CITY OF LEAVENWORTH

WATER DISTRIBUTION SYSTEM and SEWER COLLECTION SYSTEM MASTER PLAN

JUNE 10, 2008 - *FINAL*

VARELA & ASSOCIATES, INC.
ENGINEERING AND MANAGEMENT
PLANNING • DESIGN • MANAGEMENT • INSPECTION

CITY OF LEAVENWORTH

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TABLE OF CONTENTS

Abbreviations ..... **iii**

EXECUTIVE SUMMARY ..... **iv**

1. GENERAL INFORMATION **1**
1.1. Purpose 1
1.2. Scope of Work 1

2. PLANNING DATA **3**
2.1. Planning Area 3
2.2. Zoning 3
2.3. Equivalent Residential Units (ERUs) 3
2.4. Water Demands and Distribution 4
2.4.1. Estimated Water ERUs 4
2.4.2. Projected Ultimate Residential and Non-Residential ERUs 6
2.5. Sewer Flows and Drainage Basins 7
2.5.1. Equivalent Residential Units (ERUs) 7
2.5.2. Infiltration and Inflow (I/I) 7
2.5.3. Estimated Wastewater ERUs 8
2.5.4. Projected Ultimate Residential and Non-Residential ERUs 11
2.5.5. Projected Wastewater Flows 11

3. WATER DISTRIBUTION SYSTEM ANALYSIS **13**
3.1. Distribution System Hydraulics 13
3.2. Water System Evaluation Criteria 13
3.3. Hydraulic Model 14
3.4. Analysis and Methodology 16
3.5. Distribution System Findings 18
3.5.1. Summary 18
3.5.2. Condition of Distribution System 20
3.6. Distribution System Improvements and Schedule 21
3.6.1. Distribution System Improvements 21
3.6.2. Distribution System Improvements Schedule 23

4. SEWER COLLECTION SYSTEM ANALYSIS **25**
4.1. History 25
4.2. Definitions 25
4.3. Condition of Facilities and Operational Problem Areas 25
4.3.1. General 25
4.3.2. Trunk Line 1 26
4.3.3. South Interceptor 26
4.4. Flow Basins and Growth Areas 26
4.5. Analysis and Methodology 26
4.6. Collection System Findings 27
4.7. Recommended Improvements and Schedule 29

TABLES

Table 2-1 Estimated Ultimate Non-Residential ERUs 5
Table 2-2 Projected Ultimate ERUs and Water Use 6
Table 2-3 Residential ERU/Acre 9
Table 2-4 Estimated School ERUs 9
Table 2-5 Estimated Condominium ERUs/Acre 10
Table 2-6 Non-Residential ERUs/Acre 10
Table 2-7 Projected Ultimate ERUs 11
Table 2-8 Projected Ultimate Wastewater Flows 11
Table 3-1 Ultimate System Demands 14
Table 3-2 Summary of System Pressures 17
Table 3-3 Summary of Available Fire Flow 18
Table 3-4 Summary of Water Distribution System Improvements and Schedule 24
Table 4-1 Summary of Sanitary Sewer Collection System Improvements and Schedule 30

EXHIBITS

Exhibit A: Improvements Alternatives – Chumstick Highway

FIGURES (1/2 size figures included prior to the appendix, full size figures folded at back of document)

Figure 1: Planning Area and Zoning
Figure 2: Water Distribution System Analysis – Projected Ultimate Water Demand Distribution
Figure 3: Water Distribution System Analysis – Existing Water System
Figure 4: Water Distribution System Analysis – Improvements
Figure 5: Sewer Collection System Analysis – Existing Collection System and Drainage Basin Map
Figure 6: Sewer Collection System Analysis – Improvements

APPENDIX

Appendix A: Projected Ultimate Water ERUs and Demands
Appendix B: Hydraulic Output Files and Node Map
Appendix C: Projected Ultimate Wastewater ERUs and Basin flows
Appendix D: 1996 Wastewater Facility Plan TMVA-Leav10 “Evaluation of Sanitary Sewer Collection System”
Appendix E: 1996 Wastewater Facility Plan TMVA-Leav11 “South Interceptor Sewer Evaluation”
Appendix F: 2001 Sanitary Sewer Collection System Cleaning, Inspection and Testing “Summary Report and Rehabilitation Prioritization Plan”
Appendix G: City Code defining zoning classifications (excerpts)

ABBREVIATIONS

(Not all of the abbreviations below appear in this report)

AC	asbestos cement water main material
ADD	average day demand
ac-ft/yr	acre-feet per year (a measure of water volume withdrawn from a well)
add'l.	additional
ave.	average
CCS	cross connection control specialist
CDBG	Community Development Block Grant
CFP	capital facilities plan
cfs	cubic feet per second
CY	cubic yards
DI	ductile iron water main material
dia.	diameter
DOE	Wash. State Department of Ecology
DFW	Wash. State Department of Fish and Wildlife
DOH	Wash. State Department of Health
DWSRF	Drinking Water State Revolving Fund
DU	Dwelling Unit
elev.	elevation
ERU	equivalent residential user (a measure of water demand or wastewater flow in terms of an equivalent number of single family dwellings)
FF	fire flow
FmHA	Farmer's Home Administration, now known as Rural Development
gal	gallons
gpcd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
GMA	Growth Management Act
GO	general obligation (a type of bond secured by property taxes)
HP	horsepower
IOC	inorganic chemicals
I&I	infiltration and inflow
LF or L.F.	lineal feet
LID	local improvement district
max.	maximum
MCL	maximum contaminant level
MDD	max day demand
MG	million gallons
mgd	million gallons per day
mg/L	milligrams/liter
MHI	median household income
mi.	mile
min.	minimum
NRCS	Natural Resources Conservation Service (formerly SCS)
NEPA	National Environmental Protection Act
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
PHD	peak hour demand
PRV	pressure reducing valve
PVC	polyvinyl chloride (plastic) water main material
PWTF	Public Works Trust Fund
RCW	Revised Code of Washington
RD	Rural Development (formerly FmHA)
ROW	right of way
SCADA	supervisory control and data acquisition (i.e., computerized control system)
SDC	System development charges
SEPA	State Environmental Protection Act
suppl.	supplemental
UGA	urban growth area
ULID	utility local improvement district
VOC	volatile organic chemicals
WAC	Washington Administrative Code
WSDM	Water System Design Manual (published by DOH)
WSP	water system plan
WTP	water treatment plant
WWFP	Wastewater Facility Plan

EXECUTIVE SUMMARY

1. The purpose of this Master Plan is to provide the City of Leavenworth a guide for planning water distribution and sanitary sewer collection system infrastructure improvements to meet present needs and estimated ultimate growth needs. Costs and financial planning are not included in this document. The improvements identified in this Master Plan will be used to create a Capital Improvements Plan (CIP), which will include financial planning and schedule. The implementation of identified improvements is subject to financial feasibility.

2. The Planning Area consists of the present UGA, plus the area north of the UGA to the north end of the Titus Rd. loop (See **Figure 1**).

3. The water and sanitary sewer pipeline system analyses and improvements in this Master Plan are based on estimated water use and wastewater production at full buildout of the Planning Area at present zoning designations. These flow levels are roughly 3.5 times present flows, which would occur in approximately 40 to 50 years if growth rates average roughly 3% over that period. There are indications of the possibility that growth rates over the next few years could be much greater than 3%.

4. The criteria used for this Master Plan of estimating water use and wastewater production at full buildout (40-50 years) is for the purposes of long range planning. As such it is different from the criteria used in the Water System Plan and the Wastewater Facility Plan (20 year). This criteria is an important determinant in identifying improvements, estimated costs and planning improvements.

5. For the purposes of this plan, it is assumed that water supply capacity, water rights and wastewater treatment capacity will be increased as needed in the future to meet the projections included herein. If these assumptions change in the future this plan will need to be reviewed and updated as necessary. This subject should be addressed in the 2008 WSP update. The findings in the WSP should then be reflected in the water system CIP.

6. Analysis of the water system indicates current deficiencies in capacity in several areas. Analysis of the sewer system indicates no current pipeline capacity deficiencies. However operation and maintenance problems are identified in the 15” South Interceptor and a 10” collection pipe on south Commercial St. due to deteriorated pipe, root intrusion and poor grade causing sedimentation.

7. The system improvements identified in this Master Plan are summarized on Tables 3-4 and 4-1 shown on the following two pages of this Executive Summary as well as in the text of the report. The improvements are shown on Figures 4 and 6 (reproduced ½ size ahead of the Appendix, and on full size sheets in the pockets at the end of the document).

8. The pipeline layouts and alignments shown are schematic. That is, in some cases specific alignments can vary from those shown, however such variations must satisfy the capacity provided by the concept designs shown. Similarly, specific development sequences and local topography will affect improvement designs and even in some cases capacity needs or layouts. In most cases engineering predesign will be required to address project specifics. In some cases

for water system improvements a Project Report per DOH requirements will be required, such as booster stations and reservoirs.

9. The improvements shown in this Master Plan are not intended to be detailed design. Design details must be determined during the planning and design of individual projects and elements.

10. This plan should be reviewed and updated if needed approximately every six years to reflect changing development and growth patterns, water and wastewater flow data, potential regulatory and criteria changes.

Table 3-4 Summary of Water Distribution System Improvements and Schedule

(See Figure 4)

Improvement Designation	Category	Description & Purpose	Schedule	Beneficiary
1-A	Supply Transmission	Main upgrades on Icicle Rd from East Leavenworth Rd to well T-main to prevent excessive pressures when WTP operates	Necessary if/when the City upgrades the capacity of the water treatment plant	Entire system
1-B	Supply Transmission	Main upgrades from well T-main to Commercial St & Mill St to allow the City to fully utilize existing supply capacity of wells & WTP	Needed to address current deficiencies	Entire system
1-C	Supply Transmission	Replace deteriorated main in East Leavenworth Rd from Icicle Rd to Dye Rd	Schedule and size dependent on whether storage is planned at east end of town, timing of County road projects, and aging/deterioration of the existing 10" steel main	Entire system
1-D	Supply Transmission	Higher priority section of E. Lvnw. Rd. main replacement due to leakage and poor condition (approx 1/4 mile)	Replace failing pipe as soon as practical	Entire system (reduces system leakage and O&M costs)
1-E	Supply Transmission	Abandon deteriorated 10" steel main across river	When/if it is determined to be leaking	Entire system (reduces system leakage and O&M costs)
2	Downtown Transmission	Main upgrades mostly along Commercial St and Front St to provide fire flow to downtown and transmission to east end of system	These improvements are needed to address current deficiencies	Primarily the downtown and eastside areas with some degree of benefit to entire system
3	Zone 1 Transmission to Ski Hill Dr	Main upgrades from the downtown trunk main to the Pine St / Ski Hill Dr area to bolster suction pressures at Ski Hill booster station #1	Needed when the City upgrades the pumps at Ski Hill booster station #1 for growth	Entire System
4	PressureZones 2-4 (present & future)	Schematic layout of mains and looping necessary to meet minimum criteria in all pressure zones	As development occurs	Ski Hill Zone 2 - 4
5	Pressure Reducing Stations	Pressure reducing valves between zones make the storage of upper zones available to lower zones	Needed when the City constructs storage for Zone 3 and for interim fire protection before full distribution grid is constructed	Main Zone and Ski Hill Zone 2
6	Titus Rd / Chumstick Hwy Intertie	Pressure reducing station linking Titus Rd (Zone 2) and the Chumstick Hwy (Zone 1) to provide fire protection along the Chumstick Hwy and augment downtown & riverbend fire flows	These improvements are needed to address current deficiencies	Main Zone
7	Titus Rd PRV	PRV in Titus Rd near the high school to provide fire flow to Zone 1	Needed to address current deficiencies (most important prior to implementation of items 2 and 6 above)	Main Zone
8	Supply Transmission	Replace deteriorated 16" main in Icicle Rd. from WTP to East Leavenworth Rd. with 18" main.	As necessary due to maintenance issues	Main Zone
(see Figure 4)	Distribution	Replace existing 4" mains with 8" mains	As necessary due to maintenance issues or as development requires.	Main Zone

Table 4-1 Summary of Sanitary Sewer Collection System Improvements and Schedule

(See Figure 6)

Improvement Designation	Purpose	Description	Schedule	Beneficiaries
1	Increase existing capacity	Replace existing South Interceptor Sewer from MH C12 to MH A1 with 18" pipe (reconstruct at constant grade to correct isolated grade deficiencies) and MH A1 to MH H2 with 21" pipe.	Replace as needed to correct operation and maintenance deficiencies, also monitor flow and replace as pipe nears capacity.	Drainage Basin for the South Interceptor, Trunk Line 1 and Trunk Line 6
1-A	Operation and Maintenance	Replace existing South Interceptor Sewer from MH C4 to MH C6a with 18" pipe (reconstruct at constant grade to correct isolated grade deficiencies)	As soon as practical due to operational problems	Drainage Basin for the South Interceptor, Trunk Line 1 and Trunk Line 6
2	Increase existing capacity	Replace existing Trunk Line 1 from MH E7-C to MH E8-C.	Replace as needed to correct operation and maintenance deficiencies, also monitor flow and replace as pipe nears capacity.	Drainage Basin for Trunk Line 1 upstream of MH E8-C
3	Increase existing capacity	Install new MH to north of MH E15-C to intercept flow from the north, rerouting flow to Trunk Line 2. Install new 12" pipe to MH B12. Plug north invert of MH E15-C.	Needed when collection system pipe is extended north of Pine St. on Ski Hill Dr.	Drainage Basin for Trunk Line 2 upstream of MH E15-C
4	Increase existing capacity	Abandon pipe between MH B18 and MH B19. Install new 10" Pipe between MH B22 and MH B19, reroute flow to Trunk Line 3.	Needed when collection system pipes are extended north of Emig Dr. and west of Titus Rd.	Drainage Basin for Trunk Line 4 upstream of MH B19
5	Increase existing capacity	Replace portions of Trunk Line 6 with 10" pipe.	Replace as needed to correct operation and maintenance deficiencies, also monitor flow and replace as pipe nears capacity.	Drainage Basin for Trunk Line 6
6	Extend service to new area	Replace existing mains from MH A4 to MH A7 (size as noted) at minimum slopes to increase depth. Install new 10" pipe from MH A7 to Area 9 along Chumstick Hwy.	As development occurs (see Exhibit A for alternatives)	Future connections in Drainage Basin for new Trunk Line 7
7	Extend service to new area	Construct Lift Station with force main to 10" pipe at Area 9. Install new 8" pipe from Lift Station to Area 4.	As development occurs (see Exhibit A for alternatives)	Future connections in Drainage Basin for new Trunk Line 7
8	Operation and Maintenance	Install 8" gravity mains to area. Abandon existing lift station and connect residents to new gravity pipe.	As needed to correct future operation and maintenance deficiencies or replacement needs related to existing lift station.	Existing and future connections to existing lift station
9	Extend service to new area	Construct Lift Station and install 8" and 10" pipe	As development occurs	Future connections to Drainage Basin for Trunk Line 5

A maintenance program is recommended to include annual flushing of mains and a cleaning, root removal and internal TV inspection program every 5 years or as determined to optimize system condition, monitoring and maintenance/replacement. Based on the results of these inspections a rehabilitation/replacement program can be implemented and budgeted. Implementing a rehabilitation/replacement program is an important step in maintaining adequate system function preventing , system failures and to facilitate financial planning.

1. GENERAL INFORMATION

1.1. Purpose

The purpose of this master plan is to provide the City of Leavenworth a guide for planning water distribution and sanitary sewer collection system infrastructure improvements to meet present needs and estimated ultimate growth needs and to as a tool for capital improvements and budget planning.

This report documents projected ultimate growth estimates, growth distribution, design criteria and system analysis, as well as water distribution system and sewer collection system improvements to provide service to meet the projected ultimate growth.

This plan should be reviewed and updated if needed approximately every six years to reflect changing development and growth patterns, water and wastewater flow data, potential regulatory and criteria changes.

1.2. Scope of Work

The scope of work documented in this report is limited to analysis of the water distribution system and sanitary sewer collection system and does not address water supply or wastewater and treatment. The scope includes the following:

Planning
- Planning area and zoning (provided by City)
- Growth areas, densities and ultimate projected infill criteria (provided by City)

Water
- Determine and distribute projected ultimate demands within the planning area
- Update water distribution system map and computer hydraulic model (information provided by the City, field verification not included)
- Work with City staff to determine and adopt desired water distribution system design criteria (e.g. demands, max.-min. pressures, fireflows, etc.)
- Analyze pipeline system under ultimate projected development
- Identify and quantify deficiency areas
- Identify and compare improvement alternatives needed to meet projected ultimate demands and extend service to future development, focusing on pressure zone and trunk main sizes and configurations
- Provide system master plan exhibit map showing trunk main sizes, pressure zone configurations and approximate and/or assumed future reservoir and booster station locations

Sanitary Sewer
- Determine and distribute projected ultimate flows within the planning area
- Update sewer collection system map (information provided by the City, field verification not included)
- Determine system design criteria
- Discuss operational problem areas

- Analyze pipeline system under ultimate projected flows including allowance for inflow and infiltration (I&I analysis not included)
- Identify probable deficiency areas
- Provide system master plan exhibit map showing trunk main sizes and likely required lift station locations

This is not a Water System Plan or Project Report per WAC 246-290 or a Wastewater Facility Plan or Preliminary Engineering Report per WAC 173-240. Other related infrastructure such as waster supply, water storage, water rights, and wastewater treatment are not analyzed.

This Master Plan is based on available USGS contour and topographic mapping. More detailed topographical mapping is planned by the City. It may be necessary to refine or revise this Master Plan in specific areas based on either future topographical information obtained by the City or developer, or specific detailed development plans, schedules and phasing.

2. PLANNING DATA

2.1. Planning Area

The planning area for the Water Distribution and Sanitary Sewer Collection System Master Plan was provided by the City and consists of the area within the City of Leavenworth UGA, including the area north of the UGA to the north end of Titus Rd. loop, between Chumstick Hwy and the western UGA boundary. See **Figure 1**. Note that additional ERUs resulting from potential annexations which increase the present UGA area, with the exception of extension to Titus Rd. (as shown on Figure 1) are not included in this plan, or the identified improvements.

2.2. Zoning

Zoning in the planning area requiring water and sanitary sewer service consists of the following classifications.

- Residential
  - Planned Development Zone
  - Residential Multi-family Zone
  - RL-10 Zone
  - RL-12 Zone
  - RL-6 Zone
- Non-residential
  - Tourist Commercial Zone
  - Central Commercial Zone
  - General Commercial Zone
  - Light Industrial Zone

See the City Code for definitions of the land use allowed in each zone effective as of the date of this report. Excerpts from applicable City Code is included in the appendix.

2.3. Equivalent Residential Units (ERUs)

ERUs are a widely accepted and convenient unit of measure when estimating water system demands and wastewater volumes. ERUs represent the average water use or wastewater volume generated by a typical single family residence in a particular system. Thus, the figures will vary somewhat from system to system, although wastewater volume generated by a single family residence generally does not vary considerably between similar residences in similar areas. Single family water use can vary significantly from system to system, since it is affected by outside water needs for lawn irrigation. Water use and wastewater volume generated by non-residential connections, including commercial, public, recreational and industrial customer classes can vary significantly among different customers in the same customer class. Converting non-residential connections into ERUs measures the impact to the water or wastewater system of each non-residential connection in comparison to the impact of a single family residence. In this way the impact of two dissimilar connections can be compared in a similar fashion.

Calculating water ERUs and wastewater ERUs for the same residential and non-residential mix of connections will result in different ERU totals. For example, a convenience store that occupies a one acre lot occupies the same area as seven RL-6 zoned residences with lawns. The one-acre residential area is equivalent to 7 water ERUs. Since a convenience store typically irrigates (the largest water use) very little and only uses water for one bathroom, it may only use the equivalent of 1 water ERU. The same one-acre residential area is also equivalent to 7 sewer ERUs, but the convenience store may have significantly more or less than 7 sewer ERUs, depending on typical customer traffic and resulting volume of bathroom use.

2.4. Water Demands and Distribution

2.4.1. Estimated Water ERUs

Areas within City Water Service Area but outside of the Planning Area
The number of existing ERU's established in the 2002 WSP were used for the East Leavenworth Rd. and Icicle Rd. areas. These areas are within the City of Leavenworth Water System Service Area Boundary but outside the UGA and the planning area. Future growth projections have not been made for this area. As previously reported by the City there is a moratorium on new water services in these areas and very little growth is expected in these areas.

Residential ERUs
Estimated numbers of ultimate dwelling units (DU) for the urban growth area north of the City limits and the Titus Rd. loop were provided by the City. As directed by the City, dwelling units in the remaining residentially zoned areas were estimated assuming full build out using current minimum lot sizes by taking the total residential zoned area and dividing by the minimum lot size.

A large component of residential water use is irrigation for lawns and landscaping. To reflect larger water use associated with typically larger single family lots the estimated dwelling unit number was than converted into ERUs (Equivalent Residential Units) using the following formula:

- Each Dwelling Unit (DU) in areas with a minimum lot size of 6,000 s.f. or greater equals 1 ERU
- Each Dwelling Unit (DU) in areas zoned multi-family or with minimum lot size less than 6,000 s.f. equals 0.6 ERUs.

The 0.6 factor was determined by taking the total annual water use of several apartment buildings in the City and dividing by the number of units. This resulted in a factor of 0.5. This was revised to 0.6 to reflect a likely slightly higher water use for condominiums over apartments.

Cascade School District has three schools located in residential zoned areas. District annual metered water use was divided between the three locations based on number of meters and converted to ERUs.

The residential DUs and ERUs calculations are included in the Appendix. The total projected ultimate residential DUs are 5,237. Total projected residential water use ERUs are 4,316.

Non-Residential ERUs

Estimating water use for non-residential zoned areas is not as straightforward as residential water use because different building and development types can have substantially different water demands. General development types listed from high to low water use typical to non-residential zoned areas in the City include:

- Schools and Parks
- Condominiums
- Hotels
- Restaurants
- Shops

Except for schools and parks, the highest demand scenario for the non-residential zoned areas would be to assume the total area is developed into condominiums following current zoning limits. The calculations for this demand scenario are included in the Appendix and results in 4,316 ERU's and averages 29 ERU/Acre.

A large part of the downtown area is configured to serve the local tourism and consists of hotels, restaurants and shops. It is not logical to assume that all the non-residentially zoned areas in the City, including the downtown area, will be converted into maximum density condominiums. It was therefore decided to use the following methodology and assumptions for the purposes of water distribution system analysis and planning.

- Full condominium build out would occur in approximately 50% of the total area
- The remaining 50% would be a mix of motels (25%) restaurants and shops (25%)

Existing annual water use was analyzed for several hotel/motels currently located in the City. The result ranged from 4 – 26 ERU/Acre. A mix of restaurants and shops are estimated to average half the hotel/motel use and result in a range of 7 - 13 ERU/Acre. This report will use the higher end of these ranges.

Applying these assumptions to the 4,316 ERU's projected above results in the following:

Table 2-1 Estimated Ultimate Non-Residential ERUs

Development Type	Coverage	Area (acres)	ERU/Acre	ERUs
Condominiums	50%	79	29	2,291
Hotel/Motel	25%	39	20	780
Restaurant/Shops	25%	39	10	390
Light Industrial Area		5	9	45
Enchantment Park (1)		7	4.3	30
Schools (2)	n/a	n/a	n/a	n/a
Total		**169.0**		**3,536**

(1) *Enchantment park meter broken, assumed 7 acres at 1" per week for 5 months [22 weeks] = 7 * 1.83' =12.83 acre/ft = 4.2 million gallons annually. 4.2 MG divided by 365 days/yr divided by 390 gpd/ERU ~ 30 ERUs*

(2) *Cascade School District schools are located in residential zoned areas and are included in the estimated residential ERUs*

Ultimate estimated non-residential ERUs total 3,536 based on the assumptions noted previously, current zoning and height limits. The estimated ERUs were distributed to the individual sub areas in

proportion to land area, not including rights-of-way. The ERU analysis, data and calculations are included in Appendix A.

2.4.2. Projected Ultimate Residential and Non-Residential ERUs

The annual water demands associated with an ERU documented in the 2002 WSP averaged 389 gpd/ERU and unaccounted for water (difference between water produced and sold) ranged from 13%-15% between 1998 and 2000. Actual water production averaged 444 gpd/ERU. Unaccounted for water can include combination of many factors including leakage, inaccurate meters, unmetered locations, reservoir overflows, fire hydrant testing, construction, etc. In addition the unaccounted for water becomes a much smaller percentage (3-4%) during maximum day and peak hour demand conditions under which the distribution system is analyzed and designed. Unaccounted for water is therefore not included in the water distribution system demand loading.

It is assumed that the 389 gpd/ERU reported in the 2002 WSP water use will decline during the planning period. This is based on the following observations:

- The City does not have adequate water rights to supply water for the estimated growth, which will increase the importance of conservation
- It is anticipated that conservation compliance regulations will increase
- The City will be under regulatory pressure to structure water rates to promote conservation
- Current DOH regulations require water systems to meet a maximum 10% unaccounted for water, meaning system leakage will likely eventually be reduced to a hydraulically insignificant amount
- Current building codes require new buildings to install low flow plumbing fixtures
- Ultimate build out assumptions will result in individual residential lots that are smaller than existing lots and therefore will likely use less water per residential connection

This analysis therefore assumes a 15% reduction in annual average water use per ERU for ultimate distribution system demands. Reducing the 1998-2000 average annual water use of 389 gpd/ERU by 15% results in 330 gpd/ERU. By comparison, the City of Cashmere's current water demand is approximately 332 gpd/ERU after implementation of a conservation encouraging rate structure.

The current number of ERUs is approximately 2325 and current annual water use is approximately 0.9 MGD (2,325 ERUs x 389 gpd/ERU). The projected ultimate water use ERUs and resulting water demands are as follows:

Table 2-2 Projected Ultimate ERUs and Water Use

Description	Projected ERUs	Annual Average Gpd/ERU	Annual Average Water Use (MGD)
Residential	4,316	330	1.42
Non-Residential	3,536	330	1.17
Total	**7,852**	**330**	**2.59**

ERUs have been projected and estimated based on ultimate growth (at build out) utilizing current zoning restrictions and assumed development types. The result is a total of 7,852 ERUs within the

planning area. This represents a total ERU increase of 237%, or an annual ERU growth rate of between 2.45% and 3.05% over 40-50 years (a total growth factor of 3.37).

2.59 MGD calculates to approximately 2,900 acre/ft. Existing City annual water rights (Qa) is 1,465 acre/ft. The City does not currently have adequate annual water rights to support this growth. Instantaneous water rights are not analyzed. It is assumed the water rights situation will be resolved within the planning period. Additional specific boundary conditions and assumptions regarding the hydraulic analysis are documented in the Section 3.

2.5. Sewer Flows and Drainage Basins

2.5.1. Equivalent Residential Units (ERUs)

Wastewater volume is estimated based on ERUs for collection system hydraulic analysis and planning purposes. One ERU is equivalent to the wastewater volume produced in a single family residence.

Estimated ultimate Dwelling Units (DU) for the urban growth area north of the City limits and the Titus Rd. loop were provided by the City. Dwelling units in the remaining areas were estimated assuming full build out under current zoning restrictions.

2000 Census information prepared by the Washington State Office of Financial Management for the City of Leavenworth indicates the average single family residence consisted of 2.51 persons and the average multi-family residence consisted of 1.88 persons. As density increases and lot sizes shrink persons per unit typically decreases. To estimate ultimate flows this analysis assumes 2.3 persons per single family residence and 1.6 persons per multi-family residence.

DUs are converted to ERU's as follows:

- Each Dwelling Unit (DUs) in areas with a minimum lot size of 6,000 s.f. or greater equals 1 ERU
- Each Dwelling Unit (DUs) in areas zoned multi-family or with minimum lot size less than 6,000 s.f. equals 0.7 ERUs (1.6 ÷ 2.3).

2.5.2. Infiltration and Inflow (I/I)

Infiltration and Inflow (I/I) is the introduction of stormwater or ground water into wastewater collection systems. This extraneous water enters the sanitary sewer system through cracked pipes, leaking pipe joints and leaking manholes, as well as downspouts and sump pumps from homes/businesses that are connected directly to the sanitary sewer system. Once this stormwater enters the sanitary sewer it adds to the daily volume of wastewater that must be collected, pumped and treated by municipal wastewater facilities.

The 1996 Wastewater Facility Plan (WWFP) estimated the annual I/I flow component at 9.1 MG and peak month at 83,000 gpd. This results in an annual average I/I of 14 gpcd and approximately 8.5% of the total wastewater flow. The WWFP included an I/I allowance of 20 gpcd for future planning. It was noted in the WWFP that periods of high infiltration, generally during periods of snow melt and

winter runoff, do not coincide with periods of high residential and commercial wastewater flow production which peak during the height of the tourist season and festivals.

It is assumed that the future collection system will be a mix of new, old and rehabilitated pipe; therefore I/I will continue to be a contributing component of the ultimate wastewater flows. The ultimate flows estimated herein are a product of both increased density and expansion of the existing collection system.

Existing Collection System
As stated previously, estimated peak infiltration does not occur during periods of high wastewater flows, therefore this analysis will not use peak infiltration rates. Average annual I/I of 9.1 MG results in approximately 25,000 gpd.

Since I/I is more directly related to length and diameter of sewer pipe, increasing population densities within the existing collection system service area without an increase in sewer pipe length will not result in an increase in I/I. An increase in I/I would however be related to continued deterioration of the existing pipe. It is anticipated that some of the older, more deteriorated pipes will be replaced while the remaining pipe will continue to deteriorate during the 40-50 year planning period of this collection system analysis.

It is assumed the overall condition of the existing collection system will continue to deteriorate and I/I will increase during the planning period. Assuming a 50% increase in I/I results in 37,500 gpd. Distributed equally throughout the existing 470 acre collection system area results in 80 gpd/acre. To be conservative this analysis will estimate the ultimate I/I flow component within the existing collection system service area at 100 gpd/acre (an 88% increase over existing average annual I/I).

Expanded Collection System
Expanding the collection system to the UGA limits and the Titus Rd. loop increases the overall sewer pipe footage and increases the potential for I/I. This is an area with known wetlands and seasonal groundwater. New PVC sewer pipe is better at resisting infiltration than the older concrete pipe which makes up the majority of the existing collection system pipe. The larger area and lower densities allowed in this area means there will be more feet of sewer pipe per connection than in the denser areas within the existing collection system service area. The likely result will be the I/I flow component in the expanded area will be higher per connection. For this reason the 20 gpcd assumed in the 1996 WWFP will also be used in these areas.

2.5.3. Estimated Wastewater ERUs

Wastewater flows were estimated based on ERUs per acre. One ERU is equivalent to 2.3 persons. The 1996 WWFP estimated residential flow at 70 gpcd. Using 2.3 persons per ERU results in 161 gpd/ERU, not including I/I.

ERUs per acre were determined by estimating ultimate dwelling units and converting dwelling units to ERUs per the criteria established previously. Dwelling units for the UGA north of the City limits and the Titus Rd. loop were provided by the City for the growth areas.

Residential ERUs
Residential zoning includes the following classifications:

- RL-12 Zone: 1 dwelling unit per 12,000 sq.ft. area
- RL-10 Zone: 1 dwelling unit per 10,000 sq.ft. area
- RL-6 Zone: 1 dwelling unit per 6,000 sq.ft. area
- Planned Development Zone: Dwelling units estimated using RM-2 classification
- Residential Multi-family Zone (RM-2): 1 dwelling unit per 2,000 sq.ft. area

Table 2-3 Residential ERU/Acre

Current Zoning	Min. lot SF/D.U.	Calculated Max. D.U./Acre	DU to ERU factor (1)	Calculated ERU/Acre
RL-12	12,000	3.6	1.0	3.6
RL-10	10,000	4.4	1.0	4.4
RL-6	6,000	7.3	1.0	7.3
RM-2	2,000	21.8	0.7	15.2

(1) *From Section 2.5.1 one single family residential dwelling unit (DU) unit = 1 ERU, One multi-family residential dwelling unit (DU) = 0.7 ERU*

The public schools are located in the residential area. Wastewater flow for the schools was estimated as follows:

Table 2-4 Estimated School ERUs

School	Students/Faculty	gpd/person (1)	(gal)	gpd/ERU (2)	Growth (3)	ERU (4)
Cascade HS	535	16	8,560	161	200%	106
Icicle MS	294	16	4,704	161	200%	58
Osborne ES	415	16	6,640	161	200%	82

(1) *Per DOE Criteria for Sewage Works Design*
(2) *2.3 persons per ERU x 70 gpcd = 161 gpd/ERU*
(3) *Assumed allowance*
(4) *ERU equals: gal ÷ gpd/ERU x 200%*

The calculated ERUs for the schools are included in the basins where the schools are located. The area is not included when calculating ERUs based on zoning.

Non-Residential ERU/acre
Non-residential zoning requiring water and sanitary sewer service includes the following classifications:

- Tourist Commercial Zone
- Central Commercial Zone
- General Commercial Zone
- Light Industrial Zone

Estimating non-residential wastewater contributions is not as straightforward as residential wastewater contributions because different building and development types can have substantially different wastewater contributions. General development types listed from high to low wastewater contribution typical to the City include:

- Schools
- Condominiums
- Hotels
- Restaurants
- Shops

As was stated in the Section 2.3.2, a large part of the downtown area is configured to serve the local tourism and consists of hotels, restaurants and shops. It is not logical to assume that all the non-residentially zoned areas in the City, including the downtown area, will be converted into maximum density condominiums. Therefore similar assumptions used in the Section 2.3.2 were also used for sewer collection system analysis and planning.

- Full condominium build out would occur in approximately 50% of the total area
- The remaining 50% would be a mix of motels (25%) restaurants and shops (25%)

Condominium ERUs are shown in Table 2-5.

Table 2-5 Estimated Condominium ERUs/Acre

Zoning	Max. Buildable Coverage (1)	Total Buildable Area (acres) (2)	D.U. Size (SF) (3)	Max. D.U. per floor	Max. Number of Floors (4)	Max. Number of D.U. (5)	DU to ERU factor (6)	ERU per Acre (7)
TC	50%	0.50	1,500	15	2	30	0.7	21
GC	75%	0.75	1,500	22	2	44	0.7	31
CC	50%	0.50	1,500	15	4	60	0.7	42

(1) *Maximum buildable coverage from Title 18 zoning regulations as follows:*
(2) *50% Tourist Commercial (TC)*
(3) *75% General Commercial (GC)*
(4) *50% Central Commercial (CC)*
(5) *Total buildable area: 1 acre x maximum buildable coverage*
(6) *Assumed 1,250 sf per dwelling unit plus 250 sf for common space, hallways, etc.*
(7) *Maximum buildable height for TC and GC is 35 ft. (generally 2 floor max.) and for CC is 50 ft. (generally 4 floor max.)*
(8) *Maximum number of DUs: maximum DU per floor x number of floors*
(9) *One single family residential dwelling unit (DU) unit = 1 ERU, One multi-family residential dwelling unit (DU) = 0.7 ERU*
(10) *Estimated population ÷ 2.3 persons per single family dwelling unit*

From the 1996 WWFP hotel/motel contributions were estimated between 2,300 to 2,700 gpd/acre. Using 2,500 gpd/acre and assuming 161 gpd/ERU results in 15.5 ERU/acre.

From the 1996 WWFP restaurant contributions (assuming quality dining) were estimated between 2,000 to 2,500 gpd/acre and retail/shops were estimated at 1,000 to 2,000 gpd/acre. Using 2,000 gpd/acre and assuming 161 gpd/ERU results in 12.5 ERU/acre.

ERUs for the non-residential zoned areas are applied as follows:

Table 2-6 Non-Residential ERUs/Acre

Zoning	Condominiums			Hotel/Motel			Restaurants/Shops			Resulting ERU/Acre
	ERU/Acre	%	ERU/Acre	ERU/Acre	%	ERU/Acre	ERU/Acre	%	ERU/Acre	
TC	21	50%	10.5	15.5	25%	3.9	12.5	25%	3.1	18
GC	31	50%	15.5	15.5	25%	3.9	12.5	25%	3.1	23
CC	42	50%	21.0	15.5	25%	3.9	12.5	25%	3.1	28

Light Industrial zoned areas are estimated based on 2,500 gal/acre, or 16 ERU/acre.

2.5.4. Projected Ultimate Residential and Non-Residential ERUs

The projected ultimate ERUs used for this collection system analysis are as follows:

Table 2-7 Projected Ultimate ERUs

Description	Projected ERUs
Residential	4,514
Non-Residential	3,823
Total	**8,337**

2.5.5. Projected Wastewater Flows

Ultimate wastewater flows at buildout were estimated as follows:

- Divide planning area into drainage basins
- Quantify area within each drainage basin by zoning classification
- Apply ERUs per acre established herein to each drainage basin
- Apply 161 gal/ERU
- Add 100 gpd/acre I/I to the existing collection system service area
- Add 20 gpcd I/I to expanded collection system service area
- Apply peaking factor to estimated wastewater flows to analyze system under peak hour flow (per 10 State Standards, I/I not peaked, Peak Hour Factor table included in the Appendix)
- Analyze peak hour flows through the system

Drainage basins are shown on **Figure 5**. Wastewater flow calculations by basin and subbasin are included in the Appendix.

Total projected ultimate wastewater flows (including I/I) used to analyze the sewer collection system are as follows:

Table 2-8 Projected Ultimate Wastewater Flows

Annual Average Day				Peak Hour Flows	
WW Flow	I/I	Total			
(MGD)	(MGD)	(MGD)	(gpm)	(MGD)	(gpm)
1.355	.133	1.489	1,034	4.334	3,010

ERUs have been projected and estimated based on ultimate growth (at build out) utilizing current zoning restrictions and assumed development types. The result is a total of 8,337 ERUs within the planning area. Based on present annual average wastewater treatment flow of 384,000 gpd, the projected ultimate annual average flow of 1.489 MGD used in this analysis represents an increase of 288% over present flows (a total growth factor of 3.88).

This is equivalent to an annual growth rate of roughly 3% over 40-50 years. This is consistent with the projected ERU growth used to analyze the water distribution system.

The design capacity of the existing wastewater treatment plant (WWTP) is summarized as follows:

Average Annual Flow (MGD):	0.65
Maximum Monthly Average Flow (MGD):	0.84
Maximum Daily Flow (MGD):	1.28
Peak Hourly Flow (MGD):	2.60

The ultimate wastewater flows projected in this analysis exceed the current capacity of the existing WWTP. Analyzing the wastewater treatment plant is outside the scope of this work. It is assumed that capacity of the WWTP will be increased within the planning period.

This analysis assumes projected wastewater volumes will continue to flow to the current WWTP site and if a future WWTP is constructed at a different site, a lift station will be constructed to pump the wastewater from the current WWTP site to a future WWTP site.

3. WATER DISTRIBUTION SYSTEM ANALYSIS

3.1. Distribution System Hydraulics

This analysis utilizes an updated and modified version of the City's hydraulic model; the City originally constructed the model during the 1991 and 2002 Water System Plans to provide distribution system analysis. The City's 2002 Water System Plan (WSP) identifies many of the deficiencies addressed in this analysis. This analysis carries forward portions of relevant discussions from the 2002 WSP related to the distribution system.

3.2. Water System Evaluation Criteria

Section 5 of the City's 2002 Water System Plan presents design standards for evaluation of existing facilities and planning for future facilities. The Master Plan generally follows the standards used in the WSP. Deviations from the WSP criteria are shown in brackets along with DOH minimums. The following outlines the criteria used in this Master Plan:

- Supply
  - The system shall have sufficient supply capacity to meet the system maximum day demand (MDD) [DOH criteria]
- Distribution System
  - Minimum system pressure during peak hour demand (PHD) shall not be less than 40 psi at all service connections throughout the system [DOH: 30 psi min.]
  - Minimum system pressure during the max day demand (MDD) fire flow condition shall not be less than 20 psi at all service connections throughout the system [DOH criteria]
  - Minimum new pipe size shall not be less than 8" [DOH: 6" unless justified by hydraulic analysis]
- System Performance / Energy Efficiency
  - Pressure decrease from static to PHD shall not exceed 20 psi [Criteria used in Master Plan to meet customer expectations/satisfaction and decrease wear and tear on the distribution system and customer plumbing related to frequent pressure variations]
  - Pressure increase due to operation of water treatment plant pumps and/or wells shall not exceed 20 psi [Criteria used in Master Plan for energy efficiency]
  - System pressure at service connections shall not exceed 100 psi [DOH criteria unless justified by design engineer]
- Fire Flow
  - Based on discussions with the Washington Surveying & Rating Bureau (WSRB) and the local Fire District the City adopts the following fire flow criteria:
    - Residential: 1,500 gpm for 1 hour
    - Multi-family: 2,500 gpm for 2 hours
    - Schools: 2,500 gpm for 2 hours
    - Commercial: 2,500 gpm for 2 hours (for areas zoned Tourist Commercial, General Commercial, and Light Industrial)
    - Downtown: 3,500 gpm for 3 hours (for areas zoned Central Commercial)

- The system shall achieve the flow rates and durations defined above while maintaining 20 psi minimum pressure at all system service connections

The criteria defined above directly affect the improvements necessary to serve future growth. State regulations dictate some of the criteria while others are more subjective (e.g. the State does not require systems to consider performance / energy efficiency, however, this can lead to energy waste, operational difficulties, and/or customer complaints). Similarly, some State defined minimum design criteria will not provide the level of service to which most customers are accustomed (e.g. DOH requires 30 psi minimum pressure during PHD, but most customers will not be happy with less than 40 psi).

3.3. Hydraulic Model

The following describes the assumptions governing the analysis and the hydraulic model's setup.

- The areas considered for this planning period (see **Figure 2**) range in elevation from approximately 1,100 to 1,500. Based on the City's minimum and maximum allowable pressure criteria discussed below, the area must be broken into four pressure zones that each span approximately 100 vertical feet. The 2002 WSP discusses this in detail.
- The following nomenclature identifies the City's present and future pressure zones, see **Figure 4**:
  - Zone 1: existing main pressure zone that serves most of the City utilizing the water treatment plant (WTP), wells, and Icicle Reservoir; assumes highest elevation served does not exceed 1,200.
  - Zone 2: existing lower Ski Hill pressure zone that draws water from Zone 1 via existing Ski Hill booster station #1 and pumps to existing Ski Hill Reservoir #1; assumes highest elevation served does not exceed 1,300.
  - Zone 3: future mid Ski Hill pressure zone that will draw water from Zone 2 via future Ski Hill Booster Station #2 and pump to future Ski Hill Reservoir #2; assumes highest elevation served does not exceed 1,400.
  - Zone 4: future upper Ski Hill pressure zone that will draw water from either Zone 2 or Zone 3 via future Ski Hill Booster Station #3 and will operate as a closed system (no reservoir); assumes this zone serves all connections above elevation 1,400.
- Based on the figures developed in **Section 2.3**, the demands included in Table 3-1 were calculated for the City's existing and future pressure zones for use in the hydraulic model. Design of specific distribution mains may be affected by developer proposed and City approved demands that differ from those used herein for system hydraulic modeling of major facilities.

Table 3-1 Ultimate System Demands

Note: zone demands do not include demands of booster stations that pump water to a higher zone.

Pressure Zone	ERUs	ADD (1) (gpm)	MDD (2) (gpm)	PHD (3) (gpm)
Zone 1	6,232	1,428	3,071	5,042
Zone 2	923	212	455	856
Zone 3	545	125	269	559
Zone 4	152	35	75	205
Total	7,852	1,799	3,869	6,661

(1) *Based on an assumed average use of 330 gpd/ERU per Section 2.4.2*
(2) *Based on an assumed ADD to MDD peaking factor of 2.15 per discussions with Stan Adams*
(3) *Based on DOH Water System Design Manual Equation 5-3 for estimating peak demands*

- Time Frames
    - The 2002 WSP conducted analyses for the present (2002), 6-year (2008), and 20-year (2022). This analysis does not repeat the analyses of the 2002 WSP. The City plans to update its WSP in 2008 and will conduct present, 6-year, and 20-year analyses at that time.
    - For the purposes of longer-term planning this analysis considers the ultimate growth potential (build-out potential) of the City's urban growth area (UGA) and several areas that will likely become part of the UGA (see **Figure 1**).
    - It is uncertain when the City will reach ultimate/build-out growth potential; the planning horizon is estimated at approximately 40-50 years.
- The hydraulic model utilizes WaterCAD version 7.0 by Haestad Methods as the analysis engine
- Individual node demands within the hydraulic model were set based on zoning and development potential provided by the City, spatial distribution of nodes, and tributary area surrounding each node
- The following Hazen-Williams pipe roughness coefficients were used:
    - Cast Iron: 120
    - Ductile Iron: 120
    - Steel: 100
- Model Calibration
    - The City has maintained an active hydraulic model since its 1991 WSP; the City calibrated the 1991 model extensively.
    - Additional calibration was done based on hydrant flow tests conducted by Chelan County Fire District during the months of June-August in the years 1996-2000.
    - The model used in this analysis carries forward the physical characteristics of the previous models and was updated to reflect improvement projects constructed by the City since the 2002 WSP.
    - No additional calibration has been conducted since the 2002 WSP.
- Sources of Supply
    - This analysis assumes that future source capacity will be approximately equal to the system MDD (per evaluation criteria discussed previous)
    - Ultimate System MDD = 3,869 gpm = 5.6 MGD
    - This analysis assumes that the water treatment plant (WTP) will supply 3.1 MGD and the wells will supply 2.5 MGD.
    - Note: the existing WTP has capacity of 2.0 MGD and the existing wells have capacity of 2.9 MGD. Current Q_i uninterruptible surface water rights are 1.95 MGD, total Q_i interruptible surface water rights are 2.06 MGD. Current Q_i uninterruptible ground water rights are 1.44 MGD, total Q_i interruptible ground water rights are 2.88 MGD.
    - If the WTP is abandoned and water supply provided entirely through groundwater sources at the existing well site, this could effect peripheral and downtown transmission main sizing. If the supply source location changes from the assumptions described herin, than this Master Plan should be reviewed and revised as necessary.
    - This analysis assumes the City will upgrade supply facilities and acquire water rights incrementally with growth to assure supply capacity remains greater than or equal to the system MDD
    - The City may explore the feasibility of developing an additional groundwater source in the north Ski Hill area. Unless such a source exceeded a capacity of roughly 500

gpm this source would not likely effect the main sizes shown in this plan because fire flow is the main determinant in main sizing and fire flow would be provided by storage in any case. If a Ski Hill groundwater source is ultimately developed, than this Master Plan should be reviewed and revised as necessary.

- Booster Station Capacities
  - This analysis assumes the existing Ski Hill booster station #1 will have sufficient capacity to supply the MDD of Zones 2, 3, and 4 (this will exceed current capacity)
    Capacity = 455 gpm + 269 gpm + 75 gpm = 799 gpm
  - This analysis assumes the future Ski Hill booster station #2 will have sufficient capacity to supply the MDD of Zone 3 and the PHD of Zone 4
    Capacity = 269 gpm + 75 gpm = 344 gpm
  - This analysis assumes the future Ski Hill booster station #3 will have sufficient capacity to supply the PHD of Zone 4 at 40 psi minimum pressure and the MDD + fire flow rate for Zone 4 at 20 psi minimum pressure (not simultaneous)
- Storage Availability / Pressure Reducing Valves (PRV)
  - The existing Ski Hill booster station #1 has a PRV that makes the Zone 2 storage available to Zone 1 in the event of an emergency
  - This analysis assumes the City will install two additional PRVs to provide additional access to Zone 2 storage by Zone 1 (one on Titus Rd and one for the Cottage Creek development on the Chumstick Highway)
  - This analysis assumes the PRVs between Zone 2 and Zone 1 can/will be set to maintain a hydraulic grade line (HGL) of approximately 1,270 (roughly 30 psi at the pressure zone boundary – elev. 1,200)
  - When the City constructs Zone 3, the City may construct PRVs to make the Zone 3 storage available to Zone 2. This analysis neglects the future installation of PRVs (except those mentioned between Zone 2 and Zone 1)

3.4. Analysis and Methodology

This analysis systematically determined upgrades necessary for the City's system to serve projected ultimate/build-out water demand. The analysis required preliminary layout of future pressure zones to serve the Ski Hill / Titus Rd area north of Pine St. The following outlines the procedure used to form the water main layout and pressure zone concept for Zones 2, 3, and 4:

- A conceptual distribution main network was laid out along existing roadways and potential future roads with the assistance of a parcel map provided by Chelan County
- Whenever possible, mains were looped to provide the best possible flow characteristics and grid; some dead-end mains are necessary
- Pressure Zone boundaries were designated based on the 1,200, 1,300, and 1,400 contours described previously
- Demands were distributed by pressure zone and the mains were sized to meet 40 psi minimum pressure during PHD and 20 psi residual pressure during fire flow
- See **Figure 3** for existing system and **Figure 4** for future main sizing and layout

The City's water treatment plant (WTP) and wells are both located on Icicle Rd. The WTP and wells are located approximately 4.2 and 0.8 miles from the Icicle reservoir respectively. This analysis evaluated the existing transmission capacity from these two sources along Icicle Rd and East Leavenworth Rd to the main City grid. As mentioned previously, the City criteria allow a maximum

pressure fluctuation of 20 psi; this governs the sizing of these mains to meet future supply requirements.

The following table summarizes system hydraulic performance as measured by system pressure under static, max day demand, and peak hour demand conditions for existing and future conditions.

Table 3-2 Summary of System Pressures

Note: portions of this table were excerpted from the City's 2002 WSP. Fields with N/A were not calculated in the 2002 WSP and were not recalculated for this analysis

			2002 without Improvements		2022 without Improvements		Ultimate with Improvements	
Zone	**General Area**	**Static (psi)**	**Max Day (psi)**	**Peak Hour (psi)**	**Max Day (psi)**	**Peak Hour (psi)**	**Max Day (psi)**	**Peak Hour (psi)**
Zone 1	NW residential (Pine Rd.)	55-60	50-55	35-40	30-35	<20	55-60	40-50
Zone 1	W residential (Mine/West)	60-65	55-60	45-50	30-40	<20	55-60	50-60
Zone 1	W residential (Mt. View/Park) (1)	40-45	35-40	25-30	20-25	<20	70-90	80-95
Zone 1	High school	70-75	60-65	45-50	40-45	<20	65-70	55-60
Zone 1	Downtown	75-80	70-75	55-60	50-55	<20	65-75	55-70
Zone 1	Cottage Creek (along Chumstick Hwy)	65-75	N/A	N/A	N/A	N/A	65-70	55-60
Zone 1	Safeway (Hwy 2 East of River)	65-70	60-65	45-50	40-45	<20	55-60	45-50
Zone 1	Dye Rd./Hill St./Mountain Home Rd.	80-85	60-65	40-45	35-40	<20	75-80	65-70
Zone 1	East Leavenworth Rd & Dye Rd	80-85	75-80	60-65	55-60	<20	70-75	65-70
Zone 1	East Leavenworth Rd & Dempsey Rd (2)	85-90	90-95	85-90	95-100	35-40	85-90	80-85
Zone 1	Icicle Rd/Hwy 2	65-70	65-70	60-65	55-60	40-45	60-65	70-75
Zone 1	Icicle Rd at wells (2)	80-85	90-95	95-100	>100	95-100	80-85	70-75
Zone 1	Icicle Rd & Wilson St (2)	75-80	90-95	90-95	>100	80-85	85-90	80-85
Zone 2	Zone 2 (Ski Hill Lower)	45-95	N/A	N/A	N/A	N/A	50-95	50-100
Zone 2	Ranger Rd & Ski Hill Dr	75-85	N/A	N/A	N/A	N/A	80-85	80-85
Zone 2	Emig Dr (midway)	50-60	N/A	N/A	N/A	N/A	60-65	55-60
Zone 2	Emig Dr & Titus Rd	70-80	N/A	N/A	N/A	N/A	75-80	75-80
Zone 3	Zone 3 (Ski Hill Mid)	45-95	N/A	N/A	N/A	N/A	35-100	35-100
Zone 3	Titus Rd & Ski Hill Dr (Ski Hill Res #1)	30-35	N/A	N/A	N/A	N/A	30-35	30-35
Zone 4	Zone 4 (Ski Hill Upper)	40-95	N/A	N/A	N/A	N/A	40-90	40-90

(1) *This area currently served by Zone 1; in future it should be connected to Zone 2 to meet service pressure criteria*

(2) *Pressures at these locations vary with the number of wells on line, the amount of water the WTP is producing and whether or not water is being pumped from the WTP. Pressures for all possible combinations are not shown.*

Available fire flow was modeled throughout the system. The following table summarizes available fire flow as predicted by the hydraulic model. Fire flow was modeled under max day demand background conditions, with reservoir levels at the bottom of fire suppression storage while maintaining 20 psi residual pressure throughout the distribution system. See Appendix B for table of boundary conditions.

Note the fire flow criteria established in Section 3.2 and reflected in Table 3-3, is intended for water system planning purposes, not requirements which may be applicable to a specific existing or proposed building. Thus a particular proposed building may receive credits from the local fire authority which result in fire flow requirements that are less than the water system planning criteria adopted in Section 3.2. Similarly, an existing building may require greater fire flow than established in Section 3.2. Neither of these conditions replaces the criteria established herein for system planning and design.

Table 3-3 Summary of Available Fire Flow

Note: portions of this table were excerpted from the City's 2002 WSP. Fields with N/A were not calculated in the 2002 WSP and were not recalculated for this analysis

Zone	General Area	Fire Flow Criteria (gpm)	2002 without Imprvmnts (gpm)	2022 without Imprvmnts (gpm)	Ultimate with Imprvmnts (gpm)	Meets Criteria With Impr.
Zone 1	NW residential (Pine Rd.)	1,500	1000-1300	200-300	>4,000	Yes
Zone 1	W residential (Mine/West)	1,500	1000-1200	300-400	3,500-4,000	Yes
Zone 1	W res. & multi-fam (Mt. View/Park) (1)	2,500	N/A	N/A	2,500-2,800	Yes
Zone 1	High school	2,500	1200-1400	300-400	>4,000	Yes
Zone 1	Downtown	3,500	1000-1500	300-400	>4,000	Yes
Zone 1	Cottage Creek (along Chumstick Hwy)	2,500	N/A	N/A	>4,000	Yes
Zone 1	Safeway (Hwy 2 East of River)	2,500	900-1000	300-400	2,500-2,800	Yes
Zone 1	Dye Rd./Hill St./Mountain Home Rd.	2,500	200-400	0-200	3,600-3,900	Yes
Zone 1	East Leavenworth Rd & Dye Rd	1,500	1300-1400	300-400	>4,000	Yes
Zone 1	East Leavenworth Rd & Dempsey Rd	1,500	1500-2000	500-600	>4,000	Yes
Zone 1	Icicle Rd/Hwy 2	2,500	>4000	1400-1500	>4,000	Yes
Zone 1	Icicle Rd. at wells	1,500	>4000	2500-2700	>4,000	Yes
Zone 1	Icicle Rd./Wilson St.	1,500	>3000	1700-1800	>4,000	Yes
Zone 2	Zone 2 (Ski Hill Lower)	2,500	N/A	N/A	1,900-4,000	Yes
Zone 2	Ranger Rd & Ski Hill Dr	1,500	N/A	N/A	2,800-3,000	Yes
Zone 2	Emig Dr (midway)	1,500	N/A	N/A	2,400-2,600	Yes
Zone 2	Emig Dr & Titus Rd	2,500	N/A	N/A	2,400-2,600	Yes
Zone 3	Zone 3 (Ski Hill Mid)	1,500	N/A	N/A	1,600-4,000	Yes
Zone 3	Titus Rd & Ski Hill Dr (Ski Hill Res #1)	1,500	N/A	N/A	>4,000	Yes
Zone 4	Zone 4 (Ski Hill Upper)	1,500	N/A	N/A	1,500-2,000	Yes

(1) *This area currently served by Zone 1; in future it should be connected to Zone 2 to meet service pressure criteria*

The fire flows predicted in the 2002 WSP are below recommended levels at several locations throughout the distribution system as indicated in the preceding table. At present, downtown area available fire flows average approximately half the recommended value and will continue to decrease as the system grows unless the City makes transmission improvements. A similar condition exists in the multi-family area in the west part of the system (Mt. View Dr/Park Ave) with present day levels at less than half of criteria.

3.5. Distribution System Findings

3.5.1. Summary

General

According to the system operator and the findings of the 2002 WSP, the system experiences satisfactory service pressure and pressure variations under average present day demand conditions; likewise, service pressures and pressure variations are generally within acceptable limits during present MDD and PHD (see preceding table). The existing system has numerous areas that do not meet fire flow criteria (see preceding table); these deficiencies will increase if system growth continues to occur without major transmission improvements. Likewise, system service pressures will continue to steadily decrease (eventually to less than the State required minimum of 30 psi) with system growth unless the City implements transmission main improvements.

Supply Transmission

The Leavenworth distribution system lacks a backbone trunk water main of adequate size to convey sufficient water through and/or around the distribution system for delivery to smaller diameter local distribution mains and to the future growth areas on the north side of the system. The system presently relies on smaller diameter mains to convey water through the grid. These mains act as both local distribution mains and as small transmission mains. A properly sized trunk main will provide uninhibited transmission through and/or around the perimeter of the distribution system to smaller diameter mains for local distribution and service. A trunk main will also provide the backbone for fire protection, reduce fluctuations in pressure throughout the system, and provide the ability to serve the future growth areas to the north.

The key limitation in terms of supply transmission hydraulics is the 12" rough, old steel main between the wells and the City. With the WTP and the wells both operating, the combined flow exceeds the capacity of the 12" main in Icicle and the 10" main in East Leavenworth Rd. which is itself a long, relatively small diameter (10") main. The resulting high velocities cause a large amount of head loss, and elevated pressures along Icicle Rd, East Leavenworth Rd, and surrounding areas. When both well pumps are on, water must be pumped from the WTP rather than gravity flowing as is normally the case. The 12" main in Icicle and 10" main in East Leavenworth Rd do not provide adequate transmission capacity to run all of the City's sources of supply simultaneously.

Due to the fact that the wells and Icicle reservoir are located relatively close to the central part of the City on Icicle Rd., the E. Leavenworth Rd. main is and will be a secondary transmission route carrying a smaller portion of the water from WTP than does the Icicle Rd. main. For this reason, its relatively small size (10") does not present a significant problem although when, at some future point it is replaced due to age, it should be upsized. If the City wishes to consider a site for additional storage in the vicinity of East Leavenworth Rd and Dye Rd, then the 10" main will need to be replaced with something significantly larger.

Old River Crossing

The City suspects the old 10" steel main that crosses the Wenatchee River from East Leavenworth Road to the vicinity of Division St. may be leaking. The Master Plan improvements developed herein assume that this river crossing will be abandoned. However, if this crossing is abandoned before the water main improvements on front St. and Commercial St. are implemented, the areas south and east of the intersection of SR2 and East Leavenworth Rd. would experience a 20-40%decrease in fire flows. The river crossing main plays a relatively minor role in meeting system peak hour demands (PHD). Therefore, the main upgrades east of Division St. as shown in this Plan should be implemented rather than invest in replacement of the river crossing pipeline when and if it fails or is determined to be leaking excessively.

Pressure Zones

As discussed in the analysis assumptions, Zone 1 water service will be limited to areas below elevation 1,200. At present, the City serves several connections above elevation 1,200 from Zone 1 in the Mountain View Dr area. These services should eventually be connected to Zone 2. The pressure zone boundaries of elevation 1,200, 1,300, and 1,400 for Zones 2, 3, and 4 respectively from the 2002 WSP will ensure all connections meet the City's minimum pressure criteria.

Summary

In summary, the existing transmission and distribution system generally has adequate capacity to meet existing demands (in terms of providing adequate pressures, not in terms of fire flow) but does not have the ability to maintain adequate pressures at projected demands. The system lacks the overall transmission capacity (from sources of supply and within the grid) to meet projected demands at the minimum criteria defined herein (see **Section 3.2**).

3.5.2. Condition of Distribution System

Aside from the pipe size and capacity issues discussed previous, the principle concerns with the existing pipe system relate to the age and condition of the pipe. The City installed the steel transmission main on East Leavenworth Rd. in the 1930's. City personnel report that this main is heavily encrusted on the inside and that pinhole leaks occur periodically (although the frequency of leaks has reduced since installation of the polyphosphate system). Neglecting capacity concerns, the City may need to consider replacement of this main due to excessive maintenance requirements; the older the main gets, the more it will leak (the City replaced a portion of this main from Hwy 2 to Dye Rd with a 12" DI main as part of a recent County road project). The Icicle Rd transmission main is newer than the 10" steel main in East Leavenworth Rd. The City does not expect the Icicle Rd transmission main to present an unmanageable maintenance problem in the near future. Capacity issues discussed previously will most likely govern replacement of the 12" portions in Icicle Rd.

The area south of the City in the Icicle valley is presently served by numerous individual privately owned service lines tapped directly to the Icicle and East Leavenworth Rd. transmission mains. In some cases water service has been extended to additional residences by connection to the end of an existing service pipe. Service pipe size, material and installation quality varies widely in this area. The City's only control is at shut-offs (where available) at the transmission main, and at meter boxes. In many cases long runs of privately owned service pipe exist between the transmission main and a City meter. Hydrants connected directly to the transmission main provide the only fire protection to these areas; in many cases customers that are served through lengthy services will not receive fire protection due to the distance of the house from a fire hydrant.

In the Duncan Orchards area east of the City (at the northerly end of East Leavenworth Rd.), the existing water distribution system consists of a combination of developer installed PVC pipe of varying sizes and individual service extensions. The City owns none of these pipes. This area has few fire hydrants.

During the meter installation project completed in 1990, corrosion and encrustation of old iron services was evident but did not appear excessive. In no case did the internal encrustation cause the line to be unserviceable. The majority of the older service lines were a "seamed" galvanized iron pipe. If leaks occurred on service lines that were disturbed, it usually occurred along the pipe seam.

The system has an adequate number of valves in most areas; however, the transmission mains on Icicle Rd and East Leavenworth Rd have excessive distance between valves. Fire hydrants generally have inadequate valves, with perhaps 20% of the hydrants having no shut-off on the hydrant lead. In the early 1990s, City crews encountered a wood stave hydrant lead, indicating that others may exist in the system.

Fire hydrant coverage is excellent within the City limits. The service area south of the City has very sparse fire hydrant coverage. The City only installed hydrants in this area when requested and paid for by the local customers; the lack of transmission capacity and distribution mains limit the fire flow that could be withdrawn from hydrants on East Leavenworth Rd.

From the 2002 WSP, the difference between total water production and metered sales puts unaccounted for water in the range of approximately 15% or about 100 gpm on average. The City attributed the unaccounted for water to a combination of the following: meter inaccuracies, leakage, water used but not recorded for flushing/hydrant testing/street washing, unauthorized un-metered uses, backwashing at the WTP and reservoir overflows. The City believes actual system leakage to be less than the 15% indicated by production records and metered sales. During the upcoming 2008 WSP update the City will need to provide volume estimates of un-metered uses to reduce unaccounted for water to less than 10%. If unaccounted for water exceeds 10%, DOH will require the City to implement a plan to reduce it to less than 10%.

3.6. Distribution System Improvements and Schedule

As the City begins to implement the improvements identified herein, more detailed evaluations and cost estimates should be prepared during pre-design of specific projects. In some cases DOH may require a Project Report per WAC 246-290-110 to address project specifics for DOH review and approval; projects such as reservoirs and booster stations will most likely require a Project Report.

The schematic layout of improvements used for this analysis (shown on **Figure 4**) illustrates the minimum looping and transmission required within the system to meet the minimum criteria defined in **Section 3.2**. In some cases, actual layout and pipe alignments can vary from those shown on the **Figure 4** schematic; however, variation from the schematic must satisfy the looping and total transmission capacity intended by the **Figure 4** schematic.

3.6.1. Distribution System Improvements

Refer to **Figure 4** for schematic of improvements detailed herein.

1. Supply Transmission
    a) Icicle Rd
        - Replace 5,800 LF of existing 12” main with 16” from East Leavenworth Rd to the connection with the 24” well transmission main
    b) Icicle Rd
        - Replace 3,400 LF of existing 12” main with 18” from connection with the 24” well transmission main to the Icicle reservoir
        - Replace 2,000 LF of existing 12” main with 20” from Icicle reservoir to Commercial St & Mill St
    c) East Leavenworth Rd
        - Replace 16,400 LF of existing 10” main with 12” (or 16” if future storage to be constructed near Dye Rd) from Icicle Rd to Dye Rd.
2. Downtown Transmission
    - Commercial St
        - Replace 1,400 LF from Mill St to 3rd St with 18”
        - Replace 1,600 LF from 3rd St to 8th St with 16” or 18”

- Complete parallel 12" loops in Commercial St & Front St – approximately 4,700 LF of new/replacement main

3. Zone 1 Transmission to Ski Hill Dr. Booster Station
   - Replace approximately 3,300 LF of main from future downtown transmission main to Ski Hill booster station #1 at Ski Hill Dr & Pine St.
   - Finish Pine St loop, install 1,400 LF of 12" main from Central Ave to Burke Ave
4. Pressure Zones (present and future)
   - Zone 2
     - Upgrade Ski Hill booster station #1 to approximately 800 gpm capacity
     - 12" main needed from Ski Hill Dr to Titus Rd in order to provide fire protection to multi-family development
     - When Mountain View Dr area is eventually connected to Zone 2 a 14" main is required part way and 12" the rest of the way in order to provide fire protection to multi-family development
     - In general, 8" looped mains are sufficient to provide service to customers within Zone 2 (except in the areas discussed above).
   - Zone 3
     - Construct Ski Hill Booster Station #2 with approximate capacity of 350 gpm
     - Construct Ski Hill Reservoir #2 at approximate HGL of 1,520
     - In general, 8" looped mains are sufficient to provide service to customers within Zone 3 (no multi-family fire flow provided in Zone 3)
   - Zone 4
     - Construct Ski Hill Booster Station #4 with approximate capacity of 200 gpm for normal supply and 1,600 gpm fire pump supply
     - In general, 8" looped mains are sufficient to provide service to customers within Zone 3 (no multi-family fire flow provided in Zone 3)
5. Pressure Reducing Stations
   - Pressure reducing stations between pressure zones with storage provide added redundancy because they make the storage of the upper pressure zones available to the preceding zones. Zone 1 relies on Zone 2 storage for fire protection. Zone 2 will not rely on Zone 3 for fire protection; however the City should install PRVs between Zones 2 and 3for added system redundancy.
   - Zone 2 / Zone 1
     - Install 8" PRV in Titus Rd at the elevation 1,200 pressure zone boundary and set at approximately 30 psi (HGL of 1,270)
     - Install 8" PRV to link Titus Rd to the Chumstick Hwy (in the proposed Cottage Creek development) at the elevation 1,200 pressure zone boundary and set at approximately 30 psi (HGL of 1,270). See also Titus Rd / Chumstick Hwy Intertie below.
   - Zone 3 / Zone 2
     - Install 8" PRV in Ski Hill Dr at the elevation 1,300 pressure zone boundary and set at approximately 30 psi (HGL of 1,370)
     - Install 8" PRV in Titus Rd at the elevation 1,300 pressure zone boundary and set at approximately 30 psi (HGL of 1,370). See also Titus Rd PRV below.
6. Titus Rd / Chumstick Hwy Intertie
   - To meet fire flow criteria in the Chumstick Hwy area a PRV is currently needed to provide supplemental flows during emergencies
7. Titus Rd PRV
   - PRV in Titus near the high school to provide fire flow to Zone 1

3.6.2. Distribution System Improvements Schedule

Each item detailed above has a trigger that makes the improvement necessary to meet City criteria; the following outlines the various triggers for the improvements which will help the City determine phasing of improvements projects:

1. Supply Transmission Improvements
    a) Main upgrades on Icicle Rd from East Leavenworth Rd to well T-main to prevent excessive pressures when WTP operates will become necessary when the City upgrades the capacity of the water treatment plant (WTP).
    b) Main upgrades from the well T-main to Commercial St & Mill St to allow the City to fully utilize existing supply capacity of wells & WTP are needed to address current system deficiencies.
    c) Replacement of the deteriorated main in East Leavenworth Rd from Icicle Rd to Dye Rd (16" if City sites storage at east end of town, otherwise, 12") will be needed when maintenance issues dictate or if/when the City constructs storage at the east end of town.
2. Downtown Transmission Improvements
    - The system currently requires these transmission improvements to meet fire flow criteria in the downtown area and in the Safeway area
    - The system needs these improvements now to address current deficiencies.
3. Zone 1 Transmission to Ski Hill Dr
    - These improvements stiffen transmission capacity to Ski Hill booster station #1; the existing system appears to have adequate capacity for the existing pumps.
    - Once growth in the Zones 2, 3, and 4 require an upgrade of the Ski Hill booster station #1 pumps, it will become necessary to upgrade transmission capacity to the Ski Hill area.
    - The existing pumps in Ski Hill booster station #1 have approximately 460 gpm (0.66 MGD) capacity; with an assumed MDD ERU of 710 gpd/ERU it has capacity to serve approximately 930 ERUs.
    - Once the population of Zones 2, 3, and 4 exceed approximately 930 ERUs, the Zone 1 transmission improvements to Ski Hill Dr will become necessary. Assuming approximately 75 new ERUs in Zones 2, 3, and 4 per year will allow approximately 12 years of growth.
4. Pressure Zones
    - These upgrades become necessary as development in the pressure zone begins to request water service.
    - Time frames will depend on which areas request water service first.
5. Pressure Reducing Stations
    - The PRVs between Zone 2 and Zone 1 are needed currently to make Zone 2 storage available to Zone 1 for fire suppression.
    - The PRVs between Zone 3 and Zone 2 should be installed as Zone 3 is constructed.
6. Titus Rd / Chumstick Hwy Intertie
    - The system currently requires this link between Zone 1 and Zone 2 to address an existing system deficiency and provide required fire flows to the Cottage Creek development.

7. Titus Rd PRV
   - This PRV will provide interim fire flow to Zone 1 prior to the Downtown Transmission Improvements and the Titus Rd / Chumstick Hwy Intertie implementation.

The following table summarizes the required improvements and general description of when they will be required (refer to **Figure 4** for corresponding schematic map of improvements):

Table 3-4 Summary of Water Distribution System Improvements and Schedule

(See Figure 4)

Improvement Designation	Category	Description & Purpose	Schedule
1-A	Supply Transmission	Main upgrades on Icicle Rd from East Leavenworth Rd to well T-main to prevent excessive pressures when WTP operates	Necessary if/when the City upgrades the capacity of the water treatment plant
1-B	Supply Transmission	Main upgrades from well T-main to Commercial St & Mill St to allow the City to fully utilize existing supply capacity of wells & WTP	Needed to address current deficiencies
1-C	Supply Transmission	Replace deteriorated main in East Leavenworth Rd from Icicle Rd to Dye Rd (16" if City sites storage at east end of town, otherwise, 12")	Schedule and size dependent on whether storage is planned at east end of town, timing of County road projects, and aging/deterioration of the existing 10" steel main
1-D	Supply Transmission	Higher priority section of E. Lvnw. Rd. main replacement due to leakage and poor condition (approx 1/4 mile)	Replace failing pipe as soon as practical
1-E	Supply Transmission	Abandon deteriorated 10" steel main across river	When/if it is determined to be leaking
2	Downtown Transmission	Main upgrades mostly along Commercial St and Front St to provide fire flow to downtown and transmission to east end of system	These improvements are needed to address current deficiencies
3	Zone 1 Transmission to Ski Hill Dr	Main upgrades from the downtown trunk main to the Pine St / Ski Hill Dr area to bolster suction pressures at Ski Hill booster station #1	Needed when the City upgrades the pumps at Ski Hill booster station #1 for growth
4	PressureZones 2-4 (present & future)	Schematic layout of mains and looping necessary to meet minimum criteria in all pressure zones	As development occurs
5	Pressure Reducing Stations	Pressure reducing valves between zones make the storage of upper zones available to lower zones	Needed when the City constructs storage for Zone 3 and for interim fire protection before full distribution grid is constructed
6	Titus Rd / Chumstick Hwy Intertie	Pressure reducing station linking Titus Rd (Zone 2) and the Chumstick Hwy (Zone 1) to provide fire protection along the Chumstick Hwy and augment downtown & riverbend fire flows	These improvements are needed to address current deficiencies
7	Titus Rd PRV	PRV in Titus Rd near the high school to provide fire flow to Zone 1	Needed to address current deficiencies (most important prior to implementation of items 2 and 6 above)
8	Supply Transmission	Replace deteriorated 16" main in Icicle Rd. from WTP to East Leavenworth Rd. with 18" main.	As necessary due to maintenance issues
(see Figure 4)	Distribution	Replace existing 4" mains with 8" mains	As necessary due to maintenance issues or as development requires.

4. SEWER COLLECTION SYSTEM ANALYSIS

4.1. History

The 1996 Wastewater Facility Plan (WWFP) included two Technical Memoranda (TMs) which provided a history and evaluation of the existing sanitary sewer collection system and an evaluation of the South Interceptor Sewer. These TMs, titled "TMVA-LEAV10 Evaluation of Sanitary sewer Collection System" and "TMVA-LEAV 11 South Interceptor Sewer Evaluation" are included in the Appendix. This information was reviewed as part of this analysis.

4.2. Definitions

The sanitary sewer collection system consists of lateral mains, collector mains, trunk mains and interceptor mains.

Lateral Mains: The lateral mains collect wastewater from individual service connections and have no contributing mains.

Collector Mains: Collector mains collect wastewater from individual service connections and are connected to one or more lateral mains and generally define a drainage basin.

Trunk Mains: Trunk mains have fewer service connections and connect several collector mains (drainage basins) to the interceptor main.

Interceptor Mains: Interceptor mains generally have few if any service connections and connect one or more trunk mains to the wastewater treatment plant (WWTP).

4.3. Condition of Facilities and Operational Problem Areas

4.3.1. General

As recommended in the 1996 WWFP the sewer collection system pipes were cleaned and video inspected, the manholes were inspected and portions of the collection system were smoke tested. This work was performed in 2000. The information collected during this work was documented in the 2001 "Summary Report and Rehabilitation Prioritization Plan". A copy of this report is included in the Appendix.

The majority of the collection system was constructed using vitrified clay pipe, 3 foot section concrete pipe and transite (asbestos cement - ac) pipe. The remaining pipe is newer PVC with PVC being required by the City for new collection system piping. The primary deficiency in the existing pipe is root intrusion. Several pipe reaches have previously been recommended for replacement, including the entire South Interceptor.

The projected ultimate growth criteria assumed for this analysis relates to an approximate 40-50 year planning period. It is assumed that the majority of the existing concrete, clay and transite pipe will

have deteriorated to the point of requiring rehabilitation or replacement within this planning period, unrelated to capacity issues.

A maintenance program is recommended to include annual flushing of mains and a cleaning, root removal and internal TV inspection program every 5 years or as determined to optimize system condition, monitoring and maintenance/replacement. Based on the results of these inspections a rehabilitation/replacement program can be implemented and budgeted. Implementing a rehabilitation/replacement program is an important step in maintaining adequate system function preventing , system failures and to facilitate financial planning.

4.3.2. Trunk Line 1

Subsequent to the 2000 collection system inspection, the pipe from MH 12-C to MH 17-C is reported to have settled and have 1" – 2" of gravel in the bottom. This section of the trunk line will require annual cleaning and inspection and eventual replacement/rehabilitation. Timing of replacement should be determined based on comparing estimated replacement/rehabilitation costs versus continued maintenance costs.

4.3.3. South Interceptor

The South Interceptor was identified in the WWFP and the 2001 "Summary Report and Rehabilitation Prioritization Plan" as having operational and maintenance problems. The pipe reaches from MH C4 to MH C6a have been recently identified as having more severe operational and maintenance problems needing more immediate attention and should be included in the CIP and budgeted for replacement.

4.4. Flow Basins and Growth Areas

The planning area comprises 11 separate drainage basins, Basin A through Basin I, collecting the wastewater within the City Limits. There are 14 identified future growth areas, Area 1 through Area 14, located generally north of the City Limits to the UGA and beyond to Titus Rd.

The collection system consists of a number of lateral and collector sewers, trunk mains and one interceptor main. Three sewer mains enter the WWTP, the South Interceptor which carries the flows from Basin C, D, E, F, G, I, and AA, Trunk Line 2 which carries flow from Basin A, B, and BB, and Trunk Line 5 which carries flow from Basin H. These basins, growth areas and trunk mains are shown in attached **Figure 5**.

4.5. Analysis and Methodology

Design flows are based on the following design criteria:

- Projected ultimate ERUs as determined in Section 2.3
- Average Daily Flow established in Section 2.3
- Peaking factor based on the 10 State Standards equation $(18 + \sqrt{P}) \div (4 + \sqrt{P})$, see table in Appendix
- I/I estimated flow as determined in Section 2.3 (not peaked)

The hydraulic analysis of the trunk mains and interceptor mains was performed by comparing the calculated design flow (Qd) for each reach and against the design capacity (Qc) of each reach. The Qd was determined by adding the accumulated average daily flow of each contributing sub-basin, peaking the accumulated average daily flow per the Peaking Factor table (see Appendix), and adding estimated I/I. The Qc of each reach was determined using Mannings Equation [$Q=(1.486/n)AR^{2/3} S^{1/2}$] where:

- **Q** = flow in cfs
- **N** = coefficient of roughness (use 0.013)
- **A** = flow area (ft^2), assuming pipe full so flow area will equal pipe section area (maximum gravity flow is achieved at 80-85% of full flow, assuming full flow creates a 15-20% safety factor)
- **R** = hydraulic radius (ft), assuming ipe full R=A/P where A = area and P = wetted perimeter (always pipe dia. x .25 when pipe full)
- **S** = pipe slope (ft/ft)

The lateral mains and collector mains within each sub-basin were not analyzed individually as in no case did the flows from any individual sub-basin exceed the flow capacity of an 8" pipe at minimum slope.

The analysis was performed to determine the following:

- Pipe diameter required for lateral mains within identified growth areas
- Pipe diameter required for collector mains to transport the estimated flows from the identified growth areas to existing trunk lines
- Analyze existing trunk main and interceptor main capacities
- Locate connections of future collector mains to the existing collection system to optimize existing collection system capacities
- Identify capacity deficiencies within the existing collection system
- Analyze corrective options
- Recommend improvements to provide needed capacity for projected ultimate growth

4.6. Collection System Findings

The hydraulic analysis of the trunk mains and interceptor main determined the following (see **Figure 6**):

South Interceptor: Portions of the South Interceptor do not have the available capacity to accept additional flow from the identified growth areas or estimated ultimate flows within it existing drainage basin. It will be necessary to increase the capacity of portions of the South Interceptor. The recommended drainage basin, routing of specific growth areas and specific reaches requiring replacement are shown on **Figure 6** along with recommended pipe size.

Trunk Line 1: Portions of Trunk Line 1 do not have the available capacity to accept additional flow from the identified growth areas or estimated ultimate flows within it existing drainage basin. It will be necessary to increase the capacity of portions of this Trunk Line. The recommended drainage basin, routing of specific growth areas and specific reaches requiring replacement are shown on **Figure 6** along with recommended pipe size.

Trunk Line 2: Trunk Line 2 has available excess capacity and can accept additional flow from the identified growth areas. The recommended drainage basin and routing of specific growth areas including recommended improvements are shown on **Figure 6**.

Trunk Line 3: Trunk Line 3 has available excess capacity. Due the location of Trunk Line 3 there is limited potential to use the available capacity. The recommended drainage basin and routing of specific growth areas are shown on **Figure 6**.

Trunk Line 4: Portions of Trunk Line 4 do not have the capacity available to route all the identified growth areas into this main. It will be necessary to limit the areas routed into Trunk Line 4. Even when limiting the growth area boundary it will be necessary to reroute this trunk line to Trunk Line 3 and avoid capacity limiting reaches of this trunk line. The recommended drainage basin boundary, routing of specific growth areas and recommended improvements are shown on **Figure 6**.

Trunk Line 5: Trunk Line 5 has available excess capacity to accept the projected ultimate flows from Basin H.

Trunk Line 6: Portions of Trunk Line 6 do not have the available capacity to carry the projected ultimate demands from Basin G, I and AA. It will be necessary to increase the capacity of portions of this Trunk Line. The recommended drainage basin boundary, routing of specific growth areas and specific reaches requiring replacement are shown on **Figure 6** along with recommended pipe size.

Trunk Line 7: Trunk Line 7 is a new trunk line. Due to existing topography in Area 9 and Area 10 along with the capacity issues related to Trunk Line 4, it will be necessary to construct a new trunk line to serve this area. There are three alternatives available to service this area.

Alternative A: Extend Gravity Service (no lift station)
This alternative requires the replacement of existing pipe from MH A4 to MH A7 at flatter slopes, constructing a 10” main at minimum slopes along Chumstick Hwy to the midway point of Area 9, and constructing an 8” main at minimum slopes to Area 4. This option results in sewer depths of 20’-25’ in places and 4’-6’ in other locations.

Alternative B: Extend Gravity Service and construct Lift Station
This alternative requires the replacement of existing pipe from MH A4 to MH A7 at flatter slopes, constructing a 10” main at minimum slopes along Chumstick Hwy to the midway point of Area 9, installing a lift station and constructing an 8” gravity main extending to Area 4. This option results in sewer depths of 18’-22’ in places and 4’-6’ in other locations and requires the construction of a sewer lift station.

Alternative C: Construct Lift Station and Force Main
This alternative requires no replacement of existing pipe. A larger lift station is constructed near the intersection of Chumstick Hwy and North Rd. 8” Gravity mains (10” mains may be necessary depending on available pipe slope) are extended north and south of the lift station as necessary for local service. A force main is constructed from the lift station to the 10” main at MH A6. This option results in a shorter, smaller diameter sewer main at much shallower depths. A larger lift station is required to serve the ultimate projected population from this basin. The force main and lift station would need to be sized such as to accommodate the smaller, near term flows while being capable of being upgraded to accommodate the larger long term flows.

These alternatives are shown on Exhibit A (next page).

Alternative B is recommended due to the reduced sewer depths required (as compared with Alternative A) and to decrease the size of the lift station (as compared with Alternative C). If it becomes cost prohibitive to implement this alternative the other alternatives should be reconsidered.

The recommended drainage basin boundary, routing of specific growth areas and recommended improvements are shown on **Figure 6**.

4.7. Recommended Improvements and Schedule

This document plans for ultimate growth as projected to occur over the next 40-50 years. The majority of the existing collection system is currently old and has maintenance issues, as identified in earlier reports reprinted in the Appendix. It is assumed that much of the existing system will be replaced or rehabilitated within the planning period of this analysis. It is recommended that the pipe reaches noted as needing increased capacity are replaced and upsized when this rehabilitation or replacement occurs. If this does not happen within the next 15 to 20 years it will be necessary to monitor flows in order to determine when the flows are approaching the capacity of the existing pipelines and replacement becomes necessary.

In the identified growth areas it is expected that new pipe will be installed by developers as this growth occurs. Pipe diameters recommended in this report for these areas will accommodate the projected ultimate growth.

To direct the flow from the growth areas into the appropriate existing trunk lines it is recommended that improvements noted at Ski Hill Dr. and Birch St. (rerouting flow from south on Ski Hill Dr. to east on Birch St.) are implemented when the sewer main is extended north on Ski Hill Dr. to service identified growth Areas 1, 5 and 10.

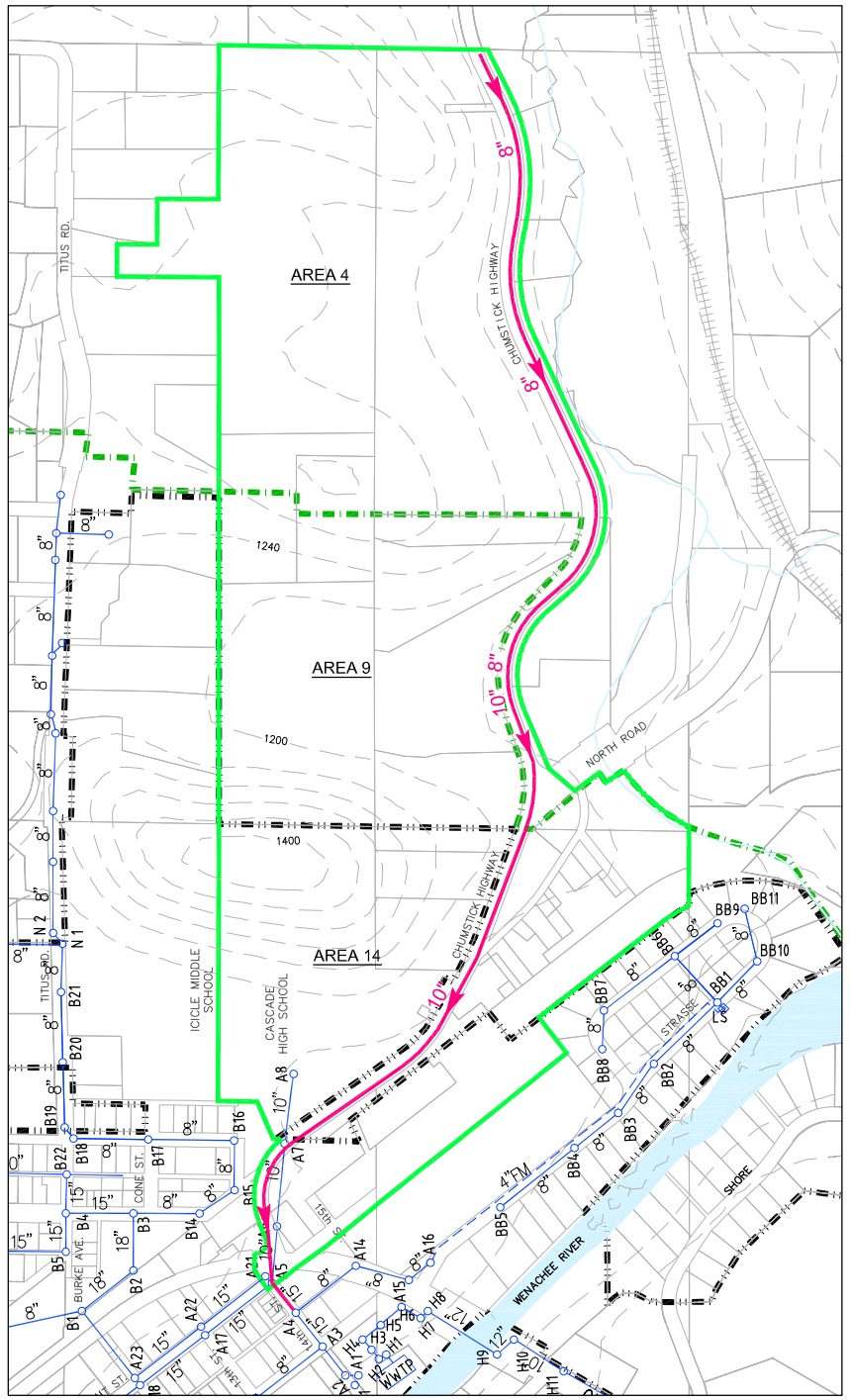
The improvements noted at Pine St. and Titus Rd. (rerouting flow from east on Pine St. to South on Titus Rd.) should be implemented as soon as practical.

Trunk Line 7 will need to be constructed as soon as practical as growth cannot occur in this drainage basin until sewer service is provided. It is assumed that developers will be required to construct this main. Depending on the costs and complexities involved with implementing the recommended improvements and the volume of the initial growth, it may be necessary to reevaluate the available alternatives for serving this area.

A summary of the recommended improvements and schedule is shown in Table 4-1.

Table 4-1 Summary of Sanitary Sewer Collection System Improvements and Schedule *(See Figure 6)*

Improvement Designation	Category	Description & Purpose	Schedule
1	Increase existing capacity	Replace existing South Interceptor Sewer from MH C12 to MH A1 with 18" pipe (reconstruct at constant grade to correct isolated grade deficiencies) and MH A1 to MH H2 with 21" pipe.	Replace as needed to correct operation and maintenance deficiencies, also monitor flow and replace as pipe nears capacity.
1-A	Operation and Maintenance	Replace existing South Interceptor Sewer from MH C4 to MH C6a with 18" pipe (reconstruct at constant grade to correct isolated grade deficiencies)	As soon as practical due to operational problems
2	Increase existing capacity	Replace existing Trunk Line 1 from MH E7-C to MH E8-C.	Replace as needed to correct operation and maintenance deficiencies, also monitor flow and replace as pipe nears capacity.
3	Increase existing capacity	Install new MH to north of MH E15-C to intercept flow from the north, rerouting flow to Trunk Line 2. Install new 12" pipe to MH B12. Plug north invert of MH E15-C.	Needed when collection system pipe is extended north of Pine St. on Ski Hill Dr.
4	Increase existing capacity	Abandon pipe between MH B18 and MH B19. Install new 10" Pipe between MH B22 and MH B19, reroute flow to Trunk Line 3.	Needed when collection system pipes are extended north of Emig Dr. and west of Titus Rd.
5	Increase existing capacity	Replace portions of Trunk Line 6 with 10" pipe.	Replace as needed to correct operation and maintenance deficiencies, also monitor flow and replace as pipe nears capacity.
6	Extend service to new area	Replace existing mains from MH A4 to MH A7 (size as noted) at minimum slopes to increase depth. Install new 10" pipe from MH A7 to Area 9 along Chumstick Hwy.	As development occurs (see Exhibit A for alternatives)
7	Extend service to new area	Construct Lift Station with force main to 10" pipe at Area 9. Install new 8" pipe from Lift Station to Area 4.	As development occurs (see Exhibit A for alternatives)
8	Operation and Maintenance	Install 8" gravity mains to area. Abandon existing lift station and connect residents to new gravity pipe.	As needed to correct future operation and maintenance deficiencies or replacement needs related to existing lift station.
9	Extend service to new area	Construct Lift Station and install 8" and 10" pipe	As development occurs



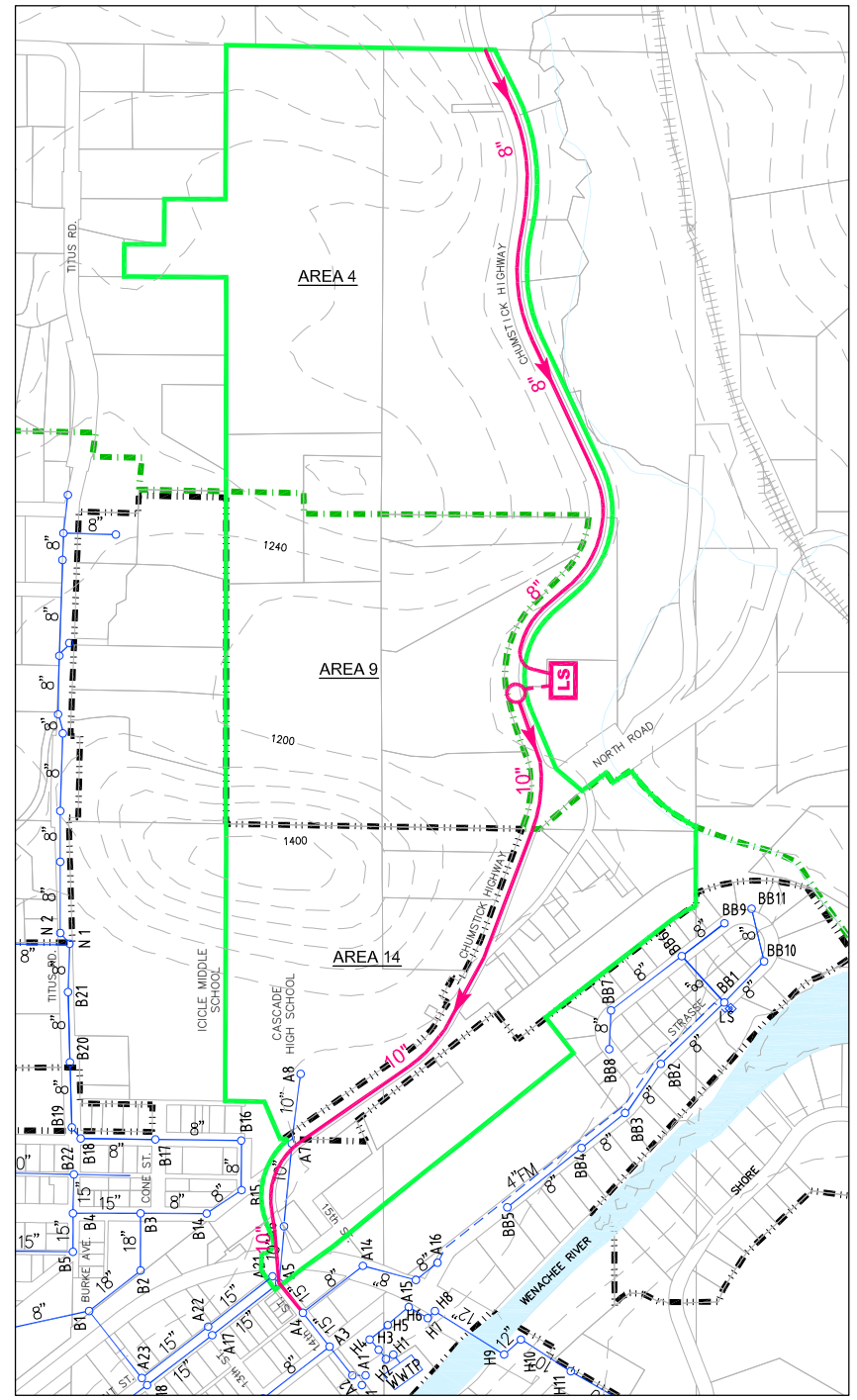
ALTERNATIVE A

EXTEND GRAVITY SERVICE (NO LIFT STATION)

PROS
OPERATION AND MAINTENANCE COST SAVINGS OVER INSTALLING LIFT STATION
WILL REPLACE SEVERAL REACHES OF EXISTING, AGED SEWER PIPES

CONS
DEEP SEWERS (20'–25' IN PLACES)
- DIFFICULT AND EXPENSIVE TO CONSTRUCT
- EXPECT INTERFERENCE WITH EXISTING UTILITIES DURING CONSTRUCTION
- FUTURE SERVICE CONNECTIONS ARE MORE DIFFICULT AND EXPENSIVE
- SHALLOW SEWERS (4'–6' IN PLACES)
- MAY INTERFERE WITH EXISTING OR FUTURE WATER PIPES
- MAY INTERFERE WITH EXISTING AND FUTURE STORM DRAINAGE PIPES

REQUIRES REPLACEMENT OF EXISTING MAINS
REQUIRES HWY 2 CROSSING
DISRUPTIVE TO HWY 2 TRAFFIC



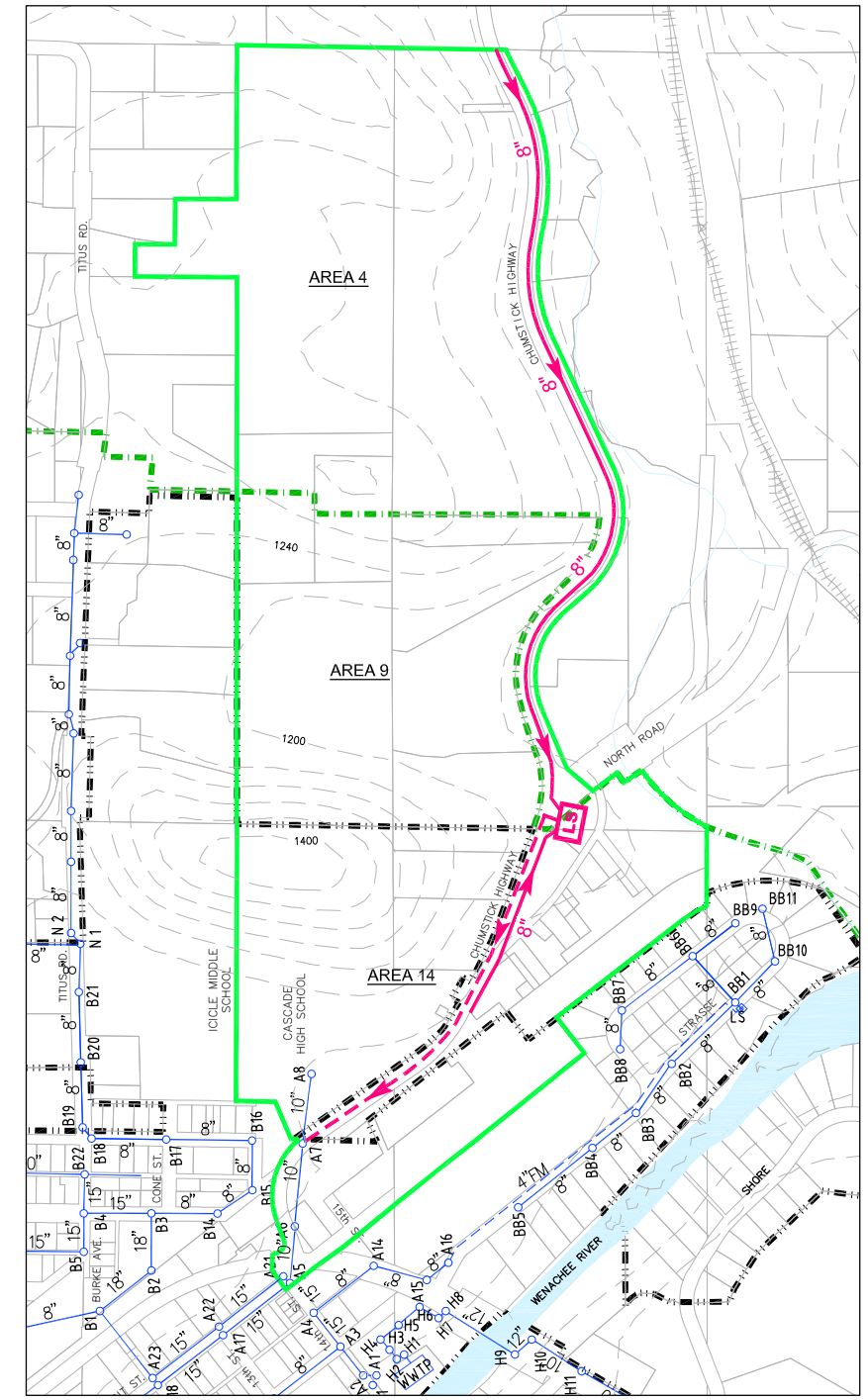
ALTERNATIVE B

EXTEND GRAVITY SERVICE AND CONSTRUCT LIFT STATION

PROS
SEWERS NOT AS DEEP AS ALTERNATIVE A (18'–22')
- LESS DIFFICULTY AND EXPENSE TO CONSTRUCT THAN ALT. A
- LESS INTERFERENCE WITH EXISTING UTILITIES DURING CONSTRUCTION THAN ALT. A
- LESS DIFFICULTY WITH FUTURE SERVICE CONNECTIONS THAT ALT. A

CONS
SHALLOW SEWERS (4'–6' IN PLACES)
- MAY INTERFERE WITH EXISTING OR FUTURE WATER PIPES
- MAY INTERFERE WITH EXISTING AND FUTURE STORM DRAINAGE PIPES REQUIRES CONSTRUCTION OF A LIFT STATION
- INCREASED OPERATION AND MAINTENANCE REQUIREMENTS
- INCREASED OPERATION AND MAINTENANCE COSTS (POWER, ETC.)
- LAND ACQUISITION/EASEMENT REQUIRED
- DESIGN COMPLICATED BY LOW INITIAL FLOWS, HIGH FUTURE FLOWS
- COMPLICATES PUMP SELECTION, FORCE MAIN DIAMETER

REQUIRES REPLACEMENT OF EXISTING MAINS
REQUIRES HWY 2 CROSSING
DISRUPTIVE TO HWY 2 TRAFFIC



ALTERNATIVE C

CONSTRUCT LIFT STATION AND FORCE MAIN

PROS
SEWERS CAN REMAIN RELATIVELY SHALLOW (8'–12')
- LESS DIFFICULTY AND EXPENSE TO CONSTRUCT THAN ALT. A/B
- LESS INTERFERENCE WITH EXISTING UTILITIES DURING CONSTRUCTION THAN ALT. A/B
- SUBSTANTIALLY LESS DIFFICULTY WITH FUTURE SERVICE CONNECTIONS THAT ALT. A/B

DOES NOT REQUIRE REPLACEMENT OF EXISTING MAINS
DOES NOT REQUIRE HWY 2 CROSSING
DOES NOT DISRUPT HWY 2 TRAFFIC

CONS
REQUIRES CONSTRUCTION OF A LARGER LIFT STATION THAN ALT B.
- INCREASED OPERATION AND MAINTENANCE REQUIREMENTS OVER ALT A/B
- INCREASED OPERATION AND MAINTENANCE COSTS (POWER, ETC.) OVER ALT A/B
- LAND ACQUISITION/EASEMENT REQUIRED (SAME AS ALT B)
- INCREASED DESIGN COMPLICATIONS THAN ALT B DUE TO HIGHER FLOW RANGE BETWEEN INITIAL FLOWS AND FUTURE FLOWS
- INCREASES COMPLICATIONS WITH PUMP SELECTION, FORCE MAIN DIAMETER

N

0 400 800
SCALE

LEGEND
- CITY LIMITS
- URBAN GROWTH AREA (UGA) BOUNDARY
- BASIN BOUNDARY
- EXISTING SEWER PIPE, DIAMETER, MATERIAL (if known), LENGTH
- EXISTING PRESSURE SEWER PIPE
- EXISTING SANITARY SEWER MANHOLE
- 10" NEW SANITARY SEWER PIPE
- IMPROVEMENTS PRESSURE FORCE MAIN SANITARY SEWER PIPE
- LS LIFT STATION

140802–IPE–Sewer–Storm–Figure 5 & 6

NO.	DATE	BY	CKD.	APP.	REVISIONS

SCALE: AS SHOWN
DESIGNED: JSM
DRAWN: TVP
CHECKED: JSM
APPROVED: MJV
PROJ. NO.: 14–08–02
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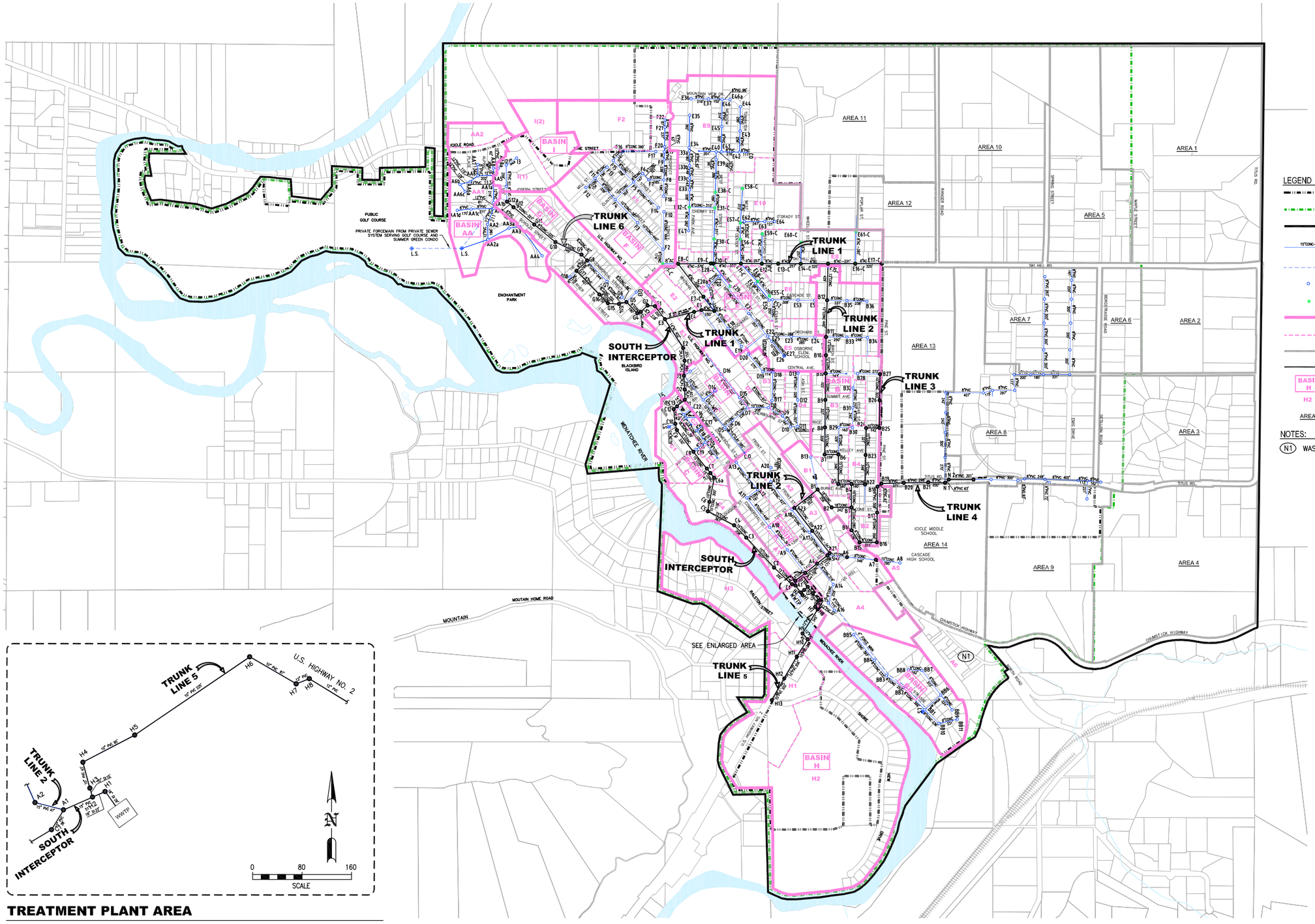
ENGINEERING AND MANAGEMENT

CITY OF LEAVENWORTH, WA
WATER DISTRIBUTION SYSTEM & COLLECTION SYSTEM MASTER PLAN

IMPROVEMENT ALTERNATIVES - CHUMSTICK HIGHWAY

EXHIBIT
A

REDUCED FIGURES



TREATMENT PLANT AREA

0 600 1200
SCALE

LEGEND

- CITY LIMITS
- URBAN GROWTH AREA (UGA) BOUNDARY
- PLANNING AREA BOUNDARY
- 15"CONC-200' — EXISTING LATERAL OR COLLECTOR SEWER PIPE, DIAMETER, MATERIAL (if known), LENGTH
- EXISTING PRESSURE SEWER PIPE
- EXISTING SANITARY SEWER MANHOLE
- EXISTING COMBINED SANITARY/STORM SEWER MANHOLE
- EXISTING BASIN BOUNDARY
- EXISTING SUB BASIN BOUNDARY
- DESIGNATED GROWTH AREA BOUNDARY
- TRUNK LINE
- BASIN H — BASIN DESIGNATION
- H2 — SUB BASIN DESIGNATION
- AREA 1 — GROWTH AREA DESIGNATION

NOTES:

(N1) WASTEWATER FROM THIS AREA IS PUMPED TO MH A7.

140802-IPE-Sewer-Storm-Figure 5 & 6

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CITY OF LEAVENWORTH, WASHINGTON
WATER DISTRIBUTION SYSTEM & SEWER COLLECTION SYSTEM MASTER PLAN

SEWER COLLECTION SYSTEM ANALYSIS
EXISTING COLLECTION SYSTEM AND DRAINAGE BASIN MAP

FIGURE
5

LEGEND - EXISTING SYSTEM

- CITY LIMITS BOUNDARY
- UGA BOUNDARY
- PLANNING AREA BOUNDARY
- 1200 — PRESSURE ZONE BOUNDARY
- PRV — PRESSURE REDUCING VALVE
- FIRE HYDRANT
- WATER VALVE
- EXISTING RESERVOIR
- 6" — EXISTING WATER MAIN
- PRIVATE WATER PIPE

STL STEEL
CI CAST IRON
DI DUCTILE IRON
(1930) INSTALLATION YEAR (IF AVAILABLE)

- 6" — ZONE 1–EXISTING WATER MAIN
- 6" — ZONE 2–EXISTING WATER MAIN
- 18" — ZONE 1–IMPROVEMENTS
- 12" — ZONE 2–IMPROVEMENTS
- 8" — ZONE 3–IMPROVEMENTS
- 10" — ZONE 4–IMPROVEMENTS
- 4" — MAINS TO BE REPLACED WITH 8" DUE TO DETERIORATION OR WHEN DEVELOPMENT REQUIRED

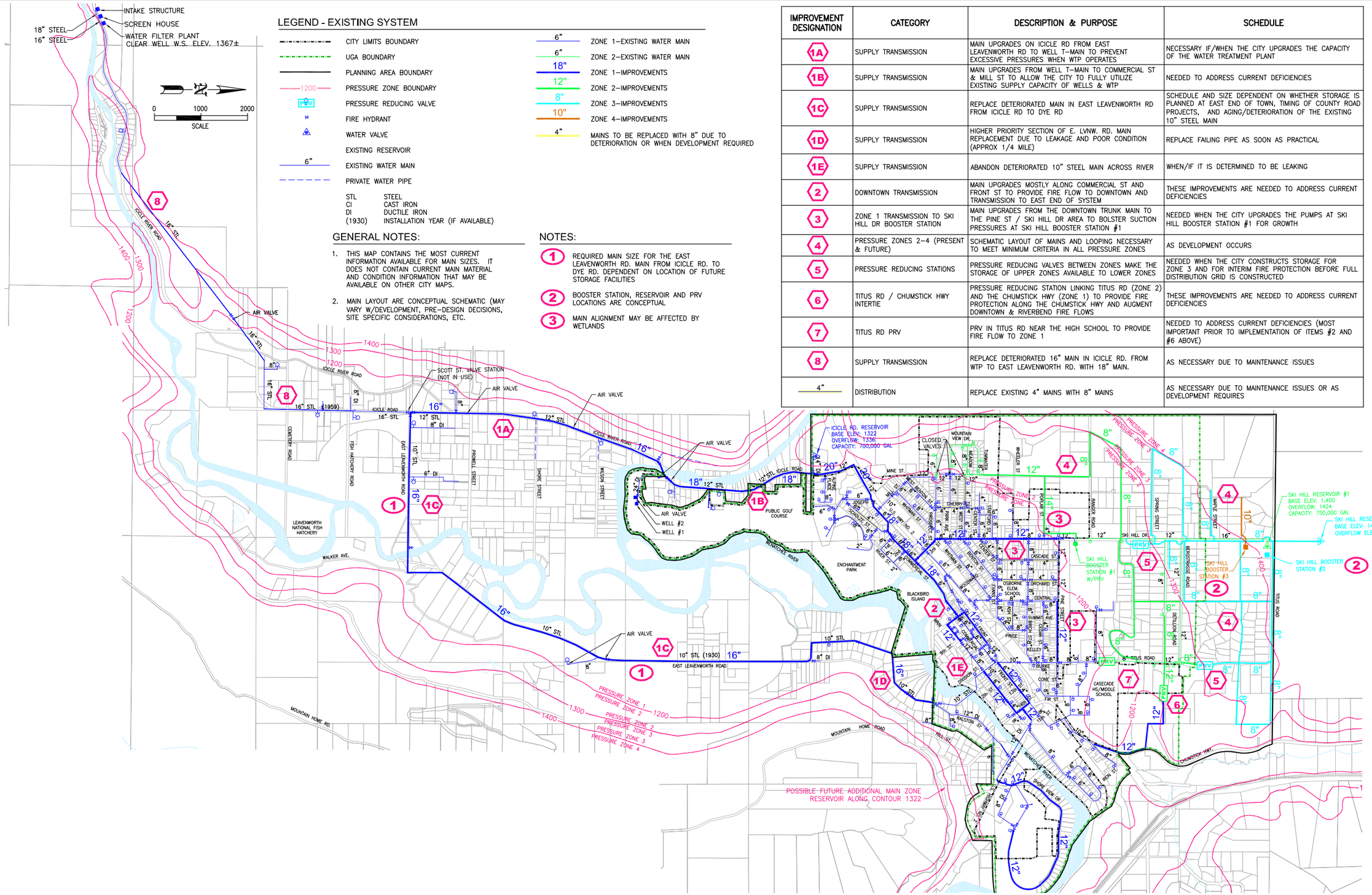
GENERAL NOTES:

1. THIS MAP CONTAINS THE MOST CURRENT INFORMATION AVAILABLE FOR MAIN SIZES. IT DOES NOT CONTAIN CURRENT MAIN MATERIAL AND CONDITION INFORMATION THAT MAY BE AVAILABLE ON OTHER CITY MAPS.
2. MAIN LAYOUT ARE CONCEPTUAL SCHEMATIC (MAY VARY W/DEVELOPMENT, PRE–DESIGN DECISIONS, SITE SPECIFIC CONSIDERATIONS, ETC.

NOTES:

1. REQUIRED MAIN SIZE FOR THE EAST LEAVENWORTH RD. MAIN FROM ICICLE RD. TO DYE RD. DEPENDENT ON LOCATION OF FUTURE STORAGE FACILITIES
2. BOOSTER STATION, RESERVOIR AND PRV LOCATIONS ARE CONCEPTUAL
3. MAIN ALIGNMENT MAY BE AFFECTED BY WETLANDS

IMPROVEMENT DESIGNATION	CATEGORY	DESCRIPTION & PURPOSE	SCHEDULE
1A	SUPPLY TRANSMISSION	MAIN UPGRADES ON ICICLE RD FROM EAST LEAVENWORTH RD TO WELL T–MAIN TO PREVENT EXCESSIVE PRESSURES WHEN WTP OPERATES	NECESSARY IF/WHEN THE CITY UPGRADES THE CAPACITY OF THE WATER TREATMENT PLANT
1B	SUPPLY TRANSMISSION	MAIN UPGRADES FROM WELL T–MAIN TO COMMERCIAL ST & MILL ST TO ALLOW THE CITY TO FULLY UTILIZE EXISTING SUPPLY CAPACITY OF WELLS & WTP	NEEDED TO ADDRESS CURRENT DEFICIENCIES
1C	SUPPLY TRANSMISSION	REPLACE DETERIORATED MAIN IN EAST LEAVENWORTH RD FROM ICICLE RD TO DYE RD	SCHEDULE AND SIZE DEPENDENT ON WHETHER STORAGE IS PLANNED AT EAST END OF TOWN, TIMING OF COUNTY ROAD PROJECTS, AND AGING/DETERIORATION OF THE EXISTING 10" STEEL MAIN
1D	SUPPLY TRANSMISSION	HIGHER PRIORITY SECTION OF E. LVNW. RD. MAIN REPLACEMENT DUE TO LEAKAGE AND POOR CONDITION (APPROX 1/4 MILE)	REPLACE FAILING PIPE AS SOON AS PRACTICAL
1E	SUPPLY TRANSMISSION	ABANDON DETERIORATED 10" STEEL MAIN ACROSS RIVER	WHEN/IF IT IS DETERMINED TO BE LEAKING
2	DOWNTOWN TRANSMISSION	MAIN UPGRADES MOSTLY ALONG COMMERCIAL ST AND FRONT ST TO PROVIDE FIRE FLOW TO DOWNTOWN AND TRANSMISSION TO EAST END OF SYSTEM	THESE IMPROVEMENTS ARE NEEDED TO ADDRESS CURRENT DEFICIENCIES
3	ZONE 1 TRANSMISSION TO SKI HILL DR BOOSTER STATION	MAIN UPGRADES FROM THE DOWNTOWN TRUNK MAIN TO THE PINE ST / SKI HILL DR AREA TO BOLSTER SUCTION PRESSURES AT SKI HILL BOOSTER STATION #1	NEEDED WHEN THE CITY UPGRADES THE PUMPS AT SKI HILL BOOSTER STATION #1 FOR GROWTH
4	PRESSURE ZONES 2–4 (PRESENT & FUTURE)	SCHEMATIC LAYOUT OF MAINS AND LOOPING NECESSARY TO MEET MINIMUM CRITERIA IN ALL PRESSURE ZONES	AS DEVELOPMENT OCCURS
5	PRESSURE REDUCING STATIONS	PRESSURE REDUCING VALVES BETWEEN ZONES MAKE THE STORAGE OF UPPER ZONES AVAILABLE TO LOWER ZONES	NEEDED WHEN THE CITY CONSTRUCTS STORAGE FOR ZONE 3 AND FOR INTERIM FIRE PROTECTION BEFORE FULL DISTRIBUTION GRID IS CONSTRUCTED
6	TITUS RD / CHUMSTICK HWY INTERTIE	PRESSURE REDUCING STATION LINKING TITUS RD (ZONE 2) AND THE CHUMSTICK HWY (ZONE 1) TO PROVIDE FIRE PROTECTION ALONG THE CHUMSTICK HWY AND AUGMENT DOWNTOWN & RIVERBEND FIRE FLOWS	THESE IMPROVEMENTS ARE NEEDED TO ADDRESS CURRENT DEFICIENCIES
7	TITUS RD PRV	PRV IN TITUS RD NEAR THE HIGH SCHOOL TO PROVIDE FIRE FLOW TO ZONE 1	NEEDED TO ADDRESS CURRENT DEFICIENCIES (MOST IMPORTANT PRIOR TO IMPLEMENTATION OF ITEMS #2 AND #6 ABOVE)
8	SUPPLY TRANSMISSION	REPLACE DETERIORATED 16" MAIN IN ICICLE RD. FROM WTP TO EAST LEAVENWORTH RD. WITH 18" MAIN.	AS NECESSARY DUE TO MAINTENANCE ISSUES
4"	DISTRIBUTION	REPLACE EXISTING 4" MAINS WITH 8" MAINS	AS NECESSARY DUE TO MAINTENANCE ISSUES OR AS DEVELOPMENT REQUIRES



140801–IPE–Water–Figure 3 & 4

NO.	DATE	BY	CKD.	APP.	REVISIONS

SCALE: AS SHOWN
DESIGNED: JJC
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APPROVED: MJV
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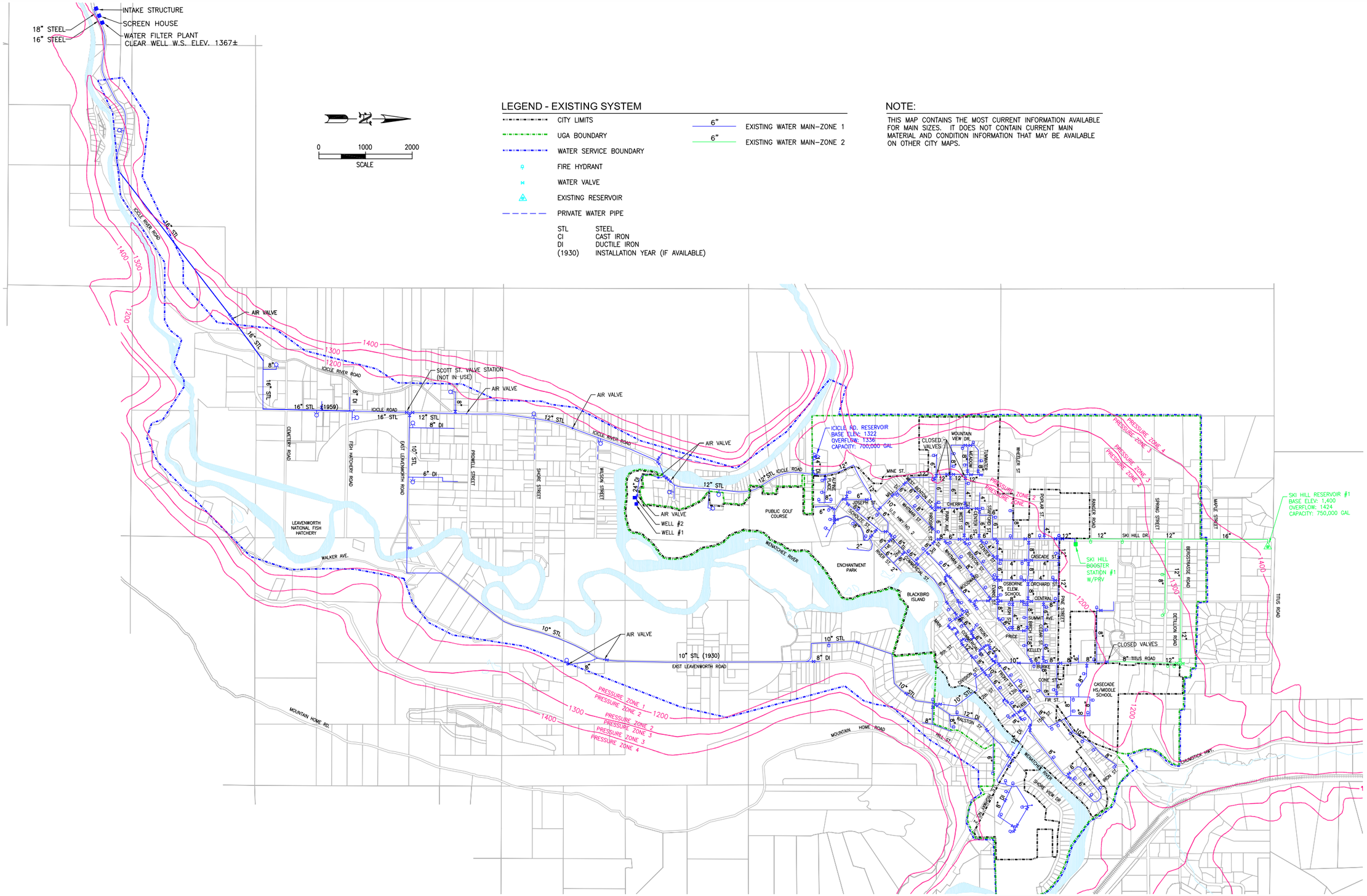
CITY OF LEAVENWORTH, WASHINGTON
WATER DISTRIBUTION SYSTEM & SEWER COLLECTION SYSTEM MASTER PLAN

WATER DISTRIBUTION SYSTEM ANALYSIS
IMPROVEMENTS

FIGURE
4



140801–IPE–Water–Figure 3 & 4

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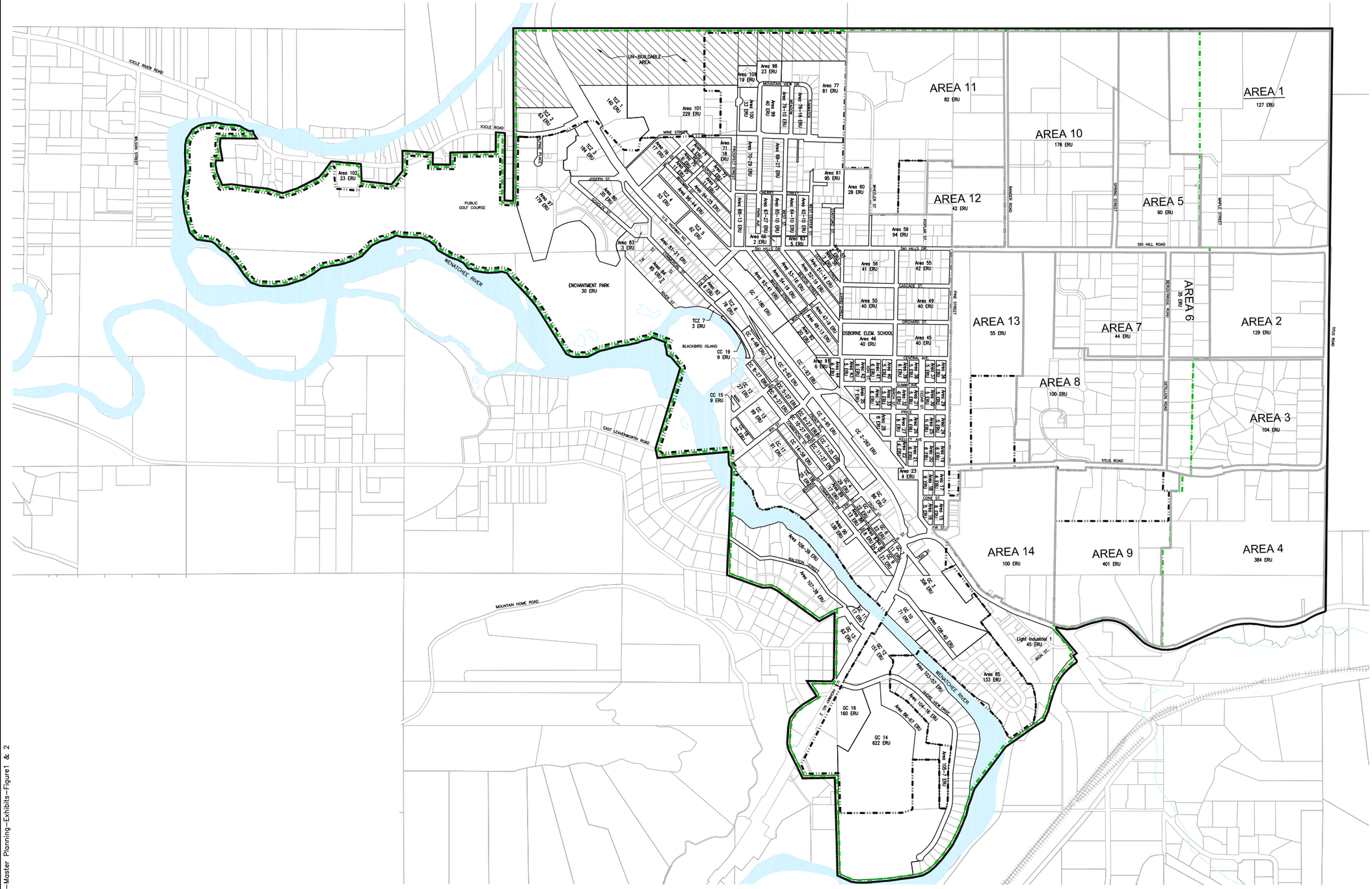
CITY OF LEAVENWORTH, WASHINGTON
WATER DISTRIBUTION SYSTEM & SEWER COLLECTION SYSTEM MASTER PLAN

WATER DISTRIBUTION SYSTEM ANALYSIS
EXISTING WATER SYSTEM

FIGURE
3



1408-IPE-Master Planning-Exhibits-Figure1 & 2

NO.	DATE	BY	CKD.	APP.	REVISIONS

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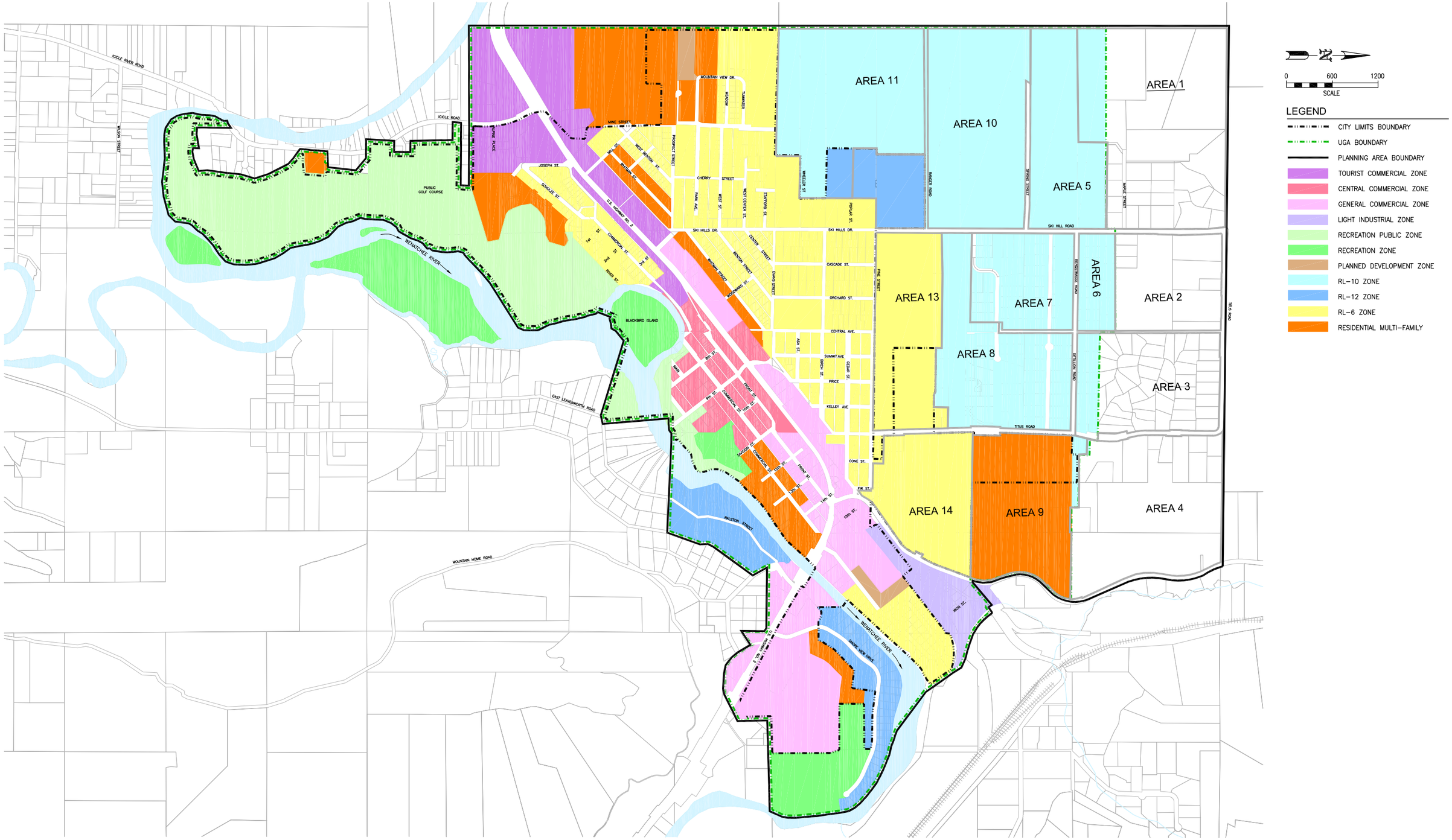
CITY OF LEAVENWORTH, WASHINGTON
WATER DISTRIBUTION SYSTEM & SEWER COLLECTION SYSTEM MASTER PLAN

WATER DISTRIBUTION SYSTEM ANALYSIS
PROJECTED ULTIMATE WATER DEMAND DISTRIBUTION

FIGURE
2



1408-IPE-Master Planning-Exhibits-Figure1

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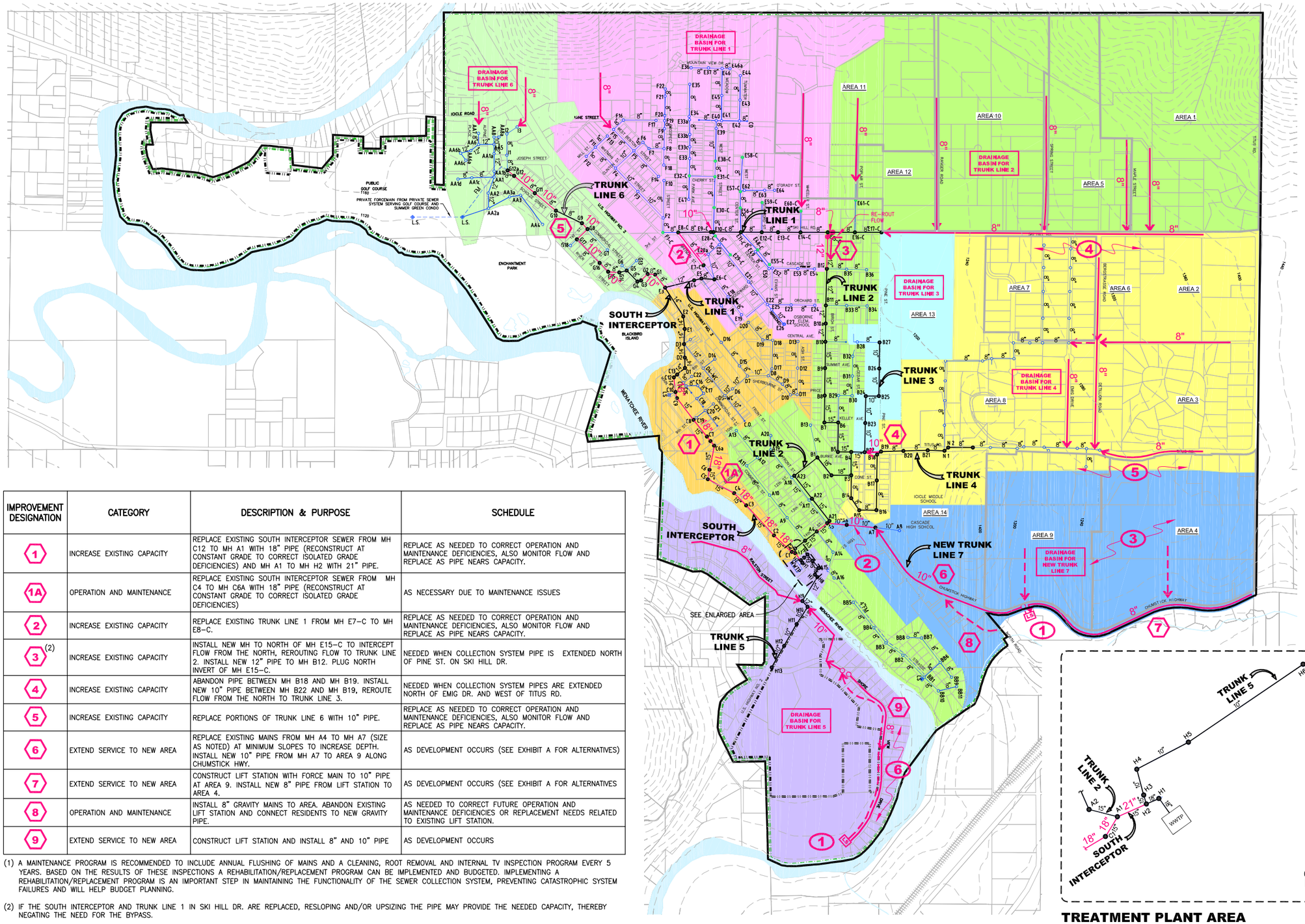
CITY OF LEAVENWORTH, WASHINGTON
WATER DISTRIBUTION SYSTEM & SEWER COLLECTION SYSTEM MASTER PLAN

PLANNING AREA AND ZONING

FIGURE
1



IMPROVEMENT DESIGNATION	CATEGORY	DESCRIPTION & PURPOSE	SCHEDULE
1	INCREASE EXISTING CAPACITY	REPLACE EXISTING SOUTH INTERCEPTOR SEWER FROM MH C12 TO MH A1 WITH 18" PIPE (RECONSTRUCT AT CONSTANT GRADE TO CORRECT ISOLATED GRADE DEFICIENCIES) AND MH A1 TO MH H2 WITH 21" PIPE.	REPLACE AS NEEDED TO CORRECT OPERATION AND MAINTENANCE DEFICIENCIES, ALSO MONITOR FLOW AND REPLACE AS PIPE NEARS CAPACITY.
1A	OPERATION AND MAINTENANCE	REPLACE EXISTING SOUTH INTERCEPTOR SEWER FROM MH C4 TO MH C6A WITH 18" PIPE (RECONSTRUCT AT CONSTANT GRADE TO CORRECT ISOLATED GRADE DEFICIENCIES)	AS NECESSARY DUE TO MAINTENANCE ISSUES
2	INCREASE EXISTING CAPACITY	REPLACE EXISTING TRUNK LINE 1 FROM MH E7–C TO MH E8–C.	REPLACE AS NEEDED TO CORRECT OPERATION AND MAINTENANCE DEFICIENCIES, ALSO MONITOR FLOW AND REPLACE AS PIPE NEARS CAPACITY.
3 (2)	INCREASE EXISTING CAPACITY	INSTALL NEW MH TO NORTH OF MH E15–C TO INTERCEPT FLOW FROM THE NORTH, REROUTING FLOW TO TRUNK LINE 2. INSTALL NEW 12" PIPE TO MH B12. PLUG NORTH INVERT OF MH E15–C.	NEEDED WHEN COLLECTION SYSTEM PIPE IS EXTENDED NORTH OF PINE ST. ON SKI HILL DR.
4	INCREASE EXISTING CAPACITY	ABANDON PIPE BETWEEN MH B18 AND MH B19. INSTALL NEW 10" PIPE BETWEEN MH B22 AND MH B19, REROUTE FLOW FROM THE NORTH TO TRUNK LINE 3.	NEEDED WHEN COLLECTION SYSTEM PIPES ARE EXTENDED NORTH OF EMIG DR. AND WEST OF TITUS RD.
5	INCREASE EXISTING CAPACITY	REPLACE PORTIONS OF TRUNK LINE 6 WITH 10" PIPE.	REPLACE AS NEEDED TO CORRECT OPERATION AND MAINTENANCE DEFICIENCIES, ALSO MONITOR FLOW AND REPLACE AS PIPE NEARS CAPACITY.
6	EXTEND SERVICE TO NEW AREA	REPLACE EXISTING MAINS FROM MH A4 TO MH A7 (SIZE AS NOTED) AT MINIMUM SLOPES TO INCREASE DEPTH. INSTALL NEW 10" PIPE FROM MH A7 TO AREA 9 ALONG CHUMSTICK HWY.	AS DEVELOPMENT OCCURS (SEE EXHIBIT A FOR ALTERNATIVES)
7	EXTEND SERVICE TO NEW AREA	CONSTRUCT LIFT STATION WITH FORCE MAIN TO 10" PIPE AT AREA 9. INSTALL NEW 8" PIPE FROM LIFT STATION TO AREA 4.	AS DEVELOPMENT OCCURS (SEE EXHIBIT A FOR ALTERNATIVES
8	OPERATION AND MAINTENANCE	INSTALL 8" GRAVITY MAINS TO AREA. ABANDON EXISTING LIFT STATION AND CONNECT RESIDENTS TO NEW GRAVITY PIPE.	AS NEEDED TO CORRECT FUTURE OPERATION AND MAINTENANCE DEFICIENCIES OR REPLACEMENT NEEDS RELATED TO EXISTING LIFT STATION.
9	EXTEND SERVICE TO NEW AREA	CONSTRUCT LIFT STATION AND INSTALL 8" AND 10" PIPE	AS DEVELOPMENT OCCURS

(1) A MAINTENANCE PROGRAM IS RECOMMENDED TO INCLUDE ANNUAL FLUSHING OF MAINS AND A CLEANING, ROOT REMOVAL AND INTERNAL TV INSPECTION PROGRAM EVERY 5 YEARS. BASED ON THE RESULTS OF THESE INSPECTIONS A REHABILITATION/REPLACEMENT PROGRAM CAN BE IMPLEMENTED AND BUDGETED. IMPLEMENTING A REHABILITATION/REPLACEMENT PROGRAM IS AN IMPORTANT STEP IN MAINTAINING THE FUNCTIONALITY OF THE SEWER COLLECTION SYSTEM, PREVENTING CATASTROPHIC SYSTEM FAILURES AND WILL HELP BUDGET PLANNING.

(2) IF THE SOUTH INTERCEPTOR AND TRUNK LINE 1 IN SKI HILL DR. ARE REPLACED, RESLOPING AND/OR UPSIZING THE PIPE MAY PROVIDE THE NEEDED CAPACITY, THEREBY NEGATING THE NEED FOR THE BYPASS.

0 600 1200
SCALE

LEGEND

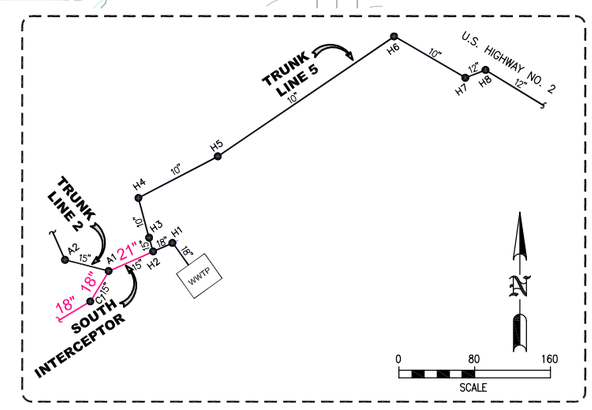
- CITY LIMITS
- URBAN GROWTH AREA (UGA) BOUNDARY
- PLANNING AREA BOUNDARY
- 8" EXISTING LATERAL OR COLLECTOR SEWER PIPE, DIAMETER (if known)
- EXISTING PRESSURE SEWER PIPE
- EXISTING SANITARY SEWER MANHOLE
- EXISTING COMBINED SANITARY/STORM SEWER MANHOLE
- DESIGNATED GROWTH AREA BOUNDARY
- 18" REPLACE GRAVITY SANITARY SEWER PIPE
- 8" NEW GRAVITY SANITARY SEWER PIPE
- NEW PRESSURE FORCE MAIN SANITARY SEWER PIPE
- LS LIFT STATION

DRAINAGE BASIN

- TRUNK LINE 1
- TRUNK LINE 2
- TRUNK LINE 3
- TRUNK LINE 4
- TRUNK LINE 5
- TRUNK LINE 6
- TRUNK LINE 7
- SOUTH INTERCEPTOR

NOTES:

1. LIFT STATION SITE TO BE CHOSEN AFTER TOPOGRAPHIC SURVEY AND PRELIMINARY SEWER DESIGN ROUTING DETERMINED
2. REPLACE EXISTING MAINS (A4–A7) AT GREATER DEPTH TO EXTEND GRAVITY SERVICE IN TO NEW TRUNK LINE 7 BASIN
3. SERVICE ALTERNATIVE FOR THIS AREA SEE EXHIBIT A AND TEXT IN THE REPORT
4. RESIDENTS BORDERING SKI HILL IN DRAINAGE BASIN TRUNK LINE 4 CAN CONNECT TO MAIN IN SKI HILL DR. AS CONVENIENT
5. PROPERTIES BORDERING TITUS RD. CAN CONNECT TO EITHER TRUNK LINE 4 OR TRUNK LINE 7 AS CONVENIENT. IT IS THE INTENT OF THE CITY TO AVOID L.S'S
6. EXISTING ON–SITE SYSTEMS



TREATMENT PLANT AREA

140802–IPE–Sewer–Storm–Figure 5 & 6

NO.	DATE	BY	CKD.	APP.	REVISIONS

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CITY OF LEAVENWORTH, WASHINGTON
WATER DISTRIBUTION SYSTEM & SEWER COLLECTION SYSTEM MASTER PLAN

SEWER COLLECTION SYSTEM ANALYSIS
IMPROVEMENTS

FIGURE
6

APPENDICES

Appendix A:	Projected Ultimate Water ERUs and Demands
Appendix B:	Hydraulic Output Files and Node Map
Appendix C:	Projected Ultimate Wastewater ERUs and Basin flows
Appendix D:	1996 Wastewater Facility Plan TMVA-Leav10 "Evaluation of Sanitary Sewer Collection System"
Appendix E:	1996 Wastewater Facility Plan TMVA-Leav11 "South Interceptor Sewer Evaluation"
Appendix F:	2001 Sanitary Sewer Collection System Cleaning, Inspection and Testing "Summary Report and Rehabilitation Prioritization Plan"
Appendix G:	City Code defining zoning classifications (excerpts)

Appendix A
Projected Ultimate Water ERUs and Demands

Water Distribution System Master Plan
Projected Ultimate Non-Residential ERU's

Dwelling Units (D.U.) based on maximum D.U. allowable using current zoning

	Map Area (by Zoning classification)	Area (Acres)	Max. Buildable Coverage (1)	Total Buildable Area (2)	Dwelling Unit Size (SF) (3)	Maximum D.U. per floor	Maximum Number of Floors (4)	Maximum Number of D.U. (5)	Water Use Factor (7)	Maximum ERUs	ERU/Acre		ERU Adjustment Factor (9)	ERU
Tourist Central Zone	1 (8)	9.3	50%	4.6	1,500	135	2	270	0.6	162	17		0.86	140
	2	4.2	50%	2.1	1,500	61	2	122	0.6	73	17		0.86	63
	3 (8)	12.2	50%	6.1	1,500	178	2	356	0.6	214	17		0.86	184
	4	3.5	50%	1.8	1,500	51	2	102	0.6	61	17		0.86	53
	5	4.1	50%	2.1	1,500	60	2	120	0.6	72	18		0.86	62
	6	5.2	50%	2.6	1,500	76	2	152	0.6	91	18		0.86	78
	7	0.2	50%	0.1	1,500	3	2	6	0.6	4	20		0.86	3
General Commercial	1	8.0	75%	6.0	1,500	174	2	348	0.6	209	26		0.86	180
	2	11.6	75%	8.7	1,500	253	2	506	0.6	304	26		0.86	262
	3	13.6	75%	10.2	1,500	296	2	592	0.6	355	26		0.86	306
	4	1.3	75%	1.0	1,500	28	2	56	0.6	34	26		0.86	29
	5	1.0	75%	0.8	1,500	22	2	44	0.6	26	26		0.86	22
	6	1.0	75%	0.8	1,500	22	2	44	0.6	26	26		0.86	22
	7	0.5	75%	0.4	1,500	11	2	22	0.6	13	26		0.86	11
	8	0.3	75%	0.2	1,500	7	2	14	0.6	8	27		0.86	7
	9	0.9	75%	0.7	1,500	20	2	40	0.6	24	27		0.86	21
	10	3.1	75%	2.3	1,500	68	2	136	0.6	82	26		0.86	71
	11	0.8	75%	0.6	1,500	17	2	34	0.6	20	25		0.86	17
	12	6.7	75%	5.0	1,500	146	2	292	0.6	175	26		0.86	151
	13	2.8	75%	2.1	1,500	61	2	122	0.6	73	26		0.86	63
	14	27.6	75%	20.7	1,500	601	2	1,202	0.6	721	26		0.86	622
	15	3.8	75%	2.9	1,500	83	2	166	0.6	100	26		0.86	86
	16	7.1	75%	5.3	1,500	155	2	310	0.6	186	26		0.86	160
Central Commercial	1	3.1	50%	1.6	1,500	45	4	180	0.6	108	35		0.86	93
	2	2.1	50%	1.1	1,500	30	4	120	0.6	72	34		0.86	62
	3	3.2	50%	1.6	1,500	46	4	184	0.6	110	34		0.86	95
	4	2.3	50%	1.2	1,500	33	4	132	0.6	79	34		0.86	68
	5	0.9	50%	0.5	1,500	13	4	52	0.6	31	34		0.86	27
	6	0.9	50%	0.5	1,500	13	4	52	0.6	31	34		0.86	27
	7	0.8	50%	0.4	1,500	12	4	48	0.6	29	36		0.86	25
	8	0.9	50%	0.5	1,500	13	4	52	0.6	31	34		0.86	27
	9	0.9	50%	0.5	1,500	13	4	52	0.6	31	34		0.86	27
	10	0.9	50%	0.5	1,500	13	4	52	0.6	31	34		0.86	27
	11	0.9	50%	0.5	1,500	13	4	52	0.6	31	34		0.86	27
	12	0.9	50%	0.5	1,500	13	4	52	0.6	31	34		0.86	27
	13	3.3	50%	1.7	1,500	48	4	192	0.6	115	35		0.86	99
	14	1.9	50%	1.0	1,500	28	4	112	0.6	67	35		0.86	58
	15	0.3	50%	0.2	1,500	4	4	16	0.6	10	33		0.86	9
	16	0.8	50%	0.4	1,500	12	4	48	0.6	29	36		0.86	25
	17	3.0	50%	1.5	1,500	44	4	176	0.6	106	35		0.86	91
	18	0.8	50%	0.4	1,500	12	4	48	0.6	29	36		0.86	25
	19	0.3	50%	0.2	1,500	4	4	16	0.6	10	33		0.86	9
Light Industrial	1	5.0	Light Industrial is not zoned for residential units, therefor ERUs are estimated using 9 ERUs per acre.							45				45
Enchantment Park	1	7.0	Enchantment park meter broken, assumed 7 acres at 1" per week for 5 months [22 weeks] = 7 * 1.83' =12.83 acre/ft = 4.2 million gallons annually. 4.2 MG divided by 365 days/yr divided by 390 gpd/ERU ~ 40 ERUs							30				30
	Total Area (acres)		Total Buildable Area (acres)					Total D.U.		Max. ERU's	Average			Total ERUs
		169.0		101.0				6,692		4,089	29			3,536

(1) Maximum Buildable Coverage from Titel 18 Zoning Regulations as follows:

50 % Tourist Commercial Zone
75 % General Commercial
40 % Residential Multi-Family
50 % Central Commercial

(2) Total Buildable area: Area x Maximum Buildable Coverage

(3) Assumed 1,250 sf per dwelling unit plus 250 sf for common space, hallways etc.

(4) Maximum buildable height for Tourist and General Commercial Zones is 35 ft (generally 2 floor max.) and for Central Commercial is 50 ft (generally 4 floor max.).

(5) Maximum number of du's equals maximum du per floor times number of floors

(6) Population per D.U. equals 2.3 persons per single family residentual unit and 1.8 per multi-family residential unit or unit zoned for less than 6,000 sf/du

(7) Factor to convert DU to ERU (City of Cashmere uses 0.8, 2nd edition Handbook of Public Water System by HDR implies 0.7 to 0.75, 2006 water use records of three apartment buildings in Leavenworth indicate between 0.5 to 0.6). The water use factor was used for all multi-

(8) Large parcel, reduced total area by 20% to account for roads, etc.

(9) Assuming 50% development consisting of Condominiums (29 ERU/acre), 25% motels/hotels (20 ERU/acre) and 25% restaurants and shops (10 ERU/acre), results in a factor of 0.862.

Water Distribution System Master Plan
Projected Ultimate Residential ERU's
Dwelling Units (D.U.) based on maximum D.U. allowable using current zoning

Map Area #	Current Zoning	Area (Acre)	Min SF/D.U.	Calculated Maximum D.U.	Population per D.U. (3)	Population	Water Use Factor (2)	Calculated ERU 's	Comments
1	RL-10	107.3	10,000	127	2.3	292	1.0	127	
2	RL-10	40.8	10,000	129	2.3	297	1.0	129	
3	RL-10	56.2	10,000	104	2.3	239	1.0	104	
4	RL-10	81.9	10,000	384	2.3	883	1.0	384	
5	RL-10	47.5	10,000	90	2.3	207	1.0	90	
6	RL-10	14.2	10,000	35	2.3	81	1.0	35	
7	RL-10	37.9	10,000	44	2.3	101	1.0	44	
8	RL-10	61.6	10,000	100	2.3	230	1.0	100	
9	RM-2	58.0	2,000	668	1.8	1,202	0.6	401	
10	RL-10	78.2	10,000	176	2.3	405	1.0	176	
11	RL-10	81.4	10,000	82	2.3	189	1.0	82	
12	RL-12	24.1	12,000	42	2.3	97	1.0	42	
13	RL-6	51.2	6,000	55	2.3	127	1.0	55	
14	RL-6	45.3	6,000	100	2.3	230	1.0	100	30 D.U. Provided by City, added 70 ERUs to account for high school (70% of Cascade school district metered use plus 20% growth, assume that school building will expand but irrigated area will likely not increase)
15	RL-6	0.8	6,000	6	2.3	13	1.0	6	
16	RL-6	0.7	6,000	5	2.3	12	1.0	5	
17	RL-6	0.8	6,000	6	2.3	13	1.0	6	
18	RL-6	0.8	6,000	6	2.3	14	1.0	6	
19	RL-6	0.8	6,000	6	2.3	13	1.0	6	
20	RL-6	0.8	6,000	6	2.3	13	1.0	6	
21	RL-6	0.8	6,000	6	2.3	13	1.0	6	
22	RL-6	0.6	6,000	4	2.3	10	1.0	4	
23	RL-6	0.6	6,000	4	2.3	10	1.0	4	
24	RL-6	0.7	6,000	5	2.3	12	1.0	5	
25	RL-6	0.7	6,000	5	2.3	12	1.0	5	
26	RL-6	0.7	6,000	5	2.3	12	1.0	5	
27	RL-6	0.9	6,000	6	2.3	14	1.0	6	
28	RL-6	1.1	6,000	8	2.3	18	1.0	8	
29	RL-6	0.7	6,000	5	2.3	12	1.0	5	
30	RL-6	0.7	6,000	5	2.3	12	1.0	5	
31	RL-6	0.7	6,000	5	2.3	12	1.0	5	
32	RL-6	0.8	6,000	6	2.3	14	1.0	6	
33	RL-6	0.7	6,000	5	2.3	12	1.0	5	
34	RL-6	0.8	6,000	6	2.3	13	1.0	6	
35	RL-6	0.9	6,000	7	2.3	15	1.0	7	
36	RL-6	0.7	6,000	5	2.3	12	1.0	5	
37	RL-6	0.7	6,000	5	2.3	12	1.0	5	
38	RL-6	0.7	6,000	5	2.3	12	1.0	5	

Water Distribution System Master Plan
Projected Ultimate Residential ERU's
Dwelling Units (D.U.) based on maximum D.U. allowable using current zoning

Map Area #	Current Zoning	Area (Acre)	Min SF/D.U.	Calculated Maximum D.U.	Population per D.U. (3)	Population	Water Use Factor (2)	Calculated ERU 's	Comments
39	RL-6	0.8	6,000	6	2.3	14	1.0	6	
40	RL-6	0.7	6,000	5	2.3	12	1.0	5	
41	RL-6	0.8	6,000	6	2.3	13	1.0	6	
42	RL-6	0.8	6,000	6	2.3	13	1.0	6	
43	RL-6	0.7	6,000	5	2.3	12	1.0	5	
44	RL-6	0.8	6,000	6	2.3	13	1.0	6	
45	RL-6	5.5	6,000	40	2.3	92	1.0	40	
46	RL-6	5.5	6,000	40	2.3	92	1.0	40	40 ERU represent school (30% of Cascade school district metered use plus 20% growth, assume that school building will expand but irrigated area will likely not increase)
47	RL-6	1.3	6,000	9	2.3	22	1.0	9	
48	RL-6	1.8	6,000	13	2.3	29	1.0	13	
49	RL-6	5.6	6,000	40	2.3	93	1.0	40	
50	RL-6	5.5	6,000	40	2.3	93	1.0	40	
51	RL-6	1.9	6,000	14	2.3	31	1.0	14	
52	RL-6	2.6	6,000	19	2.3	43	1.0	19	
53	RL-6	2.3	6,000	16	2.3	38	1.0	16	
54	RL-6	2.6	6,000	19	2.3	43	1.0	19	
55	RL-6	5.8	6,000	42	2.3	97	1.0	42	
56	RL-6	5.7	6,000	41	2.3	94	1.0	41	
57	RL-6	0.3	6,000	2	2.3	5	1.0	2	
58	RL-6	1.0	6,000	7	2.3	17	1.0	7	
59	RL-6	12.9	6,000	94	2.3	216	1.0	94	
60	RL-6	3.9	6,000	28	2.3	66	1.0	28	
61	RL-6	13.0	6,000	95	2.3	218	1.0	95	
62	RL-6	1.4	6,000	10	2.3	24	1.0	10	
63	RL-6	0.7	6,000	5	2.3	12	1.0	5	
64	RL-6	1.4	6,000	10	2.3	24	1.0	10	
65	RL-6	1.4	6,000	10	2.3	23	1.0	10	
66	RL-6	0.3	6,000	2	2.3	6	1.0	2	
67	RL-6	3.7	6,000	27	2.3	62	1.0	27	
68	RL-6	1.8	6,000	13	2.3	30	1.0	13	
69	RL-6	3.8	6,000	27	2.3	63	1.0	27	
70	RL-6	4.0	6,000	29	2.3	66	1.0	29	
71	RL-6	2.5	6,000	18	2.3	42	1.0	18	
72	RL-6	1.0	6,000	7	2.3	17	1.0	7	
73	RL-6	1.5	6,000	11	2.3	25	1.0	11	
74	RL-6	0.8	6,000	6	2.3	14	1.0	6	
75	RL-6	0.8	6,000	6	2.3	14	1.0	6	
76	RL-6	2.4	6,000	17	2.3	40	1.0	17	

Water Distribution System Master Plan
Projected Ultimate Residential ERU's
Dwelling Units (D.U.) based on maximum D.U. allowable using current zoning

Map Area #	Current Zoning	Area (Acre)	Min SF/D.U.	Calculated Maximum D.U.	Population per D.U. (3)	Population	Water Use Factor (2)	Calculated ERU 's	Comments
77	RL-6	11.1	6,000	81	2.3	186	1.0	81	
78	RL-6	2.2	6,000	16	2.3	37	1.0	16	
79	RL-6	1.4	6,000	10	2.3	24	1.0	10	
80	RL-6	4.9	6,000	35	2.3	81	1.0	35	
81	RL-6	2.8	6,000	21	2.3	48	1.0	21	
82	RL-6	0.9	6,000	6	2.3	15	1.0	6	
83	RL-6	0.4	6,000	3	2.3	6	1.0	3	
84	RL-6	11.7	6,000	85	2.3	195	1.0	85	
85	RL-6	18.3	6,000	133	2.3	306	1.0	133	
86	RM-2	5.1	2,000	111	1.8	201	0.6	67	
87	RM-2	0.6	2,000	14	1.8	25	0.6	8	
88	RM-2	1.0	2,000	21	1.8	38	0.6	13	
89	RM-2	1.3	2,000	28	1.8	50	0.6	17	
90	RM-2	10.6	2,000	231	1.8	415	0.6	138	
91	RM-2	0.4	2,000	9	1.8	17	0.6	6	
92	RM-2	1.5	2,000	33	1.8	59	0.6	20	
93	RM-2	3.2	2,000	69	1.8	124	0.6	41	
94	RM-2	1.9	2,000	41	1.8	74	0.6	25	
95	RM-2	0.8	2,000	18	1.8	32	0.6	11	
96	RM-2	3.4	2,000	74	1.8	132	0.6	44	
97	RM-2	13.7	2,000	299	1.8	538	0.6	179	
98	RM-2	1.7	2,000	38	1.8	68	0.6	23	
99	RM-2	3.1	2,000	67	1.8	121	0.6	40	
100	RM-2	2.5	2,000	55	1.8	99	0.6	33	
101	RM-2	17.5	2,000	382	1.8	687	0.6	229	See (1)
102	RM-2	1.7	2,000	38	1.8	68	0.6	23	
103	RL-12	15.6	12,000	57	2.3	130	1.0	57	
104	RL-12	4.5	12,000	16	2.3	37	1.0	16	
105	RL-12	1.9	12,000	7	2.3	16	1.0	7	
106	RL-12	10.7	12,000	39	2.3	89	1.0	39	
107	RL-12	10.8	12,000	39	2.3	90	1.0	39	
108	PDZ	3.1	2,000	67	1.8	121	0.6	40	D.U. determined by using the RM-SF zoning classification
109	PDZ	1.4	2,000	31	1.8	56	0.6	19	D.U. determined by using the RM-SF zoning classification
	Total Area (acres)			Total D.U.	Total Population			Total ERU	
		1,085		5,237		10,898		4,316	
								4.0	Average ERU/Acre

(1) apx 20% of Area 101 is inside the City Boundary

(2) 0.6 factor to convert DU to ERU (City of Cashmere uses 0.8, 2nd edition Handbook of Public Water System by HDR implies 0.7 to 0.75, 2006 water use records of three apartment buildings in Leavenworth indicate between 0.5 to 0.6). The water use factor was used for all multi-family zoning and for all zoning with a min. sf/du of 6,000 sf to account for limited irrigation

(3) Population per D.U. equals 2.3 persons per single family residentual unit and 1.8 per multi-family residential unit or unit zoned for less than 6,000 sf/du

Appendix B
Hydraulic Output Files and Node Map

CITY OF LEAVENWORTH WATER DIST. SYSTEM MASTER PLANNING

Hydraulic Analysis Boundary Conditions

Zone 1 Boundary Conditions

JJC 11/1/07

			Icicle Reservoir 0.70 MG - 14' tall			Future Reservoir (Icicle Rd Site) 24' tall, Volume TBD		
Scenario Name	Planning Period	Total Demand	Level (ft)	HGL (elev)	Volume Depleted	Level (ft)	HGL (elev)	Volume Depleted
Ultimate ADD	Ultimate	1,799	12	1,334	100,000	22	1,334	
Ultimate MDD	Ultimate	3,869	0	1,322	700,000	0	1,312	
Ultimated PHD	Ultimate	6,661	0	1,322	700,000	10	1,322	

	Assumed Supply from Wells & WTP			
Scenario Name	Wells		WTP	
	gpm	MGD	gpm	MGD
Ultimate ADD	900	1.3	900	1.3
Ultimate MDD	1736	2.5	2133	3.1
Ultimated PHD	1736	2.5	2133	3.1

Supply Assumptions:

Current well capacities 2.88 MGD, assume 2.5 MGD future capacity for supply redundancy

Current WTP treatment capacity & water rights approximately 2 MGD, assume balance of MDD taken from WTP

Zone 2 Boundary Conditions

	Ski Hill Reserevoir #1 0.75 MG - 24' tall		
Scenario Name	Level (ft)	HGL (elev)	Volume Depleted
Ultimate ADD	22	1,422	62,500
Ultimate MDD	0	1,400	750,000
Ultimated PHD	20	1,420	125,000

Scenario Name	Ski Hill Booster #1 (gpm)	
Ultimate ADD	371	= Zone 2 ADD + Zone 3 ADD + Zone 4 ADD
Ultimate MDD	798	= Zone 2 MDD + Zone 3 MDD + Zone 4 MDD
Ultimated PHD	928	= Zone 2 MDD + Zone 3 MDD + Zone 4 PHD (closed sys.)

PRV Settings	Pressure	HGL
PRV in booster	26	1,270
PRV in Titus	30	1,270
PRV to Chumstick	30	1,270

Zone 3 Boundary Conditions

	Ski Hill Reserevoir #2		
	Height & Volume Undertermined		
Scenario Name	**Level (ft)**	**HGL (elev)**	**Volume Depleted**
Ultimate ADD		1,518	
Ultimate MDD		1,500	
Ultimated PHD		1,515	

	Ski Hill Booster #2	
Scenario Name	**(gpm)**	
Ultimate ADD	160	= Zone 3 ADD + Zone 4 ADD
Ultimate MDD	343	= Zone 3 MDD + Zone 4 MDD
Ultimated PHD	473	= Zone 3 MDD + Zone 4 PHD (closed sys.)

PRV Settings	
PRV in Ski Hill Dr	closed
PRV in Titus	closed

Zone 4 Boundary Conditions

	Ski Hill Booster #3	
Scenario Name	**(gpm)**	
Ultimate ADD	35	= Zone 4 ADD (closed sys.)
Ultimate MDD	75	= Zone 4 MDD (closed sys.)
Ultimated PHD	205	= Zone 4 PHD (closed sys.)

CITY OF LEAVENWORTH WATER DIST. SYSTEM MASTER PLANNING

Hydraulic Analysis Boundary Conditions

System Characteristics

JJC 11/1/07

Total Projected ERUs:	7,852	
ERU average demand:	330	gpd
ADD:MDD Peaking Factor	2.15	per discussions w/ Stan Adams
MDD:PHD Peaking Factor	1.63	per DOH Water System Design Manual Eq. 5-3 (total system peak, higher for individual zones use individual zone peaks for model)

Total System Demands

ADD	2.591	MGD
	1,799	gpm
MDD	5.571	MGD
	3,869	gpm
PHD	6,319	gpm

(average of total system, individual zone peaks will be higher than this number, use individual peaks in model)

Demands by Pressure Zone

	ERUs	ADD (gpm)	MDD (gpm)	PHD (gpm)
Zone 1	6,232	1,428	3,071	5,042
Zone 2	923	212	455	856
Zone 3	545	125	269	559
Zone 4	152	35	75	205
Sum =	7,852	1,799	3,869	6,661

Scenario: Ultimate MDD w/ Imp.
Fire Flow Analysis
Tank Report (custom)

Label	Zone	Base Elevation (ft)	Initial HGL (ft)	Maximum Elevation (ft)	Tank Diameter (ft)	Inflow (gpm)	Current Status	Calculated Level (ft)
Zone 1 Tanks (0.70 MG	Zone-1	1,312.00	1,312.10	1,336.00	N/A	936.00	Filling	0.10
Zone 2 Tank (0.75 MG)	Zone 2	1,400.00	1,400.10	1,424.00	74.00	-989.80	Draining	0.10
Zone 3 Tank	Zone 3	1,496.00	1,518.00	1,520.00	50.00	53.80	Filling	22.00
Future Main Zone Res	Zone-1	1,312.00	1,335.00	1,336.00	84.00	0.00	Steady	23.00

Scenario: Ultimate MDD w/ Imp.
Fire Flow Analysis
Pump Report

Label	Elevation (ft)	Control Status	Intake Pump Grade (ft)	Discharge Pump Grade (ft)	Discharge (gpm)	Pump Head (ft)	Calculated Water Power (Hp)	Pump Definition
Ski Hill BS #1	1,210.00	Off	1,308.61	1,398.42	0.00	0.00	0.00	Future Ski Hill BS #1
Ski Hill BS #3	1,400.00	On	1,518.24	1,673.27	74.00	155.03	2.90	Future Ski Hill BS #3
Ski Hill BS #2	1,400.00	On	1,399.97	1,518.45	393.80	118.48	11.78	Future Ski Hill BS #2

Scenario: Ultimate MDD w/ Imp.
Fire Flow Analysis
Valve Report

Label	Elevation (ft)	Diameter (in)	Control Status	Discharge (gpm)	From HGL (ft)	To HGL (ft)	Headloss (ft)
Zone 2 PRV A	1,210.00	8	Closed	0.00	1,398.42	1,308.61	0.00
Zone 2 PRV B	1,200.00	8	Closed	0.00	1,398.23	1,308.42	0.00
Zone 2 PRV C	1,200.00	6	Closed	0.00	1,398.27	1,306.80	0.00
Zone 3 PRV A	1,300.00	6	Closed	0.00	1,517.92	1,399.34	0.00
Zone 3 PRV B	1,300.00	8	Closed	0.00	1,517.81	1,398.27	0.00

Scenario: Ultimate MDD w/ Imp.
Fire Flow Analysis
Fire Flow Report (custom)

Label	Available Fire Flow (gpm)	Needed Fire Flow (gpm)	Calculated Residual Pressure (psi)	Zone	Calculated Minimum Zone Pressure (psi)	Minimum Zone Junction
Alpensee St & Hwy 2	4,798.99	2,500.00	30.82	Zone-1	20.00	Safeway
Alpensee St Loop 1	1,737.50	2,500.00	27.37	Zone-1	20.00	Alpensee St Loop 2
Alpensee St Loop 2	1,281.63	1,500.00	20.00	Zone-1	44.70	Pine St & Ski Hill Dr
Ash St & Price Ave	4,000.00	1,500.00	29.08	Zone-1	29.61	Cedar St & Central Ave
Benton St & Mine St	3,476.72	2,500.00	20.00	Zone-1	38.57	Pine St & Ski Hill Dr
Benton St & Ski Hill Dr	4,000.00	1,500.00	42.91	Zone-1	30.70	Pine St & Ski Hill Dr
Bergstrasse Rd & Detillion Rd	2,346.10	1,500.00	61.07	Zone 3	20.00	Spring St. West
Bergstrasse Rd & Ski Hill Dr	2,263.48	1,500.00	45.54	Zone 3	20.00	Spring St. West
Bergstrasse Rd West	1,632.79	1,500.00	20.00	Zone 3	23.23	Spring St. West
Birch St & Burke Ave	4,000.00	1,500.00	36.18	Zone-1	31.59	Cedar St & Central Ave
Birch St & Cascade St	4,000.00	1,500.00	28.52	Zone-1	30.57	Pine St & Ski Hill Dr
Birch St & Central Ave	4,000.00	1,500.00	33.35	Zone-1	28.28	Cedar St & Central Ave
Birch St & Orchard St	4,000.00	1,500.00	32.56	Zone-1	30.66	Pine St & Ski Hill Dr
Birch St & Price Ave	4,000.00	1,500.00	30.66	Zone-1	29.49	Cedar St & Central Ave
Birch St & Ski Hill Dr	4,000.00	1,500.00	33.64	Zone-1	30.53	Pine St & Ski Hill Dr
Cedar St & Burke Ave	4,000.00	1,500.00	34.87	Zone-1	31.32	Cedar St & Central Ave
Cedar St & Central Ave	4,000.00	1,500.00	20.69	Zone-1	27.86	Cedar St & Price Ave
Cedar St & Price Ave	2,162.35	1,500.00	20.01	Zone-1	27.04	Cedar St & Summit Ave
Cedar St & Summit Ave	2,334.68	1,500.00	20.09	Zone-1	20.01	Cedar St & Price Ave
Center St & Cherry St	3,537.86	1,500.00	21.30	Zone-1	20.00	J-154
Center St & Ogrady Rd	3,566.89	1,500.00	20.00	Zone-1	30.93	J-154
Center St & Ski Hill Dr	4,000.00	1,500.00	40.74	Zone-1	30.67	Pine St & Ski Hill Dr
Chumstick Hwy & Cottage Creek	4,971.55	2,500.00	20.00	Zone-1	21.64	North County Shop Rd
Chumstick Hwy & County Shop Rd	4,674.58	2,500.00	22.16	Zone-1	20.00	North County Shop Rd
Chumstick Hwy & Highschool	4,564.75	2,500.00	20.00	Zone-1	27.96	North County Shop Rd
Commercial St & 1st St	5,000.00	2,500.00	49.08	Zone-1	33.57	Pine St & Ski Hill Dr
Commercial St & 2nd St	5,000.00	2,500.00	45.85	Zone-1	32.19	Pine St & Ski Hill Dr
Commercial St & 3rd St	5,000.00	2,500.00	50.05	Zone-1	31.26	Pine St & Ski Hill Dr
Commercial St & 13th St	5,000.00	2,500.00	42.58	Zone-1	27.92	Safeway
Commercial St & 14th St	5,000.00	2,500.00	45.92	Zone-1	26.69	Safeway
Commercial St & Enchantment Park W	5,000.00	2,500.00	52.39	Zone-1	34.20	Pine St & Ski Hill Dr
Commercial St & Mill St	5,000.00	2,500.00	48.30	Zone-1	36.18	Pine St & Ski Hill Dr
Commercial St Alley & 8th St	5,000.00	3,500.00	51.22	Zone-1	32.20	Pine St & Ski Hill Dr
Commercial St Alley & 9th St	5,000.00	3,500.00	42.15	Zone-1	32.27	Pine St & Ski Hill Dr
Commercial St Alley & 10th St	5,000.00	3,500.00	39.63	Zone-1	32.35	Pine St & Ski Hill Dr
Commercial St Alley & Division St	5,000.00	3,500.00	40.73	Zone-1	30.25	Safeway
Detillion Rd & Titus Rd	2,582.99	2,500.00	20.00	Zone 2	20.98	Emig Dr Mid
East Leavenworth Rd & Creek Cross	4,000.00	1,500.00	26.56	Zone-1	21.77	Safeway
East Leavenworth Rd & Dempsey Rd	4,000.00	1,500.00	25.50	Zone-1	30.91	Safeway
East Leavenworth Rd & Dye Rd	3,948.64	1,500.00	30.62	Zone-1	20.00	Safeway
East Leavenworth Rd & Hwy 2	3,851.50	2,500.00	39.91	Zone-1	20.00	Safeway
East Leavenworth Rd & Icicle Rd	4,000.00	1,500.00	62.34	Zone-1	42.95	Pine St & Ski Hill Dr
East Leavenworth Rd 1	4,000.00	1,500.00	27.47	Zone-1	25.88	Safeway
East Leavenworth Rd 2	4,000.00	1,500.00	58.25	Zone-1	41.61	Safeway
Emig Dr & Ski Hill Dr	2,222.57	1,500.00	53.94	Zone 3	20.00	Spring St. West
Emig Dr & Titus Rd	2,632.95	2,500.00	30.46	Zone 2	20.00	Emig Dr Mid
Emig Dr Mid	2,593.22	1,500.00	20.00	Zone 2	28.34	Detillion Rd & Titus Rd
Evans St & Cascade St	4,000.00	1,500.00	34.64	Zone-1	30.63	Pine St & Ski Hill Dr
Evans St & Orchard St	4,000.00	1,500.00	25.34	Zone-1	30.68	Pine St & Ski Hill Dr
Evans St & Ski Hill Dr	4,000.00	1,500.00	37.71	Zone-1	30.63	Pine St & Ski Hill Dr

Scenario: Ultimate MDD w/ Imp.
Fire Flow Analysis
Fire Flow Report (custom)

Label	Available Fire Flow (gpm)	Needed Fire Flow (gpm)	Calculated Residual Pressure (psi)	Zone	Calculated Minimum Zone Pressure (psi)	Minimum Zone Junction
Front St & 8th St	5,000.00	3,500.00	43.57	Zone-1	32.04	Pine St & Ski Hill Dr
Front St & 9th St	5,000.00	3,500.00	39.97	Zone-1	32.23	Pine St & Ski Hill Dr
Front St & 10th St	5,000.00	3,500.00	36.62	Zone-1	32.18	Safeway
Front St & 13th St	5,000.00	2,500.00	39.33	Zone-1	28.65	Safeway
Front St & 14th St	5,000.00	2,500.00	42.60	Zone-1	27.47	Safeway
Front St & Division St	5,000.00	3,500.00	41.08	Zone-1	30.97	Safeway
Front St Alley & 8th St	5,000.00	3,500.00	50.06	Zone-1	32.13	Pine St & Ski Hill Dr
Front St Alley & 14th St	5,000.00	2,500.00	44.61	Zone-1	25.97	Safeway
Front St. Alley & 9th St	5,000.00	3,500.00	38.07	Zone-1	32.29	Pine St & Ski Hill Dr
Front St. Alley & 10th St	5,000.00	3,500.00	28.68	Zone-1	32.22	Safeway
Highschool A	4,224.73	2,500.00	20.00	Zone-1	29.63	Highschool B
Highschool B	3,310.24	2,500.00	20.00	Zone-1	35.61	Highschool A
Highschool C	5,000.00	2,500.00	25.49	Zone-1	29.68	Highschool B
Hwy 2 & 3rd St	5,000.00	2,500.00	43.28	Zone-1	30.65	Pine St & Ski Hill Dr
Hwy 2 & Commercial St	5,000.00	2,500.00	49.74	Zone-1	37.05	Pine St & Ski Hill Dr
Hwy 2 & Icicle Rd	5,000.00	2,500.00	47.66	Zone-1	39.40	Pine St & Ski Hill Dr
Hwy 2 & Riverbend Dr	3,085.01	2,500.00	24.57	Zone-1	20.00	Safeway
Hwy 2 near 12th St	5,000.00	2,500.00	26.04	Zone-1	31.16	Cedar St & Central Ave
Icicle Rd & Reservoir	5,000.00	2,500.00	53.79	Zone-1	42.45	Pine St & Ski Hill Dr
Icicle Rd & Wells	4,000.00	1,500.00	70.48	Zone-1	44.09	Pine St & Ski Hill Dr
Icicle Rd A	4,000.00	1,500.00	57.08	Zone-1	42.95	Pine St & Ski Hill Dr
Icicle Rd B	4,000.00	1,500.00	59.60	Zone-1	42.95	Pine St & Ski Hill Dr
Icicle Rd C	4,000.00	1,500.00	50.85	Zone-1	43.26	Pine St & Ski Hill Dr
Icicle Rd D	4,000.00	1,500.00	52.08	Zone-1	43.63	Pine St & Ski Hill Dr
Icicle Rd E	4,000.00	1,500.00	53.67	Zone-1	43.86	Pine St & Ski Hill Dr
Icicle Rd F	5,000.00	2,500.00	77.26	Zone-1	42.24	Pine St & Ski Hill Dr
J-010	3,459.88	2,500.00	20.00	Zone-1	36.33	J-012
J-012	3,363.85	2,500.00	20.00	Zone-1	36.30	J-010
J-014	3,039.13	2,500.00	20.00	Zone-1	40.20	J-010
J-018	5,000.00	2,500.00	22.24	Zone-1	22.90	J-012
J-020	5,000.00	2,500.00	49.32	Zone-1	34.92	Pine St & Ski Hill Dr
J-024	4,000.00	1,500.00	28.97	Zone-1	37.75	Pine St & Ski Hill Dr
J-026	3,859.68	1,500.00	20.00	Zone-1	38.03	Pine St & Ski Hill Dr
J-034	3,888.71	2,500.00	20.00	Zone-1	28.32	J-036
J-036	3,075.68	3,500.00	20.00	Zone-1	37.59	Pine St & Ski Hill Dr
J-104	4,000.00	1,500.00	30.44	Zone-1	30.13	Cedar St & Central Ave
J-112	4,000.00	1,500.00	27.98	Zone-1	29.45	Cedar St & Central Ave
J-120	4,919.36	2,500.00	20.00	Zone-1	28.00	J-104
J-132	2,782.41	1,500.00	33.49	Zone 2	20.00	Ranger St West
J-146	3,054.51	1,500.00	20.00	Zone-1	34.06	Pine St & Ski Hill Dr
J-154	2,427.51	1,500.00	20.01	Zone-1	38.09	Center St & Cherry St
J-156	2,773.85	1,500.00	34.80	Zone 2	20.01	J-162
J-162	2,568.50	1,500.00	20.00	Zone 2	22.72	Ranger St West
J-164	2,782.43	1,500.00	40.91	Zone 2	20.00	Ranger St West
J-212	2,677.08	2,500.00	25.59	Zone 2	20.00	Emig Dr Mid
J-226	4,437.56	2,500.00	20.00	Zone-1	32.02	Chumstick Hwy & Highschoo
J-230	2,835.28	1,500.00	28.68	Zone 2	20.00	Emig Dr Mid
J-238	2,612.31	1,500.00	20.00	Zone 3	28.52	Titus Rd & Ski Hill Dr
J-252	2,919.31	1,500.00	41.13	Zone 3	20.00	J-238
J-258	2,343.27	1,500.00	37.70	Zone 3	20.00	Titus Rd NE

Scenario: Ultimate MDD w/ Imp.
Fire Flow Analysis
Fire Flow Report (custom)

Label	Available Fire Flow (gpm)	Needed Fire Flow (gpm)	Calculated Residual Pressure (psi)	Zone	Calculated Minimum Zone Pressure (psi)	Minimum Zone Junction
J-260	2,278.06	1,500.00	48.58	Zone 3	20.00	Titus Rd NE
J-262	2,273.60	1,500.00	40.12	Zone 3	20.00	Titus Rd NE
J-276	2,579.61	1,500.00	20.00	Zone 2	21.80	J-162
Maple St & Ski Hill Dr	2,454.64	1,500.00	32.98	Zone 3	20.00	Maple St West
Maple St West	1,824.41	1,500.00	20.00	Zone 3	31.12	Titus Rd & Ski Hill Dr
North County Shop Rd	2,010.64	2,500.00	20.00	Zone-1	44.59	Chumstick Hwy & County Sh
Park Ave & Cherry St	3,687.36	1,500.00	20.00	Zone-1	25.04	Prospect St & Cherry St
Park Ave & Mtn View Dr	2,507.93	2,500.00	20.00	Zone 2	23.46	Ranger St West
Park Ave & Smyth St	2,763.69	2,500.00	35.10	Zone 2	20.01	J-162
Pine St & Cascade St	4,000.00	1,500.00	31.25	Zone-1	30.48	Pine St & Ski Hill Dr
Pine St & Central Ave	4,000.00	1,500.00	30.64	Zone-1	29.86	Cedar St & Central Ave
Pine St & Orchard St	4,000.00	1,500.00	30.89	Zone-1	30.64	Pine St & Ski Hill Dr
Pine St & Ski Hill Dr	4,000.00	1,500.00	30.33	Zone-1	34.04	Cedar St & Central Ave
Pine St & Titus Rd	4,000.00	1,500.00	35.68	Zone-1	32.08	Cedar St & Central Ave
Prospect St & Cherry St	3,495.64	1,500.00	20.00	Zone-1	29.44	Park Ave & Cherry St
Prospect St & Mine St	2,763.88	2,500.00	35.30	Zone 2	20.00	J-162
Prospect St & Ski Hill Dr	5,000.00	2,500.00	41.90	Zone-1	30.54	Pine St & Ski Hill Dr
Prospect St & Whitman St	5,000.00	2,500.00	24.80	Zone-1	30.61	Pine St & Ski Hill Dr
Ranger St & Ski Hill Dr	3,047.05	1,500.00	48.74	Zone 2	20.00	Ranger St West
Ranger St Mid	2,782.44	1,500.00	39.24	Zone 2	20.00	Ranger St West
Ranger St West	1,858.19	1,500.00	20.01	Zone 2	38.81	Spring St & Ski HIll Dr
Riverbend Dr	2,853.09	2,500.00	26.64	Zone-1	20.00	Safeway
Safeway	2,507.34	2,500.00	20.01	Zone-1	32.64	Riverbend Dr
Spring St & Ski HIll Dr	4,000.00	1,500.00	28.93	Zone 2	28.49	Ranger St West
Spring St. West	1,597.41	1,500.00	20.00	Zone 3	24.63	Bergstrasse Rd West
Stafford St & Ogrady Rd	3,281.90	1,500.00	20.00	Zone-1	33.18	Pine St & Ski Hill Dr
Stafford St & Ski Hill Dr	4,000.00	1,500.00	38.99	Zone-1	30.64	Pine St & Ski Hill Dr
Titus Rd & Cottage Creek	2,637.42	2,500.00	33.90	Zone 2	20.00	Emig Dr Mid
Titus Rd & Highschool	4,000.00	1,500.00	26.76	Zone-1	40.76	Pine St & Ski Hill Dr
Titus Rd & Ski Hill Dr	4,000.00	1,500.00	21.75	Zone 3	34.73	J-238
Titus Rd NE	2,213.10	1,500.00	20.00	Zone 3	28.87	J-238
Village View Dr & Ski Hill Dr	3,496.41	1,500.00	37.44	Zone 2	20.00	Ranger St West
Water Treatment Plant	0.00	1,500.00	3.67	No Fire Flow	3.67	Water Treatment Plant
Wells	4,000.00	1,500.00	81.07	Zone-1	44.09	Pine St & Ski Hill Dr
West St & Cherry St	4,000.00	1,500.00	22.78	Zone-1	25.29	J-154
Wheeler St & Ski Hill Dr	4,000.00	1,500.00	34.45	Zone-1	30.59	Pine St & Ski Hill Dr
Wheeler St West	2,782.44	1,500.00	35.86	Zone 2	20.00	Ranger St West
Whitman St & Mill St	5,000.00	2,500.00	25.20	Zone-1	22.77	Benton St & Mine St
Whitman St & Ski Hill Dr	5,000.00	2,500.00	41.68	Zone-1	30.45	Pine St & Ski Hill Dr
Zone 4 Demands	273.66	1,500.00	20.17	Zone 4	20.17	Zone 4 Demands
Zone 4 Suction	3,393.57	1,500.00	20.00	Zone 3	20.71	Maple St West

Scenario: Ultimate MDD w/ Imp.
Fire Flow Analysis
Junction Report (custom)

Label	Elevation (ft)	Zone	Type	Demand (Calculated) (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)
Alpensee St & Hwy 2	1,160.00	Zone-1	Demand	35.00	1,307.91	63.99
Alpensee St Loop 1	1,121.00	Zone-1	Demand	59.00	1,307.55	80.71
Alpensee St Loop 2	1,138.00	Zone-1	Demand	26.00	1,307.52	73.34
Ash St & Price Ave	1,170.00	Zone-1	Demand	7.00	1,308.52	59.93
Benton St & Mine St	1,185.00	Zone-1	Demand	13.00	1,310.33	54.22
Benton St & Ski Hill Dr	1,168.00	Zone-1	Demand	22.00	1,308.92	60.97
Bergstrasse Rd & Detillion Rd	1,300.00	Zone 3	Demand	22.00	1,517.92	94.28
Bergstrasse Rd & Ski Hill Dr	1,341.00	Zone 3	Demand	17.00	1,517.92	76.55
Bergstrasse Rd West	1,400.00	Zone 3	Demand	7.00	1,517.90	51.01
Birch St & Burke Ave	1,167.00	Zone-1	Demand	6.00	1,308.35	61.16
Birch St & Cascade St	1,192.00	Zone-1	Demand	20.00	1,308.61	50.45
Birch St & Central Ave	1,177.00	Zone-1	Demand	12.00	1,308.52	56.90
Birch St & Orchard St	1,181.00	Zone-1	Demand	20.00	1,308.57	55.19
Birch St & Price Ave	1,170.00	Zone-1	Demand	12.00	1,308.49	59.92
Birch St & Ski Hill Dr	1,188.00	Zone-1	Demand	14.00	1,308.65	52.20
Cedar St & Burke Ave	1,167.00	Zone-1	Demand	15.00	1,308.38	61.17
Cedar St & Central Ave	1,197.00	Zone-1	Demand	11.00	1,308.51	48.24
Cedar St & Price Ave	1,188.00	Zone-1	Demand	15.00	1,308.40	52.09
Cedar St & Summit Ave	1,182.00	Zone-1	Demand	18.00	1,308.41	54.69
Center St & Cherry St	1,178.00	Zone-1	Demand	10.00	1,308.87	56.62
Center St & Ogrady Rd	1,180.00	Zone-1	Demand	0.00	1,308.81	55.73
Center St & Ski Hill Dr	1,172.00	Zone-1	Demand	10.00	1,308.81	59.19
Chumstick Hwy & Cottage Creek	1,160.00	Zone-1	Demand	64.00	1,306.80	63.51
Chumstick Hwy & County Shop Rd	1,160.00	Zone-1	Demand	10.00	1,306.82	63.52
Chumstick Hwy & Highschool	1,150.00	Zone-1	Demand	2.00	1,306.88	67.88
Commercial St & 1st St	1,164.00	Zone-1	Demand	16.00	1,310.35	63.32
Commercial St & 2nd St	1,168.00	Zone-1	Demand	14.00	1,310.03	61.45
Commercial St & 3rd St	1,156.00	Zone-1	Demand	45.00	1,309.77	66.53
Commercial St & 13th St	1,143.00	Zone-1	Demand	30.00	1,308.00	71.39
Commercial St & 14th St	1,137.00	Zone-1	Demand	35.00	1,307.95	73.96
Commercial St & Enchantment Park Wy	1,158.00	Zone-1	Demand	7.00	1,310.50	65.98
Commercial St & Mill St	1,173.00	Zone-1	Demand	65.00	1,311.02	59.71
Commercial St Alley & 8th St	1,137.00	Zone-1	Demand	45.00	1,308.74	74.30
Commercial St Alley & 9th St	1,153.00	Zone-1	Demand	55.00	1,308.56	67.30
Commercial St Alley & 10th St	1,149.00	Zone-1	Demand	44.00	1,308.48	69.00
Commercial St Alley & Division St	1,153.00	Zone-1	Demand	40.00	1,308.14	67.12
Detillion Rd & Titus Rd	1,261.00	Zone 2	Demand	31.00	1,398.27	59.39
East Leavenworth Rd & Creek Cross	1,140.00	Zone-1	Demand	19.00	1,310.38	73.72
East Leavenworth Rd & Dempsey Rd	1,125.00	Zone-1	Demand	10.00	1,320.82	84.72
East Leavenworth Rd & Dye Rd	1,150.00	Zone-1	Demand	19.00	1,308.60	68.62
East Leavenworth Rd & Hwy 2	1,140.00	Zone-1	Demand	82.00	1,307.91	72.64
East Leavenworth Rd & Icicle Rd	1,148.00	Zone-1	Demand	11.00	1,331.90	79.56
East Leavenworth Rd 1	1,115.00	Zone-1	Demand	35.00	1,314.92	86.50
East Leavenworth Rd 2	1,125.00	Zone-1	Demand	0.00	1,329.97	88.68
Emig Dr & Ski Hill Dr	1,320.00	Zone 3	Demand	11.00	1,517.92	85.63
Emig Dr & Titus Rd	1,240.00	Zone 2	Demand	27.00	1,398.28	68.48
Emig Dr Mid	1,280.00	Zone 2	Demand	13.00	1,398.35	51.20
Evans St & Cascade St	1,174.00	Zone-1	Demand	15.00	1,308.70	58.28
Evans St & Orchard St	1,176.00	Zone-1	Demand	18.00	1,308.61	57.37
Evans St & Ski Hill Dr	1,178.00	Zone-1	Demand	8.00	1,308.73	56.56
Front St & 8th St	1,160.00	Zone-1	Demand	47.00	1,308.75	64.36
Front St & 9th St	1,165.00	Zone-1	Demand	28.00	1,308.55	62.11

Scenario: Ultimate MDD w/ Imp.
Fire Flow Analysis
Junction Report (custom)

Label	Elevation (ft)	Zone	Type	Demand (Calculated) (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)
Front St & 10th St	1,170.00	Zone-1	Demand	21.00	1,308.36	59.86
Front St & 13th St	1,154.00	Zone-1	Demand	35.00	1,307.99	66.62
Front St & 14th St	1,148.00	Zone-1	Demand	11.00	1,307.93	69.19
Front St & Division St	1,160.00	Zone-1	Demand	63.00	1,308.17	64.11
Front St Alley & 8th St	1,148.00	Zone-1	Demand	32.00	1,308.85	69.59
Front St Alley & 14th St	1,142.00	Zone-1	Demand	19.00	1,307.93	71.79
Front St. Alley & 9th St	1,160.00	Zone-1	Demand	19.00	1,308.55	64.27
Front St. Alley & 10th St	1,165.00	Zone-1	Demand	19.00	1,308.35	62.02
Highschool A	1,170.00	Zone-1	Demand	10.00	1,308.41	59.88
Highschool B	1,170.00	Zone-1	Demand	10.00	1,308.41	59.88
Highschool C	1,152.00	Zone-1	Demand	10.00	1,308.41	67.67
Hwy 2 & 3rd St	1,167.00	Zone-1	Demand	53.00	1,309.44	61.62
Hwy 2 & Commercial St	1,172.00	Zone-1	Demand	5.00	1,311.26	60.25
Hwy 2 & Icicle Rd	1,183.00	Zone-1	Demand	45.00	1,311.93	55.78
Hwy 2 & Riverbend Dr	1,175.00	Zone-1	Demand	31.00	1,307.47	57.31
Hwy 2 near 12th St	1,170.00	Zone-1	Demand	129.00	1,308.17	59.78
Icicle Rd & Reservoir	1,177.00	Zone-1	Demand	47.00	1,312.81	58.76
Icicle Rd & Wells	1,142.00	Zone-1	Demand	0.00	1,323.97	78.73
Icicle Rd A	1,155.00	Zone-1	Demand	10.00	1,338.33	79.32
Icicle Rd B	1,151.00	Zone-1	Demand	8.00	1,336.03	80.05
Icicle Rd C	1,175.00	Zone-1	Demand	21.00	1,330.48	67.27
Icicle Rd D	1,175.00	Zone-1	Demand	29.00	1,328.06	66.22
Icicle Rd E	1,175.00	Zone-1	Demand	22.00	1,326.20	65.42
Icicle Rd F	1,120.00	Zone-1	Demand	11.00	1,320.44	86.72
J-010	1,172.00	Zone-1	Demand	74.00	1,310.51	59.93
J-012	1,169.00	Zone-1	Demand	31.00	1,310.49	61.22
J-014	1,163.00	Zone-1	Demand	22.00	1,310.49	63.81
J-018	1,166.00	Zone-1	Demand	11.00	1,310.49	62.52
J-020	1,167.00	Zone-1	Demand	6.00	1,310.69	62.17
J-024	1,160.00	Zone-1	Demand	7.00	1,310.31	65.03
J-026	1,120.00	Zone-1	Demand	7.00	1,310.14	82.27
J-034	1,167.00	Zone-1	Demand	44.00	1,308.73	61.32
J-036	1,165.00	Zone-1	Demand	68.00	1,308.60	62.13
J-104	1,177.00	Zone-1	Demand	15.00	1,308.57	56.92
J-112	1,179.00	Zone-1	Demand	11.00	1,308.53	56.04
J-120	1,177.00	Zone-1	Demand	13.00	1,308.60	56.94
J-132	1,210.00	Zone 2	Demand	0.00	1,397.66	81.19
J-146	1,187.00	Zone-1	Demand	22.00	1,308.69	52.65
J-154	1,181.00	Zone-1	Demand	12.00	1,308.87	55.32
J-156	1,200.00	Zone 2	Demand	9.00	1,397.60	85.49
J-162	1,235.00	Zone 2	Demand	19.00	1,397.58	70.34
J-164	1,190.00	Zone 2	Demand	10.00	1,397.64	89.83
J-212	1,230.00	Zone 2	Demand	109.00	1,398.23	72.78
J-226	1,150.00	Zone-1	Demand	151.00	1,306.97	67.91
J-230	1,260.00	Zone 2	Demand	15.00	1,398.40	59.88
J-238	1,410.00	Zone 3	Demand	13.00	1,517.91	46.69
J-252	1,350.00	Zone 3	Demand	28.00	1,517.92	72.65
J-258	1,340.00	Zone 3	Demand	54.00	1,517.81	76.93
J-260	1,280.00	Zone 3	Demand	12.00	1,517.81	102.89
J-262	1,300.00	Zone 3	Demand	12.00	1,517.81	94.24
J-276	1,230.00	Zone 2	Demand	25.00	1,397.59	72.51
Maple St & Ski Hill Dr	1,370.00	Zone 3	Demand	15.00	1,518.06	64.06

Scenario: Ultimate MDD w/ Imp.
Fire Flow Analysis
Junction Report (custom)

Label	Elevation (ft)	Zone	Type	Demand (Calculated) (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)
Maple St West	1,400.00	Zone 3	Demand	2.00	1,518.06	51.08
North County Shop Rd	1,165.00	Zone-1	Demand	10.00	1,306.82	61.36
Park Ave & Cherry St	1,179.00	Zone-1	Demand	20.00	1,309.03	56.26
Park Ave & Mtn View Dr	1,230.00	Zone 2	Demand	28.00	1,397.57	72.50
Park Ave & Smyth St	1,195.00	Zone 2	Demand	9.00	1,397.57	87.64
Pine St & Cascade St	1,193.00	Zone-1	Demand	10.00	1,308.58	50.01
Pine St & Central Ave	1,190.00	Zone-1	Demand	7.00	1,308.51	51.28
Pine St & Orchard St	1,192.00	Zone-1	Demand	10.00	1,308.55	50.43
Pine St & Ski Hill Dr	1,199.00	Zone-1	Demand	5.00	1,308.61	47.42
Pine St & Titus Rd	1,174.00	Zone-1	Demand	12.00	1,308.43	58.16
Prospect St & Cherry St	1,183.00	Zone-1	Demand	22.00	1,309.17	54.59
Prospect St & Mine St	1,188.00	Zone 2	Demand	147.00	1,397.54	90.66
Prospect St & Ski Hill Dr	1,169.00	Zone-1	Demand	20.00	1,309.27	60.69
Prospect St & Whitman St	1,173.00	Zone-1	Demand	26.00	1,309.34	58.99
Ranger St & Ski Hill Dr	1,230.00	Zone 2	Demand	35.00	1,398.42	72.87
Ranger St Mid	1,250.00	Zone 2	Demand	24.00	1,398.26	64.15
Ranger St West	1,300.00	Zone 2	Demand	18.00	1,398.32	42.54
Riverbend Dr	1,170.00	Zone-1	Demand	72.00	1,307.24	59.38
Safeway	1,185.00	Zone-1	Demand	385.00	1,306.90	52.74
Spring St & Ski HIll Dr	1,300.00	Zone 2	Demand	14.00	1,399.34	42.98
Spring St. West	1,400.00	Zone 3	Demand	30.00	1,517.89	51.01
Stafford St & Ogrady Rd	1,180.00	Zone-1	Demand	26.00	1,308.74	55.70
Stafford St & Ski Hill Dr	1,175.00	Zone-1	Demand	0.00	1,308.75	57.87
Titus Rd & Cottage Creek	1,230.00	Zone 2	Demand	0.00	1,398.27	72.80
Titus Rd & Highschool	1,177.00	Zone-1	Demand	7.00	1,308.42	56.86
Titus Rd & Ski Hill Dr	1,440.00	Zone 3	Demand	8.00	1,518.01	33.75
Titus Rd NE	1,390.00	Zone 3	Demand	17.00	1,517.82	55.30
Village View Dr & Ski Hill Dr	1,260.00	Zone 2	Demand	30.00	1,398.62	59.97
Water Treatment Plant	1,367.00	No Fire Flow	Inflow	-2,133.00	1,375.47	3.67
Wells	1,117.00	Zone-1	Inflow	-1,736.00	1,324.28	89.68
West St & Cherry St	1,179.00	Zone-1	Demand	17.00	1,308.93	56.21
Wheeler St & Ski Hill Dr	1,185.00	Zone-1	Demand	8.00	1,308.69	53.51
Wheeler St West	1,220.00	Zone 2	Demand	33.00	1,397.81	76.93
Whitman St & Mill St	1,177.00	Zone-1	Demand	21.00	1,310.44	57.74
Whitman St & Ski Hill Dr	1,168.00	Zone-1	Demand	12.00	1,309.12	61.06
Zone 4 Demands	1,520.00	Zone 4	Demand	74.00	1,673.21	66.28
Zone 4 Suction	1,400.00	Zone 3	Demand	18.00	1,518.25	51.16

Scenario: Ultimate MDD w/ Imp.
Fire Flow Analysis
Pipe Report (custom)

Label	Length (ft)	Diameter (in)	Material	Hazen-Williams C	Velocity (ft/s)	Closed?	From Node	To Node
P-002	579.00	14	Ductile Iro	120.0	1.95	false	Zone 1 Tanks (0.70 MG & Future)	Icicle Rd & Reservoir
P-004	902.00	20	Ductile Iro	120.0	2.16	false	Icicle Rd & Reservoir	Hwy 2 & Icicle Rd
P-006	829.00	20	Ductile Iro	130.0	2.11	false	Hwy 2 & Icicle Rd	Hwy 2 & Commercial St
P-008	535.00	6	Ductile Iro	120.0	1.23	false	Hwy 2 & Commercial St	J-010
P-010	282.00	6	Ductile Iro	120.0	0.22	false	J-010	J-012
P-012	651.00	8	Ductile Iro	120.0	0.07	false	J-012	J-018
P-014	264.00	6	Cast iron	120.0	0.08	false	J-018	J-014
P-016	291.00	20	Ductile Iro	120.0	2.00	false	Hwy 2 & Commercial St	Commercial St & Mill St
P-018	227.00	8	Ductile Iro	120.0	0.19	false	J-018	Commercial St & Enchantment Parl
P-020	338.00	18	Ductile Iro	120.0	2.00	false	Commercial St & Mill St	J-020
P-022	402.00	6	Cast iron	120.0	0.63	false	J-024	J-026
P-024	201.00	18	Ductile Iro	120.0	1.99	false	J-020	Commercial St & Enchantment Parl
P-026	362.00	8	Ductile Iro	120.0	0.40	false	Commercial St & 1st St	J-024
P-028	164.00	18	Ductile Iro	120.0	1.94	false	Commercial St & Enchantment Park	Commercial St & 1st St
P-030	395.00	18	Ductile Iro	120.0	1.85	false	Commercial St & 1st St	Commercial St & 2nd St
P-032	301.00	18	Ductile Iro	120.0	1.89	false	Commercial St & 2nd St	Commercial St & 3rd St
P-034	361.00	6	Cast iron	120.0	0.55	false	J-026	Commercial St & 2nd St
P-036	336.00	12	Ductile Iro	120.0	1.57	false	Hwy 2 & 3rd St	Commercial St & 3rd St
P-038	294.00	12	Ductile Iro	120.0	1.16	false	Prospect St & Ski Hill Dr	Hwy 2 & 3rd St
P-040	679.00	6	Ductile Iro	120.0	1.04	false	Hwy 2 & 3rd St	J-034
P-042	811.00	8	Ductile Iro	120.0	0.45	false	J-034	J-036
P-044	447.00	6	Cast iron	120.0	0.03	false	J-036	J-120
P-046	157.00	12	Ductile Iro	120.0	1.26	false	Front St Alley & 8th St	Front St & 8th St
P-048	1,534.00	16	Ductile Iro	120.0	1.43	false	Commercial St & 3rd St	Front St Alley & 8th St
P-050	421.00	6	Cast iron	120.0	0.86	false	Front St Alley & 8th St	Front St. Alley & 9th St
P-052	328.00	10	Steel (non	110.0	0.36	false	Front St & Division St	Commercial St Alley & Division St
P-054	774.00	12	Ductile Iro	120.0	0.64	false	Commercial St Alley & Division St	Commercial St & 13th St
P-056	360.00	12	Ductile Iro	120.0	0.56	false	Commercial St & 13th St	Commercial St & 14th St
P-058	178.00	12	Ductile Iro	120.0	0.46	false	Commercial St & 14th St	Front St Alley & 14th St
P-060	190.00	12	Ductile Iro	120.0	0.09	false	Front St Alley & 14th St	Front St & 14th St
P-062	1,366.00	8	Steel (non	110.0	0.54	false	Alpensee St & Hwy 2	Alpensee St Loop 1
P-064	356.00	12	Ductile Iro	120.0	0.62	false	Front St & 14th St	Front St & 13th St
P-066	440.00	12	Ductile Iro	120.0	0.32	false	Front St Alley & 14th St	Alpensee St & Hwy 2
P-068	799.00	12	Ductile Iro	120.0	0.72	false	Front St & 13th St	Front St & Division St
P-070	812.00	12	Ductile Iro	120.0	0.02	false	Alpensee St & Hwy 2	East Leavenworth Rd & Hwy 2
P-072	563.00	12	Ductile Iro	120.0	1.38	false	East Leavenworth Rd & Hwy 2	Hwy 2 & Riverbend Dr
P-074	334.00	12	Ductile Iro	120.0	1.30	false	Hwy 2 & Riverbend Dr	Riverbend Dr
P-076	1,159.00	8	Ductile Iro	120.0	0.63	false	Safeway	Riverbend Dr
P-078	1,107.00	6	Steel (non	110.0	0.15	false	Alpensee St Loop 1	Alpensee St Loop 2
P-080	1,172.00	12	Ductile Iro	120.0	0.81	false	Riverbend Dr	Safeway
P-082	1,050.00	6	Steel (non	110.0	0.15	false	Alpensee St Loop 1	Alpensee St Loop 2
P-084	778.00	8	Ductile Iro	120.0	0.12	false	Titus Rd & Highschool	Highschool A
P-086	148.00	8	Ductile Iro	120.0	0.00	true	Chumstick Hwy & Highschool	Highschool C
P-088	851.00	10	Ductile Iro	120.0	0.34	false	Chumstick Hwy & Highschool	Chumstick Hwy & County Shop Rd
P-090	665.00	8	Ductile Iro	120.0	0.06	false	Chumstick Hwy & County Shop Rd	North County Shop Rd
P-092	1,055.00	8	Ductile Iro	120.0	0.04	false	Highschool C	Highschool A
P-094	652.00	8	Ductile Iro	120.0	0.16	false	Titus Rd & Highschool	Pine St & Titus Rd
P-096	994.00	6	Steel (non	110.0	0.13	false	Pine St & Titus Rd	Highschool B
P-098	168.00	6	Steel (non	110.0	0.03	false	Highschool B	Highschool A
P-100	398.00	6	Steel (non	110.0	0.05	false	Highschool B	Highschool C
P-102	323.00	8	Ductile Iro	120.0	0.46	false	Pine St & Titus Rd	Cedar St & Burke Ave
P-104	195.00	8	Ductile Iro	120.0	0.46	false	Birch St & Burke Ave	Cedar St & Burke Ave

Scenario: Ultimate MDD w/ Imp.
Fire Flow Analysis
Pipe Report (custom)

Label	Length (ft)	Diameter (in)	Material	Hazen-Williams C	Velocity (ft/s)	Closed?	From Node	To Node
P-106	687.00	6	Cast iron	120.0	0.16	false	Cedar St & Burke Ave	Cedar St & Price Ave
P-108	328.00	8	Ductile Iro	120.0	0.18	false	Cedar St & Price Ave	Cedar St & Summit Ave
P-110	318.00	6	Ductile Iro	120.0	0.53	false	Cedar St & Summit Ave	Cedar St & Central Ave
P-112	1,334.00	12	Ductile Iro	120.0	0.34	false	Pine St & Central Ave	Pine St & Titus Rd
P-114	311.00	8	Ductile Iro	120.0	0.14	false	Pine St & Central Ave	Cedar St & Central Ave
P-116	336.00	8	Ductile Iro	120.0	0.23	false	Cedar St & Central Ave	Birch St & Central Ave
P-118	651.00	8	Ductile Iro	120.0	0.23	false	Birch St & Central Ave	Birch St & Price Ave
P-120	737.00	8	Ductile Iro	120.0	0.50	false	Birch St & Price Ave	Birch St & Burke Ave
P-122	300.00	8	Ductile Iro	120.0	0.92	false	Birch St & Burke Ave	Hwy 2 near 12th St
P-124	307.00	8	Cast iron	120.0	0.35	false	Ash St & Price Ave	Birch St & Price Ave
P-126	820.00	8	Cast iron	120.0	0.26	false	J-104	Ash St & Price Ave
P-128	321.00	8	Ductile Iro	120.0	0.19	false	Birch St & Central Ave	J-112
P-130	326.00	8	Ductile Iro	120.0	0.38	false	J-112	J-104
P-132	655.00	8	Ductile Iro	120.0	0.13	false	Ash St & Price Ave	J-112
P-134	127.00	8	Ductile Iro	120.0	0.59	false	J-104	J-120
P-136	189.00	12	Ductile Iro	120.0	1.38	false	Whitman St & Ski Hill Dr	Prospect St & Ski Hill Dr
P-138	1,653.00	8	Ductile Iro	120.0	0.66	false	Whitman St & Ski Hill Dr	J-120
P-140	427.00	12	Ductile Iro	120.0	1.06	false	Benton St & Ski Hill Dr	Whitman St & Ski Hill Dr
P-142	1,132.00	6	Cast iron	120.0	0.51	false	Benton St & Ski Hill Dr	Evans St & Orchard St
P-144	439.00	6	Cast iron	120.0	0.27	false	J-104	Evans St & Orchard St
P-146	442.00	6	Ductile Iro	120.0	0.44	false	Evans St & Orchard St	Evans St & Cascade St
P-148	601.00	8	Ductile Iro	120.0	0.49	false	Center St & Ski Hill Dr	Evans St & Cascade St
P-150	327.00	12	Ductile Iro	120.0	0.90	false	Center St & Ski Hill Dr	Benton St & Ski Hill Dr
P-152	277.00	12	Ductile Iro	120.0	0.68	false	Stafford St & Ski Hill Dr	Center St & Ski Hill Dr
P-154	118.00	12	Ductile Iro	120.0	0.65	false	Evans St & Ski Hill Dr	Stafford St & Ski Hill Dr
P-156	451.00	8	Ductile Iro	120.0	0.27	false	Evans St & Cascade St	Evans St & Ski Hill Dr
P-158	329.00	12	Ductile Iro	120.0	0.51	false	Evans St & Ski Hill Dr	Wheeler St & Ski Hill Dr
P-160	338.00	12	Ductile Iro	120.0	0.51	false	Wheeler St & Ski Hill Dr	Birch St & Ski Hill Dr
P-162	460.00	8	Ductile Iro	120.0	0.30	false	Birch St & Ski Hill Dr	Birch St & Cascade St
P-164	453.00	12	Ductile Iro	120.0	0.43	false	Pine St & Orchard St	Pine St & Central Ave
P-166	429.00	8	Ductile Iro	120.0	0.36	false	Birch St & Cascade St	Birch St & Orchard St
P-168	449.00	8	Ductile Iro	120.0	0.35	false	Birch St & Orchard St	Birch St & Central Ave
P-170	669.00	8	Ductile Iro	120.0	0.41	false	Birch St & Cascade St	Evans St & Cascade St
P-172	673.00	8	Ductile Iro	120.0	0.27	false	Birch St & Orchard St	Evans St & Orchard St
P-174	656.00	8	Ductile Iro	120.0	0.15	false	Pine St & Orchard St	Birch St & Orchard St
P-176	421.00	12	Ductile Iro	120.0	0.39	false	Pine St & Cascade St	Pine St & Orchard St
P-178	661.00	12	Ductile Iro	120.0	0.33	false	Birch St & Ski Hill Dr	Pine St & Ski Hill Dr
P-180	124.00	12	Ductile Iro	120.0	0.70	false	J-164	J-132
P-182	473.00	12	Ductile Iro	120.0	0.32	false	Pine St & Ski Hill Dr	Pine St & Cascade St
P-184	645.00	8	Ductile Iro	120.0	0.22	false	Pine St & Cascade St	Birch St & Cascade St
P-186	504.00	8	Ductile Iro	120.0	0.04	false	Wheeler St & Ski Hill Dr	J-146
P-188	447.00	6	Ductile Iro	120.0	0.32	false	J-146	Stafford St & Ogrady Rd
P-190	286.00	6	Ductile Iro	120.0	0.50	false	Stafford St & Ogrady Rd	Center St & Ogrady Rd
P-192	501.00	6	Ductile Iro	120.0	0.10	false	Center St & Ski Hill Dr	Center St & Ogrady Rd
P-194	135.00	6	Steel (non	110.0	0.59	false	Center St & Ogrady Rd	Center St & Cherry St
P-196	351.00	8	Ductile Iro	120.0	0.08	false	J-154	Center St & Cherry St
P-198	320.00	8	Ductile Iro	120.0	0.47	false	Center St & Cherry St	West St & Cherry St
P-200	668.00	8	Ductile Iro	120.0	0.08	false	Benton St & Ski Hill Dr	West St & Cherry St
P-202	711.00	8	Ductile Iro	120.0	0.00	true	West St & Cherry St	J-156
P-204	309.00	8	Ductile Iro	120.0	0.67	false	West St & Cherry St	Park Ave & Cherry St
P-206	708.00	6	Steel (non	110.0	0.00	true	Park Ave & Cherry St	Park Ave & Smyth St
P-208	624.00	8	Steel (non	110.0	0.00	false	Park Ave & Smyth St	Park Ave & Mtn View Dr

Scenario: Ultimate MDD w/ Imp.
Fire Flow Analysis
Pipe Report (custom)

Label	Length (ft)	Diameter (in)	Material	Hazen-Williams C	Velocity (ft/s)	Closed?	From Node	To Node
P-210	364.00	8	Steel (non	110.0	0.18	false	Park Ave & Mtn View Dr	J-162
P-212	322.00	8	Ductile Iro	120.0	0.79	false	Park Ave & Cherry St	Prospect St & Cherry St
P-214	648.00	8	Steel (non	110.0	0.16	false	J-162	J-156
P-216	275.00	12	Ductile Iro	120.0	0.54	false	J-156	J-164
P-218	321.00	12	Ductile Iro	120.0	0.44	false	Park Ave & Smyth St	J-156
P-220	713.00	6	Steel (non	110.0	0.00	true	Prospect St & Cherry St	Prospect St & Mine St
P-222	478.00	6	Steel (non	110.0	0.54	false	Prospect St & Whitman St	Prospect St & Cherry St
P-224	653.00	12	Ductile Iro	120.0	0.00	true	Prospect St & Mine St	Benton St & Mine St
P-226	208.00	8	Steel (non	110.0	0.62	false	Prospect St & Ski Hill Dr	Prospect St & Whitman St
P-228	322.00	8	Ductile Iro	120.0	0.72	false	Benton St & Mine St	Whitman St & Mill St
P-230	825.00	6	Steel (non	110.0	1.13	false	Prospect St & Cherry St	Benton St & Mine St
P-232	617.00	10	Steel (non	110.0	1.24	false	Whitman St & Mill St	Commercial St & Mill St
P-234	1,173.00	8	Steel (non	110.0	1.09	false	Prospect St & Whitman St	Whitman St & Mill St
P-236	1,060.00	18	Ductile Iro	120.0	3.92	false	Icicle Rd F	Icicle Rd & Wells
P-238	2,308.00	18	Ductile Iro	120.0	3.90	false	Icicle Rd & Reservoir	Icicle Rd F
P-240	1,129.00	24	Ductile Iro	120.0	1.23	false	Icicle Rd & Wells	Wells
P-242	1,720.00	16	Ductile Iro	120.0	2.19	false	Icicle Rd & Wells	Icicle Rd E
P-244	1,392.00	16	Ductile Iro	120.0	2.22	false	Icicle Rd E	Icicle Rd D
P-246	1,742.00	16	Ductile Iro	120.0	2.27	false	Icicle Rd D	Icicle Rd C
P-248	10,739.00	16	Steel (non	110.0	3.40	false	Water Treatment Plant	Icicle Rd A
P-250	669.00	16	Steel (non	110.0	3.39	false	Icicle Rd B	Icicle Rd A
P-252	1,214.00	16	Steel (non	110.0	3.37	false	East Leavenworth Rd & Icicle Rd	Icicle Rd B
P-254	995.00	16	Ductile Iro	120.0	2.30	false	East Leavenworth Rd & Icicle Rd	Icicle Rd C
P-256	1,407.00	12	Ductile Iro	120.0	1.88	false	East Leavenworth Rd & Icicle Rd	East Leavenworth Rd 2
P-258	6,688.00	12	Ductile Iro	120.0	1.88	false	East Leavenworth Rd 2	East Leavenworth Rd & Dempsey F
P-260	4,435.00	12	Ductile Iro	120.0	1.85	false	East Leavenworth Rd & Dempsey R	East Leavenworth Rd 1
P-262	3,778.00	12	Ductile Iro	120.0	1.75	false	East Leavenworth Rd & Creek Cros	East Leavenworth Rd 1
P-264	1,574.00	12	Ductile Iro	120.0	1.70	false	East Leavenworth Rd & Dye Rd	East Leavenworth Rd & Creek Cros
P-268	306.00	12	Ductile Iro	120.0	0.42	false	Park Ave & Smyth St	Prospect St & Mine St
P-270	344.00	12	Ductile Iro	120.0	0.08	false	Bergstrasse Rd & Ski Hill Dr	Emig Dr & Ski Hill Dr
P-272	1,324.00	8	Ductile Iro	120.0	0.00	true	Emig Dr & Ski Hill Dr	Emig Dr Mid
P-274	342.00	12	Ductile Iro	120.0	0.09	false	Detillion Rd & Titus Rd	Emig Dr & Titus Rd
P-278	1,312.00	12	Ductile Iro	120.0	0.34	false	Emig Dr Mid	Emig Dr & Titus Rd
P-280	416.00	6	Cast iron	120.0	0.69	false	Front St. Alley & 9th St	Front St. Alley & 10th St
P-282	438.00	6	Cast iron	120.0	0.64	false	Front St. Alley & 10th St	Front St & Division St
P-284	389.00	8	Ductile Iro	120.0	1.13	false	Commercial St Alley & 10th St	Commercial St Alley & Division St
P-286	307.00	12	Ductile Iro	120.0	0.00	false	Ski Hill BS #1	Ranger St & Ski Hill Dr
P-288	356.00	12	Ductile Iro	120.0	0.00	false	Pine St & Ski Hill Dr	Ski Hill BS #1
P-290	374.00	12	Ductile Iro	120.0	0.00	false	Ranger St & Ski Hill Dr	Zone 2 PRV A
P-292	421.00	12	Ductile Iro	120.0	0.00	false	Zone 2 PRV A	Pine St & Ski Hill Dr
P-294	649.00	8	Ductile Iro	120.0	1.51	false	Front St & 14th St	J-226
P-296	386.00	8	Ductile Iro	120.0	0.55	false	J-226	Chumstick Hwy & Highschool
P-298	649.00	12	Ductile Iro	120.0	1.64	false	East Leavenworth Rd & Dye Rd	East Leavenworth Rd & Hwy 2
P-300	689.00	12	Ductile Iro	120.0	0.38	false	Emig Dr Mid	J-230
P-302	636.00	12	Ductile Iro	120.0	0.85	false	Ranger St & Ski Hill Dr	Village View Dr & Ski Hill Dr
P-304	1,536.00	12	Ductile Iro	120.0	0.55	false	J-230	Village View Dr & Ski Hill Dr
P-306	2,221.00	8	Ductile Iro	120.0	0.31	false	J-230	J-212
P-308	1,321.00	12	Ductile Iro	120.0	0.06	false	Bergstrasse Rd & Ski Hill Dr	Bergstrasse Rd & Detillion Rd
P-310	1,319.00	12	Ductile Iro	120.0	0.00	true	Bergstrasse Rd & Detillion Rd	Detillion Rd & Titus Rd
P-312	1,326.00	8	Ductile Iro	120.0	0.30	false	Titus Rd NE	J-238
P-314	674.00	12	Ductile Iro	120.0	1.65	false	Village View Dr & Ski Hill Dr	Spring St & Ski HIll Dr
P-316	2,232.00	8	Ductile Iro	120.0	0.11	false	Emig Dr & Ski Hill Dr	Spring St. West

Scenario: Ultimate MDD w/ Imp.
Fire Flow Analysis
Pipe Report (custom)

Label	Length (ft)	Diameter (in)	Material	Hazen-Williams C	Velocity (ft/s)	Closed?	From Node	To Node
P-318	1,578.00	8	Ductile Iro	120.0	0.12	false	Bergstrasse Rd & Ski Hill Dr	Bergstrasse Rd West
P-320	622.00	8	Ductile Iro	120.0	0.54	false	Bergstrasse Rd & Ski Hill Dr	Maple St & Ski Hill Dr
P-322	464.00	8	Ductile Iro	120.0	0.01	false	Maple St & Ski Hill Dr	Maple St West
P-324	667.00	8	Ductile Iro	120.0	0.08	false	J-238	J-252
P-326	1,277.00	8	Ductile Iro	120.0	0.02	false	J-252	Bergstrasse Rd & Detillion Rd
P-328	1,305.00	8	Ductile Iro	120.0	0.59	false	J-252	Zone 4 Suction
P-330	630.00	8	Ductile Iro	120.0	0.65	false	Zone 4 Suction	Maple St & Ski Hill Dr
P-332	177.00	10	Ductile Iro	120.0	0.30	false	Zone 4 Suction	Ski Hill BS #3
P-334	1,178.00	10	Ductile Iro	120.0	0.30	false	Ski Hill BS #3	Zone 4 Demands
P-336	669.00	8	Ductile Iro	120.0	0.10	false	Titus Rd NE	J-258
P-338	1,335.00	8	Ductile Iro	120.0	0.31	false	J-252	J-258
P-340	1,314.00	8	Ductile Iro	120.0	0.06	false	J-258	J-260
P-342	671.00	8	Ductile Iro	120.0	0.02	false	J-260	J-262
P-344	1,314.00	8	Ductile Iro	120.0	0.09	false	J-262	Titus Rd NE
P-346	1,201.00	12	Ductile Iro	120.0	0.18	false	Chumstick Hwy & County Shop Rd	Chumstick Hwy & Cottage Creek
P-348	705.00	8	Ductile Iro	120.0	0.00	false	J-212	Zone 2 PRV B
P-350	380.00	8	Ductile Iro	120.0	0.00	false	Zone 2 PRV B	Titus Rd & Highschool
P-352	610.00	8	Ductile Iro	120.0	0.00	false	J-258	Zone 3 PRV B
P-354	678.00	8	Ductile Iro	120.0	0.00	false	Zone 3 PRV B	Detillion Rd & Titus Rd
P-356	480.00	12	Ductile Iro	120.0	0.94	false	Front St & Division St	Front St & 10th St
P-358	421.00	12	Ductile Iro	120.0	1.04	false	Front St & 10th St	Front St & 9th St
P-360	422.00	12	Ductile Iro	120.0	1.06	false	Front St & 9th St	Front St & 8th St
P-362	140.00	8	Ductile Iro	120.0	0.13	false	Front St & 9th St	Front St. Alley & 9th St
P-364	137.00	8	Ductile Iro	120.0	0.09	false	Front St & 10th St	Front St. Alley & 10th St
P-366	295.00	8	Ductile Iro	120.0	0.16	false	Front St. Alley & 9th St	Commercial St Alley & 9th St
P-368	553.00	12	Ductile Iro	120.0	0.85	false	Commercial St Alley & 8th St	Commercial St Alley & 9th St
P-370	459.00	12	Ductile Iro	120.0	0.63	false	Commercial St Alley & 9th St	Commercial St Alley & 10th St
P-372	290.00	12	Ductile Iro	120.0	0.98	false	Front St Alley & 8th St	Commercial St Alley & 8th St
P-374	501.00	10	Steel (nor	110.0	0.06	false	Front St & Division St	Hwy 2 near 12th St
P-376	973.00	8	Ductile Iro	120.0	0.15	false	Front St & 8th St	J-034
P-378	1,656.00	8	Ductile Iro	120.0	0.10	false	J-014	J-010
P-380	1,316.00	14	Ductile Iro	120.0	0.55	false	Ranger St & Ski Hill Dr	Ranger St Mid
P-382	971.00	8	Ductile Iro	120.0	0.26	false	Ranger St Mid	Ranger St West
P-384	1,619.00	12	Ductile Iro	120.0	0.79	false	Ranger St Mid	Wheeler St West
P-386	504.00	6	Ductile Iro	120.0	0.12	false	Stafford St & Ogrady Rd	Stafford St & Ski Hill Dr
P-388	159.00	12	Ductile Iro	120.0	0.00	false	Emig Dr & Ski Hill Dr	Zone 3 PRV A
P-390	165.00	12	Ductile Iro	120.0	0.00	false	Zone 3 PRV A	Spring St & Ski HIll Dr
P-392	693.00	8	Ductile Iro	120.0	0.69	false	Zone 4 Suction	Titus Rd & Ski Hill Dr
P-394	1,317.00	8	Ductile Iro	120.0	0.30	false	Titus Rd & Ski Hill Dr	J-238
P-396	249.00	12	Ductile Iro	120.0	1.12	false	Zone 2 Tank (0.75 MG)	Ski Hill BS #2
P-398	374.00	12	Ductile Iro	120.0	1.12	false	Ski Hill BS #2	Zone 4 Suction
P-400	774.00	12	Ductile Iro	120.0	0.15	false	Zone 3 Tank	Titus Rd & Ski Hill Dr
P-402	2,723.00	16	Ductile Iro	120.0	0.95	false	Spring St & Ski HIll Dr	Zone 2 Tank (0.75 MG)
P-404	595.00	8	Steel (nor	110.0	0.30	false	J-164	J-276
P-406	204.00	8	Steel (nor	110.0	0.14	false	J-276	J-162
P-408	676.00	12	Ductile Iro	120.0	0.70	false	J-132	Wheeler St West
P-410	213.00	12	Ductile Iro	120.0	0.17	false	Emig Dr & Titus Rd	Titus Rd & Cottage Creek
P-412	352.00	8	Ductile Iro	120.0	0.39	false	Titus Rd & Cottage Creek	J-212
P-414	682.00	12	Ductile Iro	120.0	0.00	false	Titus Rd & Cottage Creek	Zone 2 PRV C
P-416	1,208.00	12	Ductile Iro	120.0	0.00	false	Zone 2 PRV C	Chumstick Hwy & Cottage Creek
P-418	2,684.00	8	Ductile Iro	120.0	0.37	false	Village View Dr & Ski Hill Dr	Ranger St West
P-420	753.00	8	Ductile Iro	120.0	0.08	false	Bergstrasse Rd West	Spring St. West

Scenario: Ultimate MDD w/ Imp.
Fire Flow Analysis
Pipe Report (custom)

Label	Length (ft)	Diameter (in)	Material	Hazen-Williams C	Velocity (ft/s)	Closed?	From Node	To Node
P-422	960.00	18	Ductile Iro	120.0	0.00	true	East Leavenworth Rd & Creek Cros	Future Main Zone Res
WTP	10.00	16	Ductile Iro	120.0	0.00	true	Icicle Creek Clearwell	Water Treatment Plant

Scenario: Ultimate PHD w/ Imp.
Steady State Analysis
Tank Report (custom)

Label	Zone	Base Elevation (ft)	Initial HGL (ft)	Maximum Elevation (ft)	Tank Diameter (ft)	Inflow (gpm)	Current Status	Calculated Level (ft)
Future Main Zone Res	Zone-1	1,312.00	1,335.00	1,336.00	84.00	0.00	Steady	23.00
Zone 1 Tanks (0.70 MG	Zone-1	1,312.00	1,322.00	1,336.00	N/A	-1,862.54	Draining	10.00
Zone 2 Tank (0.75 MG)	Zone 2	1,400.00	1,420.00	1,424.00	74.00	-627.17	Draining	20.00
Zone 3 Tank	Zone 3	1,496.00	1,518.00	1,520.00	50.00	-302.30	Draining	22.00

Scenario: Ultimate PHD w/ Imp.
Steady State Analysis
Pump Report

Label	Elevation (ft)	Control Status	Intake Pump Grade (ft)	Discharge Pump Grade (ft)	Discharge (gpm)	Pump Head (ft)	Calculated Water Power (Hp)	Pump Definition
Ski Hill BS #1	1,210.00	On	1,297.40	1,420.92	930.54	123.53	29.02	Future Ski Hill BS #1
Ski Hill BS #2	1,400.00	On	1,419.83	1,517.75	461.71	97.93	11.41	Future Ski Hill BS #2
Ski Hill BS #3	1,400.00	On	1,517.42	1,639.30	205.00	121.88	6.31	Future Ski Hill BS #3

Scenario: Ultimate PHD w/ Imp.
Steady State Analysis
Valve Report

Label	Elevation (ft)	Diameter (in)	Control Status	Discharge (gpm)	From HGL (ft)	To HGL (ft)	Headloss (ft)
Zone 2 PRV A	1,210.00	8	Closed	0.00	1,420.13	1,298.31	0.00
Zone 2 PRV B	1,200.00	8	Closed	0.00	1,418.62	1,298.56	0.00
Zone 2 PRV C	1,200.00	6	Closed	0.00	1,418.76	1,295.06	0.00
Zone 3 PRV A	1,300.00	6	Closed	0.00	1,516.56	1,419.93	0.00
Zone 3 PRV B	1,300.00	8	Closed	0.00	1,516.24	1,418.76	0.00

Scenario: Ultimate PHD w/ Imp.
Steady State Analysis
Junction Report (custom)

Label	Elevation (ft)	Zone	Type	Demand (Calculated) (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)
Alpensee St & Hwy 2	1,160.00	Zone-1	Demand	57.00	1,297.59	59.53
Alpensee St Loop 1	1,121.00	Zone-1	Demand	97.00	1,296.70	76.02
Alpensee St Loop 2	1,138.00	Zone-1	Demand	43.00	1,296.61	68.62
Ash St & Price Ave	1,170.00	Zone-1	Demand	13.00	1,299.12	55.86
Benton St & Mine St	1,185.00	Zone-1	Demand	23.00	1,308.56	53.46
Benton St & Ski Hill Dr	1,168.00	Zone-1	Demand	39.00	1,301.26	57.65
Bergstrasse Rd & Detillion Rd	1,300.00	Zone 3	Demand	49.00	1,516.57	93.70
Bergstrasse Rd & Ski Hill Dr	1,341.00	Zone 3	Demand	37.00	1,516.57	75.96
Bergstrasse Rd West	1,400.00	Zone 3	Demand	15.00	1,516.48	50.40
Birch St & Burke Ave	1,167.00	Zone-1	Demand	5.00	1,298.68	56.97
Birch St & Cascade St	1,192.00	Zone-1	Demand	33.00	1,299.00	46.29
Birch St & Central Ave	1,177.00	Zone-1	Demand	17.00	1,298.96	52.76
Birch St & Orchard St	1,181.00	Zone-1	Demand	32.00	1,298.97	51.04
Birch St & Price Ave	1,170.00	Zone-1	Demand	18.00	1,298.96	55.79
Birch St & Ski Hill Dr	1,188.00	Zone-1	Demand	24.00	1,299.02	48.03
Cedar St & Burke Ave	1,167.00	Zone-1	Demand	21.00	1,298.64	56.96
Cedar St & Central Ave	1,197.00	Zone-1	Demand	12.00	1,298.72	44.01
Cedar St & Price Ave	1,188.00	Zone-1	Demand	18.00	1,298.65	47.87
Cedar St & Summit Ave	1,182.00	Zone-1	Demand	12.00	1,298.66	50.47
Center St & Cherry St	1,178.00	Zone-1	Demand	18.00	1,300.99	53.21
Center St & Ogrady Rd	1,180.00	Zone-1	Demand	0.00	1,300.53	52.15
Center St & Ski Hill Dr	1,172.00	Zone-1	Demand	19.00	1,300.45	55.57
Chumstick Hwy & Cottage Creek	1,160.00	Zone-1	Demand	105.00	1,295.06	58.43
Chumstick Hwy & County Shop Rd	1,160.00	Zone-1	Demand	16.00	1,295.11	58.46
Chumstick Hwy & Highschool	1,150.00	Zone-1	Demand	3.00	1,295.27	62.85
Commercial St & 1st St	1,164.00	Zone-1	Demand	26.00	1,308.84	62.66
Commercial St & 2nd St	1,168.00	Zone-1	Demand	22.00	1,307.34	60.29
Commercial St & 3rd St	1,156.00	Zone-1	Demand	70.00	1,306.14	64.96
Commercial St & 13th St	1,143.00	Zone-1	Demand	50.00	1,298.18	67.14
Commercial St & 14th St	1,137.00	Zone-1	Demand	56.00	1,297.95	69.63
Commercial St & Enchantment Park Wy	1,158.00	Zone-1	Demand	8.00	1,309.52	65.55
Commercial St & Mill St	1,173.00	Zone-1	Demand	108.00	1,311.76	60.03
Commercial St Alley & 8th St	1,137.00	Zone-1	Demand	75.00	1,301.66	71.24
Commercial St Alley & 9th St	1,153.00	Zone-1	Demand	91.00	1,300.88	63.98
Commercial St Alley & 10th St	1,149.00	Zone-1	Demand	71.00	1,300.50	65.55
Commercial St Alley & Division St	1,153.00	Zone-1	Demand	68.00	1,298.79	63.08
Detillion Rd & Titus Rd	1,261.00	Zone 2	Demand	59.00	1,418.76	68.26
East Leavenworth Rd & Creek Cross	1,140.00	Zone-1	Demand	32.00	1,301.09	69.70
East Leavenworth Rd & Dempsey Rd	1,125.00	Zone-1	Demand	17.00	1,317.19	83.15
East Leavenworth Rd & Dye Rd	1,150.00	Zone-1	Demand	32.00	1,298.44	64.22
East Leavenworth Rd & Hwy 2	1,140.00	Zone-1	Demand	136.00	1,297.43	68.11
East Leavenworth Rd & Icicle Rd	1,148.00	Zone-1	Demand	19.00	1,334.69	80.77
East Leavenworth Rd 1	1,115.00	Zone-1	Demand	58.00	1,307.96	83.49
East Leavenworth Rd 2	1,125.00	Zone-1	Demand	0.00	1,331.65	89.41
Emig Dr & Ski Hill Dr	1,320.00	Zone 3	Demand	22.00	1,516.56	85.04
Emig Dr & Titus Rd	1,240.00	Zone 2	Demand	51.00	1,418.77	77.34
Emig Dr Mid	1,280.00	Zone 2	Demand	25.00	1,419.01	60.14
Evans St & Cascade St	1,174.00	Zone-1	Demand	25.00	1,299.73	54.40
Evans St & Orchard St	1,176.00	Zone-1	Demand	30.00	1,299.45	53.41
Evans St & Ski Hill Dr	1,178.00	Zone-1	Demand	14.00	1,299.84	52.71
Front St & 8th St	1,160.00	Zone-1	Demand	77.00	1,301.69	61.30
Front St & 9th St	1,165.00	Zone-1	Demand	52.00	1,300.78	58.75

Scenario: Ultimate PHD w/ Imp.
Steady State Analysis
Junction Report (custom)

Label	Elevation (ft)	Zone	Type	Demand (Calculated) (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)
Front St & 10th St	1,170.00	Zone-1	Demand	35.00	1,299.82	56.17
Front St & 13th St	1,154.00	Zone-1	Demand	58.00	1,298.13	62.36
Front St & 14th St	1,148.00	Zone-1	Demand	17.00	1,297.86	64.84
Front St & Division St	1,160.00	Zone-1	Demand	103.00	1,298.86	60.08
Front St Alley & 8th St	1,148.00	Zone-1	Demand	55.00	1,302.17	66.70
Front St Alley & 14th St	1,142.00	Zone-1	Demand	28.00	1,297.86	67.43
Front St. Alley & 9th St	1,160.00	Zone-1	Demand	33.00	1,300.81	60.92
Front St. Alley & 10th St	1,165.00	Zone-1	Demand	32.00	1,299.81	58.33
Highschool A	1,170.00	Zone-1	Demand	16.00	1,298.54	55.61
Highschool B	1,170.00	Zone-1	Demand	16.00	1,298.54	55.61
Highschool C	1,152.00	Zone-1	Demand	16.00	1,298.54	63.40
Hwy 2 & 3rd St	1,167.00	Zone-1	Demand	86.00	1,304.39	59.44
Hwy 2 & Commercial St	1,172.00	Zone-1	Demand	8.00	1,312.82	60.92
Hwy 2 & Icicle Rd	1,183.00	Zone-1	Demand	73.00	1,315.71	57.42
Hwy 2 & Riverbend Dr	1,175.00	Zone-1	Demand	51.00	1,296.33	52.50
Hwy 2 near 12th St	1,170.00	Zone-1	Demand	212.00	1,298.67	55.67
Icicle Rd & Reservoir	1,177.00	Zone-1	Demand	77.00	1,319.46	61.64
Icicle Rd & Wells	1,142.00	Zone-1	Demand	0.00	1,328.98	80.90
Icicle Rd A	1,155.00	Zone-1	Demand	16.00	1,341.06	80.50
Icicle Rd B	1,151.00	Zone-1	Demand	13.00	1,338.78	81.24
Icicle Rd C	1,175.00	Zone-1	Demand	34.00	1,333.62	68.63
Icicle Rd D	1,175.00	Zone-1	Demand	47.00	1,331.84	67.86
Icicle Rd E	1,175.00	Zone-1	Demand	36.00	1,330.52	67.28
Icicle Rd F	1,120.00	Zone-1	Demand	19.00	1,325.96	89.11
J-010	1,172.00	Zone-1	Demand	122.00	1,309.67	59.56
J-012	1,169.00	Zone-1	Demand	50.00	1,309.52	60.80
J-014	1,163.00	Zone-1	Demand	36.00	1,309.53	63.39
J-018	1,166.00	Zone-1	Demand	19.00	1,309.52	62.09
J-020	1,167.00	Zone-1	Demand	10.00	1,310.35	62.02
J-024	1,160.00	Zone-1	Demand	12.00	1,308.64	64.31
J-026	1,120.00	Zone-1	Demand	12.00	1,307.90	81.29
J-034	1,167.00	Zone-1	Demand	73.00	1,301.45	58.17
J-036	1,165.00	Zone-1	Demand	111.00	1,300.43	58.59
J-104	1,177.00	Zone-1	Demand	24.00	1,299.46	52.98
J-112	1,179.00	Zone-1	Demand	18.00	1,299.14	51.98
J-120	1,177.00	Zone-1	Demand	21.00	1,299.81	53.14
J-132	1,210.00	Zone 2	Demand	0.00	1,417.88	89.94
J-146	1,187.00	Zone-1	Demand	36.00	1,299.52	48.68
J-154	1,181.00	Zone-1	Demand	20.00	1,300.98	51.91
J-156	1,200.00	Zone 2	Demand	19.00	1,417.70	94.19
J-162	1,235.00	Zone 2	Demand	37.00	1,417.65	79.02
J-164	1,190.00	Zone 2	Demand	20.00	1,417.80	98.56
J-212	1,230.00	Zone 2	Demand	205.00	1,418.62	81.61
J-226	1,150.00	Zone-1	Demand	248.00	1,295.48	62.94
J-230	1,260.00	Zone 2	Demand	29.00	1,419.17	68.86
J-238	1,410.00	Zone 3	Demand	26.00	1,516.68	46.16
J-252	1,350.00	Zone 3	Demand	58.00	1,516.64	72.10
J-258	1,340.00	Zone 3	Demand	113.00	1,516.24	76.25
J-260	1,280.00	Zone 3	Demand	26.00	1,516.22	102.20
J-262	1,300.00	Zone 3	Demand	26.00	1,516.22	93.55
J-276	1,230.00	Zone 2	Demand	46.00	1,417.66	81.19
Maple St & Ski Hill Dr	1,370.00	Zone 3	Demand	31.00	1,516.93	63.57

Scenario: Ultimate PHD w/ Imp.
Steady State Analysis
Junction Report (custom)

Label	Elevation (ft)	Zone	Type	Demand (Calculated) (gpm)	Calculated Hydraulic Grade (ft)	Pressure (psi)
Maple St West	1,400.00	Zone 3	Demand	5.00	1,516.93	50.59
North County Shop Rd	1,165.00	Zone-1	Demand	16.00	1,295.11	56.29
Park Ave & Cherry St	1,179.00	Zone-1	Demand	34.00	1,301.97	53.20
Park Ave & Mtn View Dr	1,230.00	Zone 2	Demand	54.00	1,417.62	81.17
Park Ave & Smyth St	1,195.00	Zone 2	Demand	17.00	1,417.62	96.32
Pine St & Cascade St	1,193.00	Zone-1	Demand	16.00	1,298.52	45.65
Pine St & Central Ave	1,190.00	Zone-1	Demand	13.00	1,298.60	46.99
Pine St & Orchard St	1,192.00	Zone-1	Demand	16.00	1,298.59	46.12
Pine St & Ski Hill Dr	1,199.00	Zone-1	Demand	9.00	1,298.31	42.97
Pine St & Titus Rd	1,174.00	Zone-1	Demand	20.00	1,298.60	53.91
Prospect St & Cherry St	1,183.00	Zone-1	Demand	38.00	1,302.79	51.83
Prospect St & Mine St	1,188.00	Zone 2	Demand	240.00	1,417.55	99.32
Prospect St & Ski Hill Dr	1,169.00	Zone-1	Demand	33.00	1,303.40	58.15
Prospect St & Whitman St	1,173.00	Zone-1	Demand	44.00	1,303.76	56.57
Ranger St & Ski Hill Dr	1,230.00	Zone 2	Demand	69.00	1,420.13	82.26
Ranger St Mid	1,250.00	Zone 2	Demand	47.00	1,419.59	73.37
Ranger St West	1,300.00	Zone 2	Demand	34.00	1,419.61	51.75
Riverbend Dr	1,170.00	Zone-1	Demand	119.00	1,295.76	54.41
Safeway	1,185.00	Zone-1	Demand	632.00	1,294.91	47.55
Spring St & Ski HIll Dr	1,300.00	Zone 2	Demand	26.00	1,419.93	51.89
Spring St. West	1,400.00	Zone 3	Demand	61.00	1,516.46	50.39
Stafford St & Ogrady Rd	1,180.00	Zone-1	Demand	42.00	1,300.01	51.92
Stafford St & Ski Hill Dr	1,175.00	Zone-1	Demand	0.00	1,300.02	54.09
Titus Rd & Cottage Creek	1,230.00	Zone 2	Demand	0.00	1,418.76	81.67
Titus Rd & Highschool	1,177.00	Zone-1	Demand	12.00	1,298.56	52.60
Titus Rd & Ski Hill Dr	1,440.00	Zone 3	Demand	16.00	1,517.75	33.64
Titus Rd NE	1,390.00	Zone 3	Demand	36.00	1,516.27	54.63
Village View Dr & Ski Hill Dr	1,260.00	Zone 2	Demand	57.00	1,419.88	69.17
Water Treatment Plant	1,367.00	No Fire Flow	Inflow	-2,133.00	1,378.21	4.85
Wells	1,117.00	Zone-1	Inflow	-1,736.00	1,329.29	91.85
West St & Cherry St	1,179.00	Zone-1	Demand	31.00	1,301.33	52.92
Wheeler St & Ski Hill Dr	1,185.00	Zone-1	Demand	15.00	1,299.46	49.52
Wheeler St West	1,220.00	Zone 2	Demand	61.00	1,418.30	85.80
Whitman St & Mill St	1,177.00	Zone-1	Demand	35.00	1,309.12	57.16
Whitman St & Ski Hill Dr	1,168.00	Zone-1	Demand	21.00	1,302.53	58.20
Zone 4 Demands	1,520.00	Zone 4	Demand	205.00	1,638.86	51.42
Zone 4 Suction	1,400.00	Zone 3	Demand	38.00	1,517.49	50.83

Scenario: Ultimate PHD w/ Imp.
Steady State Analysis
Pipe Report (custom)

Label	Length (ft)	Diameter (in)	Material	Hazen-Williams C	Velocity (ft/s)	Closed?	From Node	To Node
P-002	579.00	14	Ductile Iro	120.0	3.88	false	Zone 1 Tanks (0.70 MG & Future)	Icicle Rd & Reservoir
P-004	902.00	20	Ductile Iro	120.0	4.72	false	Icicle Rd & Reservoir	Hwy 2 & Icicle Rd
P-006	829.00	20	Ductile Iro	130.0	4.65	false	Hwy 2 & Icicle Rd	Hwy 2 & Commercial St
P-008	535.00	6	Ductile Iro	120.0	2.67	false	Hwy 2 & Commercial St	J-010
P-010	282.00	6	Ductile Iro	120.0	0.71	false	J-010	J-012
P-012	651.00	8	Ductile Iro	120.0	0.08	false	J-012	J-018
P-014	264.00	6	Cast iron	120.0	0.16	false	J-018	J-014
P-016	291.00	20	Ductile Iro	120.0	4.40	false	Hwy 2 & Commercial St	Commercial St & Mill St
P-018	227.00	8	Ductile Iro	120.0	0.05	false	J-018	Commercial St & Enchantment Parl
P-020	338.00	18	Ductile Iro	120.0	4.42	false	Commercial St & Mill St	J-020
P-022	402.00	6	Cast iron	120.0	1.43	false	J-024	J-026
P-024	201.00	18	Ductile Iro	120.0	4.41	false	J-020	Commercial St & Enchantment Parl
P-026	362.00	8	Ductile Iro	120.0	0.88	false	Commercial St & 1st St	J-024
P-028	164.00	18	Ductile Iro	120.0	4.41	false	Commercial St & Enchantment Park	Commercial St & 1st St
P-030	395.00	18	Ductile Iro	120.0	4.20	false	Commercial St & 1st St	Commercial St & 2nd St
P-032	301.00	18	Ductile Iro	120.0	4.32	false	Commercial St & 2nd St	Commercial St & 3rd St
P-034	361.00	6	Cast iron	120.0	1.29	false	J-026	Commercial St & 2nd St
P-036	336.00	12	Ductile Iro	120.0	3.86	false	Hwy 2 & 3rd St	Commercial St & 3rd St
P-038	294.00	12	Ductile Iro	120.0	3.05	false	Prospect St & Ski Hill Dr	Hwy 2 & 3rd St
P-040	679.00	6	Ductile Iro	120.0	2.26	false	Hwy 2 & 3rd St	J-034
P-042	811.00	8	Ductile Iro	120.0	1.39	false	J-034	J-036
P-044	447.00	6	Cast iron	120.0	1.21	false	J-036	J-120
P-046	157.00	12	Ductile Iro	120.0	2.88	false	Front St Alley & 8th St	Front St & 8th St
P-048	1,534.00	16	Ductile Iro	120.0	3.18	false	Commercial St & 3rd St	Front St Alley & 8th St
P-050	421.00	6	Cast iron	120.0	1.93	false	Front St Alley & 8th St	Front St. Alley & 9th St
P-052	328.00	10	Steel (non	110.0	0.54	false	Front St & Division St	Commercial St Alley & Division St
P-054	774.00	12	Ductile Iro	120.0	1.39	false	Commercial St Alley & Division St	Commercial St & 13th St
P-056	360.00	12	Ductile Iro	120.0	1.25	false	Commercial St & 13th St	Commercial St & 14th St
P-058	178.00	12	Ductile Iro	120.0	1.09	false	Commercial St & 14th St	Front St Alley & 14th St
P-060	190.00	12	Ductile Iro	120.0	0.20	false	Front St Alley & 14th St	Front St & 14th St
P-062	1,366.00	8	Steel (non	110.0	0.89	false	Alpensee St & Hwy 2	Alpensee St Loop 1
P-064	356.00	12	Ductile Iro	120.0	1.35	false	Front St & 14th St	Front St & 13th St
P-066	440.00	12	Ductile Iro	120.0	1.21	false	Front St Alley & 14th St	Alpensee St & Hwy 2
P-068	799.00	12	Ductile Iro	120.0	1.51	false	Front St & 13th St	Front St & Division St
P-070	812.00	12	Ductile Iro	120.0	0.65	false	Alpensee St & Hwy 2	East Leavenworth Rd & Hwy 2
P-072	563.00	12	Ductile Iro	120.0	2.28	false	East Leavenworth Rd & Hwy 2	Hwy 2 & Riverbend Dr
P-074	334.00	12	Ductile Iro	120.0	2.13	false	Hwy 2 & Riverbend Dr	Riverbend Dr
P-076	1,159.00	8	Ductile Iro	120.0	1.04	false	Safeway	Riverbend Dr
P-078	1,107.00	6	Steel (non	110.0	0.24	false	Alpensee St Loop 1	Alpensee St Loop 2
P-080	1,172.00	12	Ductile Iro	120.0	1.33	false	Riverbend Dr	Safeway
P-082	1,050.00	6	Steel (non	110.0	0.25	false	Alpensee St Loop 1	Alpensee St Loop 2
P-084	778.00	8	Ductile Iro	120.0	0.19	false	Titus Rd & Highschool	Highschool A
P-086	148.00	8	Ductile Iro	120.0	0.00	true	Chumstick Hwy & Highschool	Highschool C
P-088	851.00	10	Ductile Iro	120.0	0.56	false	Chumstick Hwy & Highschool	Chumstick Hwy & County Shop Rd
P-090	665.00	8	Ductile Iro	120.0	0.10	false	Chumstick Hwy & County Shop Rd	North County Shop Rd
P-092	1,055.00	8	Ductile Iro	120.0	0.04	false	Highschool C	Highschool A
P-094	652.00	8	Ductile Iro	120.0	0.26	false	Titus Rd & Highschool	Pine St & Titus Rd
P-096	994.00	6	Steel (non	110.0	0.21	false	Pine St & Titus Rd	Highschool B
P-098	168.00	6	Steel (non	110.0	0.08	false	Highschool B	Highschool A
P-100	398.00	6	Steel (non	110.0	0.12	false	Highschool B	Highschool C
P-102	323.00	8	Ductile Iro	120.0	0.41	false	Pine St & Titus Rd	Cedar St & Burke Ave
P-104	195.00	8	Ductile Iro	120.0	0.51	false	Birch St & Burke Ave	Cedar St & Burke Ave

Scenario: Ultimate PHD w/ Imp.
Steady State Analysis
Pipe Report (custom)

Label	Length (ft)	Diameter (in)	Material	Hazen-Williams C	Velocity (ft/s)	Closed?	From Node	To Node
P-106	687.00	6	Cast iron	120.0	0.07	false	Cedar St & Burke Ave	Cedar St & Price Ave
P-108	328.00	8	Ductile Iro	120.0	0.16	false	Cedar St & Price Ave	Cedar St & Summit Ave
P-110	318.00	6	Ductile Iro	120.0	0.41	false	Cedar St & Summit Ave	Cedar St & Central Ave
P-112	1,334.00	12	Ductile Iro	120.0	0.04	false	Pine St & Central Ave	Pine St & Titus Rd
P-114	311.00	8	Ductile Iro	120.0	0.71	false	Pine St & Central Ave	Cedar St & Central Ave
P-116	336.00	8	Ductile Iro	120.0	1.02	false	Cedar St & Central Ave	Birch St & Central Ave
P-118	651.00	8	Ductile Iro	120.0	0.03	false	Birch St & Central Ave	Birch St & Price Ave
P-120	737.00	8	Ductile Iro	120.0	0.72	false	Birch St & Price Ave	Birch St & Burke Ave
P-122	300.00	8	Ductile Iro	120.0	0.18	false	Birch St & Burke Ave	Hwy 2 near 12th St
P-124	307.00	8	Cast iron	120.0	0.87	false	Ash St & Price Ave	Birch St & Price Ave
P-126	820.00	8	Cast iron	120.0	0.76	false	J-104	Ash St & Price Ave
P-128	321.00	8	Ductile Iro	120.0	0.91	false	Birch St & Central Ave	J-112
P-130	326.00	8	Ductile Iro	120.0	1.21	false	J-112	J-104
P-132	655.00	8	Ductile Iro	120.0	0.19	false	Ash St & Price Ave	J-112
P-134	127.00	8	Ductile Iro	120.0	2.15	false	J-104	J-120
P-136	189.00	12	Ductile Iro	120.0	3.63	false	Whitman St & Ski Hill Dr	Prospect St & Ski Hill Dr
P-138	1,653.00	8	Ductile Iro	120.0	1.60	false	Whitman St & Ski Hill Dr	J-120
P-140	427.00	12	Ductile Iro	120.0	2.86	false	Benton St & Ski Hill Dr	Whitman St & Ski Hill Dr
P-142	1,132.00	6	Cast iron	120.0	1.32	false	Benton St & Ski Hill Dr	Evans St & Orchard St
P-144	439.00	6	Cast iron	120.0	0.05	false	J-104	Evans St & Orchard St
P-146	442.00	6	Ductile Iro	120.0	0.80	false	Evans St & Orchard St	Evans St & Cascade St
P-148	601.00	8	Ductile Iro	120.0	1.35	false	Center St & Ski Hill Dr	Evans St & Cascade St
P-150	327.00	12	Ductile Iro	120.0	2.58	false	Center St & Ski Hill Dr	Benton St & Ski Hill Dr
P-152	277.00	12	Ductile Iro	120.0	2.02	false	Stafford St & Ski Hill Dr	Center St & Ski Hill Dr
P-154	118.00	12	Ductile Iro	120.0	1.99	false	Evans St & Ski Hill Dr	Stafford St & Ski Hill Dr
P-156	451.00	8	Ductile Iro	120.0	0.55	false	Evans St & Cascade St	Evans St & Ski Hill Dr
P-158	329.00	12	Ductile Iro	120.0	1.70	false	Evans St & Ski Hill Dr	Wheeler St & Ski Hill Dr
P-160	338.00	12	Ductile Iro	120.0	1.83	false	Wheeler St & Ski Hill Dr	Birch St & Ski Hill Dr
P-162	460.00	8	Ductile Iro	120.0	0.25	false	Birch St & Ski Hill Dr	Birch St & Cascade St
P-164	453.00	12	Ductile Iro	120.0	0.24	false	Pine St & Orchard St	Pine St & Central Ave
P-166	429.00	8	Ductile Iro	120.0	0.28	false	Birch St & Cascade St	Birch St & Orchard St
P-168	449.00	8	Ductile Iro	120.0	0.19	false	Birch St & Orchard St	Birch St & Central Ave
P-170	669.00	8	Ductile Iro	120.0	1.29	false	Birch St & Cascade St	Evans St & Cascade St
P-172	673.00	8	Ductile Iro	120.0	1.03	false	Birch St & Orchard St	Evans St & Orchard St
P-174	656.00	8	Ductile Iro	120.0	0.92	false	Pine St & Orchard St	Birch St & Orchard St
P-176	421.00	12	Ductile Iro	120.0	0.60	false	Pine St & Cascade St	Pine St & Orchard St
P-178	661.00	12	Ductile Iro	120.0	1.65	false	Birch St & Ski Hill Dr	Pine St & Ski Hill Dr
P-180	124.00	12	Ductile Iro	120.0	1.23	false	J-164	J-132
P-182	473.00	12	Ductile Iro	120.0	1.02	false	Pine St & Ski Hill Dr	Pine St & Cascade St
P-184	645.00	8	Ductile Iro	120.0	1.04	false	Pine St & Cascade St	Birch St & Cascade St
P-186	504.00	8	Ductile Iro	120.0	0.37	false	Wheeler St & Ski Hill Dr	J-146
P-188	447.00	6	Ductile Iro	120.0	1.07	false	J-146	Stafford St & Ogrady Rd
P-190	286.00	6	Ductile Iro	120.0	1.42	false	Stafford St & Ogrady Rd	Center St & Ogrady Rd
P-192	501.00	6	Ductile Iro	120.0	0.39	false	Center St & Ski Hill Dr	Center St & Ogrady Rd
P-194	135.00	6	Steel (non	110.0	1.81	false	Center St & Ogrady Rd	Center St & Cherry St
P-196	351.00	8	Ductile Iro	120.0	0.13	false	J-154	Center St & Cherry St
P-198	320.00	8	Ductile Iro	120.0	1.26	false	Center St & Cherry St	West St & Cherry St
P-200	668.00	8	Ductile Iro	120.0	0.36	false	Benton St & Ski Hill Dr	West St & Cherry St
P-202	711.00	8	Ductile Iro	120.0	0.00	true	West St & Cherry St	J-156
P-204	309.00	8	Ductile Iro	120.0	1.82	false	West St & Cherry St	Park Ave & Cherry St
P-206	708.00	6	Steel (non	110.0	0.00	true	Park Ave & Cherry St	Park Ave & Smyth St
P-208	624.00	8	Steel (non	110.0	0.05	false	Park Ave & Smyth St	Park Ave & Mtn View Dr

Scenario: Ultimate PHD w/ Imp.
Steady State Analysis
Pipe Report (custom)

Label	Length (ft)	Diameter (in)	Material	Hazen-Williams C	Velocity (ft/s)	Closed?	From Node	To Node
P-210	364.00	8	Steel (non	110.0	0.29	false	Park Ave & Mtn View Dr	J-162
P-212	322.00	8	Ductile Iro	120.0	2.04	false	Park Ave & Cherry St	Prospect St & Cherry St
P-214	648.00	8	Steel (non	110.0	0.29	false	J-162	J-156
P-216	275.00	12	Ductile Iro	120.0	0.94	false	J-156	J-164
P-218	321.00	12	Ductile Iro	120.0	0.75	false	Park Ave & Smyth St	J-156
P-220	713.00	6	Steel (non	110.0	0.00	true	Prospect St & Cherry St	Prospect St & Mine St
P-222	478.00	6	Steel (non	110.0	1.37	false	Prospect St & Whitman St	Prospect St & Cherry St
P-224	653.00	12	Ductile Iro	120.0	0.00	true	Prospect St & Mine St	Benton St & Mine St
P-226	208.00	8	Steel (non	110.0	1.50	false	Prospect St & Ski Hill Dr	Prospect St & Whitman St
P-228	322.00	8	Ductile Iro	120.0	1.66	false	Benton St & Mine St	Whitman St & Mill St
P-230	825.00	6	Steel (non	110.0	2.68	false	Prospect St & Cherry St	Benton St & Mine St
P-232	617.00	10	Steel (non	110.0	2.84	false	Whitman St & Mill St	Commercial St & Mill St
P-234	1,173.00	8	Steel (non	110.0	2.56	false	Prospect St & Whitman St	Whitman St & Mill St
P-236	1,060.00	18	Ductile Iro	120.0	3.60	false	Icicle Rd F	Icicle Rd & Wells
P-238	2,308.00	18	Ductile Iro	120.0	3.58	false	Icicle Rd & Reservoir	Icicle Rd F
P-240	1,129.00	24	Ductile Iro	120.0	1.23	false	Icicle Rd & Wells	Wells
P-242	1,720.00	16	Ductile Iro	120.0	1.79	false	Icicle Rd & Wells	Icicle Rd E
P-244	1,392.00	16	Ductile Iro	120.0	1.85	false	Icicle Rd E	Icicle Rd D
P-246	1,742.00	16	Ductile Iro	120.0	1.92	false	Icicle Rd D	Icicle Rd C
P-248	10,739.00	16	Steel (non	110.0	3.40	false	Water Treatment Plant	Icicle Rd A
P-250	669.00	16	Steel (non	110.0	3.38	false	Icicle Rd B	Icicle Rd A
P-252	1,214.00	16	Steel (non	110.0	3.36	false	East Leavenworth Rd & Icicle Rd	Icicle Rd B
P-254	995.00	16	Ductile Iro	120.0	1.98	false	East Leavenworth Rd & Icicle Rd	Icicle Rd C
P-256	1,407.00	12	Ductile Iro	120.0	2.40	false	East Leavenworth Rd & Icicle Rd	East Leavenworth Rd 2
P-258	6,688.00	12	Ductile Iro	120.0	2.40	false	East Leavenworth Rd 2	East Leavenworth Rd & Dempsey F
P-260	4,435.00	12	Ductile Iro	120.0	2.35	false	East Leavenworth Rd & Dempsey R	East Leavenworth Rd 1
P-262	3,778.00	12	Ductile Iro	120.0	2.19	false	East Leavenworth Rd & Creek Cros	East Leavenworth Rd 1
P-264	1,574.00	12	Ductile Iro	120.0	2.10	false	East Leavenworth Rd & Dye Rd	East Leavenworth Rd & Creek Cros
P-268	306.00	12	Ductile Iro	120.0	0.68	false	Park Ave & Smyth St	Prospect St & Mine St
P-270	344.00	12	Ductile Iro	120.0	0.16	false	Bergstrasse Rd & Ski Hill Dr	Emig Dr & Ski Hill Dr
P-272	1,324.00	8	Ductile Iro	120.0	0.00	true	Emig Dr & Ski Hill Dr	Emig Dr Mid
P-274	342.00	12	Ductile Iro	120.0	0.17	false	Detillion Rd & Titus Rd	Emig Dr & Titus Rd
P-278	1,312.00	12	Ductile Iro	120.0	0.64	false	Emig Dr Mid	Emig Dr & Titus Rd
P-280	416.00	6	Cast iron	120.0	1.64	false	Front St. Alley & 9th St	Front St. Alley & 10th St
P-282	438.00	6	Cast iron	120.0	1.56	false	Front St. Alley & 10th St	Front St & Division St
P-284	389.00	8	Ductile Iro	120.0	2.73	false	Commercial St Alley & 10th St	Commercial St Alley & Division St
P-286	307.00	12	Ductile Iro	120.0	2.64	false	Ski Hill BS #1	Ranger St & Ski Hill Dr
P-288	356.00	12	Ductile Iro	120.0	2.64	false	Pine St & Ski Hill Dr	Ski Hill BS #1
P-290	374.00	12	Ductile Iro	120.0	0.00	false	Ranger St & Ski Hill Dr	Zone 2 PRV A
P-292	421.00	12	Ductile Iro	120.0	0.00	false	Zone 2 PRV A	Pine St & Ski Hill Dr
P-294	649.00	8	Ductile Iro	120.0	2.48	false	Front St & 14th St	J-226
P-296	386.00	8	Ductile Iro	120.0	0.89	false	J-226	Chumstick Hwy & Highschool
P-298	649.00	12	Ductile Iro	120.0	2.01	false	East Leavenworth Rd & Dye Rd	East Leavenworth Rd & Hwy 2
P-300	689.00	12	Ductile Iro	120.0	0.71	false	Emig Dr Mid	J-230
P-302	636.00	12	Ductile Iro	120.0	0.97	false	Ranger St & Ski Hill Dr	Village View Dr & Ski Hill Dr
P-304	1,536.00	12	Ductile Iro	120.0	1.05	false	J-230	Village View Dr & Ski Hill Dr
P-306	2,221.00	8	Ductile Iro	120.0	0.58	false	J-230	J-212
P-308	1,321.00	12	Ductile Iro	120.0	0.03	false	Bergstrasse Rd & Ski Hill Dr	Bergstrasse Rd & Detillion Rd
P-310	1,319.00	12	Ductile Iro	120.0	0.00	true	Bergstrasse Rd & Detillion Rd	Detillion Rd & Titus Rd
P-312	1,326.00	8	Ductile Iro	120.0	0.65	false	Titus Rd NE	J-238
P-314	674.00	12	Ductile Iro	120.0	0.40	false	Village View Dr & Ski Hill Dr	Spring St & Ski HIll Dr
P-316	2,232.00	8	Ductile Iro	120.0	0.23	false	Emig Dr & Ski Hill Dr	Spring St. West

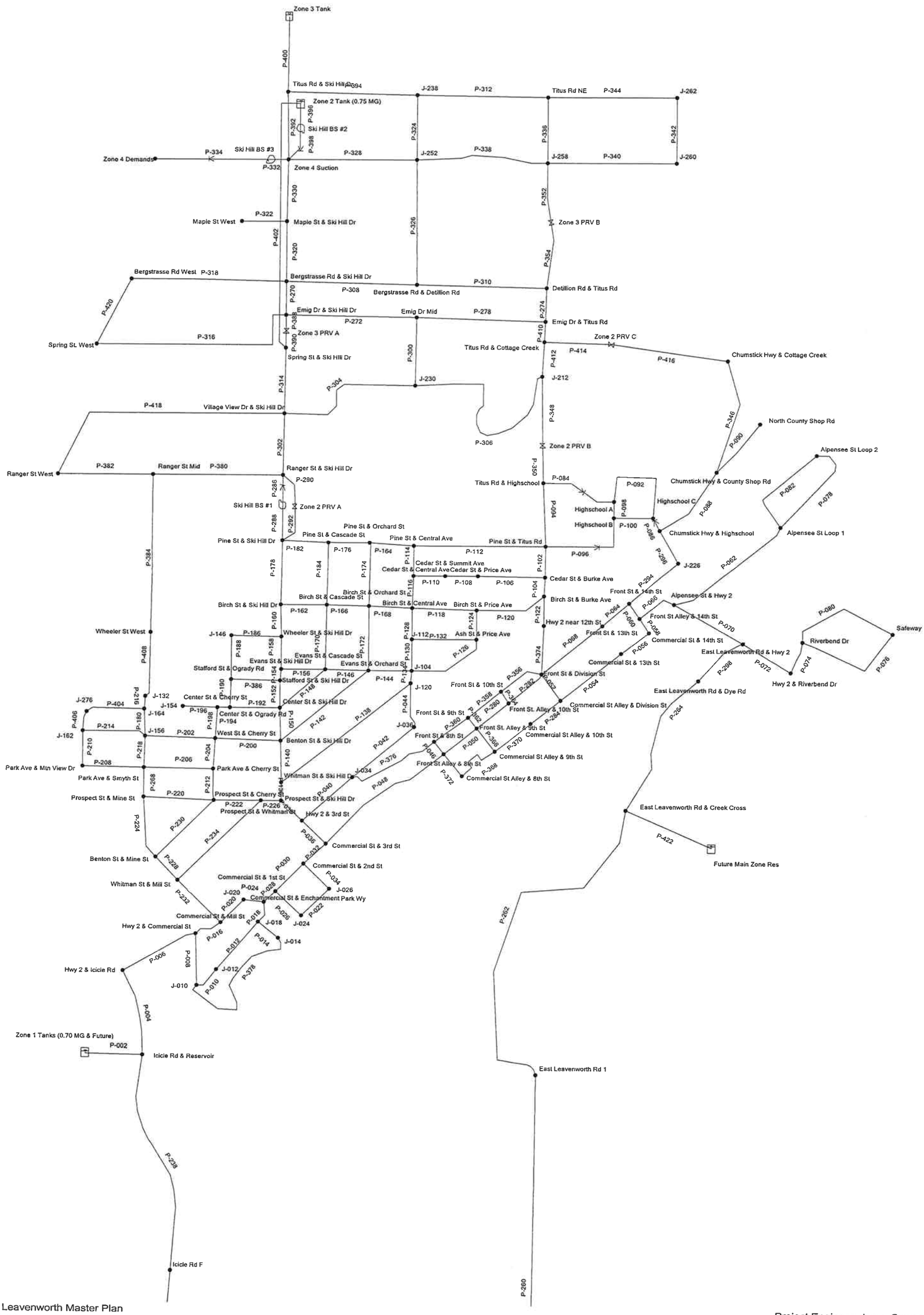
Scenario: Ultimate PHD w/ Imp.
Steady State Analysis
Pipe Report (custom)

Label	Length (ft)	Diameter (in)	Material	Hazen-Williams C	Velocity (ft/s)	Closed?	From Node	To Node
P-318	1,578.00	8	Ductile Iro	120.0	0.26	false	Bergstrasse Rd & Ski Hill Dr	Bergstrasse Rd West
P-320	622.00	8	Ductile Iro	120.0	0.92	false	Bergstrasse Rd & Ski Hill Dr	Maple St & Ski Hill Dr
P-322	464.00	8	Ductile Iro	120.0	0.03	false	Maple St & Ski Hill Dr	Maple St West
P-324	667.00	8	Ductile Iro	120.0	0.28	false	J-238	J-252
P-326	1,277.00	8	Ductile Iro	120.0	0.26	false	J-252	Bergstrasse Rd & Detillion Rd
P-328	1,305.00	8	Ductile Iro	120.0	0.98	false	J-252	Zone 4 Suction
P-330	630.00	8	Ductile Iro	120.0	1.15	false	Zone 4 Suction	Maple St & Ski Hill Dr
P-332	177.00	10	Ductile Iro	120.0	0.84	false	Zone 4 Suction	Ski Hill BS #3
P-334	1,178.00	10	Ductile Iro	120.0	0.84	false	Ski Hill BS #3	Zone 4 Demands
P-336	669.00	8	Ductile Iro	120.0	0.22	false	Titus Rd NE	J-258
P-338	1,335.00	8	Ductile Iro	120.0	0.63	false	J-252	J-258
P-340	1,314.00	8	Ductile Iro	120.0	0.13	false	J-258	J-260
P-342	671.00	8	Ductile Iro	120.0	0.04	false	J-260	J-262
P-344	1,314.00	8	Ductile Iro	120.0	0.20	false	J-262	Titus Rd NE
P-346	1,201.00	12	Ductile Iro	120.0	0.30	false	Chumstick Hwy & County Shop Rd	Chumstick Hwy & Cottage Creek
P-348	705.00	8	Ductile Iro	120.0	0.00	false	J-212	Zone 2 PRV B
P-350	380.00	8	Ductile Iro	120.0	0.00	false	Zone 2 PRV B	Titus Rd & Highschool
P-352	610.00	8	Ductile Iro	120.0	0.00	false	J-258	Zone 3 PRV B
P-354	678.00	8	Ductile Iro	120.0	0.00	false	Zone 3 PRV B	Detillion Rd & Titus Rd
P-356	480.00	12	Ductile Iro	120.0	2.31	false	Front St & Division St	Front St & 10th St
P-358	421.00	12	Ductile Iro	120.0	2.48	false	Front St & 10th St	Front St & 9th St
P-360	422.00	12	Ductile Iro	120.0	2.40	false	Front St & 9th St	Front St & 8th St
P-362	140.00	8	Ductile Iro	120.0	0.50	false	Front St & 9th St	Front St. Alley & 9th St
P-364	137.00	8	Ductile Iro	120.0	0.16	false	Front St & 10th St	Front St. Alley & 10th St
P-366	295.00	8	Ductile Iro	120.0	0.55	false	Front St. Alley & 9th St	Commercial St Alley & 9th St
P-368	553.00	12	Ductile Iro	120.0	1.92	false	Commercial St Alley & 8th St	Commercial St Alley & 9th St
P-370	459.00	12	Ductile Iro	120.0	1.42	false	Commercial St Alley & 9th St	Commercial St Alley & 10th St
P-372	290.00	12	Ductile Iro	120.0	2.13	false	Front St Alley & 8th St	Commercial St Alley & 8th St
P-374	501.00	10	Steel (non	110.0	0.75	false	Front St & Division St	Hwy 2 near 12th St
P-376	973.00	8	Ductile Iro	120.0	0.58	false	Front St & 8th St	J-034
P-378	1,656.00	8	Ductile Iro	120.0	0.32	false	J-014	J-010
P-380	1,316.00	14	Ductile Iro	120.0	1.08	false	Ranger St & Ski Hill Dr	Ranger St Mid
P-382	971.00	8	Ductile Iro	120.0	0.14	false	Ranger St Mid	Ranger St West
P-384	1,619.00	12	Ductile Iro	120.0	1.40	false	Ranger St Mid	Wheeler St West
P-386	504.00	6	Ductile Iro	120.0	0.13	false	Stafford St & Ogrady Rd	Stafford St & Ski Hill Dr
P-388	159.00	12	Ductile Iro	120.0	0.00	false	Emig Dr & Ski Hill Dr	Zone 3 PRV A
P-390	165.00	12	Ductile Iro	120.0	0.00	false	Zone 3 PRV A	Spring St & Ski HIll Dr
P-392	693.00	8	Ductile Iro	120.0	0.73	false	Zone 4 Suction	Titus Rd & Ski Hill Dr
P-394	1,317.00	8	Ductile Iro	120.0	1.10	false	Titus Rd & Ski Hill Dr	J-238
P-396	249.00	12	Ductile Iro	120.0	1.31	false	Zone 2 Tank (0.75 MG)	Ski Hill BS #2
P-398	374.00	12	Ductile Iro	120.0	1.31	false	Ski Hill BS #2	Zone 4 Suction
P-400	774.00	12	Ductile Iro	120.0	0.86	false	Zone 3 Tank	Titus Rd & Ski Hill Dr
P-402	2,723.00	16	Ductile Iro	120.0	0.26	false	Spring St & Ski HIll Dr	Zone 2 Tank (0.75 MG)
P-404	595.00	8	Steel (non	110.0	0.53	false	J-164	J-276
P-406	204.00	8	Steel (non	110.0	0.23	false	J-276	J-162
P-408	676.00	12	Ductile Iro	120.0	1.23	false	J-132	Wheeler St West
P-410	213.00	12	Ductile Iro	120.0	0.33	false	Emig Dr & Titus Rd	Titus Rd & Cottage Creek
P-412	352.00	8	Ductile Iro	120.0	0.73	false	Titus Rd & Cottage Creek	J-212
P-414	682.00	12	Ductile Iro	120.0	0.00	false	Titus Rd & Cottage Creek	Zone 2 PRV C
P-416	1,208.00	12	Ductile Iro	120.0	0.00	false	Zone 2 PRV C	Chumstick Hwy & Cottage Creek
P-418	2,684.00	8	Ductile Iro	120.0	0.35	false	Village View Dr & Ski Hill Dr	Ranger St West
P-420	753.00	8	Ductile Iro	120.0	0.16	false	Bergstrasse Rd West	Spring St. West

Scenario: Ultimate PHD w/ Imp.
Steady State Analysis
Pipe Report (custom)

Label	Length (ft)	Diameter (in)	Material	Hazen-Williams C	Velocity (ft/s)	Closed?	From Node	To Node
P-422	960.00	18	Ductile Iro	120.0	0.00	true	East Leavenworth Rd & Creek Cros	Future Main Zone Res
WTP	10.00	16	Ductile Iro	120.0	0.00	true	Icicle Creek Clearwell	Water Treatment Plant

Scenario: No Demand



Title: Leavenworth Master Plan
14-08-03 - hydraulic analysis (2007 master plan).w...
10/26/07 12:54:24 PM

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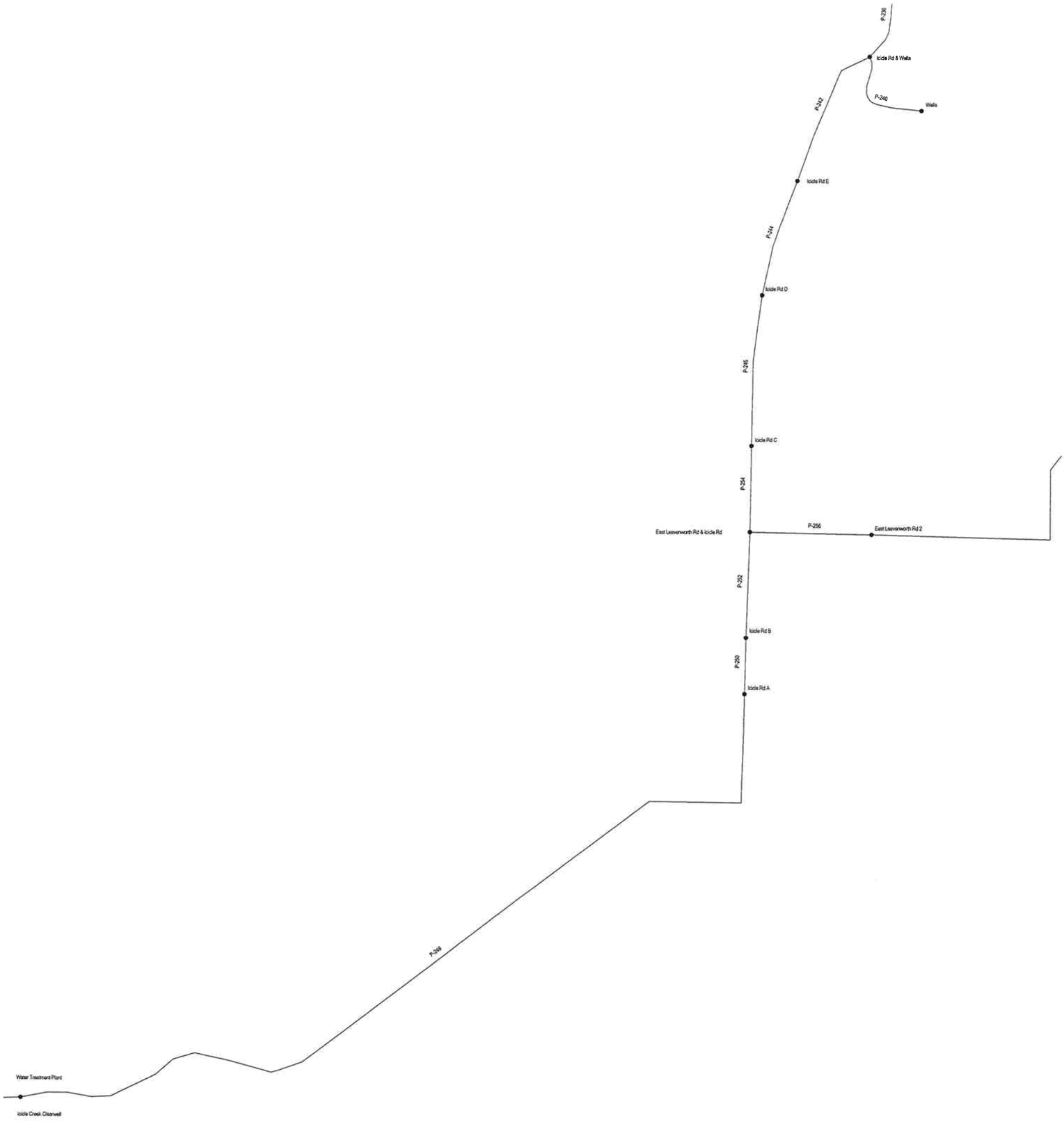
Project Engineer: Jesse Cowger
WaterCAD v7.0 [07.00.028.00]
Page 1 of 1

Scenario: No Demand



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Appendix C

Projected Ultimate Wastewater ERUs and Basin flows

Sewer Collection System Master Plan
Projected Ultimate Wastewater Flows
Existing Collection System Service Area

SUB-BASIN ID #	Single Family Residential						Multi-family Residential				Non-residential								Sub-basin and Basin Totals							SUB-BASIN ID #
	RL-6		RL-10		RL-12		RM-2		Planned Development Zone (RM-2)		Central Commercial		General Commercial		Tourist Commercial		Light Industrial									
	7.3 ERU/acre		4.4 ERU/acre		3.6 ERU/acre		15.2 ERU/acre		15.2 ERU/acre		28 ERU/acre		23 ERU/acre		18 ERU/acre		15 ERU/acre		Area		Flow	WW Flow	I/I	I/I	Total	
	(acres)	ERU	(acres)	ERU	(acres)	ERU	(acres)	ERU	(acres)	ERU	(acres)	ERU	(acres)	ERU	(acres)	ERU	(acres)	ERU	(acres)	ERU	(gpd/ERU)	(gpd) (2)	(gpd/acre)	(gpd) (3)	(gpd)	
BASIN AA																										
AA1							13.7	209							9.0	162			23	371	161	59,700	100	2,300	62,000	AA1
AA2															4.3	77			4	77	161	12,400	100	400	12,800	AA2
BASIN AA							**13.7**	**209**							**13.3**	**239**			**27**	**448**		**72,100**		**2,700**	**74,800**	**BASIN AA**
BASIN A																										
A1							6.5	99					0.3	7					7	106	161	17,100	100	700	17,800	A1
A2											3.5	97	2.6	60					6	157	161	25,300	100	600	25,900	A2
A3													5.2	119					5	119	161	19,200	100	500	19,700	A3
A4													12.2	280					12	280	161	45,100	100	1,200	46,300	A4
A5													3.5	81					4	81	161	13,000	100	400	13,400	A5
A6																	16.4	246	16	246	161	39,600	100	1,600	41,200	A6
BASIN A							**6.5**	**99**			**3.5**	**97**	**23.8**	**547**			**16.4**	**246**	**50**	**989**		**159,300**		**5,000**	**164,300**	**BASIN A**
BASIN BB																										
BB1	18.3	134							3.1	47			3.1	71					25	252	161	40,600	100	2,500	43,000	BB1
BASIN BB1	**18.3**	**134**							**3.1**	**47**			**3.1**	**71**					**25**	**252**		**40,600**		**2,500**	**43,000**	**BASIN BB1**
BASIN B																										
B1													6.8	157					7	157	161	25,300	100	700	26,000	B1
B2	2.3	17																	2	17	161	2,700	100	200	3,000	B2
B3	25.1	183																	25	183	161	29,500	100	2,500	32,000	B3
B4	7.6	55																	8	55	161	8,900	100	800	9,600	B4
BASIN B	**35.0**	**255**											**6.8**	**157**					**42**	**412**		**66,400**		**4,200**	**70,600**	**BASIN B**
BASIN C																										
C1											5.8	161							6	161	161	25,900	100	600	26,500	C1
C2											1.8	51							2	51	161	8,200	100	200	8,400	C2
C3											1.6	46							2	46	161	7,400	100	200	7,600	C3
C4							3.9	60											4	60	161	9,700	100	400	10,100	C4
BASIN C							**3.9**	**60**			**9.2**	**258**							**13**	**318**		**51,200**		**1,400**	**52,600**	**BASIN C**
BASIN D																										
D1											8.0	224							8	224	161	36,100	100	800	36,900	D1
D2											3.1	87	2.8	63					6	150	161	24,200	100	600	24,700	D2
D3	2.2	16					1.2	18											3	34	161	5,500	100	300	5,800	D3
D4	3.6	26											2.4	56					6	82	161	13,200	100	600	13,800	D4
BASIN D	**5.9**	**42**					**1.2**	**18**			**11.1**	**311**	**5.2**	**119**					**23**	**490**		**79,000**		**2,300**	**81,200**	**BASIN D**

Sewer Collection System Master Plan
Projected Ultimate Wastewater Flows
Existing Collection System Service Area

SUB-BASIN ID #	Single Family Residential						Multi-family Residential				Non-residential								Sub-basin and Basin Totals							SUB-BASIN ID #
	RL-6		RL-10		RL-12		RM-2		Planned Development Zone (RM-2)		Central Commercial		General Commercial		Tourist Commercial		Light Industrial									
	7.3 ERU/acre		4.4 ERU/acre		3.6 ERU/acre		15.2 ERU/acre		15.2 ERU/acre		28 ERU/acre		23 ERU/acre		18 ERU/acre		15 ERU/acre		Area		Flow	WW Flow	I/I	I/I	Total	
	(acres)	ERU	(acres)	ERU	(acres)	ERU	(acres)	ERU	(acres)	ERU	(acres)	ERU	(acres)	ERU	(acres)	ERU	(acres)	ERU	(acres)	ERU	(gpd/ERU)	(gpd) (2)	(gpd/acre)	(gpd) (3)	(gpd)	
BASIN E																										
E1											1.6	44			2.2	40			4	84	161	13,500	100	400	13,900	E1
E2													5.8	132					6	132	161	21,300	100	600	21,800	E2
E3	2.0	14					2.1	31											4	45	161	7,200	100	400	7,600	E3
E4	1.2	9					1.9	29											3	38	161	6,100	100	300	6,400	E4
E5 (1)	8.0	58																	8	140	161	22,500	100	800	24,800	E5
E6	7.7	56																	8	56	161	9,000	100	800	9,800	E6
E7	3.6	26																	4	26	161	4,200	100	400	4,500	E7
E8	18.3	134			4.8	17													23	151	161	24,300	100	2,300	26,600	E8
E9	29.0	212					7.4	112	1.4	22									38	346	161	55,700	100	3,800	59,500	E9
E10	14.2	104																	14	104	161	16,700	100	1,400	18,200	E10
BASIN E	**84.0**	**613**			**4.8**	**17**	**11.3**	**172**	**1.4**	**22**	**1.6**	**44**	**5.8**	**132**	**2.2**	**40**			**111**	**1,040**		**180,500**		**11,200**	**193,100**	**BASIN E**
BASIN F																										
F1	12.9	94					6.1	93							9.1	164			28	351	161	56,500	100	2,800	59,300	F1
F2							15.6	237											16	237	161	38,200	100	1,600	39,700	F2
BASIN F	**12.9**	**94**					**21.7**	**330**							**9.1**	**164**			**44**	**588**		**94,700**		**4,400**	**99,000**	**BASIN F**
BASIN G																										
G1	19.4	142													3.3	60			23	202	161	32,500	100	2,300	34,800	G1
BASIN G	**19.4**	**142**													**3.3**	**60**			**23**	**202**		**32,500**		**2,300**	**34,800**	**BASIN G**
BASIN H																										
H1													18.8	432					19	432	161	69,600	100	1,900	71,400	H1(1)
H2					22.0	79	5.1	77					26.1	600					53	756	161	121,700	100	5,300	127,000	H2
H3					21.4	77							0.8	19					22	96	161	15,500	100	2,200	17,700	H3
BASIN H					**43.4**	**156**	**5.1**	**77**					**45.7**	**1051**					**94**	**1,284**		**206,800**		**9,400**	**216,100**	**BASIN H**
BASIN I																										
I1															10.1	182			10	182	161	29,300	100	1,000	30,300	I1
I2															5.8	105			6	105	161	16,900	100	600	17,500	I2
BASIN I															**16.0**	**287**			**16**	**287**		**46,200**		**1,600**	**47,800**	**BASIN I**
Totals	**176**	**1,280**	**0**	**0**	**48**	**173**	**63**	**965**	**5**	**69**	**25**	**710**	**90**	**2,077**	**44**	**790**	**16**	**246**	**468**	**6,310**		**1,029,000**		**47,000**	**1,077,000**	**Totals**

(1) Basin Area equal 13 acres. 5 acre Osborne Elem. Sch. Removed from area calculations. 82 ERUs added for Osborne Elem. Sch. I/I calculated on 13 acres.
(2) WW Flow equals ERUs x 175 gpd/ERU (ERU = 70 gpcd x 2.5 persons/capita).
(3) I/I equals 100 gpd/acre.

Sewer Collection System Master Plan
Projected Ultimate Wastewater Flows
Expanded Collection System Service Area

Area	Dwelling Units (DU) (1)	Zoning	Pop. Per DU (2)	Estimated Population	ERU (3)	Area (acres)	Flow (gpd/ERU)	Flow (gpd)	I/I (gpcd)	I/I (gpd)	Total Flow (gpd)	Area
1	127	RL-10	2.3	292	127	107	161	20,400	20	5,800	26,200	1
2	129	RL-10	2.3	297	129	41	161	20,800	20	5,900	26,700	2
3	104	RL-10	2.3	239	104	56	161	16,700	20	4,800	21,500	3
4	384	RL-10	2.3	883	384	82	161	61,800	20	17,700	79,500	4
5	90	RL-10	2.3	207	90	48	161	14,500	20	4,100	18,600	5
6	35	RL-10	2.3	81	35	14	161	5,600	20	1,600	7,200	6
7	44	RL-10	2.3	101	44	38	161	7,100	20	2,000	9,100	7
8	100	RL-10	2.3	230	100	62	161	16,100	20	4,600	20,700	8
9	668	RM-2	1.6	1069	465	58	161	74,900	20	21,400	96,300	9
10	176	RL-10	2.3	405	176	78	161	28,300	20	8,100	36,400	10
11	82	RL-10	2.3	189	82	81	161	13,200	20	3,800	17,000	11
12	42	RL-12	2.3	97	42	24	161	6,800	20	1,900	8,700	12
13	55	RL-6	2.3	127	55	51	161	8,900	20	2,500	11,400	13
14 (4)	30	RL-6	2.3	69	194	45	161	31,200	20	1,400	32,600	14 (4)
Totals				**4,286**	**2,027**	**786**		**326,000**		**86,000**	**412,000**	**Totals**

(1) Provided by City
(2) Population estimated using 2.3 persons per single family dwelling unit and 1.6 persons per multi-family dwelling unit
(3) 2.3 Persons equal 1 ERU
(4) 30 D.U. provided by the City. Added 164 ERUs calculated for the Icicle Middle School and Cascade High School

Sewer Collection System Master Plan
Projected Ultimate Wastewater Peak Hour Flows By Basin

Existing Collection System Service Area										
Sub-Basin Designations	Area (acres)	ERU	Average Daily Wastewater Flow (gpd) (1)	(gpm)	Average Daily Infiltration & Inflow (gpd) (2)	(gpm)	Total (gpd)	Ave (gpm)	Peaking Factor (3)	Peak Hour (gpm)
BASIN AA										
AA1	23	371	59,700	41	2,300	2	62,000	43	4.1	172
AA2	4	77	12,400	9	400	0	12,800	9	4.3	37
BASIN AA	**27**	**448**	**72,100**	**50**	**2,700**	**2**	**74,800**	**52**	**4.0**	**202**
BASIN A										
A1	7	106	17,100	12	700	0	17,800	12	4.3	52
A2	6	157	25,300	18	600	0	25,900	18	4.2	74
A3	5	119	19,200	13	500	0	19,700	14	4.2	56
A4	12	280	45,100	31	1,200	1	46,300	32	4.1	129
A5	4	81	13,000	9	400	0	13,400	9	4.3	39
A6	16	246	39,600	28	1,600	1	41,200	29	4.1	114
BASIN A	**50**	**989**	**159,300**	**111**	**5,000**	**3**	**164,300**	**114**	**3.9**	**435**
BASIN BB										
BB1	25	252	40,600	28	2,500	2	43,000	30	4.1	117
BASIN BB1	**25**	**252**	**40,600**	**28**	**2,500**	**2**	**43,000**	**30**	**4.1**	**117**
BASIN B										
B1	7	157	25,300	18	700	0	26,000	18	4.2	74
B2	2	17	2,700	2	200	0	3,000	2	4.5	9
B3	25	183	29,500	20	2,500	2	32,000	22	4.2	88
B4	8	55	8,900	6	800	1	9,600	7	4.3	27
BASIN B	**42**	**412**	**66,400**	**46**	**4,200**	**3**	**70,600**	**49**	**4.0**	**187**
BASIN C										
C1	6	161	25,900	18	600	0	26,500	18	4.2	76
C2	2	51	8,200	6	200	0	8,400	6	4.3	25
C3	2	46	7,400	5	200	0	7,600	5	4.3	22
C4	4	60	9,700	7	400	0	10,100	7	4.3	29
BASIN C	**13**	**318**	**51,200**	**36**	**1,400**	**1**	**52,600**	**37**	**4.1**	**147**
BASIN D										
D1	8	224	36,100	25	800	1	36,900	26	4.2	106
D2	6	150	24,200	17	600	0	24,700	17	4.2	71
D3	3	34	5,500	4	300	0	5,800	4	4.4	17
D4	6	82	13,200	9	600	0	13,800	10	4.3	40
BASIN D	**23**	**490**	**79,000**	**55**	**2,300**	**2**	**81,200**	**56**	**4.0**	**221**
BASIN E										
E1	4	84	13,500	9	400	0	13,900	10	4.3	41
E2	6	132	21,300	15	600	0	21,800	15	4.2	63
E3	4	45	7,200	5	400	0	7,600	5	4.3	22
E4	3	38	6,100	4	300	0	6,400	4	4.4	19
E5 (1)	8	140	22,500	16	800	1	24,800	17	4.2	66
E6	8	56	9,000	6	800	1	9,800	7	4.3	27
E7	4	26	4,200	3	400	0	4,500	3	4.4	13
E8	23	151	24,300	17	2,300	2	26,600	18	4.2	72
E9	38	346	55,700	39	3,800	3	59,500	41	4.1	161
E10	14	104	16,700	12	1,400	1	18,200	13	4.2	50
BASIN E	**111**	**1,040**	**180,500**	**125**	**11,200**	**8**	**193,100**	**134**	**3.8**	**484**
BASIN F										
F1	28	351	56,500	39	2,800	2	59,300	41	4.1	163
F2	16	237	38,200	27	1,600	1	39,700	28	4.2	113
BASIN F	**44**	**588**	**94,700**	**66**	**4,400**	**3**	**99,000**	**69**	**4.0**	**266**
BASIN G										
G1	23	202	32,500	23	2,300	2	34,800	24	4.2	96
BASIN G	**23**	**202**	**32,500**	**23**	**2,300**	**2**	**34,800**	**24**	**4.2**	**96**
BASIN H										
H1	19	432	69,600	48	1,900	1	71,400	50	4.0	195
H2	53	756	121,700	85	5,300	4	127,000	88	3.9	333
H3	22	96	15,500	11	2,200	2	17,700	12	4.3	48
BASIN H	**94**	**1,284**	**206,800**	**144**	**9,400**	**7**	**216,100**	**150**	**3.8**	**552**
BASIN I										
I1	10	182	29,300	20	1,000	1	30,300	21	4.2	86
I2	6	105	16,900	12	600	0	17,500	12	4.3	51
BASIN I	**16**	**287**	**46,200**	**32**	**1,600**	**1**	**47,800**	**33**	**4.1**	**133**
Existing Collection System Sub-total	**468**	**6,310**	**1,029,300**	**715**	**47,000**	**33**	**1,077,300**	**748**	**3.2**	**2,320**

Sewer Collection System Master Plan
Projected Ultimate Wastewater Peak Hour Flows By Basin

Expanded Collection System Service Area										
Designated Growth Area Designations	Area (acres)	ERU	Average Daily Wastewater Flow (gpd) (1)	Average Daily Wastewater Flow (gpm)	Average Daily Infiltration & Inflow (gpd) (2)	Average Daily Infiltration & Inflow (gpm)	Total Average Daily Wastewater Flow (gpd)	Total Average Daily Wastewater Flow (gpm)	Peaking Factor (3)	Peak Hour (gpm)
1	107	127	20,400	14	5,800	4	26,200	18	4.2	64
2	41	129	20,800	14	5,900	4	26,700	19	4.2	65
3	56	104	16,700	12	4,800	3	21,500	15	4.2	52
4	82	384	61,800	43	17,700	12	79,500	55	4.0	184
5	48	90	14,500	10	4,100	3	18,600	13	4.2	45
6	14	35	5,600	4	1,600	1	7,200	5	4.3	18
7	38	44	7,100	5	2,000	1	9,100	6	4.3	23
8	62	100	16,100	11	4,600	3	20,700	14	4.2	50
9	58	465	74,900	52	21,400	15	96,300	67	4.0	223
10	78	176	28,300	20	8,100	6	36,400	25	4.2	88
11	81	82	13,200	9	3,800	3	17,000	12	4.3	42
12	24	42	6,800	5	1,900	1	8,700	6	4.3	22
13	51	55	8,900	6	2,500	2	11,400	8	4.3	28
14 (4)	45	194	31,200	22	1,400	1	32,600	23	4.2	92
Growth Area Sub-total	**786**	**2,027**	**326,300**	**227**	**85,600**	**59**	**411,900**	**286**	**3.6**	**875**
Collection System Total	**1,253**	**8,337**	**1,355,600**	**941**	**132,600**	**92**	**1,489,200**	**1,034**	**3.1**	**3,010**

(1) Wastewater flow (WW Flow) = 161 gpd/ERU

(2) I/I = 100 gpd/acre in the existing collection system service area, and 20 gpcd in the expanded collection system service area (includes identified growth areas)

(3) Peaking factor based on gpm resulting from using the 10 State Standards equation $(18 + \sqrt{P}) \div (4 + \sqrt{P})$ with P = Population. Population = 2.3 persons per ERU, 70 gpcd wastewater and 20 gpcd I/I.

Sewer Collection System Master Plan
Peaking Factors

ERUs	Population (2.8 persons per ERU)	Average Daily Flow (1) MGD	(cfs)	(gpm)	(2) Peak Factor
1	3	0.001	0.001	0	4.5
10	28	0.006	0.009	4	4.4
30	84	0.017	0.027	12	4.3
70	196	0.041	0.063	28	4.2
120	336	0.070	0.108	48	4.1
190	532	0.110	0.170	76	4.0
290	812	0.168	0.260	117	3.9
420	1176	0.243	0.377	169	3.8
580	1624	0.336	0.520	233	3.7
790	2212	0.458	0.709	318	3.6
1040	2912	0.603	0.933	419	3.5
1360	3808	0.788	1.220	547	3.4
1760	4928	1.020	1.578	708	3.3
2250	6300	1.304	2.018	906	3.2
2850	7980	1.652	2.556	1147	3.1
3610	10108	2.092	3.238	1453	3.0
4540	12712	2.631	4.072	1827	2.9
5710	15988	3.310	5.121	2298	2.8
7180	20104	4.162	6.439	2890	2.7
9040	25312	5.240	8.107	3639	2.6
10000	28000	5.796	8.968	4025	2.5

(1) Based on 70 gpcd wastewater and 20 gpcd I/I

(2) Peaking factor based on gpm resulting from using the 10 State Standards equation $(18 + \sqrt{P}) \div (4 + \sqrt{P})$ with P = Population. Population = 2.3 persons per ERU, 70 gpcd wastewater and 20 gpcd I/I.

Q (full capacity)

Pipe Dia (in)	8						10						12						15						18						21						Pipe Dia (in)
Pipe Slope (ft/ft)	(cfs)	(gpm)	n	A	R	S	(cfs)	(gpm)	n	A	R	S	(cfs)	(gpm)	n	A	R	S	(cfs)	(gpm)	n	A	R	S	(cfs)	(gpm)	n	A	R	S	(cfs)	(gpm)	n	A	R	S	Pipe Slope (ft/ft)
0.0010	0.38	172	0.01	0.35	0.167	0.0010	0.69	311	0.01	0.55	0.208	0.0010	1.13	506	0.01	0.79	0.25	0.0010	2.04	917	0.01	1.23	0.313	0.0010	3.32	1,491	0.01	1.77	0.375	0.0010	5.01	2,249	0.01	2.41	0.438	0.0010	0.0010
0.0012	0.42	188	0.01	0.35	0.167	0.0012	0.76	341	0.01	0.55	0.208	0.0012	1.23	554	0.01	0.79	0.25	0.0012	2.24	1,004	0.01	1.23	0.313	0.0012	3.64	1,633	0.01	1.77	0.375	0.0012	5.49	2,463	0.01	2.41	0.438	0.0012	0.0012
0.0015	0.47	210	0.01	0.35	0.167	0.0015	0.85	381	0.01	0.55	0.208	0.0015	1.38	619	0.01	0.79	0.25	0.0015	2.50	1,123	0.01	1.23	0.313	0.0015	4.07	1,826	0.01	1.77	0.375	0.0015	6.14	2,754	0.01	2.41	0.438	0.0015	0.0015
0.0022	0.57	254	0.01	0.35	0.167	0.0022	1.03	461	0.01	0.55	0.208	0.0022	1.67	750	0.01	0.79	0.25	0.0022	3.03	1,360	0.01	1.23	0.313	0.0022	4.93	2,211	0.01	1.77	0.375	0.0022	7.43	3,335	0.01	2.41	0.438	0.0022	0.0022
0.0028	0.64	287	0.01	0.35	0.167	0.0028	1.16	520	0.01	0.55	0.208	0.0028	1.89	846	0.01	0.79	0.25	0.0028	3.42	1,534	0.01	1.23	0.313	0.0028	5.56	2,495	0.01	1.77	0.375	0.0028	8.38	3,763	0.01	2.41	0.438	0.0028	0.0028
0.004	0.76	343	0.01	0.35	0.167	0.004	1.39	622	0.01	0.55	0.208	0.004	2.25	1,011	0.01	0.79	0.25	0.004	4.09	1,834	0.01	1.23	0.313	0.004	6.64	2,982	0.01	1.77	0.375	0.004	10.02	4,498	0.01	2.41	0.438	0.004	0.004
0.005	0.85	383	0.01	0.35	0.167	0.005	1.55	695	0.01	0.55	0.208	0.005	2.52	1,131	0.01	0.79	0.25	0.005	4.57	2,050	0.01	1.23	0.313	0.005	7.43	3,334	0.01	1.77	0.375	0.005	11.20	5,028	0.01	2.41	0.438	0.005	0.005
0.006	0.94	420	0.01	0.35	0.167	0.006	1.70	762	0.01	0.55	0.208	0.006	2.76	1,239	0.01	0.79	0.25	0.006	5.00	2,246	0.01	1.23	0.313	0.006	8.14	3,652	0.01	1.77	0.375	0.006	12.27	5,508	0.01	2.41	0.438	0.006	0.006
0.007	1.01	454	0.01	0.35	0.167	0.007	1.83	823	0.01	0.55	0.208	0.007	2.98	1,338	0.01	0.79	0.25	0.007	5.40	2,426	0.01	1.23	0.313	0.007	8.79	3,944	0.01	1.77	0.375	0.007	13.26	5,950	0.01	2.41	0.438	0.007	0.007
0.008	1.08	485	0.01	0.35	0.167	0.008	1.96	880	0.01	0.55	0.208	0.008	3.19	1,430	0.01	0.79	0.25	0.008	5.78	2,593	0.01	1.23	0.313	0.008	9.40	4,217	0.01	1.77	0.375	0.008	14.17	6,361	0.01	2.41	0.438	0.008	0.008
0.009	1.15	515	0.01	0.35	0.167	0.009	2.08	933	0.01	0.55	0.208	0.009	3.38	1,517	0.01	0.79	0.25	0.009	6.13	2,750	0.01	1.23	0.313	0.009	9.97	4,472	0.01	1.77	0.375	0.009	15.03	6,746	0.01	2.41	0.438	0.009	0.009
0.010	1.21	542	0.01	0.35	0.167	0.010	2.19	983	0.01	0.55	0.208	0.010	3.56	1,599	0.01	0.79	0.25	0.010	6.46	2,899	0.01	1.23	0.313	0.010	10.50	4,714	0.01	1.77	0.375	0.010	15.85	7,111	0.01	2.41	0.438	0.010	0.010
0.011	1.27	569	0.01	0.35	0.167	0.011	2.30	1,031	0.01	0.55	0.208	0.011	3.74	1,677	0.01	0.79	0.25	0.011	6.78	3,041	0.01	1.23	0.313	0.011	11.02	4,944	0.01	1.77	0.375	0.011	16.62	7,458	0.01	2.41	0.438	0.011	0.011
0.012	1.32	594	0.01	0.35	0.167	0.012	2.40	1,077	0.01	0.55	0.208	0.012	3.90	1,752	0.01	0.79	0.25	0.012	7.08	3,176	0.01	1.23	0.313	0.012	11.51	5,164	0.01	1.77	0.375	0.012	17.36	7,790	0.01	2.41	0.438	0.012	0.012
0.013	1.38	618	0.01	0.35	0.167	0.013	2.50	1,121	0.01	0.55	0.208	0.013	4.06	1,823	0.01	0.79	0.25	0.013	7.37	3,306	0.01	1.23	0.313	0.013	11.98	5,375	0.01	1.77	0.375	0.013	18.07	8,108	0.01	2.41	0.438	0.013	0.013
0.014	1.43	642	0.01	0.35	0.167	0.014	2.59	1,163	0.01	0.55	0.208	0.014	4.22	1,892	0.01	0.79	0.25	0.014	7.64	3,430	0.01	1.23	0.313	0.014	12.43	5,578	0.01	1.77	0.375	0.014	18.75	8,414	0.01	2.41	0.438	0.014	0.014
0.015	1.48	664	0.01	0.35	0.167	0.015	2.68	1,204	0.01	0.55	0.208	0.015	4.36	1,958	0.01	0.79	0.25	0.015	7.91	3,551	0.01	1.23	0.313	0.015	12.87	5,774	0.01	1.77	0.375	0.015	19.41	8,709	0.01	2.41	0.438	0.015	0.015
0.016	1.53	686	0.01	0.35	0.167	0.016	2.77	1,244	0.01	0.55	0.208	0.016	4.51	2,023	0.01	0.79	0.25	0.016	8.17	3,667	0.01	1.23	0.313	0.016	13.29	5,963	0.01	1.77	0.375	0.016	20.04	8,995	0.01	2.41	0.438	0.016	0.016
0.017	1.58	707	0.01	0.35	0.167	0.017	2.86	1,282	0.01	0.55	0.208	0.017	4.65	2,085	0.01	0.79	0.25	0.017	8.42	3,780	0.01	1.23	0.313	0.017	13.70	6,147	0.01	1.77	0.375	0.017	20.66	9,272	0.01	2.41	0.438	0.017	0.017
0.018	1.62	728	0.01	0.35	0.167	0.018	2.94	1,319	0.01	0.55	0.208	0.018	4.78	2,145	0.01	0.79	0.25	0.018	8.67	3,890	0.01	1.23	0.313	0.018	14.09	6,325	0.01	1.77	0.375	0.018	21.26	9,541	0.01	2.41	0.438	0.018	0.018
0.019	1.67	748	0.01	0.35	0.167	0.019	3.02	1,355	0.01	0.55	0.208	0.019	4.91	2,204	0.01	0.79	0.25	0.019	8.90	3,996	0.01	1.23	0.313	0.019	14.48	6,498	0.01	1.77	0.375	0.019	21.84	9,802	0.01	2.41	0.438	0.019	0.019
0.020	1.71	767	0.01	0.35	0.167	0.020	3.10	1,391	0.01	0.55	0.208	0.020	5.04	2,261	0.01	0.79	0.25	0.020	9.14	4,100	0.01	1.23	0.313	0.020	14.86	6,667	0.01	1.77	0.375	0.020	22.41	10,057	0.01	2.41	0.438	0.020	0.020
0.021	1.75	786	0.01	0.35	0.167	0.021	3.18	1,425	0.01	0.55	0.208	0.021	5.16	2,317	0.01	0.79	0.25	0.021	9.36	4,201	0.01	1.23	0.313	0.021	15.22	6,832	0.01	1.77	0.375	0.021	22.96	10,305	0.01	2.41	0.438	0.021	0.021
0.022	1.79	804	0.01	0.35	0.167	0.022	3.25	1,458	0.01	0.55	0.208	0.022	5.28	2,372	0.01	0.79	0.25	0.022	9.58	4,300	0.01	1.23	0.313	0.022	15.58	6,993	0.01	1.77	0.375	0.022	23.50	10,548	0.01	2.41	0.438	0.022	0.022
0.023	1.83	822	0.01	0.35	0.167	0.023	3.32	1,491	0.01	0.55	0.208	0.023	5.40	2,425	0.01	0.79	0.25	0.023	9.80	4,397	0.01	1.23	0.313	0.023	15.93	7,150	0.01	1.77	0.375	0.023	24.03	10,785	0.01	2.41	0.438	0.023	0.023
0.024	1.87	840	0.01	0.35	0.167	0.024	3.39	1,523	0.01	0.55	0.208	0.024	5.52	2,477	0.01	0.79	0.25	0.024	10.01	4,491	0.01	1.23	0.313	0.024	16.27	7,303	0.01	1.77	0.375	0.024	24.55	11,017	0.01	2.41	0.438	0.024	0.024
0.025	1.91	858	0.01	0.35	0.167	0.025	3.46	1,555	0.01	0.55	0.208	0.025	5.63	2,528	0.01	0.79	0.25	0.025	10.21	4,584	0.01	1.23	0.313	0.025	16.61	7,454	0.01	1.77	0.375	0.025	25.05	11,244	0.01	2.41	0.438	0.025	0.025
0.026	1.95	874	0.01	0.35	0.167	0.026	3.53	1,586	0.01	0.55	0.208	0.026	5.74	2,578	0.01	0.79	0.25	0.026	10.42	4,675	0.01	1.23	0.313	0.026	16.94	7,602	0.01	1.77	0.375	0.026	25.55	11,467	0.01	2.41	0.438	0.026	0.026
0.027	1.99	891	0.01	0.35	0.167	0.027	3.60	1,616	0.01	0.55	0.208	0.027	5.85	2,627	0.01	0.79	0.25	0.027	10.61	4,764	0.01	1.23	0.313	0.027	17.26	7,746	0.01	1.77	0.375	0.027	26.04	11,685	0.01	2.41	0.438	0.027	0.027
0.028	2.02	908	0.01	0.35	0.167	0.028	3.67	1,645	0.01	0.55	0.208	0.028	5.96	2,676	0.01	0.79	0.25	0.028	10.81	4,851	0.01	1.23	0.313	0.028	17.58	7,889	0.01	1.77	0.375	0.028	26.51	11,899	0.01	2.41	0.438	0.028	0.028
0.029	2.06	924	0.01	0.35	0.167	0.029	3.73	1,675	0.01	0.55	0.208	0.029	6.07	2,723	0.01	0.79	0.25	0.029	11.00	4,937	0.01	1.23	0.313	0.029	17.89	8,028	0.01	1.77	0.375	0.029	26.98	12,110	0.01	2.41	0.438	0.029	0.029
0.030	2.09	939	0.01	0.35	0.167	0.030	3.79	1,703	0.01	0.55	0.208	0.030	6.17	2,770	0.01	0.79	0.25	0.030	11.19	5,021	0.01	1.23	0.313	0.030	18.19	8,165	0.01	1.77	0.375	0.030	27.44	12,317	0.01	2.41	0.438	0.030	0.030

Mannings Equation ($Q=1.486/n\ A\ R^{2/3}\ S^{1/2}$)

Q= Flow in CFS

n= Coefficient of roughness (use 0.013)

A= flow area (ft^2), assume pipe full so flow area will equal pipe section area

R= hydraulic radius (ft), assume pipe full R=A/P where A = area and P=wetted perimeter (always pipe dia. x .25 when pipe full)

S= pipe slope (ft/ft)

Appendix D

1996 Wastewater Facility Plan TMVA-Leav10

“Evaluation of Sanitary Sewer Collection System”

PRELIMINARY
SUBJECT TO REVISION

Technical Memorandum: TMVA-LEAV10 11/6/95
2/5/96

CITY OF LEAVENWORTH
WASTEWATER SYSTEM FACILITY PLANNING

EVALUATION OF SANITARY SEWER COLLECTION SYSTEM

A. INTRODUCTION

This report addresses the sanitary sewer collection system including system description, deficiencies, capacity considerations, and need for inspection/monitoring programs. This report is prepared with the intention of submitting it to the City for review and comment, to be ultimately included in the facilities plan. Collection system infiltration/inflow (I/I) and the south interceptor sewer are addressed separately in the following technical memoranda:

TMVA-LEAV02:	Infiltration/Inflow Investigation
TMVA-LEAV09:	Elimination of Inflow Sources
TMVA-LEAV11:	South Interceptor Sewer

The collection system was previously addressed in the March 8, 1998, Comprehensive Water and Sewer Systems Plan hereinafter referred to as the 1988 Plan. Portions of the 1988 Plan have been updated and included in this current report.

B. SUMMARY/CONCLUSIONS

- A map of the existing collection system is shown in Figure 1 attached to this report.

- Portions of the existing collection system are near or beyond 50 years old. It is possible and likely that reaches within the system could be reaching or exceeding their useful life. The City currently does not have a regular program of cleaning and internal TV inspection of the system to identify areas of needed repair or replacement.

- There are several collection system deficiencies which have been reported. Deficiencies include sags in mains, suspected broken side sewers, sedimentation in mains, combined storm/sanitary manholes, grease from restaurants, and roots. Although the problems are of concern, they have apparently not resulted in serious problems or interruptions in service within the collection system. As discussed above, the City does not have a regular program of cleaning and TV inspection to identify and correct problem areas.

- Combined storm/sanitary sewer manholes are addressed in a separate technical memorandum (TMVA-LEAV08).

- The south interceptor sewer has some deficiencies, including flat slopes and root intrusions at the joints. The south interceptor is addressed in a separate technical memorandum (TMVA-LEAV11).

- The existing collection system has adequate capacity to handle present flows and future ultimate development within the Urban Growth Area (UGA) boundary, with the exception of approximately 1860 lineal feet of sewer main. The 1860 lineal feet is addressed in this report and shown in Figure 1 attached.

- Expansion of the collection system to serve future development within the UGA is shown schematically in Figure 1 attached.

- It is recommended that the City establish the following collection system inspection and monitoring programs:

  - Annual Cleaning and TV Inspection
  - Flow/Capacity Monitoring
  - Oil and Grease Control and Enforcement

  Details for each program are outlined in this technical memorandum.

C. DESCRIPTION

The existing sanitary collection system is shown in Figure 1 attached to this report.

The first sewer system in Leavenworth was constructed in 1934 in the area between Front Street and the Wenatchee River. In 1947 the original combined storm and sanitary sewer system was completed for most of the remainder of the City. Later additions to the system have included the high school line and lines for the Bayern Village subdivision. Between 1971 and 1973 a major project was undertaken to separate the stormwater flows from the sanitary flows by constructing a separate storm sewer system. The stormwater separation project included replacement of many sanitary sewer mains where the new storm sewers were placed below them, and resulted in a number of combined manholes with separate flow channels for storm and sanitary sewage.

The original stormwater separation project did not completely eliminate all stormwater inflow, nor provide all the separate storm sewers needed in the City. The project also had problems with the new storm and sanitary lines due to faulty construction. As a result, additional work on both systems continued with additional projects to correct the worst problems and to continue to separate the storm sewer system.

The sanitary sewer system now consists of approximately 46,000 feet of gravity lines ranging in size from 6" to 18". Most of the system consists of the original concrete pipe plus a large amount of asbestos cement (AC) pipe that was used to replace the concrete pipe during the stormwater separation project. More recent sewer installations and extensions have been done using PVC pipe. Some private lines have been installed using PVC pipe, and the 4" force main in Bayern Village is cast iron pipe. The system has over 180 sanitary manholes.

The collection system is a gravity system except for lift stations at Bayern Village, Water Front Park, and Enchantment Park. All three lift stations are reportedly in satisfactory working order, except for normal operation and maintenance, and appear to have sufficient pumping capacity. The newest and largest one of the three is the Enchantment Park lift station (capacity = 265 gpm/pump; duplex station).

The collection system drains to the existing wastewater treatment plant located next to the Wenatchee River near U.S. Highway 2. The sanitary sewer system has essentially two main interceptor/trunk line systems: one serving the north side of the City, and the other serving the south and west side of the City. A map of the existing sanitary sewer system is shown on Figure 1 attached.

1. Collection System Deficiencies/Problems

The existing collection system is an aging system with portions nearing or exceeding 50 years old. Many sewer collection systems have provided service for 75 or 100 years, depending on the conditions. Others may be near failure in less than 50 years, depending on the conditions. It is possible and likely that reaches within Leavenworth's system could be reaching or exceeding their useful life.

The City currently does not have a regular program of cleaning and internal inspection of sewer mains to identify areas needing repair or replacement; it is recommended that a program be undertaken. Further discussion of this topic is included in a later section of this report.

Several collection system deficiencies and problems were reported in the 1988 Plan. Based on discussions with City staff, very little has been done since 1988 to correct or address the deficiencies. Although these deficiencies are of concern, they have not resulted in serious problems or interruptions in sewer service within the collection system. Collection system deficiencies and problems are discussed in the following paragraphs.

Sags in Mains. Poor flow conditions in many sewer mains exist as a result of sewer main sags; poorly sloped mains can also cause similar problems. Sags exist primarily in the sewer mains that were replaced in the 1971-1973 project, and include those in Ski Hill Drive and adjacent streets. This was verified by TV inspection by Arvid Grant and Associates after the project was completed. The settlement and sags were apparently due to poor construction practices and soil conditions. Although some of the sags and breaks on the mains were repaired, most of the

problems reportedly still exist. As a result, certain mains are subject to inadequate cleansing velocities, pooling, sand and sludge deposition, and potential clogging.

Suspected Broken Side Sewers. Many side sewers on Ski Hill Drive and adjacent streets are suspected of being broken, according to City personnel, apparently as a result of line settlement as mentioned above. It the main sewer has settled, then there may be many places where the side sewers have actually broken and/or pulled away from their connections to the main. Apparently, during the 1971-1973 project, the side sewer connections were made in the AC mains by knocking holes in the main and grouting in the service lines. Such a connection would be more prone to fail than one made with a proper tee. The main line would also be prone to break at these connections due to the weakened pipe. The practice of knocking holes in the main for new services has reportedly continued until the last few years. Sewer saddles are now required for all new service connections.

Rocks, Sand and Silt in Mains. City staff have indicated that parts of the system have debris in the mains, such as rocks, sand, and silt. The reason rocks are in the mains is unknown, but could be due to poor construction practices during previous projects. Sand and silt may be entering the system from broken sewer mains and services, and through manhole lids and from stormwater inflow. The heavier debris will settle out in sags and slow moving sections of mains, and can contribute to clogging. Cleaning of the mains and elimination of potential inflow sources may solve the problem.

Combined Storm/Sanitary Manholes. There are approximately 25 combined manholes that have both storm and sanitary sewer pipe channels within the same manhole. The manholes are potential locations where raw sewage can overflow, allowing untreated sewage to discharge to the Wenatchee River. The combined manholes are addressed in a separate technical memorandum (TMVA-LEAV08).

Restaurant Grease. Grease entering the collection system from restaurants has been a problem in the past. Grease can cause a buildup in sewer mains and can contribute to clogging. The grease has also caused operational problems at the treatment plant as well as increasing the BOD_5 loading to the plant. The City has an ordinance addressing restaurant grease traps and limitations on discharge of fats, oils and greases by commercial users. The City is beginning to take more aggressive steps to control and enforce requirements addressing fats, oils and greases discharges to the sewer system. Further discussion and recommendations regarding this topic is included in later paragraphs.

Roots in Sewer Mains. City staff indicate that the primary root problems occur in the south interceptor sewer. This is discussed further in a separate technical memorandum for the south interceptor (TMVA-LEAV11). Root intrusions are typical with most older sewer systems with concrete pipe and mortared joints. Excessive roots can restrict flow and cause problems. The extent of possible root problems in the overall collection system is unknown and cannot be determined without TV inspection of the mains.

South Interceptor Sewer. There are deficiencies relating to the south interceptor sewer. The south interceptor sewer is addressed in a separate technical memorandum (TMVA-LEAV11).

D. INFILTRATION/INFLOW (I/I)

As discussed earlier in this report, I/I has been addressed separately in two technical memoranda (TMVA-LEAV02 and TMVA-LEAV09). The technical memos concluded that infiltration is not excessive during the critical design period. However, further analysis was recommended to confirm this conclusion, including possible long term flow monitoring at critical points in the collection system. Peak inflows during storm events produce overloading of the treatment plant. Recommendations were made regarding the elimination of several known inflow sources and smoke testing to identify and eliminate other inflow sources.

E. COLLECTION SYSTEM CAPACITY AND EXTENSION

The collection system was evaluated to determine adequacy to handle present and future conditions. A similar analysis was done as part of the 1988 Plan based on the sewer service area delineated at that time. The 1988 Plan was updated and expanded as part of this current planning effort. The existing collection system and schematic of future improvements is shown in Figure 1 attached.

1. Present and Future Capacity Requirements

The collection system has adequate capacity throughout to handle present peak flows. Furthermore, the majority of the sewer system has adequate capacity to handle the future ultimate peak sewage flows within the Urban Growth Area (UGA) at full development. Mains having insufficient or marginal capacity to meet future flow requirements include (see Figure 1):

- 8" sewer on Whitman Street from Ski Hill Road east approximately 600 feet; then south about 240 feet to existing 12" sewer.
- 8" sewer on Ski Hill Road from Center street south to Prospect Street (approximately 900 feet).
- 15" sewer from sewage treatment plant upstream to first manhole (approximately 120 feet).

The need for upgrade of portions of these reaches may be marginal. However, due to the lack of precision and resulting uncertainty introduced by the methodology used for estimating remaining capacity and future needed capacity of each reach, they have been shown as mains needing upgrade. Actual flow monitoring may alter the recommendation for upgrade; flow monitoring is discussed in later paragraphs.

2. Configuration of Future Collection System Extensions

The proposed schematic plan for future collection system extensions to serve outlying areas of the UGA are shown on Figure 1 attached. It should be noted that expansion of the sewer system north of Birch St. and west of Ski Hill should be connected to the trunk sewers in Birch and Pine streets, so that all flow from the future service area to the west and north side of the City will feed to the north side interceptor.

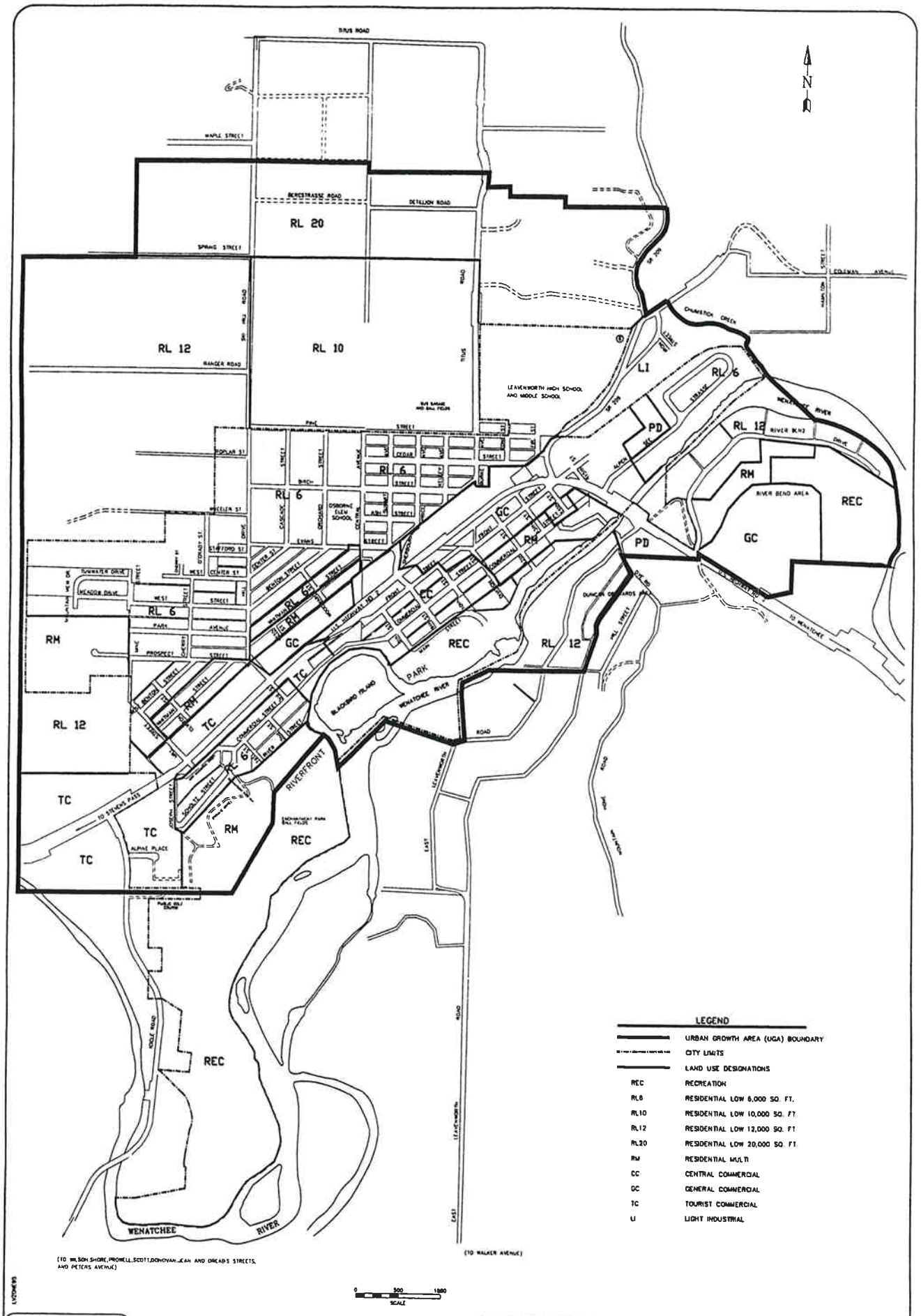
Figure 1 shows the projected peak sewer flow increases that are expected at specific points throughout the collection system. It is recommended that the City conduct flow monitoring at specific points during peak flow periods to accurately determine the available reserve capacity in key sewer mains. This data can then be used to confirm the need for future capacity upgrades as well as the projected time frame in which they will be needed and the amount of additional population the existing mains will handle prior to needed upgrade. Recommended monitoring is discussed further in a later paragraph of this report.

The peak flow increases shown in Figure 1 represent flow increases at ultimate development of the UGA. The peak flow increases shown are equivalent to a population increase of about 5000 people. This exceeds the projected 20 year sewer service population increase of 1849 by about 2.7 times. Thus the timing of recommended collection system capacity upgrades will be dependent upon the rate and distribution of future development within the UGA boundary. Depending on these factors, upgrades in the Ski Hill Road and Whitman Street areas may be postponed for several years.

3. Supporting Documentation for Projected Sewage Flows

Projected future sewage flow increases were developed based on assumed future development within the City's Urban Growth Area (UGA) boundary. The UGA boundary is shown on the attached map and represents the 20-year urban planning boundary for the City of Leavenworth. The UGA boundary was established as part of the City/County comprehensive planning effort.

For collection system planning purposes, the analysis was based on the assumption that all areas within the UGA boundary would ultimately be provided sewer service. This is consistent with the City's level of service definitions established as part of their comprehensive plan. Over the short term the RL 20 zone area on the north side of the UGA is limited to 20,000 square foot lots and will provide sewer service via individual onsite systems. However, over the long term it is assumed that future development pressures will ultimately result in rezoning and higher densities. Thus for collection system planning it has been assumed that the RL 20 area will eventually be rezoned to RL 10 with the exception of the area located east of Titus Road (i.e., area north of Rattlesnake Hill); this area is assumed to remain RL 20.



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CITY OF LEAVENWORTH, WASHINGTON

LEAVENWORTH AREA
LAND USE MAP, COMPREHENSIVE PLAN MAP

Flow projections for undeveloped residential or multi-family areas were based on the following values.

RESIDENTIAL SEWER FLOW PROJECTIONS[1]

ZONING DESIG.	DESCRIPTION	ASSUMED HOUSING DENSITY (Dwellings/acre)	ESTIMATED POPULATION DENSITY (Persons/acre)	DESIGN FLOW (gal/day/acre)
RL6	6,000 S.F. Residential	6	15	6,000
RL10	10,000 S.F. Residential	4	10	4,000
RL12	12,000 S.F. Residential	3	7.5	3,000
RL20	20,000 S.F. Residential	2[3]	5	2,000
		4[4]	10	4,000
RM2	Duplex or Single Family	6	15	6,000
RM3	Triplex or Multi-Family	12	24	10,000

(1) All flows based on 100 gpcd and 4.0 peaking factor.
(2) Based on 2.5 persons/dwelling, except for RM3 areas assumed @ 2.0 persons/dwelling.
(3) For areas east of Titus Road.
(4) For long-term future planning RL20 areas west of Titus Road were assumed to eventually be higher density @ RL10

Future commercial flow contributions for collection system planning purposes are based on the specific commercial area flow projections developed in a separate technical memorandum (TMVA-LEAV03). Total new future commercial flows were estimated at .13 mgd. Assuming a peaking factor of 4.0, additional collection system capacity of .52 mgd will be needed. This will be distributed at several points throughout the collection system as indicated in the referenced technical memorandum.

F. FUTURE INSPECTION AND MONITORING PROGRAMS

In order to better monitor the condition and ensure proper operation of the City's collection system, and to properly schedule future maintenance, replacements and upgrades, it is recommended that the City establish the following programs:

- Annual Cleaning and TV Inspection
- Flow/Capacity Monitoring
- Oil and Grease Control and Enforcement

1. Annual Cleaning and TV Inspection Program

A program of routine cleaning and TV inspection of the existing collection system was recommended in the 1988 Plan but has not yet been started by the City. It is recommended that the City begin a program to address a certain length of sewer pipe each year. A reasonable

amount would be a goal of about 5000 feet per year at a cost of about $5,000 to $10,000 per year. This would enable getting through the collection system in about 10 years. There are several contractors who perform cleaning and TV inspection work.

The purpose of such a program is to:

- Remove solids from the mains and restore capacity.
- Assess the condition of the pipe and identify sections requiring maintenance or replacement; in particular, identify reaches where failure may be imminent.
- Prioritize and budget maintenance repairs or replacement.
- Identify pockets of groundwater infiltration.
- Based on condition, determine next interval that each reach should be inspected again (2, 5, 10 or more years).

One of the goals is to identify those areas or reaches where immediate action of some type is necessary to prevent failure or other catastrophic effects. In addition, less critical defects can be identified and programmed for correction, as well as identification of those reaches where no near term work is needed. Many defects may be found such as sags, misalignments or others which are not ideal but do not have serious adverse effects or do not jeopardize continued operation of the system.

It is recommended that the City budget funds annually to enable an ongoing program to continue.

2. Collection System Flow/Capacity Monitoring

The City recently acquired continuous velocity/depth flow monitoring/recording equipment for collection system applications. Collection system flow monitoring is needed for two purposes:

- Determine reserve capacity of key sewer mains for future development.
- Identify potential high infiltration areas.

Selected monitoring locations are marked on Figure 1 attached and identified as to what purpose is being addressed. The locations are also listed in tabular form later in this report.

Reserve Capacity Monitoring. The need for and timing of future collection system capacity upgrades are dependent upon the reserve flow capacity remaining within a given existing sewer main. Evaluation of the present and future collection system capacity presented in earlier paragraphs was based on estimates of distribution of the total sewage flows throughout the collection system. Future projected increases were then added on top of this, for each area considered, to determine total future peak at selected points throughout the collection system. This method is an approximation and is adequate for areas where ample sewer main capacity exists. However, for areas where capacity is marginal, there is a high level of uncertainty due to the lack of precision of the method. Thus flow monitoring is recommended at various points

in the collection system in order to more accurately determine reserve capacity available for future development. The north interceptor sewer area has sufficient capacity such that flow monitoring is not critical. However, this is not the case in the south interceptor area and several points for monitoring are recommended. The points are shown on Figure 1 attached and also summarized later in this report. It is recommended that flow monitoring be conducted for a minimum period of 7 days continuous during at least one anticipated high flow period. High flow periods may occur at differing times or seasons at various points in the collection system. City staff should take this into consideration when planning monitoring.

Monitoring data should include a continuous record of flow depth, flow rate (or velocity), and total daily flow volume. In addition, the dates and a description of any pertinent facts such as weather conditions, snow cover/snow melt, major tourist event taking place, etc. This data should then be evaluated to determine the existing peak flow conditions and remaining reserve capacity available.

Infiltration Flow Monitoring. Infiltration was determined to be non-excessive as per TMVA-LEAV02. However, limited additional flow monitoring was recommended to confirm the absence or presence of infiltration in specific areas (see TMVA-LEAV02). Infiltration flow monitoring locations are shown on Figure 1 attached and also summarized later in this report.

It is recommended that flow monitoring be conducted for a minimum period of 7 days at each location. Monitoring at each location should be done once during the high infiltration season (varies, but usually between January through March) and once during the peak tourist season (July through August).

Monitoring data should include a continuous record of flow depth, flow rate (or velocity), and total daily flow volume. In addition, the dates and a description of pertinent weather conditions such as past precipitation levels (above or below average), precipitation during monitoring period, snow cover, snow melt, daily max & min temperatures.

The data for each location should then be evaluated to determine:

- Estimated infiltration and percent of total daily flow
- Recommendations for additional study or steps, if necessary

Summary of Flow Monitoring Locations. The recommended flow monitoring locations are shown on Figure 1 attached and are listed as follows:

LOCATION/DESCRIPTION	PURPOSE OF MONITORING[1]
Manhole on Ski Hill Road and Whitman Street	
• monitor 8" leg from north	Reserve Capacity
• monitor 8" leg from south	Reserve Capacity and Infiltration
Manhole on Ski Hill Road and West Street; monitor 8" leg from west	Infiltration
Manhole south of U.S. Highway No. 2 and east of 3rd St. where 10" and 12" main come together	
• monitor 14" leg to east	Reserve Capacity
• monitor 10" leg to west	Reserve Capacity
Manhole at alley on 9th Street between Front St. and Commercial St.; monitor 10" leg from north	Infiltration
Manhole on 9th Street and Main St.; monitor 8" leg from north	Infiltration
15" south interceptor sewer at manhole just upstream of treatment plant	Reserve Capacity
Manhole on Birch St. at Central Avenue; monitor 12" leg from west	Infiltration
Manhole just west of Cone St. and Cedar St.; monitor 15" leg from west	Infiltration

[1] Monitoring is for one or both of the following purposes: 1) determining reserve capacity available for future growth, and 2) determining degree of infiltration.

3. Control of Fats/Oils/Grease

Excessive fats, oils and grease from restaurants or other commercial establishments can cause a buildup in the sewer mains. Excessive levels also causes operational problems at the treatment plant and increases the BOD_5 loading. The City currently has a sewer use ordinance (Chapter 13.68) which includes provisions regulating the discharge of fats, oils and grease. Pertinent requirements of the ordinance include:

- Requirement for all commercial kitchens or any other cooking facilities of any commercial establishment, institution, hospital or school to have a suitable grease trap.
- Wastewater discharged to the sewer shall have a temperature not exceeding 150° Fahrenheit.

- Wastewater discharged to the sewer shall not contain more than 100 mg/l of oil or grease of mineral, animal, vegetable or petroleum origin.
- Garbage grinders are allowed from residential sources only.

The above items represent a reasonable basis for controlling fats, oils and grease discharges. The limitations set for temperature and oil/grease limitations are typical of standard ordinances generally being used throughout municipalities. Discussions with City staff indicate that past compliance monitoring and enforcement of the requirements has been intermittent and inconsistent. However, the City is taking steps to begin surveys and inspection of existing grease traps by the building inspector along with follow-up inspections and enforcement. It is recommended these efforts continue and be programmed on a regular basis to ensure compliance. No matter what size grease trap is used, the unit must be operated properly and cleaned regularly so that grease will not escape. In practice, cleaning should be done when grease and oil volumes reach about ⅓ of the retention capacity of the unit. Experience will determine the frequency required for each particular establishment. The City's ordinance provides for record keeping procedures and requirements by the owner which will aid in the monitoring and enforcement effort.

It is recommended that the City take the appropriate steps to ensure enforcement of the existing ordinance. Revisions or additions to the existing ordinance that should be considered, particularly if excessive oil and grease problems persist, include:

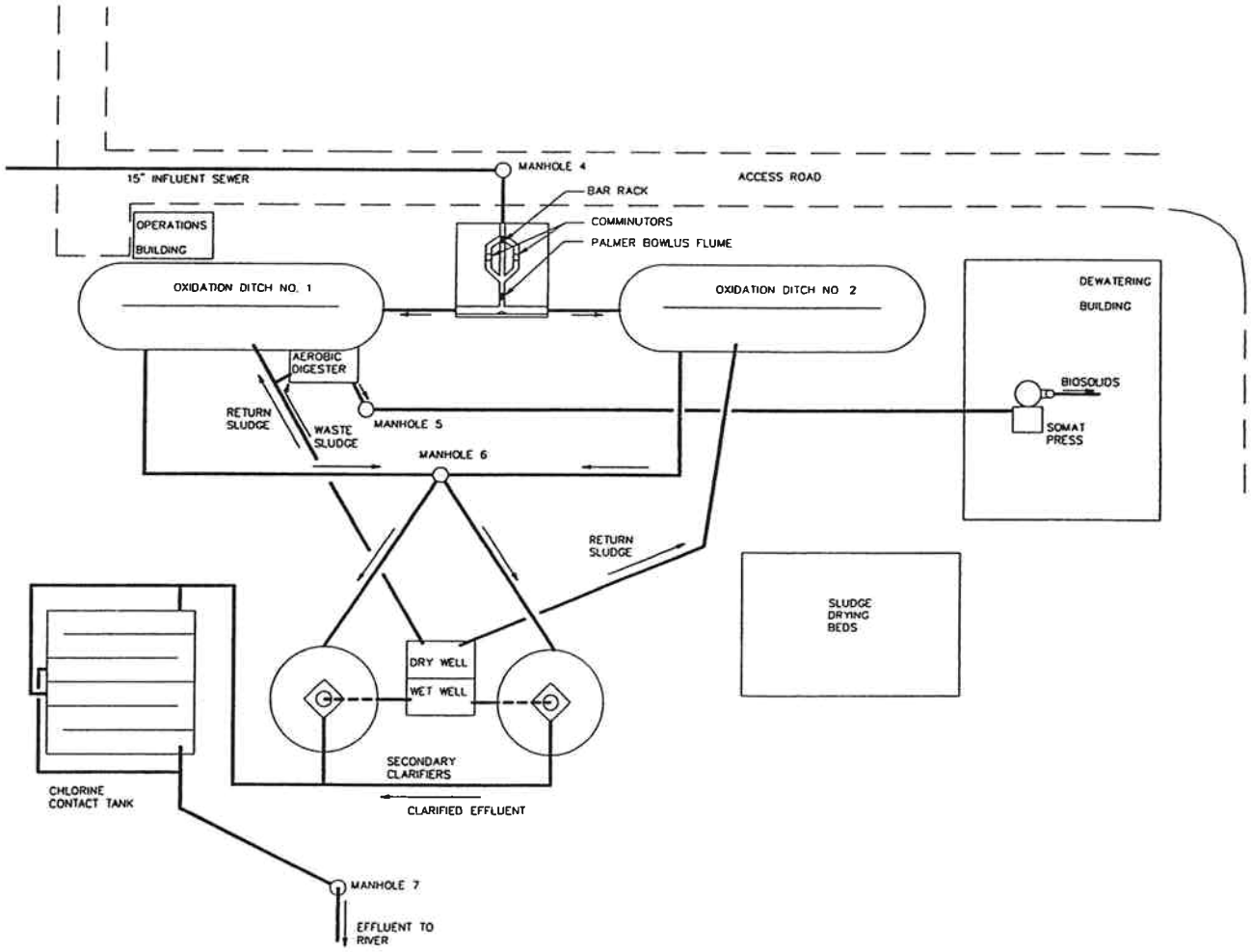
- The City may require additional interior point source removal equipment for certain establishments with persistently high oil and grease loads. Small package separator devices are available for installation on dishwasher, sink or other equipment discharges.

- The City may require that restaurant owners provide notification to the City (or have septic tank haulers provide the notification) each time grease traps are emptied. The City can then notify those restaurants who are not providing regular clean out of the traps.

- The City should consider requiring grease traps to be emptied at a regular frequency (such as monthly) unless the owner of the establishment can document that a less frequent cycle is appropriate.

- The use of enzyme and bacteria additives to the wastewater or grease traps should not be allowed. Emulsification of oil and grease using additives delays physical separation of oil and grease. The oil and grease may then separate downstream rather than in the grease trap.

- If grease and oil problems persist, the temperature limitation of 150° F. for wastewater discharges should be lowered. The high temperature wastewater reduces the effectiveness of oil and grease separation in the grease trap. Requirements for lowering wastewater temperatures would necessitate multiple tank grease traps to allow greater detention times and opportunity for cooling.



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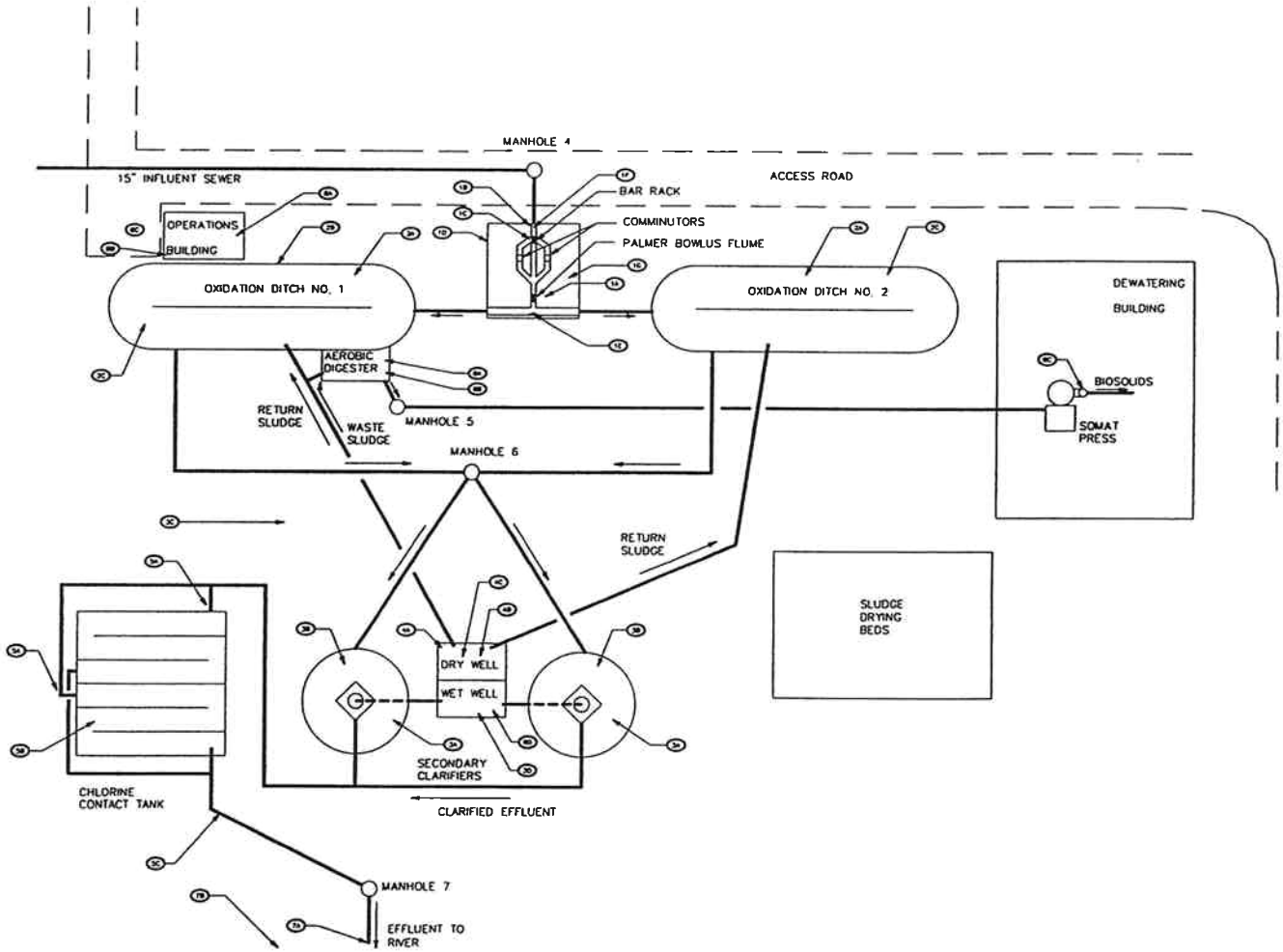
CITY OF LEAVENWORTH, WASHINGTON
WASTEWATER TREATMENT PLANT
EXISTING FACILITIES
SIMPLIFIED SCHEMATIC LAYOUT

SHEET 1 OF 3



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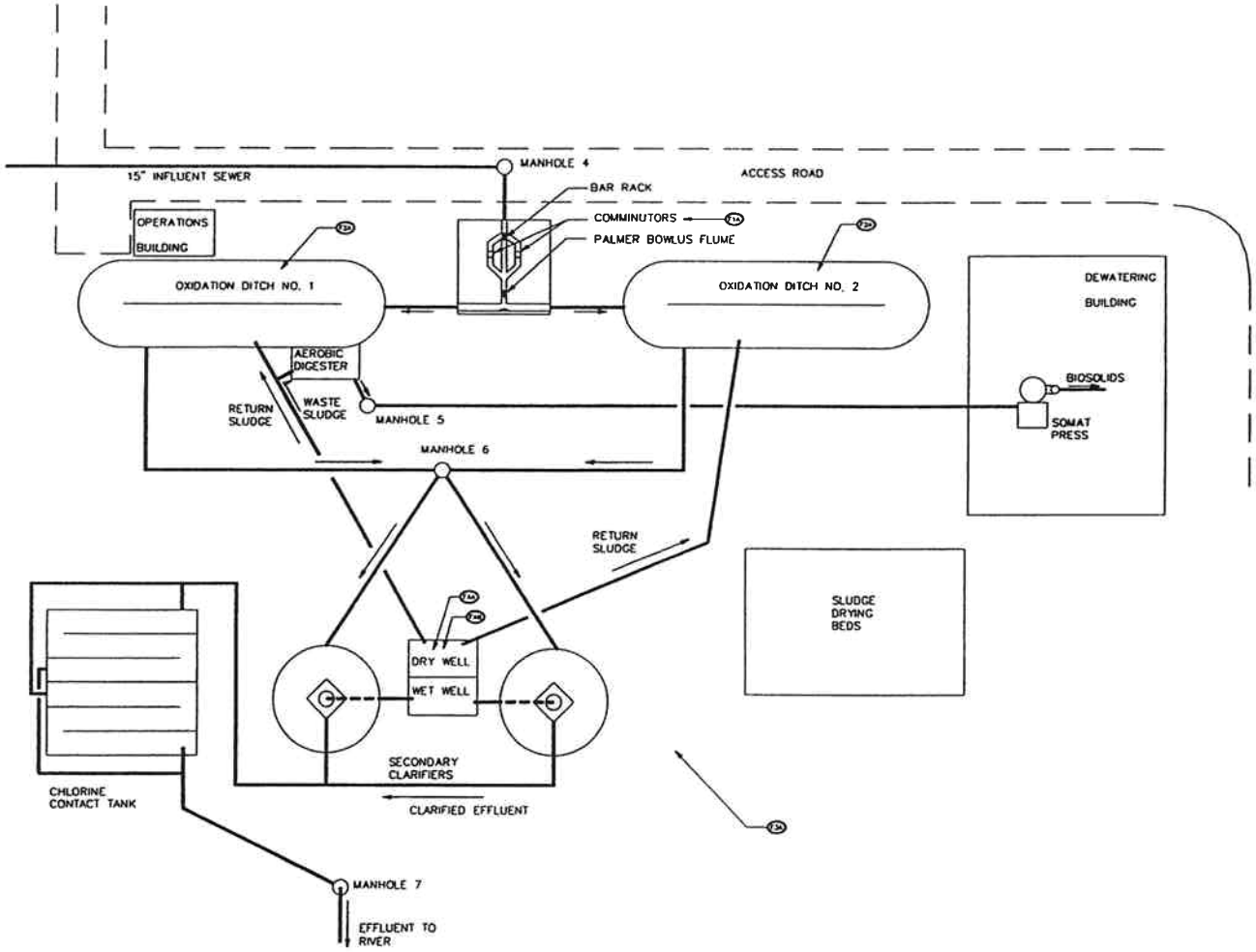
ENGINEERING AND MANAGEMENT

CITY OF LEAVENWORTH, WASHINGTON
WASTEWATER TREATMENT PLANT
PRESENT DEFICIENCIES OF EXISTING FACILITIES
SIMPLIFIED SCHEMATIC LAYOUT

SHEET 2 OF 3



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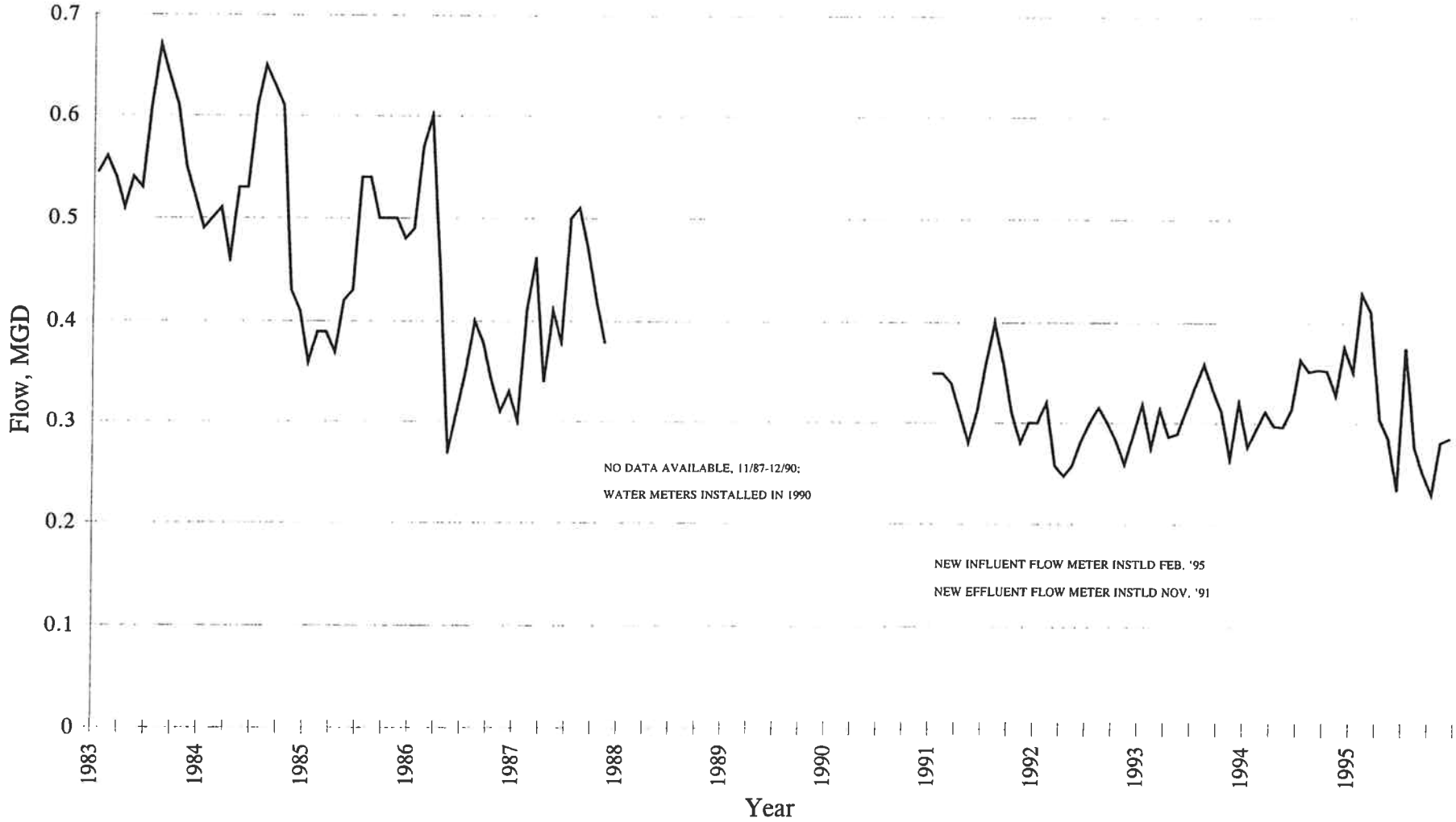
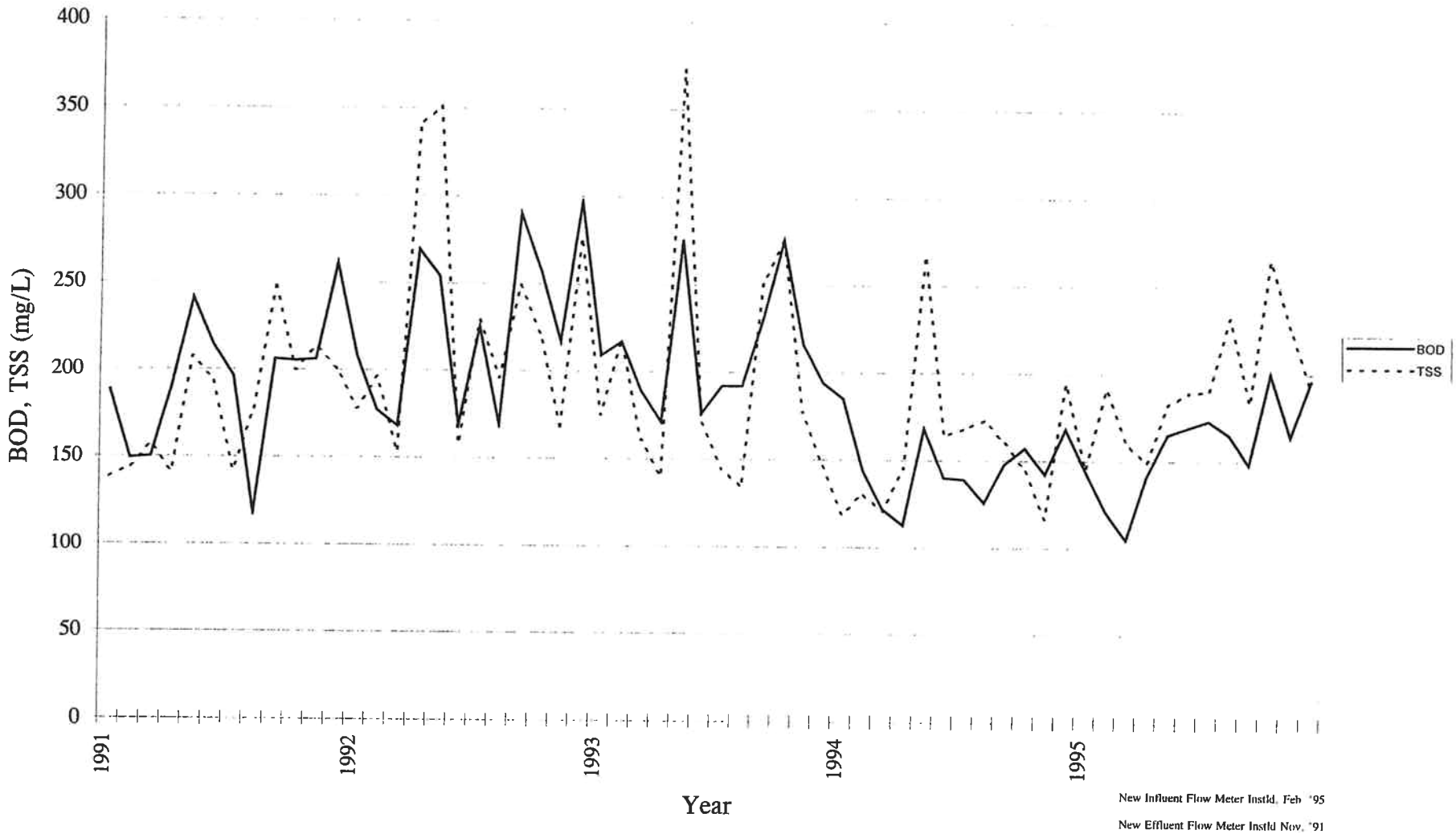
CITY OF LEAVENWORTH, WASHINGTON
WASTEWATER TREATMENT PLANT
FUTURE DEFICIENCIES OF EXISTING FACILITIES
SIMPLIFIED SCHEMATIC LAYOUT

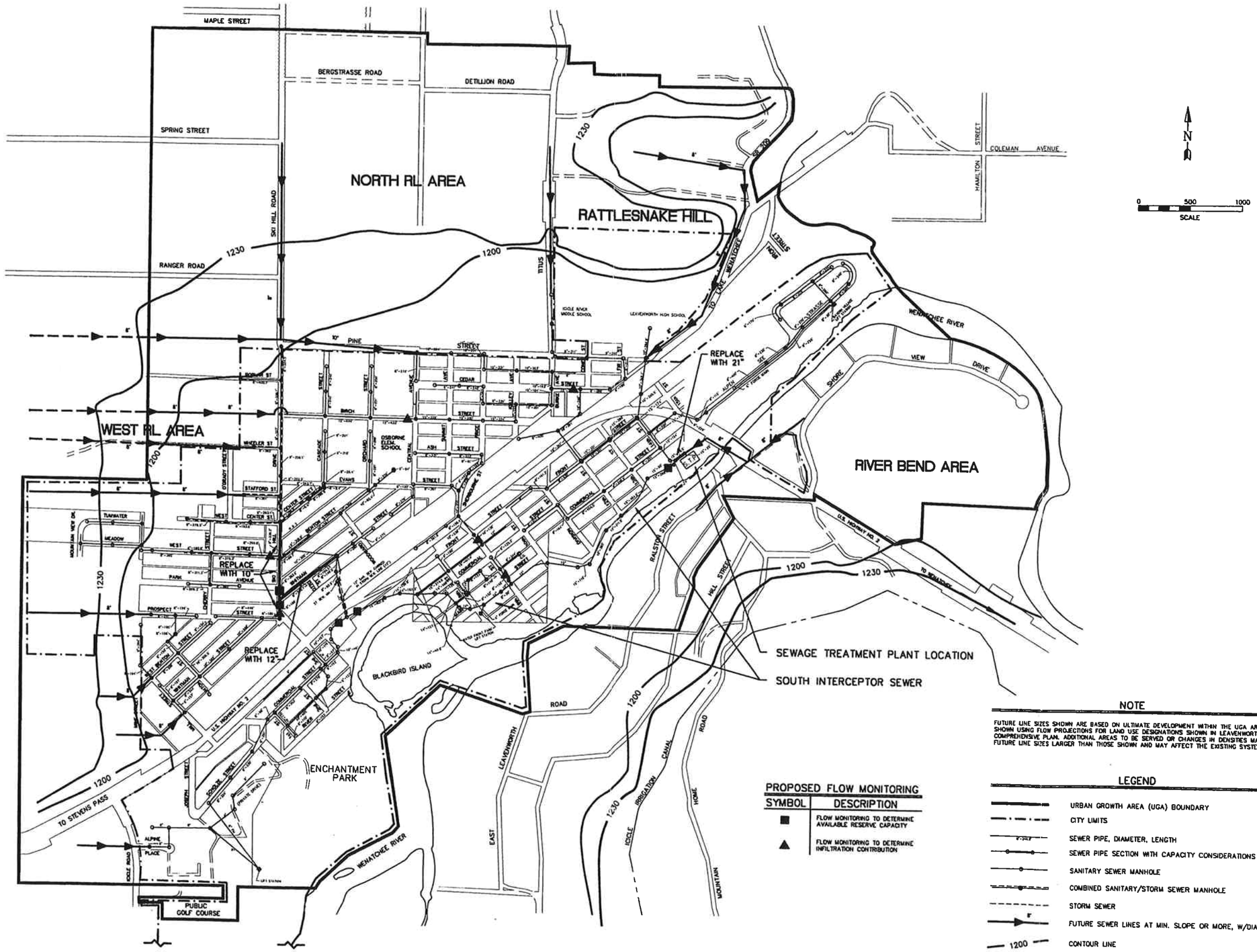
SHEET 3 OF 3

Leavenworth WWTP
Monthly Average Flows



Leavenworth WWTP
BOD and TSS Influent





NOTE

FUTURE LINE SIZES SHOWN ARE BASED ON ULTIMATE DEVELOPMENT WITHIN THE UGA AREA BOUNDARY SHOWN USING FLOW PROJECTIONS FOR LAND USE DESIGNATIONS SHOWN IN LEAVENWORTH'S DRAFT COMPREHENSIVE PLAN. ADDITIONAL AREAS TO BE SERVED OR CHANGES IN DENSITIES MAY REQUIRE FUTURE LINE SIZES LARGER THAN THOSE SHOWN AND MAY AFFECT THE EXISTING SYSTEM.

PROPOSED FLOW MONITORING

SYMBOL	DESCRIPTION
■	FLOW MONITORING TO DETERMINE AVAILABLE RESERVE CAPACITY
▲	FLOW MONITORING TO DETERMINE INFILTRATION CONTRIBUTION

LEGEND

- URBAN GROWTH AREA (UGA) BOUNDARY
- CITY LIMITS
- SEWER PIPE, DIAMETER, LENGTH
- SEWER PIPE SECTION WITH CAPACITY CONSIDERATIONS
- SANITARY SEWER MANHOLE
- COMBINED SANITARY/STORM SEWER MANHOLE
- STORM SEWER
- FUTURE SEWER LINES AT MIN. SLOPE OR MORE, W/DIAMETER
- 1200 CONTOUR LINE

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FIGURE 1

CITY OF LEAVENWORTH, WASHINGTON

EXISTING SANITARY SEWER SYSTEM AND SCHEMATIC OF FUTURE EXPANSION OF SYSTEM

Appendix E
1996 Wastewater Facility Plan TMVA-Leav11
“South Interceptor Sewer Evaluation”

PRELIMINARY
SUBJECT TO REVISION

Technical Memorandum: TMVA-LEAV11

2/5/96

CITY OF LEAVENWORTH
WASTEWATER SYSTEM FACILITY PLANNING

SOUTH INTERCEPTOR SEWER EVALUATION

DESCRIPTION

- Approximately 4000 lineal feet of 14" and 15" trunk sewer serving south and west portions of the City.
- Estimated age 50 to 60 years.

HYDRAULICS

- Has sufficient hydraulic capacity to serve existing flows and future ultimate development within the UGA boundary.
- Has sections with insufficient slope and resulting low velocities. Sedimentation will be ongoing maintenance problem; compounded by root intrusion.
- Recommend flow monitoring to document existing peak flow and remaining reserve capacity during peak tourist events. This is addressed in TMVA-LEAV10.

CONDITION

- Limited TV inspection done of portion of south interceptor November 1991; total length of 14" and 15" sewer = 3960 feet, portion TV inspected = 1360 feet, or about 34%.
- Portion TV inspected was in fair to good condition; manholes in good condition; pipeline had minor defects; one sag area (under water); significant root intrusion with roots @ 95% of all joints.
- Condition of remainder of pipe is unknown (not TV inspected); however, likely similar conditions expected.
- Previous surcharging reported, due to roots and obstructions.

I/I

- Roots at joints indicate leak potential.
- Geographic location along side hill near river suggests excessive I/I likely not a problem.

O&M CONSIDERATIONS

- Need for periodic cleaning and root removal to ensure reliable operation. Recommend every 2 years.

FUTURE UPGRADE OPTIONS (based on approximately 4000 l.f.)

- Alt. 1

  No structural upgrades to pipeline. Provide periodic regular cleaning, TV inspection and root removal (assume every 2 years). Estimated cost $20,000 initially, then $6000 to $9000/year thereafter.

- Alt. 2

  Line existing sewer using Insituform to eliminate root intrusion and joint leakage. Estimated cost $500,000-$600,000 (access could be a problem).

- Alt. 3

  Replace sewer with new pipeline and correct grade deficiencies. Estimated cost $350,000 to $400,000.

RECOMMENDATIONS

- Clean & TV inspect to confirm feasibility/advisability of Alt. 1 above.
- Recommend Alt. 1, subject to cleaning and TV inspection results.

Appendix F

2001 Sanitary Sewer Collection System Cleaning, Inspection and Testing
"Summary Report and Rehabilitation Prioritization Plan"

CITY OF LEAVENWORTH
SANITARY SEWER COLLECTION SYSTEM
CLEANING, INSPECTION AND TESTING

SUMMARY REPORT AND
REHABILITATION PRIORITIZATION PLAN

1. INTRODUCTION

1.1 Purpose

The purpose of this report is twofold. First is to summarize the work done and the findings of the completed cleaning, smoke testing, manhole and TV inspection of the sewer collection system. Second, to present a prioritized rehabilitation plan.

1.2 Background

Based on the recommendation presented in the 1996 Wastewater Facilities Plan, a Cleaning and TV inspection was performed on the collection system. The purpose of the program was to:

- Remove solids from the mains and restore capacity
- Assess condition of the pipe and identify sections requiring maintenance or replacement; in particular, identify reaches where failure may be imminent
- Prioritize and budget maintenance repairs or replacement
- Identify pockets of groundwater infiltration
- Based on condition, determine next interval that each reach should be inspected again

Manhole inspection and smoke testing was also included with the cleaning and TV inspection work. Action Services Corporation performed the cleaning, Tving, manhole inspection and smoke testing work.

1.3 Scope

A Project and Engineering Scope was developed and included in the Agreement For Engineering Services dated May 8, 1997 (Amendment No.2; November 16, 2000). Tasks completed include:

- Review TV & smoke testing written reports and digital data; provide ranking of defects; prioritize results; make recommendations and prepare cost estimate for remediation (if needed); update existing sewer collection map based on corrections noted by Action Services
- Review TV tapes, as needed to confirm prioritization and ranking of results
- Prepare written report of findings and results
- Review with City and finalize report

This report includes the results of those tasks.

2. WORK COMPLETED AND FINDINGS

2.1 TV Inspection

During March-June 2000, Action Services Corporation (ASC) conducted cleaning and TV inspection of a majority of the sanitary sewer collection system. The pipelines were inspected for deterioration, cracking, holes, joint separation, sags, roots, and grease build-up and infiltration sources.

The pipelines were first cleaned of gravel and other foreign material to aid the passing of the camera, to get a clear view of pipe defects and to restore the pipe to as near its original carrying capacity as possible. Cleaning was accomplished using high-velocity water jetting equipment. Included in this cleaning process was root cutting and the vacuum removal of the material accumulated as a result of this cleaning and root cutting operation.

The TV inspection was done with a color, video camera equipped with a rotating head. This enabled the video inspection and recording of various pipeline defects as well as the ability to view up into service laterals off the main pipeline. Video inspection and recording occurred in pipe sections between manholes and included pipeline and manhole identifications, recording time and date with a counter visible in the picture frame. Tapes were recorded in "VHS" format on standard VHS tapes. The contractor provided, both in paper as well as electronic format, log sheets containing pertinent identification information as well as descriptions and severity of defects found. Original tapes and notebooks containing the video logs and a summary of findings submitted by the contractor were provided to the City.

Approximately 54,500 lf, or approximately 94% of the total system of sewer pipe was cleaned and inspected (see **Figure 1**). In some cases, protruding service pipes, offset joints, roots, and misc. debris interrupted the progression of the camera. If so, the camera was removed and run from the opposite direction if possible, to complete the inspection of that pipeline.

Findings
A detailed compilation of the TV inspection findings is included in the ASC notebooks provided to the City. A TV Inspection Report is provided for each section of sewer pipeline inspected and video taped. Each Report was assigned a work order number (WO#) by ASC which is used in other tables and summaries in the notebooks as well as in this report to identify specific reaches of sewer pipe.

Defects noted were given a severity rating by the observer, ASC, as light, medium or heavy and included in their individual pipe section work orders. The evaluation of this information was the beginning of a rating system used to prioritize the collection system and as the basis for the recommendations.

2.2 Manhole Inspection

Manhole inspections were conducted by ASC in June 2000. Manholes were visually inspected and the condition of the channel, bottom, barrel, joints, steps, risers, ring and cover, as well as signs of infiltration recorded.

Manholes inspected were generally those included in pipelines designated for TV inspection. In all, 241 manholes, or approximately 94% of the total number of manholes in the system, were inspected. **Figure 1** identifies those manholes that were inspected.

Findings
The results of the manhole investigations are presented in the Leavenworth Manhole Inspection Log provided in the ASC notebook. Overall, the manholes inspected are in fair condition. Deterioration of risers, joints, and offset rings were the most prevalent defects noted. Missing or bad channels were the worst noted problems.

2.3 Smoke Testing

Smoke testing was conducted by ASC as well. Smoke testing was conducted in May-June 2000 in approximately 28,700 lf of collection system piping (see **Figure 1**). The purpose of the smoke testing was to identify and document possible sources of storm water inflow.

Smoke testing involves the use of non-toxic smoke forced through isolated sections of the collection system to give a visual indication of improper storm sewer cross connections such as area drains, roof drains, catch basins, etc.

Findings
The results of the smoke testing are presented in the Smoke Test Report also in the ASC notebook. Accompanying the report are photos of the locations where smoke was observed. The smoke testing revealed a number of potential problem areas including sanitary sewer services that had broken cleanouts, or missing caps and other unknown sources of smoke. Most noteworthy was the discovery that several storm drain catch basins were connected to the sewer. Locations are provided in the ASC reports. The smoke testing also revealed other issues related to building piping which may not effect the public sewer system but may be of interest to the City.

2.4 Infiltration Investigation

An infiltration investigation was performed for the 1996 Wastewater Facilities Plan. It was reported in the Facility Plan that infiltration was present in the system but it was determined that infiltration reduction was not cost effective. Infiltration alone was not considered a reason for repair/replacement in this prioritization analysis.

Findings
For this TVing and manhole inspection project, the contractor noted infiltration sources and/or possible infiltration sources in his reports. 14 pipeline reaches and 11 manholes were noted as showing infiltration or evidence of infiltration. Infiltration or evidence of infiltration defects noted in the contractor reports were weighted and used in the rating of the pipelines for the prioritization plan.

2.5 Capacity Considerations

Pipeline capacity is addressed in the 1996 Wastewater Facilities Plan. In the Facility plan the collection system was evaluated to determine its adequacy to handle current and future flows and pipelines having insufficient or marginal capacity to meet future flow requirements were identified. Neither the TV inspection work nor the manhole inspections in this project considered the pipeline capacity or surcharging. The final evaluation for this prioritization plan did however consider the pipelines identified in the Facilities Plan.

Findings
Only three of the pipeline reaches identified in the Facilities Plan as exhibiting potential capacity problems coincided with the prioritized pipelines. These pipelines were located along the South Interceptor route and affected the final prioritization as noted on **Figure 2**.

3. EVALUATION, SUMMARY AND PRIORITIZATION

3.1 Evaluation

The defects noted by ASC in the TV inspection reports were grouped into two main categories for this evaluation, spot defects and length defects.

SPOT DEFECTS

The spot defects were grouped into 5 subcategories and weighted according to their importance or potential impact on the continued operation of the existing collection system. They were then rated by multiplying the assigned defect weight by the contractors noted severity and then by the number of occurrences within the pipe run. The five subcategories of defects are as follows:

Structural Failure: Those defects noted that show evidence of current structural failure and are considered to pose the greatest risk for potential system failure and subsequent need for emergency action. These include collapsed pipe, partial collapsed pipe, hole in pipe, pipe missing, pipe broken, and shattered pipe. (Weights 9-10)

Structural Distress: Those defects noted that show potential for structural failure. These defects are considered to pose less of a risk for potential system failure and subsequent need for emergency action. These include circular cracks, crack at joint, crack longitudinal, hairline crack, and infiltration at crack. (Weights 7-8)

Roots: Those defects noted that are considered to have less potential for failure than categories 1 and 2 but pose the greatest O&M concerns. These include joints with roots and service with roots. (Weights 3-6)

Joint Defects: (see note below) Those defects noted that are considered to have less potential for failure than categories 1 and 2 but pose the greatest O&M concerns. These include separated joints, offset joints, open joint, joint with infiltration, and joint with gasket exposed. (Weights 3-6)

Minor Defects: Those defects noted that are not a failure concern, pose little or no operational concerns and minor related maintenance problems. These include deformed pipe, evidence of infiltration, service abandoned, service plugged, pipe patched, repaired hole in pipe and service with infiltration. (Weights 1-3)

Note: Roots and Joint defects are both mostly O&M concerns but they have been separated because root problems can be addressed without replacement of the pipe, whereas joint problems (if severity warrants) can only be repaired by replacement, or possibly by re-lining of the pipe.

LENGTH DEFECTS

The length defects were grouped into 3 subcategories **Deterioration, Pipe Sags,** and **Grease**. These defects were rated by multiplying the length of the noted defect by the severity of the defect.

Each pipe reach was then evaluated by comparing the spot defect rating with the length defect rating. The evaluation also included partial review of the videotapes to confirm prioritization and ranking of results.

3.2 Summary

Approximately 54,500 lf of sewer pipe in 240 reaches was TV Inspected. Out of the 240 pipe reaches, 130 (54%) are in good shape with little or no defects. Another 48 reaches have a few, mostly minor, defects. The remaining 62 reaches (26% of the TV inspected pipe runs) have multiple defects ranging from moderate to severe. The following is a summary of the defects by pipe material:

TABLE 3-2
Summary of Defects by Pipe Reach

Pipe Material	Total # of Reaches	# of Reaches exhibiting the following defects, by defect category			
		Deterioration	Roots	Structural Defects	Joint/Minor Defects
PVC	56	1	2	7	14
Clay	3		1	3	3
Concrete	135	71	68	95	107
Transite	46		2	18	24

PVC Pipe: Most prominent defects are joint problems and sags, majority of cases is minor.

Clay Pipe: Only 3 runs have clay pipe. Of these two are noted as having very bad horizontal zig-zags. They also exhibit moderate to severe structural defects.

Concrete Pipe: The majority of the noted defects are concentrated in the concrete pipe reaches. Structural defects, roots and deterioration are the most prevalent problems.

Transite Pipe: Most pipe reaches are in good condition, defects are concentrated in a few reaches. Prevalent defects are holes, breaks and offset or separated joints.

3.3 Prioritization

A Priority Schedule was developed based on the above evaluation methods using the information compiled from the collection system investigations noted above as well as engineering evaluations and judgement.

1st Priority pipelines are those which are known to have operation and maintenance (O&M) problems and/or exhibit severe enough defects to be considered at greatest risk for potential pipeline failures or increased O&M problems.

2nd Priority pipelines are those which were indicated as having less severe operational or maintenance problems than 1st Priority pipelines. These pipelines also exhibit defects but are considered to be less severe than 1st Priority pipelines.

4. RECOMMENDATIONS

4.1 Priority Replacement Plan

The overall structural integrity of the collection system pipelines inspected appears fairly good. Generally the aging system remains functional. Some problems exist however. Signs of structural failures such as broken, shattered, collapsed, or partially collapsed pipe, cracks, and holes are evident and of particular concern in some pipelines. Also the majority of the collection system inspected is older concrete pipe with 3-foot pipe sections. It is susceptible to root intrusion and deterioration due to its many joints and age, a fact that is supported by the TV inspection results and past problems the City has had with the system.

The problem of roots can either be dealt with through pipeline repair/replacement, or through ongoing routine or periodic maintenance. The appropriate solution depends on the impact the problem is having on the City, as indicated from actual problem occurrences, and the City's ability to handle ongoing maintenance procedures. In other words:

- Have roots been a problem?
- How often does the problem occur and require City action?
- Are the actual occurrences typically in the same few pipelines or widespread?

- Does the City have the manpower, equipment and/or budget to deal with the problem themselves or the budget to support an ongoing program of routine maintenance performed by outside services?

This report assumes replacement/re-lining/rehabilitation of the pipelines with moderate to heavy root problems and continued monitoring for areas not currently requiring root maintenance. If the City chooses to undertake a long-term or interim maintenance program for the root problem instead of or in addition to a replacement project, the priority schedule provided in this report should be reviewed and revised.

The plan outlined here addresses the recommended priority in which the existing pipelines should be addressed in a collection system rehabilitation project. As described in a previous section, it is based on the defects noted in the TV inspection work and the problem pipelines identified by the City. This plan assumes that either pipeline repair (lining, spot replacement, or other) or full pipeline reach replacement would take place. The term "replacement" is used for simplicity to include repair and/or replacement of existing facilities.

4.1.1 Priority 1

1st priority sewer pipelines should be included in a collection system rehabilitation project pending availability of funding.

Included in this group are the locations where the most severe structural defects appear and structural failure is a concern. These locations occur both in the pipeline reaches identified in Figure 2 as full reach replacement as well as those identified for spot repair. In the later case it is recommended to repair the specific defect rather than replace the entire pipe reach because the rest of the pipeline does not warrant priority 1 replacement.

As noted above, several of the reaches identified in **Figure 2** are included primarily because of root problems. The City could opt to take care of these reaches through ongoing periodic maintenance efforts rather than replacement if funding is not available.

4.1.2 Priority 2

2nd priority sewer pipelines should be added to the 1st priority depending on funding availability. Otherwise, 2nd priority pipelines should be re-inspected and evaluated again within the next planning cycle (5 – 10 years) to monitor and assess whether defects and deterioration have progressed to more serious levels.

Within the 2nd priority pipelines there are several reaches identified that are also included in the 1st priority pipelines as needing spot repair. These pipelines warrant spot repair under 1st priority but if funding is available, complete replacement of the pipeline is recommended.

4.1.3 Sewer Services

Generally, it is good practice to replace, if possible, sewer service pipelines from the main to the property line during a sewer main replacement project. Service pipe is typically of similar age

and condition as the sewer main and so replacing it upgrades all of the sewer pipe within the right-of-way at one time and limits the cost of resurfacing again should old service pipe fail.

Therefore, except for specific cases where existing service pipe has been replaced using PVC pipe of proper size and type, we recommend that sewer service pipe replacement be included in conjunction with mainline sewer replacements.

4.1.4 Manholes

Typically, a cost-effective sewer replacement project includes removal and replacement of the manholes as opposed to reconnecting to existing manholes and rehabilitating them as needed. The priority replacement project recommended above should include either replacement or rehabilitation of manholes associated with the pipelines replaced. Repair or replacement of additional manholes may be warranted and should be reviewed with the City further during project scope determination.

4.2 Other

4.2.1 Grease

Grease buildup discovered in the TV inspection was not determined to be a widespread or severe problem. Nonetheless, it should be remembered that excessive grease in the collection system should be avoided due to potential plugging of pipes and fouling of lift stations. Furthermore, excessive grease can cause operational problems and additional maintenance efforts at the sewage treatment plant. This is particularly true in Leavenworth's case due to the number of restaurants and commercial institutions. The City should have and enforce suitable ordinances that require restaurants, businesses or others who discharge excessive fats or oils, to maintain properly sized grease traps or other means of grease and oil removal. The City should continue to support an on-going effort to control the amount of grease entering the system and maintain it at acceptable levels.

4.2.2 Inflow Sources

Potential inflow sources were identified in the smoke testing results. The City should pursue those sources of inflow identified in the Smoke Testing Report, or other sources if known, to repair or require property owner to repair or properly seal problem areas against potential inflow.

4.2.3 Infiltration

The elimination of potential infiltration sources was previously determined as not cost effective. The coincidental elimination of potential and actual infiltration sources during a sewer and manhole replacement project is an added benefit.

5. IMPLEMENTATION

5.1 Estimated Project Costs/Funding

Typically costs for sanitary sewer collection system replacement projects range from about $90 to $120 per lineal foot of pipeline (including engineering and admin.) depending on various

factors such as accessibility for construction, impact on tourism, pavement replacement limits, service replacements, the presence of ground water or rock, etc. For estimating purposes in this report, $110 per lineal foot has been used which assumes inclusion of including service replacements at the right-of-way line.

TABLE 5-1

	PRIORITY 1	PRIORITY 2
Estimated Cost for Spot Repair @ $5000/Ea	**$ 120,000**	**($ 50,000) (1)**
Estimated Cost for Reach Replacement @ $110/Lf	**$ 837,000**	**$ 577,000**
Total	**$ 957,000**	**$ 527,000**

(1) Credit for entire reaches being replaced instead of spot repair.

5.2 Funding

A detailed funding analysis was not done. The following information is given as an indication of the estimated per ERU (equivalent residential unit) financial impact of the above recommendations (Priority 1 and Priority 2).

Loans: PWTF and/or SRF. Cost per ERU of $4.75-$5.25 based on assumed 1500 ERU's. (#3.00 - $3.50 for Priority 1 only)

Grants: CDBG – Possibility if City is eligible.
CCW – Collection Systems are not eligible for grants unless I&I reduction is cost-effective.
RD – City is eligible for RD grant/loan funds but City has declined this funding in the past due to City conflicts with RD wetland and flood plain policies.
ERU of $2.25 based on 1500 ERU's, assuming 50% grant/50% loan ($1.50 for Priority 1 only)

The above does not take into consideration possible use of City reserve funds in reducing the cost per ERU. If requested, a more detailed funding analysis can be prepared.

APPENDIX

Appendix Table 1

Legend

A. **Pipe ID (WO#):** This corresponds to contractors inspection reports.
   Yellow highlight indicates pipeline was blocked, entire reach was video inspected
   Red highlight indicates pipeline was blocked, entire reach was **not** video inspected
B. **Basin:** Each manhole number is prefixed by a letter (i.e. A16), this letter correlates to the basin.
C. **Length (ft):** The length of each pipeline that was video taped.
D. **Pipe Size:** Pipeline diameter in inches
E. **Pipe Material:** Pipeline material.
   Green highlight indicates Concrete pipe
   Yellow highlight indicates PVC pipe
   Blue highlight indicates Transite pipe
   Red highlight indicates Clay pipe
F. **Location:** Indicates descriptive location of pipeline.
G. Manhole: Indicates upstream and downstream manholes on pipeline video inspected
H. **Overall Pipe Rating:** Compilation of the spot defects. (used to prioritize pipelines)
   H: Indicates high rating
   M: Indicates moderate rating
   L: Indicates low rating
   X: Indicates minor defects exist (lowest rating)
   Red highlight: Indicates worst in system
I. **Structural Failure:** Spot defect rating compiled into Overall Pipe Rating
J. **Structural Distress:** Spot defect rating compiled into Overall Pipe Rating
K. **Roots:** Spot defect rating compiled into Overall Pipe Rating
L. **Joint Problems**: Spot defect rating compiled into Overall Pipe Rating
M. **Minor Defects**: Spot defect rating compiled into Overall Pipe Rating
N. **Deterioration**: Rating of overall deterioration within pipe run (used to prioritize pipelines)
O. **Sags**: Rating of overall deterioration within pipe run (factor in prioritization of pipelines)
P. **Grease**: Indicates existence of grease within pipe run.
Q. **Infiltration**: Indicates existence of infiltration within pipe run.
R. **1st Priority**: Indicates 1st priority ranking
   S=Spot repair otherwise pipe length shown
S. **2nd Priority**: Indicates 2nd priority ranking.

APPENDIX TABLE 1
PRIORITY REPLACEMENT SCHEDULE

A	B	C	D	E	F	G		H	I	J	K	L	M	N	P	Q	R	S	T
			PIPE					Severity Rating (X=Exists L=Low, M=Moderate, H=High)											
Pipe ID (WO#)	Basin	Length (video)	Size	Mat.	Location	Manholes		OVERALL PIPE RATING	Structural Failure	Structural Distress	Roots	Joint Problems	Minor Defects	DETERIORATION	Sags	Grease	INFILTRATION	1st PRIORITY (1)	2nd PRIORITY
		(ft)	(in)			Beg	End											(EA)	(LF)
179	A	352	18	CONC	HWY 2 & 12TH ST	B1	A23	X		X			X						
180	A	339	15	CONC	FRONT & 12TH ST	A23	A22	X		X			X		X				
181	A	347	15	CONC	FRONT & 13TH ST	A22	A21	X		X									
182A	A	413	8	CONC	COMMERCIAL & 10TH	A13	A12	M		M	L		X	H	L			413	
183	A	161	8	CONC	COMMERCIAL & DIVISION	A12	A11	X				X	X	M					161
184	A	449	8	CONC	DIVISION & COMMERCIAL	A11	A10	L	H	L	X		L	H	X			449	
185	A	347	8	CONC	COMMERCIAL & 12TH	A10	A09	L		X	L		L	H				347	
186	A	344	8	CONC	COMMERCIAL & 13TH	A09	A03	M	H	M	X	X	X	L				S	344
193	A	161	8	CONC	FRONT ST@ WAREHOUSE	A20	A19	X		X			L	H				161	
194	A	427	8	CONC	FRONT & DIVISION	A19	A18	L		M	X		X	H	X			427	
195	A	346	10	CONC	FRONT & 12TH	A18	A17	X		X			M						
196	A	347	15	CONC	FRONT & 13TH	A17	A05	X		X	X		M	L					
[illegible]	A	114	10	CONC	CHUMSTICK HIGHWAY	A7	A8	L	H	X	X			L				S	
209	A	346	8	CONC	CHUMSTICK HWY	A7	A6	M	H		M			M	X			S	346
210	A	240	10	CONC	CHUMSTICK HWY	A6	A5	X					X						
211	A	171	15	CONC	14TH & FRONT ST	A5	A4	X					X						
212	A	179	15	CONC	14TH & ALLEY	A4	A3	X		X	X		X						
213	A	152	15	CONC	14TH & COMMERCIAL	A3	A2	X			X		X						
223	A	316	8	CONC	14TH & ALLEY	A4	A14							H	X			316	
143	AA	136	8	PVC	ALPINE PLACE	AA7	AA6												
144	AA	119	12	PVC	ALPINE PLACE	AA6	AA6A												
145	AA	129	12	PVC	ALPINE PLACE	AA6A	AA6B												
146	AA	202	12	PVC	ALPINE PLACE	AA6	AA5												
147	AA	62	10	PVC	LEAVENWORTH FUN CENTER	AA8	AA8A												
148	AA	89	10	PVC	LEAVENWORTH FUN CENTER	AA8	AA5						X						
149	AA	113	12	PVC	LEAVENWORTH FUN CENTER	AA5	AA1A												
150	AA	216	12	PVC	LEVENWORTH FUN CENTER	AA1A	AA1												
154	AA	81	12	PVC	VILLAGE @ LEAVENWORTH	AA1B	AA1												
155	AA	211	12	PVC	VILLAGE @ LEAVENWORTH	AA1	AA2												
156	AA	186	12	PVC	VILLAGE @ LEAVENWORTH	AA2	AA2A	X			X								
157	AA	147	12	PVC	VILLAGE @ LEAVENWORTH	AA2A	LS												
158	AA	48	12	PVC	VILLAGE @ LEAVENWORTH	AA2B	LS	X				X							
159A	AA	271	8	PVC	VILLAGE @ LEAVENWORTH	AA1C	AA1								M				
170	AA	170	8	PVC	VILLAGE @ LEAVENWORTH	AA1D	AA1												
171	AA	127	8	PVC	VILLAGE @ LEAVENWORTH	AA2C	AA2D	X				L							
172	AA	60	8	PVC	VILLAGE @ LEAVENWORTH	AA2C	AA2												
173	AA	27	8	PVC	VILLAGE @ LEAVENWORTH	AA2	USDE												
174	AA	296	8	PVC	VILLAGE @ LEAVENWORTH	AA4	AA4A								X				
175	AA	279	8	PVC	VILLAGE @ LEAVENWORTH	AA4A	AA3												
176	AA	93	8	PVC	VILLAGE @ LEAVENWORTH	AA3	AA3A												
177	AA	333	8	PVC	VILLAGE @ LEAVENWORTH	AA3A	AA2A												

CITY OF LEAVENWORTH
SANITARY SEWER COLLECTION SYSTEM
SUMMARY REPORT

Pipe ID (WO#)	Basin	Length (video) (ft)	PIPE Size (in)	PIPE Mat.	Location	Manholes Beg	Manholes End	OVERALL PIPE RATING	Structural Failure	Structural Distress	Roots	Joint Problems	Minor Defects	DETERIORATION	Sags	Grease	INFILTRATION	1st PRIORITY[1] (EA)	2nd PRIORITY (LF)
								Severity Rating (X=Exists L=Low, M=Moderate, H=High)											
072	B	298	8	PVC	TITUS STREET	B21	B20	X				L			X				
073	B	271	8	PVC	TITUS STREET	B20	B19								X				
074	B	61	8	PVC	TITUS STREET	B18	B19												
075	B	308	8	CONC	PINE & TITUS	B18	B17	X		X				X					
076	B	356	8	CONC	PINE STREET	B17	B16	L		X	L			L					
077	B	211	8	CONC	PINE & FIR	B16	B15	X		X				L	X				
078	B	176	8	CONC	FIR & CEDAR	B15	B14	X		X	L			M	X				176
079	B	272	8	CONC	PINE & CENTER	B27	B28	X		X		X					X		
080	B	323	10	CONC	PINE & CENTER	B27	B26	X											
081	B	327	10	CONC	PINE & SUMMIT	B26	B25	X		X					X				
082	B	142	10	CONC	PINE & PRICE	B24	B25												
083	B	327	10	CONC	PRICE & ALLEY	B24	B23	X		X	X			X	X				
084	B	348	10	CONC	KELLY & ALLEY	B23	B22	M	H	M	L							S	348
085	B	238	8	CONC	CASCADE STREET	B36	B35	L		M		X					H		
086	B	237	8	CONC	CASCADE STREET	B35	B12	X		M		X		X	X				
087	B	248	8	CONC	ORCHARD STREET	B34	B33	X		M		X					L		
088	B	250	8	CONC	ORCHARD STREET	B33	B11	X		X							X		
089	B	237	8	CONC	CEDAR STREET	B32	B31	X		M				X					
[illegible]	B	160	8	CONC	CEDAR STREET	B31	B30	L		X	L			L			X		
091A	B	198	8	CONC	BIRCH & CENTRAL	B10	USCO	H			H			L				198	
092	B	429	12	CONC	BIRCH & CASCADE	B12	USCO	L	H	M		X			X			S	
093	B	440	12	CONC	BIRCH & CASCADE	B12	B11	X		L					L				
094	B	163	8	CONC	PRICE & ALLEY	B29	B30	L		M	X	X		X	X				
095	B	329	8	CONC	PRICE & ALLEY	B29	B6	H	H	H	L			M	X		X	329	
096	B	280	8	CONC	CEDAR & FIR	B14	B3	X			X			H	X			280	
[illegible]	B	400	8	CONC	FORESTRY PARKING	B1	B13	L		X	L	L		X	X				
098	B	214	12	CONC	BIRCH & ORCHARD	B11	B10A	X		X									
099	B	215	12	CONC	BIRCH & ORCHARD	B10A	B10	X		L									
100	B	322	15	CONC	BIRCH & CENTRAL	B10	B9	X				X							
101	B	327	15	CONC	BIRCH & SUMMIT	B9	B8	X			X								
102	B	329	15	CONC	BIRCH & PRICE	B8	B7	X											
103	B	159	15	CONC	KELLY & ALLEY	B6	B7	X											
104	B	346	15	CONC	KELLY & ALLEY	B6	B5	X				X							
105	B	160	15	CONC	CEDAR & BURKE	B4	B5	X		L									
106	B	279	15	CONC	CEDAR & BURKE	B4	B3	X		X									
107	B	242	18	CONC	CEDAR & FORESTRY	B3	B2	X		L									
108	B	256	18	CONC	FORESTRY YARD	B2	B1	X		X					X				
109	B	160	10	CONC	FORESTRY YARD	B22	B4	X		X									
129	BB	162	8	CONC	ALPEN SEE STRASSE	BB8	BB7	X			X								
130	BB	373	8	CONC	ALPEN SEE STRASSE	BB7	BB6	X											
131	BB	224	8	CONC	ALPEN SEE STRASSE	BB9	BB6	X		L	X								
132	BB	236	8	CONC	ALPEN SEE STRASSE	BB10	BB1	X			X			X	L				
133	BB	251	8	CONC	ALPEN SEE STRASSE	BB6	BB1	X											
135A	BB	233	8	CONC	ALPENSEE STRASSE	BB4	BB3	H		X	H			L				233	
136	BB	253	8	CONC	ALPENSEE STRASSE	BB3	BB2	X			X			H	X			253	
137	BB	366	8	CONC	ALPENSEE STRASSE	BB2	BB1	X			L	X		H	X	X		366	
234	BB	393	8	CONC	ALPENSEE STRASSE	BB5	BB4	H			H			X				383	
235	BB	231	8	CONC	ALPENSEE STRASSE	BB11	BB10	M			M			X					213
[illegible]	C	78	8	CONC	9TH & ALLEY	C20	C21	X		X									
199	C	239	8	CONC	9TH & ALLEY	C20	USCO	L		X	X	X							
200	C	142	8	TRANSITE	9TH & ALLEY	C20	C19												
[illegible]	C	2	8	TRANSITE	9TH & MAIN	C19	C08	X		X									
202	C	107	8	TRANSITE	HOSPITAL PARKING	C18	C17	X							X				
203	C	120	8	TRANSITE	HOSPITAL PARKING	C16	C17												
204	C	142	8	TRANSITE	HOSPITAL PARKING	C16	C15												
205	C	29	8	CONC	8TH STREET	C14	C15	X		X									
206	C	105	8	CONC	8TH STREET	C15	USCO	X		X				X					
207	C	105	8	CONC	8TH STREET	C14	TL	X		X	X	X		X					
[illegible]	C	96	8	CONC	8TH & ALLEY	C14	C22	X		X	X								
231	C	40	14	TRANSITE	BLACKBIRD LODGE HILLSIDE	C13	C12												
232	C	181	14	TRANSITE	BLACKBIRD LODGE HILLSIDE	C12	C10	X		X					X				
233	C	79	14	TRANSITE	BLACKBIRD LODGE HILLSIDE	C10	C09	X											
237	C	48	8	CONC	HOSPITAL PARKING LOT	C18	USDE	L	HH	X								S	
240	C	287	15	CONC	8TH & MAIN	C8	C7	X			X							287	(2)
241	C	141	15	CONC	PARK EASMENT ROAD	C7	C6A	M			M			L				141	(2)
242A	C	300	15	CONC	PARK EASMENT ROAD	C6A	C6	H			H	X						300	
243A	C	118	15	CONC	PARK EASEMENT ROAD	C6	C5	M			M			L				118	(2)
244	C	277	15	CONC	PARK EASMENT ROAD	C5	C4	H			H				X			277	
245A	C	208	15	CONC	PARK EASMENT ROAD	C4	C3	M			M	X		H	L		X	208	
246A	C	497	15	CONC	LORANE YOUNG EASEMENT	C3	C2	H		X	H			H				497	
247	C	292	15	CONC	RETIREMENT HOME	C2	C1	X			L			H	L			292	

CITY OF LEAVENWORTH
SANITARY SEWER COLLECTION SYSTEM
SUMMARY REPORT

Pipe ID (WO#)	Basin	Length (video)	PIPE Size	PIPE Mat.	Location	Manholes Beg	Manholes End	OVERALL PIPE RATING	Structural Failure	Structural Distress	Roots	Joint Problems	Minor Defects	DETERIORATION	Sags	Grease	INFILTRATION	1st PRIORITY [1]	2nd PRIORITY
		(ft)	(in)					Severity Rating (X=Exists L=Low, M=Moderate, H=High)										(EA)	(LF)
138	D	328	8	CONC	CENTRAL & ASH	D13	D12	X		M	X				X				
139	D	327	8	CONC	ASH & SUMMIT	D12	D11	L			L								
140	D	88	8	CONC	PRICE & ASH	D11	D10	X						M	X				88
141	D	164	8	CONC	PRICE & SHERBOURNE	D10	D9	X				X			X				
142	D	275	8	CONC	WHITMAN STREET	D20	D19	L	H		L							S	
151	D	114	8	CONC	WHITMAN & CENTRAL	D19	D18	X		X		X		L	X				
152	D	266	8	CONC	EVANS & CENTRAL	D18	D17	X							X				
153	D	97	8	CONC	EVANS & SUMMIT	D17	D8	M		X	X	H			M	X			97
168	D	358	8	CONC	HWY 2 @ OLD FIRE HALL	D16	D15	X		L		X			L				
169	D	154	8	CONC	HWY 2 @ SANDYS PANCAKE HSE	D15	D07	X		L		X			L				
187	D	208	10	CONC	SHERBOURNE & EVANS	D8	D6	X		M									
188	D	228	10	CONC	9TH & HWY 2	D7	D6	M		M		H		L					228
189	D	128	10	CONC	9TH & FRONT ST	D6	D5-WC	L		H		L			X				
190	D	395	10	CONC	9TH & ALLEY	D5-WC	USCO	L	H	L		L						S [3]	395
191	D	406	10	CONC	9TH & ALLEY	D5-WC	D4-WC	M	H	H		L			L			S [3]	406
192	D	178	8	TRANSITE	FRONT & 8TH	D14	D4-WC												
227	D	370	15	CONC	8TH & ALLEY	D4-WC	D3	L	H	M	X							S [3]	370
228	D	164	14	TRANSITE	ALLEY @ 8TH OVER HILLSIDE	D3	D2	X				X				X			
229	D	126	14	TRANSITE	ALLEY @ 8TH OVER HILLSIDE	D2	D1	X											
230	D	126	14	TRANSITE	ALLEY @ 8TH OVER HILLSIDE	D1	C13												
001	E	298	8	PVC	MOUNTAIN VIEW & TUMMWATER	E44	E43								X				
002	E	256	8	PVC	TUMMWATER	E43	E42								X				
003	E	216	8	PVC	TUMMWATER & MINE	E42	E41								X				
004	E	95	8	PVC	MOUNTAIN VIEW DR	E46A	E46												
005	E	314	8	PVC	MOUNTAIN VIEW DR	E46	E45												
006	E	305	8	PVC	MEADOW	E45	E41	X				X					X		
007	E	216	8	PVC	MOUNTAIN VIEW & PARK	E36	E37	X				X					X		
008	E	152	8	PVC	MOUNTAIN VIEW	E37	E46	X				X			X		X		
009	E	392	8	PVC	PARK	E35	E34								X				
010	E	40	8	PVC	PARK & MINE	E34	E33A												
011	E	180	8	PVC	PARK & MINE	E33A	E33B												
012	E	149	8	PVC	PARK & MINE	E33B	E33C								X				
013	E	143	8	PVC	PARK	E33C	E33								X				
014	E	208	8	TRANSITE	PARK	E33	E32-C	X		X		L			X				
015	E	282	8	TRANSITE	PARK & CHERRY	E32-C	E47	X											
016	E	58	10	PVC	MINE & WEST	E40	E41												
017	E	111	8	PVC	MINE & TUMMWATER	E42	USCO	X				X					X		
018	E	201	8	PVC	MINE & WEST	E40	USCO	X											
019	E	98	8	PVC	MINE & WEST	E40	E39	X		X							X		
020	E	386	8	TRANSITE	WEST	E39	E38-C	L		M		X			L		M		
021	E	189	8	CONC	WEST & CHERRY	E38-C	E31-C	L		X		M			L				
022	E	371	8	TRANSITE	WEST & CHERRY	E31-C	E30-C	X				X			L				
023	E	373	8	TRANSITE	CENTER	E58-C	E57-C	L		L		M			X				
024	E	194	8	TRANSITE	CENTER & OGRADY	E57-C	E56-C	X				X			X				
050	E	121	8	PVC	O'GRADY	E64	E63												
051	E	247	8	PVC	O'GRADY	E63	E62												
052	E	50	8	PVC	O'GRADY & CENTER	E62	E57-C												
[illegible]	E	200	8	CONC	CASCADE	E54	E53	X		X		X							
055	E	308	8	CONC	CASCADE	E53	E52	X		L					X				
056	E	34	8	CONC	CASCADE	E52	E50	X		L									
057	E	180	8	CONC	EVANS & CASCADE	E52	USCO	X		X		X							
058	E	263	8	TRANSITE	EVANS & CASCADE	E50	E49												
059	E	9	8	TRANSITE	CENTER	E49	E48-C												
060	E	260	8	TRANSITE	CENTER	E48-C	E55-C	X				X							
061	E	285	8	CONC	ORCHARD	E24	E23	X		L									
062	E	288	8	CONC	ORCHARD	E23	E22	X							L				
063	E	86	8	CONC	BENTON & ORCHARD & EVANS	E22	E25												
064	E	353	10	CONC	BENTON	E22	E21	X											
065	E	576	10	CONC	BENTON & WOODWARD	E21	E20	X		X					X				
[illegible]	E	94	8	CONC	WHITMAN & WOODWARD	E19	E18	X		X	X								
067	E	276	8	CONC	WHITMAN & WOODWARD	E18	E6-C	M	H	M	X	L			L			S	276
069	E	178	8	CONC	BENTON	E20	E20A	L	H	X	L							S	
070	E	325	8	TRANSITE	SKI HILL & PINE	E17-C	E16-C	L	H			X			X			S	
071	E	395	8	TRANSITE	POPLAR	E61-C	E16-C	X							X				
110	E	331	8	TRANSITE	SKI HILL & BIRCH	E15-C	E16-C	X	H									S	
111	E	325	8	TRANSITE	SKI HILL & BIRCH	E15-C	E14-C	L				H			X				
112	E	257	8	TRANSITE	SKI HILL & WHEELER	E14-C	E13-C	X				X			X				
113	E	257	8	TRANSITE	WHEELER STREET	E60-C	E14-C	X		X		X							

CITY OF LEAVENWORTH
SANITARY SEWER COLLECTION SYSTEM
SUMMARY REPORT

Pipe ID (WO#)	Basin	Length (video) (ft)	PIPE Size (in)	PIPE Mat.	Location	Manholes Beg	Manholes End	OVERALL PIPE RATING	Structural Failure	Structural Distress	Roots	Joint Problems	Minor Defects	DETERIORATION	Sags	Grease	INFILTRATION	1st PRIORITY (1) (EA)	2nd PRIORITY (LF)
								Severity Rating (X=Exists L=Low, M=Moderate, H=High)											
114	E	357	8	TRANSITE	STAFFORD STREET	E59-C	E12-C	X				X							
115	E	196	8	TRANSITE	SKI HILL & STAFFORD	E12-C	E13-C	L		M		L							
116	E	257	8	TRANSITE	SKI HILL & STAFFORD	E12-C	E11-C	X		L		L			L				
117	E	333	8	TRANSITE	SKI HILL & STAFFORD	E11-C	E10-C	X		X					X				
118	E	38	8	TRANSITE	SKI HILL & BENTON	E10-C	E09-C	X							L				
119	E	378	8	TRANSITE	SKI HILL & BENTON	E09-C	E08-C	X		X		X			L				
120	E	294	8	TRANSITE	CENTER & EVANS	E48-C	E11-C	X		X		X							
121	E	290	8	TRANSITE	WEST CENTER STREET	E56-C	E11-C	X							X				
122	E	297	8	TRANSITE	WEST STREET	E30-C	E10-C	L				M			L				
123	E	185	8	TRANSITE	PROSPECT & SKI HILL	F01-C	E08-C	X											
124	E	305	8	TRANSITE	BENTON & SKI HILL	E28-C	E29-C	X		X	X	X							
125	E	65	8	TRANSITE	BENTON & SKI HILL	E28-C	E09-C	X				X							
126	E	230	10	CONC	ALLEY BET BENTON & WHITMAN	E20A	E06-C	L		X	X	L			L				
127	E	506	8	TRANSITE	WHITMAN STREET	E07-C	E08-C	X				X							
128	E	94	8	TRANSITE	WHITMAN STREET	E07-C	E06-C	X	H						X			S	
[illegible]	E	191	10	CONC	BENTON & EVANS	E25	E26	L	HH	L		X			X			S	
224	E	153	14	TRANSITE	HILLSIDE @ COMMERCIAL	E2	E1	X							L				
225A	E	184	14	TRANSITE	COMMERCIAL @ HILLSIDE	E1	D3	X											
[illegible]	E	384	14	TRANSITE	HILLSIDE @ COMMERCIAL	E2	E3	X		X									
025	F	196	8	CONC	PROSPECT & WEST BENTON	F18	F8	X		X				X	X				
026/027	F	238	8	CONC	PROSPECT & MINE BENTON	F9	F8	L	H	X								S	
028/029	F	196	8	CONC	MILL & WEST BENTON	F13	F11	X		X	X								
030	F	339	8	CONC	MILL & WEST WHITMAN	F11	F4	L			L			X	X				
032	F	387	10	CONC	WEST BENTON & CLINTON	F3	F4	X		L	X				L				
[illegible]	F	185	8	CONC	PROSPECT & ALLEY	F7	F8	L		M		L		M			X		185
035	F	101	8	CONC	ALLEY & CLINTON	F7	F6							L	L				
036A	F	147	8	CONC	CLINTON & ALLEY	F6	F5	M	H	M	L			L	L			S	147
[illegible]	F	358	8	CONC	WEST BENTON & CLINTON	F5	F15	X		L	X	X			X				
039	F	154	8	CONC	MILL ST	F12	F11	M	H		M			L				S	154
040	F	419	8	CONC	WEST BENTON & CLINTON	F5	F14	X		X	X			X					
041	F	303	10	CONC	WEST BENTON & CLINTON	F5	F4	M	H	H					X			S	303
042	F	440	10	CONC	WEST BENTON & CLINTON	F3	F2	X		X				M	L				440
043	F	444	8	CONC	PROSPECT & WEST BENTON	F10	F2	L		H	X			H				444	
044	F	390	8	CONC	MINE ST	F17	F16	L		M	X	L		M	X				390
045	F	161	8	CONC	MINE & MILL	F16	F15	X						X					
046	F	87	8	PVC	PROSPECT	F22	F21	X		X					X				
047	F	237	8	PVC	PROSPECT	F21	F20												
048	F	63	8	PVC	PROSPECT	F20	F19												
049	F	96	8	PVC	PROSPECT	F19	F9	X		X									
236	F	174	8	[illegible]	WEST WHITMAN & PROSPECT	F2	F1-C	X						L	X				
160	G	120	8	PVC	SCHOLZE & JOSEPH	G12A	G12	X			X				L				
161	G	321	8	CONC	SCHOLZE STREET	G12	G11	L		X	X				X				
162A	G	325	8	CONC	SCHOLZE STREET	G11	G10	L	H	L				H	X			325	
163	G	349	8	CONC	SCHOLZE STREET	G10	G9	H			H			H	L	K		349	
164	G	97	8	CONC	SCHOLZE STREET	G9	G8	X		L	X			L	L				
165	G	344	8	CONC	COMMERCIAL & 2ND	G7	G8	L	H		L							S	
166	G	166	8	PVC	COMMERCIAL & 1ST	G8	G17	X				X							
167	G	109	8	CONC	1ST & RIVER	G17	G18	X		X	L				X				
178A	G	401	8	PVC	RIVER & FIRST	G17	G16	X				X			M				
197	G	150	8	CONC	RIVER & SECOND	G16	G15	L		X	L			L					
215	G	121	8	CONC	ALLEY & RIVER ST	G15	G14	H		X	H			H				121	
216	G	86	8	CONC	COMMERCIAL & 3RD	G5	G6	L	H	X	L			X				S	
217A	G	178	8	CONC	COMMERCIAL & 3RD	G6	USDE	M			M			X					176
218	G	93	8	CONC	COMMERCIAL & 3RD	G5	G14	L			L			H				93	
219	G	190	8	CONC	COMMERCIAL & 3RD	G5	G4	X			L			L					
220	G	47	8	TRANSITE	COMMERCIAL & 3RD	G3	G4												
221	G	116	8	TRANSITE	COMMERCIAL @ GOLF COURSE	G3	G2	X			X								
238	I	184	8	PVC	ICICLE JUNCTION FAMILY PARK	I1	I2	X		X									
239	I	259	8	PVC	ICICLE JUNCTION FAMILY PARK	I2	I1	X		X		X							
248	I	151	8	PVC	ICICLE JUNCTION 76 STATION	I3	I2	X							X				

(1) S = Spot Repair defect

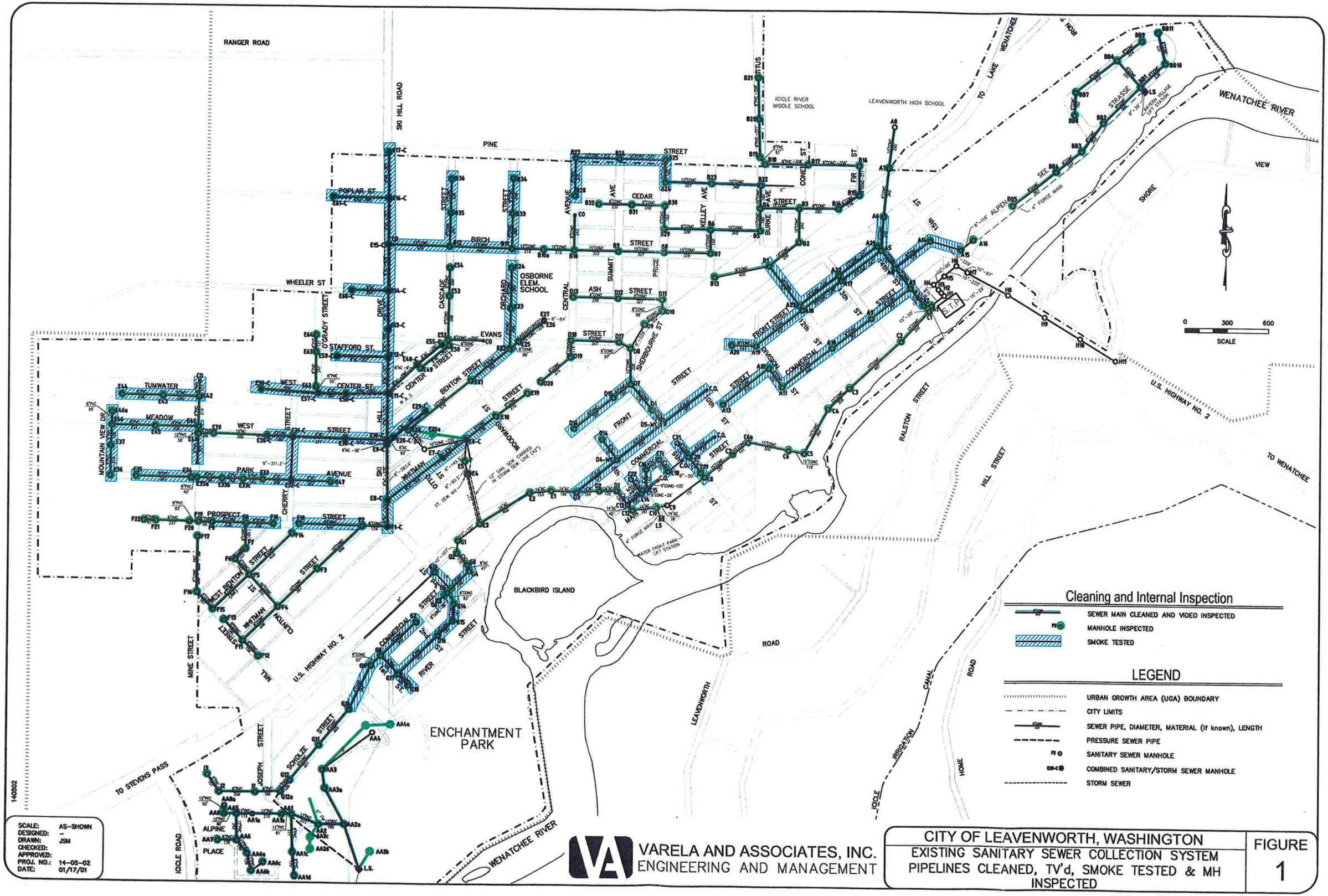
(2) Recommend replacement due to other issues regarding South Interceptor (See 1996 Wastewater Facilities Plan)

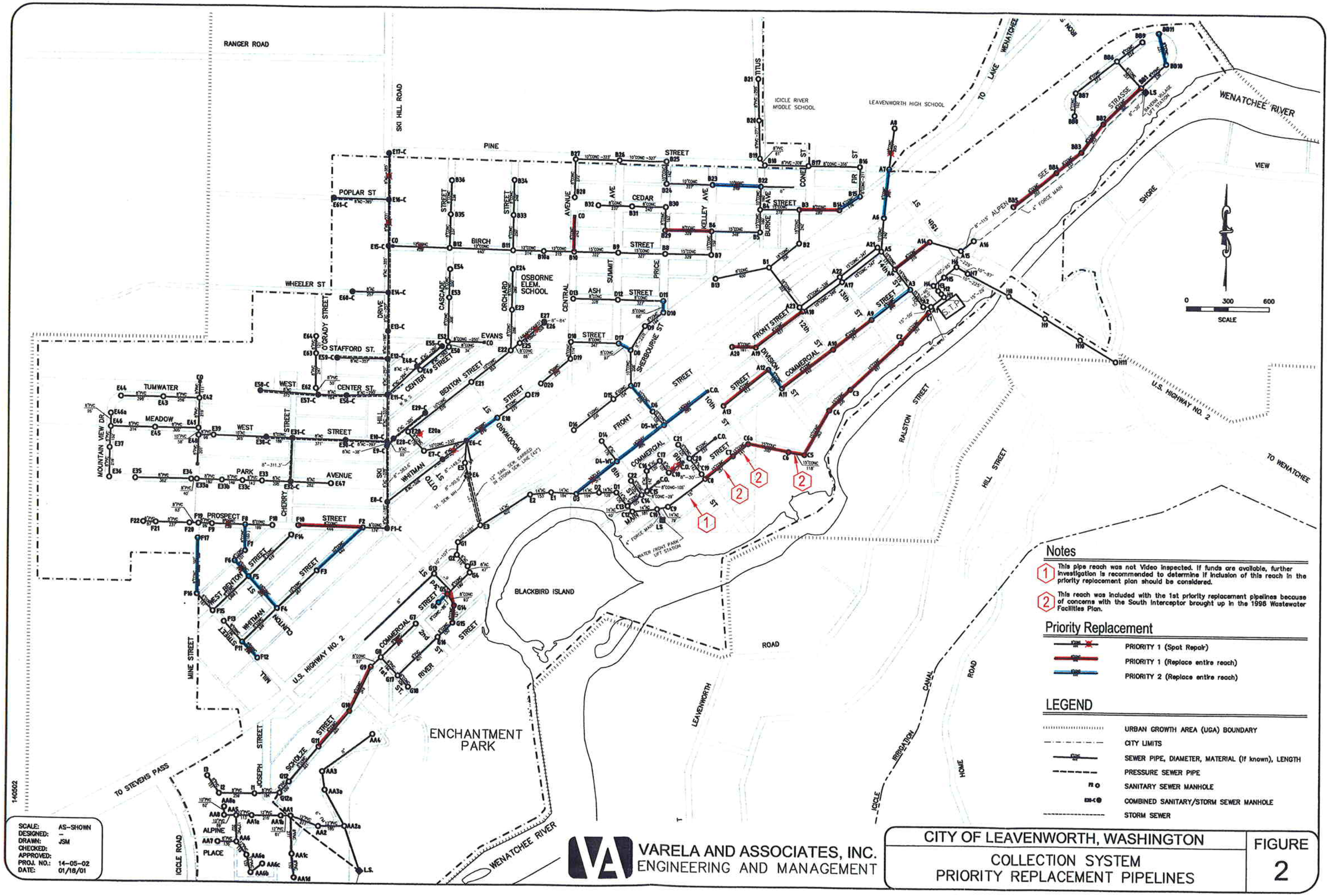
(2) Recommend either spot repair with 1st Priority or replacement with 2nd Priority

Pipe ID = Blockage in pipe, entire length video inspected

Pipe ID = Blockage in pipe, entire length WAS NOT video inspected

	TV insp	1st	2nd
TOTAL	54,412	7,607	5,245
	100%	14%	10%
Spot Repairs		24	(10)


RANGER ROAD
SKI HILL ROAD
PINE
POPLAR ST.
WHEELER ST
O'GRADY STREET
STAFFORD ST.
TUMWATER
MEADOW
WEST
CENTER ST.
MOUNTAIN VIEW DR.
PARK
AVENUE
PROSPECT
STREET
BIRCH
CEDAR
ASH
EVANS
OSBORNE ELEM. SCHOOL
ICICLE RIVER MIDDLE SCHOOL
LEAVENWORTH HIGH SCHOOL
TITUS
CONE ST
FIR ST
BURKE AVE
KELLEY AVE
SUMMIT
PRICE
CENTRAL
ORCHARD
CASCADE
BENTON STREET
SHERBOURNE ST
WOODWARD
WHITMAN
FRONT
COMMERCIAL
DIVISION
12th ST
13th ST
15th ST
FRONT AVE
STRASSE AVE
SEE
ALPEN
4" FORCE MAIN
WATER FRONT PARK LIFT STATION
S.T.P.
WENATCHEE RIVER
SHORE
VIEW
TO LAKE WENATCHEE
U.S. HIGHWAY NO. 2
TO WENATCHEE
RALSTON STREET
HILL STREET
BLACKBIRD ISLAND
ROAD
LEAVENWORTH
IRRIGATION
CANAL
HOME
ICICLE
ENCHANTMENT PARK
TO STEVENS PASS
JOSEPH
SCHOLZE
ALPINE
PLACE
ICICLE ROAD
MINE STREET
MILL
CLINTON
WEST BENTON ST
12" SAN. SEW. CARRIED IN STORM SEW. LINE (42")
51' SEW. MH
0 300 600
SCALE
Cleaning and Internal Inspection
SEWER MAIN CLEANED AND VIDEO INSPECTED
MANHOLE INSPECTED
SMOKE TESTED
LEGEND
URBAN GROWTH AREA (UGA) BOUNDARY
CITY LIMITS
SEWER PIPE, DIAMETER, MATERIAL (If known), LENGTH
PRESSURE SEWER PIPE
SANITARY SEWER MANHOLE
COMBINED SANITARY/STORM SEWER MANHOLE
STORM SEWER
140502
SCALE: AS-SHOWN
DESIGNED: -
DRAWN: JSM
CHECKED:
APPROVED:
PROJ. NO.: 14-05-02
DATE: 01/17/01
VARELA AND ASSOCIATES, INC.
ENGINEERING AND MANAGEMENT
CITY OF LEAVENWORTH, WASHINGTON
EXISTING SANITARY SEWER COLLECTION SYSTEM
PIPELINES CLEANED, TV'd, SMOKE TESTED & MH INSPECTED
FIGURE
1



CITY OF LEAVENWORTH, WASHINGTON

COLLECTION SYSTEM
PRIORITY REPLACEMENT PIPELINES

FIGURE 2

Appendix G

City Code defining zoning classifications (excerpts)

C. No part of a yard, or other open space, or off-street parking or loading space required about or in connection with any building, for the purpose of complying with this title, shall be included as part of a yard, open space, or off-street parking or loading space similarly required for any other building.

D. No yard or lot existing at the time of passage of this title shall be reduced in dimension or area below the minimum requirements set forth in this chapter. Yards or lots created after the effective date of the ordinance codified in this title shall meet at least the minimum requirements established by this title.

E. All territory which may hereafter be annexed to the city shall be zoned according to the recommendation of the city planning commission and the city council and made part of the annexation proceedings. (Ord. 551 §16.100, 1976: Ord. 531 §1(part), 1973).

Chapter 18.20

RESIDENTIAL LOW DENSITY 6,000 DISTRICT (RL6)*

Sections:

18.20.010 Purpose.
18.20.020 Permitted uses.
18.20.030 Uses requiring a conditional use permit.
18.20.040 Yard requirements--Specifications.
18.20.060 Lot size.
18.20.070 Building height.
18.20.080 Lot coverage.
18.20.090 Off-street parking.

18.20.010 Purpose. This is a restricted residential district of low density in which the principal use of land is for single-family dwellings, together with recreational, religious, and educational facilities required to serve the community. The regulations for this district are designed and intended to establish, maintain and protect the essential characteristics of the district, to develop and sustain a suitable environment for family life where children are members of most families, and to prohibit all activities of a commercial nature and those which would tend to be inharmonious with or injurious to the preservation of a residential environment. (Ord. 1089 §1(Exh. A (part)), 1998).

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* Prior ordinance history: Ords. 531, 551, 659, 720, 754, 789, 807, 852 and 1057.

18.20.020 Permitted uses. In a RL6 district, the following uses and their accessory uses are permitted outright:

A. Single-family dwelling;

B. Accessory building and/or uses as follows:

1. Garage, carport or parking space;

2. Work and/or storage sheds for noncommercial use or equipment;

3. Accessory dwelling unit, meaning a subordinate, habitable living unit added to, created within, or detached from a single-family dwelling that provides basic requirements for living, sleeping, eating, cooking and sanitation, provided the following minimum requirements are met:

a. There shall be no more than one accessory dwelling unit per building lot or home site in conjunction with a single-family structure, even if such structure is built on more than one platted lot;

b. An accessory dwelling unit may be attached to, created within, or detached from a new or existing primary single-family dwelling unit;

c. The property owner (which shall include title holders and contract purchasers) shall occupy either the primary unit or the accessory unit as their permanent residence;

d. The accessory dwelling unit will require one parking space, which is in addition to any off-street spaces required for the primary single-family dwelling unit;

e. If there is a second entrance, the primary entrance to an accessory dwelling unit shall not be visible from the yard on the same side of the lot on which the primary entrance to the primary single-family dwelling unit is located;

f. To ensure that the accessory dwelling unit is clearly secondary to the primary dwelling unit, the floor area for the accessory dwelling unit shall in no case exceed eight hundred square feet, nor be less than three hundred square feet, and the accessory dwelling unit shall contain no more than two bedrooms. The square footage of the accessory dwelling unit shall be no more than fifty percent of the area of the primary single-family dwelling;

g. An accessory dwelling unit, together with the primary single-family dwelling unit with which it is associated, shall conform to all other provisions of the LMC, and no variance of yard setback or building lot coverage requirements will be granted;

h. The accessory dwelling unit shall meet the minimum requirements of the Uniform Building Code, Uniform Fire Code, health district and all other local, state and federal agencies;

i. No more than one family, as defined in Section 18.08.160 of this title, shall be allowed to occupy an accessory dwelling unit;

j. The accessory dwelling unit must be connected to the water and sewer utilities of the dwelling unit and may not have separate services;

k. Future subdivision would require compliance with all applicable parts of the LMC including, without limitation, water and sewer hook-up; and

l. Conversions of accessory storage structures, including without limitation garages and carports, to accessory dwelling units shall only occur when that existing structure meets the required yard setbacks for a residence, including without limitation, the rear yard requirement;

C. Family day care home, provided it is licensed by the state and has a current city business license;

D. Public parks;

E. Mini-day care center home facility, provided it is licensed by the state and has a current city business license. (Ord. 1089 §1(Exh. A (part)), 1998).

18.20.030 Uses requiring a conditional use permit. In a RL6 district, the following uses and their accessory uses are permitted when authorized in accordance with Chapter 18.52:

A. Churches, convents and monasteries;

B. Day care center;

C. Educational institutions;

D. Mini-day care center, not in family day care provider's home;

E. Community center buildings, nonprofit;

F. Public libraries and governmental buildings;

G. Public recreation areas;

H. Public museums or art galleries;

I. Golf courses (not including miniature golf courses, professional putting courses, and/or driving ranges);

J. Farming, truck gardening and flower gardening;

K. Educational centers for advanced study and research in an academic field of learning;

L. Temporary subdivision tract offices subject to approval of the Leavenworth design review board;

M. Day nurseries and nursery schools;

N. Two-family dwelling, provided that the lot size is in conformance with Section 18.20.060(A), and the project is in compliance with Section 18.52.130;

O. Hospital;

P. Manufactured home park;

Q. Public utility structures;

R. Home occupations, provided the following minimum conditions shall apply to the approval of any such conditional use permit:

1. Not over twenty percent of the total floor area of one floor is to be used for the home occupation,

2. A home occupation may be conducted in a detached garage with not more than five hundred square feet

of floor area; provided, that there shall be only one garage on the property,

3. The home occupation shall be secondary to the residential use of the property,

4. No structural alterations shall be allowed to accommodate the home occupation except when otherwise required by law,

5. No persons other than the immediate resident of the structure and one outside employee may be employed in the home occupation,

6. One nonilluminated sign, not to exceed four square feet, shall be permitted subject to review by the Leavenworth design review board,

7. No window display and no sample commodities or related materials shall be displayed or stored outside the building,

8. Stock in trade or commodities kept for sale which are not produced on the premises shall not constitute more than thirty percent of the total volume of business,

9. No materials or mechanical equipment shall be used which will be detrimental to the residential use of the residence or adjoining residences because of vibration, noise, dust, smoke, odor, interference with radio or television, or other factors,

10. No materials or commodities shall be delivered to or from the residence which are of such bulk or quantity as to require delivery by commercial vehicle or a trailer, and there shall be no parking of customer's vehicles in a manner or frequency as to cause disturbance or inconvenience to nearby residents or so as to necessitate off-street parking;

S. Bed and breakfast facilities, meaning a single-family residential unit which provides transient lodging, and may include breakfast for guests only, for compensation, by renting up to three rooms within the primary residence, provided the following minimum conditions shall apply to the approval of any such conditional use permit:

1. Subsections (A) through (F) of Section 18.52.120 shall be complied with;

2. The minimum lot size for a bed and breakfast facility shall be six thousand square feet;

3. Existing bed and breakfast facilities annexed into the city after the effective date of the ordinance codified in this chapter which do not fully meet the definition and/or requirements of this section shall be allowed to continue as a nonconforming use; and

4. The bed and breakfast rooms shall not be located in any structure except the principal residence upon the subject premises; and

5. The number of bed and breakfast facilities allowed (density) in any given area shall be determined by applying the duplex division area densities, as depicted on

the official zoning map, to bed and breakfasts.

T. Wireless telecommunications facilities (WTF), in accordance with the requirements of Chapter 18.74 LMC. (Ord. 1205 §2(part), 2003; Ord. 1089 §1(Exh. A (part)), 1998).

18.20.040 Yard requirements--Specifications. A. Front Yard. There shall be a front yard of not less than twenty-five feet.

B. Side Yard. There shall be side yards of not less than five feet.

C. Rear Yard. There shall be a rear yard of not less than fifteen feet for lots without an alley adjacent to the rear yard, and a rear yard of not less than eight feet for lots with an alley adjacent to the rear yard.

D. For corner lots, six thousand square feet or greater in size, the street side yard shall be a minimum of ten feet, and at least one rear yard setback shall be provided. For corner lots less than six thousand square feet in size, the street side yard shall be a minimum of five feet and at least one rear yard setback shall be provided. For the purposes of this title, street side yard shall be that yard area which is adjacent to a public street right-of-way, but which does not provide the primary access to the residential structure, and/or which does not serve as the street address for the residence. (Ord. 1089 §1(Exh. A (part)), 1998).

18.20.060 Lot size. In a RL6 district, the lot size shall be as follows:

A. The minimum lot area shall be six thousand square feet for a single-family dwelling and twelve thousand square feet for a duplex.

B. The minimum lot width at the front building line for new land divisions shall be sixty feet for an interior lot and seventy feet for a corner lot. (Ord. 1089 §1(Exh. A (part)), 1998).

18.20.070 Building height. In a RL6 district, no building shall exceed a height of thirty-five feet. (Ord. 1089 §1(Exh. A (part)), 1998).

18.20.080 Lot coverage. In a RL6 district, buildings and structures shall not occupy more than thirty-five percent of the lot area. (Ord. 1089 §1(Exh. A (part)), 1998).

18.20.090 Off-street parking. Off-street parking shall be provided as required in Chapter 14.12. (Ord. 1146 § 1, 2000; Ord. 1089 §1(Exh. A (part)), 1998).

C. Rear Yard. There shall be a rear yard of not less than fifteen feet for lots without an alley adjacent to the rear yard, and a rear yard of not less than eight feet for lots with an alley adjacent to the rear yard.

D. For corner lots, the street side yard shall be a minimum of fifteen feet, and at least one rear yard setback shall be provided. For the purposes of this title, street side yard shall be that yard area which is adjacent to a public street right-of-way, but which does not provide the primary access to the residential structure, and/or which does not serve as the street address for the residence. (Ord. 1089 §2(Exh. B (part)), 1998).

18.21.060 Lot size. In a RL12 district, the lot size shall be as follows:

A. The minimum lot area shall be twelve thousand square feet for a single-family dwelling and duplex.

B. The minimum lot width at the front building line for new land divisions shall be eighty feet for an interior lot and ninety feet for a corner lot. (Ord. 1089 §2(Exh. B (part)), 1998).

18.21.070 Building height. In a RL12 district, no building shall exceed a height of thirty-five feet. (Ord. 1089 §2(Exh. B(part)), 1998).

18.21.080 Lot coverage. In a RL12 district, buildings and structures shall not occupy more than thirty-five percent of the lot area. (Ord. 1089 §2(Exh. B (part)), 1998).

18.21.090 Off-street parking. Off-street parking shall be provided as required in Chapter 14.12. (Ord. 1143 §1, 2001; Ord. 1089 §2(Exh. B (part)), 1998).

Chapter 18.22

MULTIFAMILY RESIDENTIAL DISTRICT*

Sections:

18.22.010 Purpose.
18.22.020 Permitted uses.
18.22.030 Site plan review.
18.22.040 Uses requiring a conditional use permit.
18.22.050 Lot size.
18.22.060 Yard requirements.
18.22.070 Building height.
18.22.080 Lot coverage.
18.22.090 Off-street parking.

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* Prior ordinance history: Ords. 551, 720, 754, 807, 921 and 983.

18.22.040 Uses requiring a conditional use permit. In a multifamily residential district, the following uses and their accessory uses are permitted when authorized in accordance with Chapter 18.52:

A. A use permitted as a conditional use in a low density residential district;

B. Club, lodge or fraternal organization;

C. Clinic, hospital or sanitarium;

D. Nursing home, retirement home, rest home or convalescent home;

E. Youth home, juvenile home or orphanage;

F. Public facilities and utilities;

G. Day care center (within existing and new church, public or semi-public buildings only). (Ord. 1089 §3(Exh. C (part)), 1998).

18.22.050 Lot size. In a multifamily residential district, the lot size shall be as follows:

A. The minimum lot area for new land divisions shall be six thousand square feet for up to three units and two thousand square feet of lot area is required for each additional dwelling unit.

B. For existing legal lots of record, at a minimum, two thousand square feet of lot area are required for each dwelling unit.

C. The minimum lot width at the front building line for new land divisions shall be sixty feet for an interior lot and seventy feet for a corner lot. (Ord. 1089 §3(Exh. C (part)), 1998).

18.22.060 Yard requirements. A. The front yard shall be a minimum of twenty-five feet. On through lots, front yards shall be required on both streets.

B. The side yard shall be a minimum of five feet.

C. The rear yard shall be a minimum of fifteen feet for lots without an alley adjacent to the rear yard, and the rear yard shall be not less than eight feet for lots with an alley adjacent to the rear yard.

D. For corner lots, the street side yard shall be a minimum of ten feet, and at least one rear yard setback shall be provided. For the purposes of this title, street side yard shall be that yard area which is adjacent to a public street right-of-way, but which does not provide the primary access to the residential structure, and/or which does not serve as the street address for the residence. (Ord. 1089 §3(Exh. C (part)), 1998).

18.22.070 Building height. In a multifamily residential district, the maximum building height shall be thirty-five feet. (Ord. 1089 §3(Exh. C (part)), 1998).

18.22.080 Lot coverage. In a multifamily residential district, buildings and structures shall not occupy more than forty percent of the lot area. (Ord. 1089 §3(Exh. C (part)), 1998).

18.22.090 Off-street parking. Off-street parking shall be provided as required in Chapter 14.12. (Ord. 1143 §1, 2000; Ord. 1089 §3(Exh. C (part)), 1998).

Chapter 18.23

RESIDENTIAL LOW DENSITY 10,000 DISTRICT (RL10)

Sections:

18.23.010 Purpose.
18.23.020 Permitted uses.
18.23.030 Uses requiring a conditional use permit.
18.23.040 Yard requirements--Specifications.
18.23.060 Lot size.
18.23.070 Building height.
18.23.080 Lot coverage.
18.23.090 Off-street parking.

18.23.010 Purpose. This is a restricted residential district of low density in which the principal use of land is for single-family dwellings, together with recreational, religious, and educational facilities required to serve the community. The regulations for this district are designed and intended to establish, maintain and protect the essential characteristics of the district, to develop and sustain a suitable environment for family life where children are members of most families, and to prohibit all activities of a commercial nature and those which would tend to be inharmonious with or injurious to the preservation of a residential environment. (Ord. 1089 §5(Exh. E (part)), 1998).

18.23.020 Permitted uses. In a RL10 district, the following uses and their accessory uses are permitted outright:

A. Single-family dwelling;

B. Accessory building and/or uses as follows:

1. Garage, carport or parking space,

2. Work and/or storage sheds for noncommercial use or equipment,

3. Accessory dwelling unit, meaning a subordinate, habitable living unit added to, created within, or detached from a single-family dwelling that provides basic requirements for living, sleeping, eating, cooking and sanitation

C. Rear Yard. There shall be a rear yard of not less than fifteen feet for lots without an alley adjacent to the rear yard, and a rear yard of not less than eight feet for lots with an alley adjacent to the rear yard.

D. For corner lots, the street side yard shall be a minimum of fifteen feet, and at least one rear yard setback shall be provided. For the purposes of this title, street side yard shall be that yard area which is adjacent to a public street right-of-way, but which does not provide the primary access to the residential structure, and/or which does not serve as the street address for the residence. (Ord. 1089 §5(Exh. E (part)), 1998).

18.23.060 Lot size. In a RL10 district, the lot size shall be as follows:

A. The minimum lot area shall be ten thousand square feet for a single-family dwelling and twelve thousand square feet for a duplex.

B. The minimum lot width at the front building line for new land divisions shall be seventy feet for an interior lot and eighty feet for a corner lot. (Ord. 1089 §5(Exh. E (part)), 1998).

18.23.070 Building height. In a RL10 district, no building shall exceed a height of thirty-five feet. (Ord. 1089 §5(Exh. E (part)), 1998).

18.23.080 Lot coverage. In a RL10 district, buildings and structures shall not occupy more than thirty-five percent of the lot area. (Ord. 1089 §5(Exh. E (part)), 1998).

18.23.090 Off-street parking. Off-street parking shall be provided as required in Chapter 14.12. (Ord. 1143 §1, 2000; Ord. 1089 §5(Exh. E (part)), 1998).

Chapter 18.24

SUPPLEMENTARY RESIDENTIAL DISTRICTS REGULATIONS*

Sections:

18.24.005 Applicability.
18.24.010 Corner lot--Obstructions to visibility prohibited.

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* Prior ordinance history: Ords. 531, 551, 727, 737, 754, 807, 857 and 989.

Chapter 18.28

GENERAL COMMERCIAL DISTRICT

Sections:

18.28.010 Purpose.
18.28.020 Permitted uses.
18.28.030 Uses requiring conditional use permits.
18.28.040 Yard requirements.
18.28.050 Building height.
18.28.060 Lot coverage.

18.28.010 Purpose. The general commercial district classification is intended to be applied to areas suitable and desirable for wholesale and retail sales and services not properly a part of the central area. (Ord. 757 §1(part), 1985: Ord. 754 §5(part), 1984: Ord. 551 §23.100, 1976: Ord. 531 §1(part), 1973).

18.28.020 Permitted uses. In a general commercial district the following uses and their accessory uses are permitted outright:

A. Apartments;

B. Automobile, boat, truck, trailer, or similar motor vehicle sales, service display, rental or storage;

C. Bed and breakfast;

D. Bakery;

E. Bank;
F. Business, technical or trade school;
G. Bus station or taxicab stand;
H. Car wash;
I. Condominiums;
J. Government structure or use of land;
K. Hotel or motel;
L. Laundry or drycleaning establishment;
M. Mortuary;
N. Newspaper, printing or lithographing establishment;
O. Offices (business and professional);
P. Broadcasting studio;
Q. Retail stores and services establishments;
R. Tavern, cocktail lounge;
S. Telephone or telegraph exchange;
T. Theater;
U. Upholstery shop;
V. On-site hazardous waste facilities shall be permitted as an accessory use to any legal land use listed in this section. Off-site hazardous waste facilities are expressly prohibited. (Ord. 839 §2, 1989; Ord. 757 §1(part), 1985: Ord. 754 §5(part), 1984: Ord. 551 §23.110, 1976: Ord. 531 §1(part), 1973).

18.28.030 Uses requiring conditional use permits. In a general commercial district, the following uses and their accessory uses are permitted when authorized in accordance with Chapter 18.64:

A. Automobile or other motor vehicle repair, not including a body shop;
B. Day care center;
C. Cabinet or glass shop;
D. Commercial amusement enterprise;
E. Electric, plumbing or heating shop;
F. Fuel sales;
G. Gasoline service station;
H. Lumber and basic construction material sales and storage;
I. Parking facilities, including structures and lots;
J. Sign painting shop;
K. Veterinarian, animal hospital;
L. Welding, sheetmetal or machine shop;
M. Public parks;
N. Manufacturing, assembling, fabricating, processing, packing, repairing or storage of goods which have not been declared a nuisance by statute, resolution, or any court of competent jurisdiction, and provided these uses shall not cause:

1. Unreasonable dissemination of dust, smoke, visible gases or noxious gases, fumes, noise, vibration, or odor beyond the boundaries of the site on which the use is conducted,

2. Hazard to fire, explosion, or other physical damage to adjacent structures or vegetation.

O. Wireless telecommunications facilities (WTF), in accordance with the requirements of Chapter 18.74 LMC. (Ord. 1205 §2(part), 2003: Ord. 757 §1 (part), 1985: Ord. 754 §5(part), 1984: Ord. 551 to 23.120, 1976: Ord. 531 §1(part), 1973).

18.28.040 Yard requirements. A. Front Yard. The front yard shall be a minimum of twenty-five feet for those parcels of real property in the general commercial district which have a direct frontage on or along State Highway 2 in the city, or which are located across the street from any residential or recreational zoning district.

B. Side Yard. The side yard shall be a minimum of ten feet when the side yard of a parcel of real property in the general commercial district abuts, touches or adjoins any residential or recreational zoning district.

C. Rear Yard. The rear yard shall be a minimum of fifteen feet when the rear yard of a parcel of real property in the general commercial district abuts, touches or adjoins any residential or recreational zoning district. (Ord. 1086 § 1, 1998: Ord. 767 §1, 1985: Ord. 757 §1(part), 1985: Ord. 754 §5(part), 1984: Ord. 720 §4(part), 1982; Ord. 551 §24.130, 1976: Ord. §531 §1(part), 1973).

18.28.050 Building height. In a general commercial district, buildings shall not exceed a height of thirty-five feet. (Ord. 757 §1(part), 1985: Ord. 754 §5(part), 1984: Ord. 551 §24.140, 1976: Ord. 531 §1(part), 1973).

18.28.060 Lot coverage. In a general commercial district, buildings shall not occupy more than seventy-five percent of the lot area. (Ord. 757 §1(part), 1985: Ord. 754 §5(part), 1984: Ord. 551 §24.150, 1976: Ord. 531 §1(part), 1973).

Chapter 18.32

CENTRAL COMMERCIAL DISTRICT

Sections:

18.32.010 Purpose.
18.32.020 Permitted uses.
18.32.030 Uses requiring conditional use permits.
18.32.040 Yard requirements.
18.32.050 Building height.

18.32.010 Purpose. The central commercial district is intended to provide an appropriately located area of concentrated retail stores, offices, and service establishments of limited nature serving the residents of the city and the surrounding area. Recognizing the established character and attractive scale of the central part of the Leavenworth business area, it is the further purpose of this district regulation to protect and enhance this area for the benefit of the city, businesses, property owner, and the general public. (Ord. 754 §6(part), 1984: Ord. 551 §24.100, 1976: Ord. 531 §1(part), 1973).

18.32.020 Permitted uses. In a central commercial district the following uses and their accessory uses are permitted outright:

A. Offices and studios (business and professional);
B. Bed and breakfasts;
C. Apartments;
D. Condominiums;
E. Retail stores and service establishments;
F. Incidental and accessory structures and uses on the same site with, and necessary for, the operation of a permitted use;
G. Bank;
H. Hotels and motels;
I. On-site hazardous waste facilities shall be permitted as an accessory use to any legal land use listed in this section. Off-site hazardous waste facilities are expressly prohibited. (Ord. 839 §3, 1989; Ord. 780 §1, 1986; Ord. 754 §6(part), 1984: Ord. 604 §1(part), 1978: Ord. 551 §24.110, 1976: Ord. 531 §1(part), 1973).

18.32.030 Uses requiring conditional use permits. In the central commercial district, the following uses and accessory uses are permitted when authorized in accordance with Chapter 18.64:

1. Professional and trade schools and colleges;
2. Clinics;
3. Day care center;
4. Incidental and accessory structures and uses located at the same site with and necessary for the operation of a conditional use;
5. Mini-day care center;
6. Parking facilities, including structures and lots;
7. Private clubs and lodges;
8. Public and private libraries, art galleries, and museums;
9. Public and private philanthropic and charitable institutions;
10. Public buildings and grounds when found by the city planning commission to be necessary for the public health, welfare or safety;

11. Public parks;

12. Public utility and public service structures or installations when found by the city planning commission to be necessary for the public health;

13. Theaters and auditoriums;

14. Manufacturing, assembling, fabricating, processing, packing, repairing or storage of goods which have not been declared a nuisance by statute, resolution, or any court of competent jurisdiction, and provided these uses shall not cause:

a. Unreasonable dissemination of dust, smoke, visible gases or noxious gases, fumes, noise, vibration, or odor beyond the boundaries of the site on which the use is conducted,

b. Hazard of fire, explosion, or other physical damage to adjacent structures or vegetation;

15. Hospital;

16. Family entertainment centers, subject to the following minimum conditions:

a. No smoking shall be allowed on the premises,

b. No alcoholic beverage shall be sold or consumed on the premises nor allowed in the possession of anyone on the premises,

c. No possession or use or sale of illegal drugs shall occur on the premises,

d. No congregating of persons shall be allowed to occur in the vicinity of the entrance to the family entertainment center which results in disturbance to adjacent businesses or pedestrians,

e. A family entertainment center shall be no larger than two thousand five hundred square feet of total floor area.

17. Wireless telecommunications facilities (WTF), in accordance with the requirements of Chapter 18.74 LMC. (Ord. 1205 §2(part), 2003: Ord. 993 §2, 1995: Ord. 754 §6(part), 1984: Ord. 604 §1(part), 1978: Ord. 551 §24.120, 1976: Ord. 531 §1(part), 1973).

18.32.040 Yard requirements. A. Front Yard. The front yard shall be a minimum of twenty-five feet for those parcels of real property in the central commercial district which have a direct frontage on or along State Highway 2 in the city, or which are located across the street from any residential or recreational zoning district.

B. Side Yard. The side yard shall be a minimum of ten feet when the side yard of a parcel of real property in the central commercial district abuts, touches or adjoins any residential or recreational zoning district.

C. Rear Yard. The rear yard shall be a minimum of fifteen feet when the rear yard of a parcel of real property in the central commercial district abuts, touches or adjoins any residential or recreational zoning district. (Ord. 1086 §2 1998: Ord. 767 §2, 1985: Ord. 754 §6(part), 1984: Ord. 720 §4(part), 1983; Ord. 551 §24.130, 1976: Ord. 531 §1(part), 1973).

18.32.050 Building height. In a central commercial district, no building shall exceed a height of fifty feet. (Ord. 754 §6(part), 1984: Ord. 551 §24.140, 1976: Ord. 531 §1(part), 1973).

Chapter 18.40

PLANNED DEVELOPMENT DISTRICT

Sections:

18.40.010 Uses conditional upon approval.
18.40.020 General public benefit requirement.
18.40.030 Perimeter transition requirements.
18.40.040 Facility, utility and area size requirement.
18.40.050 Residential project requirements--Perimeter requirements.
18.40.060 Residential project requirements--Connection to through street required when.
18.40.070 Residential project requirements--Minimum requirements.
18.40.080 Residential project requirements--Additional requirements.
18.40.090 Multiple-use project requirements.
18.40.100 Approval--Conditions.

18.40.010 Uses conditional upon approval. In a planned development district, no primary or accessory use is permitted outright. All uses in a planned development district are conditional upon approval of the Leavenworth hearing examiner, in accordance with the provisions of this chapter, which provisions shall constitute the basis for and become the zoning requirements of the particular planned development district. (Ord 1203 §19, 2003: Ord. 551 §28.100, 1976: Ord. 531 §1(part), 1973).

18.40.020 General pubiic benefit requirement. All planned development projects shall demonstrate that there is a general public benefit to be gained by deviation from

the existing zoning classification and its regulations to those of a planned development district. These deviations may include, but are not limited to:

A. Increased population density;

B. Variations from normal street development patterns, pedestrian walks, traffic circulation facilities, and other public facilities;

C. The creation of multiple-use projects including residential, commercial, or recreational facilities. (Ord. 551 §28.110(10), 1976: Ord. 531 §1(part), 1973).

18.40.030 Perimeter transition requirements. All planned development projects shall bear the burden of perimeter transition with surrounding land uses and may be required to provide for:

A. Additional or improved relationship of open spaces;

B. Additional public facilities, such as pedestrian walks, traffic circulation facilities and/or public access to lakes and streams;

C. Preservation of natural assets, such as historic land, parks, streams, or views;

D. General public benefit features which contribute to improving the total environment of the neighborhood of the proposed development. (Ord. 551 §28.110(15), 1976: Ord. 531 §1(part), 1973).

18.40.040 Facility, utility and area size requirement. A. Planned development projects shall be complete developments and may be required to include facilities such as paved streets, curbs, sidewalks, street lights, drainage, sanitary sewers, underground power and telephone lines, landscaping and off-street parking, subject to the requirements of the planning commission.

B. Planned development districts may be established on parcels of land suitable to such development and shall contain a minimum of two acres. (Ord. 551 §28.110(20), (25), 1976: Ord. 531 §1(part), 1973).

18.40.050 Residential project requirements--Perimeter requirements. Land area and buildings around the perimeter of the projects shall be in harmony with but not necessarily

identical to the development of adjoining properties. Each application shall be considered on its individual merit and must be found to be in conformity with the general intent and criteria of this chapter. (Ord. 551 §28.110(30)(1), 1976: Ord. 531 §1(part), 1973).

18.40.060 Residential project requirements--Connection to through street required when. Projects of five acres or more which funnel traffic to a principal access point shall connect at that point to a through, major residential, or higher traffic capacity street. (Ord. 551 §28.110(30)(2), 1976: Ord. 531 §1(part), 1973).

18.40.070 Residential project requirements--Minimum requirements. A. Maximum Density. A maximum density averaging one dwelling unit per two thousand square feet of site area may be permitted.

B. Minimum Setback Distances and Height Requirements. The planning commission may specify more restrictive or less restrictive setback and height requirements.

C. Maximum Land Coverage. Maximum land coverage shall be fifty percent for all buildings.

D. Parking. One and one-half parking spaces shall be provided for each dwelling unit, with all such spaces to be located to the rear of the front yard setback line. Parking shall be provided within fifty feet of the dwelling it is intended to serve.

E. Distance Between Buildings. There shall be a minimum distance of twenty feet between all multiple residential buildings.

F. Recreational Sites. There shall be designated as space for recreational purposes one or more sites within the development having a total area equal to not less than three hundred square feet for each dwelling unit.

G. Public Streets. All public streets within or adjacent to a planned development are to meet all applicable state, county, or city standards in force at the time of application. (Ord. 551 §28.110(30)(3)(a--g), 1976: Ord. 531 §1(part), 1973).

18.40.080 Residential project requirements--Additional requirements. The planning commission may use a degree of flexibility and diversification in imposing additional requirements so that the development will be in harmony with the surrounding area. In approving a planned development the planning commission may impose, in addition to the regulations and standards expressly specified by this chapter, other conditions found necessary to protect the best interest of the surrounding property, the neighborhood, or the community as a whole. These conditions may include the following:

A. Preservation of light, air, and view;

B. Elimination of undue congestion;

C. Designation of sites for recreation facilities;

D. Improvement of internal traffic circulation;

E. Requirement of suitable landscaping and/or fencing, both internally and around the perimeter of the development;

F. Improvement of public utilities;

G. Specification of a specific time limit for construction; and

H. Submission to the city, by the applicant, of an adequate performance bond in order to assure development as specified in the approval of the planned development. (Ord. 551 §28.110(30)(3)(h), 1976: Ord. 531 §1(part), 1973).

18.40.090 Multiple-use project requirements. Any planned development project containing combinations of residential, commercial, or recreational uses, may be known as a multiple-use project, and shall bear the following relationships to the zoning districts in which they are proposed:

A. In any district, the principal use or uses proposed in a multiple-use project shall be in harmony with such district.

B. In the residential districts, which abut other residential districts, multiple-use projects which include residential use should:

1. Limit land area of nonresidential uses to four percent of the gross area of the development;

2. Limit nonresidential use to those business facilities which, in size and service, can be related principally to the project; e.g., grocery, drug, and specialty shops, or professional offices. Such uses should be in ground floor locations and in buildings comparable in size, character, and architectural style with the project buildings;

3. Multi-family units shall be in character and of similar architectural style to the single-family buildings of the project;

4. Nonresidential uses permitted as a part of a planned development project in a low density residentail area shall not be designed to dominate surrounding residential uses by incorporating oversized advertising signs, intense lighting, increased building height, or other devices which focus attention on location.

C. In residential districts located in transitional areas immediately abutting and adjoining nonresidentially zoned property, multiple-use projects which include residential use should:

1. Orient nonresidential uses and their automobile circulation and parking towards the adjoining nonresidential district.;

2. Limit commercial nonresidential uses to ground floor locations;

3. Provide residential uses on all perimeters adjoining resdential districts.

D. A proposed multiple-use project in a residentially zoned area shall complete construction of fifty percent of the dwelling units or floor area of the residential part of the project prior to the issuance of building permits for any nonresidential construction. (Ord. 551 §28.110(35), 1976: Ord. 531 §1(part), 1973).

18.40.100 Approval--Conditions. The granting of approval of a planned development district constitutes an amendment to the zoning map, and must comply with the provisions set forth in the Leavenworth Comprehensive Plan and Leavenworth zoning ordinance. (Ord. 1203 §20, 2003: Ord. 551 §28.120(10), 1976: Ord. 531 §1 (part), 1973).

Chapter 18.44

TOURIST COMMERCIAL DISTRICT

Sections:

18.44.010 Purpose.
18.44.020 Permitted uses.
18.44.030 Uses requiring conditional use permits.
18.44.040 Yard requirements.
18.44.050 Building height.
18.44.060 Lot coverage.

18.44.010 Purpose. The tourist commercial district classification is intended to be applied to areas suitable and desirable for motels, restaurants, service stations and similar uses to accommodate auto-oriented patrons. (Ord. 754 1 §4(part), 1984: Ord. 551 §22.100, 1976: Ord. 531 §1(part), 1973).

18.44.020 Permitted uses. In the tourist commercial district the following uses are permitted outright:

A. Motel, hotel;
B. Bed and breakfasts;
C. Condominium;
D. Apartments;
E. Governmental offices;
F. Restaurant, drive-in restaurant;

G. Cocktail lounge, tavern;

H. Barbershop or beauty shop;

I. Drugstore;

J. Retail food store;

K. Self-service laundry;

L. Professional office;

M. Banks;

N. Retail sale, rental or repair of nonmotorized recreational equipment;

O. Retail sales and services complementary and incidental to uses listed in subsections A through N of this section;

P. On-site hazardous waste facilities shall be permitted as an accessory use to any legal land use listed in this section. Off-site hazardous waste facilities are expressly prohibited.

Q. Coffee roasting operations, subject to the following minimum conditions:

1. The coffee roasting operation shall be in combination with a restaurant, drive-in restaurant or retail food store.

2. An effective afterburner shall be used.

3. An air quality permit shall be obtained from the Washington State Department of Ecology, and a copy of the permit shall be given to the department of community development for the file.

4. An inspection report shall be obtained from Chelan County Fire District No. 3 stating that fire code inspection is complete and satisfactory, and shall be given to the department of community development for the file.

5. The building size shall be no larger than three thousand five hundred square feet.

6. No more than twenty percent of the floor area of the building shall be used for coffee roasting, assembling and packing. The twenty percent shall include fire code setbacks.

7. Only one production roaster shall be allowed.

8. Any application that does not meet conditions 5, 6 and 7 of this subsection, shall be required to obtain a conditional use permit. (Ord. 1053 §1, 1997: Ord. 877 §1, 1991: Ord. 839 §4, 1989; Ord. 807 §7, 1987: Ord. 754 §4(part), 1984: Ord. 551 §22.110, 1976: Ord. 531 §1(part), 1973).

<u>18.44.030 Uses requiring conditional use permits</u>. In a tourist commercial district, the following uses and their accessory uses are permitted when authorized in accordance with Chapter 18.52:

A. Day care center;

B. Gasoline service stations;

C. Public parks, including swimming pools;

D. Commercial amusement enterprise;

E. Recreational vehicle parks.

F. Coffee roasting, when the operation cannot meet conditions 5, 6 and 7 of Section 18.44.020(Q), subject to the following minimum conditions:

1. The coffee roasting operation shall be in combination with a restaurant, drive-in restaurant, or retail food store.

2. An effective afterburner shall be used.

3. An air quality permit shall be obtained from the Washington State Department of Ecology, and a copy of

the permit shall be given to the department of community development for the file.

4. An inspection report shall be obtained from Chelan County Fire District No. 3 stating that fire code inspection is complete and satisfactory, and shall be given to the department of community development for the file.

G. Wireless telecommunications facilities (WTF), in accordance with the requirements of Chapter 18.74 LMC. (Ord. 1205 §2(part), 2003: Ord. 1053 §2, 1997: Ord. 840 §2, 1989; Ord. 754 §4(part), 1984: Ord. 644 §1, 1979: Ord. 551 §22.120, 1976: Ord. 531 §1(part), 1973).

18.44.040 Yard requirements. A. Front Yard. There shall be a front yard of not less than twenty-five feet.

B. Side Yard. There shall be a side yard of not less than ten feet.

C. Rear Yard. There shall be a rear yard of not less than ten feet, except that yard area shall be increased to twenty feet when abutting, touching or adjoining any residential or recreational zoning district. (Ord. 1086 §3, 1998: Ord. 754 §4(part), 1984: Ord. 720 §4(part), 1983; Ord. 551 §22.130, 1976: Ord. 531 §1(part), 1973).

18.44.050 Building height. In a tourist commercial district, buildings shall not exceed a height of thirty-five feet. (Ord. 754 §4(part), 1984: Ord. 551 §22.140, 1976: Ord. 531 §1(part), 1973).

18.44.060 Lot coverage. In a tourist commercial district, buildings shall not occupy more than fifty percent of the lot area. (Ord. 754 §4(part), 1984: Ord. 551 §22.150, 1976: Ord. 531 §1(part), 1973).

Chapter 18.45

LIGHT INDUSTRIAL DISTRICT (LI)

Sections:

18.45.010 Purpose.
18.45.020 Permitted uses--Prohibited uses.
18.45.030 Uses requiring a conditional use permit.
18.45.040 Lot size.
18.45.050 Building height.
18.45.060 Yard requirements--Specifications.
18.45.070 Enclosure requirements.
18.45.080 Screening requirements.
18.45.090 Not subject to a variance.

18.45.010 Purpose. The purpose of the light industrial district is to promote the development of clean, light manufacturing of goods and wares. In addition, the

light industrial district can accommodate storage type facilities. (Ord. 1079 §2(Exh. A (part)), 1998).

18.45.020 Permitted uses--Prohibited uses. A. In the light industrial district, the following uses shall be permitted outright, provided they have not been declared a nuisance by statute, resolution, or any court of competent jurisdiction, and provided these uses shall not cause: (1) unreasonable dissemination of dust, smoke, visible gases or noxious gases, fumes, noise, vibration, or odor beyond the boundaries of the site on which the use is conducted, or (2) hazard of fire, explosion, or other physical damage to adjacent structures or vegetation.

1. Light manufacturing, assembly, processing, packaging, treatment or fabrication of wood, glass, metal, food, furniture, fixtures, computers, scientific materials, lumber, clothing, or textile goods, products and machinery;

2. Warehousing establishments;

3. Wholesale trade establishments, and storage of durable and nondurable goods including automobile parts and supplies, tires and tubes; furniture and home furnishing, lumber, manufactured homes, recreational vehicles, boats and campers and construction materials;

4. Public utility and municipal uses such as substations, fire stations and maintenance shops;

5. Mini-storage or self-storage establishments;

6. Contractor's yards;

7. Professional, private and public office buildings;

8. Processing and packaging of food, drugs, pharmaceuticals, perfumes and cosmetics;

9. Truck and freight terminals, warehousing and storage, parcel delivery service, packaging and crating;

10. Vehicle, tractor, truck, boat, manufactured home and implement sales, repair, maintenance and rental, including paint and body work;

11. Communications facilities including telephone exchanges and radio and television broadcasting stations;

12. Public/private facilities such as law enforcement and fire stations, corporate headquarters, regional headquarters and administrative offices of commercial, industrial, financial, governmental and charitable organizations, public animal control facilities, and other similar noncommercial uses;

13. High tech industry, computer assembly and similar type uses.

B. The following uses are not allowed within the light industrial district:

1. Junk/wrecking yards;

2. Feed lots, rendering or meat packing plants; and

3. Landfills. (Ord. 1079 §2(Exh. A (part)), 1998).

18.45.030 Uses requiring a conditional use permit. In the light industrial district, the following uses and their accessory uses are permitted when authorized in accordance with Chapter 18.52:

A. Heliports;

B. Gas stations and bulk fuel storage;

C. Scientific and agricultural research, testing and experimental development laboratories;

D. Agricultural uses such as sorting, packing, storage, processing, refrigeration and shipping of agricultural products, feed stores, nursery/greenhouses or other similar uses;

E. Recycling centers for the collection and temporary storage of materials.

F. Wireless telecommunications facilities (WTF), in accordance with the requirements of Chapter 18.74 LMC. (Ord. 1205 §2(part), 2003; Ord. 1079 §2(Exh. A (part)), 1998).

18.45.040 Lot size. There shall be no minimum lot size. However, a division of land must comply with RCW Chapter 58.17 and Title 17 of the Leavenworth Municipal Code. (Ord. 1079 §2(Exh. A (part)), 1998).

18.45.050 Building height. In a light industrial district, the maximum building height shall be fifty feet. (Ord. 1079 §2(Exh. A (part)), 1998).

18.45.060 Yard requirements--Specifications. A. Front Yard. There shall be a front yard of not less than twenty-five feet. For corner lots or through lots there shall be more than one front yard.

B. Side Yard. There shall be a side yard of not less than five feet.

C. Rear Yard. There shall be a rear yard of not less than ten feet.

D. When any side or rear yard is abutting, touching, or if located across a street or alley from any residential or recreational zone, the yard area shall be increased to twenty feet.

E. The provisions of Section 18.24.010 shall also apply to any buildings, structures, storage, screening and/or fencing which occurs in this district. (Ord. 1079 §2(Exh. A (part)), 1998).

18.45.070 Enclosure requirements. When any portion of a light industrial activity is located within three hundred feet of any residential zone, the light industrial use shall be completely enclosed by a building. Exceptions to the enclosure requirement shall include:

A. Off-street parking for patrons and employees of the light industrial use;

B. Off-street loading, provided no off-street loading shall occur from nine p.m. to seven a.m.;

C. Storage of materials necessary to the activity. (Ord. 1079 §2(Exh. A (part)), 1998).

18.45.080 Screening requirements. All light industrial uses shall meet the following screening requirements when abutting, touching, or if located across a street or alley from any residential, commercial or recreational zone:

A. There shall be installed and maintained in good condition a solid six foot fence on those property lines which actually abut, touch or are located across a street or alley;

B. In lieu of a fence, a view obscuring six foot tall evergreen hedge, that is as effective as a solid fence, may be used;

C. No material shall be stacked so as to be visible above the fence;

D. All material and equipment associated with the use shall be stored within the fenced area; and

E. Exterior lighting shall be designed and installed so as not to create glare upon any residential areas. (Ord. 1079 §2(Exh. A (part)), 1998).

18.45.090 Not subject to a variance. The following sections of this chapter shall not be authorized to be varied from the required standard:

A. Sections 18.45.070 and 18.45.080. (Ord. 1079 §2(Exh. A (part)), 1998).

Chapter 18.46

RECREATION DISTRICT

Sections:

18.46.010 Purpose.
18.46.020 Permitted uses.
18.46.030 Uses requiring a conditional use permit.
18.46.040 Parking/loading requirements.
18.46.050 Yard requirements.
18.46.060 Building height.
18.46.070 Lot coverage.

18.46.010 Purpose. The recreation district is to promote both passive and active recreation. This district is suitable for such uses as wildlife refuge and sanctuaries, municipal parks, ball fields, playgrounds, and golf

courses. This designation is not applicable to commercial amusement parks and other such activities. This designation may also be appropriate for institutions that utilize play fields and/or open space as part of their normal day to day operation or landscaping. (Ord. 1005 §2(part), 1996).

18.46.020 Permitted uses. In the recreation district, the following uses are permitted outright:

A. Public parks.

B. Public or private traditional nine or eighteen hole golf courses.

C. Public or private educational institutions or educational centers for advanced study and research in an academic field of learning provided:

1. There is a designated public open space that can be utilized by the general public during normal nonoperating hours.

2. The designated public open space must equal or exceed the total gross floor area of all structures and parking areas for the institution.

D. Public museums, art galleries, community center, or governmental buildings provided:

1. There is a designated public open space that can be utilized by the general public during normal nonoperating hours.

2. The designated public open space must equal or exceed the total gross floor area of all structures and parking areas for the institution.

E. Churches, convents or monasteries, provided:

1. There is a designated public open space that can be utilized by the general public during normal nonoperating hours.

2. The designated public open space must equal or exceed the total gross floor area of all structures and parking areas for the institution. (Ord. 1005 §2(part), 1996).

18.46.030 Uses requiring a conditional use permit.

A. Public utility structures.

B. Hospital.

C. Subdivision for single family residential homes provided:

1. There is dedicated the equal amount of land for public park or open space.

2. The area to be dedicated as park or open space must be equal to the total area that is being developed (including supporting infrastructure).

3. The subdivision must comply with Title 17 and Chapters 18.20 and 18.24 of this code.

D. Recreational vehicle parks pursuant to Section 18.51.040.

E. Recreational campgrounds.

F. Wireless telecommunications facilities (WTF), in accordance with the requirements of Chapter 18.74. **(Ord. 1205 §2(part), 2003;** Ord. 1005 §2(part), 1996).

18.46.040 Parking/loading requirements. All permitted uses and conditional uses must comply with Chapter 14.12 LMC. (Ord. 1166 §3(part), 2001; Ord. 1005 §2(part), 1996).

18.46.050 Yard requirements. A. Front Yard. There shall be a front yard of not less than twenty-five feet.

B. Side Yard. There shall be a side yard of not less than five feet.

C. Rear Yard. There shall be a rear yard of not less than twenty feet. (Ord. 1005 §2(part), 1996).

18.46.060 Building height. In a recreation district, the building height shall not exceed a height of thirty-five feet. (Ord. 1005 §2(part), 1996).

18.46.070 Lot coverage. In a recreation district, building/structures shall not occupy more than thirty-five percent of the buildable lot area. (Ord. 1005 §2(part), 1996).