Collection Expenditures, Year 2000 & 2001 Budget

	1995	1996	1997	1998	1999	2000 Budget	2000	2001 Budget
Number of Employees	5	5	5	5	5	5	5	5
Personal Service Cost	$ 182,777	$ 191,537	$ 200,075	$ 207,447	$ 213,672	$ 224,760	$ 218,106	$ 229,970
Average cost/hr, 2080 hr/yr	$ 17.57	$ 18.42	$ 19.24	$ 19.95	$ 20.55	$ 21.61	$ 20.97	$ 22.11
Contractual Services	$ 28,103	$ 77,168	$ 133,898	$ 60,150	$ 129,553	$ 102,950	$ 118,140	$ 157,115
Commodities	$ 12,765	$ 13,357	$ 17,751	$ 11,899	$ 18,560	$ 18,200	$ 17,471	$ 17,400
Capital Outlays	$ -	$ -	$ -		$ 799	$ 45,000	$ 27,650	$ 27,650
Total Cost	$ 223,645	$ 282,062	$ 351,723	$ 279,496	$ 362,584	$ 390,910	$ 381,367	$ 432,135

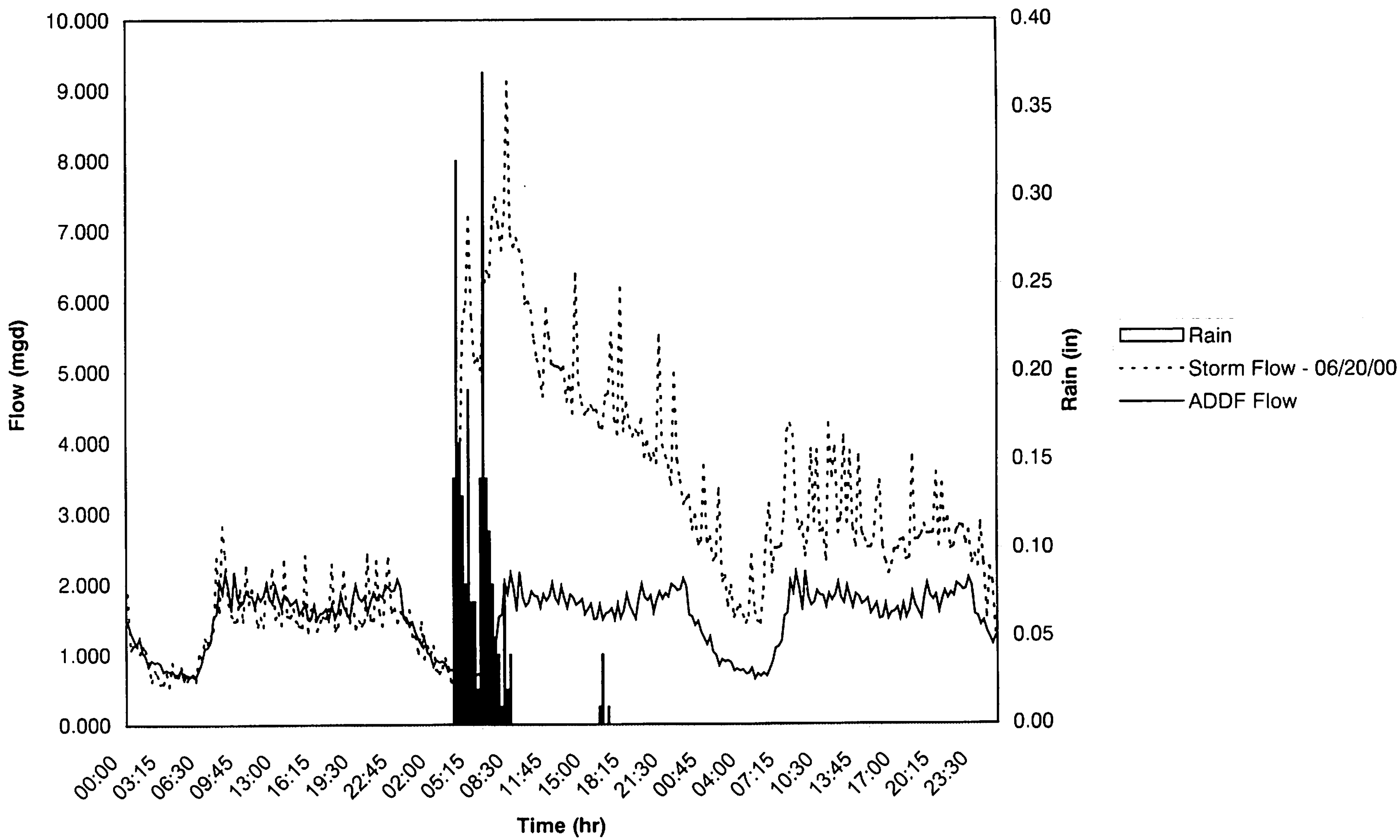
Notes for budget Items

Personal Services	Full Time, Overtime, Longevity, FICA, Life Insurance, Health Insurance, KPERS, Worker's Compensation, Unemployment Insurance, Vacation Leave Reimbursement, Corporate pass
Contractual Services	Water, Other Professional services, Uniform rental, Other rental, Building & Grounds M&R, Sewer System Equipment M&R, Vehicle M&R, Other Equipment
Commodities:	Gasoline, Diesel fuel, Vehicular Repair Parts, Chemicals, Concrete, Gravel/sand, Safety Materials, Equipment Repair Parts, Sewer System Materials, Tools,
Total Capital Projects	Sewer Equipment

APPENDIX B

EXAMPLE SUBSYSTEM RESPONSE TO RAIN EVENT

Sub01 Response to 6/20/00 Rain Event



APPENDIX C

COLLECTION SYSTEM IMPROVEMENTS CRITERIA

LEAVENWORTH, KS - FUTURE

Model Improvement Criteria

EXISTING SEWER EVALUATION:

Proposed Sewers 18" and Smaller, Allowable Flow/Cap Ratio =	1.000
Larger Existing Sewers, Allowable Flow/Cap Ratio =	1.000

RELIEF SEWER EVALUATION:

( ) Use Parallel Reliefs
(*) Use Replacement Reliefs

Proposed Sewers 18" and Smaller, n =	0.013
Large Proposed Sewers, n =	0.013
Proposed Sewers 18" and Smaller, Design Flow/Cap Ratio =	0.650
Larger Existing Sewers, Design Flow/Cap Ratio =	0.780
Relief Sewers 18" and Smaller, Design Flow/Cap Ratio =	0.650
Larger Relief Sewers, Design Flow/Cap Ratio =	0.780

PUMPING STATION EVALUATION:

Station Expansion, Allowable Flow/Cap Ratio:	2.000
Station Replaced When Flow/Cap Ratio >	2.000

FORCE MAIN EVALUATION:

( ) Use Parallel Force Mains
(*) Use Replacement Force Mains

Maximum Velocity at Peak Flow	12.0
Design Velocity for New Force Mains	6.0

APPENDIX D

RELIEF SEWER CONSTRUCTION COST

LEAVENWORTH, KS - FUTURE

RELIEF SEWER CONSTRUCTION COST
(All Cost Factors Applied)

Table Description: B&V STD COST CURVES

Current ENR: 6288.0
ENR Cost Basis: 5400.0
Additional Cost Factor: 1.20000

Overall Cost Multiplier: 1.39733

Additional Fixed Cost/foot: 0.00 $ per lineal foot

Sewer Diameter	10 ft.	15 ft.	20 ft.	25 ft.
(in)	($/ft)	($/ft)	($/ft)	($/ft)
8	78.16	123.30	168.43	213.56
10	85.09	130.51	175.92	221.33
12	93.63	139.60	185.57	231.55
15	107.77	153.88	200.00	246.11
18	116.49	163.23	209.97	256.71
21	127.38	174.61	221.84	269.07
24	140.99	188.64	236.28	283.93
27	172.69	221.04	269.39	317.73
30	190.84	239.82	288.80	337.77
33	204.82	254.21	303.61	353.00
36	218.79	268.60	318.42	368.23
42	274.40	326.17	377.95	429.72
48	331.07	383.40	435.73	488.06
54	403.87	457.59	511.32	565.05
60	446.69	502.03	557.36	612.70
66	529.36	590.91	652.47	714.02
72	558.93	621.81	684.69	747.57
84	609.81	679.67	749.54	819.41
96	649.76	726.61	803.46	880.32
108	740.58	824.42	908.26	992.10
120	852.37	950.18	1048.00	1145.81

* NOTE: Cost determined by SSMS program interpolates cost for each foot of depth greater than 10 feet.

APPENDIX E

RELIEF SEWER COST DETAIL

LEAVENWORTH, KS

Model Name: EXISTING - 1 YR 0% REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length (ft)	Slope (ft/ft)	Existing Diam. (in)	Existing Cap (cfs)	Design Flow (cfs)	Percent Utilization (Q_tot/cap)	Relief Type	Average Depth (ft)	Pipe Diam (in)	Pipe Capacity (cfs)	Construction Cost ($)
SUB01	1165	307	75	0.001867	24	9.776	15.636	159.9	Parallel	18.69	27	13.39	19,254
SUB01	1166	1165	285	0.001895	24	9.849	15.558	158.0	Parallel	20.17	27	13.46	77,245
SUB01	1167	1166	166	0.002048	24	10.239	15.454	150.9	Parallel	18.28	24	10.24	36,503
SUB01	1168	1167	223	0.001883	24	9.818	15.361	156.5	Parallel	14.58	27	13.43	48,388
SUB01	1169	1168	131	0.001985	24	10.080	15.248	151.3	Parallel	16.41	24	10.06	26,472
SUB01	1170	1169	499	0.001904	24	9.872	15.214	154.1	Parallel	18.16	24	9.86	109,158
SUB01	1171	1170	115	0.001913	24	9.896	15.096	152.5	Parallel	14.28	24	9.88	20,906
SUB01	1172	1171	224	0.001920	24	9.914	15.002	151.3	Parallel	11.09	24	9.91	33,909
SUB01	1173	1172	189	0.000476	24	4.936	14.899	301.8	Parallel	11.90	36	14.61	44,930
SUB01	1174	1173	100	0.002400	24	11.084	14.776	133.3	Parallel	12.14	24	11.08	16,138
SUB01	1175	1174	98	0.001327	24	8.242	14.653	177.8	Parallel	12.45	27	11.29	19,245
SUB01	1176	1175	301	0.001860	24	9.757	14.573	149.4	Parallel	11.76	24	9.75	47,487
SUB01	1177	1176	344	0.001890	24	9.836	14.501	147.4	Parallel	9.50	24	9.83	48,501
SUB01	1178	1177	124	0.001774	24	9.529	14.381	150.9	Parallel	8.82	24	9.51	17,483
SUB01	1179	1178	441	0.001927	24	9.932	14.328	144.3	Parallel	9.02	24	9.93	62,177
SUB01	1180	1179	310	0.001839	24	9.702	14.459	149.0	Parallel	9.53	24	0.00	43,707
SUB01	1180	255	10	0.001000	15	2.043	3.125	153.0	Parallel	9.93	18	3.32	1,165
SUB01	1185	1184	340	0.002471	24	11.247	13.052	116.0	Parallel	9.92	21	7.87	43,309
SUB01	1186	1185	125	0.002080	24	10.318	12.933	125.3	Parallel	9.42	21	7.22	15,923
SUB01	1187	1186	162	0.001975	24	10.055	12.826	127.6	Parallel	8.37	21	7.05	20,636
SUB01	1188	1187	241	0.001120	24	7.572	12.736	168.2	Parallel	7.00	27	10.36	41,620
SUB01	1189	1188	459	0.002004	24	10.128	12.699	125.4	Parallel	6.87	21	7.08	58,467
SUB01	1190	1189	594	0.001987	24	10.085	12.692	125.9	Parallel	7.10	21	7.06	75,664
SUB01	1194	720	45	0.002222	12	1.680	2.235	133.0	Parallel	8.55	15	3.04	4,850
SUB01	1195	1194	275	0.002218	12	1.678	2.083	124.1	Parallel	8.70	12	1.67	25,750
SUB01	1196	1195	370	0.002135	12	1.646	1.935	117.6	Parallel	11.00	12	1.64	38,048
SUB01	1198A	1198	332	0.008012	8	1.082	1.095	101.2	Parallel	13.14	8	1.08	35,361
SUB01	1204	490	543	0.002431	15	3.185	6.661	209.1	Parallel	12.55	21	7.81	82,247
SUB01	1205	1204	260	0.004308	15	4.240	6.530	154.0	Parallel	15.61	18	6.89	43,924
SUB01	1206	1205	380	0.004026	15	4.099	6.410	156.4	Parallel	12.09	18	6.66	51,693
SUB01	1209	1208	316	0.003513	15	3.829	6.012	157.0	Parallel	13.32	18	6.22	46,621
SUB01	1210	1209	322	0.003696	15	3.928	5.883	149.8	Parallel	12.17	18	6.39	44,044
SUB01	1211	1210	260	0.003577	15	3.864	5.748	148.8	Parallel	8.11	18	6.28	30,289

LEAVENWORTH, KS

Model Name: EXISTING - 1 YR 0% REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length (ft)	Slope (ft/ft)	Existing Diam. (in)	Existing Cap (cfs)	Design Flow (cfs)	Percent Utilization (Q_tot/cap)	Relief Type	Average Depth (ft)	Pipe Diam (in)	Pipe Capacity (cfs)	Construction Cost ($)
SUB01	1212	1211	269	0.003569	15	3.859	5.621	145.7	Parallel	8.66	18	6.27	31,338
SUB01	1213	1212	166	0.003554	15	3.851	5.480	142.3	Parallel	7.89	18	6.25	19,338
SUB01	1214	1213	35	0.002571	15	3.276	5.323	162.5	Parallel	6.05	18	5.32	4,077
SUB01	1215	1214	357	0.003641	15	3.898	5.204	133.5	Parallel	10.80	18	6.33	44,259
SUB01	1236	1215	310	0.003000	10	1.200	1.473	122.8	Parallel	10.54	10	1.20	27,901
SUB01	272	303	325	0.002369	18	5.113	5.443	106.5	Parallel	10.00	18	5.11	37,861
SUB01	273	272	438	0.002374	18	5.119	5.354	104.6	Parallel	10.00	15	3.14	47,206
SUB01	274	273	464	0.002371	18	5.115	5.266	103.0	Parallel	10.00	15	3.14	50,008
SUB01	274A	274	284	0.002394	18	5.140	5.155	100.3	Parallel	10.00	15	3.15	30,609
SUB01	299	299A	57	0.004035	12	2.263	3.430	151.6	Parallel	10.96	15	4.10	6,647
SUB01	299A	275	251	0.004143	12	2.293	3.597	156.9	Parallel	10.31	15	4.15	27,771
SUB01	302	303	21	0.007619	12	3.110	4.673	150.3	Parallel	10.00	15	5.63	2,264
SUB01	303	304	423	0.002388	18	5.134	9.502	185.1	Parallel	10.00	24	11.06	59,640
SUB01	304	305A	385	0.002364	18	5.108	9.590	187.7	Parallel	10.00	24	10.99	54,282
SUB01	305	306A	394	0.002360	18	5.103	9.818	192.4	Parallel	10.00	24	10.99	55,551
SUB01	305A	305	56	0.002321	18	5.061	9.684	191.3	Parallel	10.00	24	10.89	7,895
SUB01	306	307	115	0.002348	18	5.090	10.051	197.5	Parallel	14.43	24	10.96	21,069
SUB01	306A	306	62	0.002419	18	5.167	9.918	191.9	Parallel	10.00	24	11.13	8,742
SUB01	307	309	590	0.001966	24	10.032	25.760	256.8	Parallel	16.58	33	23.47	159,198
SUB01	309	311	174	0.006322	24	17.989	25.795	143.4	Parallel	13.43	24	146.31	30,220
SUB01	311	311A	48	0.003542	30	24.414	25.904	106.1	Parallel	12.03	21	9.42	7,036
SUB02_03	311A	9012	140	0.001000	30	12.972	25.890	199.6	Parallel	11.65	36	21.09	32,932
SUB01	314	302	409	0.007677	12	3.122	4.536	145.3	Parallel	10.00	15	5.66	44,080
SUB01	315	314	455	0.006242	12	2.815	4.401	156.3	Parallel	10.65	15	5.10	51,766
SUB01	315A	315	196	0.001122	12	1.193	4.246	355.9	Parallel	9.31	21	5.30	24,966
SUB01	316	316A	155	0.012452	10	2.445	3.766	154.0	Parallel	7.01	12	3.97	14,514
SUB01	316B	315A	170	0.003706	12	2.169	4.088	188.5	Parallel	6.59	18	6.39	19,804
SUB01	324	325	193	0.011244	10	2.323	2.969	127.8	Parallel	6.87	10	2.32	16,424
SUB01	324A	324	187	0.009679	10	2.156	2.804	130.1	Parallel	5.91	12	3.50	17,510
SUB01	325	326	376	0.012686	10	2.468	3.134	127.0	Parallel	8.73	10	2.46	31,996
SUB01	326	327	375	0.012853	10	2.484	3.289	132.4	Parallel	11.45	12	4.04	40,113
SUB01	327	327A	166	0.011687	10	2.369	3.442	145.3	Parallel	12.25	12	3.84	18,979
SUB01	327A	316	214	0.014159	10	2.607	3.606	138.3	Parallel	10.04	12	4.24	20,116

LEAVENWORTH, KS

Model Name: EXISTING - 1 YR 0% REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length	Slope	Existing Diam.	Existing Cap	Design Flow	Percent Utilization	Relief Type	Average Depth	Pipe Diam	Pipe Capacity	Construction Cost
			(ft)	(ft/ft)	(in)	(cfs)	(cfs)	(Q_tot/cap)		(ft)	(in)	(cfs)	($)
SUB01	362	361	131	0.005954	10	1.691	2.467	145.9	Parallel	11.31	12	2.74	13,843
SUB01	362A	362	182	0.004011	10	1.388	2.299	165.6	Parallel	11.15	12	2.25	18,966
SUB01	365A	365	36	0.011111	8	1.274	1.610	126.4	Parallel	12.80	8	1.28	3,724
SUB01	366	365B	163	0.005215	8	0.873	1.257	144.0	Parallel	10.18	10	1.58	14,138
SUB01	367	368	378	0.004392	12	2.361	2.671	113.1	Parallel	7.73	12	2.36	35,394
SUB01	368A	369	350	0.005086	12	2.541	2.981	117.3	Parallel	7.41	12	2.54	32,773
SUB01	370	299	434	0.004147	12	2.295	3.289	143.3	Parallel	10.09	15	4.16	47,135
SUB01	404C	367	159	0.001698	12	1.468	2.503	170.5	Parallel	10.27	15	2.66	17,532
SUB01	425A	424A	183	0.003989	10	1.384	1.455	105.1	Parallel	8.16	10	1.38	15,573
SUB01	490	490A	254	0.002441	15	3.192	6.764	211.9	Parallel	10.72	21	7.82	34,082
SUB01	490A	1190	143	0.002378	10	1.069	6.893	644.8	Parallel	9.09	24	11.03	20,162
SUB01	694	692	289	0.001488	18	4.052	5.408	133.5	Parallel	6.62	18	10.20	33,667
SUB01	695	694	251	0.001235	18	3.692	5.286	143.2	Parallel	5.17	21	14.84	31,972
SUB01	696A	695	212	0.001557	18	4.145	5.156	124.4	Parallel	7.00	18	4.16	24,696
SUB01	697	696	291	0.000103	24	2.296	4.909	213.8	Parallel	6.73	30	4.10	55,537
SUB01	698	697	283	0.000954	12	1.101	4.760	432.3	Parallel	6.60	24	6.97	39,901
SUB01	698A	698	80	0.001000	12	1.127	2.089	185.4	Parallel	8.63	18	3.32	9,320
SUB01	699	698A	193	0.001606	12	1.428	1.928	135.0	Parallel	8.84	15	2.59	20,801
SUB01	720	721	147	0.003333	12	2.057	2.404	116.9	Parallel	9.95	12	2.05	13,764
SUB01	721	698	152	0.004013	12	2.257	2.565	113.6	Parallel	9.72	12	2.25	14,233
SUB01	840A	9013	29	0.007586	10	1.908	1.953	102.4	Parallel	9.24	10	1.90	2,468
SUB02_03	Q	P	459	0.001242	30	14.457	16.226	112.2	Parallel	10.26	24	7.96	65,852
SUB02_03	R	Q	232	0.001207	30	14.252	16.284	114.3	Parallel	10.00	24	7.87	32,710
		Total:	21,950	(ft)									2,995,469

APPENDIX F

RELIEF SEWER COST DETAIL (5-YEAR STORM EVENT)

LEAVENWORTH, KS

Model Name: EXISTING - 5 YR 0% REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length (ft)	Slope (ft/ft)	Existing Diam. (in)	Existing Cap (cfs)	Design Flow (cfs)	Percent Utilization (Q_tot/cap)	Relief Type	Average Depth (ft)	Pipe Diam (in)	Pipe Capacity (cfs)	Construction Cost ($)
SUB01	1165	307	75	0.001867	24	9.776	27.356	279.8	Parallel	18.69	36	28.84	22,904
SUB01	1166	1165	285	0.001895	24	9.849	27.204	276.2	Parallel	20.17	36	29.00	91,232
SUB01	1167	1166	166	0.002048	24	10.239	27.020	263.9	Parallel	18.28	36	30.20	50,013
SUB01	1168	1167	223	0.001883	24	9.818	26.850	273.5	Parallel	14.58	36	28.92	58,966
SUB01	1169	1168	131	0.001985	24	10.080	26.655	264.4	Parallel	16.41	36	29.68	37,028
SUB01	1170	1169	499	0.001904	24	9.872	26.558	269.0	Parallel	18.16	36	29.07	149,745
SUB01	1171	1170	115	0.001913	24	9.896	26.357	266.3	Parallel	14.28	36	29.15	30,065
SUB01	1172	1171	224	0.001920	24	9.914	26.185	264.1	Parallel	11.09	36	29.22	51,443
SUB01	1173	1172	189	0.000476	24	4.936	26.003	526.8	Parallel	11.90	48	31.47	66,331
SUB01	1174	1173	100	0.002400	24	11.084	25.797	232.7	Parallel	12.14	33	25.91	22,596
SUB01	1175	1174	98	0.001327	24	8.242	25.590	310.5	Parallel	12.45	42	36.69	29,378
SUB01	1176	1175	301	0.001860	24	9.757	25.436	260.7	Parallel	11.76	36	28.76	71,135
SUB01	1177	1176	344	0.001890	24	9.836	25.293	257.1	Parallel	9.50	33	22.99	70,459
SUB01	1178	1177	124	0.001774	24	9.529	25.091	263.3	Parallel	8.82	36	28.06	27,131
SUB01	1179	1178	441	0.001927	24	9.932	24.971	251.4	Parallel	9.02	33	23.23	90,326
SUB01	1180	1179	310	0.001839	24	9.702	24.912	256.8	Parallel	9.53	33	0.00	63,495
SUB01	1180	255	10	0.001000	15	2.043	3.114	152.4	Parallel	9.93	18	3.32	1,165
SUB01	1185	1184	340	0.002471	24	11.247	20.985	186.6	Parallel	9.92	30	20.38	64,888
SUB01	1186	1185	125	0.002080	24	10.318	20.779	201.4	Parallel	9.42	30	18.70	23,857
SUB01	1187	1186	162	0.001975	24	10.055	20.582	204.7	Parallel	8.37	30	18.25	30,917
SUB01	1188	1187	241	0.001120	24	7.572	20.404	269.5	Parallel	7.00	36	22.32	52,730
SUB01	1189	1188	459	0.002004	24	10.128	20.282	200.3	Parallel	6.87	30	18.34	87,599
SUB01	1190	1189	594	0.001987	24	10.085	20.191	200.2	Parallel	7.10	30	18.29	113,364
SUB01	1191	1190	346	0.005202	18	7.577	9.460	124.9	Parallel	7.18	18	7.57	40,307
SUB01	1192	1191	429	0.004942	18	7.385	9.273	125.6	Parallel	7.36	18	7.38	49,977
SUB01	1193	1192	390	0.012077	15	7.100	9.059	127.6	Parallel	8.28	15	7.10	42,033
SUB01	1194	720	45	0.002222	12	1.680	3.493	207.9	Parallel	8.55	18	4.95	5,243
SUB01	1195	1194	275	0.002218	12	1.678	3.243	193.3	Parallel	8.70	18	4.95	32,037
SUB01	1196	1195	370	0.002135	12	1.646	2.997	182.1	Parallel	11.00	15	2.98	43,289
SUB01	1196A	1196	361	0.010360	10	2.230	2.741	122.9	Parallel	13.23	10	2.23	41,311
SUB01	1197	1196A	303	0.010396	10	2.234	2.481	111.1	Parallel	13.29	10	2.23	34,840
SUB01	1198A	1198	332	0.008012	8	1.082	1.682	155.5	Parallel	13.14	10	1.96	37,721
SUB01	1199	1198A	319	0.007962	8	1.078	1.410	130.8	Parallel	13.04	10	1.95	35,953

LEAVENWORTH, KS

Model Name: EXISTING - 5 YR 0% REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length (ft)	Slope (ft/ft)	Existing Diam. (in)	Existing Cap (cfs)	Design Flow (cfs)	Percent Utilization (Q_tot/cap)	Relief Type	Average Depth (ft)	Pipe Diam (in)	Pipe Capacity (cfs)	Construction Cost ($)
SUB01	1204	490	543	0.002431	15	3.185	10.558	331.5	Parallel	12.55	24	11.15	89,754
SUB01	1205	1204	260	0.004308	15	4.240	10.343	243.9	Parallel	15.61	21	10.40	46,897
SUB01	1206	1205	380	0.004026	15	4.099	10.141	247.4	Parallel	12.09	21	10.06	55,907
SUB01	1207	1206	242	0.019669	15	9.060	9.922	109.5	Parallel	8.69	15	9.06	26,081
SUB01	1208	1207	308	0.009545	15	6.312	9.710	153.8	Parallel	10.34	18	10.26	36,860
SUB01	1209	1208	316	0.003513	15	3.829	9.498	248.1	Parallel	13.32	21	9.38	50,163
SUB01	1210	1209	322	0.003696	15	3.928	9.285	236.4	Parallel	12.17	21	9.63	47,617
SUB01	1211	1210	260	0.003577	15	3.864	9.064	234.6	Parallel	8.11	21	9.48	33,120
SUB01	1212	1211	269	0.003569	15	3.859	8.843	229.2	Parallel	8.66	21	9.46	34,265
SUB01	1213	1212	166	0.003554	15	3.851	8.609	223.6	Parallel	7.89	21	9.44	21,146
SUB01	1214	1213	35	0.002571	15	3.276	8.360	255.2	Parallel	6.05	21	8.03	4,459
SUB01	1215	1214	357	0.003641	15	3.898	8.147	209.0	Parallel	10.80	21	9.56	48,173
SUB01	1216	1215	343	0.005656	15	4.859	5.895	121.3	Parallel	12.83	15	4.86	45,921
SUB01	1217	1216	369	0.005962	15	4.988	5.680	113.9	Parallel	15.46	15	4.98	58,350
SUB01	1218	1217	190	0.005737	15	4.893	5.443	111.2	Parallel	15.82	15	4.89	30,676
SUB01	1219	1218	252	0.006032	15	5.017	5.212	103.9	Parallel	13.01	15	5.01	34,155
SUB01	1220	1219	125	0.005680	15	4.869	4.965	102.0	Parallel	14.40	15	4.86	18,544
SUB01	1221	1220	365	0.004219	15	4.196	4.744	113.1	Parallel	9.27	15	4.19	39,338
SUB01	1227	1226	314	0.003631	12	2.147	2.735	127.4	Parallel	11.19	12	2.14	32,837
SUB01	1228	1227	278	0.003633	12	2.148	2.480	115.5	Parallel	11.12	12	2.14	28,894
SUB01	1236	1215	310	0.003000	10	1.200	2.259	188.3	Parallel	10.54	15	3.53	34,954
SUB06	2107	2106	318	0.000943	36	20.484	21.492	104.9	Parallel	13.63	27	9.49	66,080
SUB06	2108	2107	358	0.000950	36	20.560	21.615	105.1	Parallel	11.08	27	9.54	65,564
SUB06	2109	2108	108	0.001019	36	21.294	21.626	101.6	Parallel	11.01	24	7.22	16,266
SUB06	2110	2109	107	0.000935	36	20.397	21.636	106.1	Parallel	12.22	27	9.44	20,776
SUB06	2110A	2110	56	0.000893	36	19.934	21.623	108.5	Parallel	12.54	27	9.24	11,046
SUB02_03	2119	2118	603	0.000945	36	20.506	22.382	109.1	Parallel	7.73	27	9.54	104,136
SUB02_03	2120	2119	492	0.000955	36	20.614	22.620	109.7	Parallel	7.11	27	9.59	84,966
SUB02_03	2121	P	278	0.001223	30	14.346	20.872	145.5	Parallel	10.26	30	14.32	53,764
SUB01	254	1180	392	0.017781	12	4.751	6.397	134.6	Parallel	10.15	15	8.61	42,791
SUB01	255	274A	156	0.002372	18	5.116	6.464	126.3	Parallel	10.10	18	5.11	18,319
SUB01	272	303	325	0.002369	18	5.113	7.305	142.9	Parallel	10.00	18	5.11	37,861
SUB01	273	272	438	0.002374	18	5.119	7.115	139.0	Parallel	10.00	18	5.11	51,025

LEAVENWORTH, KS

Model Name: EXISTING - 5 YR 0% REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length (ft)	Slope (ft/ft)	Existing Diam. (in)	Existing Cap (cfs)	Design Flow (cfs)	Percent Utilization (Q_tot/cap)	Relief Type	Average Depth (ft)	Pipe Diam (in)	Pipe Capacity (cfs)	Construction Cost ($)
SUB01	274	273	464	0.002371	18	5.115	6.926	135.4	Parallel	10.00	18	5.11	54,054
SUB01	274A	274	284	0.002394	18	5.140	6.706	130.5	Parallel	10.00	18	5.13	33,085
SUB01	275	275A	150	0.018067	12	4.789	5.884	122.9	Parallel	10.00	12	4.79	14,046
SUB01	275A	254	164	0.018720	12	4.875	6.142	126.0	Parallel	10.00	12	4.87	15,357
SUB01	299	299A	57	0.004035	12	2.263	5.368	237.2	Parallel	10.96	18	6.67	7,152
SUB01	299A	275	251	0.004143	12	2.293	5.633	245.7	Parallel	10.31	18	6.75	29,969
SUB01	302	303	21	0.007619	12	3.110	7.377	237.2	Parallel	10.00	18	9.17	2,447
SUB01	303	304	423	0.002388	18	5.134	14.835	289.0	Parallel	10.00	27	15.14	73,051
SUB01	304	305A	385	0.002364	18	5.108	15.030	294.2	Parallel	10.00	27	15.04	66,488
SUB01	305	306A	394	0.002360	18	5.103	15.483	303.4	Parallel	10.00	30	19.92	75,195
SUB01	305A	305	56	0.002321	18	5.061	15.230	300.9	Parallel	10.00	30	19.75	10,687
SUB01	306	307	115	0.002348	18	5.090	15.930	313.0	Parallel	14.43	30	19.88	26,938
SUB01	306A	306	62	0.002419	18	5.167	15.680	303.5	Parallel	10.00	30	20.18	11,833
SUB01	307	309	590	0.001966	24	10.032	41.569	414.4	Parallel	16.58	42	44.66	202,099
SUB01	309	311	174	0.006322	24	17.989	41.637	231.5	Parallel	13.43	33	342.05	41,536
SUB01	311	311A	48	0.003542	30	24.414	41.817	171.3	Parallel	12.03	33	31.47	10,794
SUB02_03	311A	9012	140	0.001000	30	12.972	41.797	322.2	Parallel	11.65	48	45.43	48,767
SUB01	314	302	409	0.007677	12	3.122	7.143	228.8	Parallel	10.00	18	9.20	47,646
SUB01	315	314	455	0.006242	12	2.815	6.910	245.5	Parallel	10.65	18	8.29	55,770
SUB01	315A	315	196	0.001122	12	1.193	6.657	558.0	Parallel	9.31	24	7.57	27,634
SUB01	316	316A	155	0.012452	10	2.445	5.888	240.8	Parallel	7.01	15	7.20	16,705
SUB01	316A	316B	175	0.013486	12	4.138	6.148	148.6	Parallel	5.93	15	7.50	18,861
SUB01	316B	315A	170	0.003706	12	2.169	6.403	295.2	Parallel	6.59	21	9.65	21,654
SUB01	324	325	193	0.011244	10	2.323	4.606	198.3	Parallel	6.87	15	6.84	20,801
SUB01	324A	324	187	0.009679	10	2.156	4.344	201.5	Parallel	5.91	15	6.35	20,154
SUB01	325	326	376	0.012686	10	2.468	4.868	197.2	Parallel	8.73	15	7.27	40,524
SUB01	326	327	375	0.012853	10	2.484	5.120	206.1	Parallel	11.45	15	7.32	45,431
SUB01	327	327A	166	0.011687	10	2.369	5.370	226.7	Parallel	12.25	15	6.97	21,336
SUB01	327A	316	214	0.014159	10	2.607	5.631	216.0	Parallel	10.04	15	7.69	23,143
SUB01	361	324A	178	0.016629	10	2.826	4.081	144.4	Parallel	7.70	12	4.59	16,667
SUB01	362	361	131	0.005954	10	1.691	3.815	225.6	Parallel	11.31	15	4.98	15,702
SUB01	362A	362	182	0.004011	10	1.388	3.550	255.8	Parallel	11.15	15	4.09	21,545
SUB01	365	840A	333	0.010931	10	2.291	2.755	120.3	Parallel	11.02	10	2.29	31,423

LEAVENWORTH, KS

Model Name: EXISTING - 5 YR 0% REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length (ft)	Slope (ft/ft)	Existing Diam. (in)	Existing Cap (cfs)	Design Flow (cfs)	Percent Utilization (Q_tot/cap)	Relief Type	Average Depth (ft)	Pipe Diam (in)	Pipe Capacity (cfs)	Construction Cost ($)
SUB01	365A	365	36	0.011111	8	1.274	2.480	194.7	Parallel	12.80	12	3.77	4,297
SUB01	366	365B	163	0.005215	8	0.873	1.933	221.4	Parallel	10.18	12	2.57	15,533
SUB01	367	368	378	0.004392	12	2.361	4.131	175.0	Parallel	7.73	15	4.28	40,739
SUB01	368A	369	350	0.005086	12	2.541	4.631	182.3	Parallel	7.41	15	4.60	37,722
SUB01	370	299	434	0.004147	12	2.295	5.129	223.5	Parallel	10.09	18	6.76	50,924
SUB01	404C	367	159	0.001698	12	1.468	3.865	263.3	Parallel	10.27	18	4.33	18,924
SUB01	424A	424B	190	0.003842	12	2.209	2.507	113.5	Parallel	7.22	12	2.20	17,791
SUB01	424B	424C	90	0.004000	12	2.253	2.774	123.1	Parallel	9.26	12	2.25	8,427
SUB01	425A	424A	183	0.003989	10	1.384	2.235	161.5	Parallel	8.16	12	2.25	17,135
SUB01	426A	425A	147	0.004286	10	1.434	1.961	136.8	Parallel	8.37	12	2.33	13,764
SUB01	428A	404	160	0.004125	12	2.288	3.324	145.3	Parallel	10.14	15	4.15	17,451
SUB01	490	490A	254	0.002441	15	3.192	10.744	336.6	Parallel	10.72	24	11.17	37,555
SUB01	490A	1190	143	0.002378	10	1.069	10.962	1,025.4	Parallel	9.09	27	15.11	24,695
SUB04	630A	2110A	138	0.017246	10	2.878	3.322	115.4	Parallel	9.58	10	2.87	11,743
SUB04	631	630	47	0.007021	10	1.836	2.244	122.2	Parallel	6.37	10	1.83	3,999
SUB01	692	1193	205	0.016390	15	8.271	8.822	106.7	Parallel	8.42	15	8.27	22,095
SUB01	694	692	289	0.001488	18	4.052	8.608	212.4	Parallel	6.62	24	21.98	40,746
SUB01	695	694	251	0.001235	18	3.692	8.387	227.2	Parallel	5.17	24	21.20	35,389
SUB01	696A	695	212	0.001557	18	4.145	8.158	196.8	Parallel	7.00	24	8.96	29,890
SUB01	697	696	291	0.000103	24	2.296	7.714	336.0	Parallel	6.73	42	10.06	79,853
SUB01	698	697	283	0.000954	12	1.101	7.467	678.2	Parallel	6.60	27	9.54	48,873
SUB01	698A	698	80	0.001000	12	1.127	3.238	287.3	Parallel	8.63	18	3.32	9,320
SUB01	699	698A	193	0.001606	12	1.428	2.980	208.7	Parallel	8.84	18	4.21	22,483
SUB01	701	700	217	0.001935	12	1.567	2.196	140.1	Parallel	15.26	15	2.84	33,913
SUB01	720	721	147	0.003333	12	2.057	3.759	182.7	Parallel	9.95	15	3.72	15,843
SUB01	721	698	152	0.004013	12	2.257	4.017	178.0	Parallel	9.72	15	4.09	16,382
SUB01	840A	9013	29	0.007586	10	1.908	3.013	157.9	Parallel	9.24	12	3.10	2,715
SUB02_03	9012	2121A	15	0.006667	30	33.495	41.749	124.6	Parallel	11.68	27	25.29	2,834
SUB01	9013	362A	195	0.021128	10	3.185	3.286	103.2	Parallel	9.64	10	3.18	16,595
SUB06	B	A	260	0.000962	36	20.690	21.760	105.2	Parallel	13.24	27	9.59	53,046
SUB06	C	B	107	0.000841	36	19.345	21.771	112.5	Parallel	15.22	27	8.97	23,879
SUB06	E	D	407	0.000885	36	19.844	21.904	110.4	Parallel	14.84	27	9.18	89,336
SUB06	F	E	89	0.000899	36	20.001	21.906	109.5	Parallel	14.62	27	9.29	19,346

LEAVENWORTH, KS

Model Name: EXISTING - 5 YR 0% REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length	Slope	Existing Diam.	Existing Cap	Design Flow	Percent Utilization	Relief Type	Average Depth	Pipe Diam	Pipe Capacity	Construction Cost
			(ft)	(ft/ft)	(in)	(cfs)	(cfs)	(Q_tot/cap)		(ft)	(in)	(cfs)	($)
SUB06	G	F	658	0.000836	36	19.287	22.164	114.9	Parallel	14.31	30	11.88	153,357
SUB06	H	2115	413	0.000969	36	20.765	21.781	104.9	Parallel	11.82	27	9.64	78,592
SUB06	J	H	620	0.000823	36	19.137	22.047	115.2	Parallel	13.38	30	11.74	138,853
SUB02_03	K	J	650	0.000862	36	19.585	22.326	114.0	Parallel	12.84	27	9.08	130,103
SUB02_03	L	K	604	0.000844	36	19.379	22.618	116.7	Parallel	12.31	30	11.88	128,939
SUB02_03	M	L	492	0.000833	36	19.252	22.853	118.7	Parallel	11.85	30	11.81	102,813
SUB02_03	N	M	489	0.000859	36	19.551	22.853	116.9	Parallel	11.43	30	0.00	100,175
SUB02_03	N	2120	488	0.000943	36	20.484	22.853	111.6	Parallel	9.15	27	9.49	84,276
SUB02_03	P	N	106	0.006604	30	33.336	45.742	137.2	Parallel	0.00	0	0.00	0
SUB02_03	Q	P	459	0.001242	30	14.457	25.249	174.6	Parallel	10.26	33	18.62	95,192
SUB02_03	R	Q	232	0.001207	30	14.252	25.323	177.7	Parallel	10.00	33	18.39	47,519
		Total:	37,539	(ft)									6,171,733

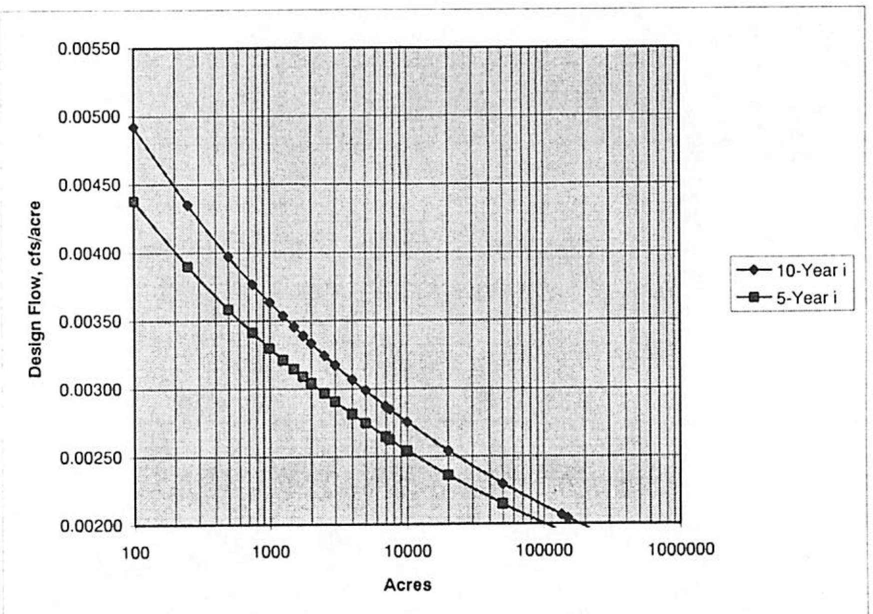
APPENDIX G

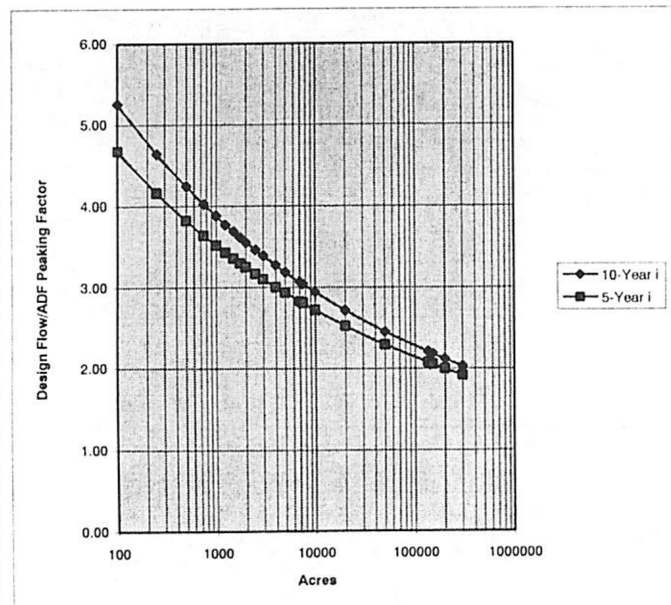
FUTURE FLOW DESIGN CURVES

Leavenworth, KS
Wastewater Design Flow Criteria
By: MLC
06/19/2001

Future Flow Criteria

Percent Zone	Zone Type	Description	Density (Units/ Acre)	Equivalent Capita/ Unit	Equivalent Capita/ Acre	Capita Usage (gpcd)	Average WWP(ADDF) (gapd)	Infil-tration (gpad)	Inflow Coeff. "K"
22%	1	Low Density Residential	1.0	3.2	3.2	100	320	100	0.0040
60%	2	Medium Density Residential	2.0	3.2	6.4	100	640	100	0.0040
0%	3	High Density Residential	5.0	3.2	16.0	100	1,600	100	0.0040
11%	4	Office & Commercial	1.0	2.9	2.9	100	290	100	0.0040
5%	5	Light/Med Industry	1.0	10.0	10.0	100	1,000	100	0.0040
0%	6	Heavy Industry	1.0	25.0	25.0	100	2,500	100	0.0040
2%	7	Public	1.0	2.0	2.0	100	200	100	0.0005
0%	8	Agricultural/ Park	1.0	1.0	1.0	100	100	100	0.0005
100%		Average(weighted)	1.6	3.5	5.4	100.0	540	100	0.0039





BLACK VEATCH

APPENDIX H

2010 RELIEF SEWER COST DETAIL
(5-YEAR STORM EVENT)

LEAVENWORTH, KS - FUTURE

Model Name: 2010 - 5 YR 0% I/I REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length	Slope	Existing Diam.	Existing Cap	Design Flow	Percent Utilization	Relief Type	Average Depth	Pipe Diam	Pipe Capacity	Construction Cost
			(ft)	(ft/ft)	(in)	(cfs)	(cfs)	(Q_tot/cap)		(ft)	(in)	(cfs)	($)
SUB05	11	10	182	0.001099	24	7.500	8.133	108.4	Replace	24.11	30	13.60	59,890
SUB01	1165	307	75	0.001867	24	9.776	30.109	308.0	Replace	18.69	42	43.51	27,330
SUB01	1166	1165	285	0.001895	24	9.849	29.896	303.5	Replace	20.17	42	43.74	108,216
SUB01	1167	1166	166	0.002048	24	10.239	29.652	289.6	Replace	18.28	42	45.55	59,784
SUB01	1168	1167	223	0.001883	24	9.818	29.422	299.7	Replace	14.58	42	43.62	71,768
SUB01	1169	1168	131	0.001985	24	10.080	29.168	289.4	Replace	16.41	42	44.77	44,643
SUB01	1170	1169	499	0.001904	24	9.872	29.006	293.8	Replace	18.16	42	43.86	179,091
SUB01	1171	1170	115	0.001913	24	9.896	28.746	290.5	Replace	14.28	42	43.97	36,653
SUB01	1172	1171	224	0.001920	24	9.914	28.528	287.8	Replace	11.09	42	44.09	63,995
SUB01	1173	1172	189	0.000476	24	4.936	28.302	573.4	Replace	11.90	54	43.08	80,190
SUB01	1174	1173	100	0.002400	24	11.084	28.047	253.0	Replace	12.14	42	49.29	29,657
SUB01	1175	1174	98	0.001327	24	8.242	27.791	337.2	Replace	12.45	42	36.69	29,378
SUB01	1176	1175	301	0.001860	24	9.757	27.602	282.9	Replace	11.76	42	43.39	88,082
SUB01	1177	1176	344	0.001890	24	9.836	27.427	278.8	Replace	9.50	42	43.74	94,397
SUB01	1178	1177	124	0.001774	24	9.529	27.180	285.2	Replace	8.82	42	42.33	34,026
SUB01	1179	1178	441	0.001927	24	9.932	27.036	272.2	Replace	9.02	42	44.20	121,015
SUB01	1180	1179	310	0.001839	24	9.702	26.946	277.7	Replace	9.53	42	0.00	85,067
SUB01	1180	255	10	0.001000	15	2.043	3.183	155.8	Replace	9.93	21	5.01	1,274
SUB01	1185	1184	340	0.002471	24	11.247	20.990	186.6	Replace	9.92	36	33.15	74,390
SUB01	1186	1185	125	0.002080	24	10.318	20.745	201.1	Replace	9.42	36	30.42	27,350
SUB01	1187	1186	162	0.001975	24	10.055	20.511	204.0	Replace	8.37	36	29.68	35,445
SUB01	1188	1187	241	0.001120	24	7.572	20.303	268.1	Replace	7.00	42	33.67	66,133
SUB01	1189	1188	459	0.002004	24	10.128	20.163	199.1	Replace	6.87	36	29.83	100,426
SUB01	1190	1189	594	0.001987	24	10.085	20.065	199.0	Replace	7.10	36	29.75	129,965
SUB01	1191	1190	346	0.005202	18	7.577	8.344	110.1	Replace	7.18	21	11.42	44,073
SUB01	1192	1191	429	0.004942	18	7.385	8.209	111.2	Replace	7.36	21	11.13	54,647
SUB01	1193	1192	390	0.012077	15	7.100	8.028	113.1	Replace	8.28	18	11.54	45,433
SUB01	1194	720	45	0.002222	12	1.680	3.251	193.5	Replace	8.55	18	4.95	5,243
SUB01	1195	1194	275	0.002218	12	1.678	3.037	181.0	Replace	8.70	18	4.95	32,037
SUB01	1196	1195	370	0.002135	12	1.646	2.841	172.6	Replace	11.00	18	4.86	46,562
SUB01	1196A	1196	361	0.010360	10	2.230	2.630	117.9	Replace	13.23	15	6.57	49,661
SUB01	1197	1196A	303	0.010396	10	2.234	2.415	108.1	Replace	13.29	15	6.58	41,849
SUB01	1198A	1198	332	0.008012	8	1.082	1.765	163.1	Replace	13.14	12	3.18	40,672

LEAVENWORTH, KS - FUTURE

Model Name: 2010 - 5 YR 0% I/I REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length (ft)	Slope (ft/ft)	Existing Diam. (in)	Existing Cap (cfs)	Design Flow (cfs)	Percent Utilization (Q_tot/cap)	Relief Type	Average Depth (ft)	Pipe Diam (in)	Pipe Capacity (cfs)	Construction Cost ($)
SUB01	1199	1198A	319	0.007962	8	1.078	1.547	143.5	Replace	13.04	12	3.17	38,786
SUB05	12	11	371	0.001132	24	7.612	8.150	107.1	Replace	26.05	30	13.79	129,132
SUB01	1204	490	543	0.002431	15	3.185	12.394	389.1	Replace	12.55	30	20.22	117,193
SUB01	1205	1204	260	0.004308	15	4.240	12.145	286.4	Replace	15.61	27	20.33	59,005
SUB01	1206	1205	380	0.004026	15	4.099	11.911	290.6	Replace	12.09	27	19.66	73,304
SUB01	1207	1206	242	0.019669	15	9.060	11.661	128.7	Replace	8.69	21	22.22	30,827
SUB01	1208	1207	308	0.009545	15	6.312	11.420	180.9	Replace	10.34	21	15.48	40,222
SUB01	1209	1208	316	0.003513	15	3.829	11.180	292.0	Replace	13.32	27	18.35	64,716
SUB01	1210	1209	322	0.003696	15	3.928	10.941	278.5	Replace	12.17	27	18.84	62,364
SUB01	1211	1210	260	0.003577	15	3.864	10.695	276.8	Replace	8.11	27	18.53	44,901
SUB01	1212	1211	269	0.003569	15	3.859	10.455	270.9	Replace	8.66	24	13.51	37,926
SUB01	1213	1212	166	0.003554	15	3.851	10.206	265.0	Replace	7.89	24	13.48	23,404
SUB01	1214	1213	35	0.002571	15	3.276	9.936	303.3	Replace	6.05	27	15.70	6,045
SUB01	1215	1214	357	0.003641	15	3.898	9.718	249.3	Replace	10.80	24	13.65	53,055
SUB01	1216	1215	343	0.005656	15	4.859	7.388	152.0	Replace	12.83	21	11.92	52,861
SUB01	1217	1216	369	0.005962	15	4.988	7.172	143.8	Replace	15.46	21	12.23	66,034
SUB01	1218	1217	190	0.005737	15	4.893	6.928	141.6	Replace	15.82	21	12.00	34,647
SUB01	1219	1218	252	0.006032	15	5.017	6.694	133.4	Replace	13.01	21	12.30	39,265
SUB01	1220	1219	125	0.005680	15	4.869	6.440	132.3	Replace	14.40	21	11.94	21,118
SUB01	1221	1220	365	0.004219	15	4.196	6.224	148.3	Replace	9.27	21	10.29	46,493
SUB01	1222	1221	357	0.005602	15	4.835	6.006	124.2	Replace	8.00	18	7.86	41,589
SUB01	1223	1222	275	0.005564	15	4.819	5.777	119.9	Replace	10.74	18	7.83	33,938
SUB01	1224	1223	272	0.005588	15	4.829	5.549	114.9	Replace	10.21	18	7.85	32,221
SUB01	1227	1226	314	0.003631	12	2.147	4.300	200.3	Replace	11.19	18	6.32	40,073
SUB01	1228	1227	278	0.003633	12	2.148	4.060	189.0	Replace	11.12	18	6.32	35,297
SUB01	1229	1266	129	0.009767	12	3.521	3.560	101.1	Replace	8.00	15	6.38	13,903
SUB01	1229A	1229	319	0.008809	10	2.057	3.317	161.3	Replace	8.00	15	6.06	34,380
SUB01	1230	1229A	316	0.008797	10	2.055	3.083	150.0	Replace	10.00	15	6.06	34,057
SUB01	1231	1230	439	0.007859	10	1.942	2.861	147.3	Replace	11.48	15	5.72	53,305
SUB01	1236	1215	310	0.003000	10	1.200	2.271	189.3	Replace	10.54	15	3.53	34,954
SUB01	1266	1228	181	0.010221	12	3.602	3.812	105.8	Replace	10.56	15	6.53	20,443
SUB05	13	12	389	0.001131	24	7.609	8.169	107.4	Replace	24.70	30	13.79	130,251
SUB05	1401	880	11	0.001818	24	9.647	11.003	114.1	Replace	6.05	30	17.50	2,099

LEAVENWORTH, KS - FUTURE

Model Name: 2010 - 5 YR 0% I/I REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length	Slope	Existing Diam.	Existing Cap	Design Flow	Percent Utilization	Relief Type	Average Depth	Pipe Diam	Pipe Capacity	Construction Cost
			(ft)	(ft/ft)	(in)	(cfs)	(cfs)	(Q_tot/cap)		(ft)	(in)	(cfs)	($)
SUB05	1415	1414	256	0.000313	24	4.003	8.882	221.9	Replace	12.71	36	11.74	62,923
SUB05	15	14	315	0.002889	18	5.647	8.036	142.3	Replace	23.37	24	12.16	84,550
SUB05	16	15	257	0.004981	18	7.414	7.920	106.8	Replace	21.34	21	11.18	60,267
SUB05	17	16	454	0.005463	15	4.775	7.887	165.2	Replace	22.46	21	11.70	111,265
SUB05	18	17	195	0.014359	15	7.741	7.829	101.1	Replace	23.86	18	12.58	47,983
SUB05	18A	18	200	0.001600	18	4.202	6.867	163.4	Replace	22.38	24	9.05	51,794
SUB05	18B	18A	190	0.001579	18	4.174	6.819	163.4	Replace	25.70	24	8.99	55,216
SUB06	2107	2106	318	0.000943	36	20.484	22.639	110.5	Replace	13.63	42	30.85	99,215
SUB06	2108	2107	358	0.000950	36	20.560	22.817	111.0	Replace	11.08	42	31.01	102,241
SUB06	2109	2108	108	0.001019	36	21.294	22.840	107.3	Replace	11.01	42	32.13	30,765
SUB06	2110	2109	107	0.000935	36	20.397	22.861	112.1	Replace	12.22	42	30.68	31,821
SUB06	2110A	2110	56	0.000893	36	19.934	22.851	114.6	Replace	12.54	42	30.01	16,839
SUB02_03	2119	2118	603	0.000945	36	20.506	23.213	113.2	Replace	7.73	42	31.01	165,468
SUB02_03	2120	2119	492	0.000955	36	20.614	23.494	114.0	Replace	7.11	42	31.17	135,009
SUB02_03	2121	P	278	0.001223	30	14.346	21.946	153.0	Replace	10.26	42	35.14	77,035
SUB01	254	1180	379	0.018391	12	4.832	7.957	164.7	Replace	10.15	18	14.24	44,683
SUB01	255	274A	156	0.002372	18	5.116	6.390	124.9	Replace	10.10	24	11.01	22,142
SUB01	272	303	325	0.002369	18	5.113	7.238	141.6	Replace	10.00	24	11.01	45,823
SUB01	273	272	438	0.002374	18	5.119	7.047	137.7	Replace	10.00	24	11.01	61,754
SUB01	274	273	464	0.002371	18	5.115	6.856	134.0	Replace	10.00	24	11.01	65,420
SUB01	274A	274	284	0.002394	18	5.140	6.634	129.1	Replace	10.00	24	11.06	40,042
SUB01	275	254	164	0.033354	12	6.507	7.703	118.4	Replace	8.80	18	19.18	19,106
SUB01	302	303	21	0.007619	12	3.110	5.675	182.5	Replace	10.00	18	9.17	2,447
SUB01	303	304	423	0.002388	18	5.134	12.882	250.9	Replace	10.00	30	20.05	80,728
SUB01	304	305A	385	0.002364	18	5.108	13.071	255.9	Replace	10.00	30	19.92	73,476
SUB01	305	306A	394	0.002360	18	5.103	13.511	264.8	Replace	10.00	30	19.92	75,195
SUB01	305A	305	56	0.002321	18	5.061	13.264	262.1	Replace	10.00	30	19.75	10,687
SUB01	306	307	115	0.002348	18	5.090	13.946	274.0	Replace	14.43	30	19.88	26,938
SUB01	306A	306	62	0.002419	18	5.167	13.702	265.2	Replace	10.00	30	20.18	11,833
SUB01	307	309	590	0.001966	24	10.032	43.599	434.6	Replace	16.58	48	63.76	235,963
SUB01	309	311	174	0.006322	24	17.989	43.734	243.1	Replace	13.43	42	650.71	53,926
SUB01	311	311A	48	0.003542	30	24.414	43.973	180.1	Replace	12.03	42	59.86	14,180
SUB02_03	311A	9012	140	0.001000	30	12.972	43.954	338.8	Replace	11.65	54	62.19	59,023

LEAVENWORTH, KS - FUTURE

Model Name: 2010 - 5 YR 0% I/I REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length (ft)	Slope (ft/ft)	Existing Diam. (in)	Existing Cap (cfs)	Design Flow (cfs)	Percent Utilization (Q_tot/cap)	Relief Type	Average Depth (ft)	Pipe Diam (in)	Pipe Capacity (cfs)	Construction Cost ($)
SUB01	314	302	409	0.007677	12	3.122	5.433	174.0	Replace	10.00	18	9.20	47,646
SUB01	315	314	455	0.006242	12	2.815	5.192	184.4	Replace	10.65	18	8.29	55,770
SUB01	315A	315	196	0.001122	12	1.193	4.932	413.4	Replace	9.31	24	7.57	27,634
SUB01	316	316A	155	0.012452	10	2.445	4.139	169.3	Replace	7.01	15	7.20	16,705
SUB01	316A	316B	175	0.013486	12	4.138	4.407	106.5	Replace	5.93	15	7.50	18,861
SUB01	316B	315A	170	0.003706	12	2.169	4.670	215.3	Replace	6.59	18	6.39	19,804
SUB01	324	325	193	0.011244	10	2.323	2.812	121.1	Replace	6.87	15	6.84	20,801
SUB01	324A	324	187	0.009679	10	2.156	2.539	117.8	Replace	5.91	15	6.35	20,154
SUB01	325	326	376	0.012686	10	2.468	3.083	124.9	Replace	8.73	15	7.27	40,524
SUB01	326	327	375	0.012853	10	2.484	3.344	134.6	Replace	11.45	15	7.32	45,431
SUB01	327	327A	166	0.011687	10	2.369	3.604	152.1	Replace	12.25	15	6.97	21,336
SUB01	327A	316	214	0.014159	10	2.607	3.873	148.6	Replace	10.04	15	7.69	23,143
SUB01	362	361	131	0.005954	10	1.691	1.987	117.5	Replace	11.31	15	4.98	15,702
SUB01	362A	362	182	0.004011	10	1.388	1.711	123.3	Replace	11.15	15	4.09	21,545
SUB01	490	490A	254	0.002441	15	3.192	12.609	395.0	Replace	10.72	30	20.26	50,266
SUB01	490A	1190	143	0.002378	10	1.069	12.859	1,202.9	Replace	9.09	30	20.01	27,291
SUB04	630A	2110A	138	0.017246	10	2.878	3.322	115.4	Replace	9.58	15	8.48	14,873
SUB04	631	630	47	0.007021	10	1.836	2.244	122.2	Replace	6.37	15	5.41	5,065
SUB01	694	692	289	0.001488	18	4.052	7.633	188.4	Replace	6.62	27	30.09	49,910
SUB01	695	694	251	0.001235	18	3.692	7.447	201.7	Replace	5.17	27	29.02	43,347
SUB01	696A	695	212	0.001557	18	4.145	7.251	174.9	Replace	7.00	27	12.27	36,612
SUB01	697	696	291	0.000103	24	2.296	6.888	300.0	Replace	6.73	42	10.06	79,853
SUB01	698	697	283	0.000954	12	1.101	6.671	605.9	Replace	6.60	27	9.54	48,873
SUB01	698A	698	80	0.001000	12	1.127	3.256	288.9	Replace	8.63	21	5.01	10,191
SUB01	699	698A	193	0.001606	12	1.428	2.996	209.8	Replace	8.84	18	4.21	22,483
SUB01	701	700	217	0.001935	12	1.567	2.208	140.9	Replace	15.26	18	4.62	35,949
SUB01	720	721	147	0.003333	12	2.057	3.494	169.9	Replace	9.95	18	6.06	17,124
SUB01	721	698	152	0.004013	12	2.257	3.726	165.1	Replace	9.72	18	6.65	17,707
SUB02_03	9012	2121A	15	0.006667	30	33.495	43.897	131.1	Replace	11.68	42	82.17	4,378
SUB06	B	A	260	0.000962	36	20.690	21.632	104.6	Replace	13.24	42	31.17	80,069
SUB06	C	B	107	0.000841	36	19.345	21.656	111.9	Replace	15.22	42	29.16	35,144
SUB06	E	D	407	0.000885	36	19.844	21.853	110.1	Replace	14.84	42	29.84	132,082
SUB06	F	E	89	0.000899	36	20.001	21.863	109.3	Replace	14.62	42	30.18	28,680

LEAVENWORTH, KS - FUTURE

Model Name: 2010 - 5 YR 0% I/I REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length (ft)	Slope (ft/ft)	Existing Diam. (in)	Existing Cap (cfs)	Design Flow (cfs)	Percent Utilization (Q_tot/cap)	Relief Type	Average Depth (ft)	Pipe Diam (in)	Pipe Capacity (cfs)	Construction Cost ($)
SUB06	G	F	658	0.000836	36	19.287	22.223	115.2	Replace	14.31	42	29.16	209,926
SUB06	H	2115	413	0.000969	36	20.765	22.496	108.3	Replace	11.82	42	31.33	121,114
SUB06	J	H	620	0.000823	36	19.137	22.816	119.2	Replace	13.38	48	41.13	227,197
SUB02_03	K	J	650	0.000862	36	19.585	23.147	118.2	Replace	12.84	48	42.13	234,517
SUB02_03	L	K	604	0.000844	36	19.379	23.492	121.2	Replace	12.31	48	41.63	214,569
SUB02_03	M	L	492	0.000833	36	19.252	23.770	123.5	Replace	11.85	48	41.38	172,413
SUB02_03	N	M	489	0.000859	36	19.551	23.770	121.6	Replace	11.43	48	0.00	169,213
SUB02_03	N	2120	488	0.000943	36	20.484	23.770	116.0	Replace	9.15	42	30.85	133,911
SUB02_03	P	N	106	0.006604	30	33.336	47.582	142.7	Replace	0.00	0	0.00	0
SUB02_03	Q	P	459	0.001242	30	14.457	26.083	180.4	Replace	10.26	42	35.43	127,188
SUB02_03	R	Q	232	0.001207	30	14.252	26.170	183.6	Replace	10.00	42	35.00	63,663
		Total:	38,946	(ft)									8,440,571

APPENDIX I

2020 RELIEF SEWER COST DETAIL (5-YEAR STORM EVENT)

LEAVENWORTH, KS - FUTURE

Model Name: 2020 - 5 YR 0% I/I REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length (ft)	Slope (ft/ft)	Existing Diam. (in)	Existing Cap (cfs)	Design Flow (cfs)	Percent Utilization (Q_tot/cap)	Relief Type	Average Depth (ft)	Pipe Diam (in)	Pipe Capacity (cfs)	Construction Cost ($)
SUB05	11	10	182	0.001099	24	7.500	15.639	208.5	Replace	24.11	36	22.12	65,405
SUB01	1165	307	75	0.001867	24	9.776	32.283	330.2	Replace	18.69	42	43.51	27,330
SUB01	1166	1165	285	0.001895	24	9.849	32.088	325.8	Replace	20.17	42	43.74	108,216
SUB01	1167	1166	166	0.002048	24	10.239	31.855	311.1	Replace	18.28	42	45.55	59,784
SUB01	1168	1167	223	0.001883	24	9.818	31.641	322.3	Replace	14.58	42	43.62	71,768
SUB01	1169	1168	131	0.001985	24	10.080	31.396	311.5	Replace	16.41	42	44.77	44,643
SUB01	1170	1169	499	0.001904	24	9.872	31.270	316.8	Replace	18.16	42	43.86	179,091
SUB01	1171	1170	115	0.001913	24	9.896	31.021	313.5	Replace	14.28	42	43.97	36,653
SUB01	1172	1171	224	0.001920	24	9.914	30.808	310.8	Replace	11.09	42	44.09	63,995
SUB01	1173	1172	189	0.000476	24	4.936	30.583	619.6	Replace	11.90	54	43.08	80,190
SUB01	1174	1173	100	0.002400	24	11.084	30.329	273.6	Replace	12.14	42	49.29	29,657
SUB01	1175	1174	98	0.001327	24	8.242	30.076	364.9	Replace	12.45	48	52.39	34,957
SUB01	1176	1175	301	0.001860	24	9.757	29.887	306.3	Replace	11.76	42	43.39	88,082
SUB01	1177	1176	344	0.001890	24	9.836	29.711	302.1	Replace	9.50	42	43.74	94,397
SUB01	1178	1177	124	0.001774	24	9.529	29.466	309.2	Replace	8.82	42	42.33	34,026
SUB01	1179	1178	441	0.001927	24	9.932	29.321	295.2	Replace	9.02	42	44.20	121,015
SUB01	1180	1179	310	0.001839	24	9.702	29.245	301.4	Replace	9.53	42	0.00	85,067
SUB01	1180	255	10	0.001000	15	2.043	3.189	156.1	Replace	9.93	21	5.01	1,274
SUB01	1181	1180	324	0.011142	24	23.882	24.370	102.0	Replace	5.18	27	32.69	55,953
SUB01	1184	1183	38	0.009737	24	22.325	23.592	105.7	Replace	10.73	27	30.56	6,830
SUB01	1185	1184	340	0.002471	24	11.247	23.415	208.2	Replace	9.92	36	33.15	74,390
SUB01	1186	1185	125	0.002080	24	10.318	23.172	224.6	Replace	9.42	36	30.42	27,350
SUB01	1187	1186	162	0.001975	24	10.055	22.941	228.2	Replace	8.37	36	29.68	35,445
SUB01	1188	1187	241	0.001120	24	7.572	22.734	300.2	Replace	7.00	42	33.67	66,133
SUB01	1189	1188	459	0.002004	24	10.128	22.593	223.1	Replace	6.87	36	29.83	100,426
SUB01	1190	1189	594	0.001987	24	10.085	22.493	223.0	Replace	7.10	36	29.75	129,965
SUB01	1191	1190	346	0.005202	18	7.577	8.819	116.4	Replace	7.18	21	11.42	44,073
SUB01	1192	1191	429	0.004942	18	7.385	8.683	117.6	Replace	7.36	21	11.13	54,647
SUB01	1193	1192	390	0.012077	15	7.100	8.502	119.7	Replace	8.28	18	11.54	45,433
SUB01	1194	720	45	0.002222	12	1.680	3.738	222.5	Replace	8.55	18	4.95	5,243
SUB01	1195	1194	275	0.002218	12	1.678	3.526	210.1	Replace	8.70	18	4.95	32,037
SUB01	1196	1195	370	0.002135	12	1.646	3.330	202.3	Replace	11.00	18	4.86	46,562
SUB01	1196A	1196	361	0.010360	10	2.230	3.119	139.9	Replace	13.23	15	6.57	49,661

LEAVENWORTH, KS - FUTURE

Model Name: 2020 - 5 YR 0% I/I REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length (ft)	Slope (ft/ft)	Existing Diam. (in)	Existing Cap (cfs)	Design Flow (cfs)	Percent Utilization (Q_tot/cap)	Relief Type	Average Depth (ft)	Pipe Diam (in)	Pipe Capacity (cfs)	Construction Cost ($)
SUB01	1197	1196A	303	0.010396	10	2.234	2.904	130.0	Replace	13.29	15	6.58	41,849
SUB01	1197A	1197	402	0.010373	10	2.232	2.698	120.9	Replace	12.63	15	6.57	53,076
SUB01	1198	1197A	199	0.010402	10	2.235	2.476	110.8	Replace	12.01	15	6.58	25,137
SUB01	1198A	1198	332	0.008012	8	1.082	2.255	208.4	Replace	13.14	15	5.78	45,395
SUB01	1199	1198A	319	0.007962	8	1.078	2.036	188.9	Replace	13.04	12	3.17	38,786
SUB05	12	11	371	0.001132	24	7.612	15.656	205.7	Replace	26.05	36	22.42	140,498
SUB01	1201	1200	321	0.007882	8	1.073	1.361	126.8	Replace	5.86	12	3.16	30,057
SUB01	1202	1201	317	0.008013	8	1.082	1.146	105.9	Replace	5.82	10	1.96	26,976
SUB01	1204	490	543	0.002431	15	3.185	14.331	450.0	Replace	12.55	30	20.22	117,193
SUB01	1205	1204	260	0.004308	15	4.240	14.092	332.4	Replace	15.61	27	20.33	59,005
SUB01	1206	1205	380	0.004026	15	4.099	13.877	338.5	Replace	12.09	27	19.66	73,304
SUB01	1207	1206	242	0.019669	15	9.060	13.641	150.6	Replace	8.69	21	22.22	30,827
SUB01	1208	1207	308	0.009545	15	6.312	13.415	212.5	Replace	10.34	24	22.11	44,423
SUB01	1209	1208	316	0.003513	15	3.829	13.190	344.5	Replace	13.32	27	18.35	64,716
SUB01	1210	1209	322	0.003696	15	3.928	12.966	330.1	Replace	12.17	27	18.84	62,364
SUB01	1211	1210	260	0.003577	15	3.864	12.733	329.5	Replace	8.11	27	18.53	44,901
SUB01	1212	1211	269	0.003569	15	3.859	12.501	323.9	Replace	8.66	27	18.50	46,456
SUB01	1213	1212	166	0.003554	15	3.851	12.253	318.2	Replace	7.89	27	18.45	28,668
SUB01	1214	1213	35	0.002571	15	3.276	11.985	365.8	Replace	6.05	27	15.70	6,045
SUB01	1215	1214	357	0.003641	15	3.898	11.767	301.9	Replace	10.80	27	18.68	64,414
SUB01	1216	1215	343	0.005656	15	4.859	9.454	194.6	Replace	12.83	24	17.02	57,611
SUB01	1217	1216	369	0.005962	15	4.988	9.237	185.2	Replace	15.46	21	12.23	66,034
SUB01	1218	1217	190	0.005737	15	4.893	8.995	183.8	Replace	15.82	21	12.00	34,647
SUB01	1219	1218	252	0.006032	15	5.017	8.761	174.6	Replace	13.01	21	12.30	39,265
SUB01	1220	1219	125	0.005680	15	4.869	8.509	174.8	Replace	14.40	21	11.94	21,118
SUB01	1221	1220	365	0.004219	15	4.196	8.293	197.6	Replace	9.27	24	14.69	51,462
SUB01	1222	1221	357	0.005602	15	4.835	8.076	167.0	Replace	8.00	21	11.85	45,475
SUB01	1223	1222	275	0.005564	15	4.819	7.847	162.8	Replace	10.74	21	11.81	36,952
SUB01	1224	1223	272	0.005588	15	4.829	7.619	157.8	Replace	10.21	21	11.84	35,188
SUB01	1227	1226	314	0.003631	12	2.147	6.389	297.6	Replace	11.19	21	9.54	43,527
SUB01	1228	1227	278	0.003633	12	2.148	6.149	286.3	Replace	11.12	21	9.54	38,353
SUB01	1229	1266	129	0.009767	12	3.521	5.650	160.5	Replace	8.00	18	10.38	15,028
SUB01	1229A	1229	319	0.008809	10	2.057	5.406	262.8	Replace	8.00	18	9.86	37,162

LEAVENWORTH, KS - FUTURE

Model Name: 2020 - 5 YR 0% I/I REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length (ft)	Slope (ft/ft)	Existing Diam. (in)	Existing Cap (cfs)	Design Flow (cfs)	Percent Utilization (Q_tot/cap)	Relief Type	Average Depth (ft)	Pipe Diam (in)	Pipe Capacity (cfs)	Construction Cost ($)
SUB01	1230	1229A	316	0.008797	10	2.055	5.164	251.3	Replace	10.00	18	9.85	36,813
SUB01	1231	1230	439	0.007859	10	1.942	4.942	254.5	Replace	11.48	18	9.31	57,215
SUB01	1232	1231	209	0.015789	10	2.753	4.699	170.7	Replace	11.83	15	8.11	26,052
SUB01	1233	1975	168	0.017262	10	2.879	4.208	146.2	Replace	9.86	15	8.48	18,107
SUB01	1236	1215	310	0.003000	10	1.200	2.271	189.3	Replace	10.54	15	3.53	34,954
SUB01	1266	1228	181	0.010221	12	3.602	5.902	163.9	Replace	10.56	18	10.62	22,033
SUB05	13	12	389	0.001131	24	7.609	15.677	206.0	Replace	24.70	36	22.42	142,084
SUB05	1401	880	11	0.001818	24	9.647	18.110	187.7	Replace	6.05	36	28.45	2,406
SUB05	1402	1401	115	0.002435	24	11.164	18.072	161.9	Replace	6.84	33	26.07	23,555
SUB05	1403	1402	248	0.002984	24	12.359	18.065	146.2	Replace	7.35	33	28.87	50,796
SUB05	1404	1403	84	0.002857	24	12.093	18.021	149.0	Replace	8.00	33	28.28	17,205
SUB05	1405	1404	396	0.003030	24	12.454	18.047	144.9	Replace	9.25	33	29.11	81,110
SUB05	1406	1405	234	0.003077	24	12.550	16.650	132.7	Replace	9.50	30	22.76	44,659
SUB05	1407	1406	274	0.002993	24	12.378	16.648	134.5	Replace	8.75	30	22.43	52,292
SUB05	1408	1407	335	0.003015	24	12.423	16.140	129.9	Replace	8.50	30	22.50	63,934
SUB05	1409	1408	291	0.002955	24	12.299	16.141	131.2	Replace	7.55	30	22.31	55,537
SUB05	1410	1409	105	0.002952	24	12.292	16.099	131.0	Replace	7.20	30	22.28	20,039
SUB05	1411	1410	179	0.002961	24	12.311	16.073	130.6	Replace	8.54	30	22.31	34,162
SUB05	1412	1411	72	0.003056	24	12.507	16.024	128.1	Replace	8.78	30	22.69	13,741
SUB05	1413	1412	367	0.002997	24	12.386	16.040	129.5	Replace	7.74	30	22.46	70,041
SUB05	1415	1414	256	0.000313	24	4.003	16.064	401.3	Replace	12.71	48	25.29	92,014
SUB05	1417	2273	158	0.003481	24	13.349	15.992	119.8	Replace	10.25	30	24.19	30,542
SUB05	1418	1417	200	0.003500	24	13.385	15.978	119.4	Replace	10.53	30	24.26	39,208
SUB05	1419	1419A	233	0.003519	24	13.421	15.931	118.7	Replace	10.73	30	24.33	46,133
SUB05	1419A	1418	106	0.003491	24	13.368	15.938	119.2	Replace	10.28	30	24.23	20,520
SUB05	1420	1420A	215	0.003442	24	13.274	15.874	119.6	Replace	12.56	30	24.06	46,424
SUB05	1420A	1419	90	0.003444	24	13.277	15.886	119.7	Replace	10.73	30	24.06	17,820
SUB05	1421	1420	299	0.003478	24	13.343	15.883	119.0	Replace	17.34	30	24.19	78,561
SUB05	1422	1421	254	0.003425	24	13.241	15.880	119.9	Replace	20.59	30	24.02	74,824
SUB05	1423	1422	258	0.003450	24	13.289	15.877	119.5	Replace	19.92	30	24.09	74,309
SUB05	15	14	315	0.002889	18	5.647	15.573	275.8	Replace	23.37	30	22.05	101,371
SUB05	16	15	257	0.004981	18	7.414	15.459	208.5	Replace	21.34	27	21.85	72,564
SUB05	17	16	454	0.005463	15	4.775	15.427	323.1	Replace	22.46	27	22.88	133,103

Time: 08:46:40
Date: 08/30/2001

LEAVENWORTH, KS - FUTURE

Model Name: 2020 - 5 YR 0% I/I REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length	Slope	Existing Diam.	Existing Cap	Design Flow	Percent Utilization	Relief Type	Average Depth	Pipe Diam	Pipe Capacity	Construction Cost
			(ft)	(ft/ft)	(in)	(cfs)	(cfs)	(Q_tot/cap)		(ft)	(in)	(cfs)	($)
SUB05	18	17	195	0.014359	15	7.741	15.371	198.6	Replace	23.86	24	27.11	53,251
SUB05	18A	18	200	0.001600	18	4.202	14.433	343.5	Replace	22.38	33	21.15	65,425
SUB05	18B	18A	190	0.001579	18	4.174	14.387	344.7	Replace	25.70	33	21.02	68,387
SUB01	1975	1232	179	0.017263	10	2.879	4.454	154.7	Replace	10.35	15	8.48	19,869
SUB06	2107	2106	318	0.000943	36	20.484	24.421	119.2	Replace	13.63	48	44.04	117,362
SUB06	2108	2107	358	0.000950	36	20.560	24.589	119.6	Replace	11.08	48	44.27	122,570
SUB06	2109	2108	108	0.001019	36	21.294	24.608	115.6	Replace	11.01	42	32.13	30,765
SUB06	2110	2109	107	0.000935	36	20.397	24.625	120.7	Replace	12.22	48	43.81	37,911
SUB06	2110A	2110	56	0.000893	36	19.934	24.613	123.5	Replace	12.54	48	42.85	20,028
SUB02_03	2119	2118	603	0.000945	36	20.506	24.084	117.4	Replace	7.73	42	31.01	165,468
SUB02_03	2120	2119	492	0.000955	36	20.614	24.356	118.2	Replace	7.11	48	44.51	162,887
SUB02_03	2121	P	278	0.001223	30	14.346	22.858	159.3	Replace	10.26	42	35.14	77,035
SUB05	2273	1416	143	0.003427	24	13.245	16.018	120.9	Replace	9.78	30	24.02	27,291
SUB05	2367	1423	20	0.002500	24	11.312	15.539	137.4	Replace	14.73	30	20.51	4,744
SUB05	2368	2367	284	0.002183	24	10.571	15.543	147.0	Replace	9.28	33	24.69	58,170
SUB05	2369	2368	306	0.002484	24	11.276	15.551	137.9	Replace	8.40	30	20.42	58,399
SUB05	2370	2369	270	0.002333	24	10.928	15.549	142.3	Replace	12.29	33	25.53	61,410
SUB05	2371	2370	422	0.001943	24	9.973	15.585	156.3	Replace	19.49	33	23.29	125,999
SUB05	2372	2371	408	0.002083	24	10.326	15.616	151.2	Replace	26.05	33	24.12	148,261
SUB05	2373	2372	425	0.002094	24	10.353	15.650	151.2	Replace	25.28	33	24.18	151,205
SUB05	2374	2373	493	0.002170	24	10.539	15.700	149.0	Replace	22.29	33	24.63	160,836
SUB01	254	1180	379	0.018391	12	4.832	7.957	164.7	Replace	10.15	18	14.24	44,683
SUB01	255	274A	156	0.002372	18	5.116	6.315	123.4	Replace	10.10	24	11.01	22,142
SUB01	272	303	325	0.002369	18	5.113	7.164	140.1	Replace	10.00	24	11.01	45,823
SUB01	273	272	438	0.002374	18	5.119	6.972	136.2	Replace	10.00	24	11.01	61,754
SUB01	274	273	464	0.002371	18	5.115	6.781	132.6	Replace	10.00	24	11.01	65,420
SUB01	274A	274	284	0.002394	18	5.140	6.559	127.6	Replace	10.00	24	11.06	40,042
SUB01	275	254	164	0.033354	12	6.507	7.703	118.4	Replace	8.80	18	19.18	19,106
SUB01	302	303	21	0.007619	12	3.110	5.675	182.5	Replace	10.00	18	9.17	2,447
SUB01	303	304	423	0.002388	18	5.134	12.805	249.4	Replace	10.00	30	20.05	80,728
SUB01	304	305A	385	0.002364	18	5.108	12.994	254.4	Replace	10.00	30	19.92	73,476
SUB01	305	306A	394	0.002360	18	5.103	13.434	263.3	Replace	10.00	30	19.92	75,195
SUB01	305A	305	56	0.002321	18	5.061	13.187	260.6	Replace	10.00	30	19.75	10,687

LEAVENWORTH, KS - FUTURE

Model Name: 2020 - 5 YR 0% I/I REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length (ft)	Slope (ft/ft)	Existing Diam. (in)	Existing Cap (cfs)	Design Flow (cfs)	Percent Utilization (Q_tot/cap)	Relief Type	Average Depth (ft)	Pipe Diam (in)	Pipe Capacity (cfs)	Construction Cost ($)
SUB01	306	307	115	0.002348	18	5.090	13.869	272.5	Replace	14.43	30	19.88	26,938
SUB01	306A	306	62	0.002419	18	5.167	13.625	263.7	Replace	10.00	30	20.18	11,833
SUB01	307	309	590	0.001966	24	10.032	45.497	453.5	Replace	16.58	48	63.76	235,963
SUB01	309	311	174	0.006322	24	17.989	45.591	253.4	Replace	13.43	42	650.71	53,926
SUB01	311	311A	48	0.003542	30	24.414	45.821	187.7	Replace	12.03	42	59.86	14,180
SUB02_03	311A	9012	140	0.001000	30	12.972	45.797	353.0	Replace	11.65	54	62.19	59,023
SUB01	314	302	409	0.007677	12	3.122	5.433	174.0	Replace	10.00	18	9.20	47,646
SUB01	315	314	455	0.006242	12	2.815	5.192	184.4	Replace	10.65	18	8.29	55,770
SUB01	315A	315	196	0.001122	12	1.193	4.932	413.4	Replace	9.31	24	7.57	27,634
SUB01	316	316A	155	0.012452	10	2.445	4.139	169.3	Replace	7.01	15	7.20	16,705
SUB01	316A	316B	175	0.013486	12	4.138	4.407	106.5	Replace	5.93	15	7.50	18,861
SUB01	316B	315A	170	0.003706	12	2.169	4.670	215.3	Replace	6.59	18	6.39	19,804
SUB01	324	325	193	0.011244	10	2.323	2.812	121.1	Replace	6.87	15	6.84	20,801
SUB01	324A	324	187	0.009679	10	2.156	2.539	117.8	Replace	5.91	15	6.35	20,154
SUB01	325	326	376	0.012686	10	2.468	3.083	124.9	Replace	8.73	15	7.27	40,524
SUB01	326	327	375	0.012853	10	2.484	3.344	134.6	Replace	11.45	15	7.32	45,431
SUB01	327	327A	166	0.011687	10	2.369	3.604	152.1	Replace	12.25	15	6.97	21,336
SUB01	327A	316	214	0.014159	10	2.607	3.873	148.6	Replace	10.04	15	7.69	23,143
SUB01	362	361	131	0.005954	10	1.691	1.987	117.5	Replace	11.31	15	4.98	15,702
SUB01	362A	362	182	0.004011	10	1.388	1.711	123.3	Replace	11.15	15	4.09	21,545
SUB01	490	490A	254	0.002441	15	3.192	14.544	455.6	Replace	10.72	30	20.26	50,266
SUB01	490A	1190	143	0.002378	10	1.069	14.791	1,383.6	Replace	9.09	30	20.01	27,291
SUB04	630A	2110A	138	0.017246	10	2.878	3.322	115.4	Replace	9.58	15	8.48	14,873
SUB04	631	630	47	0.007021	10	1.836	2.244	122.2	Replace	6.37	15	5.41	5,065
SUB01	694	692	289	0.001488	18	4.052	8.109	200.1	Replace	6.62	27	30.09	49,910
SUB01	695	694	251	0.001235	18	3.692	7.923	214.6	Replace	5.17	27	29.02	43,347
SUB01	696A	695	212	0.001557	18	4.145	7.727	186.4	Replace	7.00	27	12.27	36,612
SUB01	697	696	291	0.000103	24	2.296	7.365	320.8	Replace	6.73	42	10.06	79,853
SUB01	698	697	283	0.000954	12	1.101	7.149	649.3	Replace	6.60	27	9.54	48,873
SUB01	698A	698	80	0.001000	12	1.127	3.256	288.9	Replace	8.63	21	5.01	10,191
SUB01	699	698A	193	0.001606	12	1.428	2.996	209.8	Replace	8.84	18	4.21	22,483
SUB01	701	700	217	0.001935	12	1.567	2.208	140.9	Replace	15.26	18	4.62	35,949
SUB01	720	721	147	0.003333	12	2.057	3.980	193.5	Replace	9.95	18	6.06	17,124

LEAVENWORTH, KS - FUTURE

Model Name: 2020 - 5 YR 0% I/I REMOVAL

RELIEF SEWER COST DETAIL BY MANHOLE

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length (ft)	Slope (ft/ft)	Existing Diam. (in)	Existing Cap (cfs)	Design Flow (cfs)	Percent Utilization (Q_tot/cap)	Relief Type	Average Depth (ft)	Pipe Diam (in)	Pipe Capacity (cfs)	Construction Cost ($)
SUB01	721	698	152	0.004013	12	2.257	4.212	186.6	Replace	9.72	18	6.65	17,707
SUB05	9	2374	269	0.003866	24	14.067	15.694	111.6	Replace	19.64	30	25.51	76,739
SUB06	9000	WWTP	53	0.004151	42	64.829	66.476	102.5	Replace	10.39	48	92.54	17,763
SUB02_03	9012	2121A	15	0.006667	30	33.495	45.725	136.5	Replace	11.68	42	82.17	4,378
SUB06	B	A	260	0.000962	36	20.690	21.714	104.9	Replace	13.24	42	31.17	80,069
SUB06	C	B	107	0.000841	36	19.345	21.734	112.3	Replace	15.22	42	29.16	35,144
SUB06	E	D	407	0.000885	36	19.844	21.918	110.5	Replace	14.84	42	29.84	132,082
SUB06	F	E	89	0.000899	36	20.001	21.925	109.6	Replace	14.62	42	30.18	28,680
SUB06	G	F	658	0.000836	36	19.287	22.268	115.5	Replace	14.31	42	29.16	209,926
SUB06	H	2115	413	0.000969	36	20.765	23.398	112.7	Replace	11.82	42	31.33	121,114
SUB06	J	H	620	0.000823	36	19.137	23.703	123.9	Replace	13.38	48	41.13	227,197
SUB02_03	K	J	650	0.000862	36	19.585	24.020	122.6	Replace	12.84	48	42.13	234,517
SUB02_03	L	K	604	0.000844	36	19.379	24.353	125.7	Replace	12.31	48	41.63	214,569
SUB02_03	M	L	492	0.000833	36	19.252	24.622	127.9	Replace	11.85	48	41.38	172,413
SUB02_03	N	M	489	0.000859	36	19.551	24.622	125.9	Replace	11.43	48	0.00	169,213
SUB02_03	N	2120	488	0.000943	36	20.484	24.622	120.2	Replace	9.15	48	44.04	161,562
SUB02_03	P	N	106	0.006604	30	33.336	49.285	147.8	Replace	0.00	0	0.00	0
SUB02_03	Q	P	459	0.001242	30	14.457	26.919	186.2	Replace	10.26	42	35.43	127,188
SUB02_03	R	Q	232	0.001207	30	14.252	27.032	189.7	Replace	10.00	42	35.00	63,663
		Total:	48,709 (ft)										10,871,194

APPENDIX J

COMPARISON OF THE CONSTRUCTION COST FOR I/I REMOVAL

Time: 11:20:10
Date: 08/31/2001

LEAVENWORTH, KS - FUTURE

Page: 1
Rept: SubComp2

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Model: 2010 - 5 YR 30% I/I REMOVAL Total Flow	Relief Dia.	Construction Cost	Model: 2010 - 5 YR 0% I/I REMOVAL Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
Basin:											
Subsys	SUB01										
SUB01	1165	307	75	0	0	21.139	36	22,904	30.109	42	27,330
SUB01	1166	1165	285	0	0	21.015	36	91,232	29.896	42	108,216
SUB01	1167	1166	166	0	0	20.860	36	50,013	29.652	42	59,784
SUB01	1168	1167	223	0	0	20.718	36	58,966	29.422	42	71,768
SUB01	1169	1168	131	0	0	20.553	36	37,028	29.168	42	44,643
SUB01	1170	1169	499	0	0	20.480	36	149,745	29.006	42	179,091
SUB01	1171	1170	115	0	0	20.308	36	30,065	28.746	42	36,653
SUB01	1172	1171	224	0	0	20.164	36	51,443	28.528	42	63,995
SUB01	1173	1172	189	0	0	20.010	48	66,331	28.302	54	80,190
SUB01	1174	1173	100	0	0	19.833	33	22,596	28.047	42	29,657
SUB01	1175	1174	98	0	0	19.656	42	29,378	27.791	42	29,378
SUB01	1176	1175	301	0	0	19.528	36	71,135	27.602	42	88,082
SUB01	1177	1176	344	0	0	19.410	36	75,266	27.427	42	94,397
SUB01	1178	1177	124	0	0	19.237	36	27,131	27.180	42	34,026
SUB01	1179	1178	441	0	0	19.141	36	96,489	27.036	42	121,015
SUB01	1180	1179	310	0	0	19.198	36	67,827	26.946	42	85,067
SUB01	1180	255	10	0	0	3.169	21	1,274	3.183	21	1,274
SUB01	1181	1180	324	0	0	16.283	0	0	21.961	0	0
SUB01	1182	1181	41	0	0	16.084	0	0	21.686	0	0
SUB01	1183	1182	149	0	0	15.903	0	0	21.442	0	0
SUB01	1184	1183	38	0	0	15.703	0	0	21.167	0	0
SUB01	1185	1184	340	0	0	15.578	30	64,888	20.990	36	74,390
SUB01	1186	1185	125	0	0	15.400	33	25,603	20.745	36	27,350
SUB01	1187	1186	162	0	0	15.232	33	33,181	20.511	36	35,445
SUB01	1188	1187	241	0	0	15.100	36	52,730	20.303	42	66,133
SUB01	1189	1188	459	0	0	15.035	33	94,013	20.163	36	100,426
SUB01	1190	1189	594	0	0	15.011	33	121,664	20.065	36	129,965
SUB01	1191	1190	346	0	0	6.052	0	0	8.344	21	44,073
SUB01	1192	1191	429	0	0	5.950	0	0	8.209	21	54,647
SUB01	1193	1192	390	0	0	5.825	0	0	8.028	18	45,433
SUB01	1194	720	45	0	0	2.450	18	5,243	3.251	18	5,243
SUB01	1195	1194	275	0	0	2.299	18	32,037	3.037	18	32,037
SUB01	1196	1195	370	0	0	2.163	18	46,562	2.841	18	46,562
SUB01	1196A	1196	361	0	0	2.014	0	0	2.630	15	49,661

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2010 - 5 YR 30% I/I REMOVAL			Model: 2010 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB01	1197	1196A	303	0	0	1.859	0	0	2.415	15	41,849
SUB01	1197A	1197	402	0	0	1.711	0	0	2.208	0	0
SUB01	1198	1197A	199	0	0	1.549	0	0	1.985	0	0
SUB01	1198A	1198	332	0	0	1.393	12	40,672	1.765	12	40,672
SUB01	1199	1198A	319	0	0	1.238	10	35,953	1.547	12	38,786
SUB01	1200	1477	256	0	0	0.907	0	0	1.091	0	0
SUB01	1201	1200	321	0	0	0.751	0	0	0.873	0	0
SUB01	1202	1201	317	0	0	0.595	0	0	0.656	0	0
SUB01	1204	490	543	0	0	9.333	27	107,163	12.394	30	117,193
SUB01	1205	1204	260	0	0	9.159	24	50,558	12.145	27	59,005
SUB01	1206	1205	380	0	0	8.999	24	61,145	11.911	27	73,304
SUB01	1207	1206	242	0	0	8.822	0	0	11.661	21	30,827
SUB01	1208	1207	308	0	0	8.654	21	40,222	11.420	21	40,222
SUB01	1209	1208	316	0	0	8.487	24	54,550	11.180	27	64,716
SUB01	1210	1209	322	0	0	8.322	24	52,058	10.941	27	62,364
SUB01	1211	1210	260	0	0	8.150	24	36,658	10.695	27	44,901
SUB01	1212	1211	269	0	0	7.979	24	37,926	10.455	24	37,926
SUB01	1213	1212	166	0	0	7.797	24	23,404	10.206	24	23,404
SUB01	1214	1213	35	0	0	7.599	24	4,935	9.936	27	6,045
SUB01	1215	1214	357	0	0	7.439	21	48,173	9.718	24	53,055
SUB01	1216	1215	343	0	0	5.747	18	49,032	7.388	21	52,861
SUB01	1217	1216	369	0	0	5.602	18	61,822	7.172	21	66,034
SUB01	1218	1217	190	0	0	5.432	18	32,471	6.928	21	34,647
SUB01	1219	1218	252	0	0	5.272	18	36,447	6.694	21	39,265
SUB01	1220	1219	125	0	0	5.093	18	19,704	6.440	21	21,118
SUB01	1221	1220	365	0	0	4.949	18	42,521	6.224	21	46,493
SUB01	1222	1221	357	0	0	4.802	0	0	6.006	18	41,589
SUB01	1223	1222	275	0	0	4.644	0	0	5.777	18	33,938
SUB01	1224	1223	272	0	0	4.484	0	0	5.549	18	32,221
SUB01	1225	1554	230	0	0	4.130	0	0	5.054	0	0
SUB01	1226	1226A	92	0	0	3.757	0	0	4.538	0	0
SUB01	1226A	1225	165	0	0	3.945	0	0	4.798	0	0
SUB01	1227	1226	314	0	0	3.591	18	40,073	4.300	18	40,073
SUB01	1228	1227	278	0	0	3.424	18	35,297	4.060	18	35,297
SUB01	1229	1266	129	0	0	3.065	0	0	3.560	15	13,903
SUB01	1229A	1229	319	0	0	2.893	15	34,380	3.317	15	34,380

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2010 - 5 YR 30% I/I REMOVAL			Model: 2010 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB01	1231	1230	439	0	0	2.577	15	53,305	2.861	15	53,305
SUB01	1232	1231	209	0	0	2.404	0	0	2.618	0	0
SUB01	1233	1975	168	0	0	2.050	0	0	2.122	0	0
SUB01	1236	1215	310	0	0	1.638	15	34,954	2.271	15	34,954
SUB01	1237	2289	158	0	0	1.235	0	0	1.712	0	0
SUB01	1238	1654	134	0	0	0.828	0	0	1.147	0	0
SUB01	1239	1238	266	0	0	0.623	0	0	0.863	0	0
SUB01	1240	1239	183	0	0	0.416	0	0	0.577	0	0
SUB01	1241	1240	172	0	0	0.209	0	0	0.289	0	0
SUB01	1266	1228	181	0	0	3.246	0	0	3.812	15	20,443
SUB01	1477	1199	61	0	0	1.070	0	0	1.316	0	0
SUB01	1554	1224	224	0	0	4.307	0	0	5.301	0	0
SUB01	1654	1237	232	0	0	1.033	0	0	1.432	0	0
SUB01	1975	1232	179	0	0	2.228	0	0	2.371	0	0
SUB01	205	205A	533	0	0	0.209	0	0	0.289	0	0
SUB01	205A	206	130	0	0	0.407	0	0	0.564	0	0
SUB01	206	207	286	0	0	0.612	0	0	0.848	0	0
SUB01	207	208	251	0	0	0.809	0	0	1.121	0	0
SUB01	208	208A	76	0	0	1.003	0	0	1.391	0	0
SUB01	208A	210	100	0	0	1.202	0	0	1.667	0	0
SUB01	210	214	487	0	0	1.398	0	0	1.941	0	0
SUB01	214	214A	184	0	0	1.571	0	0	2.183	0	0
SUB01	214A	234A	164	0	0	1.759	0	0	2.445	0	0
SUB01	219	426A	291	0	0	1.225	0	0	1.699	0	0
SUB01	2289	1236	250	0	0	1.438	0	0	1.994	0	0
SUB01	233	255	329	0	0	2.333	0	0	3.244	0	0
SUB01	234	234A	97	0	0	0.209	0	0	0.289	0	0
SUB01	234A	233	82	0	0	2.143	0	0	2.980	0	0
SUB01	254	1180	379	0	0	5.711	18	44,683	7.957	18	44,683
SUB01	255	274A	156	0	0	5.610	21	20,018	6.390	24	22,142
SUB01	272	303	325	0	0	6.225	24	45,823	7.238	24	45,823
SUB01	273	272	438	0	0	6.089	24	61,754	7.047	24	61,754
SUB01	274	273	464	0	0	5.955	21	59,104	6.856	24	65,420
SUB01	274A	274	284	0	0	5.792	21	36,176	6.634	24	40,042
SUB01	275	254	164	0	0	5.530	0	0	7.703	18	19,106
SUB01	275A	275	31	0	0	5.342	0	0	7.441	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2010 - 5 YR 30% I/I REMOVAL			Model: 2010 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB01	299C	299B	186	0	0	5.001	0	0	6.961	0	0
SUB01	302	303	21	0	0	4.039	18	2,447	5.675	18	2,447
SUB01	303	304	423	0	0	10.367	27	73,051	12.882	30	80,728
SUB01	304	305A	385	0	0	10.501	27	66,488	13.071	30	73,476
SUB01	305	306A	394	0	0	10.825	27	68,042	13.511	30	75,195
SUB01	305A	305	56	0	0	10.638	27	9,671	13.264	30	10,687
SUB01	306	307	115	0	0	11.143	27	24,786	13.946	30	26,938
SUB01	306A	306	62	0	0	10.959	27	10,708	13.702	30	11,833
SUB01	307	309	590	0	0	32.352	42	202,099	43.599	48	235,963
SUB01	309	311	174	0	0	32.394	33	41,536	43.734	42	53,926
SUB01	311	311A	48	0	0	32.545	42	14,180	43.973	42	14,180
SUB01	314	302	409	0	0	3.874	18	47,646	5.433	18	47,646
SUB01	315	314	455	0	0	3.711	18	55,770	5.192	18	55,770
SUB01	315A	315	196	0	0	3.529	21	24,966	4.932	24	27,634
SUB01	316	316A	155	0	0	2.966	15	16,705	4.139	15	16,705
SUB01	316A	316B	175	0	0	3.156	0	0	4.407	15	18,861
SUB01	316B	315A	170	0	0	3.344	18	19,804	4.670	18	19,804
SUB01	324	325	193	0	0	2.025	0	0	2.812	15	20,801
SUB01	324A	324	187	0	0	1.829	0	0	2.539	15	20,154
SUB01	325	326	376	0	0	2.219	0	0	3.083	15	40,524
SUB01	326	327	375	0	0	2.404	0	0	3.344	15	45,431
SUB01	327	327A	166	0	0	2.587	15	21,336	3.604	15	21,336
SUB01	327A	316	214	0	0	2.778	15	23,143	3.873	15	23,143
SUB01	361	324A	178	0	0	1.631	0	0	2.264	0	0
SUB01	362	361	131	0	0	1.432	0	0	1.987	15	15,702
SUB01	362A	362	182	0	0	1.234	0	0	1.711	15	21,545
SUB01	365	840A	333	0	0	0.625	0	0	0.866	0	0
SUB01	365A	365	36	0	0	0.417	0	0	0.578	0	0
SUB01	365B	365A	27	0	0	0.209	0	0	0.289	0	0
SUB01	366	366A	348	0	0	1.400	0	0	1.944	0	0
SUB01	366A	368N	282	0	0	1.591	0	0	2.210	0	0
SUB01	367A	367B	97	0	0	2.395	0	0	3.325	0	0
SUB01	367B	368N	349	0	0	2.590	0	0	3.597	0	0
SUB01	368B	369A	369	0	0	4.497	0	0	6.253	0	0
SUB01	368N	368B	405	0	0	4.341	0	0	6.032	0	0
SUB01	369A	370A	395	0	0	4.667	0	0	6.492	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2010 - 5 YR 30% I/I REMOVAL			Model: 2010 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB01	417	814	357	0	0	0.405	0	0	0.561	0	0
SUB01	424E	367A	197	0	0	2.205	0	0	3.061	0	0
SUB01	424F	424E	137	0	0	2.011	0	0	2.791	0	0
SUB01	424G	424F	196	0	0	1.818	0	0	2.522	0	0
SUB01	425A	424G	250	0	0	1.621	0	0	2.248	0	0
SUB01	426A	425A	157	0	0	1.421	0	0	1.971	0	0
SUB01	436	436A	123	0	0	0.413	0	0	0.572	0	0
SUB01	436A	219	392	0	0	1.030	0	0	1.427	0	0
SUB01	436B	9011	304	0	0	0.209	0	0	0.289	0	0
SUB01	439	436	285	0	0	0.209	0	0	0.289	0	0
SUB01	478A	366	312	0	0	1.206	0	0	1.674	0	0
SUB01	483	478A	118	0	0	1.006	0	0	1.397	0	0
SUB01	484	483	442	0	0	0.810	0	0	1.124	0	0
SUB01	485	484	409	0	0	0.615	0	0	0.852	0	0
SUB01	486	485	406	0	0	0.414	0	0	0.574	0	0
SUB01	487	486	254	0	0	0.209	0	0	0.289	0	0
SUB01	490	490A	254	0	0	9.473	27	45,634	12.609	30	50,266
SUB01	490A	1190	143	0	0	9.649	27	24,695	12.859	30	27,291
SUB01	692	1193	205	0	0	5.666	0	0	7.808	0	0
SUB01	694	692	289	0	0	5.559	24	40,746	7.633	27	49,910
SUB01	695	694	251	0	0	5.441	24	35,389	7.447	27	43,347
SUB01	696	696A	21	0	0	5.130	0	0	7.002	0	0
SUB01	696A	695	212	0	0	5.312	24	29,890	7.251	27	36,612
SUB01	697	696	291	0	0	5.081	36	63,669	6.888	42	79,853
SUB01	698	697	283	0	0	4.930	24	39,901	6.671	27	48,873
SUB01	698A	698	80	0	0	2.333	18	9,320	3.256	21	10,191
SUB01	699	698A	193	0	0	2.150	18	22,483	2.996	18	22,483
SUB01	699A	699	157	0	0	1.958	0	0	2.728	0	0
SUB01	700	699A	300	0	0	1.773	0	0	2.469	0	0
SUB01	701	700	217	0	0	1.589	15	33,913	2.208	18	35,949
SUB01	702	701	191	0	0	1.397	0	0	1.940	0	0
SUB01	720	721	147	0	0	2.628	18	17,124	3.494	18	17,124
SUB01	721	698	152	0	0	2.794	18	17,707	3.726	18	17,707
SUB01	811	702	62	0	0	1.197	0	0	1.663	0	0
SUB01	812	811	233	0	0	1.001	0	0	1.390	0	0
SUB01	813	812	308	0	0	0.807	0	0	1.120	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2010 - 5 YR 30% I/I REMOVAL			Model: 2010 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB01	840A	9013	29	0	0	0.827	0	0	1.145	0	0
SUB01	9011	436A	48	0	0	0.413	0	0	0.572	0	0
SUB01	9013	362A	195	0	0	1.032	0	0	1.431	0	0
SUB01	996	417	690	0	0	0.209	0	0	0.289	0	0
		Sub. Total:	45771		0			3,862,631			4,953,783
	Basin:										
	Subsys	SUB02_03									
SUB02_03	2118	2117	653	0	0	17.307	0	0	22.864	0	0
SUB02_03	2119	2118	603	0	0	17.609	0	0	23.213	42	165,468
SUB02_03	2120	2119	492	0	0	17.853	0	0	23.494	42	135,009
SUB02_03	2121	P	278	0	0	16.231	36	61,544	21.946	42	77,035
SUB02_03	2121A	2121	408	0	0	16.231	0	0	21.946	0	0
SUB02_03	2121A	R	47	0	0	16.231	0	0	21.946	0	0
SUB02_03	311A	9012	140	0	0	32.525	48	48,767	43.954	54	59,023
SUB02_03	9012	2121A	15	0	0	32.468	0	0	43.897	42	4,378
SUB02_03	AA	Z	423	0	0	5.153	0	0	5.153	0	0
SUB02_03	AB	AA	393	0	0	5.218	0	0	5.218	0	0
SUB02_03	AC	AB	434	0	0	5.289	0	0	5.289	0	0
SUB02_03	AD	AC	440	0	0	5.362	0	0	5.362	0	0
SUB02_03	AE	AD	383	0	0	2.699	0	0	2.699	0	0
SUB02_03	AF	AE	223	0	0	2.709	0	0	2.709	0	0
SUB02_03	AG	AD	16	0	0	2.682	0	0	2.682	0	0
SUB02_03	AH	AG	75	0	0	2.686	0	0	2.686	0	0
SUB02_03	AI	AH	54	0	0	2.688	0	0	2.688	0	0
SUB02_03	AJ	AI	468	0	0	2.709	0	0	2.709	0	0
SUB02_03	K	J	650	0	0	17.524	0	0	23.147	48	234,517
SUB02_03	L	K	604	0	0	17.839	0	0	23.492	48	214,569
SUB02_03	M	L	492	0	0	18.096	0	0	23.770	48	172,413
SUB02_03	N	M	489	0	0	18.096	0	0	23.770	48	169,213
SUB02_03	N	2120	488	0	0	18.096	0	0	23.770	42	133,911
SUB02_03	P	N	106	0	0	36.234	0	0	47.582	0	0
SUB02_03	Q	P	459	0	0	20.424	42	127,188	26.083	42	127,188
SUB02_03	R	Q	232	0	0	20.512	42	63,663	26.170	42	63,663
SUB02_03	S	R	610	0	0	4.849	0	0	4.849	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length (ft)	CIP Diameter (in)	CIP Cost (ft/ft)	Model: 2010 - 5 YR 30% I/I REMOVAL Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)	Model: 2010 - 5 YR 0% I/I REMOVAL Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)
SUB02_03	T	S	139	0	0	4.864	0	0	4.864	0	0
SUB02_03	U	T	119	0	0	4.877	0	0	4.877	0	0
SUB02_03	V	U	268	0	0	4.906	0	0	4.906	0	0
SUB02_03	W	V	444	0	0	4.954	0	0	4.954	0	0
SUB02_03	X	W	606	0	0	5.026	0	0	5.026	0	0
SUB02_03	Y	X	347	0	0	5.071	0	0	5.071	0	0
SUB02_03	Z	Y	87	0	0	5.082	0	0	5.082	0	0
		Sub. Total:	11685		0			301,162			1,556,387
	Basin:										
	Subsys	SUB04									
SUB04	627	633	592	0	0	0.621	0	0	0.621	0	0
SUB04	630	630A	386	0	0	2.811	0	0	2.811	0	0
SUB04	630A	2110A	138	0	0	3.322	15	14,873	3.322	15	14,873
SUB04	631	630	47	0	0	2.244	15	5,065	2.244	15	5,065
SUB04	632	631	193	0	0	1.698	0	0	1.698	0	0
SUB04	633	632	627	0	0	1.168	0	0	1.168	0	0
		Sub. Total:	1983		0			19,938			19,938
	Basin:										
	Subsys	SUB05									
SUB05	10	9	288	0	0	8.160	0	0	8.160	0	0
SUB05	1068	948	109	0	0	0.380	0	0	0.380	0	0
SUB05	11	10	182	0	0	8.133	30	59,890	8.133	30	59,890
SUB05	12	11	371	0	0	8.150	30	129,132	8.150	30	129,132
SUB05	13	12	389	0	0	8.169	30	130,251	8.169	30	130,251
SUB05	13A	13	136	0	0	0.078	0	0	0.078	0	0
SUB05	14	13	361	0	0	8.068	0	0	8.068	0	0
SUB05	1401	880	11	0	0	11.003	30	2,099	11.003	30	2,099
SUB05	1402	1401	115	0	0	10.964	0	0	10.964	0	0
SUB05	1403	1402	248	0	0	10.945	0	0	10.945	0	0
SUB05	1404	1403	84	0	0	10.898	0	0	10.898	0	0
SUB05	1405	1404	396	0	0	10.902	0	0	10.902	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2010 - 5 YR 30% I/I REMOVAL			Model: 2010 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length (ft)	CIP Diameter (in)	CIP Cost (ft/ft)	Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)	Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)
SUB05	1405A	1405	233	0	0	1.450	0	0	1.450	0	0
SUB05	1405B	1405A	372	0	0	1.403	0	0	1.403	0	0
SUB05	1405C	1405B	147	0	0	1.342	0	0	1.342	0	0
SUB05	1405D	1405C	188	0	0	1.283	0	0	1.283	0	0
SUB05	1406	1405	234	0	0	9.557	0	0	9.557	0	0
SUB05	1407	1406	274	0	0	9.536	0	0	9.536	0	0
SUB05	1408	1407	335	0	0	9.033	0	0	9.033	0	0
SUB05	1409	1408	291	0	0	9.022	0	0	9.022	0	0
SUB05	1410	1409	105	0	0	8.979	0	0	8.979	0	0
SUB05	1411	1410	179	0	0	8.947	0	0	8.947	0	0
SUB05	1412	1411	72	0	0	8.897	0	0	8.897	0	0
SUB05	1413	1412	367	0	0	8.898	0	0	8.898	0	0
SUB05	1414	1413	436	0	0	8.888	0	0	8.888	0	0
SUB05	1415	1414	256	0	0	8.882	36	62,923	8.882	36	62,923
SUB05	1416	1415	238	0	0	8.847	0	0	8.847	0	0
SUB05	1417	2273	158	0	0	8.766	0	0	8.766	0	0
SUB05	1418	1417	200	0	0	8.733	0	0	8.733	0	0
SUB05	1419	1419A	233	0	0	8.655	0	0	8.655	0	0
SUB05	1419A	1418	106	0	0	8.684	0	0	8.684	0	0
SUB05	1420	1420A	215	0	0	8.572	0	0	8.572	0	0
SUB05	1420A	1419	90	0	0	8.604	0	0	8.604	0	0
SUB05	1421	1420	299	0	0	8.552	0	0	8.552	0	0
SUB05	1422	1421	254	0	0	8.531	0	0	8.531	0	0
SUB05	1423	1422	258	0	0	8.512	0	0	8.512	0	0
SUB05	1424	1423	200	0	0	0.302	0	0	0.302	0	0
SUB05	1425	1424	340	0	0	0.228	0	0	0.228	0	0
SUB05	1426	1425	249	0	0	0.153	0	0	0.153	0	0
SUB05	1427	1426	404	0	0	0.078	0	0	0.078	0	0
SUB05	1428	1407	115	0	0	0.593	0	0	0.593	0	0
SUB05	1429	1428	302	0	0	0.524	0	0	0.524	0	0
SUB05	1430	1429	194	0	0	0.451	0	0	0.451	0	0
SUB05	1431	1430	227	0	0	0.379	0	0	0.379	0	0
SUB05	1432	1431	321	0	0	0.306	0	0	0.306	0	0
SUB05	1433	1432	255	0	0	0.231	0	0	0.231	0	0
SUB05	1434	1433	365	0	0	0.156	0	0	0.156	0	0
SUB05	1435	1434	347	0	0	0.078	0	0	0.078	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length (ft)	CIP Diameter (in)	CIP Cost (ft/ft)	Model: 2010 - 5 YR 30% I/I REMOVAL Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)	Model: 2010 - 5 YR 0% I/I REMOVAL Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)
SUB05	1449	1448	403	0	0	1.959	0	0	1.959	0	0
SUB05	1450	1449	398	0	0	1.916	0	0	1.916	0	0
SUB05	1451	1450	402	0	0	1.863	0	0	1.863	0	0
SUB05	1452	1451	400	0	0	1.819	0	0	1.819	0	0
SUB05	1453	1452	402	0	0	1.773	0	0	1.773	0	0
SUB05	1454	1453	424	0	0	1.729	0	0	1.729	0	0
SUB05	1455	1454	89	0	0	1.667	0	0	1.667	0	0
SUB05	1456	1455	180	0	0	1.542	0	0	1.542	0	0
SUB05	1457	3026	68	0	0	1.422	0	0	1.422	0	0
SUB05	1458	1457	187	0	0	1.360	0	0	1.360	0	0
SUB05	1459	1458	251	0	0	1.299	0	0	1.299	0	0
SUB05	1460	1460A	304	0	0	1.172	0	0	1.172	0	0
SUB05	1460A	1459	89	0	0	1.233	0	0	1.233	0	0
SUB05	1461	1460	148	0	0	1.106	0	0	1.106	0	0
SUB05	1462	1461	98	0	0	1.040	0	0	1.040	0	0
SUB05	1463	1462	354	0	0	0.979	0	0	0.979	0	0
SUB05	1464	1463	270	0	0	0.915	0	0	0.915	0	0
SUB05	1465	1464	193	0	0	0.849	0	0	0.849	0	0
SUB05	1466	1465	244	0	0	0.783	0	0	0.783	0	0
SUB05	15	14	315	0	0	8.036	24	84,550	8.036	24	84,550
SUB05	1571	1466	155	0	0	0.714	0	0	0.714	0	0
SUB05	1572	1571	301	0	0	0.649	0	0	0.649	0	0
SUB05	1573	1572	277	0	0	0.583	0	0	0.583	0	0
SUB05	1574	1573	128	0	0	0.511	0	0	0.511	0	0
SUB05	1575	1574	393	0	0	0.442	0	0	0.442	0	0
SUB05	1576	1575	396	0	0	0.372	0	0	0.372	0	0
SUB05	1577	1576	353	0	0	0.302	0	0	0.302	0	0
SUB05	1578	1577	367	0	0	0.230	0	0	0.230	0	0
SUB05	1579	1578	401	0	0	0.155	0	0	0.155	0	0
SUB05	1580	1579	400	0	0	0.078	0	0	0.078	0	0
SUB05	15A	15	182	0	0	0.078	0	0	0.078	0	0
SUB05	16	15	257	0	0	7.920	21	60,267	7.920	21	60,267
SUB05	17	16	454	0	0	7.887	21	111,265	7.887	21	111,265
SUB05	18	17	195	0	0	7.829	18	47,983	7.829	18	47,983
SUB05	1893	9006	306	0	0	15.481	0	0	15.481	0	0
SUB05	1894	1893	195	0	0	15.478	0	0	15.478	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2010 - 5 YR 30% I/I REMOVAL			Model: 2010 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB05	1895A	1895	130	0	0	15.515	0	0	15.515	0	0
SUB05	1896	1895A	219	0	0	15.519	0	0	15.519	0	0
SUB05	1897	1448	181	0	0	13.707	0	0	13.707	0	0
SUB05	1898	1897	226	0	0	13.706	0	0	13.706	0	0
SUB05	1899	1898	263	0	0	13.713	0	0	13.713	0	0
SUB05	18A	18	200	0	0	6.867	24	51,794	6.867	24	51,794
SUB05	18B	18A	190	0	0	6.819	24	55,216	6.819	24	55,216
SUB05	19	18	284	0	0	0.974	0	0	0.974	0	0
SUB05	1900	1899	245	0	0	13.719	0	0	13.719	0	0
SUB05	1901	1900	115	0	0	13.689	0	0	13.689	0	0
SUB05	1902	1901	103	0	0	13.654	0	0	13.654	0	0
SUB05	1903	1902	148	0	0	12.871	0	0	12.871	0	0
SUB05	1904	9009	305	0	0	12.404	0	0	12.404	0	0
SUB05	1905	1904	350	0	0	12.434	0	0	12.434	0	0
SUB05	1906	1905	381	0	0	12.436	0	0	12.436	0	0
SUB05	1907	1906	528	0	0	12.457	0	0	12.457	0	0
SUB05	1908	1907	160	0	0	12.421	0	0	12.421	0	0
SUB05	1909	1908	331	0	0	12.407	0	0	12.407	0	0
SUB05	1910	1909	117	0	0	12.362	0	0	12.362	0	0
SUB05	20	19	255	0	0	0.913	0	0	0.913	0	0
SUB05	21	20	199	0	0	0.846	0	0	0.846	0	0
SUB05	22	21	276	0	0	0.783	0	0	0.783	0	0
SUB05	2273	1416	143	0	0	8.805	0	0	8.805	0	0
SUB05	23	22	276	0	0	0.719	0	0	0.719	0	0
SUB05	2367	1423	20	0	0	8.184	0	0	8.184	0	0
SUB05	2368	2367	284	0	0	8.176	0	0	8.176	0	0
SUB05	2369	2368	306	0	0	8.168	0	0	8.168	0	0
SUB05	2370	2369	270	0	0	8.154	0	0	8.154	0	0
SUB05	2371	2370	422	0	0	8.175	0	0	8.175	0	0
SUB05	2372	2371	408	0	0	8.189	0	0	8.189	0	0
SUB05	2373	2372	425	0	0	8.204	0	0	8.204	0	0
SUB05	2374	2373	493	0	0	8.231	0	0	8.231	0	0
SUB05	23A	23	132	0	0	0.078	0	0	0.078	0	0
SUB05	24	23	187	0	0	0.578	0	0	0.578	0	0
SUB05	25	24	297	0	0	0.512	0	0	0.512	0	0
SUB05	26	25	261	0	0	0.444	0	0	0.444	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2010 - 5 YR 30% I/I REMOVAL			Model: 2010 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB05	28	27	295	0	0	0.300	0	0	0.300	0	0
SUB05	29	28	295	0	0	0.226	0	0	0.226	0	0
SUB05	30	29	320	0	0	0.154	0	0	0.154	0	0
SUB05	3002	3003	332	0	0	0.230	0	0	0.230	0	0
SUB05	3003	3004	336	0	0	0.304	0	0	0.304	0	0
SUB05	3004	3005	145	0	0	0.378	0	0	0.378	0	0
SUB05	3005	663	191	0	0	0.452	0	0	0.452	0	0
SUB05	3013	887	183	0	0	1.554	0	0	1.554	0	0
SUB05	3026	1456	288	0	0	1.488	0	0	1.488	0	0
SUB05	3032	1455	47	0	0	0.078	0	0	0.078	0	0
SUB05	31	30	318	0	0	0.078	0	0	0.078	0	0
SUB05	397	896	239	0	0	0.232	0	0	0.232	0	0
SUB05	398	397	228	0	0	0.156	0	0	0.156	0	0
SUB05	663	9009	98	0	0	0.526	0	0	0.526	0	0
SUB05	686	3002	304	0	0	0.155	0	0	0.155	0	0
SUB05	686A	686	205	0	0	0.078	0	0	0.078	0	0
SUB05	782	785	306	0	0	0.078	0	0	0.078	0	0
SUB05	785	786	243	0	0	0.156	0	0	0.156	0	0
SUB05	786	787	217	0	0	0.232	0	0	0.232	0	0
SUB05	787	802	257	0	0	0.308	0	0	0.308	0	0
SUB05	802	803	185	0	0	0.382	0	0	0.382	0	0
SUB05	803	804	278	0	0	0.453	0	0	0.453	0	0
SUB05	804	805	196	0	0	0.524	0	0	0.524	0	0
SUB05	805	806	259	0	0	0.594	0	0	0.594	0	0
SUB05	806	807	152	0	0	0.666	0	0	0.666	0	0
SUB05	807	808	263	0	0	0.738	0	0	0.738	0	0
SUB05	808	809	260	0	0	0.803	0	0	0.803	0	0
SUB05	809	810	250	0	0	0.867	0	0	0.867	0	0
SUB05	810	1902	18	0	0	0.930	0	0	0.930	0	0
SUB05	880	1910	12	0	0	12.303	0	0	12.303	0	0
SUB05	881	880	267	0	0	1.386	0	0	1.386	0	0
SUB05	882	881	299	0	0	1.331	0	0	1.331	0	0
SUB05	883	882	276	0	0	1.274	0	0	1.274	0	0
SUB05	884	883	298	0	0	1.216	0	0	1.216	0	0
SUB05	885	884	227	0	0	1.146	0	0	1.146	0	0
SUB05	885	1405D	94	0	0	1.216	0	0	1.216	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2010 - 5 YR 30% I/I REMOVAL			Model: 2010 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB05	887	886	339	0	0	1.620	0	0	1.620	0	0
SUB05	888	3013	157	0	0	1.487	0	0	1.487	0	0
SUB05	890	888	511	0	0	1.431	0	0	1.431	0	0
SUB05	891	890	89	0	0	1.362	0	0	1.362	0	0
SUB05	892	891	246	0	0	1.298	0	0	1.298	0	0
SUB05	893	892	251	0	0	1.233	0	0	1.233	0	0
SUB05	894	893	300	0	0	1.169	0	0	1.169	0	0
SUB05	895	894	125	0	0	1.099	0	0	1.099	0	0
SUB05	896	895	236	0	0	0.307	0	0	0.307	0	0
SUB05	899	398	237	0	0	0.078	0	0	0.078	0	0
SUB05	9	2374	269	0	0	8.202	0	0	8.202	0	0
SUB05	9003	9002	14	0	0	15.438	0	0	15.438	0	0
SUB05	9004	9003	309	0	0	15.446	0	0	15.446	0	0
SUB05	9005	9004	141	0	0	15.426	0	0	15.426	0	0
SUB05	9006	9005	309	0	0	15.451	0	0	15.451	0	0
SUB05	9009	1903	17	0	0	12.816	0	0	12.816	0	0
SUB05	904	895	298	0	0	0.737	0	0	0.737	0	0
SUB05	905	904	148	0	0	0.665	0	0	0.665	0	0
SUB05	906	905	331	0	0	0.595	0	0	0.595	0	0
SUB05	907	906	245	0	0	0.528	0	0	0.528	0	0
SUB05	908	907	285	0	0	0.455	0	0	0.455	0	0
SUB05	909	908	215	0	0	0.382	0	0	0.382	0	0
SUB05	910	909	126	0	0	0.307	0	0	0.307	0	0
SUB05	911	910	167	0	0	0.232	0	0	0.232	0	0
SUB05	912	911	201	0	0	0.155	0	0	0.155	0	0
SUB05	913	912	352	0	0	0.078	0	0	0.078	0	0
SUB05	946	885	235	0	0	0.601	0	0	0.601	0	0
SUB05	947	946	299	0	0	0.528	0	0	0.528	0	0
SUB05	948	947	291	0	0	0.455	0	0	0.455	0	0
SUB05	949	1068	149	0	0	0.306	0	0	0.306	0	0
SUB05	950	949	274	0	0	0.231	0	0	0.231	0	0
SUB05	951	950	269	0	0	0.156	0	0	0.156	0	0
SUB05	952	951	170	0	0	0.078	0	0	0.078	0	0
		Sub. Total:	47612		0			795,370			795,370

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2010 - 5 YR 30% I/I REMOVAL			Model: 2010 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length (ft)	CIP Diameter (in)	CIP Cost (ft/ft)	Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)	Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)
	Basin:										
	Subsys	SUB06									
SUB06	2106	9000	181	0	0	17.008	0	0	22.512	0	0
SUB06	2107	2106	318	0	0	17.109	0	0	22.639	42	99,215
SUB06	2108	2107	358	0	0	17.229	0	0	22.817	42	102,241
SUB06	2109	2108	108	0	0	17.235	0	0	22.840	42	30,765
SUB06	2110	2109	107	0	0	17.242	0	0	22.861	42	31,821
SUB06	2110A	2110	56	0	0	17.226	0	0	22.851	42	16,839
SUB06	2111	2110A	403	0	0	16.154	0	0	21.755	0	0
SUB06	2112	2111	149	0	0	16.176	0	0	21.801	0	0
SUB06	2113	2112	350	0	0	16.283	0	0	21.966	0	0
SUB06	2114	2113	179	0	0	16.317	0	0	22.029	0	0
SUB06	2115	2114	89	0	0	15.840	0	0	23.921	0	0
SUB06	2115	G	13	0	0	17.153	0	0	22.183	0	0
SUB06	2116	2115	432	0	0	16.797	0	0	22.189	0	0
SUB06	2117	2116	598	0	0	17.016	0	0	22.511	0	0
SUB06	9000	WWTP	53	0	0	48.165	0	0	58.111	0	0
SUB06	9001	9000	53	0	0	15.491	0	0	15.491	0	0
SUB06	9002	9001	67	0	0	15.471	0	0	15.471	0	0
SUB06	9010	9000	245	0	0	16.618	0	0	21.338	0	0
SUB06	A	9010	419	0	0	16.742	0	0	21.510	0	0
SUB06	B	A	260	0	0	16.814	0	0	21.632	42	80,069
SUB06	C	B	107	0	0	16.821	0	0	21.656	42	35,144
SUB06	D	C	66	0	0	16.801	0	0	21.642	0	0
SUB06	E	D	407	0	0	16.940	0	0	21.853	42	132,082
SUB06	F	E	89	0	0	16.937	0	0	21.863	42	28,680
SUB06	G	F	658	0	0	17.191	0	0	22.223	42	209,926
SUB06	H	2115	413	0	0	16.958	0	0	22.496	42	121,114
SUB06	J	H	620	0	0	17.231	0	0	22.816	48	227,197
SUB06	WWTP		43	0	0	48.181	0	0	58.122	0	0
		Sub. Total:	6841		0			0			1,115,093
		TOTAL:	113892		0			4,979,101			8,440,571

LEAVENWORTH, KS - FUTURE

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2020 - 5 YR 30% I/I REMOVAL			Model: 2020 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
	Basin:										
	Subsys	SUB01									
SUB01	1165	307	75	0	0	23.387	42	27,330	32.283	42	27,330
SUB01	1166	1165	285	0	0	23.252	42	108,216	32.088	42	108,216
SUB01	1167	1166	166	0	0	23.087	36	50,013	31.855	42	59,784
SUB01	1168	1167	223	0	0	22.935	42	71,768	31.641	42	71,768
SUB01	1169	1168	131	0	0	22.760	36	37,028	31.396	42	44,643
SUB01	1170	1169	499	0	0	22.674	36	149,745	31.270	42	179,091
SUB01	1171	1170	115	0	0	22.494	36	30,065	31.021	42	36,653
SUB01	1172	1171	224	0	0	22.340	36	51,443	30.808	42	63,995
SUB01	1173	1172	189	0	0	22.181	48	66,331	30.583	54	80,190
SUB01	1174	1173	100	0	0	22.004	36	24,012	30.329	42	29,657
SUB01	1175	1174	98	0	0	21.826	42	29,378	30.076	48	34,957
SUB01	1176	1175	301	0	0	21.713	36	71,135	29.887	42	88,082
SUB01	1177	1176	344	0	0	21.612	36	75,266	29.711	42	94,397
SUB01	1178	1177	124	0	0	21.444	36	27,131	29.466	42	34,026
SUB01	1179	1178	441	0	0	21.373	36	96,489	29.321	42	121,015
SUB01	1180	1179	310	0	0	21.436	36	67,827	29.245	42	85,067
SUB01	1180	255	10	0	0	3.177	21	1,274	3.189	21	1,274
SUB01	1181	1180	324	0	0	18.648	0	0	24.370	27	55,953
SUB01	1182	1181	41	0	0	18.451	0	0	24.100	0	0
SUB01	1183	1182	149	0	0	18.280	0	0	23.862	0	0
SUB01	1184	1183	38	0	0	18.083	0	0	23.592	27	6,830
SUB01	1185	1184	340	0	0	17.980	33	69,639	23.415	36	74,390
SUB01	1186	1185	125	0	0	17.812	33	25,603	23.172	36	27,350
SUB01	1187	1186	162	0	0	17.656	33	33,181	22.941	36	35,445
SUB01	1188	1187	241	0	0	17.523	42	66,133	22.734	42	66,133
SUB01	1189	1188	459	0	0	17.455	33	94,013	22.593	36	100,426
SUB01	1190	1189	594	0	0	17.426	33	121,664	22.493	36	129,965
SUB01	1191	1190	346	0	0	6.486	0	0	8.819	21	44,073
SUB01	1192	1191	429	0	0	6.403	0	0	8.683	21	54,647
SUB01	1193	1192	390	0	0	6.281	0	0	8.502	18	45,433
SUB01	1194	720	45	0	0	2.916	18	5,243	3.738	18	5,243
SUB01	1195	1194	275	0	0	2.766	18	32,037	3.526	18	32,037
SUB01	1196	1195	370	0	0	2.631	18	46,562	3.330	18	46,562
SUB01	1196A	1196	361	0	0	2.485	15	49,661	3.119	15	49,661

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2020 - 5 YR 30% I/I REMOVAL			Model: 2020 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB01	1197	1196A	303	0	0	2.334	12	37,537	2.904	15	41,849
SUB01	1197A	1197	402	0	0	2.192	0	0	2.698	15	53,076
SUB01	1198	1197A	199	0	0	2.032	0	0	2.476	15	25,137
SUB01	1198A	1198	332	0	0	1.876	12	40,672	2.255	15	45,395
SUB01	1199	1198A	319	0	0	1.721	12	38,786	2.036	12	38,786
SUB01	1200	1477	256	0	0	1.390	0	0	1.578	0	0
SUB01	1201	1200	321	0	0	1.236	10	27,316	1.361	12	30,057
SUB01	1202	1201	317	0	0	1.084	10	26,976	1.146	10	26,976
SUB01	1204	490	543	0	0	11.265	27	107,163	14.331	30	117,193
SUB01	1205	1204	260	0	0	11.093	24	50,558	14.092	27	59,005
SUB01	1206	1205	380	0	0	10.935	24	61,145	13.877	27	73,304
SUB01	1207	1206	242	0	0	10.762	18	28,193	13.641	21	30,827
SUB01	1208	1207	308	0	0	10.596	21	40,222	13.415	24	44,423
SUB01	1209	1208	316	0	0	10.432	24	54,550	13.190	27	64,716
SUB01	1210	1209	322	0	0	10.281	24	52,058	12.966	27	62,364
SUB01	1211	1210	260	0	0	10.122	24	36,658	12.733	27	44,901
SUB01	1212	1211	269	0	0	9.964	24	37,926	12.501	27	46,456
SUB01	1213	1212	166	0	0	9.791	24	23,404	12.253	27	28,668
SUB01	1214	1213	35	0	0	9.597	27	6,045	11.985	27	6,045
SUB01	1215	1214	357	0	0	9.453	24	53,055	11.767	27	64,414
SUB01	1216	1215	343	0	0	7.794	21	52,861	9.454	24	57,611
SUB01	1217	1216	369	0	0	7.651	21	66,034	9.237	21	66,034
SUB01	1218	1217	190	0	0	7.481	21	34,647	8.995	21	34,647
SUB01	1219	1218	252	0	0	7.322	21	39,265	8.761	21	39,265
SUB01	1220	1219	125	0	0	7.143	21	21,118	8.509	21	21,118
SUB01	1221	1220	365	0	0	7.000	21	46,493	8.293	24	51,462
SUB01	1222	1221	357	0	0	6.855	21	45,475	8.076	21	45,475
SUB01	1223	1222	275	0	0	6.700	21	36,952	7.847	21	36,952
SUB01	1224	1223	272	0	0	6.544	21	35,188	7.619	21	35,188
SUB01	1225	1554	230	0	0	6.202	0	0	7.136	0	0
SUB01	1226	1226A	92	0	0	5.836	0	0	6.626	0	0
SUB01	1226A	1225	165	0	0	6.022	0	0	6.884	0	0
SUB01	1227	1226	314	0	0	5.671	21	43,527	6.389	21	43,527
SUB01	1228	1227	278	0	0	5.504	21	38,353	6.149	21	38,353
SUB01	1229	1266	129	0	0	5.149	18	15,028	5.650	18	15,028
SUB01	1229A	1229	319	0	0	4.977	18	37,162	5.406	18	37,162

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2020 - 5 YR 30% I/I REMOVAL			Model: 2020 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB01	1231	1230	439	0	0	4.655	18	57,215	4.942	18	57,215
SUB01	1232	1231	209	0	0	4.484	15	26,052	4.699	15	26,052
SUB01	1233	1975	168	0	0	4.136	15	18,107	4.208	15	18,107
SUB01	1236	1215	310	0	0	1.638	15	34,954	2.271	15	34,954
SUB01	1237	2289	158	0	0	1.235	0	0	1.712	0	0
SUB01	1238	1654	134	0	0	0.828	0	0	1.147	0	0
SUB01	1239	1238	266	0	0	0.623	0	0	0.863	0	0
SUB01	1240	1239	183	0	0	0.416	0	0	0.577	0	0
SUB01	1241	1240	172	0	0	0.209	0	0	0.289	0	0
SUB01	1266	1228	181	0	0	5.328	18	22,033	5.902	18	22,033
SUB01	1477	1199	61	0	0	1.551	0	0	1.802	0	0
SUB01	1554	1224	224	0	0	6.373	0	0	7.377	0	0
SUB01	1654	1237	232	0	0	1.033	0	0	1.432	0	0
SUB01	1975	1232	179	0	0	4.310	15	19,869	4.454	15	19,869
SUB01	205	205A	533	0	0	0.209	0	0	0.289	0	0
SUB01	205A	206	130	0	0	0.407	0	0	0.564	0	0
SUB01	206	207	286	0	0	0.612	0	0	0.848	0	0
SUB01	207	208	251	0	0	0.809	0	0	1.121	0	0
SUB01	208	208A	76	0	0	1.003	0	0	1.391	0	0
SUB01	208A	210	100	0	0	1.202	0	0	1.667	0	0
SUB01	210	214	487	0	0	1.398	0	0	1.941	0	0
SUB01	214	214A	184	0	0	1.571	0	0	2.183	0	0
SUB01	214A	234A	164	0	0	1.759	0	0	2.445	0	0
SUB01	219	426A	291	0	0	1.225	0	0	1.699	0	0
SUB01	2289	1236	250	0	0	1.438	0	0	1.994	0	0
SUB01	233	255	329	0	0	2.333	0	0	3.244	0	0
SUB01	234	234A	97	0	0	0.209	0	0	0.289	0	0
SUB01	234A	233	82	0	0	2.143	0	0	2.980	0	0
SUB01	254	1180	379	0	0	5.711	18	44,683	7.957	18	44,683
SUB01	255	274A	156	0	0	5.575	21	20,018	6.315	24	22,142
SUB01	272	303	325	0	0	6.190	24	45,823	7.164	24	45,823
SUB01	273	272	438	0	0	6.045	24	61,754	6.972	24	61,754
SUB01	274	273	464	0	0	5.912	21	59,104	6.781	24	65,420
SUB01	274A	274	284	0	0	5.755	21	36,176	6.559	24	40,042
SUB01	275	254	164	0	0	5.530	0	0	7.703	18	19,106
SUB01	275A	275	31	0	0	5.342	0	0	7.441	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length (ft)	CIP Diameter (in)	CIP Cost (ft/ft)	Model: 2020 - 5 YR 30% I/I REMOVAL Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)	Model: 2020 - 5 YR 0% I/I REMOVAL Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)
SUB01	299C	299B	186	0	0	5.001	0	0	6.961	0	0
SUB01	302	303	21	0	0	4.039	18	2,447	5.675	18	2,447
SUB01	303	304	423	0	0	10.264	27	73,051	12.805	30	80,728
SUB01	304	305A	385	0	0	10.407	27	66,488	12.994	30	73,476
SUB01	305	306A	394	0	0	10.747	27	68,042	13.434	30	75,195
SUB01	305A	305	56	0	0	10.554	27	9,671	13.187	30	10,687
SUB01	306	307	115	0	0	11.079	27	24,786	13.869	30	26,938
SUB01	306A	306	62	0	0	10.887	27	10,708	13.625	30	11,833
SUB01	307	309	590	0	0	34.487	42	202,099	45.497	48	235,963
SUB01	309	311	174	0	0	34.544	36	44,016	45.591	42	53,926
SUB01	311	311A	48	0	0	34.705	42	14,180	45.821	42	14,180
SUB01	314	302	409	0	0	3.874	18	47,646	5.433	18	47,646
SUB01	315	314	455	0	0	3.711	18	55,770	5.192	18	55,770
SUB01	315A	315	196	0	0	3.529	21	24,966	4.932	24	27,634
SUB01	316	316A	155	0	0	2.966	15	16,705	4.139	15	16,705
SUB01	316A	316B	175	0	0	3.156	0	0	4.407	15	18,861
SUB01	316B	315A	170	0	0	3.344	18	19,804	4.670	18	19,804
SUB01	324	325	193	0	0	2.025	0	0	2.812	15	20,801
SUB01	324A	324	187	0	0	1.829	0	0	2.539	15	20,154
SUB01	325	326	376	0	0	2.219	0	0	3.083	15	40,524
SUB01	326	327	375	0	0	2.404	0	0	3.344	15	45,431
SUB01	327	327A	166	0	0	2.587	15	21,336	3.604	15	21,336
SUB01	327A	316	214	0	0	2.778	15	23,143	3.873	15	23,143
SUB01	361	324A	178	0	0	1.631	0	0	2.264	0	0
SUB01	362	361	131	0	0	1.432	0	0	1.987	15	15,702
SUB01	362A	362	182	0	0	1.234	0	0	1.711	15	21,545
SUB01	365	840A	333	0	0	0.625	0	0	0.866	0	0
SUB01	365A	365	36	0	0	0.417	0	0	0.578	0	0
SUB01	365B	365A	27	0	0	0.209	0	0	0.289	0	0
SUB01	366	366A	348	0	0	1.400	0	0	1.944	0	0
SUB01	366A	368N	282	0	0	1.591	0	0	2.210	0	0
SUB01	367A	367B	97	0	0	2.395	0	0	3.325	0	0
SUB01	367B	368N	349	0	0	2.590	0	0	3.597	0	0
SUB01	368B	369A	369	0	0	4.497	0	0	6.253	0	0
SUB01	368N	368B	405	0	0	4.341	0	0	6.032	0	0
SUB01	369A	370A	395	0	0	4.667	0	0	6.492	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2020 - 5 YR 30% I/I REMOVAL			Model: 2020 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB01	417	814	357	0	0	0.405	0	0	0.561	0	0
SUB01	424E	367A	197	0	0	2.205	0	0	3.061	0	0
SUB01	424F	424E	137	0	0	2.011	0	0	2.791	0	0
SUB01	424G	424F	196	0	0	1.818	0	0	2.522	0	0
SUB01	425A	424G	250	0	0	1.621	0	0	2.248	0	0
SUB01	426A	425A	157	0	0	1.421	0	0	1.971	0	0
SUB01	436	436A	123	0	0	0.413	0	0	0.572	0	0
SUB01	436A	219	392	0	0	1.030	0	0	1.427	0	0
SUB01	436B	9011	304	0	0	0.209	0	0	0.289	0	0
SUB01	439	436	285	0	0	0.209	0	0	0.289	0	0
SUB01	478A	366	312	0	0	1.206	0	0	1.674	0	0
SUB01	483	478A	118	0	0	1.006	0	0	1.397	0	0
SUB01	484	483	442	0	0	0.810	0	0	1.124	0	0
SUB01	485	484	409	0	0	0.615	0	0	0.852	0	0
SUB01	486	485	406	0	0	0.414	0	0	0.574	0	0
SUB01	487	486	254	0	0	0.209	0	0	0.289	0	0
SUB01	490	490A	254	0	0	11.404	27	45,634	14.544	30	50,266
SUB01	490A	1190	143	0	0	11.578	27	24,695	14.791	30	27,291
SUB01	692	1193	205	0	0	6.124	0	0	8.285	0	0
SUB01	694	692	289	0	0	6.016	24	40,746	8.109	27	49,910
SUB01	695	694	251	0	0	5.898	24	35,389	7.923	27	43,347
SUB01	696	696A	21	0	0	5.588	0	0	7.480	0	0
SUB01	696A	695	212	0	0	5.769	24	29,890	7.727	27	36,612
SUB01	697	696	291	0	0	5.539	42	79,853	7.365	42	79,853
SUB01	698	697	283	0	0	5.388	24	39,901	7.149	27	48,873
SUB01	698A	698	80	0	0	2.333	18	9,320	3.256	21	10,191
SUB01	699	698A	193	0	0	2.150	18	22,483	2.996	18	22,483
SUB01	699A	699	157	0	0	1.958	0	0	2.728	0	0
SUB01	700	699A	300	0	0	1.773	0	0	2.469	0	0
SUB01	701	700	217	0	0	1.589	15	33,913	2.208	18	35,949
SUB01	702	701	191	0	0	1.397	0	0	1.940	0	0
SUB01	720	721	147	0	0	3.093	18	17,124	3.980	18	17,124
SUB01	721	698	152	0	0	3.259	18	17,707	4.212	18	17,707
SUB01	811	702	62	0	0	1.197	0	0	1.663	0	0
SUB01	812	811	233	0	0	1.001	0	0	1.390	0	0
SUB01	813	812	308	0	0	0.807	0	0	1.120	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2020 - 5 YR 30% I/I REMOVAL			Model: 2020 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB01	840A	9013	29	0	0	0.827	0	0	1.145	0	0
SUB01	9011	436A	48	0	0	0.413	0	0	0.572	0	0
SUB01	9013	362A	195	0	0	1.032	0	0	1.431	0	0
SUB01	996	417	690	0	0	0.209	0	0	0.289	0	0
		Sub. Total:	45771		0			4,366,668			5,293,755

Basin:

Subsys SUB02_03

Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
SUB02_03	2118	2117	653	0	0	18.370	0	0	23.747	0	0
SUB02_03	2119	2118	603	0	0	18.671	0	0	24.084	42	165,468
SUB02_03	2120	2119	492	0	0	18.914	0	0	24.356	48	162,887
SUB02_03	2121	P	278	0	0	17.313	36	61,544	22.858	42	77,035
SUB02_03	2121A	2121	408	0	0	17.313	0	0	22.858	0	0
SUB02_03	2121A	R	47	0	0	17.313	0	0	22.858	0	0
SUB02_03	311A	9012	140	0	0	34.686	48	48,767	45.797	54	59,023
SUB02_03	9012	2121A	15	0	0	34.632	36	3,534	45.725	42	4,378
SUB02_03	AA	Z	423	0	0	5.153	0	0	5.153	0	0
SUB02_03	AB	AA	393	0	0	5.218	0	0	5.218	0	0
SUB02_03	AC	AB	434	0	0	5.289	0	0	5.289	0	0
SUB02_03	AD	AC	440	0	0	5.362	0	0	5.362	0	0
SUB02_03	AE	AD	383	0	0	2.699	0	0	2.699	0	0
SUB02_03	AF	AE	223	0	0	2.709	0	0	2.709	0	0
SUB02_03	AG	AD	16	0	0	2.682	0	0	2.682	0	0
SUB02_03	AH	AG	75	0	0	2.686	0	0	2.686	0	0
SUB02_03	AI	AH	54	0	0	2.688	0	0	2.688	0	0
SUB02_03	AJ	AI	468	0	0	2.709	0	0	2.709	0	0
SUB02_03	K	J	650	0	0	18.587	0	0	24.020	48	234,517
SUB02_03	L	K	604	0	0	18.901	0	0	24.353	48	214,569
SUB02_03	M	L	492	0	0	19.157	0	0	24.622	48	172,413
SUB02_03	N	M	489	0	0	19.157	0	0	24.622	48	169,213
SUB02_03	N	2120	488	0	0	19.157	0	0	24.622	48	161,562
SUB02_03	P	N	106	0	0	38.354	0	0	49.285	0	0
SUB02_03	Q	P	459	0	0	21.448	42	127,188	26.919	42	127,188
SUB02_03	R	Q	232	0	0	21.532	42	63,663	27.032	42	63,663
SUB02_03	S	R	610	0	0	4.849	0	0	4.849	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Model: 2020 - 5 YR 30% I/I REMOVAL Total Flow	Relief Dia.	Construction Cost	Model: 2020 - 5 YR 0% I/I REMOVAL Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB02_03	T	S	139	0	0	4.864	0	0	4.864	0	0
SUB02_03	U	T	119	0	0	4.877	0	0	4.877	0	0
SUB02_03	V	U	268	0	0	4.906	0	0	4.906	0	0
SUB02_03	W	V	444	0	0	4.954	0	0	4.954	0	0
SUB02_03	X	W	606	0	0	5.026	0	0	5.026	0	0
SUB02_03	Y	X	347	0	0	5.071	0	0	5.071	0	0
SUB02_03	Z	Y	87	0	0	5.082	0	0	5.082	0	0
		Sub. Total:	11685		0			304,696			1,611,916
	Basin:										
	Subsys	SUB04									
SUB04	627	633	592	0	0	0.621	0	0	0.621	0	0
SUB04	630	630A	386	0	0	2.811	0	0	2.811	0	0
SUB04	630A	2110A	138	0	0	3.322	15	14,873	3.322	15	14,873
SUB04	631	630	47	0	0	2.244	15	5,065	2.244	15	5,065
SUB04	632	631	193	0	0	1.698	0	0	1.698	0	0
SUB04	633	632	627	0	0	1.168	0	0	1.168	0	0
		Sub. Total:	1983		0			19,938			19,938
	Basin:										
	Subsys	SUB05									
SUB05	10	9	288	0	0	15.668	0	0	15.668	0	0
SUB05	1068	948	109	0	0	0.380	0	0	0.380	0	0
SUB05	11	10	182	0	0	15.639	36	65,405	15.639	36	65,405
SUB05	12	11	371	0	0	15.656	36	140,498	15.656	36	140,498
SUB05	13	12	389	0	0	15.677	36	142,084	15.677	36	142,084
SUB05	13A	13	136	0	0	0.078	0	0	0.078	0	0
SUB05	14	13	361	0	0	15.605	0	0	15.605	0	0
SUB05	1401	880	11	0	0	18.110	36	2,406	18.110	36	2,406
SUB05	1402	1401	115	0	0	18.072	33	23,555	18.072	33	23,555
SUB05	1403	1402	248	0	0	18.065	33	50,796	18.065	33	50,796
SUB05	1404	1403	84	0	0	18.021	33	17,205	18.021	33	17,205
SUB05	1405	1404	396	0	0	18.047	33	81,110	18.047	33	81,110

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2020 - 5 YR 30% I/I REMOVAL			Model: 2020 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB05	1405A	1405	233	0	0	1.450	0	0	1.450	0	0
SUB05	1405B	1405A	372	0	0	1.403	0	0	1.403	0	0
SUB05	1405C	1405B	147	0	0	1.342	0	0	1.342	0	0
SUB05	1405D	1405C	188	0	0	1.283	0	0	1.283	0	0
SUB05	1406	1405	234	0	0	16.650	30	44,659	16.650	30	44,659
SUB05	1407	1406	274	0	0	16.648	30	52,292	16.648	30	52,292
SUB05	1408	1407	335	0	0	16.140	30	63,934	16.140	30	63,934
SUB05	1409	1408	291	0	0	16.141	30	55,537	16.141	30	55,537
SUB05	1410	1409	105	0	0	16.099	30	20,039	16.099	30	20,039
SUB05	1411	1410	179	0	0	16.073	30	34,162	16.073	30	34,162
SUB05	1412	1411	72	0	0	16.024	30	13,741	16.024	30	13,741
SUB05	1413	1412	367	0	0	16.040	30	70,041	16.040	30	70,041
SUB05	1414	1413	436	0	0	16.062	0	0	16.062	0	0
SUB05	1415	1414	256	0	0	16.064	48	92,014	16.064	48	92,014
SUB05	1416	1415	238	0	0	16.047	0	0	16.047	0	0
SUB05	1417	2273	158	0	0	15.992	30	30,542	15.992	30	30,542
SUB05	1418	1417	200	0	0	15.978	30	39,208	15.978	30	39,208
SUB05	1419	1419A	233	0	0	15.931	30	46,133	15.931	30	46,133
SUB05	1419A	1418	106	0	0	15.938	30	20,520	15.938	30	20,520
SUB05	1420	1420A	215	0	0	15.874	30	46,424	15.874	30	46,424
SUB05	1420A	1419	90	0	0	15.886	30	17,820	15.886	30	17,820
SUB05	1421	1420	299	0	0	15.883	30	78,561	15.883	30	78,561
SUB05	1422	1421	254	0	0	15.880	30	74,824	15.880	30	74,824
SUB05	1423	1422	258	0	0	15.877	30	74,309	15.877	30	74,309
SUB05	1424	1423	200	0	0	0.302	0	0	0.302	0	0
SUB05	1425	1424	340	0	0	0.228	0	0	0.228	0	0
SUB05	1426	1425	249	0	0	0.153	0	0	0.153	0	0
SUB05	1427	1426	404	0	0	0.078	0	0	0.078	0	0
SUB05	1428	1407	115	0	0	0.593	0	0	0.593	0	0
SUB05	1429	1428	302	0	0	0.524	0	0	0.524	0	0
SUB05	1430	1429	194	0	0	0.451	0	0	0.451	0	0
SUB05	1431	1430	227	0	0	0.379	0	0	0.379	0	0
SUB05	1432	1431	321	0	0	0.306	0	0	0.306	0	0
SUB05	1433	1432	255	0	0	0.231	0	0	0.231	0	0
SUB05	1434	1433	365	0	0	0.156	0	0	0.156	0	0
SUB05	1435	1434	347	0	0	0.078	0	0	0.078	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2020 - 5 YR 30% I/I REMOVAL			Model: 2020 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB05	1449	1448	403	0	0	1.959	0	0	1.959	0	0
SUB05	1450	1449	398	0	0	1.916	0	0	1.916	0	0
SUB05	1451	1450	402	0	0	1.863	0	0	1.863	0	0
SUB05	1452	1451	400	0	0	1.819	0	0	1.819	0	0
SUB05	1453	1452	402	0	0	1.773	0	0	1.773	0	0
SUB05	1454	1453	424	0	0	1.729	0	0	1.729	0	0
SUB05	1455	1454	89	0	0	1.667	0	0	1.667	0	0
SUB05	1456	1455	180	0	0	1.542	0	0	1.542	0	0
SUB05	1457	3026	68	0	0	1.422	0	0	1.422	0	0
SUB05	1458	1457	187	0	0	1.360	0	0	1.360	0	0
SUB05	1459	1458	251	0	0	1.299	0	0	1.299	0	0
SUB05	1460	1460A	304	0	0	1.172	0	0	1.172	0	0
SUB05	1460A	1459	89	0	0	1.233	0	0	1.233	0	0
SUB05	1461	1460	148	0	0	1.106	0	0	1.106	0	0
SUB05	1462	1461	98	0	0	1.040	0	0	1.040	0	0
SUB05	1463	1462	354	0	0	0.979	0	0	0.979	0	0
SUB05	1464	1463	270	0	0	0.915	0	0	0.915	0	0
SUB05	1465	1464	193	0	0	0.849	0	0	0.849	0	0
SUB05	1466	1465	244	0	0	0.783	0	0	0.783	0	0
SUB05	15	14	315	0	0	15.573	30	101,371	15.573	30	101,371
SUB05	1571	1466	155	0	0	0.714	0	0	0.714	0	0
SUB05	1572	1571	301	0	0	0.649	0	0	0.649	0	0
SUB05	1573	1572	277	0	0	0.583	0	0	0.583	0	0
SUB05	1574	1573	128	0	0	0.511	0	0	0.511	0	0
SUB05	1575	1574	393	0	0	0.442	0	0	0.442	0	0
SUB05	1576	1575	396	0	0	0.372	0	0	0.372	0	0
SUB05	1577	1576	353	0	0	0.302	0	0	0.302	0	0
SUB05	1578	1577	367	0	0	0.230	0	0	0.230	0	0
SUB05	1579	1578	401	0	0	0.155	0	0	0.155	0	0
SUB05	1580	1579	400	0	0	0.078	0	0	0.078	0	0
SUB05	15A	15	182	0	0	0.078	0	0	0.078	0	0
SUB05	16	15	257	0	0	15.459	27	72,564	15.459	27	72,564
SUB05	17	16	454	0	0	15.427	27	133,103	15.427	27	133,103
SUB05	18	17	195	0	0	15.371	24	53,251	15.371	24	53,251
SUB05	1893	9006	306	0	0	22.390	0	0	22.390	0	0
SUB05	1894	1893	195	0	0	22.407	0	0	22.407	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2020 - 5 YR 30% I/I REMOVAL			Model: 2020 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB05	1895A	1895	130	0	0	22.498	0	0	22.498	0	0
SUB05	1896	1895A	219	0	0	22.523	0	0	22.523	0	0
SUB05	1897	1448	181	0	0	20.644	0	0	20.644	0	0
SUB05	1898	1897	226	0	0	20.665	0	0	20.665	0	0
SUB05	1899	1898	263	0	0	20.698	0	0	20.698	0	0
SUB05	18A	18	200	0	0	14.433	33	65,425	14.433	33	65,425
SUB05	18B	18A	190	0	0	14.387	33	68,387	14.387	33	68,387
SUB05	19	18	284	0	0	0.974	0	0	0.974	0	0
SUB05	1900	1899	245	0	0	20.728	0	0	20.728	0	0
SUB05	1901	1900	115	0	0	20.708	0	0	20.708	0	0
SUB05	1902	1901	103	0	0	20.682	0	0	20.682	0	0
SUB05	1903	1902	148	0	0	19.870	0	0	19.870	0	0
SUB05	1904	9009	305	0	0	19.397	0	0	19.397	0	0
SUB05	1905	1904	350	0	0	19.482	0	0	19.482	0	0
SUB05	1906	1905	381	0	0	19.519	0	0	19.519	0	0
SUB05	1907	1906	528	0	0	19.588	0	0	19.588	0	0
SUB05	1908	1907	160	0	0	19.564	0	0	19.564	0	0
SUB05	1909	1908	331	0	0	19.577	0	0	19.577	0	0
SUB05	1910	1909	117	0	0	19.539	0	0	19.539	0	0
SUB05	20	19	255	0	0	0.913	0	0	0.913	0	0
SUB05	21	20	199	0	0	0.846	0	0	0.846	0	0
SUB05	22	21	276	0	0	0.783	0	0	0.783	0	0
SUB05	2273	1416	143	0	0	16.018	30	27,291	16.018	30	27,291
SUB05	23	22	276	0	0	0.719	0	0	0.719	0	0
SUB05	2367	1423	20	0	0	15.539	30	4,744	15.539	30	4,744
SUB05	2368	2367	284	0	0	15.543	33	58,170	15.543	33	58,170
SUB05	2369	2368	306	0	0	15.551	30	58,399	15.551	30	58,399
SUB05	2370	2369	270	0	0	15.549	33	61,410	15.549	33	61,410
SUB05	2371	2370	422	0	0	15.585	33	125,999	15.585	33	125,999
SUB05	2372	2371	408	0	0	15.616	33	148,261	15.616	33	148,261
SUB05	2373	2372	425	0	0	15.650	33	151,205	15.650	33	151,205
SUB05	2374	2373	493	0	0	15.700	33	160,836	15.700	33	160,836
SUB05	23A	23	132	0	0	0.078	0	0	0.078	0	0
SUB05	24	23	187	0	0	0.578	0	0	0.578	0	0
SUB05	25	24	297	0	0	0.512	0	0	0.512	0	0
SUB05	26	25	261	0	0	0.444	0	0	0.444	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length (ft)	CIP Diameter (in)	CIP Cost (ft/ft)	Model: 2020 - 5 YR 30% I/I REMOVAL Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)	Model: 2020 - 5 YR 0% I/I REMOVAL Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)
SUB05	28	27	295	0	0	0.300	0	0	0.300	0	0
SUB05	29	28	295	0	0	0.226	0	0	0.226	0	0
SUB05	30	29	320	0	0	0.154	0	0	0.154	0	0
SUB05	3002	3003	332	0	0	0.230	0	0	0.230	0	0
SUB05	3003	3004	336	0	0	0.304	0	0	0.304	0	0
SUB05	3004	3005	145	0	0	0.378	0	0	0.378	0	0
SUB05	3005	663	191	0	0	0.452	0	0	0.452	0	0
SUB05	3013	887	183	0	0	1.554	0	0	1.554	0	0
SUB05	3026	1456	288	0	0	1.488	0	0	1.488	0	0
SUB05	3032	1455	47	0	0	0.078	0	0	0.078	0	0
SUB05	31	30	318	0	0	0.078	0	0	0.078	0	0
SUB05	397	896	239	0	0	0.232	0	0	0.232	0	0
SUB05	398	397	228	0	0	0.156	0	0	0.156	0	0
SUB05	663	9009	98	0	0	0.526	0	0	0.526	0	0
SUB05	686	3002	304	0	0	0.155	0	0	0.155	0	0
SUB05	686A	686	205	0	0	0.078	0	0	0.078	0	0
SUB05	782	785	306	0	0	0.078	0	0	0.078	0	0
SUB05	785	786	243	0	0	0.156	0	0	0.156	0	0
SUB05	786	787	217	0	0	0.232	0	0	0.232	0	0
SUB05	787	802	257	0	0	0.308	0	0	0.308	0	0
SUB05	802	803	185	0	0	0.382	0	0	0.382	0	0
SUB05	803	804	278	0	0	0.453	0	0	0.453	0	0
SUB05	804	805	196	0	0	0.524	0	0	0.524	0	0
SUB05	805	806	259	0	0	0.594	0	0	0.594	0	0
SUB05	806	807	152	0	0	0.666	0	0	0.666	0	0
SUB05	807	808	263	0	0	0.738	0	0	0.738	0	0
SUB05	808	809	260	0	0	0.803	0	0	0.803	0	0
SUB05	809	810	250	0	0	0.867	0	0	0.867	0	0
SUB05	810	1902	18	0	0	0.930	0	0	0.930	0	0
SUB05	880	1910	12	0	0	19.478	0	0	19.478	0	0
SUB05	881	880	267	0	0	1.386	0	0	1.386	0	0
SUB05	882	881	299	0	0	1.331	0	0	1.331	0	0
SUB05	883	882	276	0	0	1.274	0	0	1.274	0	0
SUB05	884	883	298	0	0	1.216	0	0	1.216	0	0
SUB05	885	884	227	0	0	1.146	0	0	1.146	0	0
SUB05	885	1405D	94	0	0	1.216	0	0	1.216	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length (ft)	CIP Diameter (in)	CIP Cost (ft/ft)		Model: 2020 - 5 YR 30% I/I REMOVAL Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)	Model: 2020 - 5 YR 0% I/I REMOVAL Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)
SUB05	887	886	339	0		0	1.620	0	0	1.620	0	0
SUB05	888	3013	157	0		0	1.487	0	0	1.487	0	0
SUB05	890	888	511	0		0	1.431	0	0	1.431	0	0
SUB05	891	890	89	0		0	1.362	0	0	1.362	0	0
SUB05	892	891	246	0		0	1.298	0	0	1.298	0	0
SUB05	893	892	251	0		0	1.233	0	0	1.233	0	0
SUB05	894	893	300	0		0	1.169	0	0	1.169	0	0
SUB05	895	894	125	0		0	1.099	0	0	1.099	0	0
SUB05	896	895	236	0		0	0.307	0	0	0.307	0	0
SUB05	899	398	237	0		0	0.078	0	0	0.078	0	0
SUB05	9	2374	269	0		0	15.694	30	76,739	15.694	30	76,739
SUB05	9003	9002	14	0		0	22.243	0	0	22.243	0	0
SUB05	9004	9003	309	0		0	22.275	0	0	22.275	0	0
SUB05	9005	9004	141	0		0	22.268	0	0	22.268	0	0
SUB05	9006	9005	309	0		0	22.330	0	0	22.330	0	0
SUB05	9009	1903	17	0		0	19.814	0	0	19.814	0	0
SUB05	904	895	298	0		0	0.737	0	0	0.737	0	0
SUB05	905	904	148	0		0	0.665	0	0	0.665	0	0
SUB05	906	905	331	0		0	0.595	0	0	0.595	0	0
SUB05	907	906	245	0		0	0.528	0	0	0.528	0	0
SUB05	908	907	285	0		0	0.455	0	0	0.455	0	0
SUB05	909	908	215	0		0	0.382	0	0	0.382	0	0
SUB05	910	909	126	0		0	0.307	0	0	0.307	0	0
SUB05	911	910	167	0		0	0.232	0	0	0.232	0	0
SUB05	912	911	201	0		0	0.155	0	0	0.155	0	0
SUB05	913	912	352	0		0	0.078	0	0	0.078	0	0
SUB05	946	885	235	0		0	0.601	0	0	0.601	0	0
SUB05	947	946	299	0		0	0.528	0	0	0.528	0	0
SUB05	948	947	291	0		0	0.455	0	0	0.455	0	0
SUB05	949	1068	149	0		0	0.306	0	0	0.306	0	0
SUB05	950	949	274	0		0	0.231	0	0	0.231	0	0
SUB05	951	950	269	0		0	0.156	0	0	0.156	0	0
SUB05	952	951	170	0		0	0.078	0	0	0.078	0	0
		Sub. Total:	47612			0			2,764,974			2,764,974

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: 2020 - 5 YR 30% I/I REMOVAL			Model: 2020 - 5 YR 0% I/I REMOVAL		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
	Basin:										
	Subsys	SUB06									
SUB06	2106	9000	181	0	0	17.765	0	0	24.275	0	0
SUB06	2107	2106	318	0	0	17.864	0	0	24.421	48	117,362
SUB06	2108	2107	358	0	0	17.981	0	0	24.589	48	122,570
SUB06	2109	2108	108	0	0	17.984	0	0	24.608	42	30,765
SUB06	2110	2109	107	0	0	17.989	0	0	24.625	48	37,911
SUB06	2110A	2110	56	0	0	17.970	0	0	24.613	48	20,028
SUB06	2111	2110A	403	0	0	16.858	0	0	23.478	0	0
SUB06	2112	2111	149	0	0	16.891	0	0	23.524	0	0
SUB06	2113	2112	350	0	0	17.022	0	0	23.691	0	0
SUB06	2114	2113	179	0	0	17.068	0	0	23.754	0	0
SUB06	2115	2114	89	0	0	16.589	0	0	25.686	0	0
SUB06	2115	G	13	0	0	18.428	0	0	22.227	0	0
SUB06	2116	2115	432	0	0	17.823	0	0	23.081	0	0
SUB06	2117	2116	598	0	0	18.084	0	0	23.398	0	0
SUB06	9000	WWTP	53	0	0	54.060	0	0	66.476	48	17,763
SUB06	9001	9000	53	0	0	22.291	0	0	22.291	0	0
SUB06	9002	9001	67	0	0	22.277	0	0	22.277	0	0
SUB06	9010	9000	245	0	0	17.826	0	0	21.416	0	0
SUB06	A	9010	419	0	0	17.949	0	0	21.600	0	0
SUB06	B	A	260	0	0	18.020	0	0	21.714	42	80,069
SUB06	C	B	107	0	0	18.026	0	0	21.734	42	35,144
SUB06	D	C	66	0	0	18.004	0	0	21.718	0	0
SUB06	E	D	407	0	0	18.150	0	0	21.918	42	132,082
SUB06	F	E	89	0	0	18.154	0	0	21.925	42	28,680
SUB06	G	F	658	0	0	18.467	0	0	22.268	42	209,926
SUB06	H	2115	413	0	0	18.013	0	0	23.398	42	121,114
SUB06	J	H	620	0	0	18.296	0	0	23.703	48	227,197
SUB06	WWTP		43	0	0	54.077	0	0	66.477	0	0
		Sub. Total:	6841		0			0			1,180,611
		TOTAL:	113892		0			7,456,276			10,871,194

APPENDIX K

PLANT INSPECTION REPORTS

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date:
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Raw Sewage Pump Station**

	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description	Original construction in 1963. Modifications made to Motor Control Cer flooding occurred in 1993.	1963/1993		X	
Structural	Bent screen on window next to MCC's. Last tread on stairs into dry pit not installe possible trip hazard. Lower flight of stairs needs replacing. Lower riser on last stair is corroded completely away. Floor sealer in dry pit in poor condition. Roofing needs repair. Grating in good condition. Minor corrosion noted. One window broken. Hatch on south side of basin needs new hardware and cable tie hold downs. Hoods on PRV's and hatch doors are badly corroded.	1963/1963		X	

Process Equipment:

	Comments	Year Constructed/ Last Renovation	Pump P6	Drives and all other pump	
Raw Sewage Pumps	Need new pumps -- 4 influent pumps, 3 Fairbanks-Morse, 1 Allis-Chalm Pumps to be rebuilt in a few years. Electromagnetic AFD's on Pump 6 has a DC drive is which becoming obsolete. Piping needs pain Valves in good condition except spring on check valve for Pump 6 is corroded. Packing on Pump 6 - no water flush, not rope packin	1963/1977	X	X	

	Comments	Year Constructed/ Last Renovation	Good	Fair	Poor
Sump Pump:	Newer sump pump.	1963/1993	X		
Bridge Crane:	Slight checks and breaks noted in wire rope hoist.	1963/1963		X	
HVAC:	Electric Unit Heater in corner is ok. Corrosion on burner box near south door. Louv stuck in open position. New unit heater in basement. Corrosion and missing screens noted on ventilation ductwork.	1963/1963		X	
Electrical:	Bar screen panels in good condition. Allen Bradley MCCs installed in 1993. City installed new PA System, some exposed wiring noted.	1998	X		
Controls:	Ultrasonic level system. Bar screen level controls ok. Level control/lead-lag configuration. Flow meter magmeter might fit on the discharge of the pumps - no existing meter now. Old bubbler system out of service. New ultrasonic system in service.			X	

Area not flooded in (1994).
10 mgd capacity perhaps with a full wet well.
Info. Taken from control board:

P1, P2, P3, P4 are constant speed
P6 is variable speed
P5 not installed (future variable speed)

Pump Settings	on	off	Circuit	
1	7.80	6.80	1	manual P5 & P6
2	12.55	11.55	2	manual P1, P2, P3, P4
3	13.05	11.80	3	auto const speed P1
4	13.30	12.05	4	auto const speed P2
5	13.55	12.30	5	auto const speed P3
6	14.05	12.55	6	auto const speed P5 & P6
7	13.80	12.80	7	auto const speed P4

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date:
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Screening Chamber**

	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:	Screenings pit constructed in 1963. Concrete roof slab installed 1977. Mechanical bar screens replaced in 1998. Fiberglass bar screen enclosure installed 1998.	1963/1998	X		
Structural:	Entrance door into screening chamber sticks. Grating in screening chamber n replacement in isolated locations. Exposed rebar noted in beam south of entryway steps into screening chamber. Entryway enclosure showing signs of water damage. Slight water leakage from cracks in screen chamber walls due to settlement. Top slab needs improved slope to keep water from ponding. Consider installation of drain underneath screenings dumpster to carry water into screen chamber. North access hatch needs new hardware springs and new cable tie hold down. South access hatch needs new hatch or new hardware. Recycle valve into pump station wet well is badly corroded. Consider constructing steps into FRP bar screen enclosure.	1963/1977		X	
Process Equipment:					
Mechanical Bar Screens	Condition appears good.	1998/1998	X		
Serpentix Conveyor	Slight corrosion noted on conveyor hood.	1998/1998	X		
Jib Crane	Hoist missing, but available. Slight corrosion noted on jib. Should be cleaned repainted.	1977/1977	X		
HVAC:	Differential pressure switch shuts unit down when filters are installed. Potentially un flow condition into screen chamber. Anchor bolts for make-up air unit are corroding.	1998/1998	X		
Electrical:	City added light to tell that conveyor is off without entering the FRP enclosur lights in screening chamber are functioning well.	1998/1998	X		
Controls:	City reports H2S meter replaced once a year. Metering air suction piping need to prevent moisture from entering gas meter sensors.	1998/1998	X		

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date:
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Preaeration Structure**

Item	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:	Aerated grit structure - 2 bays. Original wood baffling.			X	
Structural:	Corner of concrete cracked from brick expansion. Basins in good shape. Paint in good condition.			X	
Process Equipment:					
Grit Collector Screws	Cyclones altered by City. Collectors get 3 yds./week, submersible pumps - Vauhn Chopper Pumps - 1 being rebuilt, the other in the past year. Grit settles before it gets to the colleciton ends. Prefer sloped sides with auger down the middle. Grit cyclones have been changed around by plant staff. Weir on basin - corroded, stop plates in good condition. Grit cleanup done in-house - takes 2 weeks x 7 people per side. Both sides cleaned annually. Reuse diffuser system.	1972	X (Screws)	X (Pumps)	
Blowers and Aerators	Blowers replaced within past 5 years. 3 yds./week out of each side Hoffman 4027A 60 HP. 3x centrifugal blowers.	1972	X		
Scum Pump	Pump doesn't run. Scum or grease not a problem. New scum troughs wo be used if functional.	1972			
HVAC:					
Electrical:	Corrosion on light receptacle switches.		X		
Controls:					

Grit is filling the holding tank. Doesn't seem to clear the pumps.

Aerated influent sampler - this may affect process analysis.

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date: ____________
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: Primary Flow Splitter

	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:			☐	☐	☐
Structural:			☐	☐	☐
Process Equipment:					
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
HVAC:			☐	☐	☐
Electrical:			☐	☐	☐
Controls:			☐	☐	☐

Downward opening cippoletti, may be added to provide more head to PC #4. Overall good condition.

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date:
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Primary Clarifiers**

	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:	Launders replaced and coal tarred.			X	
Structural:	Sections of rusted handrail. Handrail openings not compliant. Corrosion on ga weirs.			X	X (Fair to poor)
Process Equipment:					
Primary Clarifier Equipment	Walker Process. 2 drives replaced 2 years ago. 1 drive existin never replaced. Equipment nameplate missing. Rex drive.		X (2)	X (1)	
	Walkway corroded.				X
	Scum trough corroded. Weir and launder replacement.				X
HVAC:					
Electrical:	Electrical boxes corroded. SE basin light needs repair.			X	
Controls:					

Cones are drained with Sundal Pumps. PC #4 difficulty pumping all the way down.
#4 has concrete launder.
#1 & #2 have metal launders.

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date:
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Primary Sludge Pump Station**

	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:	Window Broken.		X		
Structural:	Desk frames slightly corroded. Bottom riser on stairs needs replacing. Roof in need of replacement. Bubbling and cracks obvious.			X	
Process Equipment:					
Primary Sludge Pumps	2 staters replaced since 1993. 5 pumps replaced in 1993 - cycles every 2 hours. Check valves need replaced. 3 for clarifiers 2 for scum.	1993	X (Pumps)		
Sump Pump	Original.	1972	X		
Bridge Crane		1972	X		
HVAC:	Never replaced, little major maintenance. Automatic motors of louvers and burne	1973	X		
Electrical:	MCC not replaced in 1993.		X		
Controls:					

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date:
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Settled Sewage Pump Station**

	Comments	Year Constructed/ Last Renovation	Good	Fair	Poor
General Description:	Uses pressure indicators for control valves to towers could be replaced Small exterior paint defects. Gate actuator control valves good exterior service. Nugings on stairs have heaved - need repai stairs		X	X	
Structural:	Missing handrail. Piping needs paint touch ups.		X		
Process Equipment:					
Settled Sewage Pumps	Manually rotate pumping cycle seal water.	1972		X	
Air Compressors	2 air compressor paint in good condition. Worthington brand.	1972	X		
Sump Pump	Motor rebuilt in 1993.	1972	X		
Strainer	Paint in poor condition on strainer. 3-month cleaning interval on strainer.	1972	X	X Paint	
Nonpotable Water Pumps	Guard well replacing. 1 pump to be replaced.	1972	X		
Pressure Tank	Paint in moderate condition.	1972	X		
Bridge Crane	Ok.	1972	X		
HVAC:	Poor air changes. Cold in wastewater time, only two ENH's. Fan rebuilt, multiple t				X
Electrical:	Transformer being replaced. Replacing and use reduced power factor.				

Controls: ______________________________

Grinders to be installed by City on sludge pumps prior to sludge pumping.

Sitework

Poor drainage on south end of plant

Perimeter fence

Poor drainage around P.C. #3 area

No water hydrants for fire on site

New milling for new roads - asphalt in bad shape

Maintenance garage needs more space

Sluice gates in settled sewage pump station have bound actuators

Maintenance Shed

Exterior metal panel ok -- north side needs replacing

Interior metal panel poor base connection

Not enough room to park both flush trucks, more laydowns and space area

Bowed wall on west side of building exterior

Recirculation pumping is higher maintenance

No flow metering of system, if system is down, pump output could be reported instead of just pressure. This would result in effluent compliance.

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date:
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Trickling Filters**

Item	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:	Signs of algae growth near bottom.		X		
Structural:	Spalling concrete at TF effluent box.		X		
Process Equipment:					
Trickling Filter Distribution Equipment	Good flow distribtion. Some rust noted on arms North distributor is rusted -- south isn't.		X	X	
	Holes noted in fiberglass near FRP panels.		X		
	Some logs of media on north TF near center.		X		
HVAC:					
Electrical:	Lights ok.		X		
Controls:					

Influent manhole west of TF's in bad condition - bricks missing.
Snail shells recycle to settled sewage pump station.
Control equipment on recirculation pumping needs examination/enhancement.
New stair tower. Replaced 15 yrs ago.

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date: ____________
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: Final Flow Splitter

	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:			☐	☐	☐
Structural:	Grating good condition.		X	☐	☐
Process Equipment:					
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
HVAC:			☐	☐	☐
Electrical:			☐	☐	☐
Controls:			☐	☐	☐

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date: ____________
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Final Clarifiers**

	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:			☐	☐	☐
Structural:	Weir plates delaminating. Concrete in good shape. Clean process every 3 months. Arms in good condition.		☐	☐	X
Process Equipment:					
Final Clarifier Equipment			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
HVAC:			☐	☐	☐
Electrical:	Electrical boxes rusted.		☐	X	☐
Controls:			☐	☐	☐

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date: ____________
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Final Sludge Return Manhole**

	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:	Sludge vault actuators modified by City staff.		X		
Structural:					
Process Equipment:					
HVAC:	PRU functions in good condition.		X		
Electrical:					
Controls:					

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date:
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: Chlorine Contact Basin
Not Used

Item	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:	Algae growing in basin.	1972		X	
Structural:	Handrail missing on one basin. Chain across opening is dangerous. Doors in bad shape. Window missing on south door.	1972		X	X
Process Equipment:					
Chlorine Scales		1972			
Monorail		1972			
Evaporator		1972			
Residual Chlorine Analyzer		1972			
Chlorinators	Removed.	1972			
Sample Pump		1972			
HVAC:					
Electrical:	Lights not functioning. MCC room old unit heater. Chlorinator room - new unit heater.			X	
Controls:					

Bridge monorail -- no reverse button.
Shop maintenance room possible ?.
Possible new lights.

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date:
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: Sludge Holding Tanks

	Comments	Year Constructed/ Last Renovation	Good	Fair	Poor
General Description:					
Structural:	Bridge wall poor. Insulation on pipes in fair shape.				X
Process Equipment:					
Sludge Tank Mixers	One tank being used. One tank uses impeller mixer (north duty). Air mix on other (South Emergency). Philadelphia mixer 31.0 HP 20 RPM, wall baffles.	1972		X	
	Odor control H2S meter middle of the tank.	1984			
	Enclosure & equipment. Air blower in poor condition. Sutorbilt 6HC 2100 RPM Model GAFHDLA.				X
HVAC:					
Electrical:	Hand station for blower in bad shape (corrosion).				X
Controls:	Add sludge level sensor in both tanks.			X	X

Signage needs replacing.
Vibration isolator on odor control duct on south tank.

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date:
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: Sludge Pump House

Item	Comments	Year Constructed/ Last Renovation	Good	Fair	Poor
General Description:	Clean Ferrous staining off of walls.			X	
Structural:	Some concrete spalling.		X		
Process Equipment:					
Sludge Pumps	? and stators replaced once since 1993.	1993	X		
Ferrous Chloride Pumps	One diaphragm replaced since installation.	1996	X		
Ferrous Chloride Storage Tank		1996	X		
HVAC:	PRV-9 not operational in hand position. Larens Cook Model 150 C5B, Mark PRU-9 Job #299-53745-9900-0794-0006 1/2 HP.		X		
Electrical:	Some ballasts are rusty.				
Controls:					

H2S set up to feed to sludge pumps.
New sludge pump ? transformer.

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date:
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Filter Control Building**
Filter Room

	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:					
Structural:	Corrosion on potable water piping.			X	
Process Equipment:					
Lime Day Tank		1994	X		
Day Bin Activator		1994	X		
Maintenance Gate		1994	X		
Knife Gate		1994	X		
Lime Feeder		1994	X		
Screw Conveyor		1994	X		
Sludge Blender		1994	X		
Belt Conveyor	Rollers on conveyor mildly corroded.	1994	X		
Belt Filter Press	Changed belt once.	1994	X		

Washwater Pump	1994	X		
HVAC: Some corrosion on ductwork over press.			X	
Electrical: Corrosion BFP panel.			X	
Controls:				
Needs fiberglass door on BFP room to Control room.			X	
Install sill over Control room door for leakage.				X

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date: ____________
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Filter Control Building**
Control Room

	Comments	Year Constructed/ Last Renovation	Good	Fair	Poor
General Description:	No air conditioning. Ok in cold weather.		☐	☐	X
Structural:			☐	☐	☐
Process Equipment:					
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
HVAC:			☐	☐	☐
Electrical:			☐	☐	☐
Controls:			☐	☐	☐

Air flows in Lobby areas aren't balanced or adjusted enough for good airflow. Honeywell has checked twice on it. No result.
Flooring in basement is poor - need seamless flooring.

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date:
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: Filter Control Building
Sludge Loading Station

	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:			☐	☐	☐
Structural:	Floor in good condition. Some damage to paint.		X	☐	☐
Process Equipment:					
Sludge Hopper			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
HVAC:			☐	☐	☐
Electrical:			☐	☐	☐
Controls:	H2S meter MSA is corroding 02 meter.		X	X	☐

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date: ____________
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Filter Control Building**
Polymer Room

Item	Comments	Year Constructed/ Last Renovation	Condition: Good	Condition: Fair	Condition: Poor
General Description:	Emergency eyewash good.		X		
Structural:	Some paint damage on ceiling.		X		
Process Equipment:					
Polymer Mixing Tanks		1994	X		
Polymer Mixers		1994	X		
Polymer Feed Pump		1994			
Polymer Dilution Panel	Paint in good shape. Replaced trasmission on one pump last y	1994	X		
HVAC:					
Electrical:					
Controls:					

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date: ____________
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Filter Control Building**
Scrubber Room

	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:					
Structural:					
Process Equipment:					
Odor Control Scrubber		1994			
Scrubber Recycle Pump	Routine work on recycle pump.	1994	X		
HVAC:	Minor corrosion on louver.		X		
Electrical:					
Controls:					
	Corrosion on Eyewash.			X	
	Tile in hallway needs repair.			X	

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date: ______
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Filter Control Building**
Odor Control Room

Item	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:					
Structural:	Slight concrete spalling on floor.		X		
Process Equipment:					
Caustic Scale	Corrosion on pump scales.	1994		X	
Caustic Feed Pump	1 GPH. Corrosion on caustic lines near new connections.	1994	X		
Hypochlorite Scale	Corrosion on pump scales.	1994		X	
Hypochlorite Feed Pump	New Neptune pumps 1997 LLGPH Model 532A.	1994	X		
HVAC:					
Electrical:	Corrosion of unistrut hangers.		X		
Controls:					

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date:
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: Filter Control Building
Hydrogen Peroxide Room

Item	Comments	Year Constructed/ Last Renovation	Condition: Good	Fair	Poor
General Description:					
Structural:					
Process Equipment:					
Drum Rotator and Scale		1994			
Hydrogen Peroxide Pump	10 GPH Neptune pump replaced instead of ChemCon 1997.	1994	X		
HVAC:					
Electrical:					
Controls:					

Added new H2O2 line into sludge holding tank use 8 drums/year.

LEAVENWORTH, KANSAS
WASTEWATER MASTER PLAN

B&V Project 37372
Date:
Comments By: ACR, DMB

PLANT INSPECTION REPORT

Facilities: **Filter Control Building**
Lime Feed Room

Item	Comments	Year Constructed/ Last Renovation	Good	Fair	Poor
General Description:	Paint in good condition. Roof needs cleaning/weeding.			X	
Structural:	Repaint one of lime transfer bend. Some paint damage on lime cones.		X	X	
Process Equipment:					
Dust Collector	Shakers type --- need help	1994		X	X
Lime Storage Silos	Original.		X	X	
Bin Gates		1994	X		
Bin Activators		1994	X		
Rotary Feeders		1994	X		
Rotary Airlocks		1994	X		
Transfer Blower		1994	X		

HVAC:	Have dust corrosion on PRV on lime room roof.		X	X	
Electrical:					
Controls:					

Boiler left in place -- 1970's Vintage.
Scrubber MAU Room -- when wind blows into the intake, pressure sensor trips out the area.
Storage Room floor needs repainting.
Service Room needs new hardware on door.

APPENDIX L

HISTORICAL PLANT LOADS

	TSS I	TSS I Influent Pounds	TSS E	BOD I	BOD I Influent Pounds	ppd/kcft	BOD E	CorrEff	EffTemp,C	FLOW	Influent BOD Load If Flow 25% Greater Than Listed	ppd/kcft	Influent TSS Load If Flow 25% Greater Than Listed	% BOD Removal
	mg/l	ppd	mg/l	mg/l	ppd		mg/l			mgd				
Jan-97	347	6,592	13	293	5,559	105	30	28	17	2.262	6,949	92	8,239	90%
Feb-97	317	12,596	16	245	9,263	175	30	27	15	3.915	11,579	153	15,745	88%
Mar-97	207	6,208	14	211	6,248	118	33	30	16	3.637	7,810	103	7,760	84%
Apr-97	227	8,403	10	206	7,451	70	22	20	16	4.663	9,314	123	10,504	89%
May-97	266	8,966	10	229	7,526	71	27	26	19	3.802	9,407	124	11,207	88%
Jun-97	302	7,829	12	230	5,950	56	26	27	22	3.156	7,437	49	9,786	89%
Jul-97	415	10,197	29	285	7,183	136	32	35	24	2.711	8,978	119	12,746	89%
Aug-97	585	13,977	8	331	7,718	73	24	26	24	2.727	9,647	64	17,471	93%
Sep-97	379	8,611	13	309	7,021	66	27	30	24	2.858	8,776	58	10,763	91%
Oct-97	444	9,897	8	297	6,635	63	23	23	22	2.779	8,294	55	12,371	92%
Nov-97	374	7,947	11	297	6,317	60	29	27	18	2.647	7,896	52	9,934	90%
Dec-97	381	10,063	16	265	7,032	66	22	21	17	3.303	8,789	58	12,579	92%
Jan-98	337	8,569	12	245	6,235	59	22	20	16	3.078	7,794	52	10,711	91%
Feb-98	453	10,565	12	264	6,165	58	21	19	16	2.771	7,706	51	13,206	92%
Mar-98	320	9,568	11	208	5,906	56	19	17	16	3.699	7,383	49	11,960	91%
Apr-98	402	11,808	11	198	5,851	55	19	18	18	3.582	7,314	48	14,759	91%
May-98	390	9,279	12	266	6,354	60	23	23	21	2.904	7,943	52	11,599	91%
Jun-98	305	8,358	8	218	6,016	57	20	21	22	3.427	7,519	50	10,448	91%
Jul-98	325	9,198	9	222	6,077	57	20	21	23	3.213	7,596	50	11,498	91%
Aug-98	212	4,899	9	209	4,837	46	17	18	23	3.006	6,047	40	6,123	92%
Sep-98	137	3,253	18	188	4,395	41	15	16	23	2.918	5,494	36	4,066	92%
Oct-98	151	3,758	6	149	3,673	35	12	12	20	3.107	4,591	30	4,698	92%
Nov-98	232	5,583	8	143	3,255	31	14	13	19	3.368	4,069	27	6,978	90%
Dec-98	303	8,421	12	191	5,181	49	17	16	18	3.566	6,477	43	10,527	91%
Jan-99	349	10,308	11	237	7,047	67	15	14	17	3.695	8,809	58	12,885	94%
Feb-99	296	9,943	14	149	4,981	47	18	16	16	3.953	6,226	41	12,429	88%
Mar-99	312	10,913	24	146	4,976	47	17	16	18	4.200	6,220	41	13,641	88%
Apr-99	479	14,719	55	105	3,609	34	18	17	18	3.492	4,511	30	18,399	83%
May-99	471	14,544	4	103	3,020	29	8	8	21	3.641	3,776	25	18,180	92%
Jun-99	510	13,672	11	135	3,638	34	12	12	22	3.253	4,548	30	17,090	91%
Jul-99	331	8,501	14	197	5,092	48	8	9	22	3.101	6,365	42	10,627	96%
Aug-99	341	8,872	17	148	3,879	37	12	12	23	3.168	4,849	32	11,089	92%

Sep-99	364	8,498	10	161	3,878	37	11	12	22	3.000	4,848	32	10,623	93%
Oct-99	499	11,712	17	200	4,629	44	19	20	23	2.733	5,786	38	14,640	91%
Nov-99	380	7,391	21	202	3,802	36	14	14	21	2.305	4,752	31	9,238	93%
Dec-99	564	11,891	9	246	5,172	49	14	14	20	2.513	6,465	43	14,864	94%
Jan-00	423	9,976	13	220	5,174	49	25	24	20	2.734	6,467	43	12,470	89%
Feb-00	481	11,054	21	183	4,172	39	22	23	21	2.874	5,215	34	13,818	88%
Mar-00	333	9,702	13	242	7,254	68	15	0	0	3.514	9,067	60	12,128	94%
Apr-00	429	10,601	12	251	6,164	58	17	0	0	2.995	7,705	51	13,251	93%
May-00	288	7,672	18	270	6,662	63	16	0	0	3.018	8,328	55	9,590	94%
Jun-00	764	20,779	12	249	6,608	62	18	0	0	3.300	8,260	55	25,974	93%

1997	354	9,274	13	266	6,992	88	27	27	19	3.205	8,740	88	11,592	90%
1998	297	7,772	11	208	5,329	50	18	18	19	3.220	6,661	44	9,714	91%
1999	408	10,914	17	169	4,477	42	14	14	20	3.255	5,596	37	13,642	91%
Entire data	367	9650	14	218	5657	60	20	18	18	3.204	7072	55	12062	1
Max	764	20779	55	331	9263	175	33	35	24	4.663	11579	153	25974	1
Min	137	3253	4	103	3020	29	8	0	0	2.262	3776	25	4066	1
Conc at 4.0 mgd										Design flow				
avg										4.000	212		362	
max										4.000	347		779	

APPENDIX M

NPDES PERMIT

Sent out 3/22/99

Kansas Permit No.: M-MO12-IO01

Federal Permit No.: KS0036366

KANSAS WATER POLLUTION CONTROL PERMIT AND AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Pursuant to the Provisions of Kansas Statutes Annotated 65-164 and 65-165, the Federal Water Pollution Control Act as amended, (33 U.S.C. 1251 et seq: the "Act"),

.992

Owner:	Leavenworth, City of
Owner's Address:	100 N. 5th Street Leavenworth, Kansas 66048
Facility Name:	Leavenworth Wastewater Treatment Plant
Facility Location:	1800 S. 2nd Street Leavenworth, Kansas 66048 SE¼,NW¼,NE¼, Section 1, Township 9S, Range 22E Leavenworth County, Kansas
Receiving Stream & Basin:	Missouri River Missouri River Basin

is authorized to discharge from the wastewater treatment facility described herein, in accordance with effluent limitations and monitoring requirements as set forth herein.

This permit shall become effective March 1, 1999, will supersede all previous permits and/or agreements in effect between the Kansas Department of Health and Environment and the permittee, and will expire December 31, 2003.

FACILITY DESCRIPTION:

1. Aerated grit basin
2. Primary settling basin
3. Trickling filters - plastic media
4. Final settling basin
5. Chlorine contact basin
6. Belt Filter Press for Sludge Dewatering
7. Pug Mill for Lime Addition
8. Design P.E. = 55,000 @ 6.88 MGD

[signature]

Acting Secretary, Kansas Department of Health and Environment

February 26, 1999
Date

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

The permittee is authorized to discharge from outfall(s) with serial number(s) as specified in this permit. The effluent limitations shall become effective on the dates specified herein. Such discharges shall be controlled, limited, and monitored by the permittee as specified. There shall be no discharge of floating solids or visible foam in other than trace amounts.

Monitoring reports shall be submitted on or before the 28th day of the following month. In the event no discharge occurs, written notification is still required.

Effective Date Outfall Number and Effluent Parameters	EFFLUENT LIMITATIONS Final Limitations** Upon Issuance	MONITORING REQUIREMENTS Measurement Frequency	Sample Type
001			
Biochemical Oxygen Demand (5-Day)***		*Twice Weekly	24-Hour Composite
Weekly Average-mg/l	45		
Monthly Average-mg/l	30		
Total Suspended Solids		*Twice Weekly	24-Hour Composite
Weekly Average-mg/l	45		
Monthly Average-mg/l	30		
Fecal Coliform (colonies per 100 ml)	Monitor	Twice Weekly	Grab
pH - Standard Units	6.0-9.0	Twice Weekly	Grab
Whole Effluent Toxicity - See Supplemental Conditions G.1.			
Priority Pollutant Scan - See Supplemental Conditions G.2.			
Flow - MGD	Monitor	Daily	

*Influent sample required also.
**Minimum removal of 85% required for Biochemical Oxygen Demand (5-Day).
***If inhibited Biochemical Oxygen Demand (5-Day) test is used, limits are 5-mg/l less than shown.

B. STANDARD CONDITIONS

In addition to the specified conditions stated herein, the permittee shall comply with the attached Standard Conditions dated August 1, 1996.

C. SUPPLEMENTAL CONDITIONS

(1) Sludge disposal shall be in accordance with the 40 CFR Part 503 Sludge Regulations.

PRETREATMENT PROGRAM

The permittee shall develop and submit a local pretreatment program upon receiving written notification from the Kansas Department of Health and Environment (KDHE). KDHE will notify the permittee once a determination has been made, as to whether any industries, under the permittee's jurisdiction, are subject to EPA categorical pretreatment standards. If a program is required, the permittee will be given nine months from the date of notification to submit an approvable pretreatment program to KDHE.

SCHEDULE OF COMPLIANCE

None

SUPPLEMENTAL INFORMATION

Kansas Statute 1997 Supp. 65-1,177 requires the following statement be included in Kansas-issued NPDES permits. The Statute concerns the chloride, ammonia and atrazine concentration limits which may be placed in NPDES permits. Monitoring for these parameters is not required in this permit. Therefore, the following statement, although required to be included by statute, is not applicable to this permit.

"The permittee who does not agree to meet effluent limitations as necessary to attain the aquatic life criteria for ammonia and chlorides within the 1994 surface water quality standards incurs and acknowledges the legal duty and obligation to bring the facilities and operations authorized by this permit into compliance with the permit effluent limitations based on the 1994 surface water quality standards within 24 months after July 1, 1999, unless before July 1, 1999 revised numeric criteria for ammonia and chlorides are adopted pursuant to subsection (g) of K.S.A. 1997 Supp. 65-1,177, in which case the permittee incurs and acknowledges the legal duty and obligation to bring such facilities and operations into compliance with the permit effluent limitation based on the revised criteria within 24 months following the date of adoption of the rules and regulations containing the revised criteria."

G. BIOMONITORING AND PRIORITY POLLUTANTS

See next page.

G. BIOMONITORING AND PRIORITY POLLUTANTS

1. Biomonitoring - Whole Effluent Toxicity Testing (Acute)
The permittee shall conduct acute toxicity testing as follows:

a. The procedure shall be in accordance with the U.S. EPA's Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, fourth edition, (EPA 600/4-90/027F) as published in August 1993. Each test shall be conducted on two species, Fathead Minnows (Pimephales Promelas) and Ceriodaphnia Dubia or Daphnia Pulex.

b. Toxicity tests, as detailed in "a" above, shall be conducted annually.

c. If the Median Lethal Concentration (LC50) of the effluent, determined through toxicity test detailed in "a" above, is less than 13% effluent, the permittee shall immediately notify KDHE by telephone. A written notification shall be submitted within five (5) working days, including a copy of the test report and the steps taken to reduce the toxicity of the effluent.

If the LC50 of the effluent, determined through toxicity test detailed in "a" above, is greater than or equal to 13% effluent, the permittee shall submit a copy of the test report with the next scheduled discharge monitoring report.

d. The Permittee shall also test a portion of the effluent sample used for the biomonitoring (WET) for the following substances (required minimum reportable detection levels are in parenthesis):

Total Antimony (10 μg/L)
Total Arsenic (10 μg/L)
Total Beryllium (5 μg/L)
Total Cadmium (2 μg/L)
Total Chromium (10 μg/L)
Total Copper (10 μg/L)
Total Lead (5 μg/L)
Total Mercury
(0.2 μg/L-Cold Vapor Method)
Total Nickel (50 μg/L)
Total Selenium (5 μg/L)
Total Silver (2 μg/L)
Total Thallium (10 μg/L)
Total Zinc (20 μg/L)
Ammonia (0.2 mg/L)
Total Hardness (as $CaCO_3$ mg/L)
pH
Effluent Temperature (during sampling)

The Permittee may coordinate this testing with any other testing required by this permit and use the test results to satisfy this, as well as the other corresponding testing requirements.

2. Permittee shall conduct a Priority Pollutant Scan on the effluent for the parameters listed in Table I, Priority Pollutant Scan, on the following pages. The Priority Pollutant Scan shall be conducted between January 1 and June 30, 2003 and the results shall be reported with the next Discharge Monitoring Report following receipt of the results but not later than August 28, 2003.

Sample type shall be 24-hour composite except for Volatiles which shall be a grab sample.

See Supplemental Condition G.1.d. for minimum detection limits for certain metals in the Priority Pollutant Scan.

Table I
Priority Pollutant Scan

Metals
Total Arsenic (ug/l)
Total Beryllium (ug/l)
Total Cadmium (ug/l)
Total Chromium (ug/l)
Total Copper (ug/l)
Total Lead (ug/l)
Total Mercury (ug/l)
Total Molybdenum (ug/l)
Total Potassium (ug/l)
Total Nickel (ug/l)
Total Selenium (ug/l)
Total Silver (ug/l)
Total Thallium (ug/l)
Total Zinc (ug/l)

Pesticides
Aldrin (mg/l)
Alpha-BHC (mg/l)
Beta-BHC (mg/l)
Gamma-BHC (mg/l)
Delta-BHC (mg/l)
Chlordane (mg/l)
4,4-DDT (mg/l)
4,4-DDD (mg/l)
4,4-DDE (mg/l)
Dieldrin (mg/l)
Alpha-endosulfan (mg/l)
Beta-endosulfan (mg/l)
Endosulfan sulfate (mg/l)
Endrin (mg/l)
Endrin aldehyde (mg/l)
Heptachlor (mg/l)
Heptachlor epoxide (mg/l)
Toxaphene (mg/l)
Malathion (mg/l)
Diazinon (mg/l)

Polychlorinated Biphenyls (mg/l)
PCB-1242
PCB-1254
PCB-1221
PCB-1232
PCB-1248
PCB-1260
PCB-1016

Priority Pollutant Scan (continued)

se/Neutral
Acenaphthene (mg/l)
Acenaphtylene (mg/l)
Anthracene (mg/l)
Benzidine (mg/l)
Benzo(a) anthracene (mg/l)
Benzo(a)pyrene (mg/l)
3,4-benzofluoranthene (mg/l)
Benzo (ghi) perylene (mg/l)
Benzo (b) fluoranthene (mg/l)
Bis(2-chloroethoxy)methane (mg/l)
Bis(2-chloroethyl)ether (mg/l)
Bis(2-ethylhexyl)phthalate (mg/l)
Bis(2-chloroisopropyl) ether (mg/l)
1,2-diphenylhydrazine (mg/l)
Fluoranthene (mg/l)
Fluorene (mg/l)
Nitrobenzene (mg/l)
N-nitrosodimethylamine (mg/l)
N-nitrosodi-n-propylamine (mg/l)
N-nitrosodiphenylamine (mg/l)
Phenanthrene (mg/l)
Pyrene (mg/l)
,4-trichlorobenzene (mg/l)
romophenyl phenyl ether (mg/l)
Butyl benzyl phthalate (mg/l)
2-chloronaphthalene (mg/l)
4-chlorophenyl phenyl ether (mg/l)
Chrysene (mg/l)
Dibenzo(a,h) anthracene (mg/l)
1,2-dichlorobenzene (mg/l)
1,3-dichlorobenzene (mg/l)
1,4-dichlorobenzene (mg/l)
3,3-dichlorobenzidine (mg/l)
Dimethyl phthalate (mg/l)
Diethyl phthalate (mg/l)
Di-n-butyl phthalate (mg/l)
2,4-dinitrotoluene (mg/l)
2,6-dinitrotoluene (mg/l)
Di-n-octyl phthalate (mg/l)
Hexachlorobenzene (mg/l)
Hexachlorobutadiene (mg/l)
Hexachlorocyclopentadiene (mg/l)
Hexachloroethane (mg/l)
Indeno (1,2,3-cd) pyrene (mg/l)
Naphthalene (mg/l)
Isophorone (mg/l)

Priority Pollutant Scan (continued)

Ac[illegible] Compounds
- [illegible]hlorophenol (mg/l)
- 2,4-dichlorophenol (mg/l)
- 2,4-dimethylphenol (mg/l)
- 2,4-dinitrophenol (mg/l)
- 2-nitrophenol (mg/l)
- 4-nitrophenol (mg/l)
- Parachlorometa cresol (mg/l)
- Pentachlorophenol (mg/l)
- Phenol (mg/l)
- 4,6-dinitro-o-cresol (mg/l)
- 2,4,6-trichlorophenol (mg/l)

Volatiles
- Acrolein (mg/l)
- Acrylonitrile (mg/l)
- Benzene (mg/l)
- Bromoform (mg/l)
- Carbon Tetrachloride (mg/l)
- Chlorobenzene (mg/l)
- Chlorodibromomethane (mg/l)
- Chloroethane (mg/l)
- 2-chloroethylvinyl ether (mg/l)
- Chloroform (mg/l) (mg/l)
- Dichlorobromomethane (mg/l)
- 1,1-dichloroethane (mg/l)
- [illegible]-dichloroethane (mg/l)
- 1,1-dichloroethylene (mg/l)
- 1,2-dichloropropane (mg/l)
- 1,3-dichloropropylene (mg/l)
- Ethylbenzene (mg/l)
- Methyl bromide (mg/l)
- Methyl chloride (mg/l)
- Methylene chloride (mg/l)
- 1,1,2,2-tetrachloroethane (mg/l)
- Tetrachloroethylene (mg/l)
- Toluene (mg/l)
- 1,2 trans-dichloroethylene (mg/l)
- 1,1,1-trichloroethane (mg/l)
- 1,1,2-trichloroethane (mg/l)
- Trichloroethylene (mg/l)
- Vinyl chloride (mg/l)

Miscellaneous
- Total Cyanide (mg/l)*
- Total Phenols (mg/l)

* The total cyanide analysis must include preliminary treatment of the sample to avoid NO_2^- interference. Addition of sulfamic acid to the sample before distillation can prevent such interference, see Standard Methods for the Examination of Water and Wastewater, 18th Edition, 4500-CN^- B. Preliminary Treatment of Samples.

APPENDIX N

ECONOMIC ALTERNATIVES OF WWTP REHABILITATION, WWTP PROCESS IMPROVEMENTS, AND COLLECTION SYSTEM IMPROVEMENTS

Leavenworth, Kansas
Wastewater Master Plan
MASTER CAPITAL COST MODEL
Present Worth Capital Costs of Alternatives

Item	1st Year Acquired or Installed	Life (Years)	Total Cost ($)	2001 Year 0 1	2002 Year 1 0.956937799	2003 Year 2 0.91573	2004 Year 3 0.876297	2005 Year 4 0.83856134	2006 Year 5 0.802451	2007 Year 6 0.767896	2008 Year 7 0.73482846	2009 Year 8 0.703185	2010 Year 9 0.672904428	2011 Year 10 0.643928	2012 Year 11 0.6161987	2013 Year 12 0.589664	2014 Year 13 0.564272	2015 Year 14 0.53997286	2016 Year 15 0.51672	2017 Year 16 0.494469	2018 Year 17 0.473176	2019 Year 18 0.4528	2020 Year 19 0.43330179	2021 Year 20 0.4146429	TOTAL PRESENT WORTH	REMAINING VALUE 0.41464286	NET PRESENT WORTH	EQUIVALENT ANNUAL COST 14.00793645
RECOMMENDED PHYSICAL IMPROVMENTS AT WWTP																												
Influent Pump Station Rehab																									**$285,040**	**$14,252**	**$270,788**	**$19,331**
Structure Improvements	2002	20	$110,600	-	$110,600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$110,600	$5,530	$105,070	$7,501
Install new 7500 gpm pumping unit	2002	20	$86,140	-	$86,140	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$86,140	$4,307	$81,833	$5,842
Replace magnetic drive on pump 6	2002	20	$32,500	-	$32,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$32,500	$1,625	$30,875	$2,204
Upgrade pump controls	2002	10	$27,900	-	$27,900	-	-	-	-	-	-	-	-	-	$27,900	-	-	-	-	-	-	-	-	-	$55,800	$2,790	$53,010	$3,784
Primary Clarifier Rehab																									**$515,375**	**$25,769**	**$489,606**	**$34,952**
Replace scum baffles and effluent weirs	2002	20	$135,945	-	$135,945	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$135,945	$6,797	$129,148	$9,220
New stairs, walkway, and handrail	2002	20	$72,030	-	$72,030	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$72,030	$3,602	$68,429	$4,885
New EDI and spiral rake arm	2002	20	$302,400	-	$302,400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$302,400	$15,120	$287,280	$20,508
New receptacles and J-boxes	2002	20	$5,000	-	$5,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$5,000	$250	$4,750	$339
Primary Sludge Pump Station Rehab																									**$25,410**	**$1,271**	**$24,140**	**$1,723**
Replace stair section	2002	20	$4,980	-	$4,980	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$4,980	$249	$4,731	$338
Replace existing roof	2002	20	$20,430	-	$20,430	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$20,430	$1,022	$19,409	$1,386
Final Clarifier Rehab																									**$55,315**	**$2,766**	**$52,549**	**$3,751**
Replace effluent weirs and scum baffle	2002	20	$45,315	-	$45,315	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$45,315	$2,266	$43,049	$3,073
Replace receptacles and conduit	2002	10	$5,000	-	$5,000	-	-	-	-	-	-	-	-	-	$5,000	-	-	-	-	-	-	-	-	-	$10,000	$500	$9,500	$678
Sludge Storage Tank Rehab																									**$124,122**	**$55,855**	**$68,267**	**$4,873**
North- replace walkway and handrail	2010	20	$37,280	-	-	-	-	-	-	-	-	-	$37,280	-	-	-	-	-	-	-	-	-	-	-	$37,280	$16,776	$20,504	$1,464
South - new walkway and handrail	2010	20	$31,520	-	-	-	-	-	-	-	-	-	$31,520	-	-	-	-	-	-	-	-	-	-	-	$31,520	$14,184	$17,336	$1,238
North- replace mixer	2010	20	$21,161	-	-	-	-	-	-	-	-	-	$21,161	-	-	-	-	-	-	-	-	-	-	-	$21,161	$9,522	$11,639	$831
South - install new mixing system and dem	2010	20	$31,161	-	-	-	-	-	-	-	-	-	$31,161	-	-	-	-	-	-	-	-	-	-	-	$31,161	$14,022	$17,139	$1,223
Install new hand stations and level sensor	2010	10	$1,500	-	-	-	-	-	-	-	-	-	$1,500	-	-	-	-	-	-	-	-	-	$1,500	-	$3,000	$1,350	$1,650	$118
Settled Sewage Pump Station Rehab																									**$125,720**	**$6,286**	**$119,434**	**$8,526**
Paint rehab	2002	20	$2,568	-	$2,568	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$2,568	$128	$2,440	$174
Install new HVAC system	2002	20	$104,252	-	$104,252	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$104,252	$5,213	$99,039	$7,070
Install pump controls	2002	20	$18,900	-	$18,900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$18,900	$945	$17,955	$1,282
Chlorine Contact Basin Rehab																									**$52,490**	**$23,221**	**$29,270**	**$2,089**
Replace missing handrail	2010	20	$990	-	-	-	-	-	-	-	-	-	$990	-	-	-	-	-	-	-	-	-	-	-	$990	$446	$545	$39
Replace existing doors	2010	20	$10,500	-	-	-	-	-	-	-	-	-	$10,500	-	-	-	-	-	-	-	-	-	-	-	$10,500	$4,725	$5,775	$412
Replace interior lighting	2010	10	$20,000	-	-	-	-	-	-	-	-	-	$20,000	-	-	-	-	-	-	-	-	-	$20,000	-	$40,000	$18,000	$22,000	$1,571
Replace interior gas unit heater	2002	20	$1,000	-	$1,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$1,000	$50	$950	$68
Filter Control Building Rehab																									**$187,500**	**$31,710**	**$155,790**	**$11,122**
Filter room improvements	2002	20	$26,300	-	$26,300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$26,300	$1,315	$24,985	$1,784
Admin room improvements	2002	20	$10,416	-	$10,416	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$10,416	$521	$9,895	$706
Sludge loading area improvements	2002	20	$1,584	-	$1,584	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$1,584	$79	$1,505	$107
Lime feed room improvements	2002	20	$300	-	$300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$300	$15	$285	$20
Construct New Garage	2005	20	$148,900	-	-	-	-	$148,900	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**$148,900**	**$29,780**	**$119,120**	**$8,504**
Improve Site Drainage / Repave																									**$311,126**	**$62,225**	**$248,901**	**$17,769**
Milling and repaving plant roads	2005	20	$72,126	-	-	-	-	$72,126	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$72,126	$14,425	$57,701	$4,119
Extend perimeter fencing	2005	20	$4,000	-	-	-	-	$4,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$4,000	$800	$3,200	$228
Extend fire hydrants	2005	20	$135,000	-	-	-	-	$135,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$135,000	$27,000	$108,000	$7,710
General grading improvements	2005	20	$100,000	-	-	-	-	$100,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$100,000	$20,000	$80,000	$5,711
Rehabilitate Grit Facility																									**$510,210**	**$25,511**	**$484,700**	**$34,602**
Concrete rehab	2002	20	$163,400	-	$163,400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$163,400	$8,170	$155,230	$11,082
Replace scum skimmer and weirs	2002	20	$17,010	-	$17,010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$17,010	$851	$16,160	$1,154
Install new concrete topping in grit loading	2002	20	$5,500	-	$5,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$5,500	$275	$5,225	$373
Install new grit transport screws and appur	2002	20	$324,300	-	$324,300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$324,300	$16,215	$308,085	$21,994
Plant-wide Odor Control	2008	20	$800,000	-	-	-	-	-	-	-	$800,000	-	-	-	-	-	-	-	-	-	-	-	-	-	**$800,000**	**$280,000**	**$520,000**	**$37,122**
RECOMMENDED PROCESS EXPANSION AT WWTP																												
Alternative No. 2 - Add one trickling filter and CEPT capability now, 1 TF later																									**$2,512,605**	**$1,131,044**	**$1,381,561**	**$98,627**
New TF, Settled Sewage Pumping, CEPT	2002	50	$546,300	-	$546,300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$546,300	$338,706	$207,594	$14,820
Second TF	2015	50	$524,541	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$524,541	-	-	-	-	-	-	$524,541	$461,596	$62,945	$4,494
New Primary Clarifier																									$164,167	$22,937	$141,230	$10,082
Pilings	2002	50	$25,840	-	$25,840	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$25,840	$16,021	$9,819	$701
Concrete and Fill	2002	20	$129,012	-	$129,012	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$129,012	$6,451	$122,561	$8,749
Piping	2002	20	$9,315	-	$9,315	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$9,315	$466	$8,849	$632
Equipment - Pumps, TF, and CEPT	2002	20	$477,100	-	$477,100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$477,100	$23,855	$453,245	$32,356
Pumps & TF	2015	20	$352,610	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$352,610	-	-	-	-	-	-	$352,610	$246,827	$105,783	$7,552
Scum and sludge equipment	2002	20	$283,720	-	$283,720	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$283,720	$14,186	$269,534	$19,242

RECOMMENDED COLLECTION SYSTEM IMPROVEMENTS																													
Existing Lines																										**$1,743,700**	**$639,357**	**$1,104,343**	**$78,837**
EX_00_01		2002	30	$196,800	-	$196,800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$196,800	$72,160	$124,640	$8,898
EX_00_02		2002	30	$659,400	-	$659,400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$659,400	$241,780	$417,620	$29,813
EX_00_03		2002	30	$142,100	-	$142,100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$142,100	$52,103	$89,997	$6,425
EX_00_04		2002	30	$251,400	-	$251,400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$251,400	$92,180	$159,220	$11,366
EX_00_05		2002	30	$454,800	-	$454,800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$454,800	$166,760	$288,040	$20,563
EX_00_06		2002	30	$39,200	-	$39,200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$39,200	$14,373	$24,827	$1,772
Future Lines																										**$2,939,900**	**$2,505,803**	**$434,097**	**$30,989**
FU_10_01		2010	30	$164,900	-	-	-	-	-	-	-	-	-	$164,900	-	-	-	-	-	-	-	-	-	-	-	$164,900	$104,437	$60,463	$4,316
FU_10_02		2010	30	$143,900	-	-	-	-	-	-	-	-	-	$143,900	-	-	-	-	-	-	-	-	-	-	-	$143,900	$91,137	$52,763	$3,767
FU_10_03		2010	30	$699,500	-	-	-	-	-	-	-	-	-	$699,500	-	-	-	-	-	-	-	-	-	-	-	$699,500	$443,017	$256,483	$18,310
FU_20_01		2020	30	$290,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$290,500	-	$290,500	$280,817	$9,683	$691
FU_20_02		2020	30	$398,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$398,500	-	$398,500	$385,217	$13,283	$948
FU_20_03		2020	30	$166,800	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$166,800	-	$166,800	$161,240	$5,560	$397
FU_20_04		2020	30	$145,500	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$145,500	-	$145,500	$140,650	$4,850	$346
FU_20_05		2020	30	$477,600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$477,600	-	$477,600	$461,680	$15,920	$1,136
FU_20_06		2020	30	$452,700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	$452,700	-	$452,700	$437,610	$15,090	$1,077
Plumbing Mechanical	6%	2002	20	$171,000	-	$171,000	-	-	$9,000	-	-	-	-	-	-	-	-	-		-	-	-	-		-	$180,000	$8,550	$171,450	$12,239
HVAC/Mech. (% of constr)	6%	2002	20	$171,000	-	$171,000	-	-	$9,000	-	-	-	-	-	-	-	-	-		-	-	-	-		-	$180,000	$8,550	$171,450	$12,239
Electrical (% of constr)	6%	2002	10	$166,000	-	$36,000	-	-	$28,000	-	-	-	-	-	-	$36,000	-	-		-	-	-	-	-	-	$100,000	$16,600	$83,400	$5,954
Instrumentation (% of constr)	5%	2002	10	$136,000	-	$24,000	-	-	$23,000	-	-	-	-	-	-	$24,000	-	-		-	-	-	-	-	-	$71,000	$13,600	$57,400	$4,098
General Requirements (% of constr)	10%	2002	10	$1,061,000		$514,000			$53,000					-		$9,000										$576,000	$106,100	$469,900	$33,545
Construction Subtotal				$11,418,000	-	$5,654,757	-	-	$582,026	-	-	$800,000	-	$1,162,412	-	$101,900	-	-	$877,151	-	-	-	-	$1,953,100	-	$11,608,580	$5,011,186	$6,597,394	$470,975
Contingency (% of subtotal)	25%	2002	10	$2,855,000	-	$1,414,000	-	-	$146,000	-	-	$200,000	-	$291,000	-	$25,000	-	-	$219,000	-	-	-	-	$488,000	-				
ELA (% of subtotal w/cont)	20%	2002	10	$2,855,000		$1,414,000		-	$146,000	-	-	$200,000	-	$291,000	-	$25,000	-	-	$219,000	-	-	-	-	$488,000	-				
Interest During Construction (1 yrs)		2002	1	$385,000		$191,000		-	$20,000	-	-	$27,000	-	$39,000	-	$3,000	-	-	$30,000	-	-	-	-	$66,000	-				
Total (Nearest $1k)				$17,513,000		$8,674,000			$894,000			$1,227,000		$1,783,000		$155,000			$1,345,000					$2,995,000	$0	$17,073,000	$5,011,186		
Factored Totals (Nearest $1k)						$8,300,000			$750,000			$902,000		$1,200,000		$96,000			$726,000					$1,298,000	$0	$13,272,000	$2,077,852	$11,194,148	$861,000
Baseline for costs =	1/1/2001																												
ENR Building Cost Index =	3545																												
Interest Rate =	4.5%																												

Leavenworth, Kansas
Wastewater Master Plan

Present Worth Capital Costs of Alternatives

Item	1st Year Acquired or Installed	Life (Years)	Total Cost ($)	2001 Year 0 1.00000	2002 Year 1 0.95694	2003 Year 2 0.91573	2004 Year 3 0.87630	2005 Year 4 0.83856	2006 Year 5 0.80245	2007 Year 6 0.76790	2008 Year 7 0.73483	2009 Year 8 0.70319	2010 Year 9 0.67290
Structure Cost													
Influent Pump Station Rehab	2002	20	$110,600	-	$110,600	-	-	-	-	-	-	-	-
Primary Clarifier Rehab													
Replace scum baffles and effluent weirs	2002	20	$135,945	-	$135,945	-	-	$0	-	-	-	-	$0
New stairs, walkway, and handrail	2002	20	$72,030	-	$72,030	-	-	$0	-	-	-	-	$0
New Primary Clarifier													
Pilings	2002	50	$25,840										
Concrete and Fill	2002	20	$129,012										
Primary Sludge Pump Station Rehab													
Replace stair section	2002	20	$4,980	-	$4,980	-	-	$0	-	-	-	-	$0
Replace existing roof	2002	20	$20,430	-	$20,430	-	-	$0	-	-	-	-	$0
Final Clarifier Rehab													
Replace effluent weirs and scum baffle	2002	20	$45,315	-	$45,315	-	-	$0	-	-	-	-	$0
Replace receptacles and conduit	2002	10	$5,000	-	$5,000	-	-	$0	-	-	-	-	$0
Sludge Storage Tank Rehab													
North- replace walkway and handrail	2010	20	$37,280	-	$0	-	-	$0	-	-	-	-	$37,280
South - new walkway and handrail	2010	20	$31,520	-	$0	-	-	$0	-	-	-	-	$31,520
Settled Sewage Pump Station Rehab													
Paint rehab	2002	20	$2,568	-	$2,568	-	-	$0	-	-	-	-	$0
Chlorine Contact Basin Rehab													
Replace missing handrail	2010	20	$990	-	$0	-	-	$0	-	-	-	-	$990
Replace existing doors	2010	20	$10,500	-	$0	-	-	$0	-	-	-	-	$10,500
Replace interior lighting	2010	10	$20,000	-	$0	-	-	$0	-	-	-	-	$20,000
Filter Control Building Rehab													
Filter room improvements	2002	20	$26,300	-	$26,300	-	-	$0	-	-	-	-	$0
Admin room improvements	2002	20	$10,416	-	$10,416	-	-	$0	-	-	-	-	$0
Sludge loading area improvements	2002	20	$1,584	-	$1,584	-	-	$0	-	-	-	-	$0
Lime feed room improvements	2002	20	$300	-	$300	-	-	$0	-	-	-	-	$0
Construct New Garage	2005	20	$148,900	-	$0	-	-	$148,900	-	-	-	-	$0
Improve Site Drainage / Repave													
Milling and repaving plant roads	2005	20	$72,126	-	$0	-	-	$72,126	-	-	-	-	$0
Extend perimeter fencing	2005	20	$4,000	-	$0	-	-	$4,000	-	-	-	-	$0
Extend fire hydrants	2005	20	$135,000	-	$0	-	-	$135,000	-	-	-	-	$0
General grading improvements	2005	20	$100,000	-	$0	-	-	$100,000	-	-	-	-	$0
Rehabilitate Grit Facility													
Concrete rehab	2002	20	$163,400	-	$163,400	-	-	$0	-	-	-	-	$0
Replace scum skimmer and weirs	2002	20	$17,010	-	$17,010	-	-	$0	-	-	-	-	$0
Equipment Cost													
Influent Pump Station Rehab													
Install new 7500 gpm pumping unit	2002	20	$86,140	-	$86,140	-	-	$0	-	-	-	-	$0
Replace magnetic drive on pump 6	2002	20	$32,500	-	$32,500	-	-	$0	-	-	-	-	$0
Upgrade pump controls	2002	10	$27,900	-	$27,900	-	-	$0	-	-	-	-	$0
Primary Clarifier Rehab													
New EDI and spiral rake arm	2002	20	$302,400	-	$302,400	-	-	$0	-	-	-	-	$0
New Primary Clarifier													
Scum and sludge equipment													
Piping	2002	20	$283,720										
Primary Sludge Pump Station Rehab	2002	20	$9,315	-	$9,315	-	-	$0	-	-	-	-	$0
Final Clarifier Rehab			$0										
Sludge Storage Tank Rehab													
North- replace mixer	2010	20	$21,161	-	$0	-	-	$0	-	-	-	-	$21,161
South - install new mixing system and demo blower system	2010	20	$31,161	-	$0	-	-	$0	-	-	-	-	$31,161
Install new hand stations and level sensor	2010	10	$1,500	-	$0	-	-	$0	-	-	-	-	$1,500
Settled Sewage Pump Station Rehab													
Install new HVAC system	2002	20	$104,252	-	$104,252	-	-	$0	-	-	-	-	$0
Install pump controls	2002	20	$18,900	-	$18,900	-	-	$0	-	-	-	-	$0
Chlorine Contact Basin Rehab													
Replace interior gas unit heater	2002	20	$1,000	-	$1,000	-	-	$0	-	-	-	-	$0
Filter Control Building Rehab			$0										
Construct New Garage			$0										
Improve Site Drainage / Repave			$0										
Rehabilitate Grit Facility													
Install new grit transport screws and appurtenances	2002	20	$324,300	-	$324,300	-	-	$0	-	-	-	-	$0
Plumbing Mechanical 5%	2002	20	$9,000	-	$9,000	-	-	$9,000	-	-	-	-	-
HVAC/Mech. (% of constr) 6%	2002	20	$9,000	-	$9,000	-	-	$9,000	-	-	-	-	-
Electrical (% of constr) 6%	2002	10	$48,000	-	$36,000	-	-	$9,000	-	-	-	-	$3,000
Instrumentation (% of constr) 5%	2002	10	$26,000	-	$24,000	-	-	$0	-	-	-	-	$3,000
General Requirements (% of constr) 10%	2002	10	$267,000		$160,000			$49,000					$16,000
Construction Subtotal			$2,824,000	-	$1,760,685	-	-	$536,026					$176,112
Contingency (% of subtotal) 25%	2002	10	$706,000	-	$440,000	-	-	$134,000					$44,000
ELA (% of subtotal w/cont) 20%	2002	10	$706,000	-	$440,000	-	-	$134,000					$44,000
Interest During Construction (1 yrs)	2002	1	$95,000	-	$59,000	-	-	$18,000					$6,000
Total for Alternative 1 (Nearest $1k)			$4,331,000	$0	$2,700,000	$0	$0	$822,000	$0	$0	$0	$0	$270,000
Factored Totals (Nearest $1k)				$0	$2,584,000	$0	$0	$689,000	$0	$0	$0	$0	$182,000

Item	2011 Year 10 0.64393	2012 Year 11 0.61620	2013 Year 12 0.58966	2014 Year 13 0.56427	2015 Year 14 0.53997	2016 Year 15 0.51672	2017 Year 16 0.49447	2018 Year 17 0.47318	2019 Year 18 0.45280	2020 Year 19 0.43330	2021 Year 20 0.41464	TOTAL PRESENT WORTH	REMAINING VALUE 0.41464	NET PRESENT WORTH	EQUIVALENT ANNUAL COST 14.00794
Structure Cost															
Influent Pump Station Rehab	-	-	-	-	-	-	-	-	-	-	-		$5,530		
Primary Clarifier Rehab															
Replace scum baffles and effluent weirs	-	-	-	-	-	-	-	-	-	-	-		$6,797		
New stairs, walkway, and handrail	-	-	-	-	-	-	-	-	-	-	-		$3,602		
New Primary Clarifier															
Pilings															
Concrete and Fill															
Primary Sludge Pump Station Rehab															
Replace stair section	-	-	-	-	-	-	-	-	-	-	-		$249		
Replace existing roof	-	-	-	-	-	-	-	-	-	-	-		$1,022		
Final Clarifier Rehab															
Replace effluent weirs and scum baffle	-	-	-	-	-	-	-	-	-	-	-		$2,266		
Replace receptacles and conduit	-	$5,000	-	-	-	-	-	-	-	-	-		$500		
Sludge Storage Tank Rehab															
North- replace walkway and handrail	-	-	-	-	-	-	-	-	-	-	-		$16,776		
South - new walkway and handrail	-	-	-	-	-	-	-	-	-	-	-		$14,184		
Settled Sewage Pump Station Rehab															
Paint rehab	-	-	-	-	-	-	-	-	-	-	-		$128		
Chlorine Contact Basin Rehab															
Replace missing handrail	-	-	-	-	-	-	-	-	-	-	-		$446		
Replace existing doors	-	-	-	-	-	-	-	-	-	-	-		$4,725		
Replace interior lighting	-	-	-	-	-	-	-	-	-	* $20,000	-		$18,000		
Filter Control Building Rehab															
Filter room improvements	-	-	-	-	-	-	-	-	-	-	-		$1,315		
Admin room improvements	-	-	-	-	-	-	-	-	-	-	-		$521		
Sludge loading area improvements	-	-	-	-	-	-	-	-	-	-	-		$79		
Lime feed room improvements	-	-	-	-	-	-	-	-	-	-	-		$15		
Construct New Garage	-	-	-	-	-	-	-	-	-	-	-		$29,780		
Improve Site Drainage / Repave															
Milling and repaving plant roads	-	-	-	-	-	-	-	-	-	-	-		$14,425		
Extend perimeter fencing	-	-	-	-	-	-	-	-	-	-	-		$800		
Extend fire hydrants	-	-	-	-	-	-	-	-	-	-	-		$27,000		
General grading improvements	-	-	-	-	-	-	-	-	-	-	-		$20,000		
Rehabilitate Grit Facility															
Concrete rehab	-	-	-	-	-	-	-	-	-	-	-		$8,170		
Replace scum skimmer and weirs	-	-	-	-	-	-	-	-	-	-	-		$851		
Equipment Cost															
Influent Pump Station Rehab															
Install new 7500 gpm pumping unit	-	-	-	-	-	-	-	-	-	-	-		$4,307		
Replace magnetic drive on pump 6	-	-	-	-	-	-	-	-	-	-	-		$1,625		
Upgrade pump controls	-	$27,900	-	-	-	-	-	-	-	-	-		$2,790		
Primary Clarifier Rehab															
New EDI and spiral rake arm	-	-	-	-	-	-	-	-	-	-	-		$15,120		
New Primary Clarifier															
Scum and sludge equipment															
Piping															
Primary Sludge Pump Station Rehab	-	-	-	-	-	-	-	-	-	-	-		$466		
Final Clarifier Rehab															
Sludge Storage Tank Rehab															
North- replace mixer	-	-	-	-	-	-	-	-	-	-	-		$9,522		
South - install new mixing system and demo blower system	-	-	-	-	-	-	-	-	-	-	-		$14,022		
Install new hand stations and level sensor	-	-	-	-	-	-	-	-	-	* $1,500	-		$1,350		
Settled Sewage Pump Station Rehab															
Install new HVAC system	-	-	-	-	-	-	-	-	-	-	-		$5,213		
Install pump controls	-	-	-	-	-	-	-	-	-	-	-		$945		
Chlorine Contact Basin Rehab															
Replace interior gas unit heater	-	-	-	-	-	-	-	-	-	-	-		$50		
Filter Control Building Rehab															
Construct New Garage															
Improve Site Drainage / Repave															
Rehabilitate Grit Facility															
Install new grit transport screws and appurtenances	-	-	-	-	-	-	-	-	-	-	-		$16,215		
Plumbing Mechanical 5%	-	-	-	-	-	-	-	-	-	-	-		$450		
HVAC/Mech. (% of constr) 6%	-	-	-	-	-	-	-	-	-	-	-		$450		
Electrical (% of constr) 6%	-	$36,000	-	-	* $9,000	-	-	-	-	* $3,000	-		$9,900		
Instrumentation (% of constr) 5%	-	$24,000	-	-	$0	-	-	-	-	* $3,000	-		$5,100		
General Requirements (% of constr) 10%		$9,000													
Construction Subtotal	-	$101,900			$9,000					$27,500	-				
Contingency (% of subtotal) 25%		$203,800									-				
ELA (% of subtotal w/cont) 20%		$407,600									-				
Interest During Construction (1 yrs)		$815,200									-				
Total for Alternative 1 (Nearest $1k)	$0	$1,529,000	$0	$0	$9,000	$0	$0	$0	$0	$28,000	$0		$259,000		
Factored Totals (Nearest $1k)	$0	$942,000	$0	$0	$5,000	$0	$0	$0	$0	$12,000	$0	$4,414,000	$107,000	$4,307,000	$331,000

Baseline for costs = Jan-01
ENR Building Cost Index = 3545
Interest Rate = 4.50%

* No mark-up - assume the City will coordinate this work

Leavenworth, Kansas
Wastewater Master Plan

Present Worth Capital Costs of Alternatives

Item		1st Year Acquired or Installed	Life (Years)	Total Cost ($)	2001 Year 0 1.00000	2002 Year 1 0.95694	2003 Year 2 0.91573	2004 Year 3 0.87630	2005 Year 4 0.83856	2006 Year 5 0.80245	2007 Year 6 0.76790	2008 Year 7 0.73483	2009 Year 8 0.70319	2010 Year 9 0.67290
Alternative No. 1 - Add two additional trickling filters														
Structure		2001	50	$879,000	$879,000	-	-	-	-	-	-	-	-	-
Equipment		2001	20	$690,200	$690,200	-	-	-	-	-	-	-	-	-
Plumbing Mechanical	0%	2001	20	$0										
HVAC/Mech. (% of constr)	0%	2001	20	$0										
Electrical (% of constr)	6%	2001	10	$94,000	$94,000	-	-	-	-	-	-	-	-	-
Instrumentation (% of constr)	5%	2001	10	$78,000	$78,000	-	-	-	-	-	-	-	-	-
General Requirements (% of constr)	10%	2001		$174,000	$174,000									
Construction Subtotal				$1,915,000	$1,915,000									
Contingency (% of subtotal)	25%	2001		$479,000	$479,000									
ELA (% of subtotal w/cont)	20%	2001		$479,000	$479,000									
Interest During Construction (1 yrs)		2001	1	$65,000	$65,000									
Total for Alternative 1 (Nearest $1k)				$2,938,000	$2,938,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Factored Totals (Nearest $1k)					$2,938,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Alternative No. 2 - Add one trickling filter and CEPT capability now, 1 TF later														
Structure		2001	50	$546,300	$546,300	-	-	-	-	-	-	-	-	-
		2015	50	$524,541	-	-	-	-	-	-	-	-	-	-
Equipment		2001	20	$477,100	$477,100	-	-	-	-	-	-	-	-	-
		2015	20	$352,610	-	-	-	-	-	-	-	-	-	-
Plumbing Mechanical	0%	2001	20	$0										
HVAC/Mech. (% of constr)	0%	2001	20	$0										
Electrical (% of constr)	6%	2001	10	$114,000	$61,000	-	-	-	-	-	-	-	-	-
Instrumentation (% of constr)	5%	2001	10	$95,000	$51,000	-	-	-	-	-	-	-	-	-
General Requirements (% of constr)	10%	2001		$211,000	$114,000									
Construction Subtotal				$2,321,000	$1,249,000									
Contingency (% of subtotal)	25%	2001		$580,000	$312,000									
ELA (% of subtotal w/cont)	20%	2001		$580,000	$312,000									
Interest During Construction (1 yrs)		2001	1	$78,000	$42,000									
Total for Alternative 2 (Nearest $1k)				$3,559,000	$1,915,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Factored Totals (Nearest $1k)					$1,915,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Alternative No. 3 - Effluent Filtration, CEPT capability, and 1 Trickling Filter														
Structure		2001	50	$1,007,800	$1,007,800	-	-	-	-	-	-	-	-	-
Equipment		2001	20	$1,447,400	$1,447,400	-	-	-	-	-	-	-	-	-
HVAC/Mech. (included above)	0%	2001	20	$0										
Electrical (included above)	6%	2001	10	$147,000	$147,000	-	-	-	-	-	-	-	-	-
Instrumentation (% of constr)	5%	2001	10	$123,000	$123,000	-	-	-	-	-	-	-	-	-
General Requirements (% of constr)	10%	2001		$273,000	$273,000									
Construction Subtotal				$2,998,000	$2,998,000									
Contingency (% of subtotal)	25%	2001		$750,000	$750,000									
ELA (% of subtotal w/cont)	20%	2001		$750,000	$750,000									
Interest During Construction (1 yrs)		2001		$101,000	$101,000									
Total for Alternative 3 (Nearest $1k)				$4,599,000	$4,599,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Factored Totals (Nearest $1k)					$4,599,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Alternative No. 4 - Add CEPT capability and two intermediate clarifiers														
Structure		2001	50	$696,900	$696,900	-	-	-	-	-	-	-	-	-
Equipment		2001	20	$1,905,900	$1,905,900	-	-	-	-	-	-	-	-	-
Plumbing Mechanical	0%	2001	20	$0										
HVAC/Mech. (% of constr)	0%	2001	20	$0										
Electrical (% of constr)	6%	2001	10	$156,000	$156,000	-	-	-	-	-	-	-	-	-
Instrumentation (% of constr)	5%	2001	10	$130,000	$130,000	-	-	-	-	-	-	-	-	-
General Requirements (% of constr)	10%	2001		$289,000	$269,000									
Construction Subtotal				$3,178,000	$3,178,000									
Contingency (% of subtotal)	25%	2001		$795,000	$795,000									
ELA (% of subtotal w/cont)	20%	2001		$795,000	$795,000									
Interest During Construction (1 yrs)		2001	1	$107,000	$107,000									
Total for Alternative 4 (Nearest $1k)				$4,875,000	$4,875,000	$0	$0	$0	$0	$0	$0	$0	$0	$0
Factored Totals (Nearest $1k)					$4,875,000	$0	$0	$0	$0	$0	$0	$0	$0	$0

Item	2011 Year 10 0.64393	2012 Year 11 0.61620	2013 Year 12 0.58966	2014 Year 13 0.56427	2015 Year 14 0.53997	2016 Year 15 0.51672	2017 Year 16 0.49447	2018 Year 17 0.47318	2019 Year 18 0.45280	2020 Year 19 0.43330	2021 Year 20 0.41464	TOTAL PRESENT WORTH	REMAINING VALUE 0.41464	NET PRESENT WORTH	EQUIVALENT ANNUAL COST 14.00794
Alternative No. 1 - Add two additional trickling filters															
Structure	-	-	-	-	-	-	-	-	-	-	-		$527,400		
Equipment	-	-	-	-	-	-	-	-	-	-	$690,200		$690,200		
Plumbing Mechanical															
HVAC/Mech. (% of constr)															
Electrical (% of constr)	$94,000	-	-	-	-	-	-	-	-	-	$94,000		$94,000		
Instrumentation (% of constr)	$78,000	-	-	-	-	-	-	-	-	-	$78,000		$78,000		
General Requirements (% of constr)															
Construction Subtotal	$172,000										$862,000				
Contingency (% of subtotal)															
ELA (% of subtotal w/cont)															
Interest During Construction (1 yrs)															
Total for Alternative 1 (Nearest $1k)	$172,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$862,000		$1,390,000		
Factored Totals (Nearest $1k)	$111,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$357,000	$3,406,000	$576,000	$2,830,000	$218,000
Alternative No. 2 - Add one trickling filter and CEPT capability now, 1 TF later															
Structure	-	-	-	-	-	-	-	-	-	-	-		$327,780		
	-	-	-	-	$524,541	-	-	-	-	-	-		$461,596		
Equipment	-	-	-	-	-	-	-	-	-	-	$477,100		$477,100		
	-	-	-	-	$352,610	-	-	-	-	-	-		$246,827		
Plumbing Mechanical															
HVAC/Mech. (% of constr)															
Electrical (% of constr)	$61,000	-	-	-	$53,000	-	-	-	-	-	$61,000		$82,200		
Instrumentation (% of constr)	$51,000	-	-	-	$44,000	-	-	-	-	-	$51,000		$68,600		
General Requirements (% of constr)					$97,000										
Construction Subtotal	$112,000				$1,071,000						$589,000				
Contingency (% of subtotal)					$268,000										
ELA (% of subtotal w/cont)					$268,000										
Interest During Construction (1 yrs)					$36,000										
Total for Alternative 2 (Nearest $1k)	$112,000	$0	$0	$0	$1,643,000	$0	$0	$0	$0	$0	$589,000		$1,664,000		
Factored Totals (Nearest $1k)	$72,000	$0	$0	$0	$887,000	$0	$0	$0	$0	$0	$244,000	$3,118,000	$690,000	$2,428,000	$187,000
Alternative No. 3 - Effluent Filtration, CEPT capability, and 1 Trickling Filter															
Structure	-	-	-	-	-	-	-	-	-	-	-		$604,680		
Equipment	-	-	-	-	-	-	-	-	-	-	$1,447,400		$1,447,400		
HVAC/Mech. (included above)															
Electrical (included above)	$147,000	-	-	-	-	-	-	-	-	-	$147,000		$147,000		
Instrumentation (% of constr)	$123,000	-	-	-	-	-	-	-	-	-	$123,000		$123,000		
General Requirements (% of constr)															
Construction Subtotal	$270,000										$1,717,000				
Contingency (% of subtotal)															
ELA (% of subtotal w/cont)															
Interest During Construction (1 yrs)															
Total for Alternative 3 (Nearest $1k)	$270,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,717,000		$2,322,000		
Factored Totals (Nearest $1k)	$174,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$712,000	$5,485,000	$963,000	$4,522,000	$348,000
Alternative No. 4 - Add CEPT capability and two intermediate clarifiers															
Structure	-	-	-	-	-	-	-	-	-	-	-		$418,140		
Equipment	-	-	-	-	-	-	-	-	-	-	$1,905,900		$1,905,900		
Plumbing Mechanical															
HVAC/Mech. (% of constr)															
Electrical (% of constr)	$156,000	-	-	-	-	-	-	-	-	-	$156,000		$156,000		
Instrumentation (% of constr)	$130,000	-	-	-	-	-	-	-	-	-	$130,000		$130,000		
General Requirements (% of constr)															
Construction Subtotal	$286,000										$2,192,000				
Contingency (% of subtotal)															
ELA (% of subtotal w/cont)															
Interest During Construction (1 yrs)															
Total for Alternative 4 (Nearest $1k)	$286,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$2,192,000		$2,610,000		
Factored Totals (Nearest $1k)	$184,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$909,000	$5,968,000	$1,082,000	$4,886,000	$376,000

Baseline for costs = Jan-01
ENR Building Cost Index = 3545
Interest Rate = 4.50%

Leavenworth, Kansas
Wastewater Master Plan

Titles and column headers are linked to "Capital" sheet. Do not change here.

Operations & Maintenance Costs for Each Alternative

Item	2000 Annual Cost ($)	2001 Year PRESENT	2002 Year 1	2003 Year 2	2004 Year 3	2005 Year 4	2006 Year 5	2007 Year 6	2008 Year 7	2009 Year 8	2010 Year 9	2011 Year 10	2012 Year 11	2013 Year 12	2014 Year 13	2015 Year 14	2016 Year 15	2017 Year 16	2018 Year 17	2019 Year 18	2020 Year 19	2021 Year 20	TOTAL PRESENT WORTH	EQUIV. ANNUAL COST
		1.00000	0.95694	0.91573	0.87630	0.83856	0.80245	0.76790	0.73483	0.70319	0.67290	0.64393	0.61620	0.58966	0.56427	0.53997	0.51672	0.49447	0.47318	0.45280	0.43330	0.41464		
Alternative No. 1 - Add two additional trickling filters																								
Polymer			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Maintenance			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Labor			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Energy	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700	$70,700		
Solids Disposal			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Total for Alternative 1 (Nearest $1k)	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000	$71,000		
Factored Totals (Nearest $1k)		$71,000	$68,000	$65,000	$62,000	$60,000	$57,000	$55,000	$52,000	$50,000	$48,000	$46,000	$44,000	$42,000	$40,000	$38,000	$37,000	$35,000	$34,000	$32,000	$31,000	$29,000	$996,000	$76,600
Alternative No. 2 - Add one trickling filter and CEPT capability now, 1 TF later																								
Additional Polymer	$3,900	$3,900	$4,000	$4,100	$4,100	$4,200	$4,300	$4,300	$4,400	$4,400	$4,500	$4,600	$4,600	$4,700	$4,800	$4,900	$4,900	$5,000	$5,100	$5,200	$5,200	$5,300		
Add'l Ferric Chloride	$29,500	$30,000	$30,400	$30,900	$31,300	$31,800	$32,300	$32,800	$33,200	$33,700	$34,300	$34,800	$35,300	$35,800	$36,400	$36,900	$37,500	$38,000	$38,600	$39,200	$39,800	$40,300		
Maintenance			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Labor			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Energy	$37,000	$37,100	$37,100	$37,100	$37,100	$37,200	$37,200	$37,200	$37,200	$37,300	$37,300	$37,300	$37,300	$37,400	$37,400	$37,400	$37,400	$37,500	$37,500	$37,500	$37,600	$37,600		
Additional Solids Disposal	$5,200	$5,300	$5,300	$5,400	$5,500	$5,600	$5,700	$5,800	$5,800	$5,900	$6,000	$6,100	$6,200	$6,300	$6,400	$6,500	$6,600	$6,700	$6,800	$6,900	$7,000	$7,100		
Total for Alternative 2 (Nearest $1k)	$76,000	$76,000	$77,000	$78,000	$78,000	$79,000	$80,000	$80,000	$81,000	$81,000	$82,000	$83,000	$83,000	$84,000	$85,000	$86,000	$86,000	$87,000	$88,000	$89,000	$90,000	$90,000		
Factored Totals (Nearest $1k)		$76,000	$74,000	$71,000	$68,000	$66,000	$64,000	$61,000	$60,000	$57,000	$55,000	$53,000	$51,000	$50,000	$48,000	$46,000	$44,000	$43,000	$42,000	$40,000	$39,000	$37,000	$1,145,000	$88,000
Alternative No. 3 - Effluent Filtration, CEPT capability, and 1 Trickling Filter																								
Additional Polymer	$3,900	$3,900	$4,000	$4,100	$4,100	$4,200	$4,300	$4,300	$4,400	$4,400	$4,500	$4,600	$4,600	$4,700	$4,800	$4,900	$4,900	$5,000	$5,100	$5,200	$5,200	$5,300		
Add'l Ferric Chloride	$29,500	$30,000	$30,400	$30,900	$31,300	$31,800	$32,300	$32,800	$33,200	$33,700	$34,300	$34,800	$35,300	$35,800	$36,400	$36,900	$37,500	$38,000	$38,600	$39,200	$39,800	$40,300		
Maintenance			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Labor			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Energy	$37,000	$37,100	$37,100	$37,100	$37,100	$37,200	$37,200	$37,200	$37,200	$37,300	$37,300	$37,300	$37,300	$37,400	$37,400	$37,400	$37,400	$37,500	$37,500	$37,500	$37,600	$37,600		
Additional Solids Disposal	$5,200	$5,300	$5,300	$5,400	$5,500	$5,600	$5,700	$5,800	$5,800	$5,900	$6,000	$6,100	$6,200	$6,300	$6,400	$6,500	$6,600	$6,700	$6,800	$6,900	$7,000	$7,100		
Total for Alternative 3 (Nearest $1k)	$76,000	$76,000	$77,000	$78,000	$78,000	$79,000	$80,000	$80,000	$81,000	$81,000	$82,000	$83,000	$83,000	$84,000	$85,000	$86,000	$86,000	$87,000	$88,000	$89,000	$90,000	$90,000		
Factored Totals (Nearest $1k)		$76,000	$74,000	$71,000	$68,000	$66,000	$64,000	$61,000	$60,000	$57,000	$55,000	$53,000	$51,000	$50,000	$48,000	$46,000	$44,000	$43,000	$42,000	$40,000	$39,000	$37,000	$1,145,000	$88,000
Alternative No. 4 - Add CEPT capability and two intermediate clarifiers																								
Additional Polymer	$3,900	$3,800	$4,000	$4,100	$4,100	$4,200	$4,300	$4,300	$4,400	$4,400	$4,500	$4,600	$4,600	$4,700	$4,800	$4,900	$4,900	$5,000	$5,100	$5,200	$5,200	$5,300		
Add'l Ferric Chloride	$29,500	$30,000	$30,400	$30,900	$31,300	$31,800	$32,300	$32,800	$33,200	$33,700	$34,300	$34,800	$35,300	$35,800	$36,400	$36,900	$37,500	$38,000	$38,600	$39,200	$39,800	$40,300		
Maintenance			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Labor			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0		
Energy	$1,700	$1,700	$1,700	$1,700	$1,800	$1,800	$1,800	$1,800	$1,900	$1,900	$1,900	$1,900	$2,000	$2,000	$2,000	$2,100	$2,100	$2,100	$2,100	$2,200	$2,200	$2,200		
Solids Disposal	$5,200	$5,300	$5,300	$5,400	$5,500	$5,600	$5,700	$5,800	$5,800	$5,900	$6,000	$6,100	$6,200	$6,300	$6,400	$6,500	$6,600	$6,700	$6,800	$6,900	$7,000	$7,100		
Total for Alternative 4 (Nearest $1k)	$40,000	$41,000	$41,000	$42,000	$43,000	$43,000	$44,000	$45,000	$45,000	$46,000	$47,000	$47,000	$48,000	$49,000	$50,000	$50,000	$51,000	$52,000	$53,000	$54,000	$54,000	$55,000		
Factored Totals (Nearest $1k)		$41,000	$39,000	$38,000	$38,000	$36,000	$35,000	$35,000	$33,000	$32,000	$32,000	$30,000	$30,000	$29,000	$28,000	$27,000	$26,000	$26,000	$25,000	$24,000	$23,000	$23,000	$650,000	$50,000

Linked to "Capital" sheet - Do not change values here.

Baseline for costs =	Jan-01	
ENR Building Cost Index =	3545	
Interest Rate =	4.50%	
Polymer cost	$2.50 $/lb	
Polymer dose	5.25 lb/dt	Based on actual plant data
Ferric Chloride cost	$0.70 /gallon	Based on phone conversation with Midland Resources vice-president
Ferric Chloride purity	38%	
Ferric Chloride dose	15 mg/l	
Ferric Chloride specific gravity	11.4 S.G.	
Solids Disposal cost	$17.50 /dt	
Electrical cost	$0.05 /kWh	
Wire-to-water efficiency	68.0%	
Pump Flow to Trickling Filters	10 mgd	
Pump Head to Trickling Filters	42 ft	

Leavenworth, Kansas
Wastewater Master Plan

Present Worth (PW) and Equivalent Annual Costs (EAC) of Alternatives

COSTS BY ALTERNATIVE

Alternative No. 1 - Add two additional trickling filters	
Capital Cost PW	$2,830,000
O&M PW	$996,000
PW Total	**$3,826,000**
Capital Cost EAC	$218,000
O&M EAC	$76,600
EAC Total	**$294,600**
Alternative No. 2 - Add one trickling filter and CEPT capability now, 1 TF later	
Capital Cost PW	$2,428,000
O&M PW	$1,145,000
PW Total	**$3,573,000**
Capital Cost EAC	$187,000
O&M EAC	$88,000
EAC Total	**$275,000**
Alternative No. 3 - Effluent Filtration, CEPT capability, and 1 Trickling Filter	
Capital Cost PW	$4,522,000
O&M PW	$1,145,000
PW Total	**$5,667,000**
Capital Cost EAC	$348,000
O&M EAC	$88,000
EAC Total	**$436,000**
Alternative No. 4 - Add CEPT capability and two intermediate clarifiers	
Capital Cost PW	$4,886,000
O&M PW	$650,000
PW Total	**$5,536,000**
Capital Cost EAC	$376,000
O&M EAC	$50,000
EAC Total	**$426,000**
Selected Rehab. Improvements	
Capital Cost PW	$4,331,000
O&M PW	
PW Total	**$4,331,000**
Capital Cost EAC	$331,000
O&M EAC	
EAC Total	**$331,000**

Note: THESE COSTS INCLUDE ENGINEERING, LEGAL, ADMINSTRATIVE, AND INTEREST DURING CONSTRUCTION COSTS.

APPENDIX O

SYSTEM RECONFIGURATION COST COMPARISON

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length (ft)	CIP Diameter (in)	CIP Cost (ft/ft)	Model: MODIFICATIONS Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)	Model: NO MODIFICATIONS Total Flow (cfs)	Relief Dia. (in)	Construction Cost ($)
Basin:											
Subsys	SUB01										
SUB01	1165	307	75	0	0	26.345	42	27,330	22.116	36	22,904
SUB01	1166	1165	285	0	0	26.209	42	108,216	21.982	36	91,232
SUB01	1167	1166	166	0	0	26.043	42	59,784	21.817	36	50,013
SUB01	1168	1167	223	0	0	25.890	42	71,768	21.666	36	58,966
SUB01	1169	1168	131	0	0	25.715	42	44,643	21.492	36	37,028
SUB01	1170	1169	499	0	0	25.627	42	179,091	21.406	36	149,745
SUB01	1171	1170	115	0	0	25.447	42	36,653	21.226	36	30,065
SUB01	1172	1171	224	0	0	25.298	42	63,995	21.072	36	51,443
SUB01	1173	1172	189	0	0	25.149	54	80,190	20.909	48	66,331
SUB01	1174	1173	100	0	0	24.972	36	24,012	20.729	36	24,012
SUB01	1175	1174	98	0	0	24.795	42	29,378	20.551	42	29,378
SUB01	1176	1175	301	0	0	24.682	42	88,082	20.438	36	71,135
SUB01	1177	1176	344	0	0	24.582	42	94,397	20.337	36	75,266
SUB01	1178	1177	124	0	0	24.413	42	34,026	20.168	36	27,131
SUB01	1179	1178	441	0	0	24.343	42	121,015	20.098	36	96,489
SUB01	1180	1179	310	0	0	24.136	42	85,067	20.163	36	67,827
SUB01	1180	255	10	0	0	0.209	0	0	3.179	21	1,274
SUB01	1181	1180	324	0	0	18.648	0	0	18.648	0	0
SUB01	1182	1181	41	0	0	18.451	0	0	18.451	0	0
SUB01	1183	1182	149	0	0	18.280	0	0	18.280	0	0
SUB01	1184	1183	38	0	0	18.083	0	0	18.083	0	0
SUB01	1185	1184	340	0	0	17.980	33	69,639	17.980	33	69,639
SUB01	1186	1185	125	0	0	17.812	33	25,603	17.812	33	25,603
SUB01	1187	1186	162	0	0	17.656	33	33,181	17.656	33	33,181
SUB01	1188	1187	241	0	0	17.523	42	66,133	17.523	42	66,133
SUB01	1189	1188	459	0	0	17.455	33	94,013	17.455	33	94,013
SUB01	1190	1189	594	0	0	17.426	33	121,664	17.426	33	121,664
SUB01	1191	1190	346	0	0	6.486	0	0	6.486	0	0
SUB01	1192	1191	429	0	0	6.403	0	0	6.403	0	0
SUB01	1193	1192	390	0	0	6.281	0	0	6.281	0	0
SUB01	1194	720	45	0	0	2.916	18	5,243	2.916	18	5,243
SUB01	1195	1194	275	0	0	2.766	18	32,037	2.766	18	32,037
SUB01	1196	1195	370	0	0	2.631	18	46,562	2.631	18	46,562
SUB01	1196A	1196	361	0	0	2.485	15	49,661	2.485	15	49,661

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: MODIFICATIONS			Model: NO MODIFICATIONS		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB01	1197	1196A	303	0	0	2.334	12	37,537	2.334	12	37,537
SUB01	1197A	1197	402	0	0	2.192	0	0	2.192	0	0
SUB01	1198	1197A	199	0	0	2.032	0	0	2.032	0	0
SUB01	1198A	1198	332	0	0	1.876	12	40,672	1.876	12	40,672
SUB01	1199	1198A	319	0	0	1.721	12	38,786	1.721	12	38,786
SUB01	1200	1477	256	0	0	1.390	0	0	1.390	0	0
SUB01	1201	1200	321	0	0	1.236	10	27,316	1.236	10	27,316
SUB01	1202	1201	317	0	0	1.084	10	26,976	1.084	10	26,976
SUB01	1204	490	543	0	0	11.265	27	107,163	11.265	27	107,163
SUB01	1205	1204	260	0	0	11.093	24	50,558	11.093	24	50,558
SUB01	1206	1205	380	0	0	10.935	24	61,145	10.935	24	61,145
SUB01	1207	1206	242	0	0	10.762	18	28,193	10.762	18	28,193
SUB01	1208	1207	308	0	0	10.596	21	40,222	10.596	21	40,222
SUB01	1209	1208	316	0	0	10.432	24	54,550	10.432	24	54,550
SUB01	1210	1209	322	0	0	10.281	24	52,058	10.281	24	52,058
SUB01	1211	1210	260	0	0	10.122	24	36,658	10.122	24	36,658
SUB01	1212	1211	269	0	0	9.964	24	37,926	9.964	24	37,926
SUB01	1213	1212	166	0	0	9.791	24	23,404	9.791	24	23,404
SUB01	1214	1213	35	0	0	9.597	27	6,045	9.597	27	6,045
SUB01	1215	1214	357	0	0	9.453	24	53,055	9.453	24	53,055
SUB01	1216	1215	343	0	0	7.794	21	52,861	7.794	21	52,861
SUB01	1217	1216	369	0	0	7.651	21	66,034	7.651	21	66,034
SUB01	1218	1217	190	0	0	7.481	21	34,647	7.481	21	34,647
SUB01	1219	1218	252	0	0	7.322	21	39,265	7.322	21	39,265
SUB01	1220	1219	125	0	0	7.143	21	21,118	7.143	21	21,118
SUB01	1221	1220	365	0	0	7.000	21	46,493	7.000	21	46,493
SUB01	1222	1221	357	0	0	6.855	21	45,475	6.855	21	45,475
SUB01	1223	1222	275	0	0	6.700	21	36,952	6.700	21	36,952
SUB01	1224	1223	272	0	0	6.544	21	35,188	6.544	21	35,188
SUB01	1225	1554	230	0	0	6.202	0	0	6.202	0	0
SUB01	1226	1226A	92	0	0	5.836	0	0	5.836	0	0
SUB01	1226A	1225	165	0	0	6.022	0	0	6.022	0	0
SUB01	1227	1226	314	0	0	5.671	21	43,527	5.671	21	43,527
SUB01	1228	1227	278	0	0	5.504	21	38,353	5.504	21	38,353
SUB01	1229	1266	129	0	0	5.149	18	15,028	5.149	18	15,028
SUB01	1229A	1229	319	0	0	4.977	18	37,162	4.977	18	37,162

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: MODIFICATIONS			Model: NO MODIFICATIONS		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB01	1231	1230	439	0	0	4.655	18	57,215	4.655	18	57,215
SUB01	1232	1231	209	0	0	4.484	15	26,052	4.484	15	26,052
SUB01	1233	1975	168	0	0	4.136	15	18,107	4.136	15	18,107
SUB01	1236	1215	310	0	0	1.638	15	34,954	1.638	15	34,954
SUB01	1237	2289	158	0	0	1.235	0	0	1.235	0	0
SUB01	1238	1654	134	0	0	0.828	0	0	0.828	0	0
SUB01	1239	1238	266	0	0	0.623	0	0	0.623	0	0
SUB01	1240	1239	183	0	0	0.416	0	0	0.416	0	0
SUB01	1241	1240	172	0	0	0.209	0	0	0.209	0	0
SUB01	1266	1228	181	0	0	5.328	18	22,033	5.328	18	22,033
SUB01	1477	1199	61	0	0	1.551	0	0	1.551	0	0
SUB01	1554	1224	224	0	0	6.373	0	0	6.373	0	0
SUB01	1654	1237	232	0	0	1.033	0	0	1.033	0	0
SUB01	1975	1232	179	0	0	4.310	15	19,869	4.310	15	19,869
SUB01	205	205A	533	0	0	0.209	0	0	0.209	0	0
SUB01	205A	206	130	0	0	0.407	0	0	0.407	0	0
SUB01	206	207	286	0	0	0.612	0	0	0.612	0	0
SUB01	207	208	251	0	0	0.809	0	0	0.809	0	0
SUB01	208	208A	76	0	0	1.003	0	0	1.003	0	0
SUB01	208A	210	100	0	0	1.202	0	0	1.202	0	0
SUB01	210	214	487	0	0	1.398	0	0	1.398	0	0
SUB01	214	214A	184	0	0	1.571	0	0	1.571	0	0
SUB01	214A	234A	164	0	0	1.759	0	0	1.759	0	0
SUB01	219	426A	291	0	0	1.225	0	0	1.225	0	0
SUB01	2289	1236	250	0	0	1.438	0	0	1.438	0	0
SUB01	233	255	329	0	0	2.333	0	0	2.333	0	0
SUB01	234	234A	97	0	0	0.209	0	0	0.209	0	0
SUB01	234A	233	82	0	0	2.143	0	0	2.143	0	0
SUB01	254	1180	379	0	0	5.711	18	44,683	4.365	0	0
SUB01	255	274A	156	0	0	2.698	0	0	5.578	21	20,018
SUB01	272	303	325	0	0	3.317	0	0	6.192	24	45,823
SUB01	273	272	438	0	0	3.179	0	0	6.047	24	61,754
SUB01	274	273	464	0	0	3.039	0	0	5.914	21	59,104
SUB01	274A	274	284	0	0	2.876	0	0	5.757	21	36,176
SUB01	275	254	164	0	0	5.530	0	0	4.182	0	0
SUB01	275A	275	31	0	0	5.342	0	0	3.995	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: MODIFICATIONS			Model: NO MODIFICATIONS		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB01	299C	299B	186	0	0	5.001	0	0	3.647	0	0
SUB01	302	303	21	0	0	4.039	18	2,447	5.203	18	2,447
SUB01	303	304	423	0	0	7.461	24	59,640	11.340	27	73,051
SUB01	304	305A	385	0	0	7.587	24	54,282	11.483	27	66,488
SUB01	305	306A	394	0	0	7.897	24	55,551	11.824	30	75,195
SUB01	305A	305	56	0	0	7.717	24	7,895	11.630	27	9,671
SUB01	306	307	115	0	0	8.200	24	21,069	12.159	30	26,938
SUB01	306A	306	62	0	0	8.023	24	8,742	11.968	30	11,833
SUB01	307	309	590	0	0	34.356	42	202,099	34.313	42	202,099
SUB01	309	311	174	0	0	34.416	36	44,016	34.371	36	44,016
SUB01	311	311A	48	0	0	34.578	42	14,180	34.531	42	14,180
SUB01	314	302	409	0	0	3.874	18	47,646	5.045	18	47,646
SUB01	315	314	455	0	0	3.711	18	55,770	4.890	18	55,770
SUB01	315A	315	196	0	0	3.529	21	24,966	4.716	24	27,634
SUB01	316	316A	155	0	0	2.966	15	16,705	4.179	15	16,705
SUB01	316A	316B	175	0	0	3.156	0	0	4.361	15	18,861
SUB01	316B	315A	170	0	0	3.344	18	19,804	4.539	18	19,804
SUB01	324	325	193	0	0	2.025	0	0	3.285	15	20,801
SUB01	324A	324	187	0	0	1.829	0	0	3.101	15	20,154
SUB01	325	326	376	0	0	2.219	0	0	3.469	15	40,524
SUB01	326	327	375	0	0	2.404	0	0	3.643	15	45,431
SUB01	327	327A	166	0	0	2.587	15	21,336	3.817	15	21,336
SUB01	327A	316	214	0	0	2.778	15	23,143	3.999	15	23,143
SUB01	361	324A	178	0	0	1.631	0	0	2.915	12	16,667
SUB01	362	361	131	0	0	1.432	0	0	2.727	15	15,702
SUB01	362A	362	182	0	0	1.234	0	0	2.540	15	21,545
SUB01	365	840A	333	0	0	0.625	0	0	1.973	0	0
SUB01	365A	365	36	0	0	0.417	0	0	1.777	12	4,297
SUB01	365B	365A	27	0	0	0.209	0	0	1.579	0	0
SUB01	366	366A	348	0	0	1.400	0	0	1.400	0	0
SUB01	366A	368N	282	0	0	1.591	0	0	0.209	0	0
SUB01	367A	367B	97	0	0	2.395	0	0	2.395	0	0
SUB01	367B	368N	349	0	0	2.590	0	0	2.590	0	0
SUB01	368B	369A	369	0	0	4.497	0	0	3.128	0	0
SUB01	368N	368B	405	0	0	4.341	0	0	2.962	0	0
SUB01	369A	370A	395	0	0	4.667	0	0	3.303	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Model: MODIFICATIONS Total Flow	Relief Dia.	Construction Cost	Model: NO MODIFICATIONS Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB01	417	814	357	0	0	0.405	0	0	0.405	0	0
SUB01	424E	367A	197	0	0	2.205	0	0	2.205	0	0
SUB01	424F	424E	137	0	0	2.011	0	0	2.011	0	0
SUB01	424G	424F	196	0	0	1.818	0	0	1.818	0	0
SUB01	425A	424G	250	0	0	1.621	0	0	1.621	0	0
SUB01	426A	425A	157	0	0	1.421	0	0	1.421	0	0
SUB01	436	436A	123	0	0	0.413	0	0	0.413	0	0
SUB01	436A	219	392	0	0	1.030	0	0	1.030	0	0
SUB01	436B	9011	304	0	0	0.209	0	0	0.209	0	0
SUB01	439	436	285	0	0	0.209	0	0	0.209	0	0
SUB01	478A	366	312	0	0	1.206	0	0	1.206	0	0
SUB01	483	478A	118	0	0	1.006	0	0	1.006	0	0
SUB01	484	483	442	0	0	0.810	0	0	0.810	0	0
SUB01	485	484	409	0	0	0.615	0	0	0.615	0	0
SUB01	486	485	406	0	0	0.414	0	0	0.414	0	0
SUB01	487	486	254	0	0	0.209	0	0	0.209	0	0
SUB01	490	490A	254	0	0	11.404	27	45,634	11.404	27	45,634
SUB01	490A	1190	143	0	0	11.578	27	24,695	11.578	27	24,695
SUB01	692	1193	205	0	0	6.124	0	0	6.124	0	0
SUB01	694	692	289	0	0	6.016	24	40,746	6.016	24	40,746
SUB01	695	694	251	0	0	5.898	24	35,389	5.898	24	35,389
SUB01	696	696A	21	0	0	5.588	0	0	5.588	0	0
SUB01	696A	695	212	0	0	5.769	24	29,890	5.769	24	29,890
SUB01	697	696	291	0	0	5.539	42	79,853	5.539	42	79,853
SUB01	698	697	283	0	0	5.388	24	39,901	5.388	24	39,901
SUB01	698A	698	80	0	0	2.333	18	9,320	2.333	18	9,320
SUB01	699	698A	193	0	0	2.150	18	22,483	2.150	18	22,483
SUB01	699A	699	157	0	0	1.958	0	0	1.958	0	0
SUB01	700	699A	300	0	0	1.773	0	0	1.773	0	0
SUB01	701	700	217	0	0	1.589	15	33,913	1.589	15	33,913
SUB01	702	701	191	0	0	1.397	0	0	1.397	0	0
SUB01	720	721	147	0	0	3.093	18	17,124	3.093	18	17,124
SUB01	721	698	152	0	0	3.259	18	17,707	3.259	18	17,707
SUB01	811	702	62	0	0	1.197	0	0	1.197	0	0
SUB01	812	811	233	0	0	1.001	0	0	1.001	0	0
SUB01	813	812	308	0	0	0.807	0	0	0.807	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: MODIFICATIONS			Model: NO MODIFICATIONS		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB01	840A	9013	29	0	0	0.827	0	0	2.156	15	3,126
SUB01	9011	436A	48	0	0	0.413	0	0	0.413	0	0
SUB01	9013	362A	195	0	0	1.032	0	0	2.351	0	0
SUB01	996	417	690	0	0	0.209	0	0	0.209	0	0
		Sub. Total:	45771		0			4,261,422			4,507,979

Basin:

Subsys SUB02_03

Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
SUB02_03	2118	2117	653	0	0	18.311	0	0	18.291	0	0
SUB02_03	2119	2118	603	0	0	18.610	0	0	18.591	0	0
SUB02_03	2120	2119	492	0	0	18.851	0	0	18.834	0	0
SUB02_03	2121	P	278	0	0	17.250	36	61,544	17.226	36	61,544
SUB02_03	2121A	2121	408	0	0	17.250	0	0	17.226	0	0
SUB02_03	2121A	R	47	0	0	17.250	0	0	17.226	0	0
SUB02_03	311A	9012	140	0	0	34.559	48	48,767	34.512	48	48,767
SUB02_03	9012	2121A	15	0	0	34.505	36	3,534	34.458	36	3,534
SUB02_03	AA	Z	423	0	0	5.153	0	0	5.153	0	0
SUB02_03	AB	AA	393	0	0	5.218	0	0	5.218	0	0
SUB02_03	AC	AB	434	0	0	5.289	0	0	5.289	0	0
SUB02_03	AD	AC	440	0	0	5.362	0	0	5.362	0	0
SUB02_03	AE	AD	383	0	0	2.699	0	0	2.699	0	0
SUB02_03	AF	AE	223	0	0	2.709	0	0	2.709	0	0
SUB02_03	AG	AD	16	0	0	2.682	0	0	2.682	0	0
SUB02_03	AH	AG	75	0	0	2.686	0	0	2.686	0	0
SUB02_03	AI	AH	54	0	0	2.688	0	0	2.688	0	0
SUB02_03	AJ	AI	468	0	0	2.709	0	0	2.709	0	0
SUB02_03	K	J	650	0	0	18.527	0	0	18.507	0	0
SUB02_03	L	K	604	0	0	18.838	0	0	18.821	0	0
SUB02_03	M	L	492	0	0	19.091	0	0	19.076	0	0
SUB02_03	N	M	489	0	0	19.091	0	0	19.076	0	0
SUB02_03	N	2120	488	0	0	19.091	0	0	19.076	0	0
SUB02_03	P	N	106	0	0	38.223	0	0	38.193	0	0
SUB02_03	Q	P	459	0	0	21.377	42	127,188	21.374	42	127,188
SUB02_03	R	Q	232	0	0	21.461	42	63,663	21.458	42	63,663
SUB02_03	S	R	610	0	0	4.849	0	0	4.849	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: MODIFICATIONS			Model: NO MODIFICATIONS		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB02_03	T	S	139	0	0	4.864	0	0	4.864	0	0
SUB02_03	U	T	119	0	0	4.877	0	0	4.877	0	0
SUB02_03	V	U	268	0	0	4.906	0	0	4.906	0	0
SUB02_03	W	V	444	0	0	4.954	0	0	4.954	0	0
SUB02_03	X	W	606	0	0	5.026	0	0	5.026	0	0
SUB02_03	Y	X	347	0	0	5.071	0	0	5.071	0	0
SUB02_03	Z	Y	87	0	0	5.082	0	0	5.082	0	0
		Sub. Total:	11685		0			304,696			304,696
	Basin:										
	Subsys	SUB04									
SUB04	627	633	592	0	0	0.621	0	0	0.621	0	0
SUB04	630	630A	386	0	0	2.811	0	0	2.811	0	0
SUB04	630A	2110A	138	0	0	3.322	15	14,873	3.322	15	14,873
SUB04	631	630	47	0	0	2.244	15	5,065	2.244	15	5,065
SUB04	632	631	193	0	0	1.698	0	0	1.698	0	0
SUB04	633	632	627	0	0	1.168	0	0	1.168	0	0
		Sub. Total:	1983		0			19,938			19,938
	Basin:										
	Subsys	SUB05									
SUB05	10	9	288	0	0	15.677	0	0	15.677	0	0
SUB05	1068	948	109	0	0	0.382	0	0	0.382	0	0
SUB05	11	10	182	0	0	15.649	36	65,405	15.649	36	65,405
SUB05	12	11	371	0	0	15.665	36	140,498	15.665	36	140,498
SUB05	13	12	389	0	0	15.685	36	142,084	15.685	36	142,084
SUB05	13A	13	136	0	0	0.079	0	0	0.079	0	0
SUB05	14	13	361	0	0	15.613	0	0	15.613	0	0
SUB05	1401	880	11	0	0	18.078	36	2,406	18.078	36	2,406
SUB05	1402	1401	115	0	0	18.041	33	23,555	18.041	33	23,555
SUB05	1403	1402	248	0	0	18.033	33	50,796	18.033	33	50,796
SUB05	1404	1403	84	0	0	17.988	33	17,205	17.988	33	17,205
SUB05	1405	1404	396	0	0	18.014	33	81,110	18.014	33	81,110

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: MODIFICATIONS			Model: NO MODIFICATIONS		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB05	1405A	1405	233	0	0	1.389	0	0	1.389	0	0
SUB05	1405B	1405A	372	0	0	1.342	0	0	1.342	0	0
SUB05	1405C	1405B	147	0	0	1.280	0	0	1.280	0	0
SUB05	1405D	1405C	188	0	0	1.220	0	0	1.220	0	0
SUB05	1406	1405	234	0	0	16.675	30	44,659	16.675	30	44,659
SUB05	1407	1406	274	0	0	16.672	30	52,292	16.672	30	52,292
SUB05	1408	1407	335	0	0	16.161	30	63,934	16.161	30	63,934
SUB05	1409	1408	291	0	0	16.161	30	55,537	16.161	30	55,537
SUB05	1410	1409	105	0	0	16.119	30	20,039	16.119	30	20,039
SUB05	1411	1410	179	0	0	16.093	30	34,162	16.093	30	34,162
SUB05	1412	1411	72	0	0	16.043	30	13,741	16.043	30	13,741
SUB05	1413	1412	367	0	0	16.059	30	70,041	16.059	30	70,041
SUB05	1414	1413	436	0	0	16.081	0	0	16.081	0	0
SUB05	1415	1414	256	0	0	16.082	48	92,014	16.082	48	92,014
SUB05	1416	1415	238	0	0	16.066	0	0	16.066	0	0
SUB05	1417	2273	158	0	0	16.010	30	30,542	16.010	30	30,542
SUB05	1418	1417	200	0	0	15.995	30	39,208	15.995	30	39,208
SUB05	1419	1419A	233	0	0	15.948	30	46,133	15.948	30	46,133
SUB05	1419A	1418	106	0	0	15.955	30	20,520	15.955	30	20,520
SUB05	1420	1420A	215	0	0	15.890	30	46,424	15.890	30	46,424
SUB05	1420A	1419	90	0	0	15.903	30	17,820	15.903	30	17,820
SUB05	1421	1420	299	0	0	15.899	30	78,561	15.899	30	78,561
SUB05	1422	1421	254	0	0	15.895	30	74,824	15.895	30	74,824
SUB05	1423	1422	258	0	0	15.892	30	74,309	15.892	30	74,309
SUB05	1424	1423	200	0	0	0.304	0	0	0.304	0	0
SUB05	1425	1424	340	0	0	0.229	0	0	0.229	0	0
SUB05	1426	1425	249	0	0	0.154	0	0	0.154	0	0
SUB05	1427	1426	404	0	0	0.079	0	0	0.079	0	0
SUB05	1428	1407	115	0	0	0.596	0	0	0.596	0	0
SUB05	1429	1428	302	0	0	0.526	0	0	0.526	0	0
SUB05	1430	1429	194	0	0	0.454	0	0	0.454	0	0
SUB05	1431	1430	227	0	0	0.381	0	0	0.381	0	0
SUB05	1432	1431	321	0	0	0.307	0	0	0.307	0	0
SUB05	1433	1432	255	0	0	0.232	0	0	0.232	0	0
SUB05	1434	1433	365	0	0	0.156	0	0	0.156	0	0
SUB05	1435	1434	347	0	0	0.079	0	0	0.079	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: MODIFICATIONS			Model: NO MODIFICATIONS		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB05	1449	1448	403	0	0	1.970	0	0	1.970	0	0
SUB05	1450	1449	398	0	0	1.926	0	0	1.926	0	0
SUB05	1451	1450	402	0	0	1.873	0	0	1.873	0	0
SUB05	1452	1451	400	0	0	1.829	0	0	1.829	0	0
SUB05	1453	1452	402	0	0	1.783	0	0	1.783	0	0
SUB05	1454	1453	424	0	0	1.739	0	0	1.739	0	0
SUB05	1455	1454	89	0	0	1.676	0	0	1.676	0	0
SUB05	1456	1455	180	0	0	1.550	0	0	1.550	0	0
SUB05	1457	3026	68	0	0	1.430	0	0	1.430	0	0
SUB05	1458	1457	187	0	0	1.367	0	0	1.367	0	0
SUB05	1459	1458	251	0	0	1.306	0	0	1.306	0	0
SUB05	1460	1460A	304	0	0	1.178	0	0	1.178	0	0
SUB05	1460A	1459	89	0	0	1.239	0	0	1.239	0	0
SUB05	1461	1460	148	0	0	1.112	0	0	1.112	0	0
SUB05	1462	1461	98	0	0	1.045	0	0	1.045	0	0
SUB05	1463	1462	354	0	0	0.984	0	0	0.984	0	0
SUB05	1464	1463	270	0	0	0.920	0	0	0.920	0	0
SUB05	1465	1464	193	0	0	0.853	0	0	0.853	0	0
SUB05	1466	1465	244	0	0	0.787	0	0	0.787	0	0
SUB05	15	14	315	0	0	15.581	30	101,371	15.581	30	101,371
SUB05	1571	1466	155	0	0	0.717	0	0	0.717	0	0
SUB05	1572	1571	301	0	0	0.652	0	0	0.652	0	0
SUB05	1573	1572	277	0	0	0.586	0	0	0.586	0	0
SUB05	1574	1573	128	0	0	0.514	0	0	0.514	0	0
SUB05	1575	1574	393	0	0	0.445	0	0	0.445	0	0
SUB05	1576	1575	396	0	0	0.374	0	0	0.374	0	0
SUB05	1577	1576	353	0	0	0.304	0	0	0.304	0	0
SUB05	1578	1577	367	0	0	0.231	0	0	0.231	0	0
SUB05	1579	1578	401	0	0	0.156	0	0	0.156	0	0
SUB05	1580	1579	400	0	0	0.079	0	0	0.079	0	0
SUB05	15A	15	182	0	0	0.079	0	0	0.079	0	0
SUB05	16	15	257	0	0	15.466	27	72,564	15.466	27	72,564
SUB05	17	16	454	0	0	15.433	27	133,103	15.433	27	133,103
SUB05	18	17	195	0	0	15.377	24	53,251	15.377	24	53,251
SUB05	1893	9006	306	0	0	22.390	0	0	22.390	0	0
SUB05	1894	1893	195	0	0	22.406	0	0	22.406	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: MODIFICATIONS			Model: NO MODIFICATIONS		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB05	1895A	1895	130	0	0	22.497	0	0	22.497	0	0
SUB05	1896	1895A	219	0	0	22.521	0	0	22.521	0	0
SUB05	1897	1448	181	0	0	20.632	0	0	20.632	0	0
SUB05	1898	1897	226	0	0	20.652	0	0	20.652	0	0
SUB05	1899	1898	263	0	0	20.685	0	0	20.685	0	0
SUB05	18A	18	200	0	0	14.434	33	65,425	14.434	33	65,425
SUB05	18B	18A	190	0	0	14.387	33	68,387	14.387	33	68,387
SUB05	19	18	284	0	0	0.980	0	0	0.980	0	0
SUB05	1900	1899	245	0	0	20.715	0	0	20.715	0	0
SUB05	1901	1900	115	0	0	20.694	0	0	20.694	0	0
SUB05	1902	1901	103	0	0	20.667	0	0	20.667	0	0
SUB05	1903	1902	148	0	0	19.852	0	0	19.852	0	0
SUB05	1904	9009	305	0	0	19.376	0	0	19.376	0	0
SUB05	1905	1904	350	0	0	19.460	0	0	19.460	0	0
SUB05	1906	1905	381	0	0	19.497	0	0	19.497	0	0
SUB05	1907	1906	528	0	0	19.566	0	0	19.566	0	0
SUB05	1908	1907	160	0	0	19.541	0	0	19.541	0	0
SUB05	1909	1908	331	0	0	19.554	0	0	19.554	0	0
SUB05	1910	1909	117	0	0	19.515	0	0	19.515	0	0
SUB05	20	19	255	0	0	0.917	0	0	0.917	0	0
SUB05	21	20	199	0	0	0.851	0	0	0.851	0	0
SUB05	22	21	276	0	0	0.788	0	0	0.788	0	0
SUB05	2273	1416	143	0	0	16.036	30	27,291	16.036	30	27,291
SUB05	23	22	276	0	0	0.723	0	0	0.723	0	0
SUB05	2367	1423	20	0	0	15.552	30	4,744	15.552	30	4,744
SUB05	2368	2367	284	0	0	15.555	33	58,170	15.555	33	58,170
SUB05	2369	2368	306	0	0	15.563	30	58,399	15.563	30	58,399
SUB05	2370	2369	270	0	0	15.561	33	61,410	15.561	33	61,410
SUB05	2371	2370	422	0	0	15.597	33	125,999	15.597	33	125,999
SUB05	2372	2371	408	0	0	15.627	33	148,261	15.627	33	148,261
SUB05	2373	2372	425	0	0	15.661	33	151,205	15.661	33	151,205
SUB05	2374	2373	493	0	0	15.710	33	160,836	15.710	33	160,836
SUB05	23A	23	132	0	0	0.079	0	0	0.079	0	0
SUB05	24	23	187	0	0	0.581	0	0	0.581	0	0
SUB05	25	24	297	0	0	0.515	0	0	0.515	0	0
SUB05	26	25	261	0	0	0.446	0	0	0.446	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: MODIFICATIONS			Model: NO MODIFICATIONS		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB05	28	27	295	0	0	0.301	0	0	0.301	0	0
SUB05	29	28	295	0	0	0.228	0	0	0.228	0	0
SUB05	30	29	320	0	0	0.155	0	0	0.155	0	0
SUB05	3002	3003	332	0	0	0.231	0	0	0.231	0	0
SUB05	3003	3004	336	0	0	0.306	0	0	0.306	0	0
SUB05	3004	3005	145	0	0	0.380	0	0	0.380	0	0
SUB05	3005	663	191	0	0	0.454	0	0	0.454	0	0
SUB05	3013	887	183	0	0	1.562	0	0	1.562	0	0
SUB05	3026	1456	288	0	0	1.496	0	0	1.496	0	0
SUB05	3032	1455	47	0	0	0.079	0	0	0.079	0	0
SUB05	31	30	318	0	0	0.079	0	0	0.079	0	0
SUB05	397	896	239	0	0	0.233	0	0	0.233	0	0
SUB05	398	397	228	0	0	0.157	0	0	0.157	0	0
SUB05	663	9009	98	0	0	0.528	0	0	0.528	0	0
SUB05	686	3002	304	0	0	0.156	0	0	0.156	0	0
SUB05	686A	686	205	0	0	0.079	0	0	0.079	0	0
SUB05	782	785	306	0	0	0.079	0	0	0.079	0	0
SUB05	785	786	243	0	0	0.156	0	0	0.156	0	0
SUB05	786	787	217	0	0	0.233	0	0	0.233	0	0
SUB05	787	802	257	0	0	0.310	0	0	0.310	0	0
SUB05	802	803	185	0	0	0.384	0	0	0.384	0	0
SUB05	803	804	278	0	0	0.456	0	0	0.456	0	0
SUB05	804	805	196	0	0	0.526	0	0	0.526	0	0
SUB05	805	806	259	0	0	0.597	0	0	0.597	0	0
SUB05	806	807	152	0	0	0.669	0	0	0.669	0	0
SUB05	807	808	263	0	0	0.742	0	0	0.742	0	0
SUB05	808	809	260	0	0	0.807	0	0	0.807	0	0
SUB05	809	810	250	0	0	0.872	0	0	0.872	0	0
SUB05	810	1902	18	0	0	0.935	0	0	0.935	0	0
SUB05	880	1910	12	0	0	19.454	0	0	19.454	0	0
SUB05	881	880	267	0	0	1.394	0	0	1.394	0	0
SUB05	882	881	299	0	0	1.338	0	0	1.338	0	0
SUB05	883	882	276	0	0	1.281	0	0	1.281	0	0
SUB05	884	883	298	0	0	1.222	0	0	1.222	0	0
SUB05	885	884	227	0	0	1.152	0	0	1.152	0	0
SUB05	885	1405D	94	0	0	1.152	0	0	1.152	0	0

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

						Model: MODIFICATIONS			Model: NO MODIFICATIONS		
Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Total Flow	Relief Dia.	Construction Cost	Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
SUB05	887	886	339	0	0	1.629	0	0	1.629	0	0
SUB05	888	3013	157	0	0	1.495	0	0	1.495	0	0
SUB05	890	888	511	0	0	1.439	0	0	1.439	0	0
SUB05	891	890	89	0	0	1.369	0	0	1.369	0	0
SUB05	892	891	246	0	0	1.305	0	0	1.305	0	0
SUB05	893	892	251	0	0	1.240	0	0	1.240	0	0
SUB05	894	893	300	0	0	1.175	0	0	1.175	0	0
SUB05	895	894	125	0	0	1.104	0	0	1.104	0	0
SUB05	896	895	236	0	0	0.309	0	0	0.309	0	0
SUB05	899	398	237	0	0	0.079	0	0	0.079	0	0
SUB05	9	2374	269	0	0	15.704	30	76,739	15.704	30	76,739
SUB05	9003	9002	14	0	0	22.243	0	0	22.243	0	0
SUB05	9004	9003	309	0	0	22.275	0	0	22.275	0	0
SUB05	9005	9004	141	0	0	22.268	0	0	22.268	0	0
SUB05	9006	9005	309	0	0	22.329	0	0	22.329	0	0
SUB05	9009	1903	17	0	0	19.795	0	0	19.795	0	0
SUB05	904	895	298	0	0	0.741	0	0	0.741	0	0
SUB05	905	904	148	0	0	0.669	0	0	0.669	0	0
SUB05	906	905	331	0	0	0.598	0	0	0.598	0	0
SUB05	907	906	245	0	0	0.531	0	0	0.531	0	0
SUB05	908	907	285	0	0	0.458	0	0	0.458	0	0
SUB05	909	908	215	0	0	0.384	0	0	0.384	0	0
SUB05	910	909	126	0	0	0.309	0	0	0.309	0	0
SUB05	911	910	167	0	0	0.233	0	0	0.233	0	0
SUB05	912	911	201	0	0	0.156	0	0	0.156	0	0
SUB05	913	912	352	0	0	0.079	0	0	0.079	0	0
SUB05	946	885	235	0	0	0.605	0	0	0.605	0	0
SUB05	947	946	299	0	0	0.531	0	0	0.531	0	0
SUB05	948	947	291	0	0	0.457	0	0	0.457	0	0
SUB05	949	1068	149	0	0	0.308	0	0	0.308	0	0
SUB05	950	949	274	0	0	0.232	0	0	0.232	0	0
SUB05	951	950	269	0	0	0.157	0	0	0.157	0	0
SUB05	952	951	170	0	0	0.079	0	0	0.079	0	0
		Sub. Total:	47612		0			2,764,974			2,764,974

MODEL COMPARISON REPORT BY SUBSYS - 2 MODEL FILES

Sub-System	Upstream Manhole	Dnstream Manhole	Pipe Length	CIP Diameter	CIP Cost	Model: MODIFICATIONS Total Flow	Relief Dia.	Construction Cost	Model: NO MODIFICATIONS Total Flow	Relief Dia.	Construction Cost
			(ft)	(in)	(ft/ft)	(cfs)	(in)	($)	(cfs)	(in)	($)
	Basin:										
	Subsys	SUB06									
SUB06	2106	9000	181	0	0	17.728	0	0	17.714	0	0
SUB06	2107	2106	318	0	0	17.826	0	0	17.813	0	0
SUB06	2108	2107	358	0	0	17.941	0	0	17.930	0	0
SUB06	2109	2108	108	0	0	17.944	0	0	17.933	0	0
SUB06	2110	2109	107	0	0	17.948	0	0	17.938	0	0
SUB06	2110A	2110	56	0	0	17.930	0	0	17.920	0	0
SUB06	2111	2110A	403	0	0	16.824	0	0	16.804	0	0
SUB06	2112	2111	149	0	0	16.856	0	0	16.836	0	0
SUB06	2113	2112	350	0	0	16.986	0	0	16.968	0	0
SUB06	2114	2113	179	0	0	17.031	0	0	17.014	0	0
SUB06	2115	2114	89	0	0	16.549	0	0	16.531	0	0
SUB06	2115	G	13	0	0	18.359	0	0	18.327	0	0
SUB06	2116	2115	432	0	0	17.770	0	0	17.745	0	0
SUB06	2117	2116	598	0	0	18.029	0	0	18.005	0	0
SUB06	9000	WWTP	53	0	0	53.848	0	0	54.012	0	0
SUB06	9001	9000	53	0	0	22.292	0	0	22.292	0	0
SUB06	9002	9001	67	0	0	22.277	0	0	22.277	0	0
SUB06	9010	9000	245	0	0	17.753	0	0	17.734	0	0
SUB06	A	9010	419	0	0	17.875	0	0	17.857	0	0
SUB06	B	A	260	0	0	17.944	0	0	17.927	0	0
SUB06	C	B	107	0	0	17.950	0	0	17.934	0	0
SUB06	D	C	66	0	0	17.928	0	0	17.912	0	0
SUB06	E	D	407	0	0	18.085	0	0	18.050	0	0
SUB06	F	E	89	0	0	18.089	0	0	18.053	0	0
SUB06	G	F	658	0	0	18.399	0	0	18.366	0	0
SUB06	H	2115	413	0	0	17.959	0	0	17.935	0	0
SUB06	J	H	620	0	0	18.239	0	0	18.217	0	0
SUB06	WWTP		43	0	0	53.864	0	0	54.027	0	0
		Sub. Total:	6841		0			0			0
		TOTAL:	113892		0			7,351,030			7,597,587

APPENDIX P

CIP RELIEF SEWER COST DETAIL

Model Name: 2020 - 5 YR 30% I/I REMOVAL SUB01 FINAL

CIP RELIEF SEWER COST DETAIL

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length	Slope	Existing Diameter	Existing Capacity	Design Flow	Percent Utilization	Relief Type	Average Depth	Pipe Diam	Pipe Capacity	Construction Cost
			(ft)	(ft/ft)	(in)	(cfs)	(cfs)	(Q_tot/cap)		(ft)	(in)	(cfs)	($)
CIP Project:	EX_00_01												
SUB02_03	311A	9012	140	0.00100	30	12.97	34.555	266.4	Replace	11.65	42	31.81	40,809
SUB02_03	9012	2121A	15	0.00667	30	33.50	34.501	103.0	Replace	11.68	42	82.17	4,378
SUB01	311	311A	48	0.00354	30	24.41	34.574	141.6	Replace	12.03	42	59.86	14,180
SUB01	309	311	174	0.00632	24	17.99	34.411	191.3	Replace	13.43	42	650.71	53,926
SUB01	307	309	590	0.00197	24	10.03	34.350	342.4	Replace	16.58	42	44.66	202,099
		Sub. Total:	967	(ft)								$	315,392
CIP Project:	EX_00_02												
SUB01	1176	1175	301	0.00186	24	9.76	24.619	252.3	Replace	11.76	42	43.39	88,082
SUB01	1175	1174	98	0.00133	24	8.24	24.734	300.1	Replace	12.45	42	36.69	29,378
SUB01	1174	1173	100	0.00240	24	11.08	24.912	224.8	Replace	12.14	42	49.29	29,657
SUB01	1173	1172	189	0.00048	24	4.94	25.090	508.3	Replace	11.90	42	22.04	55,582
SUB01	1172	1171	224	0.00192	24	9.91	25.240	254.6	Replace	11.09	42	44.09	63,995
SUB01	1171	1170	115	0.00191	24	9.90	25.387	256.5	Replace	14.28	42	43.97	36,653
SUB01	1170	1169	499	0.00190	24	9.87	25.569	259.0	Replace	18.16	42	43.86	179,091
SUB01	1169	1168	131	0.00199	24	10.08	25.658	254.5	Replace	16.41	42	44.77	44,643
SUB01	1168	1167	223	0.00188	24	9.82	25.834	263.1	Replace	14.58	42	43.62	71,768
SUB01	1167	1166	166	0.00205	24	10.24	25.988	253.8	Replace	18.28	42	45.55	59,784
SUB01	1166	1165	285	0.00190	24	9.85	26.155	265.6	Replace	20.17	42	43.74	108,216
SUB01	1165	307	75	0.00187	24	9.78	26.293	269.0	Replace	18.69	42	43.51	27,330
SUB01	1180	1179	310	0.00184	24	9.70	24.069	248.1	Replace	9.53	42	0.00	85,067
SUB01	1177	1176	344	0.00189	24	9.84	24.518	249.3	Replace	9.50	42	43.74	94,397
SUB01	1178	1177	124	0.00177	24	9.53	24.348	255.5	Replace	8.82	42	42.33	34,026
SUB01	1179	1178	441	0.00193	24	9.93	24.277	244.4	Replace	9.02	42	44.20	121,015
		Sub. Total:	3,625	(ft)								$	1,128,684
CIP Project:	EX_00_03												
SUB01	303	304	423	0.00239	18	5.13	7.503	146.1	Replace	10.00	24	11.06	59,640
SUB01	304	305A	385	0.00236	18	5.11	7.630	149.4	Replace	10.00	24	10.99	54,282
SUB01	305	306A	394	0.00236	18	5.10	7.942	155.6	Replace	10.00	24	10.99	55,551

Model Name: 2020 - 5 YR 30% I/I REMOVAL SUB01 FINAL

CIP RELIEF SEWER COST DETAIL

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length	Slope	Existing Diameter	Existing Capacity	Design Flow	Percent Utilization	Relief Type	Average Depth	Pipe Diam	Pipe Capacity	Construction Cost
			(ft)	(ft/ft)	(in)	(cfs)	(cfs)	(Q_tot/cap)		(ft)	(in)	(cfs)	($)
SUB01	305A	305	56	0.00232	18	5.06	7.761	153.3	Replace	10.00	24	10.89	7,895
SUB01	306	307	115	0.00235	18	5.09	8.248	162.0	Replace	14.43	24	10.96	21,069
SUB01	306A	306	62	0.00242	18	5.17	8.069	156.2	Replace	10.00	24	11.13	8,742
		Sub. Total:	1,435	(ft)								$	207,179
CIP Project:	EX_00_04												
SUB01	1189	1188	459	0.00200	24	10.13	17.534	173.1	Replace	6.87	36	29.83	100,426
SUB01	1188	1187	241	0.00112	24	7.57	17.604	232.5	Replace	7.00	36	22.32	52,730
SUB01	1187	1186	162	0.00198	24	10.06	17.737	176.4	Replace	8.37	36	29.68	35,445
SUB01	1186	1185	125	0.00208	24	10.32	17.895	173.4	Replace	9.42	36	30.42	27,350
SUB01	1185	1184	340	0.00247	24	11.25	18.064	160.6	Replace	9.92	36	33.15	74,390
SUB01	1190	1189	594	0.00199	24	10.09	17.505	173.6	Replace	7.10	36	29.75	129,965
		Sub. Total:	1,921	(ft)								$	420,306
CIP Project:	EX_00_05												
SUB01	490A	1190	143	0.00238	10	1.07	11.624	1,087.4	Replace	9.09	24	11.03	20,162
SUB01	1204	490	543	0.00243	15	3.19	11.308	355.0	Replace	12.55	24	11.15	89,754
SUB01	490	490A	254	0.00244	15	3.19	11.449	358.7	Replace	10.72	24	11.17	37,555
SUB01	1215	1214	357	0.00364	15	3.90	9.486	243.4	Replace	10.80	24	13.65	53,055
SUB01	1214	1213	35	0.00257	15	3.28	9.631	294.0	Replace	6.05	24	11.47	4,935
SUB01	1213	1212	166	0.00355	15	3.85	9.826	255.2	Replace	7.89	24	13.48	23,404
SUB01	1212	1211	269	0.00357	15	3.86	10.000	259.1	Replace	8.66	24	13.51	37,926
SUB01	1211	1210	260	0.00358	15	3.86	10.159	262.9	Replace	8.11	24	13.53	36,658
SUB01	1210	1209	322	0.00370	15	3.93	10.319	262.7	Replace	12.17	24	13.76	52,058
SUB01	1209	1208	316	0.00351	15	3.83	10.471	273.5	Replace	13.32	24	13.40	54,550
SUB01	1208	1207	308	0.00955	15	6.31	10.636	168.5	Replace	10.34	24	22.11	44,423
SUB01	1207	1206	242	0.01967	15	9.06	10.802	119.2	Replace	8.69	24	31.73	34,120
SUB01	1206	1205	380	0.00403	15	4.10	10.977	267.8	Replace	12.09	24	14.36	61,145
SUB01	1205	1204	260	0.00431	15	4.24	11.136	262.6	Replace	15.61	24	14.85	50,558
		Sub. Total:	3,855	(ft)								$	600,303

Model Name: 2020 - 5 YR 30% I/I REMOVAL SUB01 FINAL

CIP RELIEF SEWER COST DETAIL

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length	Slope	Existing Diameter	Existing Capacity	Design Flow	Percent Utilization	Relief Type	Average Depth	Pipe Diam	Pipe Capacity	Construction Cost
			(ft)	(ft/ft)	(in)	(cfs)	(cfs)	(Q_tot/cap)		(ft)	(in)	(cfs)	($)
CIP Project:	EX_00_06												
SUB01	366	366A	348	0.02851	15	10.91	1.408	12.9	Replace	7.18	15	10.90	37,506
		Sub. Total:	348	(ft)								$	37,506
CIP Project:	FU_10_01												
SUB01	315A	315	196	0.00112	12	1.19	3.548	297.4	Replace	9.31	18	3.51	22,834
SUB01	315	314	455	0.00624	12	2.82	3.732	132.6	Replace	10.65	18	8.29	55,770
SUB01	316B	315A	170	0.00371	12	2.17	3.362	155.0	Replace	6.59	18	6.39	19,804
SUB01	316	316A	155	0.01245	10	2.45	2.982	122.0	Replace	7.01	18	11.70	18,056
SUB01	327A	316	214	0.01416	10	2.61	2.793	107.1	Replace	10.04	18	12.50	25,009
SUB01	327	327A	166	0.01169	10	2.37	2.601	109.8	Replace	12.25	18	11.34	22,830
SUB01	316A	316B	175	0.01349	12	4.14	3.174	76.7	Replace	5.93	18	12.20	20,387
SUB01	314	302	409	0.00768	12	3.12	3.896	124.8	Replace	10.00	18	9.20	47,646
SUB01	302	303	21	0.00762	12	3.11	4.062	130.6	Replace	10.00	18	9.17	2,447
		Sub. Total:	1,961	(ft)								$	234,783
CIP Project:	FU_10_02												
SUB01	698	697	283	0.00095	12	1.10	5.415	491.8	Replace	6.60	24	6.97	39,901
SUB01	697	696	291	0.00010	24	2.30	5.567	242.5	Replace	6.73	24	2.26	41,029
SUB01	696	696A	21	0.00667	24	18.47	5.616	30.4	Replace	8.73	24	57.49	2,961
SUB01	696A	695	212	0.00156	18	4.15	5.799	139.9	Replace	7.00	24	8.96	29,890
SUB01	694	692	289	0.00149	18	4.05	6.048	149.3	Replace	6.62	24	21.98	40,746
SUB01	695	694	251	0.00124	18	3.69	5.929	160.6	Replace	5.17	24	21.20	35,389
		Sub. Total:	1,347	(ft)								$	189,916
CIP Project:	FU_10_03												
SUB05	18B	18A	190	0.00158	18	4.17	14.387	344.7	Replace	25.70	30	16.30	65,482
SUB05	18A	18	200	0.00160	18	4.20	14.434	343.5	Replace	22.38	30	16.40	62,423
SUB05	18	17	195	0.01436	15	7.74	15.377	198.6	Replace	23.86	30	49.15	63,689
SUB05	17	16	454	0.00546	15	4.78	15.433	323.2	Replace	22.46	30	30.31	142,056

Model Name: 2020 - 5 YR 30% I/I REMOVAL SUB01 FINAL

CIP RELIEF SEWER COST DETAIL

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length	Slope	Existing Diameter	Existing Capacity	Design Flow	Percent Utilization	Relief Type	Average Depth	Pipe Diam	Pipe Capacity	Construction Cost
			(ft)	(ft/ft)	(in)	(cfs)	(cfs)	(Q_tot/cap)		(ft)	(in)	(cfs)	($)
SUB05	16	15	257	0.00498	18	7.41	15.466	208.6	Replace	21.34	30	28.94	77,595
SUB05	15	14	315	0.00289	18	5.65	15.581	275.9	Replace	23.37	30	22.05	101,371
SUB05	14	13	361	0.00607	24	17.62	15.613	88.6	Replace	24.68	30	31.96	120,805
SUB05	13	12	389	0.00113	24	7.61	15.685	206.1	Replace	24.70	30	13.79	130,251
SUB05	12	11	371	0.00113	24	7.61	15.665	205.8	Replace	26.05	30	13.79	129,132
SUB05	11	10	182	0.00110	24	7.50	15.649	208.7	Replace	24.11	30	13.60	59,890
SUB05	10	9	288	0.01340	24	26.19	15.677	59.9	Replace	18.54	30	47.48	79,056
SUB05	9	2374	269	0.00387	24	14.07	15.704	111.6	Replace	19.64	30	25.51	76,739
		Sub. Total:	3,471	(ft)								$	1,108,489
CIP Project:	FU_20_01												
SUB01	721	698	152	0.00401	12	2.26	3.273	145.0	Replace	9.72	18	6.65	17,707
SUB01	1196A	1196	361	0.01036	10	2.23	2.494	111.8	Replace	13.23	18	10.69	52,956
SUB01	1196	1195	370	0.00214	12	1.65	2.641	160.4	Replace	11.00	18	4.86	46,562
SUB01	1195	1194	275	0.00222	12	1.68	2.777	165.5	Replace	8.70	18	4.95	32,037
SUB01	1194	720	45	0.00222	12	1.68	2.929	174.3	Replace	8.55	18	4.95	5,243
SUB01	720	721	147	0.00333	12	2.06	3.107	151.0	Replace	9.95	18	6.06	17,124
		Sub. Total:	1,350	(ft)								$	171,629
CIP Project:	FU_20_02												
SUB01	1477	1199	61	0.02771	8	2.01	1.554	77.2	Replace	10.89	12	5.93	6,211
SUB01	1198A	1198	332	0.00801	8	1.08	1.881	173.8	Replace	13.14	12	3.18	40,672
SUB01	1199	1198A	319	0.00796	8	1.08	1.725	160.0	Replace	13.04	12	3.17	38,786
SUB01	1198	1197A	199	0.01040	10	2.24	2.038	91.2	Replace	12.01	12	3.63	22,311
SUB01	1197A	1197	402	0.01037	10	2.23	2.199	98.5	Replace	12.63	12	3.62	47,363
SUB01	1197	1196A	303	0.01040	10	2.23	2.343	104.9	Replace	13.29	12	3.63	37,537
SUB01	1202	1201	317	0.00801	8	1.08	1.085	100.3	Replace	5.82	12	3.18	29,682
SUB01	1201	1200	321	0.00788	8	1.07	1.238	115.4	Replace	5.86	12	3.16	30,057
SUB01	1200	1477	256	0.02719	8	1.99	1.392	69.8	Replace	7.06	12	5.87	23,971
		Sub. Total:	2,510	(ft)								$	276,590

Model Name: 2020 - 5 YR 30% I/I REMOVAL SUB01 FINAL

CIP RELIEF SEWER COST DETAIL

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length	Slope	Existing Diameter	Existing Capacity	Design Flow	Percent Utilization	Relief Type	Average Depth	Pipe Diam	Pipe Capacity	Construction Cost
			(ft)	(ft/ft)	(in)	(cfs)	(cfs)	(Q_tot/cap)		(ft)	(in)	(cfs)	($)
CIP Project:	FU_20_03												
SUB01	1228	1227	278	0.00363	12	2.15	5.513	256.7	Replace	11.12	21	9.54	38,353
SUB01	1227	1226	314	0.00363	12	2.15	5.681	264.6	Replace	11.19	21	9.54	43,527
SUB01	1226	1226A	92	0.03989	12	7.12	5.847	82.2	Replace	10.63	21	31.64	12,267
SUB01	1225	1554	230	0.02204	15	9.59	6.215	64.8	Replace	14.75	21	23.52	39,617
SUB01	1554	1224	224	0.02201	15	9.58	6.387	66.6	Replace	9.98	21	23.51	28,534
SUB01	1224	1223	272	0.00559	15	4.83	6.559	135.8	Replace	10.21	21	11.84	35,188
SUB01	1223	1222	275	0.00556	15	4.82	6.716	139.4	Replace	10.74	21	11.81	36,952
SUB01	1222	1221	357	0.00560	15	4.84	6.873	142.2	Replace	8.00	21	11.85	45,475
SUB01	1221	1220	365	0.00422	15	4.20	7.018	167.3	Replace	9.27	21	10.29	46,493
SUB01	1220	1219	125	0.00568	15	4.87	7.163	147.1	Replace	14.40	21	11.94	21,118
SUB01	1219	1218	252	0.00603	15	5.02	7.342	146.3	Replace	13.01	21	12.30	39,265
SUB01	1218	1217	190	0.00574	15	4.89	7.503	153.3	Replace	15.82	21	12.00	34,647
SUB01	1217	1216	369	0.00596	15	4.99	7.673	153.8	Replace	15.46	21	12.23	66,034
SUB01	1216	1215	343	0.00566	15	4.86	7.817	160.9	Replace	12.83	21	11.92	52,861
SUB01	1226A	1225	165	0.03982	12	7.11	6.034	84.9	Replace	14.75	21	31.62	28,420
		Sub. Total:	3,851	(ft)								$	568,751
CIP Project:	FU_20_04												
SUB01	1233	1975	168	0.01726	10	2.88	4.137	143.7	Replace	9.86	18	13.80	19,571
SUB01	1975	1232	179	0.01726	10	2.88	4.312	149.8	Replace	10.35	18	13.80	21,438
SUB01	1232	1231	209	0.01579	10	2.75	4.487	163.0	Replace	11.83	18	13.20	27,923
SUB01	1231	1230	439	0.00786	10	1.94	4.659	239.9	Replace	11.48	18	9.31	57,215
SUB01	1230	1229A	316	0.00880	10	2.06	4.811	234.1	Replace	10.00	18	9.85	36,813
SUB01	1229A	1229	319	0.00881	10	2.06	4.983	242.2	Replace	8.00	18	9.86	37,162
SUB01	1229	1266	129	0.00977	12	3.52	5.156	146.4	Replace	8.00	18	10.38	15,028
SUB01	1266	1228	181	0.01022	12	3.60	5.336	148.1	Replace	10.56	18	10.62	22,033
		Sub. Total:	1,940	(ft)								$	237,183
CIP Project:	FU_20_05												
SUB05	1401	880	11	0.00182	24	9.65	18.078	187.4	Replace	6.05	30	17.50	2,099

Model Name: 2020 - 5 YR 30% I/I REMOVAL SUB01 FINAL

CIP RELIEF SEWER COST DETAIL

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length	Slope	Existing Diameter	Existing Capacity	Design Flow	Percent Utilization	Relief Type	Average Depth	Pipe Diam	Pipe Capacity	Construction Cost
			(ft)	(ft/ft)	(in)	(cfs)	(cfs)	(Q_tot/cap)		(ft)	(in)	(cfs)	($)
SUB05	1407	1406	274	0.00299	24	12.38	16.672	134.7	Replace	8.75	30	22.43	52,292
SUB05	1406	1405	234	0.00308	24	12.55	16.675	132.9	Replace	9.50	30	22.76	44,659
SUB05	1405	1404	396	0.00303	24	12.45	18.014	144.6	Replace	9.25	30	22.58	75,576
SUB05	1404	1403	84	0.00286	24	12.09	17.988	148.7	Replace	8.00	30	21.93	16,032
SUB05	1403	1402	248	0.00298	24	12.36	18.033	145.9	Replace	7.35	30	22.39	47,330
SUB05	1402	1401	115	0.00244	24	11.16	18.041	161.6	Replace	6.84	30	20.22	21,948
		Sub. Total:	1,362	(ft)								$	259,936
CIP Project:	FU_20_06												
SUB05	1423	1422	258	0.00345	24	13.29	15.892	119.6	Replace	19.92	30	24.09	74,309
SUB05	1422	1421	254	0.00343	24	13.24	15.895	120.0	Replace	20.59	30	24.02	74,824
SUB05	1421	1420	299	0.00348	24	13.34	15.899	119.2	Replace	17.34	30	24.19	78,561
SUB05	1420	1420A	215	0.00344	24	13.27	15.890	119.7	Replace	12.56	30	24.06	46,424
SUB05	1420A	1419	90	0.00344	24	13.28	15.903	119.8	Replace	10.73	30	24.06	17,820
SUB05	1419	1419A	233	0.00352	24	13.42	15.948	118.8	Replace	10.73	30	24.33	46,133
SUB05	1419A	1418	106	0.00349	24	13.37	15.955	119.4	Replace	10.28	30	24.23	20,520
SUB05	1418	1417	200	0.00350	24	13.39	15.995	119.5	Replace	10.53	30	24.26	39,208
SUB05	1417	2273	158	0.00348	24	13.35	16.010	119.9	Replace	10.25	30	24.19	30,542
SUB05	2273	1416	143	0.00343	24	13.25	16.036	121.1	Replace	9.78	30	24.02	27,291
SUB05	1416	1415	238	0.00803	24	20.27	16.066	79.3	Replace	10.23	30	36.76	45,958
SUB05	1415	1414	256	0.00031	24	4.00	16.082	401.7	Replace	12.71	30	7.22	55,652
SUB05	1414	1413	436	0.00807	24	20.33	16.081	79.1	Replace	11.10	30	36.85	87,908
SUB05	1413	1412	367	0.00300	24	12.39	16.059	129.7	Replace	7.74	30	22.46	70,041
SUB05	1412	1411	72	0.00306	24	12.51	16.043	128.3	Replace	8.78	30	22.69	13,741
SUB05	1411	1410	179	0.00296	24	12.31	16.093	130.7	Replace	8.54	30	22.31	34,162
SUB05	1410	1409	105	0.00295	24	12.29	16.119	131.1	Replace	7.20	30	22.28	20,039
SUB05	1409	1408	291	0.00296	24	12.30	16.161	131.4	Replace	7.55	30	22.31	55,537
SUB05	1408	1407	335	0.00302	24	12.42	16.161	130.1	Replace	8.50	30	22.50	63,934
		Sub. Total:	4,235	(ft)								$	902,604
CIP Project:	FU_20_07												
SUB05	2374	2373	493	0.00217	24	10.54	15.710	149.1	Replace	22.29	30	19.10	153,438

Model Name: 2020 - 5 YR 30% I/I REMOVAL SUB01 FINAL

CIP RELIEF SEWER COST DETAIL

Sewer Segment			Existing Sewer Data						Relief Sewer Data				
Subsystem	Upstream Manhole	Downstream Manhole	Sewer Length	Slope	Existing Diameter	Existing Capacity	Design Flow	Percent Utilization	Relief Type	Average Depth	Pipe Diam	Pipe Capacity	Construction Cost
			(ft)	(ft/ft)	(in)	(cfs)	(cfs)	(Q_tot/cap)		(ft)	(in)	(cfs)	($)
SUB05	2373	2372	425	0.00209	24	10.35	15.661	151.3	Replace	25.28	30	18.75	144,720
SUB05	2372	2371	408	0.00208	24	10.33	15.627	151.3	Replace	26.05	30	18.70	142,008
SUB05	2371	2370	422	0.00194	24	9.97	15.597	156.4	Replace	19.49	30	18.06	119,765
SUB05	2370	2369	270	0.00233	24	10.93	15.561	142.4	Replace	12.29	30	19.80	57,586
SUB05	2369	2368	306	0.00248	24	11.28	15.563	138.0	Replace	8.40	30	20.42	58,399
SUB05	2368	2367	284	0.00218	24	10.57	15.555	147.1	Replace	9.28	30	19.15	54,201
SUB05	2367	1423	20	0.00250	24	11.31	15.552	137.5	Replace	14.73	30	20.51	4,744
		Sub. Total:	2,628	(ft)								$	734,861
		Total:	36,806	(ft)								$	7,394,112

APPENDIX Q

CMOM PROGRAM ELEMENTS

BLACK AND VEATCH CORPORATION

MEMORANDUM
CMOM Program Elements September 18, 2001

Capacity, Management, Operation and Maintenance (CMOM) Program Elements

Overview

EPA's proposed rule was signed January 4, 2001 but subsequently withdrawn from the Federal Register delaying the comment and review period indefinitely. The proposed rule would establish three standard NPDES permit conditions for POTW's and municipal sanitary sewer collection systems and a framework for under the NPDES permit program for regulating municipal satellite collection systems.

The proposed standard permit conditions include:

1. Capacity, Management, Operation and Maintenance requirements for all municipal sanitary sewer collection systems (Proposed 40 CFR 122.42 (e))
2. A prohibition on discharges to waters of the United States that occur prior to a publicly owned treatment works (POTW) that includes a framework for raising a defense for unavoidable discharges (proposed 40 CFR 122.42 (f))
3. Reporting, public notification and recordkeeping requirements for discharges from a municipal sanitary sewer collection system (proposed 40 CFR 122.42 (G))

Municipal satellite collection systems are systems owned and/or operated by one entity that discharges to a regional collection system or POTW that is owned or operated by a different entity. The proposed rule would expand the scope of the NPDES permit program to include municipal satellite collection systems. EPA is proposing the implementation of standard permit conditions throughout the entire collection system, including the satellite system. NPDES authorities would have flexibility in determining which entity (the satellite system or the regional system) would have the responsibility for development and implementation of a CMOM program within the municipal satellite system.

Within the reporting and recordkeeping requirements, EPA is proposing a definition for sanitary sewer overflows (SSOs) that includes wastewater backups into buildings caused by blockages or other flow conditions in the public portions of the collection system as one of three classes of overflows. The three include:

- Overflows or releases of wastewater that reach waters of the United States
- Overflows or releases of wastewater that do not reach waters of the United States
- Wastewater backups into buildings caused by conditions in a sanitary sewer other than the building lateral

EPA recognizes the proposed prohibition standard permit condition (item #2) and the proposed reporting, public, notification, and recordkeeping standard permit condition would apply to different classes of SSOs. The prohibition requirement would apply only

Source: Internet Version of Proposed Rule for NPDES Permit Requirements for Municipal Sanitary Sewer Collection Systems, Municipal Satellite Collection Systems, and Sanitary Sewer Overflows to the SSOs that reach waters of the United Staes while the reporting requirement would be tiered with the three classes of SSOs.

Municipal satellite system coverage would be included in 40CFR 122.38. After EPA takes final action on all the proposed rules, States with authorized NPDES programs would have to evaluate whether revisions to their NPDES programs were necessary and whether a one or a two-year timeframe was applicable per 40CFR 123.62.

Proposed CMOM Standard Condition

The proposed CMOM program approach provide for the following:

- Clarify general performance standards
- Provide a flexible framework for municipalities to identify and incorporate widely accepted industry practices for managing, maintaining, operating, providing for capacity requirements, and reporting SSOs for their collection systems
- Self-assessments and information management monitoring and improving the performance of their collection system
- Establish minimum documentation requirements for program performance, oversight by the NPDES authority, and for supplying the public timely information about specific events

CMOM Program General Standards would include:

- CMOM Program- A written program summary would
    1. identify the CMOM goals,
    2. provide for the organizational structure to enable implementation of the program measures,
    3. provide adequate legal authority (sewer use ordinances, service agreements) for the program (controlling I/I sources, ensuring proper design and construction, requiring, proper installation, inspection and testing of new and rehabilitated sewers, govern flows from sateliite collection systems, and maintain a pretreatment program)
    4. ensure appropriate collection system activities are directed to achieve effective performance (maintenance of facilities and equipment, adequate mapping, use of timely and relevant information, preventive maintenance programs, capacity assessment, rehabilitation action plan, training, equipment and parts inventory
    5. provide necessary design and performance standards,
    6. ensure monitoring, measurement and updating of the elements.
- Overflow Emergency Response Plan
- System Evaluation and Capacity Assurance Plan

Source: Internet Version of Proposed Rule for NPDES Permit Requirements for Municipal Sanitary Sewer Collection Systems, Municipal Satellite Collection Systems, and Sanitary Sewer Overflows

- Program Audits
- Communication

EPA does not intend to approve CMOM programs. CMOM programs can and should be developed to be updated and amended as needed. Potential permit violations would be evaluated by the occurrence of an SSO, failure to implement provisions of the CMOM program, or failure to comply with the documentation and responsiveness requirements. EPA would evaluate the adequacy of the CMOM standard permit condition by evaluating general performance in 5 areas. The Permittee would need to:

- Properly manage, operate and maintain at all times the parts of the collection system the permittee owns or has responsibility for or over which it has operational control
- Provide adequate capacity to convey base flows and peak flows
- Take all feasible steps to stop, and mitigate the impact of, sanitary sewer overflows
- Provide notification to parties with a reasonable potential for exposure to pollutants associated with the overflow event
- Develop a written summary of their CMOM program and make it, and required program audits, available to the public upon request.

Minimum levels for CMOM program activities are not specified at this time. The expectation is the program will be tailored to the local conditions as defined by sufficient utility operating data.

Overflow Emergency Response Plan

The response plan provides a standardized course of action for personnel to follow in the event of an SSO. The plan should describe the permittee's options for response, remediation and the appropriate notifications and reporting necessary under different SSO scenarios. At a minimum, the plan would:

- Identify SSOs and the permittee's roles from complaint through resolution
- Provide immediate response and emergency operations to addresss the SSO including mobilizing equipment and crews and documenting the findings and response
- Notification as required by the standard permit condition
- Adequate training and distribution of the plan

Program Audit Report

The program audit report is the heart of the ongoing CMOM process. EPA is proposing comprehensive audits every 5 years at a minimum. The audit would include

- Interviews with facility managers
- Field inspections of equipment and resources
- Interviews with field personnel, first line supervisors, and observation of field crew responses
- Review of records and other documentation to be maintained

The audit report would address the findings of the audit, including the deficiencies, necessary steps to respond to the findings of the audit, and a schedule for implementing the necessary corrections.

GLOSSARY OF TERMS AND ABBREVIATIONS

10 States Standards	-	Great Lakes Upper Mississippi River Basin Standards
AA	-	annual average
APL	-	alternate pollutant limit
ADDF	-	average daily dry weather flow
ADF	-	average daily flow
biosolids	-	treated wastewater treatment residuals, or sludge
BOD_5	-	biochemical oxygen demand
CFR	-	Code of Federal Regulations
cfs	-	cubic feet per second
CMOM	-	Capacity, Management, Operation, and Maintenance
dtpd	-	dry tons per day
EPA	-	(US) Environmental Protection Agency
GIS	-	Geographic Information System
gpcd	-	gallons per capita per day
gpd	-	gallons per day
gpd/sf	-	gallons per day per square foot
gpm	-	gallons per minute
HLR	-	hydraulic loading rate
HRT	-	hydraulic retention time
HVAC	-	heating, ventilating, air conditioning
I/I	-	inflow/infiltration
kcf	-	1,000 cubic feet

LAP	-	local area panel
maximum month (MM)	-	highest 30-day average
MCC	-	motor control center
mg/kg	-	milligrams per kilogram
mg/L	-	milligrams per liter
MG	-	million gallons
mgd	-	million gallons per day
NPDES	-	National Pollutant Discharge Elimination System
O&M	-	operation and maintenance
PD	-	peak day
pH	-	a measure of acidity/alkalinity
PH	-	peak hour
POTW	-	publicly owned treatment works
ppcd	-	pounds per capita per day
ppd	-	pounds per day
ppm	-	parts per million
scfm/lin ft	-	standard cubic feet per linear foot
SLR	-	solids loading rate
SOR	-	surface overflow rate
SSMS	-	Sanitary Sewer Management System
TCLP	-	toxicity characteristics leaching procedure (a test conducted on biosolids)
tpy	-	tons per year
TSS	-	total suspended solids
UV	-	ultraviolet
WPC	-	City of Leavenworth Water Pollution Control Department
WWP	-	wastewater production
WWTP	-	wastewater treatment plant