City of Eagle Lake
Comprehensive Infrastructure Planning Study
March 2006

Section 4 – Wastewater Plan

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1.0 Purpose of the Wastewater Plan

The purpose of this Wastewater Plan is to provide guidance to the City of Eagle Lake, as well as existing and future landowners, in preparing for future growth and development. This report summarizes the findings of the wastewater system analysis portion of the Comprehensive Infrastructure Planning Study. The objectives of the Sanitary Sewer Plan are as follows:

- Make a preliminary determination of the trunk sewer and lift station improvements that will be required for a 20-year planning period.
- Identify corridors and preliminary sizing for trunk sanitary sewers that will serve the ultimate development of the study area.
- Determine the approximate locations and approximate required capacities of lift stations that would be required to serve the growth areas.

2.0 Existing Wastewater System

The City's existing wastewater collection system consists of pipes ranging in size from 8-inch to 18-inch and three lift stations. The Main Lift Station (L.S. #1), located in the City Park off Linda Drive, pumps all of the City's wastewater to the City of Mankato through a 14-inch forcemain. Mankato treats sewage from Eagle Lake at its regional wastewater treatment plant and discharges it to the Minnesota River. The Industrial Park Lift Station (L.S. #2), located north of LeRay Avenue, collects wastewater from the City's current industrial park and areas north of LeRay Avenue and pumps it to gravity sewer in LeRay Avenue which eventually flows to L.S. #1 through the 15-inch park interceptor sewer. The Eagle Ridge Lift Station (L.S. #3) collects wastewater from the Eagle Ridge subdivision and pumps it directly to L.S. #1. There is also a small lift station (L.S. #4) servicing the mobile home park in the southeast portion of the City. Figure 2.1 shows the City's existing sanitary sewer system.

2.1 Existing Wastewater Districts

In order to evaluate the City's sanitary sewer system, it is necessary to divide the City up into wastewater districts. The wastewater districts were used to model the existing system and to plan for future growth. Figure 2.2 shows the City's wastewater system and the districts that were established. Figure No. 2.3 shows the existing lift station service areas and forcemain sizes. Following is a description of each district:

Northwest Commercial

This area is approximately 60-acres and serves the existing commercial enterprises west of CSAH 56 north of CSAH 17, residential customers west of Cate St. and north of DM&E railroad, and any future customers along Le Ray Ave between US 14 and DM&E Rail road right of way. The ultimate outlet for this district is a 10-inch pipe in LeRay Avenue which drains into the Park Interceptor District.

Industrial Park

This area is approximately 49-acres and serves the northern part of Eagle Lake from the DM&E Railroad right-of-way to US 14, including the industrial park on the east end of town. Also included in this area is Linda Drive from Le Sueur Avenue to CSAH 17. Excluded from this area is Second Street from Le Ray Avenue south. This district drains to L.S. #2, which pumps into a 15-inch pipe in LeRay Avenue, which drains into the Park Interceptor District.

Creek Side

This area is approximately 52-acres and is bounded by 598th Avenue to the west, CSAH 17 to the north, Matthew Court (including lots along the east side) to the east, and Le Sueur Avenue (including lots along the south side) to the south. The ultimate outlet for this district is a 12-inch pipe in LeSueur Avenue, which drains into the Park Interceptor District.

Oldtown

This area is approximately 162-acres and includes the original plat of Eagle Lake and its oldest development areas. This service area is bounded by Thomas and Linda Drive on the west, Connie Lane (including lots along the south side) to the south, Agency Street to the west, and CSAH 17 to the North. Also included in this area are Quail Court and Second Street north of CSAH 17. The ultimate outlet for this area is a 15-inch pipe, shared by the Greenfield District, draining directly into L.S. #1.

Eagle Ridge

This service area is approximately 15-acres and includes all lots in the Eagle Ridge subdivision. The district drains to a 12-inch pipe draining into L.S. #3, which pumps directly to L.S. #1.

Timber Ridge

This area is approximately 9-acres and includes all lots along Timber Ridge Trail. The outlet for this district is a 10-inch pipe draining directly to L.S. #1.

Greenfield

This area is approximately 72-acres and is bounded by Thomas Drive on the west and Joan Lane (including north lots) to the north including all developed areas to the Eagle Lake city limits. This service area includes Country Manor Mobile Home Park, which is served by a small lift station, L.S. #4, pumping to gravity sewer at the intersection of Thomas Drive and Agency Street. This ultimate outlet for this district is a 15-inch pipe, shared by the Old-Town district, draining directly to L.S. #1.

Park Interceptor

This area is approximately 50-acres and includes lots along Linda Drive, north of Le Sueur Avenue; and lots along Le Ray Avenue between Cate Street and North 2nd Street. The district drains to the 15-inch interceptor sewer running through the main park and ultimately to L.S. #1.

3.0 Design Considerations for Wastewater Collection Systems

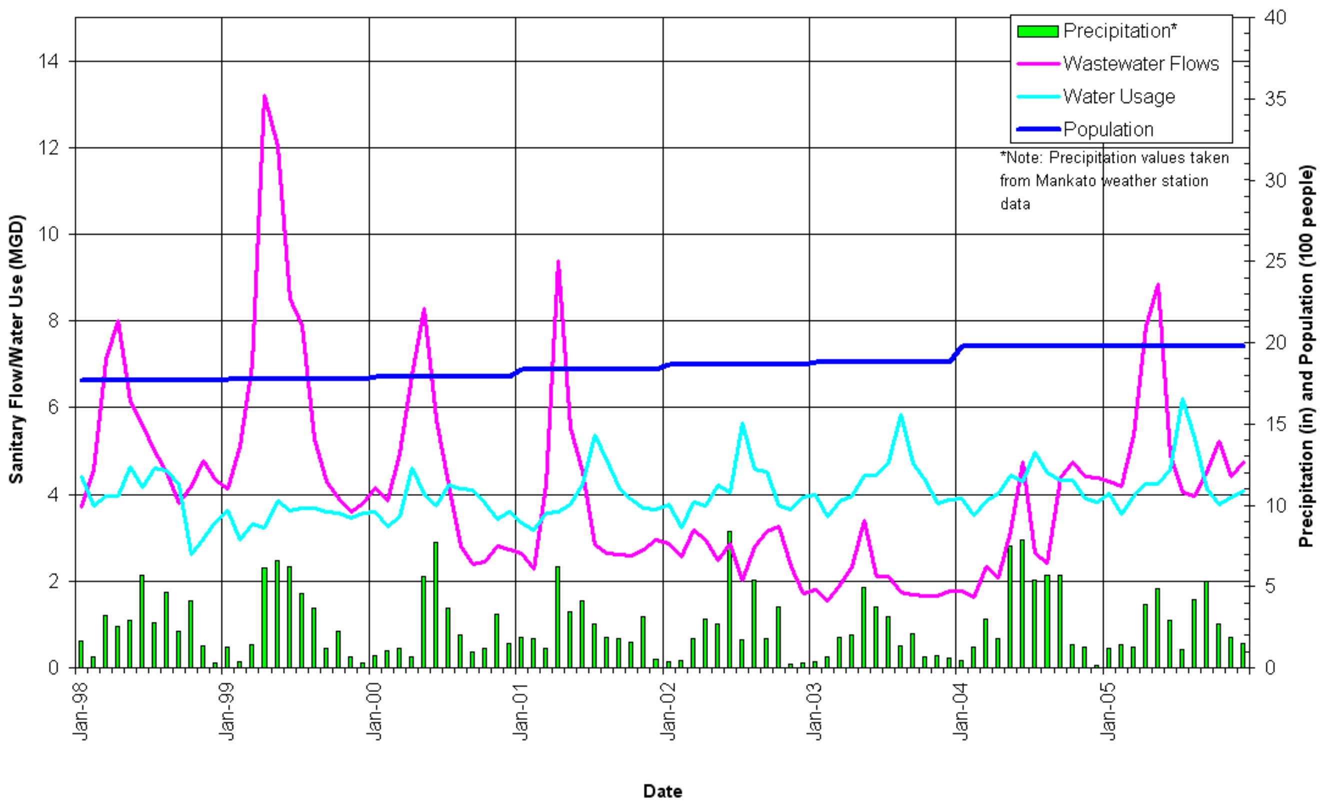
When evaluating or designing a wastewater collection system, there are several factors that need to be considered including:

- Average and Maximum Wastewater Flows including Residential, Commercial, and Industrial Flows.
- Depth and Gravity Flow Capacity of Sanitary Sewer Pipes
- Depth and Pumping Capacity of Lift Stations

3.1 Existing Wastewater Flows

Figure 3.1 shows the City's total wastewater flows on a monthly basis from 1998 to 2005, as compared to water use and precipitation data.

Figure 3.1 - Water Usage and Sanitary Sewer Flows
City of Eagle Lake



As the figure shows, water use is typically higher in the summer months and lower in the winter months. This is due to outdoor water use such as lawn watering. In the springtime and early summer, the wastewater flows spike dramatically due to groundwater infiltration and inflow.

It should be noted that there appears to be some discrepancy between the water usage data and the wastewater flow data from August 2000 to September 2004. Between these months the water usage is lower than the wastewater flow through the winter months. This is unexpected due to the fact that there is typically very little outdoor water use during the winter months and the majority of the water should be flowing into the sanitary sewer. A comparison of water sales and water pumpage indicates that the water use data is accurate. However, monthly wastewater flows appear to have dropped significantly from August 2000 to September 2004 without a corresponding significant drop in rainfall. Therefore, it appears that there may have been an issue with the wastewater metering during this time period. Given the wastewater flow data from 2005, it appears that the problem has been corrected. Table 3.1 shows the historical wastewater flows from 1998 to 2005.

Table 3.1 – Projected Wastewater Flows

Year	Population	Total Annual Wastewater Flow (gal)	Average Day Wastewater Flow (gal)	Max Day Wastewater Flow (gal)	Ratio Average to Maximum	Average Daily Wastewater Flow Per Capita
1998	1,808	61,656,900	168,923	761,000	4.5	93
1999	1,828	78,708,000	215,638	1,025,000	4.8	80
2000	1,787	51,209,000	140,299	381,000	2.7	80
2001	1,837	44,868,000	122,926	811,000	6.6	165
2002	1,866	32,150,000	88,082	175,000	2.0	47
2003	1,879	23,688,000	64,899	313,000	4.8	35
2004	1,974	38,713,000	106,063	957,000	9.0	54
2005	2,025	62,376,000	170,893	678,000	4.0	84

Note: Shaded values indicate data may be corrupted due to inaccurate wastewater metering.

As the table shows, from 1998 to 2005, the total per capita watewater flow has averaged 80 gpd. If the data from 2000 to 2004 is ignored, the average is 85 gpd. This is representative of a City whose water use mostly residential.

Table 3.2 – Housing Density Assumptions for Wastewater Flow Calculations

Zone	Description	Units Per Acre
R-1	Low density residential	2.5
R-2	Medium density residential	4.2
R-3	Limited high density residential	9.3
R-4	High density residential	12.7

Maximum day wastewater flow represents the peak flow during the wet months in the spring or summer when infiltration and inflow are high. As shown in Table 3.2, the ratio of average day use to maximum day use from 1998 to 2005 averaged 4.8. If the data from 2000-2004 is ignored, the average is 4.4.

3.2 Projected Wastewater Flows

In order to calculate future wastewater flows from undeveloped areas, assumptions need to be made regarding future per capita residential wastewater flows, commercial and industrial flows, housing density, and peaking factors.

Residential wastewater design flows are commonly determined on a basis of population density and average per capita wastewater generation. Table 3.2 details the assumptions made regarding future housing density to calculate residential wastewater flows.

Based on the data shown in Table 3.1, an average per capita daily wastewater flow of 85 gpd will be assumed for the wastewater flow projections.

Commercial and industrial wastewater flows vary considerably with the type and size of business or industry that is generating the wastewater. For the purpose of this report the assumptions show in Table 3.3 were used for estimating commercial and industrial wastewater flows.

Table 3.3 - Factors for Commercial & Industrial Wastewater Flow Calculations

Zone	Description	Gallons per Acre/per Day
C-1	Commercial	1500[1]
I-1	Light Industrial	1500[1]
I-2	Heavy Industrial	2500[2]

(1) Equivalent to 5.55 residential units per acre

(2) Equivalent to 9.26 residential units per acre

To avoid flooding, sanitary sewer pipes and lift stations must be sized to accommodate not only the average daily flow, but also the maximum daily flow. For the purpose of modeling the City's existing wastewater system, and determining the improvements necessary to accommodate the future growth areas, the peaking factors shown in Table 3.4 were used.

Table 3.4 - Peaking Factors Used for Wastewater Flows

System	Peaking Factor
Existing	5.0$^{(1)}$
Extended	3.0$^{(2)}$

(1) Based on data shown in Table 3.1
(2) Based on Recommended Standards for Wastewater Facilities[1]

Maximum day wastewater flow represents the peak flow during the wet months in the spring or summer when infiltration and inflow are high. As shown in Table 3.4, a value of 5.0 was used for the existing system. For the extended growth areas, a value of 3.0 was used. A lower value was used because the majority of inflow and infiltration is expected to occur within the older parts of the sanitary sewer system, where the pipe and manholes are not watertight, and where unauthorized discharges such as sump pumps or footing drains may still be connected to the sanitary sewer system. Newly constructed sewers are required to be watertight, and sump pump connections to the storm sewer are provided. Therefore, as the City grows, it is expected that the percentage of wastewater flow consisting of clear water from infiltration and inflow will drop. In addition, studies have shown that as a City grows in population, peak wastewater flows become muted. The 3.0 value used for the growth areas in this study is taken from the publication Recommended Standards for Wastewater Facilities[1], also known as Ten States Standards.

Using these assumptions, and the various land uses shown on the City's Land Use Plan, the projected wastewater flows for the 20-year growth area and the ultimate area were projected as shown in Table 3.5.

[1] [1] Recommended Standards for Wastewater Facilities, 2004 Edition, Great Lakes-Upper Mississippi River Bord of State and Provincial Public Health and Environmental Managers

Table 3.5 – Projected Wastewater Flows

Year	Population	Total Annual Wastewater Flow (gal)	Average Day Wastewater Flow (gal)	Max Day Wastewater Flow (gal)	Ratio Average to Maximum	Average Daily Wastewater Flow Per Capita
2015	2,551	79,145,000	216,835	650,505	3.0	85
2025	3,297	102,289,000	280,245	840,735	3.0	85
Ultimate	14,334	791,926,000	2,169,660	6,508,979	3.0	151

As the table shows, for 2015 and 2025, the assumed average daily wastewater flow per capita is 85 gpd. This is representative of a City whose water use mostly residential. As the City grows, if commercial and industrial development takes place according to the land use plan, the per capita wastewater flow will rise considerably due to the non-residential water use. For the Ultimate projection, a value of 151 gpd was used. This value represents a considerable amount of commercial and industrial wastewater flow and would be a conservative estimate. If future commercial and industrial businesses are low-water using businesses, this value may be lower.

3.3 Pipe Depth and Capacity

The driving energy of flow in a sanitary sewer pipe is gravity. Therefore, the pipes must be laid on a grade (or slope) to force flow. Slopes are expressed in percentage (%) and represent the number of feet of vertical elevation change in 100 feet of pipe. For example a grade of 1.00% is one foot of fall in 100 feet. The slope together with the diameter and a factor representing the smoothness of the pipe is used to calculate the actual flow that a full pipe can carry. Typically, this volume is expressed in cubic feet per second (cfs) or gallons per minute (gpm). This rate of flow is the actual capacity of the pipe. Table 3.6 details the design criteria that is used for sizing of trunk sanitary sewer pipes.

Table 3.6 - Minimum Requirements for Design

Requirement	**Minimum Value[(1)]**
Pipe Diameter	8 inches
Depth	12 feet
Full Flow Velocity/Slope	2.0 feet/second[(2)]
Manhole spacing	400 feet +/-
[(1)]Based on Recommended Standards for Wastewater Facilities	
[(2)]Minimum slope to provide required velocity: 8" – 0.40%, 10" – 0.28%, 12" – 0.22%, 15" – 0.17%, 18" – 0.12%	

The minimum pipe size of 8-inches is dictated by Ten States Standards and Minnesota Pollution Control Agency (MPCA) requirements and was historically dictated by cleaning and maintenance requirements. Larger pipe sizes may be necessary to accommodate larger flows. The minimum pipe depth of 12-feet has been determined as the minimum depth to serve a residential home with an 8-foot basement. In commercial and industrial areas, where buildings would not have a basement, the minimum depth could be reduced to 6-feet. The minimum velocity/slope is dictated by Ten States Standards and Minnesota Pollution Control Agency (MPCA) requirements. The minimum manhole spacing of 400-feet is dictated by Ten States Standards and is historically based on the maximum reach of cleaning equipment.

3.4 Lift Stations

Lift stations are used to pump the wastewater from a deeper sewer to a gravity sewer at a higher elevation. Lift stations are provided to serve areas where gravity sewer extensions would not be deep enough to provide service to the adjacent properties. The lift station discharge flows through a forcemain pipe that flows by pressure rather than by gravity. The peak hourly flow from the contributing area is used for sizing the lift station pumps and force main. For a City the size of Eagle Lake, a typical lift station would be a duplex or triplex (two or three pump), submersible pump lift station.

4.0 Evaluation of Existing Wastewater System

To determine the effect of development on the City's wastewater system, the existing wastewater collection system was modeled using Haestad Methods, Inc. SewerCAD software. The computer network model is used to analyze steady state flows for pipe collection systems. The information required for the model includes data such as diameter, length, slope, and Manning's N number (the pipe roughness factor) for each pipe in the system. Other data required includes ground and rim elevation of manholes, lift station structure sizes, pump sizes, elevations, foremain length and diameter, and wastewater flows. The computer network model was calibrated using the total flow data at L.S. #1 (main lift station).

The computer model calculated the design capacity and actual flow for each pipe in the system. It also calculated the hydraulic grade line for each pipe run which will indicated the depth of any flooding that is occurring. For lift stations, the peak flow rate is calculated and compared to the pump capacity with one, two, or three pumps running.

Figure 4.1 shows the capacity of the City's existing sanitary sewer collection pipes in terms of percentage of design capacity currently being used. As the Figure shows, nearly all of the pipes in the system are currently using less than 25% of their design capacity. Detailed output from the computer model is included in the Appendix.

As for the existing lift stations, the computer model results show that the all of the existing lift stations and forcemain pipes have excess design capacity to accommodate additional development. Table 4.1 shows the configurations of each major lift station, along with design capacity and the existing estimated peak flow to the lift station.

Table 4.1 – Existing Lift Station Configurations and Capacities

Lift Station	Wet Well Sump Elev (ft)	Alarm Elev (ft)	# of Pumps	Design Point		Discharge Forcemain Diameter (in)	Existing Estimated Peak Flow (gpm)	Estimated Percentage Capacity Currently Utilized (%)
				Discharge (gpm)	TDH (ft)			
L.S. #3 Eagle Ridge	949.00	956.80	2	430	62	6	23	5%
L.S. #2 Industrial Park	964.5	970.00	2	200	62	4	48	24%
L.S. #1 Main	956.00	967.50	3	1096	73	14	374	34%

5.0 Proposed Wastewater Collection System Improvements

The following is a summary of the preliminary design process that was utilized to develop the proposed trunk sanitary sewer and lift station improvements within the study area that will be necessary to accommodate growth.

- Based on the existing wastewater districts the expansion areas were divided into wastewater districts based on the existing trunk lines that would be serving those areas. The depth of existing sanitary sewers, topography and other manmade or natural boundaries, generally determined wastewater collection districts boundaries.
- Using the assumptions listed in Section 3.2, the estimated wastewater flow that would be generated within each wastewater district was determined.
- The pipe sizes, slopes, and approximate locations of interceptor sewers that would serve each wastewater collection district were determined.
- The approximate locations and required capacities of lift stations that would be required to serve growth areas were determined.

5.1 20-year Growth Area Improvements

Based on the predicted wastewater generation due to new development and the capacity of the existing collection system, no predictable deficiencies were found in the sanitary sewer system due to the increased flow from the projected 20-year growth areas discussed in Section 1 of this Infrastructure Plan.

Even though no upgrades are necessary to the existing sanitary sewer system for the expected 20-year growth areas, trunk sewer lines and a lift station will be required within the new developments to insure adequate capacity for future expansion. The proposed trunk line and lift station improvements are listed below and shown in Figure 5.1:

- 12-inch trunk sanitary sewer within Eagle Ridge No. 2 & 3
- 10-inch trunk sanitary sewer within the Coves of Eagle Lake
- 10-inch and 12-inch trunk sanitary sewer within Eagle Heights
- Lift Station within Eagle Heights

Note that the sanitary sewer layout shown in Figure 5.1 is schematic in nature. The actual location of the trunk sewer can be modified to follow platted streets within the proposed subdivisions. The remainder of the streets within the subdivisions should have 8-inch sanitary sewer.

This plan assumes that gravity trunk sewer should be constructed whenever feasible to minimize the number of lift stations that Eagle Lake will ultimately have to maintain. It would be possible to construct additional lift stations on the west side of town, which would connect to the existing 14-inch forcemain flowing to Mankato. However, this is no recommended as it will ultimately create high operation and maintenance cost for the City, and will create the need for multiple wastewater metering locations.

5.2 Ultimate Growth Area Improvements

For the Ultimate Growth Area, additional trunk sewers and lift stations will be needed to service the future growth areas. Figure No. 5.1 shows the size and approximate location of these trunk sewers and lift stations. Note that the locations of the trunk lines and lift stations is schematic in nature. In general, the trunk sewers follow low swales within the service areas and lift stations are located in the lowest spots within the service areas. The actual locations of the future trunk sewers and lift stations will need to be coordinated with the proposed subdivision layouts. However, it is important to note the discharge point for each lift station and trunk sewer. Relocating the discharge point of these trunk sewers from what is shown on Figure 5.1 may result in impacts to the existing system that are not identified in this plan.

Based on the estimated flows from the ultimate growth area, two improvements to the existing sanitary sewer system will be necessary at some point in the future, beyond the projected 20-year growth.

Thomas Drive Interceptor

In order to prevent the overloading of the Thomas Drive interceptor a new 15-inch interceptor along 211th Street will be required to handle the full discharge of the Eagle Heights lift station, L.S. #5, when that facility has reached maximum capacity. The 211th Street interceptor is also designed to accept the discharge of future Lift Station #7. This new interceptor will run from the Main lift station south along the eastern boundary of Eagle Ridge to 211th Street, then east to the intersection of 211th Street and Agency (CSAH 27). Building this sewer at minimum grade will ensure adequate depth for serving development along 211th Street.

Linda Drive/Park Interceptor Sewer

Based on the estimated flows, deficiency was found in the Linda Drive/Park Interceptor trunk sewer. Currently Linda Drive is combination of 10- and 12-inch pipe. These pipes will need to be upgraded to 15-inch pipe in order to accommodate the estimated expansion flow. Along with the upgrade to the Linda Drive portion of this line, the 15-inch pipe Park Interceptor currently serving the northern portion of the City will need to be upgraded to an 18-inch pipe.

Table 5.1 shows the maximum development that can occur within the contributing watershed for each interceptor sewer before improvements are necessary. The table includes the Thomas Drive and Linda Drive/Park Interceptors as well as the other major interceptors in the City. Figure 5.2 shows the location of these major interceptors.

Table 5.1 - Estimated Future Development Capacities for Current Interceptor System

Interceptor	Max Capacity (gpd)	Existing Flow (gpd)	Number of Future Residential Units[1]	Number of Future Developed Acres[2]
LeSueur Ave Interceptor	759,457	5,225	1163	457
Linda Dr/Park Interceptor	889,192	165,954	1116	439
Thomas Drive Interceptor	1,338,666	185,669	1779	700
Timber Ridge Interceptor	1,052,713	161,297	1375	541
Eagle Ridge I Interceptor	844,618	6,405	1293	509
Eagle Ridge II & II Interceptor	743,080	0	1974	777
[1] Assuming: peaking factor = 3, 85 gal/person/day, 2.5 persons/unit				
[2] Assuming: 2.5 units/acre, for Commercial & Industrial uses see Table 3.3 for equivalent residential unit loadings				

Figure 5.3 shows the percentage of design capacity utilized for the sanitary sewer pipes in the system assuming the proposed improvements discussed above are implemented to accommodate full development of the ultimate growth area.

Lift Station and Forcemain Upgrades

In Section 4.0, the existing configuration and capacities of the existing major lift stations was discussed. Based on the existing configuration of the lift stations and flows that currently are being served, a maximum developable area was determined for each lift station. The maximum amount of development that each lift station can accommodate at its current configuration, above and beyond what is currently being served, can been seen in Table 5.2.

Table 5.2 - Maximum Lift Station Capacities and Corresponding Development

Lift Station		Number of Future Residential Units[1]	Number of Future Developed Acres[2]
L.S. #1 - Main		4270	1708
L.S. #3 - Eagle Ridge		1565	626
L.S. #2 - Industrial Park[3]			
Forcemain Configuration	**1-4”**	798	319
	1-4” lag, 1-8” lead	2546	1018
	2-8”	3472	1389

[1] Assuming: peaking factor = 3, 80 gal/person/day, 2.7 persons/unit

[2] Assuming: 2.5 units/acre, for Commercial & Industrial uses see Table 3.3 for equivalent residential unit loadings

[3] Industrial park currently has 2 pumps discharging into a 4” force main. An 8” force main is installed and can be connected to pump #2. A third pump position is present and is designed to accommodate a pump discharging into an 8” force main.

In order to server the estimated flows for the ultimate growth area, upgrades the lift stations will be required when they reach capacity at their current configurations. To serve the ultimate growth area flow, the lift station’s pumps and force mains would require upgrades as shown in Table 5.3.

Table 5.3 – Required Upgrades for Lift Stations for Ultimate Growth Area

Lift Station	Pump[(1)]	Forcemain[(2)]
Main	X	X
Eagle Ridge	X	X
Industrial Park[(3)]		

(1) Pump upgrades include installation of larger pumps, or additional pumps of existing capacity
(2) Forcemain upgrades include replacement with larger diameter forcemain, or re-routing of the forcemain
(3) Does not require upgrade to pumps if existing pumps are moved to 8-inch positions

Figure 5.4 shows the extended lift station service areas under the ultimate growth scenario.

6.0 Cost Estimates for 20-year Improvements and Financing

According to the recommendations in this study, the following improvements to the City's wastewater system will be necessary within the next 20-years:

- 12-inch trunk sanitary sewer within Eagle Ridge No. 2 & 3
- 10-inch trunk sanitary sewer within the Coves of Eagle Lake
- 10-inch and 12-inch trunk sanitary sewer within Eagle Heights
- Lift Station within Eagle Heights

For the trunk sanitary sewer improvements, it is typical for cities to require that the developer pay for the minimum sewer size, and for the city to pay for the incremental cost of oversizing. As discussed in Section 3.3, the minimum sanitary sewer size for the City is 8-inch diameter. Therefore, the City would be responsible for the incremental increase in cost from an 8-inch sanitary sewer to the necessary trunk line size. Table 6.1 shows the City's share of the over sizing cost for the 20-yr development areas.

Table 6.1 – Trunk Sewer Over Sizing Cost					
Development Area	**Oversize Unit Cost 10-inch**	**Oversize Unit Cost 12-inch**	**10-inch Pipe (LF)**	**12-Inch Pipe (LF**	**Total Oversize Cost**
Eagle Ridge II & III	$5	$10	1,191	1,095	$16,905
Eagle Heights	$5	$10	7,545	0	$37,725
Coves of Eagle Lake	$5	$10	5,321	0	$26,605
Total					$81,235

Table 6.2 shows the City's share of lift station over-sizing costs for the 20-year development areas.

Table 6.2 – Lift Station Over Sizing Cost						
Development Area	**Lift Station Cost**	**Developable Area (ac)**	**Cost Per Acre**	**Area in development**	**City Share**	**Developers Share**
Eagle Heights	$80,000	567	$141	180	$54,620	$25,380

A common method of financing improvements that are necessary to accommodate development is to apply an area charge to developments as they are platted. In the case of the sanitary sewer system improvements, this charge would be referred to as a Sewer Area Charge (SAC). The SAC would consist of a charge per acre of developable property within a proposed subdivision.

Table 6.3 shows the total City cost for the 20-yr improvements.

Table 6.3 Estimated Cost, 20-yr Improvements	
Item	**Estimated Cost**
Trunk Sanitary Sewer Oversizing	$81,235
Eagle Heights Lift Station	$54,620
Total	**$135,855**

The estimated total expected developable area for the 20-yr growth period is 519-acres. If the City desired to recoup the entire cost of the 20-yr improvements through a SAC fee applied to the expected development, then the SAC fee would need to be set at a minimum of $262 per acre. To account for variations in the estimated sewer pipe length and the amount of developable acreage, and to build a fund balance as soon as possible, we recommend that the SAC fee be set at a minimum of $1,000 per developable acre.

APPENDIX

SewerCAD Output