Wastewater Collection System Master Plan

Prepared for:

City of Winston

SHN Consulting Engineers & Geologists, Inc.

275 Market Avenue
Coos Bay, OR 97420-2219
541/266-9890

March 2016

614005.141

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Reference: 614005.141

March 4, 2016

City Council
City of Winston
201 NW Douglas Blvd.
Winston, OR 97496

Subject: Final Wastewater Collection System Master Plan

Dear Council:

Enclosed please find three (3) copies of the final Wastewater Collection System Master Plan report. This Plan has incorporated all of the City's final comments. Once the plan is adopted, the City can begin its implementation.

Submittal of this plan fulfills SHN's contractual responsibilities to complete a Wastewater Collection System Master Plan. Therefore, the City can release the unpaid balances being held as retainage.

Should you have any questions or comments, feel free to give me a call at 541-266-9890.

Sincerely,

SHN Consulting Engineers & Geologists, Inc.

Steven K. Donovan, PE
Principal Engineer

SKD: dkl

Enclosures: Three (3) copies Final Wastewater Collection System Master Plan

Reference: 614005.141

Wastewater Collection System Master Plan

Final Draft

Prepared for:

City of Winston
201 NW Douglas Blvd.
Winston, OR 97469

REGISTERED PROFESSIONAL
ENGINEER
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OREGON
JULY 17, 1981
RONALD F. STILLMAKER

Expiration: 6/30/2016

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March 2016

QA/QC: SKD

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Table of Contents

Appendices

List of Illustrations

Figures **Page**

Tables **Page**

Acronyms and Abbreviations

AAF	annual average flow
ADWF	average dry weather flow
AWWF	average wet weather flow
BOD	biochemical oxygen demand
CAD	computer assisted drafting
City	City of Winston
DEQ	Oregon Department of Environmental Quality
DMR	daily monitoring report
EDU	equivalent dwelling unit
EPA	Environmental Protection Agency
FOG	Fats, Oils, and Grease Program
GO	general obligation bonds
GP	grinder pump
gpd	gallons per day
gpcd	gallons per capita per day
I/I	infiltration and inflow
mgd	million gallons per day
mg/L	milligrams per liter
MMDWF	maximum month dry weather flow
MMWWF	maximum month wet weather flow
O&M	operations and maintenance
PIF	peak instantaneous flow
PS	pump station
STEP	septic tank effluent pump
TSS	total suspended solids
UGB	urban growth boundary
WWTF	wastewater treatment facility

Executive Summary

Introduction

The City of Winston owns and operates the sanitary sewer collection system serving customers within the incorporated area of the City limits along with a few customers immediately outside the City limits. Wastewater collected within Winston is conveyed to a wastewater treatment plant, which is jointly owned by the City and by Green Sanitary District. The plant has recently been upgraded and is not included in this Master Plan. Other more specific plans have been prepared for the Wastewater Treatment Facility.

The current service population for the City of Winston wastewater collection system is 5,410 persons. The current estimated number of equivalent dwelling units (EDU) is 2,222 including 1,818 residential units and 416 non-residential units. The City of Winston has experienced rapid population growth since 1970. An average annual growth rate of 1.86% has been adopted by the Winston Comprehensive Land Use Plan. Over the next 20 years an additional 935 EDUs are planned. Sufficient buildable land exists within the planning area to accommodate this growth.

Faced with ongoing development in the form of new subdivisions and new businesses, the primary purpose of this Plan is to examine how the existing City of Winston wastewater collection system infrastructure can support the current and 20 year future population in the City of Winston, whether I/I in the collection system can be controlled, and whether or not the collection system infrastructure is capable of supporting expansion areas inside the City urban growth boundary (UGB) but outside city limits

Existing System

The existing collection system is comprised of 20 separate drainage basins containing approximately 25 miles of gravity piping (not including individual service laterals), 2.8 miles of forcemain piping, 678 manholes, and 3 pumping stations and a STEP system. About 52% of the piping system is made up of concrete pipe which was installed prior to the 1970's. Infiltration and Inflow in the system has been determined to be significant.

Hydraulic Analyses

To evaluate the ability of the existing collection system to meet future capacity needs, a hydraulic analysis was conducted. Using SewerCAD, a computer model of the major sewers serving the service area was developed and calibrated. Once calibrated against existing wastewater treatment plant recorded flows, the hydraulic model of the collection system was then modified by increasing service area population to the projected year 2035 population. The model was used to evaluate the flow characteristics and capacities of the pipes and pump stations making up the collection system.

Maintenance and Reliability Analysis

To evaluate the structural condition of the existing collection system and identify future repair/replacement needs, a maintenance and reliability analysis was conducted. Structural deficiencies were identified using available sewer condition and maintenance data and linking these data to a graphical representation of the collection system. This analysis included extensive discussions with the City's sewer maintenance staff to confirm known areas that require routine maintenance and areas where other structural deficiencies had been observed. In addition, a condition assessment of all lift and pump stations was conducted.

Recommended Collection System Improvements/Capital Improvement Plan

Based on the collection system hydraulic analysis and the maintenance and reliability analyses, several capital improvement projects were identified that need to be completed in the next 20 years to maintain adequate conveyance and system reliability. Winston is faced with a lift station (Snow Avenue) that is 35-years old, has inadequate capacity for current flows let alone future increased flows, is deteriorated, has antiquated equipment, and does not meet current code and DEQ requirements. The City is also experiencing excessive I/I problems originating from the older portions of the system made up of concrete piping that has deteriorated and is failing. Six basins have been identified as target areas for rehabilitation of the old, leaky, concrete pipes. A sequence and schedule has been proposed to install cured-in-place pipe liners for each of the targeted basins. The sequence and schedule has been derived on the basis of availability for financing the repairs through the accumulation of revenues acquired from increased user fees.

Other projects identified by this master plan include; System flood proofing; Siphon Evaluation; Siphon replacement; Replace STEP System with Gravity System (Basin B). Total capital improvement project costs for all identified projects are estimated to be approximately $9.8 million dollars

The recommended improvements in this Wastewater Collection Master Plan are comprehensive and meant to last at least 20-years into the future with additional work needed. Ongoing system maintenance and I/I location and repairs should continue in efforts to avoid worsening of the I/I problem over time.

1.0 Introduction, Purpose, and Need

1.1 Introduction

The City of Winston (City), an incorporated City in Douglas County, Oregon, provides sanitary sewage service to businesses and citizens of the City of Winston and to some authorized customers located outside the City Limits. As shown in Figure 1, the City of Winston is located in central Douglas County, approximately seven and one half miles south of the City of Roseburg along the north bank of the South Umpqua River.

Originally identified as a crossroad community known as Coos Junction, Winston developed as a rural residential area while the community of Dillard (south of Winston) served as the primary business center through most of the early 1900s. After World War II, more people moved to the area and located in Coos Junction to work in the Roseburg Forest Product's Mill south of Dillard. In the early 1950s the City of Coos Junction was incorporated and in 1955 the City changed its name to the City of Winston.

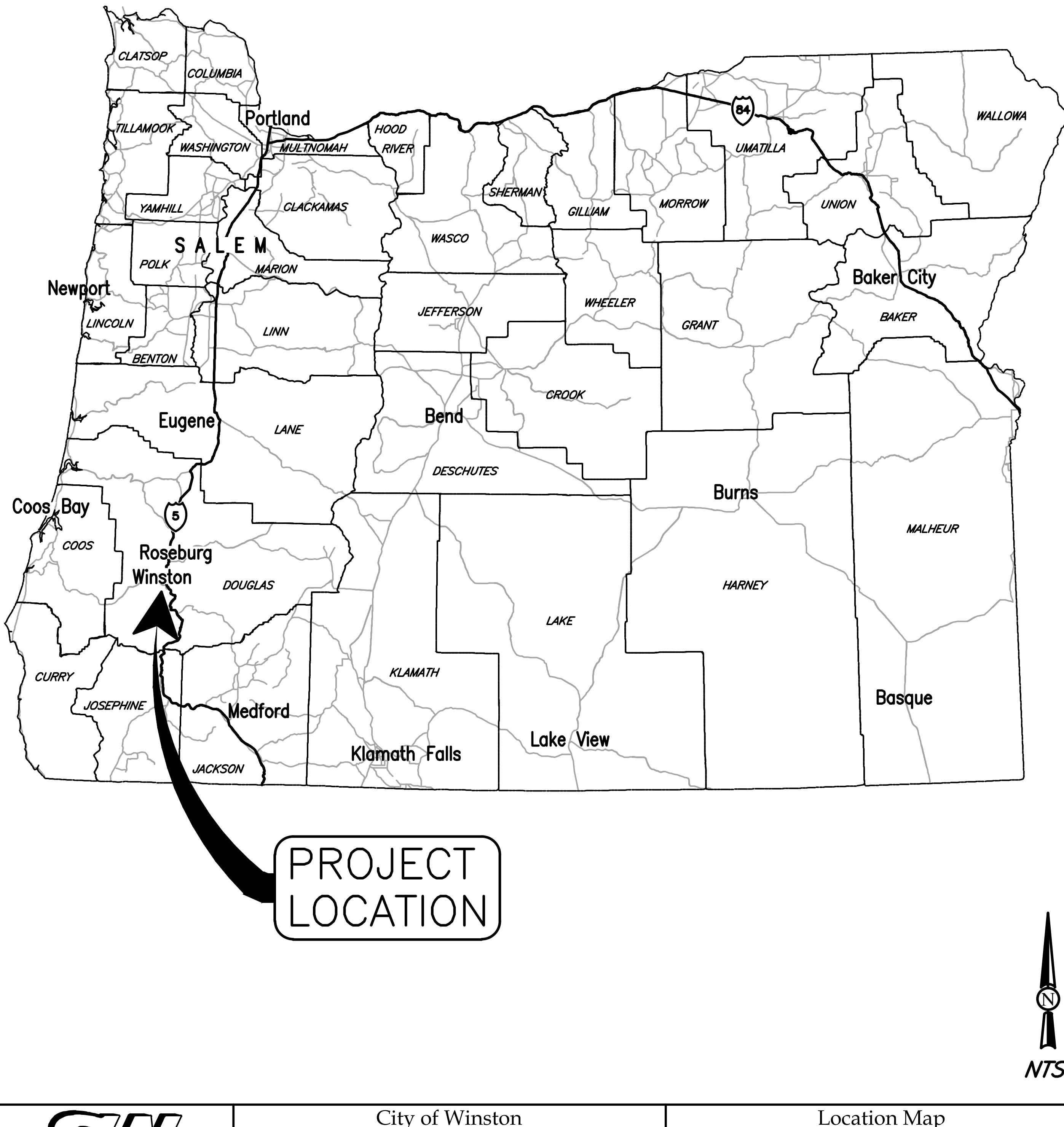
Today, the City has eclipsed its neighboring communities. As a large urban center, the City provides urban services in an area encompassing approximately 2,025 acres. Within its boundaries wastewater is collected from a total of 1,818 households. Infrastructure within the City of Winston currently includes three pump stations, approximately 25.4 miles of collection system consisting of 6-inch to 30-inch diameter pipelines, and over 2.8 miles of a 4-inch, 6-inch, and 12-inch pressure main from its three lift stations.. The City of Winston has partnered with the Green Sanitary District for ownership and operational responsibility for the Winston Green Regional Wastewater Treatment Facility (WWTF).

1.2 Background and Need

The City of Winston sewer system was constructed in 1957 in response to concerns about public health from the density of housing in the area. By the early 1970s, continued growth within the Winston area caused the City to raise concerns about the capacity of its wastewater treatment system. The neighboring community of Green concurrently began discussing how to solve their wastewater problems. Results of these discussions led to a 1974 regional wastewater treatment study that recommended construction of a centralized treatment facility, located between Winston and Green. By 1980, the new facility was constructed (with Douglas County as the Owner) for a total cost of $9.2 million using a 68 percent grant from the Environmental Protection Agency (EPA) and a 32 percent loan from Douglas County.

The new WWTF utilized Rotating Biological Contactors as the secondary process and had a design capacity of 3.5 million gallons per day (MGD). At the same time, the City collection system was modified to convey flows from the old plant to the new regional facility. Modifications to the City system included construction of the following:

- A new raw sewage pump station known as the Parkway Pump Station (PS),
- A new 12-inch force main to route flows from Parkway PS to the new interceptor sewer leading to the WWTF, and
- A 12-inch to 30-inch interceptor from the Parkway PS discharge to the WWTF.



SHN Consulting Engineers & Geologists, Inc.	City of Winston Wastewater Master Plan Winston, Oregon	Location Map SHN 614005
May 2015	614005-LOCATION-MAP	Figure 1

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In 1993, the biological capacity of the treatment facility was achieved and additional, more stringent regulatory criteria (total maximum daily loads and waste load allocations) were pending for wastewater discharges to the South Umpqua River. In 1994 a Wastewater Facilities Plan was prepared to address the regional WWTF needs. In 1995 an agreement developed between the City and Green stipulated that once flows reached 85 percent of the capacity of the facility, planning for a WWTF expansion would be undertaken. In 1997, a Pre-design report was also prepared, providing further details regarding the proposed improvements. By 1999, a new modern facility capable of treating up to 5.0 MGD was constructed. In 2003, the City's Parkway station was also modified to improve pumping to the WWTF systems. In 2005, the agreement between the City and Green was modified to require a feasibility study at 75% of peak dry weather capacity. In 2010 a new feasibility study of the plant was undertaken and an upgrade that enhanced raw sewage pumping capacity, nutrient removal, and disinfection was completed in 2013. Today the WWTF is rated a 10.0 MGD capacity.

1.3 Study Objective

The primary purpose of this Plan is to examine how the existing City of Winston wastewater collection system infrastructure can support the current and 20 year future population in the City of Winston, whether I/I in the collection system can be controlled, and whether or not the collection system infrastructure is capable of supporting expansion areas inside the City urban growth boundary (UGB) but outside city limits.

1.4 Scope of Study

Preparation of this Master Plan is based on four general tasks, as described below:

Task 1: Planning and Background - hold a scoping meeting with the City and establish the Master Plan objectives and define the City's understanding of existing conditions.

Task 2: Collect and analyze data pertaining to population and flows, the level of service provided by the existing system, the potential impacts of expansion on the existing system, evaluate pump stations, and summarize into the analysis of the collection system.

Task 3: Prepare a hydraulic model of the sewer system and analyze existing and future conditions. Evaluate deficiencies with the existing system, projected deficiencies from growth induced flows, and evaluate alternatives to improve and ready the system for continued development.

Task 4: Based on preceding work, develop a capital improvement plan and prepare a Master Plan Report.

Planning Period

The planning period for this Wastewater Collection System Master Plan is 20 years, ending in the year 2035. The period must be short enough for current users to benefit from system improvements, yet long enough to provide reserve capacity for future growth and increased demand. Existing residents should not pay an unfair portion for improvements sized for future growth, yet it is not economical to build improvements that will be undersized in a relatively short time. Infrastructure needs are often projected over 20 years, which is a typical planning period for most municipal master plans. It is important to note that the useful life of the recommended infrastructure and often financing of the infrastructure, are often longer than the 20 year planning period.

Planning Area

The Planning Area encompasses the City of Winston City limits and the City urban growth boundary (UGB) which generally defines the planning area. Potential growth areas inside the UGB include large areas to the west and north of the City limits.

It is unknown whether additional UGB acreage will be annexed into the City limits during the 20-year planning period, however, a reasonable assessment of expansion areas was required to evaluate how much or if any of the surrounding areas would be served by the City's existing infrastructure system. The plan presumes that most development will occur on developable land tracks to the northwest that generally follow the eastern slopes of the Lookingglass Creek valley. This land should be easier and more efficient to develop because topography is gentler. Additionally, growth could occur along Highway 42 to Brockway Road ("Four Corners"), where City zoning allows commercial and high density residential development. The plan does not consider how developers would construct the sewer system serving their developments, rather the plan considers how to manage the existing sewer system to prevent creating overflow conditions. Recommendations for annexation into the study area are not intended or inferred by this plan.

1.5 Authorization

The firm of SHN Consulting Engineers and Geologists, Inc. was retained by the City of Winston to prepare a Wastewater Collection System Master Plan. Furthermore, the plan does not consider lands outside the City UGB.

2.0 Study Area Characteristics

2.1 Study Area

The City of Winston, shown in Figure 2, is located in central Douglas County southwest of the City of Roseburg. The City of Winston City Limits has a total area of approximately 4.2 square miles. The Winston area serves as a bedroom community adjacent to a major transportation hub for north and south moving traffic and commerce along Interstate 5. The Umpqua River forms the boundary of the City to the north, east, and south. Interstate 5 runs west of the City. Highway 99 crosses north and south through the City merging with and becoming Highway 42/99 at the center of the City. A portion of the southern boundary of the City is adjacent to the South Umpqua River and its related flood plain.

2.2 Physical Environment

City residents enjoy four distinct seasons in a year. Summers are typically dry with low humidity and provide a long 217-day growing season. Winters are cool without much freezing. Snowfall is rare while winter rains represent the majority of the areas annual 34-inches of rainfall. The climate in general can be characterized as moderate with low and high temperatures ranging between 34 to 48 degrees Fahrenheit in January, 39 to 63 in April, 53 to 84 in July, and 43 to 67 in October. A summary of climate data for the Roseburg area, typical for Winston, is provided below in Table 1.

Table 1
Roseburg Area Climate Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. T High	48°	54°	57°	62°	68°	76°	84°	84°	78°	67°	54°	48°
Avg. T Low	34°	35°	37°	38°	44°	50°	54°	54°	48°	44°	38°	34°
Mean T	41°	45°	48°	51°	57°	64°	68°	68°	64°	55°	47°	42°
Avg. Precip.	5.0 in	3.7 in	3.6 in	2.3 in	1.5 in	0.8 in	0.4 in	0.7 in	1.1 in	2.4 in	5.7 in	5.6 in

2.3 Economic and Demographic Conditions

The City of Winston has an economic base consisting of a major forest products industrial complex located adjacent to the community, various commercial services, tourism (Wild Life Safari), farming, construction, and public service occupations. The Wild Life Safari is integral to the identity of the City of Winston.

According to the 2010 Census, the Winston work force for persons over the age of 16 is estimated at 2,965 persons and is divided equally between men and women. The unemployment rate reported for Winston residents was 5.6 percent, which compares to a State average rate of 6.5 percent during the year 2000. Approximately 27 percent of the workforce includes both parents in the labor force and 37 percent of these families have children (2012 updates) under the age of 6.

According to the census data, the median household income for Winston is $ 31,360. Median mortgage values for owner occupied homes were $141,756 with the average gross rent being $ 641 per month or 24 percent of the monthly median household income.

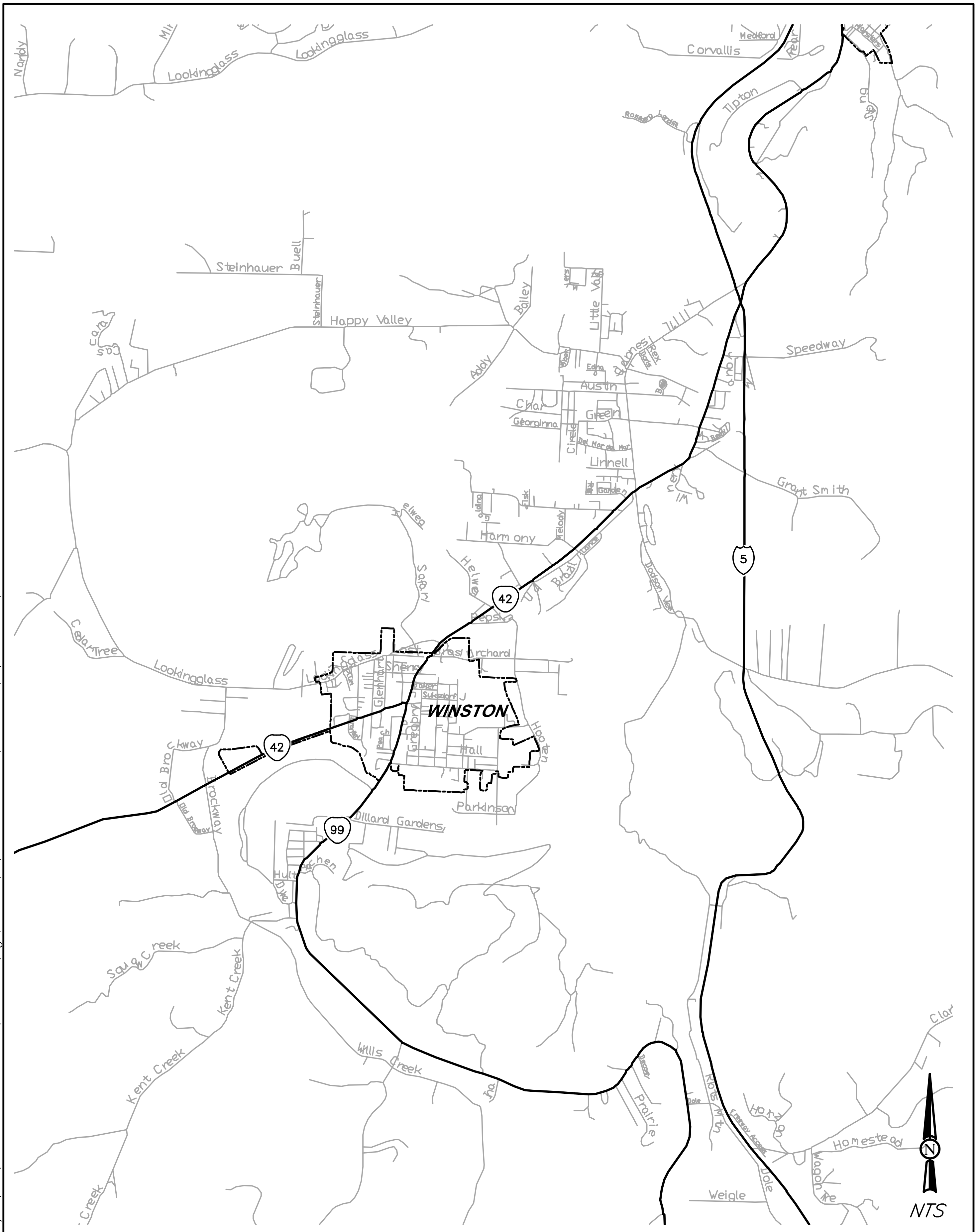
2.4 Population

The current (year 2010) population of the City of Winston was estimated at 5,379 persons based on the 2010 U.S. Census. The average household size is 2.50 persons, as reported by 2010 Census. The City population estimate is summarized in Table 2.

Table 2
Historical Population Growth in the City of Winston

Year	2014[1]	2010	2000	1990	1980	1970
Estimated Population	5,410	5,379	4,613	3,773	3,359	2,468

1. PSU Population and Research Center



SHN Consulting Engineers & Geologists, Inc.	City of Winston Wastewater Master Plan Winston, Oregon	Vicinity Map SHN 614005
May 2015	614005-VICINITY-MAP	Figure 2

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2.5 Population Growth

The City of Winston has experienced rapid population growth since 1970. According to the Comprehensive Plan, the average growth for the City from 1970 to 2000 was approximately 2.1 percent per year. The average growth rate for Douglas County over this same time period was only 1.4 percent per year.

The County attributes the high growth rate for the Winston area to the availability of relatively inexpensive housing, the availability of water and sewer service, access to I-5, and the proximity to major employment centers. The outlook for continued population growth in the Winston area is reported to be dependent on factors such as the economic outlook for Douglas County, fertility and mortality rates, migration trends, and the capacity of infrastructure to sustain these high growth rates. City Comprehensive Plan suggests that a sustained growth rate of 1.86 percent should be utilized for population projections for 2020. For lack of other guidance, a 1.86 percent growth rate will be used for all City population estimates to year 2035.

Equivalent Dwelling Units

Projections for population growth are often utilized to estimate the future demand for public utility services, such as water and sewer. Typically, the future demand is based on an estimated number of residential homes, called average dwelling units, projected for the planning horizon. Residential dwelling units are only a portion of the demand placed on a public utility service. Commercial, industrial, and institutional customers will also demand services. Accounting for these customer types requires comparing the demand for services from the respective customer with the demand from the average dwelling unit. The relationship is defined as the equivalent dwelling unit (EDU) methodology. The typical method for establishing EDU counts for wastewater systems is based on equating nonresidential water usage to residential water usage.

The EDU methodology is also used by the City as the basis for establishing fair and equitable user charges. An example of the EDU methodology follows:

Example:

> *If a typical residential family requires, on the average, 250 gallons of water per day while a restaurant requires 1000 gallons of water per day, the demand for water from the restaurant is numerically equal to four residential units. In this case, the restaurant is said to be equal to four EDU's.*

Equivalent Populations

By comparing the usage from commercial and institutional users with the total number of residential units in a community, the demand for public services can be established in terms of EDU's. The total number of EDU's can be further used to estimate future demands based on the average household size and the future population. In the example provided above, if the average household consisted of 2.6 persons and in 20 years there are 100 households and one restaurant in the community, the equivalent population of the community would be 270 (260 people for the 100 houses + 10 equivalent people for the restaurant).

By evaluating the demand for the residential customers, the commercial, industrial, and institutional demand can be converted from connections to EDU's. The combination of EDU's can then be used to evaluate sewer usage based on equivalent population values. Table 3 summarizes City data on sewer accounts, EDU totals, and the equivalent population used.

Table 3
Customer Class
City of Winston Service Area

Account Types	Sewer Accounts	
	2015	2035
Residential	1110	N/A
Multi Family Residential	340	N/A
Manufactured Home Park Units	346	N/A
Institutions	4	N/A
Industrial	0	N/A
Commercial	120	N/A
Number of Billing Accounts	1920	N/A
Total Number of EDUs[1]	2222	3157
Equivalent Population[2]	5621	7986

1. EDUs based on City data.
2. Based on Comprehensive Plan estimate of 2.53 people per household

Based on a continued 1.86 percent growth rate through the 2035 plan year, the equivalent population of the City of Winston is estimated at 7,986 equivalent persons.

2.6 Land Use Characteristics

Residential

Residential land use comprises up to 60% of the developed lands within the city limits. Residential housing includes single-family homes, trailer parks, manufactured homes, apartments, and duplex units which are spread throughout the community.

According to City comprehensive Plan Data, approximately 53 percent of housing in the City is single family residential, approximately 24 percent is manufactured homes, and 23 percent is multi-family units including duplexes.

Commercial

Commercial land use comprises approximately 11% of the developed land within the City. The majority of commercial establishments (120 sewer accounts) are located along Highway 42 and Highway 99. Commercial activity appears to cater to the frequent travelers coming from Interstate 5 and visitors whose destination is the Wildlife Safari Park.

Industrial

There is no industrial land within the city limits. Existing industrial land is located in neighboring communities south and east of the city.

Public

Public land uses comprise approximately 13% of the developed lands within the UGB. These areas consist of four schools, city parks, a fire station, municipal services, community center, and city hall.

3.0 Wastewater Characteristics

3.1 Terminology

As a preface to the review of wastewater characteristics, the following terms are defined below.

Base Sanitary

The base sanitary flow represents the domestic component of the wastewater in the sanitary sewer system resulting from the use of potable water.

Base Infiltration

The average amount of extraneous water entering the sewer system during the dry season is referred to as base infiltration. This parameter is determined by subtracting the Base Sanitary flow from the Average Dry Weather flow. In general, the base infiltration is not cost effective to remove from the system and an allowance for this flow is typically included in the estimate of flows for each future connection.

Infiltration and Inflow

Infiltration and inflow (I/I) describes a broad range of extraneous flow entering into a wastewater collection system. Infiltration is defined as groundwater that leaks into pipelines through joints and pipe or manhole defects. Infiltration typically occurs on a continuous but gradually varying rate. Inflow is defined as direct flow into the collection system through openings in manholes, lateral clean-outs, improperly installed storm water systems, and area or roof drains. Inflow typically causes a significant rate of change in flow over a short period of time and usually is correlated to rainfall events. The impacts of I/I can be significant and cause sizing problems in pipelines, pump stations, and wastewater treatment facilities.

Average Dry Weather Flow

The average daily flow in the sewer system occurring during the dry season months, from the beginning of May through the end of October, is the average dry weather flow (ADWF).

Average Wet Weather Flow

The average daily flow in the sewer system occurring during the wet season months, from the beginning of November through the end of April, is referred to as average wet weather flow (AWWF).

Yearly Average Flow

The yearly average flow or annual average daily flow (AAF) is the daily flow averaged for the entire year. The AAF is based on a 365 day running average and is not necessarily on a calendar basis. Changes in the ADF can be reflective of a community's effort to control infiltration and inflow.

Maximum Month Dry Weather Flow

The maximum month dry weather flow (MMDWF) is the monthly average flow, which has a 10 percent probability of occurrence from May through October in any given year. This flow represents the wettest dry weather season monthly average flow, which is probabilistically occurring every ten years. For western Oregon, the highest monthly average dry weather flow typically occurs in May.

Maximum Month Wet Weather Flow

The maximum month wet weather flow (MMWWF) is the monthly average flow, which has only a 20 percent probability of occurrence from November through April in any given year. This flow represents the wettest wet season monthly average flow that is anticipated to have a five-year recurrence interval. For western Oregon, typically the month of January has the highest averaged wet weather flow period.

Peak Week

This flow parameter is the largest averaged flow experienced over a 7-day period during any year. The peak weekly flow is probabilistically estimated as the flow occurring 1.9 percent of the time or 1 week out to 52 weeks of the year. The peak week is based on a probability analysis projected from the peak day, MMWWF and AAF.

Peak Day

The peak day flow is the largest daily flow experienced over a 24-hour period during any year. The peak daily flow has a 0.27 percent probability of occurrence or 1 day in 365 day of any given year. Projection of the peak day flow is based on a regression analysis of daily plant flows during or immediately following wet season significant rain fall events (greater than 1-inch in a 24 hour period).

Peak Instantaneous Flow

The peak instantaneous flow (PIF) is the highest sustained hourly flow rate during wet weather. The peak instantaneous flow has 0.011 percent probability of occurrence (1 hour in 8,760 hours of the year). This flow parameter provides the basis for the hydraulic design of channels and pumps at the treatment facility and peak pumping capacity at lift stations in the collection system.

Equivalent Dwelling Units

An equivalent dwelling unit (EDU) is the term for equating commercial, industrial, and institutional wastewater flow rates and strength to the rates and strength generated by a typical residential household.

3.2 Wastewater Volume

Wastewater flows within the City of Winston vary through the year, with wet weather flows exceeding dry weather flow. This typical western Oregon pattern reflects the presence of infiltration and inflow in the collection system. A plot of the historical flows and cumulative monthly rainfall based on data from the WWTF over a three year period including; 2012, 2013, and 2014 are provided in Figure 3.

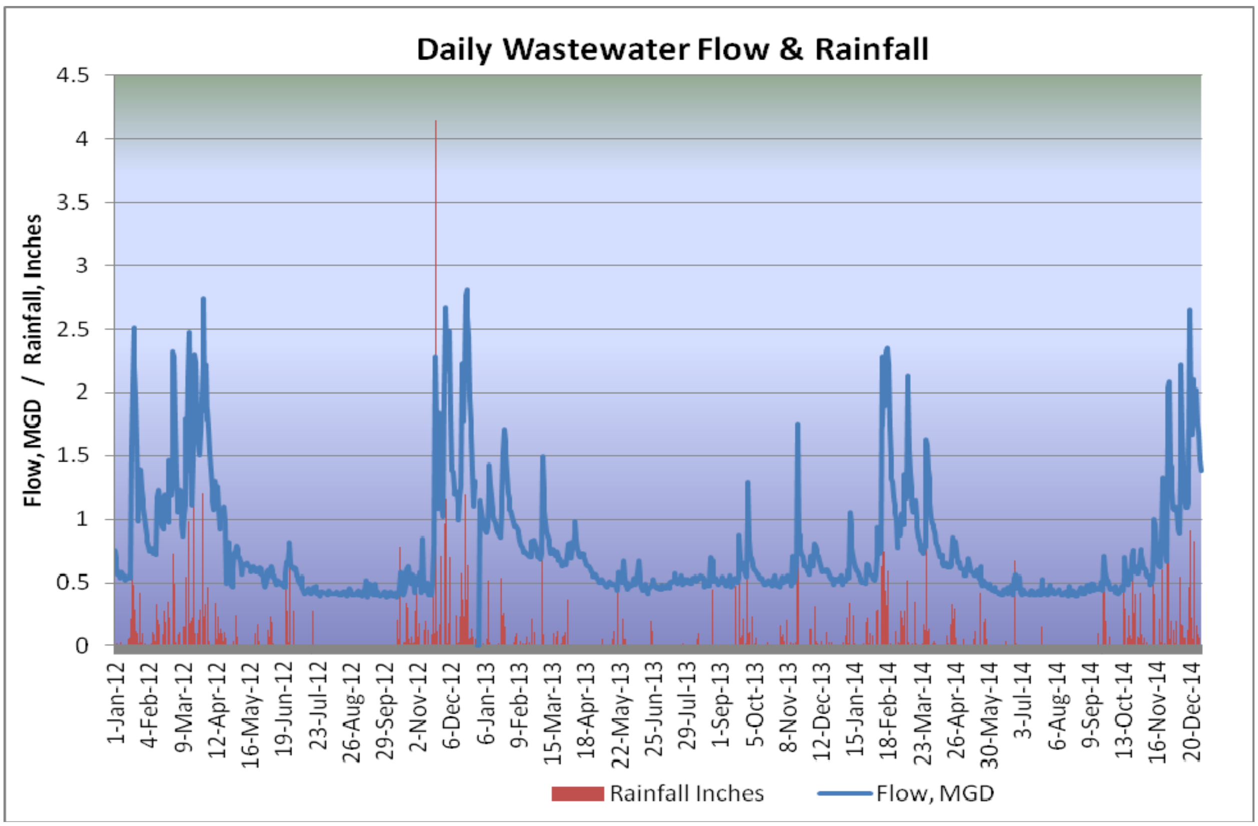


Figure 3

A comparison of the City ADF and the AWWF shows a 46 percent average difference between flows delivered to the WWTF during the summer and winter seasons. Also, the comparison of the AAF and the peak day flow shows a 3.1 to 1 peaking factor. As a general engineering guide, a wastewater collection system should be conservatively designed to handle a peaking factor for the peak day of greater than 4:1 with 75 percent of the rated full pipe flow. Considering existing standards it can be concluded I/I in the entire system is excessive, (See Section 7.2.1). More importantly, the significance of the magnitude of infiltration and inflow in a collection system is relative to the City's share of the capacity of the regional wastewater treatment system.

3.3 Dry Weather Flows

Average Dry Weather Flow

The City average dry weather flow (ADF) was estimated to be 0.49MGD based on an analysis of DMR flow records for the months of May through October from year 2011 through 2014. The average dry weather flow can be divided into the following two descriptive engineering components:

1. Base sanitary flow, and
2. Base infiltration

Base Sanitary Flow

The portion of sewer system flow that is entirely attributable to domestic sanitary sewage is known as the base sanitary flow. Base sanitary flows are determined from average residential water consumption and/or the recorded seasonal low wastewater volumes. Water consumption records for winter months of November through April from a period in 2003 indicate that the typical household domestic water use is 211 gpd / EDU's. Assuming approximately 80 percent of the domestic water reaches the treatment plant [1] the base sanitary flow is approximated as 169 gpd/EDU's (68 gpcd) or 00.375 MGD for permanent residences. Winter water usage is employed to estimate base sanitary flow due to the potential for irrigation water use during the summer months.

Base Infiltration

In determining projected flows, allowances must be made for unavoidable infiltration which is dependent upon such factors as the quality of material, workmanship in the sewers and building connections, maintenance efforts, and the elevation of the ground water compared with the elevation of the sewer pipes. The base infiltration is found from the difference in the ADF and the base sanitary flow. Accordingly, the base infiltration is estimated at 0.115 MGD or 21 gpcd (51 gpd/EDU). The addition of future connections to the system will include a reduced allowance for base infiltration of 20 gpd/EDU's, in new units because it is assumed that modern construction of sewer connections will result in reduced amounts of infiltration (20 gpd/EDU new connection compares to 51 gpd/EDU existing connection).

3.4 Average Wet Weather

As previously discussed, the wet weather period between November and April results in increased flows in the collection system because of I/I. The analysis of the wet weather season data from the WWTF suggests that the City average wet weather flow during this period was approximately 1.250 MGD or 222 gpcd.

[1] Metcalf and Eddy, 1991

3.5 Annual Average Flow

The AAF experienced in the City collection system has been determined by averaging the ADF and the AWWF, resulting in an annual average flow of 0.89 MGD or 158 gpcd.

3.6 Maximum Monthly Flows

The calculation of Maximum Monthly Flows is somewhat more complex than that for other flow parameters. The methodology employed is based on Department of Environmental Quality (DEQ) guidelines that identify the seasonal maximum monthly average flow, which has the probability of recurrence once every 5 years during the winter and once every 10 years during the summer. The basis of these recurrence intervals is the DEQ policy to accept a failure of a treatment facility or overloading of the collection system due to rainfall effects once every 5 years.

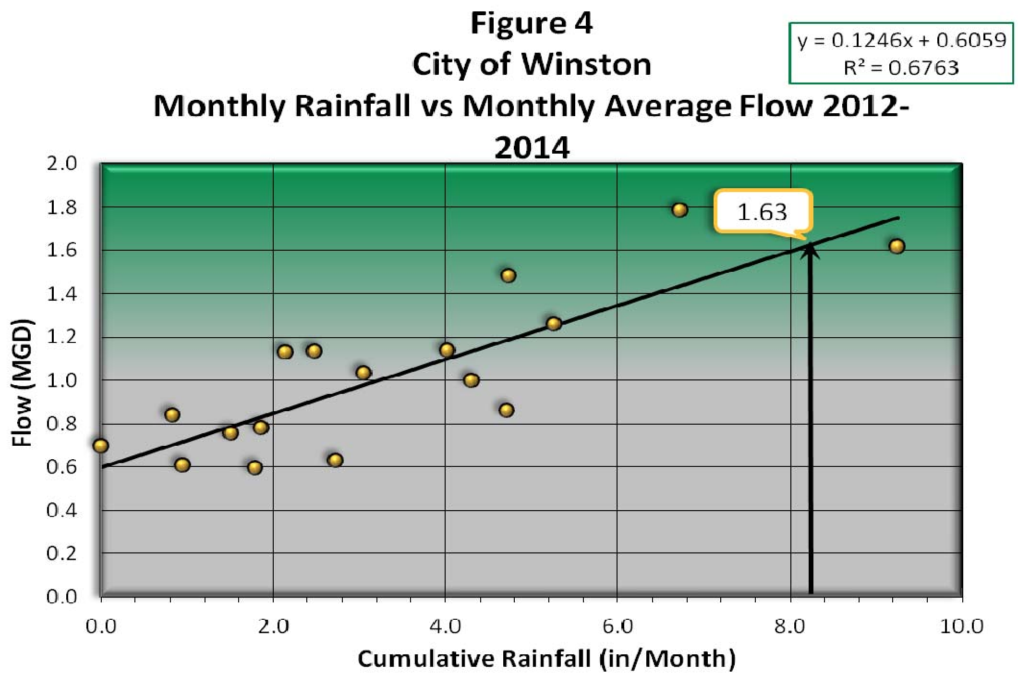
Calculation of the Maximum Monthly Flow is based on identifying the monthly rainfall and the monthly average wastewater flows during the months when I/I impacts the collection system. Once these flows are identified, they are plotted on a graph to establish a linear relationship between monthly rainfall and wastewater flow. The resulting relationship is used to predict the monthly average flow for the 80 percent and 90 percent probability (one in five year and one in ten year recurrence). The method estimates the anticipated flow that will occur if rainfall for the month exceeds the historic probabilistic amounts for the dry and wet seasons. For western Oregon, the historically dry and wet season months with the highest rainfall occur during May and January, respectively.

Maximum Month Dry Weather Flow

The MMDWF was ascertained from the plot shown in Figure 4 as developed from the maximum monthly average flows and rainfall recorded at the WWTF between the periods of year 2011 through year 2014. Based on historical climatological data (1940 – 1979) the maximum rainfall with the one-in-ten year recurrence for the month of May is 3.1 inches as recorded for Roseburg, Oregon. The calculated MMDWF with the same recurrence interval is 0.55 MGD or 18 gpcd.

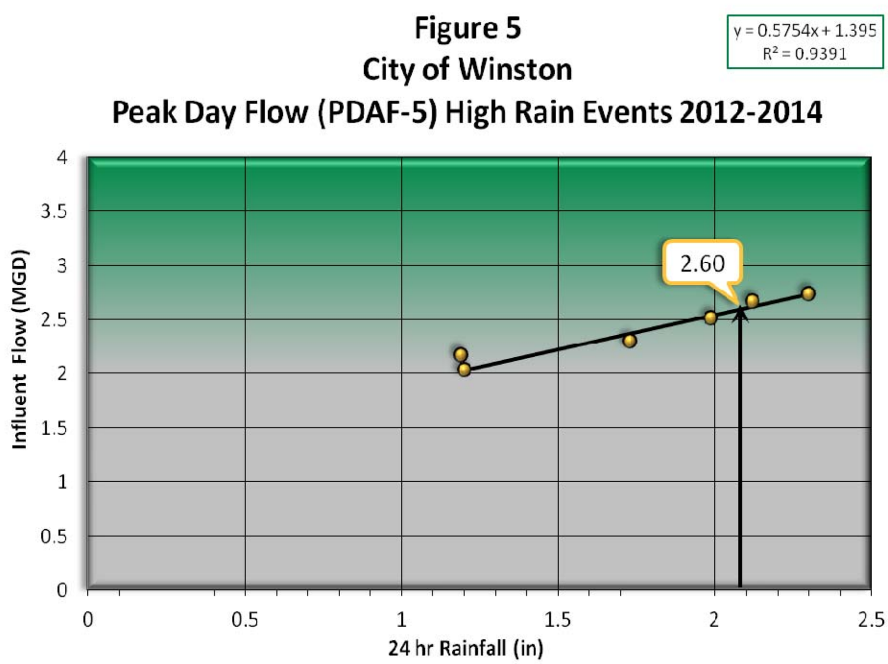
Maximum Month Wet Weather Flow

The MMWWF was also ascertained from the plot shown in Figure 4, on the following page. Based on the same climatological data, the maximum monthly rainfall with the one in five year recurrence interval for January is 8.2 inches. The calculated MMWWF for the 5-year recurrence interval is 1.63 MGD or 290 gpcd.



3.7 Peak Day Flow Event

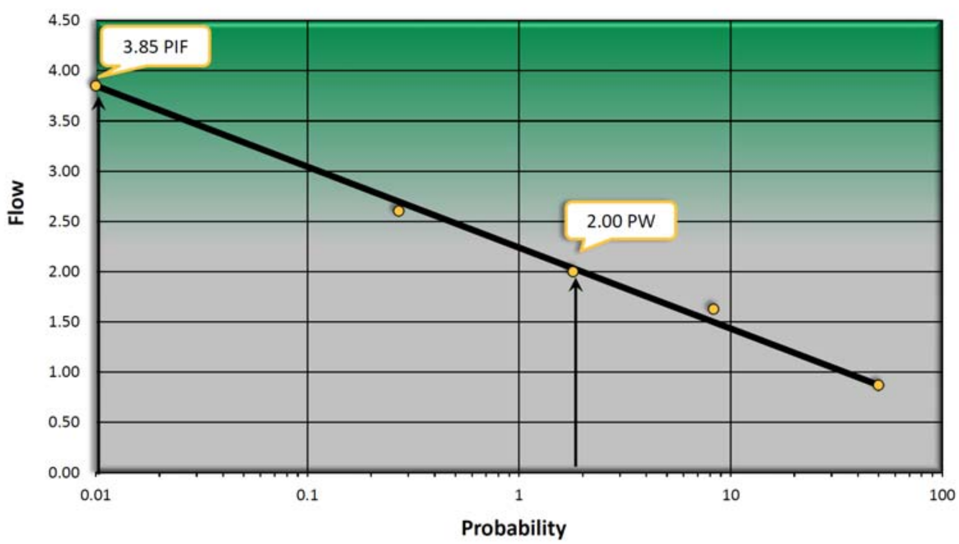
During times of extended, heavy precipitation, I/I flows impact the City system causing flows received at the WWTF to increase. The Peak Day Flow event is determined from a plot of the recorded daily flow that occurred during, or 24 hours after, a significant rainfall event. By performing a regression analysis of this data, a linear relationship is established as shown in Figure 5. The Peak Day Flow is based on the intercept of this line with the 5-year, 24-hour precipitation event. For the City, the 5-year rainfall event is a 2.1 -inch storm event resulting in a Peak Day Flow of 2.6 MGD.



3.8 Peak Instantaneous Flow

Determination of the PIF results from a probability projection of the Annual Average, Maximum Month, and Peak Day Flow parameters. The example plot shown in Figure 6, projects the PIF at 3.85 MGD.

Figure 6
City of Winson
Peak Instantaneous and Peak Week Flow (PDAF-5)



Summary of Existing Flows

The evaluation of dry and wet weather wastewater flows for the City collection system was based on the recorded flow data reported in the Winston Green Wastewater Treatment Facility daily monitoring reports for the period beginning in January 2012 and ending in December 2014.

Per capita design values were established from the equivalent population using the methodology presented in Section 2. The equivalent population was averaged for each year of data to establish the per capita design value. A summary of the flow data is provided in Table 4 below.

Table 4
City Summary of Flow Projections

Flow Parameter	Daily Flow	Per-capita Flow[1]
Base Sanitary	0.375 MGD	67 gpcd
Base I/I	0.115 MGD	21 gpcd
Average Dry Weather Flow (ADWF)	0.49 MGD	87 gpcd
Average Wet Weather Flow (AWWF)	1.25 MGD	222 gpcd
Average Annual Flow (AAF)	0.89MGD	158 gpcd
Max Month Dry Weather (MMDWF-10)	0.55 MGD	98 gpcd
Max Wet Month Weather (MMWWF-5)	1.63 MGD	290 gpcd
Peak Day Avg. Flow (PDAF-5)	2.6 MGD	463 gpcd
Peak Instantaneous Flow (PIF-5)	3.85 MGD	685 gpcd

1. per capita flow based on equivalent population

3.11 Flow Projections

Projected population growth and the existing per capita design values developed above will be used to predict wastewater flow characteristics at the end of the 20-year planning period. These wastewater characteristics form the basis for evaluating alternatives and, if necessary, the basis for recommending the design or modification of new facilities.

The potential for growth, residential and commercial, exists in the City. Based on historical data, it is likely that the current growth trends will continue and within this planning period, the City will begin to experience build-out in portions of the system's core. Therefore, it is reasonable to assume that growth could occur at the rates discussed in Section 2 and as this growth occurs, it may include build-out or require expansion of the City sewer system into UGB areas. Extensions of the City's sewer system would generally occur by developers as demand for sewer service is generated. What is critical for the City to understand is whether the existing sewer system has capacity for the new flows generated by development. If not, improvements need to be identified and improved as part of the developers cost.

The permitted capacity of the WWTF and the City's wastewater collection system will need to accommodate this growth. It is anticipated that the recommended improvements presented in this plan will become necessary to support the growth of up to 935 new EDUs.

Basis of Wastewater Flow Projections

The following are the assumptions made to project flows within the City's system during the 20 year planning period.

- The equivalent population for the plan year 2015 is estimated at 5,621 equivalent persons, which is based on water consumption records for a portion of the Winston Dillard Water District customer base, the City's current customer base, and an average of 2.5 persons per household.
- Wastewater flow records for the low flow dry season months allow estimating the average dry weather flows in the collection system. These dry weather flows will serve as the basis for projecting increased flows due to population increases.
- When evaluating new connection impacts and projecting future flows, the base infiltration component will be reduced to 20-gpd for each new connection as previously discussed. New sanitary sewer connections will have less I/I due to newer construction methods resulting in a decreased base infiltration component.
- The growth rate for the City during the 20 year planning period is estimated at 1.83 percent, based on the City Comprehensive Plan of current trends.
- It has been assumed that growth within the City will occur within the City's boundaries, however, future scenarios include an assessment of impacts from areas outside of the City's current boundaries but inside the UGB.
- Infiltration is projected to decrease by approximately 25% over the planning period, accounting for improvements to the existing aged concrete pipe system (CIPP projects).

Projected Flows Based on Current Conditions

Based on the assumptions stated above, unit design values, equivalent population, and flow projections for five-year increments are summarized in Table 5. The 20-year unit design values reflect a general decline in the per-capita flow rate. This change is based on newer construction providing reduced infiltration and inflow.

Table 5
City of Winston Flow Projections[1]

Year		Avg. 2012-2014	2015	2020	2025	2030	2035	20-Year
Population Equivalence		**5,621**	**5,734**	**6,297**	**6,860**	**7,423**	**7,986**	**per- capita**
Flow Design Parameter	**Per capita flow, gpcd**	**MGD**	**MGD**	**MGD**	**MGD**	**MGD**	**MGD**	**gpcd**
Base Sanitary	67	0.375	0.382	0.418	0.455	0.491	0.527	66
Base I/I[2]	21	0.115	0.113	0.100	0.088	0.076	0.064	8
ADF	87	0.49	0.495	0.519	0.543	0.567	0.591	74
AWWF	222	1.25	1.255	1.278	1.302	1.326	1.350	169
AAF	158	0.89	0.896	0.928	0.959	0.991	1.022	128
MMDWF	98	0.55	0.560	0.607	0.655	0.703	0.751	94
MMWWF	290	1.63	1.632	1.641	1.650	1.660	1.669	209
PDAF-5	463	2.6	2.595	2.571	2.547	2.524	2.500	313
PIF-5	685	3.850	3.814	3.633	3.452	3.271	3.091	387

1. Growth projections are based on the County Average 1.86% annual growth
2. Base Sanitary is reduced to 20 gal/EDU (7.4 gpcd) for new connections only

4.0 Existing Wastewater Collection System

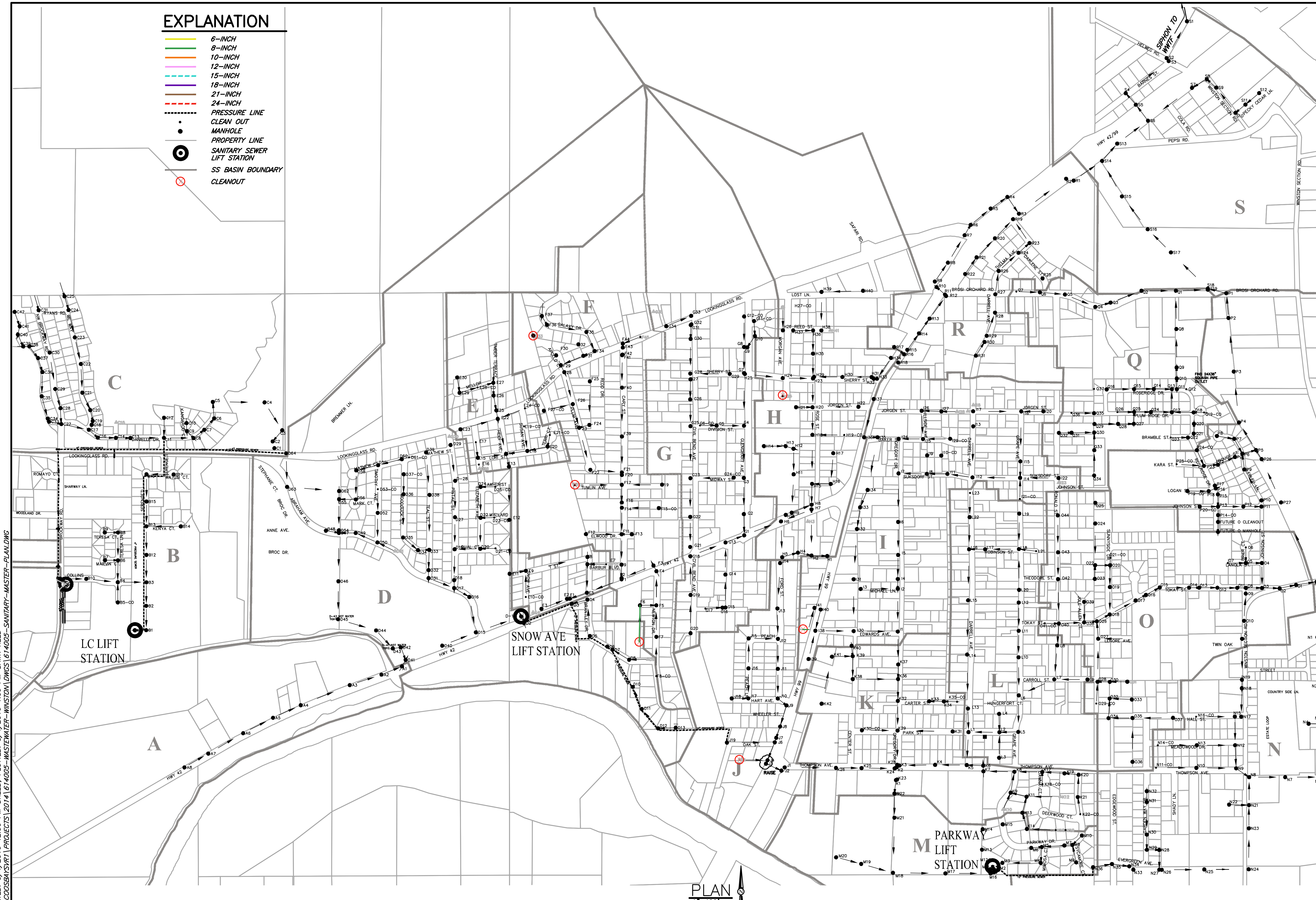
4.1 General

As shown in Figure 7, the City of Winston serves an area of approximately 2,025 acres. Within this area, the City has constructed and maintains nearly 25 miles of gravity pipelines, 2.8 miles of forcemain piping, 678 sanitary manholes, three pump stations, and STEP systems. The two primary pump stations, Parkway and Snow Avenue Lift Stations, are considered major facilities. The Lookingglass Station is a small facility serving a dozen residential units in a low lying residential area. In the past, the City has allowed the addition of approximately 50 STEP systems for residential services. All of the STEP systems are maintained and serviced by the City on a routine maintenance schedule. The maintenance schedule includes pumping and servicing the units and annual inspecting and servicing the STEP systems occurs every 12 months at the City's cost.

The inventory of the collection system ranges in size from 6-inch to 30-inch diameter pipe for the gravity system and 6-inch and 12-inch pipe for the two major pressure pipelines. Based on previous planning studies conducted by the City, the service area has been divided into 19 sub-basins, each identified by letter. Manholes and pipelines have been tagged with the sub-basin designation followed by a numerical assignment beginning at the lowest section of the basin and working up through the tributaries. An inventory of piping for each sub-basin is provided in Table 6. A detailed breakdown of the inventory including pipeline is provided in Table 7.

Table 6
Inventory by Basin

Basin ID	Concrete	PVC
A	2,257	--
B	--	3,741
C	--	6,511
D	3,203	10,703
E	3,245	2,620
F	6,365	2,627
G	5,170	2,702
H	7,105	2,111
I	10,667	--
J	4,226	--
K	4,963	3,168
L	6,780	--
M	1,609	2,468
N	4,513	4,557
O	1,844	6,947
P	2,970	2,841
Q	991	5,629
R	--	5,678
S	3,302	1,349
TOTAL	**69,211**	**63,652**



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NO.	DATE	REVISION	BY

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DR FMK
CHK AHR
APVD

CITY OF WINSTON
SANITARY SEWER MASTER PLAN
WINSTON, OREGON

FIGURE - 7, EXISTING SYSTEM

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Table 7 System Lengths by Pipe Size		
Lineal Feet	**Pipe Size**	**Inch Diameter Miles (IDM)**
1,122	6 inch pipe	1.3
104,058	8 inch pipe	157.7
92	10 inch pipe	1.7
6,855	12 inch pipe	15.6
6,401	15 inch pipe	18.2
2,798	18 inch pipe	9.5
3,449	21 inch pipe	13.7
7,214	24 inch pipe	32.8
47	30 inch pipe	0.3
132,863	**Total**	**250.8**

4.2 Wastewater Collection System Modeling & Inventory

The existing wastewater collection system for the City of Winston was hydraulically modeled using Sewer CAD. The following provides a summary of the approach employed to develop the model and analyze the system.

The existing sanitary sewer system data was first compiled from City of Winston survey information. The manhole rim elevation, pipe invert, pipe size and material, pump information, wet well size and location, and installation dates, etc. were compiled in Sewer CAD and output to a database.

The sanitary sewer flow data was estimated from a combination of the City's sewer system base model, aerial photography, Winston-Green WWTF influent flow data, and Parkway and Snow Avenue pump station flow records.

The sewer model was run in steady-state condition using the existing physical parameters of the system and the estimated I/I data. The model was then calibrated using a combination of flow data collected from the City's Snow Avenue and Parkway Pump Station and the influent flow meter at the WWTF. Flows generated for equivalent households were applied to the model to account for wet season flow conditions.

Dry Weather Flow Diurnal Pattern

The dry weather diurnal pattern was estimated from sanitary flow data. The diurnal pattern was established using the Sewer CAD default applied to the base condition. The peaking factors for peak day were applied to the base sanitary condition to estimate flow conditions during wet weather.

4.3 Basin Descriptions

Basin A

Sewer Basin A is comprised of approximately 364 acres located in the southwest portion of the City. Existing land-use in Basin A is primarily institutional (high school). The Basin A collection system flows by gravity through a series of 8-inch PVC sewer mains. This system discharges directly to the Snow Avenue Lift Station, which is located within Basin D.

There are approximately 191 acres of vacant land zoned for commercial and low and high density residential within the current basin boundaries. For the purposes of this study, and based upon the topography of the land, it was assumed that Basin A would drain through Basin D when developed.

Basin B

Sewer Basin B is located in the west portion of the City, just north of Basin A. Basin B is comprised entirely of residential development. The basin collection system flows by gravity through a series of 8-inch PVC sewer mains tributary to Snow Avenue. Basin B also has an area of residential development in the flood plain which includes STEP tanks and the Lookingglass Lift Station. Basin B encompasses approximately 110 acres, with 22.5 acres of vacant land.

Basin C

Sewer Basin C is comprised of approximately 960 acres in the northwest portion of the City. Basin C is a residential basin. Approximately 245 acres of vacant land remain within this Basin. Much of the City's future development is anticipated in Basin C which is also tributary to the Snow Avenue Lift Station.

Basin D

Sewer Basin D consists of approximately 201 acres including residential and commercial land located in the western half of the City. There are approximately 5 acres of vacant land within Basin D, but the majority is in the flood plain. Basin D includes the Snow Avenue Lift Station.

Basin E

Sewer Basin E consists of approximately 38 acres of residential and commercial land use located in the northern portion of the City. Sewer Basin E straddles Highway 42 and related commercial establishments along the highway. There are approximately 12 acres of vacant land inside Basin E, zoned public reserve and residential. Most residential development in this Basin will occur at low density or be included in infill of existing developments.

Basin F

Basin F consists of approximately 90 acres of mixed residential and commercial land located north and near the center of the City. There are approximately 13 acres of buildable vacant land in Basin F, zoned residential.

Basin G

Sewer Basin G consists of approximately 95 acres of low and high density residential land near the center of the City. Aside from single-family residential dwellings, the Basin includes commercial land along Highway 42.

Basin H

Sewer Basin H consists of approximately 101 acres of low and high density residential land on the north side of the City and commercial land in the center of the City. Basin H is served by some of the original sewer system.

Basin I

Sewer Basin I consists of approximately 81 acres of high density residential and commercial land located in the center of the City. Basin I is served by the original sewer system. This basin includes some of the highest density residential and commercial developments.

Basin J

Sewer Basin J consists of approximately 49 acres of residential and public facility land located near the southern portion of the City. Basin J includes the Winston Dillard Water District's water treatment facility. Much of the sewer system in this basin is the older system.

Basin K

Sewer Basin K is a residential basin located in the south central just north of the City park. Basin K consists of approximately 61 acres of land, all of which is zoned for high and low density residential. Basin K is served by the old sewer system.

Basin L

Sewer Basin L consists of approximately 58 acres of land located in the central portion of the City. Basin L is nearly fully built out with all of the sewer system being served by the older collection system.

Basin M

Basin M consists of approximately 59 acres of residential and public land located in the south portion of the City adjacent to the South Umpqua River. This basin includes two parks and the Parkway Lift Station. Basin M is assumed to be built out.

Basin N

Sewer Basin N consists of approximately 309 acres of land comprised of a mixture of residential land located in the south eastern portion of the City. There is vacant land in the basin however some of the developable land is in the County and therefore utilizes onsite sewer systems.

Basin O

Sewer Basin O is a residential basin located in the eastern portion of the City along the edge of the South Umpqua River valley. Basin O consists of medium density residential areas. Basin O is primarily served by the interceptor sewer, consequently there is no downstream pumping facilities before the WWTF.

Basin P

Sewer Basin P consists of approximately 189 acres of mostly residential land use draining to the main interceptor.

Basin Q

Sewer Basin Q consists of approximately 55 acres of mostly residential land that is located on the east side of the City. Basin Q drains to the City's main interceptor.

Basin R

Basin R includes a small residential area located on the eastern side of the City along Highway 99. The basin includes small area of residential land and commercial land located along the Highway 99 corridor. Basin R drains to the City's main interceptor.

Basin S

Basin S includes a small area of residential land east of the City located in the low lying lands of the South Umpqua River valley. Sanitary flows from Basin S flow directly to the City's main interceptor.

4.4 Allocation of Existing and Future Flows

Existing flows have been allocated throughout the City based on the existing sewer system layout, current land use, and the City's sewer customer database. Future flows have been allocated to the vacant lands according to land-use designations as shown in Figure 8, on the following page. The vacant land inventory includes City Comprehensive Plan data on the density of housing based on land-use criteria. A summary of the potential new units and flows from each respective basin is provided in Table 8, on the following page. The potential new units inside city limit represent an estimate of build-out conditions within the respective Basins inside the existing city limits, growth will only occur outside the UGB and at the density called for by City zoning.

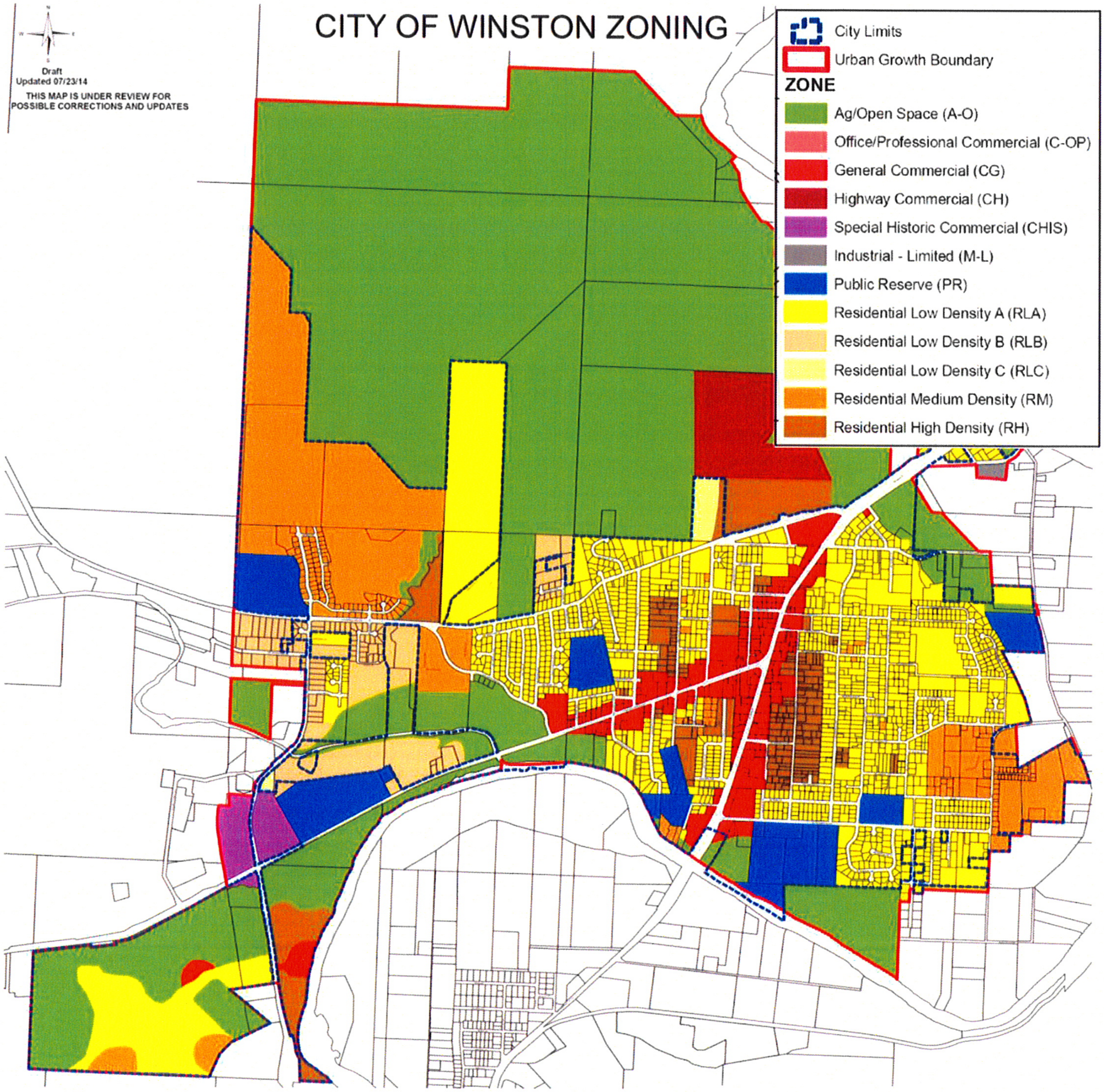
Table 8 Allocation of Existing and Projected Annual Average Flows in Sewer Basins							
Basin	**Area (acres)**	**Existing Units (EDU)**	**Annual Avg. Flow, (gpd)**	**Developable Land[1] (acres)**	**Developable Land Zoning[2]**	**Potential New Units, (EDU)**	**Annual Avg. Flow[3], (gpd)**
A	364	45	17,496	25.25	LD	65	35,451
B	110	17	6,651	22.50	LD	58	24,203
C	960	72	28,218	244.75	LD	629	226,805
D	201	201	78,818	4.70	LD	13	69,292
E	38	99	38,637	11.50	LD	30	41,491
F	90	192	74,973	--	--	--	61,958
G	95	150	58,682	--	--	--	48,495
H	101	153	59,895	4.50	C	12	53,377
I	81	225	88,023	--	--	--	72,742
J	49	121	47,337	--	--	--	39,119
K	61	150	58,682	--	--	--	48,495
L	58	176	68,854	--	--	--	56,901
M	59	71	27,881	--	--	--	23,041
N	309	155	60,731	5.00	LD	13	54,345
O	85	125	48,902	17.50	LD	45	54,962
P	189	61	23,864	16.75	LD	43	33,647
Q	55	110	43,034	5.00	LD	13	39,720
R	450	63	24,811	3.75	LD	10	23,621
S	190	35	13,792	2.00	LD	5	13,060
Totals	**3,544**	**2,222**	**869,278**	**363.20**	**--**	**935**	**1,020,724**

1. Developable land includes all vacant land within the existing City limits with exception of Publically owned land and Ag/Open Space zoned land
2. LD zoning includes all of the City's Low Density Residential Zones.
3. Future Annual Average Flow takes into account a 40% reduction in I/I

4.5 Description of Pumping Facilities

Winston maintains and operates three lift stations are located in the service area and are intended to lift sewage, in a series, from one basin to another with the Parkway pump station discharging into a gravity main line that ultimately discharges into the joint Winston and Green Sanitary district wastewater treatment facility.

Figure 9 illustrates the existing arrangement of pump stations in the City and the basins served by each station. A summary and detailed description of each pump station is provided below:



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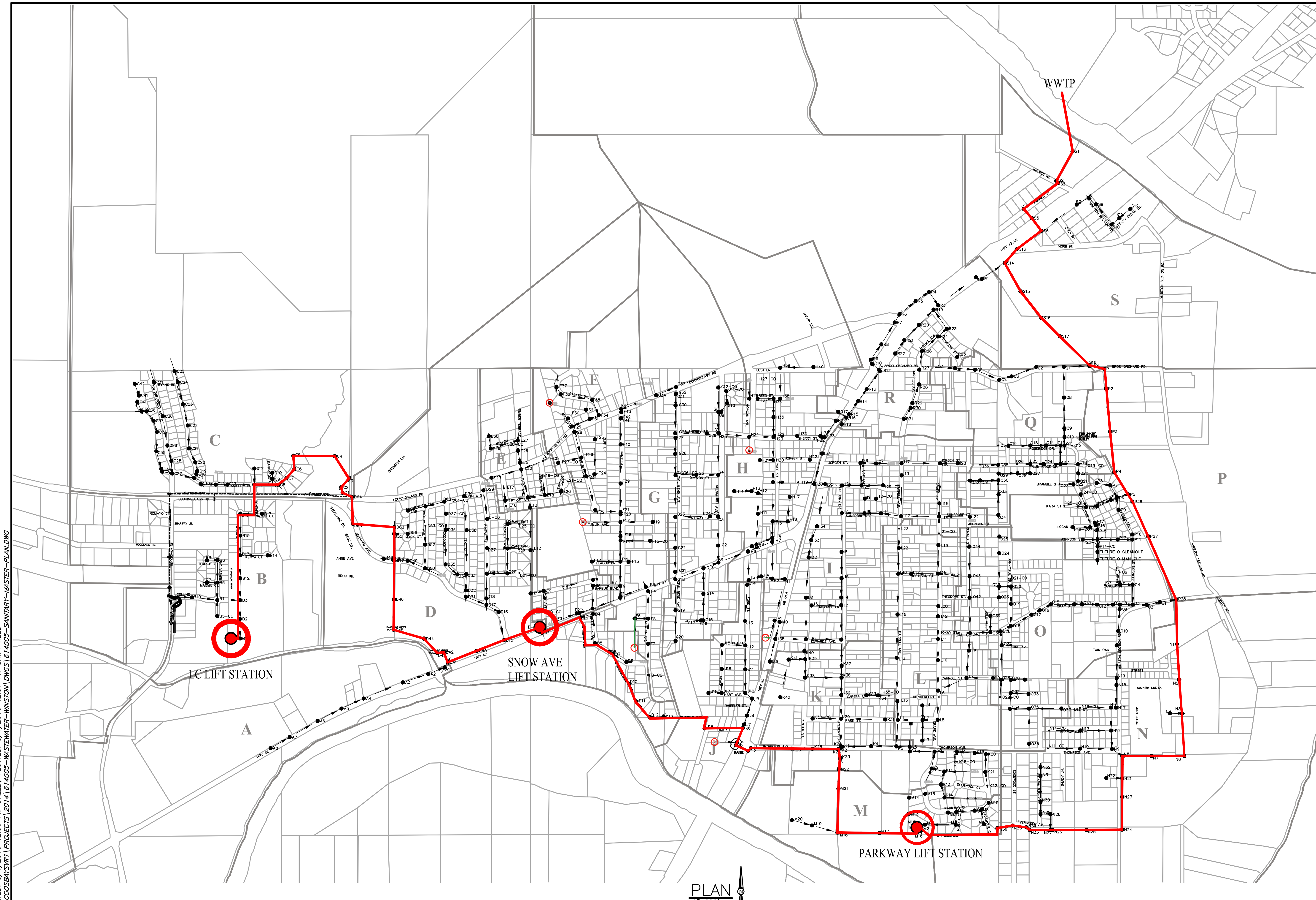

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FIGURE – 9, PUMPING DIAGRAM

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4.5.1 Parkway Pump Station

Parkway Pump Station along with its discharge piping is a relatively new facility which was renovated only a couple of years ago. The Station receives discharge from Snow Ave. Pump Station along with gravity drainage form basins H, I, J, K, L, and M.

Table 9
Parkway Lift Station Design Data

	High Flow Pumps (existing)	Low Flow Pump (new)
Type	Duplex, submersible	Single, submersible
Pump type	Variable speed, non-clog	Variable speed, non-clog
Capacity	1950 gpm @ 101-feet TDH	550 gpm @ 100-feet TDH
Pump HP	100	28
Level control type	Pressure Transducer	
Overflow point	Manhole on park trail, south of adjacent field	
Overflow discharge	Influent sewer line	
Avg. time to overflow	43 Minutes @ wet weather flows	
Auxiliary power type	Permanent diesel generator	
Location	Lift Station	
Output		
Fuel tank capacity		
Transfer switch	Automatic	
Alarm telemetry type	Auto dialer	
EPA reliability class	I	
Force main	12-inch (existing)	6-inch (new)
Length, type	1000-feet, DI & PVC & AC	1000-feet, DI &PVC (C900)
Profile	Ascending	Ascending
Discharge manhole	West end of Evergreen Ave.	West end of Evergreen Ave.
Air/Vacuum release valves	At pump discharge	At pump discharge
Average detention	20 minutes	5 minutes
Sulfide control system	Backdrain	Backdrain

4.5.2 Snow Avenue Pump Station

The Snow Avenue Pump Station unit is located at the intersection of Snow Ave. and Hwy 42. The pump station was installed approximately 35 years ago and is showing its age. The configuration is made up of a wet well, dry pit system with access to the pumps and controls through confined space entrance into the deep, dry pit. Repair parts are becoming difficult to acquire. The station receives flows from Lookingglass Creek Pump station along with gravity flows from Basins A, C, D, E, F, & G.

Table 10 Snow Avenue Pump Station Design Data	
Parameter	**Value/Description**
Station	**Snow Street Pump Station**
Piping:	10-inch
Type:	PVC
Pump Type (2)	Shaft driven self-priming constant speed centrifugal.
Brand:	Hydromatic
Draw down Pump #1 at 100% speed	590 gpm
Draw down Pump #2 at 100% speed	585 gpm
Motors:	25 hp
Drive:	Direct
Impeller Diameter	Unknown
Level Control:	Bubbler with float backup
Auxiliary Power Type:	Portable generator set, stored @ PW Yard
Alarm Type:	Dialer
EPA Reliability Class I:	Yes
Wet Well Diameter:	Circular 8' Diameter, Semi-conical storage bottom, (storage/drawdown)
Wet Well Volume:	375 gal/ft
Force Main	
Length:	2,581 LF
Diameter:	10"
Detention Time @ ADF	36 minutes
Material:	PVC
Profile:	441 LF Ascending, 339 LF Descending,1462 LF Ascending, 339 Descending
Blow-off Valve	
Vacuum Release Valves:	2
Sulfide Control System:	None
Discharge	
Location:	MH J19 at the top of Oak Street
Condition:	Deterioration of concrete
Firm Capacity:	585 gpm

4.5.3 Lookingglass Creek Pump Station

Lookingglass Creek Pump Station is a small more current installation serving a small development area in the southwest corner of the City which makes up drainage basin B. Considering the small number of households served, and minimal potential growth for the area, the pump station may be a little oversized.

Table 11 Lookingglass Creek Pump Station Design Data	
Parameter	**Value/Description**
Station	**Lookingglass Creek Pump Station**
Piping:	6-inch
Type:	Pre-Engineered
Pump Type (2)	Submersible, Flyte
Alarm Type:	Pressure sensor, auto dialer
EPA Reliability Class I:	Yes
Wet Well Diameter:	6'
Wet Well Volume:	470 gallons/cycle, 211 gal/ft
Force Main	
Length:	1935
Diameter:	4"
Detention Time @ ADF	8.1 hours
Material:	PVC
Profile:	ascending
Blow-off Valve	None
Vacuum Release Valves:	none
Sulfide Control System:	Compressed air injection
Discharge	
Location:	Serengeti Drive
Condition:	Good
Firm Capacity:	160 gallons per minute

5.0 Design Criteria and Level of Service

5.1 General

In previous sections of this Master Plan, background information, projections for growth, and the anticipated wastewater flows were developed. A hydraulic model with hydrologic features was prepared to simulate the operation of the system for both current and future conditions. This section builds upon this information by identifying and examining deficiencies within the collection system. Operational strategies are presented that will address the prevention of these types of deficiencies by extending the life of the system. In Section 6, recommendations are presented in the form of a capital improvement plan, which outline alternatives to correct or prevent deficiencies including the anticipated costs. Financial strategies and possible financing agencies are presented in Section 7.

5.2 Inventory of Collection System

Utilizing existing City as-built data, a complete inventory of the collection system was prepared. A summary of the gravity system inventory based on material, and size was provided in

Chapter 4. The areas shaded in Table 12, representing the oldest and most deteriorated material in the system, are shown in red on Figure 10. These areas have been identified as the highest priority for maintenance, investigations, and rehabilitation.

5.3 Basis for System Evaluation

Development of engineering solutions required identifying the goals for the infrastructure based on standard engineering and wastewater operating principals. The following provides a brief discussion concerning the basis for evaluating and planning the City's improvements.

5.3.1 Gravity Sewer Design

Collection systems should be designed considering natural ground slope, subsurface conditions, capacity requirements, minimum slope considerations, minimum flow velocities required to maintain solids suspension, and potential sulfide and odor generation. Whenever possible, gravity collection systems should be utilized for wastewater service rather than systems that require a pump station.

Collection systems should be designed for the ultimate build-out of a sewer basin, taking into account zoning and UGB limitations. This will ensure that the piping is adequate for practically any type and amount of development that may occur within the basin.

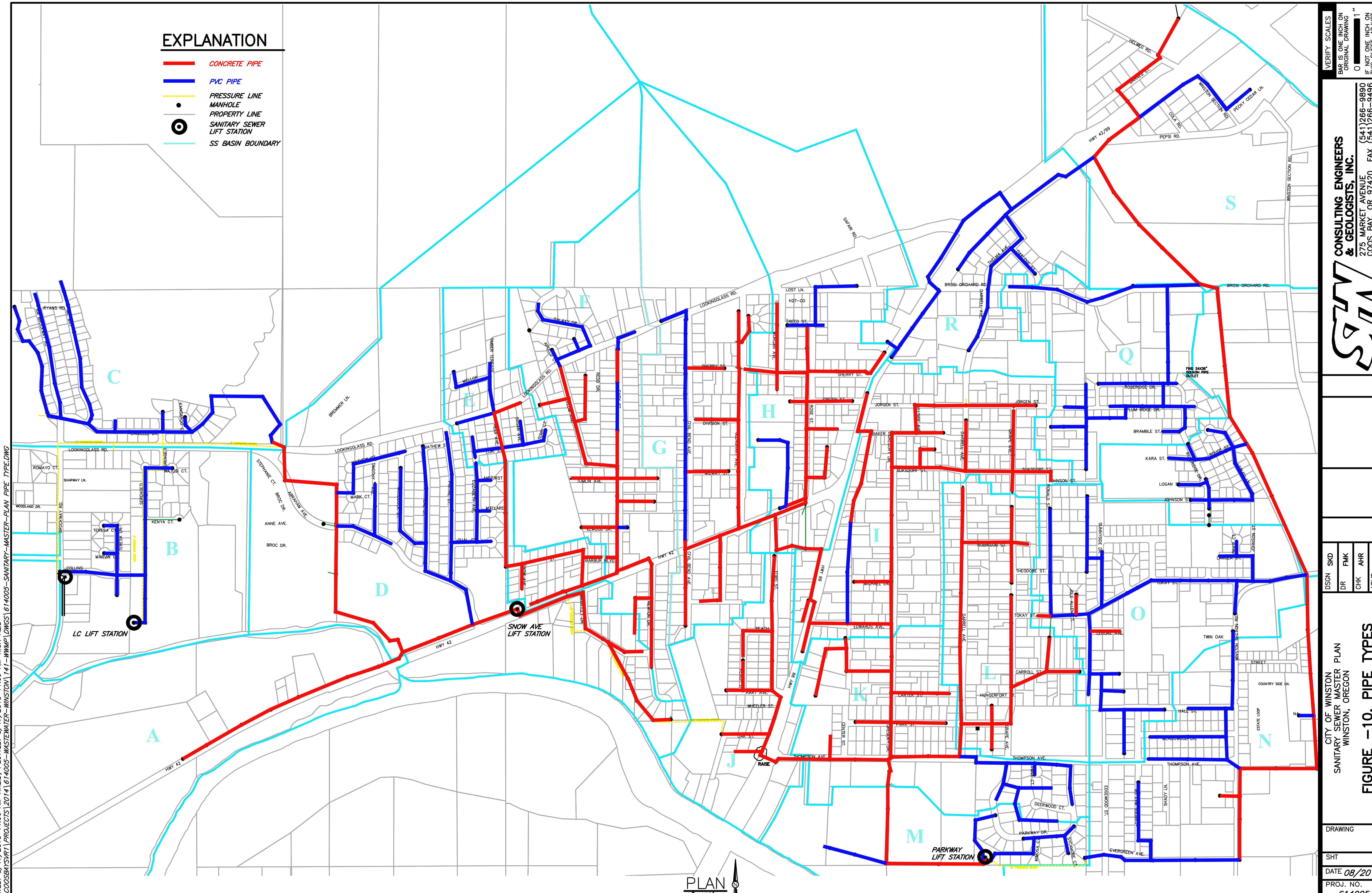
The minimum diameter of sewers should be 8-inches. Smaller sewers are difficult to clean or maintain using modern cleaning, TV-inspection, and repair equipment. Pipe diameter sizing should be based on anticipated flows and master planning, not minimum slope considerations.

Manholes should be spaced no more than 500 feet apart for sewers up to 24-inches in diameter. Manholes should also be constructed where sewer alignment, slope, or pipe size changes occur. To facilitate self cleaning, a "drop" or elevation change should occur from the inlet side of the manhole to the outlet and should be required to be incorporated into the manhole base. Flow channels in manholes should include a minimum 0.1-foot drop when the flow is straight through the manhole. If a manhole is constructed with a channel where the flow direction changes by 90-degrees with piping of the same size, the channel should include a base with a drop of 0.2-feet between the inlet and outlet piping runs.

Manholes should have a minimum inside diameter of 48-inches at the bottom and have a standard 23-inch manhole access opening and lid. Manholes located in areas where standing water is common or in the 100 year flood plain should be constructed with a water tight frame and lid to reduce the inflow into the manhole.

Flat top manholes should be utilized for all manhole installations under 6-feet. Otherwise, standard eccentric cone type manholes should be used. New manholes in Winston should not be provided with integrated ladders in the manhole sections.

Manholes with pipes entering the manhole with inverts two feet or more above the bottom of the manhole should be designed as a drop manhole. An inside drop manhole can be used for all inlets that are 12-inches in diameter or less. Inlets larger than 12-inches will require an outside drop.



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\\COOSBAYSVR1\PROJECTS\2014\614005-WASTEWATER-WINSTON\141-WWMP\DWGS\614005-SANITARY-MASTER-PLAN PIPE TYPE.DWG

Minimum pipe slopes are established to ensure that flow velocities are high enough to provide a self-cleaning action for the gravity piping sections.

Slope is also an important design concern for avoiding hydrogen sulfide problems. Sewers with long, flat pipe runs tend to be prone to hydrogen sulfide generation due to long residence times, poor oxygen transfer, and deposition of solids in the pipe section. Current conventional design practice recommends that a minimum velocity of two feet per second (fps) be achieved regardless of pipe size to maintain a self-cleaning action in sanitary sewers. It is desirable to have a velocity of 3 fps or more whenever topography and existing conditions allow. Minimum pipe slope for service laterals should be 2-percent or ¼-inch drop per foot.

Standard methods of determining the slope for self-cleaning velocities are based on pipes flowing at least half-full. Where flows are expected to be less than half-full and adequate grade (topography) exists, a slope should be used that will provide velocities of three fps for full or half full pipes. In general, minimum pipe slopes should be established based on the information in Table 12.

Table 12
Recommended Slopes for Gravity Sewers (ft/ft)

Nominal Pipe Diameter (in)	Minimum Slope (2 fps)	Recommended Slope (3 fps)
4	0.02	0.02
6	0.0060	0.0110
8	0.0040	0.0075
10	0.0028	.0056
12	0.0022	0.0044
14	0.0016	0.0035
15	0.0015	0.0033
Table 12, Continued		
Nominal Pipe Diameter (in)	**Minimum Slope (2 fps)**	**Recommended Slope (3 fps)**
16	0.0014	0.003
18	0.0012	0.0026
24	0.0008	0.0018
27	0.0007	0.0015
30	0.0006	0.0013
32	0.0005	0.0012
36	0.0005	0.0011

1. Based on a Manning's 'n' of 0.013

While the information in the table above provides the theoretical slopes to attain 2 fps or 3 fps for various pipe sizes, it is not usually considered practical to construct a gravity pipeline at a slope less than 0.2%. Therefore, while larger diameter pipes (larger than 12-inch) could be placed at a flatter slope, practical application will result in pipes with higher capacities and flow velocities than if they were placed at the minimum slopes presented above.

5.3.2 Force Mains

Force mains for public pump stations should have a nominal diameter of at least 4-inches so that they are capable of passing larger solids that are pumped by the solids handling pump stations. In general, velocities of at least 3.5 fps are desirable in force mains to help maintain a self-cleaning or scouring action on the inside of the pipes.

Very high velocities in a force main result in high friction losses and inefficient operations requiring larger pump motors and higher energy costs. Velocities above 8 fps are considered excessive.

According to Oregon DEQ, Oregon Standards for Design and Construction of Wastewater Pump Stations (May 2001); pump discharge lines including force mains shall have a design velocity of 3.5 to 8 feet per second (fps). When variable speed drives are used, flows may be reduced to provide a minimum velocity of 2 fps provided the controls are set to increase pump speed to provide a minimum flushing velocity of 3.5 fps for a short time period at the beginning of each pumping cycle.

The standard for pump station piping shall be cement-mortar lined or plastic-lined ductile iron. The standard for force main piping shall be the same as the station piping however heavy wall PVC (C900) or HDPE may also be used. When force mains require air injection, piping shall be plastic-lined ductile iron or heavy wall PVC or HDPE. In general, piping should use 45° elbows and wyes rather than 90° bends.

In addition to correct sizing of the force mains based around proper cleansing velocities, the number of high points should be kept to a minimum as these will create a point for air and other gases to be trapped. Trapped gases can reduce a pipes capacity or cause a piping system to become plugged. Typically, a designer should include a means of releasing trapped air at high points through the use of a combination air/vacuum release valve designed for sewer service unless air injection is required. If it is determined that velocities are high enough to keep entrained air moving, air release systems may not be required. Proper force main design should also address transient or pressure surges due to sudden velocity changes, especially in long force mains.

Force mains less than 300 feet may be cleaned by conventional methods provided there is access from both the discharge manhole and the station end. Pig launch and retrieval systems shall be provided at all other stations unless waived by the Owner as not being required, particularly at stations equipped with variable speed drives.

Detention times in force mains should also be studied to ensure that sanitary fluids do not reside within the piping too long. If so, high levels of hydrogen sulfide (H_2S) and other gases can form in the sewer causing odor issues, corrosion, and safety concerns. This problem can be reduced by injecting air directly into the force main or backdraining the force main into the wetwell. Generally, the force main shall be designed such that the H_2S concentration remains below 0.1 mg/L at 20°C at the point of discharge into the gravity system. When the detention time in the force main averages more than 35 minutes (during low-flow periods in July-September) H_2S control will be required. When the force main is continuously ascending and of moderate length and size, backdrainage should be considered along with an oversized wetwell. Alternatively, where backdrainage is not feasible, continuous air injection is needed with a design air delivery of 2 SCFM. When air injection is used, the force main may not contain air release valves and careful pump sizing must be used to accommodate air in the force main.

5.3.3 Pump Stations

The correct design of pump (lift) stations is an important and critical element of any sanitary sewer collection system. Pump stations should be designed to handle the peak flows experienced by the system without bypassing or overflowing. The pump stations should also be designed so as not to increase the total sulfide generation potential of the collection system.

Contemporary design practices require some wetwell storage of wastewater plus retention in the force main, both of which tend to increase the potential for sulfide generation. In these cases, supplemental aeration or sulfide treatment must be provided to reduce the production of sulfide.

To minimize sulfide generation, wetwells should be sized to be as small as possible while still allowing for future growth. Consideration should be given to detention times, pump cycle times, and storage volumes when sizing the depth and diameter of the wetwell. Wetwell detention times of 30 minutes or less are recommended to avoid sulfide generation. When detention times in the pump station wetwell exceed 25 to 30 minutes, a system for control of sulfide generation and the accompanying odor and corrosion problems is recommended.

Pumps should be sized so that the station can handle the peak hourly flow rates with the largest pump in the station off line. Stations should be configured around duplex, triplex, or larger and consider all flow ranges when sizing the pumps and combinations of pumps in operation at any one time.

Pump stations should have provisions for redundant power generation equipment. This can be accomplished through a standby generation system housed at the station or through the use of trailer-mounted portable generator and manual transfer switch gear. Power outage frequency and duration must be considered in pump station design to ensure that overflows do not occur due to power outages.

Proper level controls and alarms capable of autodial should be included in each pump station. Redundant high wetwell level sensors or floats should be included as a backup to the regular level sensors.

Designs for pump stations should meet the latest DEQ requirements for pump station design and construction. A summary of the general design criteria for DEQ follows:

Design of the pump station shall include: (per Oregon Standards for Design and Construction of Wastewater Pump Stations, May 2001, Oregon Department of Environmental Quality.)

- A station with firm capacity to pump the peak hourly and peak instantaneous flows associated with the 5-year, 24-hour storm intensity of its tributary area, without overflows from the station or its collection system.
- A design consistent with EPA Class I reliability standards for mechanical and electrical components and alarms.

- A pumping system consisting of multiple pumps, with one spare pump sized for the largest series of same-capacity pumps to provide for system redundancy.
- Pumps with a minimum of five years' service history for a similar duty and size, unless otherwise approved by the Owner. To ensure a valid warranty, pumps shall either be supplied directly by the manufacturer, or by suppliers who are authorized and licensed by the manufacturer to provide manufacturer's warranty services for the pumps to be furnished.
- Inlet, station, and force main piping with all necessary pressure control and measurement features, surge protection systems, air-vacuum/release valves, isolation valves, couplings, odor control systems, and other appurtenances required for a complete and operable system.
- Mechanical systems for heating and ventilating as required by the selected station equipment, local climatic conditions, and applicable codes.
- Plumbing systems for potable water, wash down, and drainage, unless otherwise approved by the Owner.
- Appropriate sound attenuation for noise created by pumping, mechanical, or electrical systems, including a standby generator.
- Electrical systems for lighting, power, communications, security, control, and instrumentation. A motor control center is to be provided for motor starters, accessories, and devices. The motor control center shall provide an isolated, ultra-filtered power, 120 VAC section designed with separate branch circuits for microprocessor-based instrumentation, controls, etc.
- A secondary source of electrical power. Standby generators shall be of sufficient size to start and run the Firm Pumping Capacity of the station, along with all other associated electrical loads necessary to keep the station operational and functioning. At the Owner's discretion, a secondary power feeder from an independent substation may be required as a redundant Oregon Standards for Design and Construction of Wastewater Pump Stations Page 6 power source. With the Owner's approval, the requirement for standby power may be satisfied by providing a trailer-mounted generator and an emergency power connection with manual transfer switch meeting the Owner's specifications.
- A complete system of alarms and alarm telemetry to facilitate operation and maintenance of the station at all hours, including an autodialer or radio telemetry.
- Where required by the Owner, a design to allow remote monitoring of the station through a connection with a Supervisory Control and Data Acquisition (SCADA) system so the Owner can remotely control and monitor station activities. Programmable logic controllers and alarm telemetry must meet the Owner's preferences and standards.
- Structures of adequate size, with interior and exterior clearances to facilitate access for ease of operation and maintenance of all systems. Architectural aspects shall be subject to the Owner's approval.
- Site development including an access road and parking, security, lighting, drainage, signs, and landscaping meeting the Owner's requirements.

5.3.4 Pressure Sewers

Pressure sewer systems include individual pump stations on each parcel of property. Typical pump station equipment includes a grinder pump (GP) or a septic tank effluent pump (STEP). The advantage to a pressure sewer system is that they can generally be installed to provide sewer service independent of ground topology. Also, the pumping equipment and tankage generally become the property and responsibility of the sewer customer and not the municipality. However; Oregon Department of Environmental Quality STEP system guidelines require that, regardless of ownership, the municipality is under complete control of all tanks, pumps, service lines and other components of the system on private and public property.

A STEP system typically includes a small pump and tank. STEP systems typically utilize a 1,000-gallon septic tank with an internal pump that conveys the liquid supernatant to the gravity collection system. Solids remain in the tank and are partially digested through natural processes. Because the effluent experiences some pretreatment and only the supernatant is pumped into the collection system, the strength of the effluent is less than that of GP systems (STEP effluent: BOD_5 100 to 150 mg/L and TSS of 50 to 70 mg/L).

The force main for a single pressure sewer system is much smaller than force mains for large pump stations (1 to 1.5 inch diameter). These small force mains are usually installed in relatively shallow trenches using PVC or HDPE piping. Cleanouts and check valves are utilized to prevent backflow from the collection system and provide access for flushing.

GP systems utilize smaller holding tanks and a pumping system that grinds all solids into small enough pieces to be pumped into the collection system. GP systems should be designed so that a pipe velocity of 3 to 5 fps is achieved at least once every day. Because all solids are ground up and pumped as part of the effluent from a GP system, the strength of the effluent is typically twice that of a STEP system (i.e. BOD and TSS of 350 mg/L).
STEP systems require pump out of system tanks at 3 to 5 year intervals. Owing to their tendency to accumulate grease in the tanks, GP units are often pumped on an annual basis for the purposes of maintenance and cleaning.

The City will no longer accept STEP systems as a part of their facilities. Where gravity service is not readily available, the City will only accept standard grinder pump systems.

5.4 Collections Monitoring Program

In order to monitor conditions in the collection system and develop and implement an ongoing infiltration and inflow reduction program, it is necessary to identify the following:

- Priorities of concern based on the age of the collection system components.
- The impact of high groundwater and rainfall on the collection system.
- Areas in the system with potential for limited hydraulic capacity.
- Areas in the system experiencing blockages or overflow problems.

The ongoing evaluation of the collection system performed by the City operational staff should involve the following inspections and investigative techniques:

1. Expansion of electronic database and record conversion
2. Manhole inspection
3. Smoke testing
4. Line cleaning and closed circuit televising inspection
5. Annual flow mapping studies
6. Flow monitoring data collection and analysis

Expansion of Electronic Database

The City has an extensive database including infrastructure mapping on electronic media. Modeling prepared for this project also provides a recorded benchmark of the system performance based on the data available for the study period. Both records should be maintained and updated as new information becomes available. The City should expand the electronic database into a GIS system that allows access to images of historical records, operational records, and data collected during future collection system investigations.

Methods for retaining records of physical inspections, smoke testing, flow mapping, and flow monitoring should be developed. Future engineering services and/or Construction contracting should include requirements to provide the City with coordinates for, and electronic copies of, any new design layouts or inspections performed on the City's facilities.

Physical Inspections

Records of sewer system inspections involving observing interior and exterior manhole conditions should be recorded in an electronic database. Manhole inspections performed during routine activities should include examining the frame, cover, grade rings, joints between barrel sections, the base, and the pipe penetrations for sources of infiltration, the presence of roots, or deterioration. A standardized checklist form should be developed and carried in the vehicles of the operations staff to document their observations. Over the life of the facility, there should be multiple records of inspection reports for each manhole in the City.

Smoke Testing

There are several methods available for identifying I/I sources in sewer systems. One method, the smoke test, is a relatively inexpensive and quick method for detecting I/I sources (primarily inflow). Smoke testing involves the release of nontoxic smoke into a partitioned section of a sewer system. Visible smoke plumes will emanate from direct openings in the sewer. Ideally, smoke signs will only be observed rising from each house's vent. In practice, smoke signs appear from a variety of locations making this test particularly useful in identifying the following inflow sources:

- Combined storm sewer sections,
- Point source leaks in drainage paths or ponding areas,
- Yard and area drains,
- Roof drains,
- Abandoned building sewers,

- Open clean outs, and
- Faulty service connections.

The City is very familiar with smoke testing and is conscientious of informing customers of these testing activities. A form letter should be prepared that notifies customers of the testing schedule, reason for testing, and the activities that can be expected to occur around the neighborhood. A similar letter is on file that informs customers of any problems relevant to the respective private property. A review of the City policy in relation to private sewer lateral maintenance and repairs should be performed in order that ground rules can be established which benefit both the City and the user.

Recommended smoke testing activities should be scheduled according to the following:

Age of System	Annual Interval Between Smoke Testing
Known problem areas	Within 5 years
New Construction	End of 20 year period
New construction older than 20 years	Once every 15 years or less
Old construction (AC and concrete pipe)	Once every 10 years or less

A notebook and map of the testing areas, year of the test, and the locations of deficiencies in the City system should be prepared. Minor repairs to the system should be completed within one year unless a significant problem is encountered. Where major construction is required but an emergency is not warranted, the project should be added to the capital improvement plan and scheduled according to other project priorities.

Cleaning and Televising

Television inspection and cleaning of sewer mains is an essential collection system-monitoring and maintenance tool. Cleaning provides an effective method for removing excessive grease build-up and line blockages. The existing program implemented by the City should continue.

DVD files, GIS/GPS Data, video logs, and written reports for each pipeline segment should be collected and stored in a database. Based upon an annual rate of 28,000 feet per year, the City would have a complete record of the system within the 5-year planning period. Any new sewers should be televised as a requirement of acceptance and the video record stored in the City's database. Problem areas should be inspected as frequently as required.

Flow Mapping Studies

Flow mapping studies have not been used by the City to evaluate the collection system. Such studies can help review the effectiveness of past repair projects, and to track the growth of I/I flows in problem areas. Each wet season the City should continue to implement a flow-mapping study in a few basins to identify the amount of I/I present in various sections of the collection system. Ideally, the flow monitoring studies should encompass the entire City within a 5-year time frame.

To maintain consistency in timing of the data, the City could establish a study start date based piezometer levels near the City's office or after a target amount of rainfall (i.e. 1 week after a significant rainfall event after 50-percent of the average rainfall in January has occurred).

Results from the annual flow mapping studies should be recorded on a map of the collection system. Any problem areas should be investigated further using CCTV or evaluated for repair using funds dedicated in a replacement budget category.

Flow Monitoring Studies

The City should initiate monitoring flows in the collection system using an open channel flow meter. Candidate basins for flow study should be based on the areas where the majority of the concrete pipe remains or areas where the City operational staff has identified problems. The duration of each installation should be extended to a minimum of three months during the wet season to capture multiple storm induced flow periods. Basin G should be established as the rehabilitation control basin.

Estimated Staffing Requirements for Monitoring Program

Carrying out a successful collection system monitoring program will take a commitment by the City to dedicate staffing hours to perform the functions outlined above. The following are estimates of staff hours to perform selected tasks from the monitoring program:

Manhole Inspection	1 hour per Manhole for inspection and record keeping (crew of two) 8 Manholes per day 680 manholes in system (inspect all on 5 year rotation) 17 person days/year staff time
Smoke Testing	1,200 lineal ft of mainline smoke test/day (3 person crew) 2 week/year smoke testing campaign of identified problem areas 42 person days/year staff time
Clean/TV	1,600 lineal ft of production/day (2 person crew) 28,000 lineal ft. per year (inspect all on 10 year rotation) 35 person days/year staff time
Flow Mapping/Monitoring	3 month/year campaign to monitor identified problem areas Flow monitor installation, periodic reading, recording and data analyses. 60 person days/year staff time

Estimated Total Staff time for Monitoring Program – 154 person days ≈ 2/3 of one FTE
(Note: Estimate of staff time only includes items listed for sewer system. Additional routine maintenance duties are not included in total manpower commitment.)

5.5 Typical System Deficiencies

Based on discussion with City operations staff and one electro scan event, sources of I/I in the collection system have included poor lateral taps, leaky lateral pipelines, leaky pipe joints, structural defects, and root intrusion. Similar problems are anticipated once the sewer system-monitoring program has been implemented. A summary of the types of problems encountered in the last few years is included below.

Major Line Failures

Major pipeline failures have been observed within the system, though somewhat infrequently. However, areas of repeated frequent plugging have been observed.

Spot Failures

Spot failures can occur in many forms including circumferential cracks, holes in the pipe walls, areas of minor root intrusion, chipped and broken pipe joints, displaced or gapped joints, and joints with excessive deflection. Some areas of spot failure may exhibit signs of active or past I/I or downstream sections will have observable quantities of sand and gravel. Often, spot failures are candidates for rehabilitation using modern, highly cost effective, trenchless spot repair techniques.

Leaky Service Laterals

As is the case in many older collection systems, leaky service laterals in the sewer system are contributing sources of the I/I. Service laterals not of PVC material should be scheduled for replacement in any future manhole-to-manhole rehab projects. Laterals should be repaired to the edge of right-of-way where a two way cleanout should be installed.

Heavy Grease Accumulations

There are a few areas which have been identified through the City's Fats, Oils, and Grease Program (FOG) as problem areas associated with grease accumulation. The lack of significant grease accumulation generally indicates effective grease removal mechanisms on commercial establishments or frequent cleaning by the City or both.

The removal of grease from the sewer system is important to the proper operation of the system because excessive accumulation of grease can lead to clogging, backflow, and flooding problems. Enforcement of the City's grease trap ordinances and ongoing inspections are a priority for the City. Annual cleaning of lines experiencing grease accumulation should also be considered as part of the City's routine maintenance program. The problem areas should be highlighted on the Public Works cleaning schedule.

Leaky Manholes

Physical observations made during routine inspections have identified a few manholes that allow infiltration into the system. Manholes should be rehabilitated using grouts and special lining materials. Manhole rehab projects can be performed quickly. Annual programs are often very effective means of repairing existing manholes.

Root Intrusion

Root intrusion is believed to be the single largest cause of sewage spills in the United States. Uncontrolled, root intrusions will grow and eventually lead to massive root balls that clog sewers and destroy the pipe. Root controls such as Root – X and root routing followed by a spot repair liner (in massive root problem areas) should be periodically performed whenever a root problem is encountered. Laterals and mainline sections with frequent root intrusion problems should be scheduled for point repair.

Pipes with little to no slope (Flat Grade Pipes)

As a result of mapping and modeling the existing sanitary collection system within the City, it has become apparent that there are considerable lengths of sewer piping which was installed at grades which do not allow wastewater to flow at minimal scouring velocities (2 ft./sec.). With low scour velocities, pipes have a tendency to accumulate solids in the bottom of the pipe. Annual cleaning of flat grade pipes should also be considered as part of the City's routine maintenance program**.** The problem areas should be highlighted on the Public Works cleaning schedule.

5.6 Collection System Improvement Programs

Repair and rehabilitation of the sewer main lines and lateral connections will maintain or reduce the I/I levels currently present in the system. Based on the analysis performed in the preceding section, eventually the City will need to address capacity limitations at the WWTF induced by I/I in the collection system unless a 40 percent I/I reduction is achieved. Therefore, a major sewer rehabilitation project is envisioned, however, smaller projects that are phased over several years as sewer monitoring and I/I flow mapping data indicate. The description of alternatives presented below is based on this approach.

Complete Pipe Replacement

Pipeline replacement by conventional "cut and cover" means is normally required when the existing pipeline is either undersized or deteriorated so badly that other methods of rehabilitation are not feasible.

The obvious advantage of pipe replacement is the service life gained with modern materials and methods, which is generally accepted as more than 50 years. The cost of replacement, though, is generally two times higher than rehabilitation and the associated inconveniences and restoration required can be bothersome to the public. Replacing pipelines also removes any "incidental" I/I (i.e. minor leaks that would not individually be cost effective to remove). Complete replacement also provides the opportunity to correct any misalignments, increase the hydraulic capacity of the line, repair service connections, or eliminate storm water entry points such as catch basins. Complete replacement of a deteriorated pipe segment should therefore significantly reduce I/I especially if service laterals can be replaced to the property line. When rehabilitation of sewers using alternative "trenchless" methodologies is employed, replacement of lateral sewers by conventional construction is typically still required.

Cured In Place Pipe Rehabilitation

Cured in place pipe (CIPP) is best described as "manufacturing a new pipe within an existing pipe". A CIPP installation uses a plastic lined felt bag that has been impregnated with resins. The impregnated bag is lifted over an existing manhole and inverted (turned inside out) allowing the plastic exterior to be turned inward. The inner space of the bag is then filled with water or air pressure to extend the inverted bag into the existing pipe. The weight of water or air pressure drives the bag's inversion until the entire section of liner has been turned inside out and the end has been retrieved at the downstream manhole. Once the liner is in place, it is filled with hot water or steam to force the resin-impregnated material against the interior surface of the existing sewer pipe. The heated water or steam causes the resins in the bag to cure and harden into a new pipe.

The use of CIPP lining is appropriate for pipelines requiring minor structural repair, sealing holes, leaky joints, and leaky misalignments and for correcting corrosion problems. Because this method of rehabilitation does not require excavations, it may be used under highways, railroads, and buildings. Openings for service lateral connections are typically made with special cutters and sealers from inside the pipe. The entire process typically requires less than 24-hours to complete for each manhole section lined. In larger sewer lines, the 24-hour time frame requires the use of bypass pumping equipment to convey flows around the work area. If properly completed, the service life of a cured-in-place pipe has been claimed by several lining manufacturers to be 50 years. In most cases, CIPP provides an economically preferable alternative to complete pipe replacement, often costing less than half the cost of a new cut pipeline.

There is approximately 65,000 lineal feet of old (60 years) concrete pipe in the City's sewer system. These sections of the sewer system require manhole-to-manhole rehabilitation. Rehabilitation of these sewers is necessary to prevent escalation of I/I causing capacity issues at pump stations or the WWTF and to complete the work before the sewer deteriorates to a condition that the pipe can no longer be rehabilitated.

Grouting

Chemical grouting of manholes is recommended for the majority of smaller manhole repairs required within the City. Chemical grouts used for rehabilitation of sewers include acrylamide, acrylate, or urethane gels. Typical applications consist of two separate chemicals that are pumped through separate hoses to the joint or manhole being sealed. Once the two chemicals are mixed together they are pumped through the defect to the exterior of the structure where the mixture forms a gel or foam that expands around the defect and into the surrounding earth. Typical applications include one tank to mix and dispense the grout and another tank to mix and dispense a catalyst. Once mixed, the catalyst initiates a chemical reaction changing both liquids into a gel (grout). Depending upon the amount of catalyst utilized, the time required to form the grout can be adjusted from a few seconds to several minutes.

The latest and most promising application of grouting is the development of lateral packer. Lateral packers are similar to joint packers except that a packer gland is extended up the service line allowing the connection and several joints to be grouted in one application. Lateral packing can be used in conjunction with CIPP lining when only minor defects are observed at the connection.

Chemical grouting does not improve the structural strength of a pipeline or manhole, therefore this method of rehabilitation should not be used on facilities that are badly broken or deteriorated. If the groundwater table drops below the level of the pipe, the chemical grout may become dehydrated and its useful life shortened. Also, many chemical grouts do not have shear strength and will tear or fracture if a load is applied to the surrounding earth. When used appropriately, rehabilitation by chemical grouting should serve a useful life of ten years.

Manhole Repairs

The City should conduct yearly manhole inspections to identify if any major structural repairs or corrosion prevention are required. A goal of completing up to 60 inspections per year will allow the City to inspect all of the manholes in the system in just under 10 years. In the case of a major structural repair, the City should develop experience with a preferred manhole lining system. In addition to manhole rehabilitation, it is recommended that the City continue to install manhole lid liners to seal manhole lids in potential inflow areas. It is recommended that the City stock lid liners for this purpose.

Internal Spot Repairs

There are two highly effective methods for performing internal spot repairs without requiring excavations. The two methods are Link-Pipe and ambient cured soft liners. Each method has its advantages.

Link-Pipe is a stainless steel grouting sleeve that is used to accomplish small spot repairs within a sewer line; these sleeves come in a variety of lengths—12, 18, 24 and 36 inches—and diameters ranging between four and 36 inches. Link-Pipe can be used to restore partially collapsed pipes, replace collapsed pipes, close holes created by material loss in pipe walls, and seal infiltrating cracked pipes and pipe joints. This method of rehabilitation requires no trenching and can be performed without bypassing water.

The second method of performing a spot repair is to install an ambient cure soft liner. This type of liner is very similar to CIPP except that the liner does not require an inversion system and the resin does not require an external heat source to harden. Spot repair liners are especially applicable when a section of pipe requires a repair over a few feet in length. Another advantage of an ambient cure liner is that it can be used to repair laterals with or without having to excavate at the mainline connection. A special feature of an ambient cure lateral liner was the invention of a 'top hat.' This mechanism can be inserted and used to seal the lateral connection at the main.

Lateral and Mainline Point Repairs

Mainline and service point repairs describe the installation of short sections of new sewer pipe or new lateral connections using conventional open cut construction techniques. These repairs will require excavation, pipe replacement, and reconnection. Lateral repairs will require installation of new sewer lateral piping and a new connection to the main.

6.0 Capital Improvement Plan

6.1 Basis of Capital Improvement Cost Estimates

The estimated construction costs in this Section are based on actual construction bidding results from similar work, published cost guides, and other construction cost experience. Reference was made to the available drawings of the existing facilities to determine construction quantities. Where required, estimates were based on preliminary layouts of the proposed improvements. Construction costs are based on the anticipation cost of construction starting in the year 2015.

Contingencies

A contingency factor equal to 20 percent of the estimated construction cost has been added. Recognizing the cost estimates are based on concepts only, allowances must be made for variations in final quantities, bidding market conditions, adverse construction conditions, unanticipated specialized investigations, and other difficulties which cannot be foreseen at this time but which may tend to increase final costs.

6.2 Basis for Cost Estimate

The construction cost estimates presented in this Plan will include a number of basic components, each of which is discussed in the following sections. The estimates presented are preliminary and are based on the level of detail and planning presented in the Master Plan. As projects proceed and as site specific and new information becomes available, the estimates should be reviewed and updated.

6.2.1 Construction Costs

Construction costs are estimated using a combination of engineering experience with similar past projects, material cost data provided by equipment suppliers, and material and labor cost estimates and indexes published by such sources as the Engineering News Record and others.

Whenever possible, existing as-built drawings were studied to determine the scope of work required for constructing and implementing improvements to existing facilities. When appropriate, preliminary layouts were developed and utilized when preparing construction cost estimates.

Future changes in the cost of labor, equipment and materials will justify comparable changes in the cost estimates provided in this Plan. For this reason, common engineering practice is to tie planning cost estimates to a construction index which is updated regularly in response to changes in the economy and the construction marketplace.

The Engineering News Record (ENR) construction cost index (CCI) is commonly used for engineering planning and estimating purposes. The ENR index is based on a beginning value of 100 established in the year 1913. Cost estimates prepared in this plan are based on April 2015 costs and "linked" directly to an ENR index of 7722. Future ENR indices can be used to calculate the estimated cost of projects for future construction times using the following method:
Updated Cost Estimate = Plan Cost Estimate x (current ENR CCI / 7722)

If specific ENR index figures are not available, the historical ENR growth pattern has been around 3.6% per year.

6.2.2 Contingencies

Contingencies are a prudent inclusion in planning cost estimates to account for unforeseen circumstances that may increase costs. For the purposes of this planning document and the preliminary cost estimates provided, a contingency amount between 15 and 25 percent of the estimated construction cost is used depending on the available information, number of unknowns, and other potential unknown factors that could affect the final project costs. After design work is completed for a project and updated construction cost estimates are completed, contingency is typically reduced to 10% for estimates used immediately prior to construction.

While efforts have been made to provide costs for all facets of the proposed projects, it is appropriate that allowances be made for variations in the final design, bidding market conditions, adverse construction conditions, unanticipated specialized investigation and studies, and other difficulties which cannot be foreseen at this time but may tend to increase the final costs of the proposed projects.

6.2.3 Engineering

The cost of engineering services for major capital improvement projects typically include surveying, foundation explorations, preparation of contract documents and project drawings, development of construction and material specifications, bidding services, construction management, inspection, construction staking, start up services, and the preparation of operation and maintenance manuals.

Depending on the size and type of the project and the required scope of engineering services, engineering costs may range between 18 to 25 percent.

In some cases, additional engineering or technical services may be required such as flow studies, predesign reports, environmental reports or others. These additional services would typically be in addition to the regular engineering services covering surveying, design, bidding, construction management, and construction inspection.

For the purposes of conservative planning, the cost estimates prepared in this Master Plan assume that all projects will require a relatively comprehensive and complete scope of engineering services. Therefore, an engineering cost of 20% is assumed for nearly all projects. In the future, if it is determined that some projects will not warrant this level of service, the cost for engineering on those projects can be reduced. On the other hand, smaller and less expensive projects may warrant a higher engineering cost percentage.

6.2.4 Legal and Administrative

Legal and administrative costs include such items as legal counsel review of contracts and contract documents, costs related to obtaining and recording easements and permits, additional administration expenses occurring during a project, and other miscellaneous legal and administrative costs.

This cost category also includes potential costs for internal budget planning, grant administration, liaison costs, interest on interim loan financing, advertising and other non-construction costs related to the projects. A cost equal to 3% of the estimated construction cost is used for the estimates in this Plan.

6.2.5 Land Acquisition Costs

On occasion projects require the acquisition of land for placement of new piping, pump stations, or other system components when available property is not available on an existing site or within an existing public right-of-way. In some cases, a property owner will require reimbursement for providing an easement across his/her property. An effort was made in the plan to anticipate and identify which projects would require land or easement acquisition. For these projects, costs have been included for the purchase of additional properties for the improvements.

Property costs can vary depending on location, market volatility, owner's willingness to sell, and many other factors. In some cases, the City may have to condemn property when an owner is unwilling to sell and no alternative site is available. If needed, the condemnation process also has significant costs associated with it.

When a project is undertaken, the City should review the potential need for land acquisition. If it is determined that additional land is required, the costs for the acquisition of that land should be reviewed and updated based on the land cost climate at the time.

6.2.6 Other Studies and Special Investigations

In some cases, predesign reports, environmental reports, archeological investigations, special flow studies, and other investigations may be required prior to beginning actual design activities for a project. These studies may be driven by funding or regulatory agencies or by special needs of a specific project.

An effort has been made to identify projects where these special studies will most likely be required. However, the need for these investigations and studies will be confirmed on a case by case basis throughout the planning period.

7.0 Development and Evaluation of Alternatives

7.1 Pump Station Improvement Alternatives

Because the Winston system is primarily a wastewater conveyance system, it stands to reason that the system's pump stations must be well maintained and sized properly to convey existing and future wastewater flows.

This section will address each station, its condition, deficiencies (if any) and develop alternatives for the improvements that are required to satisfy existing and future capacity and infrastructure needs.

7.1.1 Snow Ave. Pump Station

The existing firm capacity of the Snow Ave. Pump Station is 585 gpm. The required 20-year firm capacity of Snow Ave. Pump Station is projected to be 840 gpm. This flow includes all flow from Looking Glass Pump Station as well as gravity flows from Basin A, B, C, D, E & F. The velocity in the existing 10-inch force main at a flow of 840 gpm is 3.4 fps which is within the acceptable range. The minimum flow from the pump station to maintain a force main velocity of 3.5 fps is 860 gpm. If variable speed drives are employed and an initial flushing flow of at least 860 gpm is provided, flows may then be reduced to 490 gpm during summer months if needed resulting in a 2 fps force main velocity.

A summary of the deficiencies identified for Snow Avenue Pump Station include:

1. The 35-year old station has passed its useful life suffering frequent failures and the City is experiencing difficulties in obtaining replacement parts.
2. The station is a wet well/dry well configuration requiring confined space entry protocol in order to perform routine maintenance and inspections.
3. There is no on-site back-up power supply for the station
4. The Station Capacity will not meet projected growth requirements
5. Wet well capacity is less than half of recommended capacity.
6. The metal dry well walls are experiencing deterioration (pin holes observed in metal).

The force main for Snow Ave. station is an existing 10-inch PVC pipe with a length of 2,581 feet and a volume of 10,529 gallons. The force main begins at the station and terminates at MH J-19. The existing concrete wetwell is 8 feet in diameter with 7.5 feet of water depth between the wetwell invert and the high water alarm. The start/stop range with a single pump operating is 2 feet, or equivalent to approximately 450 gallons storage between cycles.

The number of EDUs served by Snow Street Pump Station is projected to increase from an estimated 464 EDU to a total of 1,229 over 20 years.
Snow Ave. Pump Station requires improvements and an increase in capacity. Alternatives to consider include construction of a new pump station adjacent to the existing one, a new station across the highway from the existing or installation of new equipment and larger pumps in the existing station.

Snow Ave. Pump Station – Option A, New Equipment and Control Building at Existing Station

New pumping equipment is required to handle 840 gpm at a total dynamic head of approximately 56 feet. At least two pumps are required, each having a capacity of 840 gpm. The pumps will require motors of approximately 20 Hp each. Two submersible pumps of this size fit inside the existing 96-inch diameter wetwell. The controls would have to be relocated from the existing dry well to a new control building on site. The depth of the existing wet well limits the capacity of the structure to between 400-500 gallons, which is insufficient to keep the minimum time between pump starts between eight to ten minutes, or roughly six starts per hour New pumping equipment located in the existing wetwell is not a viable option.

Snow Ave. Pump Station – Option B, New Pump Station

A new wetwell with a minimum diameter of 10 feet is recommended. The existing 10-inch force main can continue to be used. Two submersible pumps with motors of approximately 20 Hp will be installed in the wetwell. A pump control building with back-up generator will also be part of the new station installation project.

Table 13 Snow Ave. Pump Station Replacement					
ITEM NO.	ITEM DESCRIPTION	UNIT	EST. QTY.	UNIT PRICE	TOTAL PRICE
1	Mobilization	LS	100%	$55,000	$55,000
2	Site Preparation, Temporary Fac. and Controls	LS	100%	$30,000	$30,000
3	Demolition of Existing Structure	LS	100%	$20,000	$20,000
4	10 ft Diameter Concrete Wet Well	LS	100%	$75,000	$75,000
5	Pumps	LS	100%	$80,000	$80,000
6	Control Building	LS	100%	$75,000	$75,000
7	Pump Controls	LS	100%	$35,000	$35,000
8	Pipe and Fittings	LS	100%	$25,000	$25000,
9	Valve Vault	EA	1	$12,000	$12,000
10	Earthwork	LS	100%	$2,500	$2,500
11	Potable Water (meter/service)	LS	100%	$6,500	$6,500
12	Site Work (Fencing, Landscaping etc.)	LS	100%	$15,000	$15,000
13	Discharge Manholes	EA	3	$6,000	$18,000
14	Backup Power, (Generator)	EA	1	50,000	$50,000
15	Clean Up and Surface Restoration	LS	100%	$5,000	$5,000
Subtotal (estimated construction cost)					**$497,500**
Engineering (Design and Construction Period Services,(20% of Construction Cost))					$99,500
Contingency (20% of Construction Cost)					$99,500
Administration (3% of Construction Cost)					$14,925
Total					**$711,425**

There has been some discussion associated with the possible need to relocate Snow Ave. Pump Station to a location across roadway to the south side of Hwy 42. A pre-design report for the proposed project will have to address this issue and possible additional costs for the relocation.

7.1.2 Lookingglass Creek Pump Station

The existing firm capacity of Lookingglass Creek Pump Station is 160 gpm. The station receives flow only from residential development situated in Basin B. The required 20-year firm capacity of Lookingglass Creek Pump Station is projected to be approximately 51 gpm. The velocity in the existing 4-inch force main at a flow of 120 gpm is 4.0 fps which is within the acceptable range. The minimum flow from the pump station to maintain a force main velocity of 2.0 fps is 80 gpm. It appears the pump station will accommodate any projected future growth associated with the drainage area. The pumps at this station may be oversized for the service area. At dry weather flows, the station experiences about 6 starts/hr, which is acceptable.

The force main for Snow Ave. station is an existing 4-inch pipe with a length of 1,935 feet and a volume of 170 gallons. The force main begins at the station and terminates at MH C-11. The existing concrete wetwell is 4 feet in diameter. This report has no recommendations for improving the pump station.

The number of EDUs served by Snow Street Pump Station is projected to increase from an estimated 17 EDU to a total of 75 over the 20 year planning period.

7.1.3 Parkway Pump Station

The existing firm capacity of the Parkway Pump Station is 1,950 gpm for the high flow duplex pump operation and 550 gpm for the low flow single pump operation. The required 20-year firm capacity of Snow Ave. Pump Station is 840 gpm. Flows for Parkway includes all flow from Snow Ave. Pump Station as well as gravity flows from Basins G, H, I, J, K, L & M. The velocity in the existing 12-inch force main at a flow of 1,950 gpm is 5.5 fps which is within the acceptable range. The velocity in the existing 6-inch force main at a flow of 550 gpm is 6.24 fps which is also within the acceptable range

The force mains for Parkway station consist of a low flow force main of 6" diameter and a high flow force main of 12" diameter. Both mains begin at the station and terminate at MH J-14. Both force mains are approximately 1,000 feet in length.

The number of EDUs served by Parkway Pump Station is projected to increase from an estimated 1,575 EDU to a total of 2,382 over 20 year planning period. Parkway Pump Station is a relatively new facility which was also renovated only a couple of years ago. This report has no recommendations for improving the pump station.

7.2 Wastewater Collection System Piping Projects

7.2.1 Leaky, Old, Pipe Replacement/Renovation

Infiltration and Inflow (I/I) represents a significant portion of the total flows that must be handled by the Winston wastewater collection system. Infiltration exists throughout the system in a majority of the sub basins. Metcalf & Eddy's text "*Wastewater Engineering: Collection and Pumping of Wastewater*", suggests that infiltration rates for whole collection systems (including service connections) that are greater than 1500 gpd/IDM are considered excessive. This standard, using inch diameter-miles (IDM,) considers infiltration with regard to length and diameter of collection system piping. Table 14 represents and inventory of Winston's pipe in respect to length and diameter and shows the subsequent IDM for each size along with a total IDM for the System.

Table 14
System Lengths by Pipe Size

Lineal Feet	Pipe Size	IDM
1,122	6 inch pipe	1.3
104,058	8 inch pipe	157.7
920	10 inch pipe	1.7

Table 14, Continued		
Lineal Feet	**Pipe Size**	**IDM**
6,855	12 inch pipe	15.6
6,401	15 inch pipe	18.2
2,798	18 inch pipe	9.5
3,449	21 inch pipe	13.7
7,214	24 inch pipe	32.8
47	30 inch pipe	0.3
132,863	**TOTAL**	**250.8**
	Total miles of pipe	**25.16**

Comparing daily flow and rainfall data obtained from treatment plant operational records, during extended periods without significant rainfall during wet weather/high groundwater periods, an infiltration contribution of approximately .71 mgd was determined to occur. Considering the infiltration and IDM of the system, the City experiences an infiltration rate of approximately 3,000 gpd/IDM. That figure is twice the level of the standard threshold for determining excessive I/I.

Considering that over half of the City's collection system is comprised of older concrete pipe, the high infiltration rate is to be expected. Older concrete pipe, compared to PVC or HDP plastic pipes, has 3 -4 times as many joints per equivalent length which are typically not as watertight as the plastic pipes nor as flexible, leading to displaced joints and more avenues for infiltration to be introduced into the system. Concrete pipe also has a tendency to deteriorate over time much more extensively than plastic pies sewer gasses and being much more rigid it cracks easily.

These issues all lead up to the need for the City to initiate a rehabilitation program for its aging concrete sewer pipes. With advances in trenchless technologies, it is anticipated that the majority of the concrete sewer line renovations can be accomplished through installation of cured in place pipe (CIPP) system. This method of rehabilitation results in a sealed system without the need for major "dig and replace" operations. Typically, CIPP projects cost about half as much as direct burial replacement work and results in a water-tight, 50 plus year lifetime system. Prior to performing a CIPP project, a detailed video analyses of the area in question will need to be performed to confirm the system under consideration is sound enough for this method.

Upon reviewing comparative proportions of concrete system and age of each system, basins E, F, H, I, K, and L are proposed to be the focus for a concrete pipe renovation program. The following tables represent cost estimates for performing CIPP renovations to concrete pipe in each candidate drainage basin.

Table 15 Basin E Renovation Estimate				
Item	**Unit**	**Estimated Quantity**	**Unit Price**	**Total Cost**
Mobilization	LS	100%	$14,536.00	$14,536
Site Prep., Temp. Facilities, and Controls	LS	100%	$14,536.00	$14,536
Pre- and Post Cleaning & CCTV Insp.	LF	3,245	$3.50	$11,359

Table 15, Continued				
Item	**Unit**	**Estimated Quantity**	**Unit Price**	**Total Cost**
CIPP Lining 8-inch	LF	3,245	$32.00	$103,855
Internal Lateral Reinstatement	EA		$1,800.00	$0
External Lateral Reinstatement	EA	39	$4,500.00	$175,500
Clean Up and Surface Restoration	LS	100%	$5,814.00	$5,814
			Subtotal Construction Cost	**$325,599**
		Engineering	20%	65,120
		Contingency	20%	65,120
			TOTAL	**$455,839**

Table 16
Basin F Renovation Estimate

Item	Unit	Estimated Quantity	Unit Price	Total Cost
Mobilization	LS	100%	$37,847.00	$37,847
Site Prep., Temp. Facilities, and Controls	LS	100%	$37,847.00	$37,847
Pre- and Post Cleaning & CCTV Insp.	LF	6,365	$3.50	$22,277
CIPP Lining 8-inch	LF	6,365	$32.00	$203,673
Internal Lateral Reinstatement	EA		$1,800.00	$0
External Lateral Reinstatement	EA	118	$4,500.00	$531,000
Clean Up and Surface Restoration	LS	100%	$15,139.00	$15,139
			Subtotal Construction Cost	**$847,784**
		Engineering	20%	169,557
		Contingency	20%	169,557
			TOTAL	**$1,186,897**

Table 17
Basin H Renovation Estimate

Item	Unit	Estimated Quantity	Unit Price	Total Cost
Mobilization	LS	100%	$36,458.00	$36,458
Site Prep., Temp. Facilities, and Controls	LS	100%	$36,458.00	$36,458
Pre- and Post Cleaning & CCTV Insp.	LF	7,105	$3.50	$24,866
CIPP Lining 8-inch	LF	5,275	$32.00	$168,788
CIPP Lining 12-inch	LF	1,200	$48.00	$57,600
CIPP Lining 15-inch	LF	630	$56.00	$35,280
Internal Lateral Reinstatement	EA		$1,800.00	$0
External Lateral Reinstatement	EA	119	$4,500.00	$535,500
Clean Up and Surface Restoration	LS	100%	$14,583.00	$14,583

Table 17, Continued Basin H Renovation Estimate		
Subtotal Construction Cost		**$909,533**
Engineering	20%	181,907
Contingency	20%	181,907
TOTAL		**$1,273,347**

Table 18
Basin I Renovation Estimate

Item	Unit	Estimated Quantity	Unit Price	Total Cost
Mobilization	LS	100%	$61,536.00	$61,536
Site Prep., Temp. Facilities, and Controls	LS	100%	$61,536.00	$61,536
Pre- and Post Cleaning & CCTV Insp.	LF	10,667	$3.50	$37,334
CIPP Lining 8-inch	LF	8,887	$32.00	$284,381
CIPP Lining 15-inch	LF	1,780	$56.00	$99,680
Internal Lateral Reinstatement	EA		$1,800.00	$0
External Lateral Reinstatement	EA	202	$4,500.00	$909,000
Clean Up and Surface Restoration	LS	100%	$24,614.00	$24,614
			Subtotal Construction Cost	**$1,478,082**
		Engineering	20%	295,616
		Contingency	20%	295,616
			TOTAL	**$2,069,314**

Table 19
Basin K Renovation Estimate

Item	Unit	Estimated Quantity	Unit Price	Total Cost
Mobilization	LS	100%	$31,814	$31,814
Site Prep., Temp. Facilities, and Controls	LS	100%	$31,814.00	$31,814
Pre- and Post Cleaning & CCTV Insp.	LF	4,226	$3.50	$14,790
CIPP Lining 8-inch	LF	2,406	$32.00	$76,987
CIPP Lining 12-inch	LF	120	$48.00	$5,760
CIPP Lining 15-inch	LF	1,700	$56.00	$95,200
Internal Lateral Reinstatement	EA		$1,800.00	$0
External Lateral Reinstatement	EA	121	$4,500.00	$544,500
Clean Up and Surface Restoration	LS	100%	$12,726.00	$12,726
			Subtotal Construction Cost	**$813,590**
		Engineering	20%	162,718
		Contingency	20%	162,718
			TOTAL	**$1,139,026**

Table 20 Basin L Renovation Estimate				
Item	Unit	Estimated Quantity	Unit Price	Total Cost
Mobilization	LS	100%	$49,835.00	$49,835
Site Prep., Temp. Facilities, and Controls	LS	100%	$49,835.00	$49,835
Pre- and Post Cleaning & CCTV Insp.	LF	6,780	$3.50	$23,732
CIPP Lining 8-inch	LF	6,780	$32.00	$216,975
Internal Lateral Reinstatement	EA		$1,800.00	$0
External Lateral Reinstatement	EA	168	$4,500.00	$756,000
Clean Up and Surface Restoration	LS	100%	$19,934.00	$19,934
			Subtotal Construction Cost	**$1,116,311**
		Engineering	20%	223,262
		Contingency	20%	223,262
			TOTAL	**$1,562,836**

Total estimated costs for renovating the City's old, leaky pipe system in the targeted basins is approximately $7.7 million.

7.2.2 Flood Proofing

A portion of the City's collection system has been installed within low lying areas that are prone to flooding. In order to reduce the affects of flooding on those parts of the system, the City needs to consider flood proofing those facilities. The primary introduction of flood waters into the collection system would be through the manholes. It is recommended that the City enter into a manhole sealing project which would include sealing the internal portions of the main barrel, cone and risers along with sealing the lids. Forty Five (45) manholes have been identified as needing a sealing treatment to prevent flood water intrusion. The following is the estimated costs for performing the project:

Table 21 Flood proof Low Lying System				
Item	**Unit**	**Estimated Quantity**	**Unit Price**	**Total Estimated Cost**
Mobilization	LS	100%	$11,250.00	$11,250
Site Prep., Temp. Facilities, and Controls	LS	100%	$11,250.00	$11,250
Man hole Sealing	EA	45	$5,000.00	$225,000
Clean Up and Surface Restoration	LS	100%	$4,500.00	$4,500
Subtotal Construction Cost				**$252,000**
Engineering			20%	50,400
Contingency			20%	50,400
Total				**$352,800**

7.2.3 Siphon Replacement

In 1979, a siphon consisting of two twelve inch diameter and one fifteen inch diameter PVC pipes were installed as a river crossing, carrying the entire City's collected wastewater to the jointly owned wastewater treatment plant. The condition of the siphon pipes are suspect, but due to the difficulty in taking it out of service and performing an inspection on the system, the exact condition of the system is unknown. Because of the importance of this piping system, it is a high priority of the City to have an analyses performed to determine the level of functioning and future life span of the siphon. A condition assessment cost is estimated to be $10,000 (includes taking isolate pipes temporarily out of service). Should the system need to be replaced, current technology would indicate that a horizontal directional drill (HDD) be performed to install new pipe(s) for the crossing. A cost estimate for replacing the system is presented as follows:

Table 22
Replace Siphon

Item	Unit	Estimated Quantity	Unit Price	Total Estimated Cost
Mobilization	LS	100%	$17,500	$17,500
Site Prep., Temp. Facilities, and Controls	LS	100%	$17,500	$17,500
HDD	LF	1000	$350	$350,000
Clean Up and Surface Restoration	LS	100%	$7,000	$7,000
Subtotal Construction Cost				**$392,000**
Engineering			20%	78,400
Contingency			20%	78,400
Total				**$548,800**

7.2.4 STEP System Replacement with Gravity System

Basin B also has an area of residential development in the flood plain which includes a STEP system. The Basin contains approximately 50 residences served by the STEP systems. All of the STEP systems are maintained and serviced by the City on a routine maintenance schedule. The maintenance schedule includes pumping and servicing the units, annual inspections, and servicing the STEP. When the Lookingglass Creek pump station and related collection system was installed, a gravity sewer line was extended from that development to the Brockway Road area for future gravity system installation to replace the STEP served systems. When considering existing services, local topography and depth of the receiving manhole, a gravity system to most, if not all, of the STEP served area can be accomplished. The gravity system in this area would reduce the considerable maintenance activities and associated costs with the STEP type system. Estimated costs for installing a gravity system in the area are presented in table 23:

Considering the cost of installing a new gravity system for the area, further study should be conducted to evaluate the cost/benefit ratio for performing the project and to determine the extent of gravity installation to receive the best value for the replacement.

Table 23 Basin B, STEP System Replacement with Gravity System				
Item	Unit	Estimated Quantity	Unit Price	Total Cost
Mobilization	LS	100%	$36,000	$36,000
Site Prep., Temp. Facilities, and Controls	LS	100%	$15,000	$15,000
8" PVC Sewer Line	LF	3,500	$80	$280,000
Manholes	EA	6	$6,000	$36,000
Lateral Connection	EA	50	$400	$20,000
Decommission Tanks, Clean Up, & Surface Restoration	LS	100%	$10,000	$10,000
Subtotal Construction Cost				**$397,000**
Engineering			20%	79,400
Contingency			20%	79,400
Total				**$555,800**

7.3 Additional I/I Reduction Program

Along with performing targeted basin pipe renovation to remove infiltration, the City should develop a program to systematically evaluate and remove simple and cost-effective I/I sources in the other basins as they are discovered.

As part of the maintenance program, the City should constantly be on the lookout for leaky manholes, broken piping sections, storm drainage (roof drain, catch basin, manhole lid, etc) and other sources of I/I that are cost effective to remove and rehabilitate.

If through regular cleaning and televising activities a pipe section is found that is in poor condition and shows active infiltration, the City may wish to schedule that section for a rehabilitation project. If during the process of collecting data on existing manholes, specific manholes are identified as leaking, a project could be undertaken to seal and rehabilitate a number of manholes.

Furthermore, the City should develop a program where they systematically perform smoke testing and flow mapping of each sanitary collection basin on a rotating basis. Through smoke testing efforts, many inflow sources can be discovered and eliminated. In many cases the inflow sources are on private property and must be corrected at the expense of private property owners.

Flow mapping of individual basins can aid the City by establishing which piping sections and which basins have more flow than is reasonable. These piping sections and basins can then be scheduled for televising to determine if rehabilitation work is appropriate. In addition to flow mapping, the City can install flow meters in specific piping runs to collect data about the flows in individual basins.

In summary, the City should develop an I/I reduction program including:

1. Systematic smoke testing of basins on a rotating basis.
2. Flow mapping of basins on a rotating basis.
3. Identification of deficiencies during televising or manhole inspections.
4. Development of projects to correct deficiencies as part of system maintenance.

The City may use in-house forces to undertake this work or consultants and contractors to complete the necessary tasks.

7.4 Fats, Oils, and Grease Program (FOG)

Operations personnel have reported several piping sections and lift stations that require regular flushing and cleaning due to the buildup of fats, oils, and grease (FOG) in the collection system piping and wetwells. Household and commercial FOG, when dumped into the collection system enters the system as a liquid. When the FOG cools, it often congeals and collects to form clogs and buildups in the piping sections.

It is likely that most of the "problem sections" in Winston are the result of FOG being dumped into the collection system rather than deficiencies with the piping systems themselves. The maintenance costs and problems associated with FOG in Winston result in additional maintenance, collection system problems, and, ultimately, increased operational costs for the City.

The only way to eliminate this problem is for the City with the established FOG program to eliminate the discharge of FOG into the collection system.

The FOG program should be directed at both residential and commercial sanitary sewer customers. For residential customers, the FOG program should include:

> Public education program to educate the public on what FOG is, what impacts it has on the system, the costs of dealing with FOG, and what residential customers should do to reduce the FOG in their wastewater.

While residential customers can make a major difference in reducing the amount of FOG entering the collection system, commercial FOG contributors account for the majority of FOG related problems with the collection system. Restaurants, grocery stores (with delis, chicken cookers, etc.), and other commercial establishments all contribute a significant amount of FOG to the wastewater collection system. An effective FOG program should include the following points for commercial accounts:

1. Commercial FOG contributors must install grease traps, interceptors, or other facilities to intercept and remove the FOG before it enters the sanitary sewer.

2. Grease traps and grease interceptors must be emptied and cleaned on a regular basis. The owner must report the cleaning to the City.
3. The City must maintain a database of FOG contributors to ensure that they have grease traps and that the traps are being cleaned on a regular basis. Reports should be generated regularly for inspections of traps that are due for cleaning
4. A member of the City staff must be responsible for inspecting and enforcing the FOG requirements including the cleaning and maintaining of grease interceptor equipment.
5. Emulsifiers, thinners, or other agents intended to break the FOG down cannot be used and discharged to the system.

As FOG programs have been established in many communities, best management practices (BMP's), procedures, and other information is widely available. A sampling of information from other communities is provided in Appendix D of this Master Plan.

8.0 Recommended Plan

8.1 Introduction

Winston is faced with a lift station (Snow Ave.) that is 35-years old, has inadequate capacity for current flows let alone future increased flows, is deteriorated, has antiquated equipment, and does not meet current code and DEQ requirements. The City is also experiencing excessive I/I problems originating from the older portions of the system made up of concrete piping that has deteriorated and is failing.

The recommended improvements in this Wastewater Collection Master Plan are comprehensive and meant to last at least 20-years into the future with additional work needed. Ongoing system maintenance and I/I location and repairs should continue in efforts to avoid worsening of the I/I problem over time. Cleaning, televising, and repair of the worst I/I contributing piping sections as presented in Section 7.2 should begin immediately. Since I/I occurs throughout the system, specific basin targeted I/I reduction projects are proposed to occur as the City can afford them over the projected lifetime of this plan.

8.2 Project Cost Summary

A description of the existing system components and deficiencies is presented in Section 4.0. The basis of planning and cost estimating is presented in Section 6.0. The development and evaluation of alternatives for each project is presented in Section 7.0.

8.2.1 Wastewater Pump Station Improvement Project

Snow Ave. Pump Station Replacement - $632,000

8.2.2 Wastewater Collection System Projects

CIPP Renovations to basins E, F, H, I, K, & L	$ 7,700,000
System flood proofing	$ 352,800
Interceptor/Siphon Evaluation	$30,000
Siphon replacement	$548,800
Replace STEP System with Gravity System, Basin B	$555,800
The total cost of all projects is:	$ 9,819,400

In addition to the identified capital improvement needs, the City must continue to pursue I/I and make repairs as defects are discovered. The results of flow mapping discussed in Section 5.2 should be used to prioritize efforts. The highlighted sections of piping shown in Figure 10 and discussed in Section 7.2 should be cleaned and televised over the next 2 years. As the sources of infiltration are located during these operations, small projects to conduct spot repairs and pipe lining should be developed. The City has the necessary equipment to conduct cleaning and TV inspections in-house. To allow actual repairs it is recommended that an annual budget allowance of at least $50,000 be provided.

8.3 Project Prioritization

Due to age, deterioration, inability to acquire parts and capacity problems Snow Ave. Pump Station replacement is considered the highest priority project in the system.

It is very important that the City determine the condition of the major trunk line, siphon that carries all of the community's wastewater in an under-river crossing to the wastewater treatment plant. It is recommended that this project also be considered of highest priority due to the significance of failure.

Old, leaky, concrete pipes have resulted in excess inflow and infiltration in the system. The high volumes of I/I have impacted the wastewater treatment plant capacity, with the City, on occasion, exceeding their allotment of treatment capacity shared with Green Sanitary District. Due to the large quantity of sewer pipe that needs to be rehabilitated and the associated cost, it is recommended that a multi-year renovation program be initiated. The renovation is proposed to be an on-going priority project ranked just behind the two projects described above.

Flood proofing some of the low-lying manholes within the City is the final priority of the projects presented.

Priorities are listed as follows:

Priority 1:

Snow Ave. Pump Station Replacement
Interceptor/Siphon Flow Analyses

Priority 2:

Concrete Pipe Renovation, Basins E, F, H, I, K, & L

Priority 3:

Flood Proofing Low-Lying Manholes
Replace STEP System with Gravity System, Basin B

8.4 Plan Implementation

8.4.1 Schedule

The Priority 1 projects can be completed without an increase in sewer rates (see Section 8.4.3). A loan will be needed to allow the projects to be constructed but sufficient revenue is already being generated to make the necessary loan payments even if no grant assistance is available. Sufficient funds will already be available to allow design and other preliminary work for Priority 1 to commence immediately while the lengthy process of obtaining funding for construction commences. The City should seek the most attractive funding package for the Priority 1 projects. As soon as possible, a "One-Stop" meeting should be requested where the City can meet with all of the various potential funding agencies and the best loan/grant package selected. The funding applications should then be completed and turned in immediately.

The Priority 2 projects are recommended to be performed over an expanded period of time using revenues acquired from user fee increases with projects being completed in phases as funds are accumulated. The collection of funds to proceed with the Priority 2 projects will need to be initiated immediately. A basin by basin phased schedule of revenue and expenditures related to the sewer pipe renovation project is presented below:

Table 24
Winston Sewer Rehabilitation Schedule

Year	Revenue Accumulation	Basin Rehabilitation	
1	$ 362,736		
2	$ 725,472		
3	$ 1,088,208	Basin K	
4	$ 311,944		
5	$ 674,680		
6	$ 1,037,416		
7	$ 1,400,152	Basin I	
8	$ 284,788		
9	$ 647,524		
10	$ 1,010,260		Phase 2
11	$ 1,372,996	Basin H	
12	$ 462,432		

13	$	825,168		
14	$	1,187,904		
15	$	1,550,640		
16	$	1,913,376	**Basin J**	**Phase 2**
17	$	206,812		
18	$	569,548		
19	$	932,284		
20	$	1,295,020	**Basin F**	
21	$	470,856		
22	$	833,592	**Basin E**	**Phase 3**
23	$	740,528		
24	$	1,103,264		
25	$	1,466,000	**Basin L**	
1. Based upon $12/mo. Per EDU Revenues				

The Priority 3 project (System Flood-proofing) should be initiated as soon as possible but can be delayed until funding becomes available.

8.4.2 Potential Financing Options

8.4.2.1 Grant and Loan Programs

Some level of outside funding assistance in the form of grants or low interest loans will help assure that the proposed improvement projects are affordable to the City of Winston. The amount and types of outside funding will dictate the amount of local funding that the City will have to secure. In evaluating grant and loan programs, the major objective is to select a program, or a combination of programs, which are most applicable and available to the intended project.

A brief listing of the major Federal and State funding programs, which are typically utilized to assist qualifying City's in the financing of improvement programs, is given below. Each of the government assistance programs has its own particular prerequisites and requirements. These assistance programs promote such goals as aiding economic development, benefiting areas of low to moderate-income families, and providing for specific community improvement projects. Not all City's or projects may qualify for all programs.

1. DEQ Clean Water State Revolving Fund (CWSRF)
   - Current rate of 2.88% on 20 year loan for Design/Construction projects, 0.5% annual fee

2. USDA Water and Waste Disposal Loans and Grants
   - Grants may be provided to reduce costs to a "reasonable level" for rural users

3. OECDD Water/Wastewater Fund

4. OECDD Special Public Works Fund

5. HUD, Community Development Block Grant

The US Census data three year (2011-2013) average median household income (MHI) for Oregon is $54,067. The US Census data five year (2009-2013) average median household income (MHI) for the City of Winston is $32,232. The percent of low/moderate income persons in Winston is unknown without a special income survey. Since Winston appears to have a low MHI, it may be prudent to look into determination of percent of low/moderate income persons in order to qualify for HYD Community Development Block Grants.. This means that Block Grant funding will not be available.

The Infrastructure Finance Authority (IFA) helps communities develop infrastructure and public facilities and address their utility and economic needs through these programs:

Low-interest loans

Interest rates are determined during the financial review. Loan terms will not exceed 25 years.

Grants

Grants are available for projects that meet one or more of the following criteria:

- Job creation and/or retention as a direct result for the project.
- The project deals with critical public safety issues and the IFA's financial analysis determines the City's borrowing ability cannot finance the project.
- There is an imminent threat that the City will lose permits and the IFA's financial analysis determines the City's borrowing ability cannot finance the project.

The level of grant assistance for communities in general is declining and loan funds will certainly be required for the majority of the improvement needs. It may be possible to obtain up to 20% grant assistance for some projects however the level of grant money that Winston will obtain cannot be known at this time. It is recommended that a "One-Stop" meeting be requested where the various funding agencies can meet with the City and the most attractive funding package can be determined. It is likely that multiple funding sources will be required.

Since 100% grant funding will not be possible and existing rates do not provide adequate funds for all of the needed collection system upgrades, modifications to rates will be required at some point in the future.

8.4.2.2 Local Funding Sources

Local revenue sources for capital expenditures include ad valorem taxes, various types of bonds, lease and tenant revenues. Local revenue sources for operating costs include ad valorem taxes, and lease and tenant charges and user fees.

Property Taxes

There are three types of property taxes that taxing districts may impose: taxes from the permanent rates, local option levies, and bond levies. Only the permanent rates are fixed. Bond levies typically are approved in terms of dollars, and the rates are calculated as the total levy divided by the assessed value in the district. Local option levies may be approved either in rate or dollar terms. If the local option levy is in dollar terms, then rates are calculated the same way as for bond levy rates.

Taxes from the permanent rates, typically referred to as operating taxes, are used to fund the general operating budgets of the taxing districts. They account for the single largest component of property taxes. Strictly speaking, the permanent rates are rate limits, so districts may use any rate up to their permanent rate. Local option taxes represent the only way taxing districts can raise operating revenue beyond the permanent rate amount. Even so, these taxes are the first to be reduced if the Measure 5 limitations are exceeded. Because voters at the local level must approve these levies, they represent one aspect of local control over the level of property taxes. Measure 50 requires that local option levies, in elections other than general elections, be approved by a majority of voters with at least 50 percent of all registered voters actually voting. Bond levies have remained largely unchanged. They are used to pay principal and interest for bonded debt. Under the provisions of Measure 50, new bond levies, like new

Local Option and Serial Levies

The Oregon Constitution allows a local government to levy annually the amount that would be raised by its permanent rate limit (Base) without further authorization from the voters. When a local government has to increase the permanent rate limit or when the rate limit does not provide enough revenue to meet estimated expenditures, the government may request a local option levy from the voters. Approval requires a "double majority." This means that at least 50 percent of the registered voters must vote, and a majority of those who vote must approve the levy. Since 1991, the constitution has limited the maximum amount of taxes to support the public schools to $5 per $1,000 of real market value. The maximum amount to support other government operations is $10 per $1,000 of real market value.

Voters can approve local option levies for up to five years for operations and up to 10 years or the useful life of capital projects, whichever is less. Local option levies require a "double majority" for approval. A common funding mechanism for capital projects is to acquire voter approval for a serial levy (more than one year) to pay for the cost of specifically targeted projects.

Bonds

The municipal bond market is the source of most loans for public agencies in the United States, including Oregon. The municipal bond market will purchase one of two types of bonds from the City — a general obligation bond or a revenue bond. The two types of bonds differ in how the City chooses to repay the loan, and are discussed in more detail below.

General Obligation Bonds

General obligation (G.O.) bonds are backed by the City's full faith and credit, as the City pledges to assess property taxes sufficient to pay the annual debt service. This tax is exempt from the State's constitutional limit of $10/$1,000 of assessed value. The City may, at its discretion, use any other source of revenue, including user fees or leasehold/tenant revenues, to repay the bonds. If it uses these other sources, it then reduces the amount to be collected from taxes.

Oregon Revised statutes limit the maximum bond term to forty (40) years for agencies. Except in the event that RD will purchase the bonds, the realistic term for which G.O. bonds should be issued is fifteen (15) to twenty (20) years. Under the present economic climate, the lower interest rates will be associated with the shorter terms.

Financing of capital improvements by G.O. bonds is usually accomplished by the following procedure:

1. Determination of the capital costs required for the improvement.
2. An election by the voters to authorize the sale of bonds.
3. The bonds are offered for sale.
4. The revenue from the bond sale is used to pay the capital costs associated with the project(s).

General Obligation bonds are preferable to revenue bonds in matters of simplicity and cost of issuance. Since the bonds are secured by the power to tax, these bonds usually command a lower interest rate than other types of bonds. General obligation bonds lend themselves readily to competitive public sale at a reasonable interest rate because of their high degree of security, their tax-exempt status, and public acceptance.

These bonds can be revenue-supported wherein a portion of the user fee is pledged toward payment of the debt service. Using this method, the need to collect additional property taxes to retire the bonds is eliminated. Such revenue-supported G.O. bonds have most of the advantages of revenue bonds, plus lower interest rate and ready marketability.

General obligation bonds are normally associated with the financing of facilities, which benefit an entire community and must be approved by a majority vote.

The disadvantage of G.O. bond debt is that it is often added to the debt ratios of the underlying agency, thereby restricting the flexibility of the agency to issue debt for other purposes. Furthermore, G.O. bond authorizations must be approved by a majority vote and often necessitate extensive public information programs.

Revenue Bonds

For revenue bonds, the City pledges the net operating revenue of the City to repay the bonds. The primary source of the net revenue is user fees, leases and tenant fees, and the primary security is the City's pledge to charge user fees sufficient to pay all operating costs and debt service. The lender requires the City to provide two additional securities for the revenue bonds that are not required by a G.O. bond. First, the City must establish a bond reserve fund equal to the lesser of maximum annual debt service or 10% of the bond amount. Second, the City must increase user fees such that net the cash flow from operations plus interest earnings are equal to or greater than 125% of annual debt service, known as a 1.25 debt coverage ratio.

The general shift away from ad valorem property taxes and toward a greater reliance on user fees makes revenue bonds a frequently used option for payment of long term debt. Many agencies prefer revenue bonding, because it insures that no tax will be levied. In addition, debt obligation will be limited to system users and tenants since repayment is derived from such fees. An advantage with revenue bonds is that they do not count against a municipality's direct debt, but instead are considered "overlapping debt". This feature can be a crucial advantage for a municipality near its debt limit. Rating agencies evaluate closely the amount of direct debt when assigning credit ratings. Revenue bonds also may be used in financing projects extending beyond normal municipal boundaries. These bonds may be supported by a pledge of revenues received in any legitimate and ongoing area of operation, within or without the geographical boundaries of the issuer.

Successful issuance of revenue bonds depends on the bond market evaluation of the revenue pledged. Revenue bonds are most commonly retired with revenue from user fees. Recent legislation has eliminated the requirement that the revenues pledged to bond payment have a direct relationship to the services financed by revenue bonds. Revenue bonds may be paid with all or any portion of revenues derived by a public body or any other legally available monies. If additional security to finance revenue bonds is needed, a public body may mortgage grant security and interests in facilities, projects, utilities or systems owned or operated by a public body.

Normally, there are no legal limitations on the amount of revenue bonds to be issued, but excessive issue amounts are generally unattractive to bond buyers because they represent high investment risks. In rating revenue bonds, buyers consider the economic justification for the project, reputation of the borrower, methods and effectiveness for billing and collecting, rate structures, a provision for rate increases as needed to meet debt service requirements, track record in obtaining rate increases historically, adequacy of reserve funds provided in the bond documents, supporting covenants to protect projected revenues, and the degree to which forecasts of net revenues are considered sound and economical.

Agencies may elect to issue revenue bonds for revenue producing facilities without a vote of the electorate (ORS 288.805-288.945). Certain notice and posting requirements must be met and a sixty (60) day waiting period is mandatory. A petition signed by five percent of the municipality's registered voters may cause the issue to be referred to an election.

Improvement Bonds

Improvement (Bancroft) bonds can be issued under an Oregon law called the Bancroft Act. The bonds are an intermediate form of financing that is less than full-fledged G.O. or revenue bonds, but is quite useful especially for smaller issuers or for limited purposes.

An improvement bond is payable only from the receipts of special benefit assessments, not from general tax revenues. Such bonds are issued only where certain properties are recipients of special benefits not occurring to other properties. For a specific improvement, all property within the improvement area is assessed on an equal basis, regardless of whether it is developed or undeveloped. The assessment is designed to apportion the cost of improvements, approximately in proportion to the afforded direct or indirect benefits, among the benefited property owners. This assessment becomes a direct lien against the property, and owners have the option of either paying the assessment in cash or applying for improvement bonds. If the improvement bond option is taken, the City sells Bancroft improvement bonds to finance the construction, and the assessment is paid over 20 years in 40 semi-annual installments with interest. Cities and special districts are limited to improvement bonds not exceeding three percent of true cash value.

With improvement bond financing, an improvement district is formed, the boundaries are established, and the benefited properties and property owners are determined. The engineer usually determines an approximate assessment, either on a square foot or a front-foot basis. Property owners are then given an opportunity to object to the project assessments. The assessments against the properties are usually not levied until the actual cost of the project is determined. Since this determination is normally not possible until the project is completed, funds are not available from assessments for the purpose of making monthly payments to the contractor. Therefore, some method of interim financing must be arranged, or a pre-assessment program, based on the estimated total costs, must be adopted. Commonly, warrants are issued to cover debts, with the warrants to be paid when the project is complete.

The primary disadvantage to this source of revenue is that the property to be assessed must have a true cash value at least equal to 50 percent of the total assessments to be levied. As a result, owners of undeveloped property usually require a substantial cash payment. In addition, the development of an assessment district is very cumbersome and expensive when facilities for an entire community are contemplated. In comparison, G.O. bonds can be issued in lieu of improvement bonds, and are usually more favorable.

Capital Construction (Sinking) Fund

Sinking funds are often established by budget for a particular construction purpose. Budgeted amounts from each annual budget are carried in a sinking fund until sufficient revenues are available for the needed project. Such funds can also be developed with revenue derived from system development charges or serial levies.

A City may wish to develop sinking funds for future improvements. This fund can be used to rehabilitate or maintain existing infrastructure, construct new infrastructure elements, or to obtain grant and loan funding for larger projects.

The disadvantage of a sinking fund is that it is usually too small to undertake any significant projects. Also, setting aside money generated from user fees without a designated and specified need is not generally accepted in agency budgeting processes.

Franchise Fees

The City has the authority pursuant to the City Charter and ORS Chapters 221, 415 to issue franchises allowing the use of public rights of way for utility and other purposes. The City Council may grant exclusive or non-exclusive franchises for solid waste collection, waste recycling services, natural gas distribution, electric power distribution, telecommunications services, cable television services, water distribution and other services. Franchises shall be granted by a franchise agreement approved by ordinance.

Franchise agreements may include the assessment of fees for a utility's use of the City right-of-way. Such fees may be used at the discretion of the City; however the amount of fees may not be significant enough to impact any major improvement project costs.

8.4.3 Funding Recommendations

This Master Plan outlines a plan for all necessary improvements, which represent a significant investment for the City. Therefore, a strategy and plan for financing the recommended improvements must be developed.

While the financing package that the City will ultimately utilize depends on the results of coordination with the various funding agencies, this section will summarize the general direction the City should proceed with and provide some insight into the potential impacts to rate payers.

As outlined earlier in this section, improvements projects recommend for the City total in excess of approximately $9.2 million dollars. The City should proceed with the following steps as it moves forward with the financing strategy for the water system improvement projects:

1. As soon as this Wastewater Master Plan is approved, the City should contact Infrastructure Finance Authority (IFA) to schedule a one-stop meeting. At this one-stop meeting, all of the potential agencies who may be able to provide funding will send representatives to discuss the funding needs and develop a funding package for the improvement projects. The agencies will make recommendations and will discuss what each agency can offer. The result will be a funding package made up of grants and loans from a number of agencies to fund the projects.
2. Following the one-stop meeting, the City should immediately process the necessary paperwork to apply for the funding included in the funding package recommended at the one-stop meeting. This will require numerous applications and other administrative efforts to apply for funding. The City should apply to any and all programs or agencies that have the potential to provide grant money to reduce the impact to rate payers.
3. Due to the magnitude of the required improvements, the City will not likely receive grants sufficient to cover all of the costs of the project. In fact, the City will most likely be required to take out loans for a significant portion of the project costs.
4. Once the City receives notification that they have secured the necessary funding \to complete the work, they can begin the pre-design and design activities in preparation for bidding and construction of the improvements.

A

Model Attribute Reports

Existing Wet Weather Flows

Scenario: WetWeatherFlows

Gravity Pipe Report

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)	Length (ft)	Material	Section Size	Total Flow (gpd)	Design Capacity (gpd)	Excess Design Capacity (gpd)	Velocity In (ft/s)	Flow/Full Capacity (%)	Average Velocity (ft/s)
2	A3	518.27	A2	517.32	0.003125	304.00	Concrete	8 inch	68,986.86	436,578.31	367,591.44	1.41	15.8	1.41
3	E5	514.40	E1	512.93	0.008963	164.00	Concrete	8 inch	259,854.64	739,390.53	479,535.89	2.69	35.1	2.99
4	E6	517.11	E5	514.80	0.008885	260.00	Concrete	8 inch	70,178.00	736,133.29	665,955.29	1.84	9.5	2.06
5	E8	517.33	E6	517.31	0.000303	66.00	Concrete	8 inch	63,158.00	135,950.30	72,792.30	0.81	46.5	0.59
6	E9	520.62	E8	517.63	0.005191	576.00	Concrete	8 inch	61,376.00	562,680.02	501,304.02	1.64	10.9	1.64
7	E11	521.78	E9	520.82	0.006400	150.00	Concrete	8 inch	45,824.00	624,780.01	578,956.01	1.62	7.3	1.62
8	E12	523.97	E11	521.88	0.004265	490.00	Concrete	8 inch	41,774.00	510,049.40	468,275.40	1.36	8.2	1.36
9	E13	540.11	E12	524.17	0.032866	485.00	Concrete	8 inch	28,544.00	1,415,827.78	1,387,283.78	1.44	2.0	2.49
10	A4	519.72	A3	518.27	0.003008	482.00	Concrete	8 inch	60,778.86	428,348.87	367,570.00	1.34	14.2	1.34
11	F1	521.79	E5	516.30	0.016195	339.00	Concrete	8 inch	185,248.64	993,856.00	808,607.36	2.43	18.6	3.37
12	F2	521.87	F1	521.79	0.008000	10.00	Concrete	8 inch	176,095.64	698,525.29	522,429.65	2.39	25.2	2.58
13	F3	524.94	F2	521.87	0.009840	312.00	Concrete	8 inch	43,351.40	774,691.93	731,340.53	1.62	5.6	1.85
14	F9	522.67	F2	521.87	0.006504	123.00	Concrete	8 inch	120,292.17	629,839.04	509,546.87	2.14	19.1	2.15
15	F11	524.59	F9	522.67	0.006931	277.00	Concrete	8 inch	116,971.17	650,201.35	533,230.18	2.13	18.0	2.18
16	F14	528.14	F11	524.69	0.014315	241.00	Concrete	8 inch	105,910.00	934,411.48	828,501.48	2.07	11.3	2.75
17	F16	528.88	F14	528.14	0.015417	48.00	Concrete	8 inch	99,403.00	969,688.80	870,285.80	2.03	10.3	2.77
18	F17	531.04	F16	528.88	0.013416	161.00	Concrete	8 inch	98,107.00	904,588.53	806,481.53	2.02	10.8	2.63
19	F20	532.63	F17	531.04	0.017865	89.00	Concrete	8 inch	93,760.00	1,043,856.26	950,096.26	2.00	9.0	2.87
20	F21	532.94	F20	532.63	0.013478	23.00	Concrete	8 inch	91,357.00	906,680.07	815,323.07	1.98	10.1	2.58
21	F22	537.03	F21	532.94	0.014201	288.00	Concrete	8 inch	66,491.00	930,684.65	864,193.65	1.82	7.1	2.39
22	D54	515.89	D47	515.57	0.013913	23.00	Concrete	12 inch	141,368.60	2,715,969.58	2,574,600.98	2.07	5.2	2.82
23	D64	523.37	D63	522.07	0.004248	306.00	Concrete	15 inch	89,954.60	2,721,143.81	2,631,189.21	1.58	3.3	1.58
25	H18	536.74	H15	530.90	0.013094	446.00	Concrete	8 inch	98,120.24	893,667.85	795,547.61	2.02	11.0	2.60
26	H20	539.82	H18	536.84	0.011920	250.00	Concrete	8 inch	86,078.24	852,658.78	766,580.54	1.95	10.1	2.42
27	H23	544.26	H20	539.82	0.016882	263.00	Concrete	8 inch	79,328.24	1,014,730.59	935,402.35	1.91	7.8	2.68
28	H2	524.12	H1	523.66	0.003217	143.00	Concrete	15 inch	258,499.51	2,367,834.96	2,109,335.46	1.96	10.9	1.96
29	H4	524.83	H2	524.27	0.004409	127.00	Concrete	12 inch	254,638.51	1,528,994.71	1,274,356.20	2.23	16.7	2.23
30	H5	525.32	H4	524.98	0.002282	149.00	Concrete	12 inch	251,209.51	1,099,917.61	848,708.10	1.76	22.8	1.76
31	H6	526.61	H5	525.37	0.003804	326.00	Concrete	12 inch	247,186.51	1,420,090.01	1,172,903.50	2.10	17.4	2.10
32	D40	501.04	D15	500.73	0.000939	330.00	Concrete	21 inch	306,901.46	3,138,623.13	2,831,721.67	1.28	9.8	1.28
34	J9	526.13	J8	524.92	0.006020	201.00	Concrete	8 inch	24,034.00	605,943.03	581,909.03	1.31	4.0	1.31
36	J4	519.12	J3	518.83	0.008286	35.00	Concrete	15 inch	844,728.43	3,800,191.73	2,955,463.30	3.27	22.2	3.85
37	J6	520.30	J4	519.32	0.005600	175.00	Concrete	15 inch	841,528.67	3,124,169.19	2,282,640.53	3.27	26.9	3.34
38	J19	538.87	J6	520.35	0.042575	435.00	Concrete	12 inch	808,665.67	4,751,051.01	3,942,385.35	3.43	17.0	6.98
39	B2	510.26	B1	508.39	0.008462	221.00	PVC	8 inch	13,538.20	933,910.29	920,372.09	1.19	1.4	1.49
40	I2	525.87	I1	522.43	0.008821	390.00	Concrete	8 inch	192,298.00	733,472.88	541,174.88	2.46	26.2	2.74
41	I5	529.40	I4	526.80	0.011927	218.00	Concrete	8 inch	179,392.00	852,895.00	673,503.00	2.40	21.0	2.99
42	I6	532.61	I5	529.40	0.010664	301.00	Concrete	8 inch	173,506.00	806,503.78	632,997.78	2.38	21.5	2.85
42.5	C14	531.25	C13	530.98	0.002015	134.00	PVC	12 inch	57,580.80	1,343,651.58	1,286,070.78	1.32	4.3	1.32
43	I7	548.26	I6	532.61	0.035488	441.00	Concrete	8 inch	165,379.00	1,471,211.18	1,305,832.18	2.35	11.2	4.31
43.5	C16	531.47	C14	531.25	0.001341	164.00	PVC	12 inch	53,962.80	1,096,343.38	1,042,380.58	1.12	4.9	1.12
44	B3	512.37	B2	510.26	0.009860	214.00	PVC	8 inch	7,571.20	1,008,126.04	1,000,554.84	1.03	0.8	1.32
44.5	C17	532.26	C16	531.47	0.007383	107.00	PVC	12 inch	49,534.80	2,572,046.64	2,522,511.84	1.57	1.9	1.98
45	I11	564.16	I8	557.70	0.034362	188.00	Concrete	8 inch	96,763.00	1,447,686.33	1,350,923.33	2.02	6.7	3.64
46	I8	557.70	I7	548.26	0.036732	257.00	Concrete	8 inch	103,702.00	1,496,775.19	1,393,073.19	2.05	6.9	3.81
47	I12	568.14	I11	564.16	0.017229	231.00	Concrete	8 inch	91,687.00	1,025,115.23	933,428.23	1.99	8.9	2.81
47.5	D2	511.13	WW-1	506.82	0.064328	67.00	Concrete	8 inch	289,377.40	1,980,789.72	1,691,412.32	2.79	14.6	6.27
48	B12	513.89	B3	512.37	0.006104	249.00	PVC	8 inch	4,474.60	793,236.36	788,761.76	0.91	0.6	0.95
49	B13	517.26	B12	513.89	0.012962	260.00	PVC	8 inch	4,126.00	1,155,869.41	1,151,743.41	0.89	0.4	1.20
50	L2	523.63	L1	518.31	0.018932	281.00	Concrete	8 inch	68,273.34	1,074,582.58	1,006,309.24	1.83	6.4	2.67
51	L15	535.79	L14	528.86	0.014028	494.00	Concrete	8 inch	107,823.00	924,996.91	817,173.91	2.08	11.7	2.74
52	L16	542.46	L15	535.89	0.014159	464.00	Concrete	8 inch	94,485.00	929,310.48	834,825.48	2.00	10.2	2.65
53	L13	526.51	L1	518.36	0.037907	215.00	Concrete	8 inch	126,885.00	1,520,536.03	1,393,651.03	2.18	8.3	4.09
54	Q13	513.94	Q11	513.42	0.011556	45.00	PVC	8 inch	12,405.00	1,091,379.79	1,078,974.79	1.17	1.1	1.62
55	Q1	491.62	S19	490.38	0.004247	292.00	PVC	8 inch	23,756.20	661,606.72	637,850.52	1.38	3.6	1.38
56	D41	501.64	D40	501.04	0.001676	358.00	Concrete	21 inch	297,991.46	4,192,271.55	3,894,280.09	1.56	7.1	1.56
57	R9	529.98	R8	524.94	0.024115	209.00	PVC	8 inch	4,177.37	1,576,603.98	1,572,426.61	0.88	0.3	1.50
58	B4	514.50	B3	512.37	0.008192	260.00	PVC	8 inch	2,797.00	918,932.52	916,135.52	0.81	0.3	0.91
59	R10	532.15	R9	530.03	0.040000	53.00	PVC	8 inch	3,884.77	2,030,535.04	2,026,650.27	0.86	0.2	1.74
60	R11	535.45	R10	532.15	0.032353	102.00	PVC	8 inch	3,810.57	1,826,153.91	1,822,343.34	0.86	0.2	1.61
61	O8	504.47	O3	502.98	0.010136	147.00	PVC	8 inch	40,215.20	1,022,150.77	981,935.57	1.59	3.9	2.20
62	O13	507.92	O12	506.88	0.006228	167.00	PVC	8 inch	39,645.40	801,196.28	761,550.88	1.58	4.9	1.85
63	O14	508.78	O13	508.12	0.007253	91.00	PVC	8 inch	39,411.60	864,632.91	825,221.31	1.58	4.6	1.94
64	O15	511.33	O14	508.88	0.009176	267.00	PVC	8 inch	39,284.20	972,540.97	933,256.77	1.58	4.0	2.11
65	O16	513.21	O15	511.43	0.012448	143.00	PVC	8 inch	38,910.40	1,132,719.75	1,093,809.35	1.57	3.4	2.34
66	O17	514.69	O16	513.21	0.013832	107.00	PVC	8 inch	38,710.20	1,194,041.61	1,155,331.41	1.57	3.2	2.42
67	O18	519.62	O17	514.79	0.018090	267.00	PVC	8 inch	38,560.40	1,365,521.14	1,326,960.74	1.57	2.8	2.66
68	O38	524.91	O26	523.06	0.015948	116.00	Concrete	8 inch	16,958.00	986,265.88	969,307.88	1.27	1.7	1.65
70	O40	542.30	O38	524.91	0.075281	231.00	Concrete	24 inch	13,826.00	0,114,768.20	0,100,942.20	1.03	0.0	2.26
71	O26	522.96	O18	519.72	0.024179	134.00	PVC	8 inch	30,625.60	1,578,703.60	1,548,078.00	1.47	1.9	2.75
72	K23	506.33	K1	505.55	0.065000	12.00	Concrete	15 inch	,538,097.26	0,643,812.38	9,105,715.12	3.94	14.5	9.55
73	K24	510.61	K23	507.78	0.027212	104.00	Concrete	15 inch	907,771.44	6,886,793.81	5,979,022.37	3.34	13.2	6.02
74	K25	512.77	K24	510.61	0.007152	302.00	Concrete	15 inch	879,798.84	3,530,725.35	2,650,926.51	3.31	24.9	3.70
75	K26	514.19	K25	512.77	0.006094	233.00	Concrete	15 inch	871,644.84	3,259,167.97	2,387,523.13	3.30	26.7	3.48
76	K3	506.83	K2	506.73	0.003333	30.00	PVC	8 inch	244,668.63	586,164.98	341,496.34	2.48	41.7	2.48
77	K4	510.94	K3	509.43	0.004646	325.00	Concrete	8 inch	239,091.60	532,333.67	293,242.06	2.30	44.9	2.30
78	K5	517.06	K4	510.94	0.021250	288.00	Concrete	8 inch	230,316.60	1,138,456.94	908,140.33	2.59	20.2	3.95
79	K6	523.96	K5	521.31	0.017550	151.00	PVC	8 inch	8,620.00	1,344,977.30	1,336,357.30	1.06	0.6	1.67
80	K7	524.83	K6	523.96	0.016731	52.00	PVC	8 inch	8,408.60	1,313,222.90	1,304,814.30	1.06	0.6	1.63
81	K8	540.43	K7	525.03	0.054610	282.00	PVC	8 inch	8,335.80	2,372,555.05	2,364,219.25	1.05	0.4	2.45
82	L1	518.16	K5	517.06	0.003667	300.00	Concrete	8 inch	213,035.60	472,903.86	259,868.25	2.04	45.0	2.04
83	K29	510.35	K28	509.56	0.002532	312.00	Concrete	15 inch	620,626.82	2,100,761.65	1,480,134.83	2.31	29.5	2.31
84	K37	513.18	K36	512.67	0.003835	133.00	Concrete	15 inch	558,261.23	2,585,233.65	2,026,972.42	2.60	21.6	2.60
85	I1	518.63	K37	513.43	0.017333	300.00	Concrete	15 inch	554,670.23	5,496,441.08	4,941,770.85	2.90	10.1	4.44
86	K32	511.74	K29	510.45	0.004778	270.00	Concrete	15 inch	612,202.82	2,885,715.45	2,273,512.64	2.89	21.2	2.89
87	K36	512.67	K32	511.74	0.004697	198.00	Concrete	15 inch	583,790.23	2,861,207.87	2,277,417.64	2.83	20.4	2.83
88	I4	526.80	I2	525.87	0.010568	88.00	Concrete	8 inch	181,768.00	802,855.30	621,087.30	2.41	22.6	2.88
89	I30	519.55	I1	518.88	0.001667	402.00	Concrete	15 inch	343,084.23	1,704,374.03	1,361,289.80	1.68	20.1	1.68
90	Q17	518.05	Q13	513.94	0.019571	210.00	PVC	8 inch	12,342.00	1,420,338.16	1,407,996.16	1.16	0.9	1.94

Scenario: WetWeatherFlows

Gravity Pipe Report

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)	Length (ft)	Material	Section Size	Total Flow (gpd)	Design Capacity (gpd)	Excess Design Capacity (gpd)	Velocity In (ft/s)	Flow/Full Capacity (%)	Average Velocity (ft/s)
91	S19	490.18	S18	489.86	0.032000	10.00	PVC	8 inch	23,770.20	1,816,165.75	1,792,395.55	1.38	1.3	2.81
92	C7	529.34	C6	528.93	0.002993	137.00	PVC	12 inch	74,987.00	1,637,528.35	1,562,541.35	1.64	4.6	1.64
93	K2	506.73	K1	506.05	0.005812	117.00	Concrete	12 inch	247,827.63	1,755,397.02	1,507,569.39	2.42	14.1	2.44
94	M17	500.01	M16	499.76	0.000610	410.00	Concrete	24 inch	,839,580.07	3,610,260.68	1,770,680.62	1.93	51.0	1.79
95	M18	500.78	M17	500.21	0.001192	478.00	Concrete	24 inch	,828,510.07	5,048,751.15	3,220,241.09	2.29	36.2	2.29
96	M21	504.31	M18	500.98	0.006633	502.00	Concrete	21 inch	,808,739.89	3,340,374.51	5,531,634.61	3.78	21.7	4.29
97	M22	504.93	M21	504.51	0.001918	219.00	Concrete	24 inch	,795,185.89	5,402,698.83	4,607,512.93	2.71	28.0	2.71
98	K1	505.03	M22	505.00	0.000242	124.00	Concrete	24 inch	,789,272.89	2,274,103.73	484,830.84	2.05	78.7	1.24
99	C8	529.82	C7	529.34	0.003902	123.00	PVC	12 inch	74,795.20	1,869,929.56	1,795,134.36	1.75	4.0	1.80
100	M12	512.92	M11	502.18	0.110722	97.00	PVC	8 inch	1,537.20	3,378,288.74	3,376,751.54	0.69	0.0	1.89
101	M13	515.18	M12	513.12	0.020396	101.00	PVC	8 inch	1,401.40	1,449,951.30	1,448,549.90	0.67	0.1	1.02
102	M16	499.76	M11	499.48	0.007368	38.00	Concrete	24 inch	,840,606.07	2,550,114.94	0,709,508.88	3.69	14.7	4.42
103	D42	502.61	D41	501.64	0.007886	123.00	Concrete	15 inch	212,075.60	3,707,437.54	3,495,361.94	2.23	5.7	2.54
104	C11	530.26	C8	529.82	0.001636	269.00	PVC	12 inch	74,623.00	1,210,618.71	1,135,995.71	1.32	6.2	1.32
105	C13	530.98	C11	530.26	0.002361	305.00	PVC	12 inch	58,007.80	1,454,365.33	1,396,357.53	1.40	4.0	1.40
107	P9	521.39	P6	510.88	0.072483	145.00	PVC	8 inch	8,481.00	2,733,366.39	2,724,885.39	1.06	0.3	2.71
109	P6	510.58	P5	494.28	0.126357	129.00	PVC	8 inch	14,808.60	3,608,938.15	3,594,129.55	1.23	0.4	3.92
112	S3	484.89	S2	484.52	0.011563	32.00	Concrete	24 inch	,262,780.94	5,721,224.11	3,458,443.18	3.92	14.4	5.50
113	S13	487.05	S6	486.50	0.001571	350.00	Concrete	24 inch	,234,645.94	5,795,725.51	3,561,079.57	2.67	38.6	2.67
114	S14	487.42	S13	487.10	0.001531	209.00	Concrete	24 inch	,225,195.94	5,720,873.33	3,495,677.40	2.66	38.9	2.64
115	R8	524.74	R7	510.46	0.048904	292.00	PVC	8 inch	4,586.17	2,245,190.37	2,240,604.20	0.90	0.2	1.96
116	R7	510.06	R6	507.39	0.024495	109.00	PVC	8 inch	4,738.77	1,588,996.26	1,584,257.49	0.91	0.3	1.56
117	N32	544.88	N26	528.75	0.068638	235.00	Concrete	12 inch	,858,937.07	6,032,496.57	4,173,559.50	4.70	30.8	10.46
118	N33	549.73	N32	544.88	0.098980	49.00	PVC	12 inch	,852,592.07	9,417,378.21	7,564,786.15	4.69	19.7	14.42
119	N34	563.98	N33	549.73	0.089623	159.00	PVC	12 inch	,852,523.47	3,961,197.59	7,108,674.12	4.69	20.7	13.91
121	J7	524.33	J6	520.85	0.080930	43.00	Concrete	8 inch	28,138.00	2,221,736.42	2,193,598.42	1.44	1.3	3.40
122	J8	524.92	J7	524.33	0.005413	109.00	Concrete	8 inch	26,977.00	574,579.20	547,602.20	1.30	4.7	1.30
123	I38	519.91	I30	519.55	0.001032	349.00	Concrete	15 inch	289,607.98	1,340,846.52	1,051,238.54	1.35	21.6	1.35
124	I40	522.26	I38	520.21	0.010302	199.00	Concrete	15 inch	278,979.81	4,237,316.70	3,958,336.89	2.40	6.6	3.02
125	I41	522.88	I40	522.41	0.007966	59.00	Concrete	15 inch	273,606.81	3,726,176.78	3,452,569.98	2.39	7.3	2.74
126	H1	523.56	I41	522.88	0.001399	486.00	Concrete	15 inch	272,013.81	1,561,625.36	1,289,611.56	1.48	17.4	1.48
128	G1	527.42	H6	526.71	0.001989	357.00	Concrete	12 inch	50,958.00	1,026,854.47	975,896.47	1.05	5.0	1.05
129	G13	527.91	G1	527.42	0.002678	183.00	Concrete	12 inch	34,939.10	1,191,478.82	1,156,539.72	1.04	2.9	1.04
130	G18	528.65	G13	528.01	0.001860	344.00	Concrete	8 inch	24,191.10	336,858.81	312,667.71	0.87	7.2	0.87
131	H7	527.96	H6	526.61	0.004515	299.00	Concrete	12 inch	187,426.51	1,547,195.24	1,359,768.73	2.06	12.1	2.06
133	H8	528.06	H7	528.01	0.001190	42.00	Concrete	8 inch	179,353.51	269,461.98	90,108.47	1.48	66.6	1.28
134	H15	530.85	H8	528.16	0.014158	190.00	Concrete	8 inch	103,250.24	929,258.37	826,008.13	2.05	11.1	2.72
135	R12	540.02	R11	536.90	0.195000	16.00	PVC	8 inch	3,667.77	4,483,299.97	4,479,632.20	0.85	0.1	2.97
137	D16	509.31	D15	502.38	0.021193	327.00	PVC	8 inch	122,447.80	1,477,995.91	1,355,548.11	2.15	8.3	3.96
139	D46	508.69	D45	507.45	0.003584	346.00	Concrete	15 inch	191,015.60	2,499,270.86	2,308,255.26	1.86	7.6	1.86
140	C1	524.27	D64	523.57	0.005983	117.00	Concrete	12 inch	81,692.60	1,781,024.61	1,699,332.01	1.78	4.6	1.78
141	D43	503.45	D42	502.61	0.011351	74.00	Concrete	12 inch	208,754.60	2,453,226.31	2,244,471.71	2.31	8.5	2.95
142	D47	515.57	D46	508.89	0.015182	440.00	Concrete	15 inch	181,673.60	5,144,017.36	4,962,343.76	2.13	3.5	3.05
143	C2	524.70	C1	524.27	0.006825	63.00	PVC	8 inch	78,533.60	838,773.01	760,239.41	1.90	9.4	2.33
144	C3	525.38	C2	524.70	0.005075	134.00	PVC	12 inch	78,445.40	2,132,353.68	2,053,908.28	1.78	3.7	2.00
145	C4	526.16	C3	525.38	0.002591	301.00	PVC	12 inch	78,257.80	1,523,776.38	1,445,518.58	1.58	5.1	1.58
146	C5	527.82	C4	526.26	0.003312	471.00	PVC	12 inch	77,836.40	1,722,697.52	1,644,861.12	1.72	4.5	1.72
147	C6	528.93	C5	527.92	0.006733	150.00	PVC	12 inch	75,197.00	2,456,248.15	2,381,051.15	1.76	3.1	2.18
148	D55	519.38	D54	515.89	0.012332	283.00	Concrete	12 inch	140,747.60	2,557,015.30	2,416,267.70	2.07	5.5	2.70
149	D62	520.42	D55	519.38	0.013867	75.00	Concrete	12 inch	104,804.60	2,711,439.19	2,606,634.59	1.91	3.9	2.58
150	K28	509.31	K23	507.78	0.011418	134.00	Concrete	15 inch	629,731.82	4,461,016.69	3,831,284.88	3.00	14.1	3.98
151	S15	488.00	S14	487.42	0.001568	370.00	Concrete	24 inch	,198,632.44	5,788,601.07	3,589,968.63	2.66	38.0	2.66
152	S16	488.38	S15	488.20	0.000474	380.00	Concrete	24 inch	,188,642.44	3,182,034.91	993,392.47	1.98	68.8	1.69
153	S17	488.76	S16	488.58	0.000602	299.00	Concrete	24 inch	,178,382.44	3,587,245.87	1,408,863.43	2.07	60.7	1.85
154	S18	489.36	S17	488.76	0.001277	470.00	Concrete	24 inch	,170,309.44	5,223,807.71	3,053,498.27	2.43	41.5	2.45
155	P1	489.68	S18	489.46	0.001272	173.00	Concrete	24 inch	,133,849.24	5,213,732.86	3,079,883.62	2.51	40.9	2.44
156	P2	489.91	P1	489.68	0.001022	225.00	Concrete	24 inch	,129,178.24	4,674,478.27	2,545,300.03	2.31	45.5	2.25
157	D63	522.07	D62	520.42	0.003474	475.00	Concrete	12 inch	102,779.60	1,357,091.09	1,254,311.49	1.58	7.6	1.58
158	P3	491.30	P2	490.21	0.002224	490.00	Concrete	21 inch	,123,103.24	4,829,815.08	2,706,711.84	3.01	44.0	3.01
159	P4	492.45	P3	491.50	0.002043	465.00	Concrete	21 inch	,109,873.24	4,628,610.33	2,518,737.09	2.91	45.6	2.91
160	P5	492.93	P4	492.65	0.000946	296.00	Concrete	24 inch	,097,318.24	4,496,697.22	2,399,378.99	2.27	46.6	2.18
161	P26	493.05	P5	492.93	0.001237	97.00	Concrete	24 inch	,074,517.64	5,142,392.74	3,067,875.10	2.31	40.3	2.40
162	P27	493.95	P26	493.05	0.002088	431.00	Concrete	24 inch	,071,898.64	6,681,025.13	4,609,126.50	2.90	31.0	2.90
163	P28	494.98	P27	493.95	0.001301	792.00	Concrete	24 inch	,060,261.64	5,272,499.02	3,212,237.38	2.44	39.1	2.44
164	N1	496.89	P28	495.18	0.003386	505.00	Concrete	21 inch	,987,357.24	5,958,921.44	3,971,564.21	3.45	33.4	3.45
165	D17	510.42	D16	509.52	0.005625	160.00	PVC	8 inch	121,990.00	761,450.64	639,460.64	2.15	16.0	2.47
166	N2	498.39	N1	496.89	0.003731	402.00	Concrete	18 inch	,973,722.24	4,146,895.82	2,173,173.58	3.59	47.6	3.59
167	N3	500.45	N2	498.39	0.005296	389.00	Concrete	18 inch	,962,868.24	4,940,254.60	2,977,386.36	4.03	39.7	4.08
168	N6	503.72	N3	500.45	0.006728	486.00	Concrete	18 inch	,944,742.24	5,568,603.08	3,623,860.84	4.02	34.9	4.44
169	N7	505.74	N6	503.72	0.005344	378.00	Concrete	18 inch	,931,620.24	4,962,726.10	3,031,105.86	4.01	38.9	4.07
170	N8	507.52	N7	505.84	0.005122	328.00	Concrete	18 inch	,921,150.07	4,858,567.50	2,937,417.43	4.00	39.5	4.00
171	N20	507.90	N8	507.54	0.001412	255.00	Concrete	21 inch	,894,328.87	3,847,657.92	1,953,329.06	2.49	49.2	2.47
172	N22	508.30	N20	508.00	0.001429	210.00	Concrete	24 inch	,881,467.87	5,526,007.45	3,644,539.58	2.48	34.0	2.46
173	N23	508.82	N22	508.30	0.001394	373.00	Concrete	24 inch	,875,797.87	5,458,932.72	3,583,134.86	2.44	34.4	2.44
174	N4	503.78	N3	503.35	0.003185	135.00	PVC	8 inch	7,623.00	572,991.05	565,368.05	0.89	1.3	0.89
175	N9	516.48	N8	509.72	0.047273	143.00	PVC	8 inch	17,965.20	2,207,424.31	2,189,459.11	1.29	0.8	2.95
176	D18	510.81	D17	510.55	0.003611	72.00	PVC	8 inch	67,466.20	610,099.85	542,633.65	1.78	11.1	1.78
177	N21	517.20	N20	511.17	0.033132	182.00	Concrete	8 inch	4,914.00	1,421,543.33	1,416,629.33	0.93	0.3	1.46
178	N24	518.78	N23	509.40	0.023160	405.00	PVC	18 inch	,865,726.87	3,430,982.45	1,565,255.58	3.97	13.9	8.27
179	N25	527.34	N24	518.78	0.022119	387.00	PVC	18 inch	,865,159.87	3,125,482.40	1,260,322.53	3.97	14.2	8.14
180	N26	528.75	N25	527.54	0.052609	23.00	Concrete	18 inch	,864,618.07	5,571,099.82	3,706,481.76	3.97	12.0	9.19
181	D19	517.71	D18	510.81	0.024555	281.00	PVC	8 inch	67,365.40	1,590,932.95	1,523,567.55	1.82	4.2	3.50
183	Q8	493.30	Q1	491.82	0.004241	349.00	PVC	8 inch	19,276.40	661,147.92	641,871.52	1.31	2.9	1.31
184	Q9	496.85	Q8	493.30	0.010143	350.00	PVC	8 inch	18,079.80	1,022,493.71	1,004,413.91	1.29	1.8	1.73
185	Q10	503.72	Q9	496.85	0.068700	100.00	PVC	8 inch	17,589.80	2,661,085.70	2,643,495.90	1.28	0.7	3.34
186	Q11	513.32	Q10	504.62	0.089691	97.00	PVC	8 inch	12,540.80	3,040,564.72	3,028,023.92	1.17	0.4	3.30
187	O1	499.26	P28	496.28	0.015851	188.00	PVC	8 inch	51,520.40	1,278,232.04	1,226,711.64	1.69	4.0	2.77
188	O2	500.81	O1	499.36	0.009477	153.00	PVC	8 inch	46,444.40	988,368.23	941,923.83	1.65	4.7	2.24
189	O3	502.98	O2	500.81	0.013478	161.00	PVC	8 inch	46,230.20	1,178,684.09	1,132,453.89	1.65	3.9	2.53

Scenario: WetWeatherFlows

Gravity Pipe Report

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)	Length (ft)	Material	Section Size	Total Flow (gpd)	Design Capacity (gpd)	Excess Design Capacity (gpd)	Velocity In (ft/s)	Flow/Full Capacity (%)	Average Velocity (ft/s)
190	J1	517.26	K26	514.24	0.006467	467.00	Concrete	15 inch	865,353.84	3,357,264.54	2,491,910.70	3.30	25.8	3.55
191	J2	518.33	J1	517.31	0.024878	41.00	Concrete	15 inch	852,480.67	6,584,892.51	5,732,411.84	3.28	12.9	5.72
192	J3	518.50	J2	518.35	0.000974	154.00	Concrete	21 inch	851,373.67	3,195,954.32	2,344,580.65	1.83	26.6	1.74
193	R1	489.03	S14	487.92	0.003535	314.00	PVC	10 inch	20,920.50	1,094,469.99	1,073,549.49	1.21	1.9	1.21
194	R2	489.34	R1	489.03	0.004366	71.00	PVC	10 inch	16,380.90	1,216,350.86	1,199,969.96	1.21	1.3	1.21
195	R3	491.20	R2	489.34	0.003612	515.00	PVC	10 inch	16,281.50	1,106,267.24	1,089,985.74	1.13	1.5	1.13
196	R4	494.00	R3	491.20	0.014660	191.00	PVC	8 inch	5,595.57	1,229,257.38	1,223,661.81	0.96	0.5	1.38
197	R5	500.67	R4	494.00	0.035860	186.00	PVC	8 inch	5,328.17	1,922,591.14	1,917,262.97	0.93	0.3	1.85
198	R6	507.09	R5	500.67	0.027319	235.00	PVC	8 inch	5,067.77	1,678,085.46	1,673,017.69	0.93	0.3	1.65
199	R19	504.52	R3	492.35	0.132283	92.00	PVC	8 inch	9,964.93	3,692,596.62	3,682,631.69	1.11	0.3	3.53
200	S4	485.60	S3	484.89	0.001455	488.00	Concrete	24 inch	,261,916.94	5,576,731.68	3,314,814.75	2.60	40.6	2.60
201	S5	486.10	S4	485.75	0.002518	139.00	Concrete	24 inch	,248,740.94	7,336,469.36	5,087,728.42	3.18	30.7	3.18
202	S6	486.40	S5	486.10	0.001648	182.00	Concrete	24 inch	,244,987.94	5,935,884.19	3,690,896.26	2.75	37.8	2.72
203	N35	575.78	N34	563.98	0.067429	175.00	PVC	12 inch	,852,300.87	7,772,829.88	5,920,529.01	4.69	23.8	12.56
204	D44	505.95	D43	503.85	0.009417	223.00	Concrete	12 inch	206,756.60	2,234,452.09	2,027,695.49	2.30	9.3	2.75
205	O11	505.30	O8	504.67	0.007975	79.00	PVC	8 inch	40,009.40	906,644.90	866,635.50	1.58	4.4	2.02
206	O12	506.68	O11	505.50	0.006519	181.00	PVC	8 inch	39,898.80	819,751.48	779,852.68	1.58	4.9	1.88
208	M11	499.48	M1	499.35	0.004062	32.00	Concrete	30 inch	,844,798.27	5,895,998.97	5,051,200.70	3.49	10.9	3.49
209	M2	512.46	M1	505.06	0.180488	41.00	PVC	8 inch	4,959.60	4,313,247.94	4,308,288.34	0.91	0.1	3.18
210	M3	525.52	M2	512.96	0.142727	88.00	PVC	8 inch	4,902.20	3,835,605.88	3,830,703.68	0.93	0.1	2.92
211	D31	511.68	D17	510.72	0.003840	250.00	PVC	8 inch	52,529.80	629,138.27	576,608.47	1.69	8.3	1.69
212	D32	512.38	D31	511.87	0.006986	73.00	PVC	8 inch	52,179.80	848,602.19	796,422.39	1.71	6.1	2.08
213	L14	528.76	L13	526.61	0.004379	491.00	Concrete	8 inch	121,080.00	516,791.81	395,711.81	1.87	23.4	1.87
214	D33	516.88	D32	512.38	0.024457	184.00	PVC	8 inch	52,077.60	1,587,734.34	1,535,656.74	1.71	3.3	3.23
215	D45	507.25	D44	506.35	0.002500	360.00	Concrete	15 inch	200,735.60	2,087,423.35	1,886,687.75	1.66	9.6	1.66
216	A1	514.81	D41	501.64	0.193676	68.00	Concrete	8 inch	76,249.86	3,436,968.65	3,360,718.79	1.89	2.2	6.22
217	A2	517.32	A1	514.81	0.012488	201.00	Concrete	8 inch	74,413.86	872,722.10	798,308.23	1.88	8.5	2.36
218	D3	512.05	D2	511.13	0.001953	471.00	Concrete	8 inch	287,568.40	345,160.11	57,591.71	1.71	83.3	1.71
219	E1	512.73	D3	512.55	0.003529	51.00	Concrete	8 inch	274,851.40	463,968.30	189,116.89	2.14	59.2	2.14
479	C27	532.84	C17	532.26	0.002257	257.00	PVC	8 inch	47,067.00	482,311.84	435,244.84	1.36	9.8	1.36
484	C33	533.31	C27	532.84	0.004159	113.00	PVC	8 inch	45,087.20	654,772.15	609,684.95	1.64	6.9	1.66
646	B1	508.00	LC	507.00	0.004329	231.00	PVC	8 inch	13,861.60	667,996.99	654,135.39	1.19	2.1	1.19
D1	D15	500.71	WW-1	500.32	0.000894	436.00	Concrete	21 inch	441,121.26	3,062,699.26	2,621,577.99	1.32	14.4	1.40
P-222	M1	499.15	WW-3	498.50	0.011818	55.00	Concrete	24 inch	,852,055.87	5,894,095.55	4,042,039.69	3.70	11.7	5.23
P-223	S2	484.42	O-1	482.00	0.027191	89.00	Concrete	24 inch	,267,926.11	4,108,665.19	1,840,739.07	3.92	9.4	7.46

Future Wet Weather Flows

2035

Scenario: Scenario 3

Gravity Pipe Report

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)	Length (ft)	Material	Section Size	Total Flow (mgd)	Design Capacity (mgd)	Excess Design Capacity (mgd)	Veloc In (ft/s)	Flow/Full Capa (%)	Average Velocity (ft/s)
2	A3	518.27	A2	517.32	0.003125	304.00	Concrete	8 inch	.09341093	.43657831	.34316737	1.54	21.4	1.54
3	E5	514.40	E1	512.93	0.008963	164.00	Concrete	8 inch	.33422608	.73939053	.40516445	1.48	45.2	1.48
4	E6	517.11	E5	514.80	0.008885	260.00	Concrete	8 inch	.10206631	.73613329	.63406697	2.05	13.9	2.29
5	E8	517.33	E6	517.31	0.000303	66.00	Concrete	8 inch	.09504309	.13595030	.04090721	0.95	69.9	0.65
6	E9	520.62	E8	517.63	0.005191	576.00	Concrete	8 inch	.09313004	.56268002	.46954998	1.85	16.6	1.85
7	E11	521.78	E9	520.82	0.006400	150.00	Concrete	8 inch	.07753456	.62478001	.54724545	1.89	12.4	1.89
8	E12	523.97	E11	521.88	0.004265	490.00	Concrete	8 inch	.07186880	.51004940	.43818060	1.60	14.1	1.60
9	E13	540.11	E12	524.17	0.032866	485.00	Concrete	8 inch	.05712800	.41582778	.35869978	1.75	4.0	3.07
10	A4	519.72	A3	518.27	0.003008	482.00	Concrete	8 inch	.05409417	.42834887	.37425469	1.30	12.6	1.30
11	F1	521.79	E5	516.30	0.016195	339.00	Concrete	8 inch	.22673021	.99385600	.76712578	2.58	22.8	3.57
12	F2	521.87	F1	521.79	0.008000	10.00	Concrete	8 inch	.21753841	.69852529	.48098688	2.55	31.1	2.73
13	F3	524.94	F2	521.87	0.009840	312.00	Concrete	8 inch	.04827570	.77469193	.72641623	1.67	6.2	1.91
14	F9	522.67	F2	521.87	0.006504	123.00	Concrete	8 inch	.14516679	.62983904	.48467225	2.26	23.0	2.27
15	F11	524.59	F9	522.67	0.006931	277.00	Concrete	8 inch	.14092869	.65020135	.50927266	2.24	21.7	2.30
16	F14	528.14	F11	524.69	0.014315	241.00	Concrete	8 inch	.13225108	.93441148	.80216040	2.20	14.2	2.93
17	F16	528.88	F14	528.14	0.015417	48.00	Concrete	8 inch	.12564446	.96968880	.84404434	2.17	13.0	2.96
18	F17	531.04	F16	528.88	0.013416	161.00	Concrete	8 inch	.12392473	.90458853	.78066380	2.16	13.7	2.81
19	F20	532.63	F17	531.04	0.017865	89.00	Concrete	8 inch	.11934406	.04385626	.92451220	2.14	11.4	3.08
20	F21	532.94	F20	532.63	0.013478	23.00	Concrete	8 inch	.11687229	.90668007	.78980778	2.12	12.9	2.77
21	F22	537.03	F21	532.94	0.014201	288.00	Concrete	8 inch	.08185460	.93068465	.84883005	1.92	8.8	2.54
22	D54	515.89	D47	515.57	0.013913	23.00	Concrete	12 inch	.53956807	.71596958	.17640151	3.02	19.9	4.17
23	D64	523.37	D63	522.07	0.004248	306.00	Concrete	15 inch	.47807426	.72114381	.24306956	2.58	17.6	2.58
25	H18	536.74	H15	530.90	0.013094	446.00	Concrete	8 inch	.11968531	.89366785	.77398254	2.14	13.4	2.76
26	H20	539.82	H18	536.84	0.011920	250.00	Concrete	8 inch	.10708646	.85265878	.74557232	2.07	12.6	2.58
27	H23	544.26	H20	539.82	0.016882	263.00	Concrete	8 inch	.09961312	.01473059	.91511747	2.03	9.8	2.86
28	H2	524.12	H1	523.66	0.003217	143.00	Concrete	15 inch	.34299842	.36783496	.02483654	2.13	14.5	2.13
29	H4	524.83	H2	524.27	0.004409	127.00	Concrete	12 inch	.33898609	.52899471	.19000862	2.42	22.2	2.42
30	H5	525.32	H4	524.98	0.002282	149.00	Concrete	12 inch	.33526607	.09991761	.76465154	1.90	30.5	1.90
31	H6	526.61	H5	525.37	0.003804	326.00	Concrete	12 inch	.33033224	.42009001	.08975777	2.28	23.3	2.28
32	D40	501.04	D15	500.73	0.000939	330.00	Concrete	21 inch	.73646143	.13862313	.40216170	0.47	23.5	0.47
34	J9	526.13	J8	524.92	0.006020	201.00	Concrete	8 inch	.05008380	.60594303	.55585923	1.62	8.3	1.62
36	J4	519.12	J3	518.83	0.008286	35.00	Concrete	15 inch	.24674033	.80019173	.55345141	3.68	32.8	4.29
37	J6	520.30	J4	519.32	0.005600	175.00	Concrete	15 inch	.24036696	.12416919	.88380223	3.68	39.7	3.71
38	J19	538.87	J6	520.35	0.042575	435.00	Concrete	12 inch	.17961251	.75105101	.57143850	3.90	24.8	7.77
39	B2	510.26	B1	508.39	0.008462	221.00	PVC	8 inch	.04487036	.93391029	.88903993	1.63	4.8	2.13
40	I2	525.87	I1	522.43	0.008821	390.00	Concrete	8 inch	.22626993	.73347288	.50720295	2.58	30.8	2.86
41	I5	529.40	I4	526.80	0.011927	218.00	Concrete	8 inch	.21292960	.85289500	.63996540	2.53	25.0	3.14
42	I6	532.61	I5	529.40	0.010664	301.00	Concrete	8 inch	.20637116	.80650378	.60013263	2.51	25.6	2.99
42.5	C14	531.25	C13	530.98	0.002015	134.00	PVC	12 inch	.18823610	.34365158	.15541547	1.87	14.0	1.87
43	I7	548.26	I6	532.61	0.035488	441.00	Concrete	8 inch	.19733214	.47121118	.27387904	2.48	13.4	4.54
43.5	C16	531.47	C14	531.25	0.001341	164.00	PVC	12 inch	.18251330	.09634338	.91383009	1.60	16.6	1.60
44	B3	512.37	B2	510.26	0.009860	214.00	PVC	8 inch	.03860160	.00812604	.96952444	1.57	3.8	2.15
44.5	C17	532.26	C16	531.47	0.007383	107.00	PVC	12 inch	.17723922	.57204664	.39480742	2.21	6.9	2.90
45	I11	564.16	I8	557.70	0.034362	188.00	Concrete	8 inch	.11570436	.44768633	.33198197	2.12	8.0	3.84
46	I8	557.70	I7	548.26	0.036732	257.00	Concrete	8 inch	.12293626	.49677519	.37383893	2.16	8.2	4.00
47	I12	568.14	I11	564.16	0.017229	231.00	Concrete	8 inch	.11002420	.02511523	.91509103	2.09	10.7	2.97
47.5	D2	511.13	WW-1	506.82	0.064328	67.00	Concrete	8 inch	.37567764	.98078972	.60511208	1.67	19.0	1.67
48	B12	513.89	B3	512.37	0.006104	249.00	PVC	8 inch	.03368566	.79323636	.75955070	1.51	4.2	1.75
49	B13	517.26	B12	513.89	0.012962	260.00	PVC	8 inch	.03249700	.15586941	.12337241	1.50	2.8	2.25
50	L2	523.63	L1	518.31	0.018932	281.00	Concrete	8 inch	.08388474	.07458258	.99069784	1.94	7.8	2.83
51	L15	535.79	L14	528.86	0.014028	494.00	Concrete	8 inch	.12110470	.92499691	.80389221	2.15	13.1	2.84
52	L16	542.46	L15	535.89	0.014159	464.00	Concrete	8 inch	.10687500	.92931048	.82243548	2.07	11.5	2.74
53	L13	526.51	L1	518.36	0.037907	215.00	Concrete	8 inch	.14094443	.52053603	.37959160	2.24	9.3	4.22
54	Q13	513.94	Q11	513.42	0.011556	45.00	PVC	8 inch	.02778843	.09137979	.06359136	1.45	2.5	2.06
55	Q1	491.62	S19	490.38	0.004247	292.00	PVC	8 inch	.05912482	.66160672	.60248191	1.76	8.9	1.81
56	D41	501.64	D40	501.04	0.001676	358.00	Concrete	21 inch	.73158544	.19227155	.46068611	0.47	17.5	0.47
57	R9	529.98	R8	524.94	0.024115	209.00	PVC	8 inch	.00760874	.57660398	.56899523	1.03	0.5	1.80
58	B4	514.50	B3	512.37	0.008192	260.00	PVC	8 inch	.00380500	.91893252	.91512752	0.86	0.4	1.00
59	R10	532.15	R9	530.03	0.040000	53.00	PVC	8 inch	.00728706	.03053504	.02324798	1.02	0.4	2.11
60	R11	535.45	R10	532.15	0.032353	102.00	PVC	8 inch	.00714192	.82615391	.81901198	1.01	0.4	1.95
61	O8	504.47	O3	502.98	0.010136	147.00	PVC	8 inch	.09032194	.02215077	.93182883	1.98	8.8	2.79
62	O13	507.92	O12	506.88	0.006228	167.00	PVC	8 inch	.08579291	.80119628	.71540337	1.95	10.7	2.32
63	O14	508.78	O13	508.12	0.007253	91.00	PVC	8 inch	.08530222	.86463291	.77933069	1.95	9.9	2.44
64	O15	511.33	O14	508.88	0.009176	267.00	PVC	8 inch	.07372674	.97254097	.89881422	1.87	7.6	2.54
65	O16	513.21	O15	511.43	0.012448	143.00	PVC	8 inch	.07298700	.13271975	.05973276	1.87	6.4	2.82
66	O17	514.69	O16	513.21	0.013832	107.00	PVC	8 inch	.07249146	.19404161	.12155015	1.86	6.1	2.92
67	O18	519.62	O17	514.79	0.018090	267.00	PVC	8 inch	.07145781	.36552114	.29406332	1.86	5.2	3.20
68	O38	524.91	O26	523.06	0.015948	116.00	Concrete	8 inch	.02569039	.98626588	.96057549	1.42	2.6	1.87
70	O40	542.30	O38	524.91	0.075281	231.00	Concrete	24 inch	.02225120	.11476820	.09251700	1.16	0.1	2.62
71	O26	522.96	O18	519.72	0.024179	134.00	PVC	8 inch	.05314901	.57870360	.52555458	1.71	3.4	3.24
72	K23	506.33	K1	505.55	0.065000	12.00	Concrete	15 inch	.10856211	.64381238	.53525027	4.40	19.8	10.45
73	K24	510.61	K23	507.78	0.027212	104.00	Concrete	15 inch	.31656775	.88679381	.57022606	3.75	19.1	6.69
74	K25	512.77	K24	510.61	0.007152	302.00	Concrete	15 inch	.28598768	.53072535	.24473768	3.72	36.4	4.10
75	K26	514.19	K25	512.77	0.006094	233.00	Concrete	15 inch	.27762213	.25916797	.98154584	3.71	39.2	3.86
76	K3	506.83	K2	506.73	0.003333	30.00	PVC	8 inch	.29876315	.58616498	.28740182	2.61	51.0	2.61
77	K4	510.94	K3	509.43	0.004646	325.00	Concrete	8 inch	.29317016	.53233367	.23916350	2.42	55.1	2.42
78	K5	517.06	K4	510.94	0.021250	288.00	Concrete	8 inch	.28382750	.13845694	.85462943	2.77	24.9	4.19
79	K6	523.96	K5	521.31	0.017550	151.00	PVC	8 inch	.01600726	.34497730	.32897004	1.25	1.2	2.02
80	K7	524.83	K6	523.96	0.016731	52.00	PVC	8 inch	.01574022	.31322290	.29748267	1.24	1.2	1.98
81	K8	540.43	K7	525.03	0.054610	282.00	PVC	8 inch	.01539180	.37255505	.35716325	1.24	0.6	2.96
82	L1	518.16	K5	517.06	0.003667	300.00	Concrete	8 inch	.25631121	.47290386	.21659265	2.14	54.2	2.14
83	K29	510.35	K28	509.56	0.002532	312.00	Concrete	15 inch	.77320448	.10076165	.32755717	2.45	36.8	2.45
84	K37	513.18	K36	512.67	0.003835	133.00	Concrete	15 inch	.70011311	.58523365	.88512054	2.77	27.1	2.77
85	I1	518.63	K37	513.43	0.017333	300.00	Concrete	15 inch	.69591358	.49644108	.80052750	3.09	12.7	4.75
86	K32	511.74	K29	510.45	0.004778	270.00	Concrete	15 inch	.76399904	.88571545	.12171641	3.07	26.5	3.07
87	K36	512.67	K32	511.74	0.004697	198.00	Concrete	15 inch	.72601222	.86120787	.13519566	3.01	25.4	3.01
88	I4	526.80	I2	525.87	0.010568	88.00	Concrete	8 inch	.21563128	.80285530	.58722402	2.54	26.9	3.02
89	I30	519.55	I1	518.88	0.001667	402.00	Concrete	15 inch	.43360214	.70437403	.27077188	1.79	25.4	1.79
90	Q17	518.05	Q13	513.94	0.019571	210.00	PVC	8 inch	.02721000	.42033816	.39312816	1.44	1.9	2.46

Gravity Pipe Report

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)	Length (ft)	Material	Section Size	Total Flow (mgd)	Design Capacity (mgd)	Excess Design Capacity (mgd)	Velocity In (ft/s)	Flow/Full Capacity (%)	Average Velocity (ft/s)
91	S19	490.18	S18	489.86	0.032000	10.00	PVC	8 inch	.05995770	.81616575	.75620805	0.38	3.3	3.70
92	C7	529.34	C6	528.93	0.002993	137.00	PVC	12 inch	.28458930	.63752835	.35293905	2.42	17.4	2.42
93	K2	506.73	K1	506.05	0.005812	117.00	Concrete	12 inch	.30201846	.75539702	.45337856	2.56	17.2	2.59
94	M17	500.01	M16	499.76	0.000610	410.00	Concrete	24 inch	.47810019	.61026068	.13216049	2.12	68.6	1.92
95	M18	500.78	M17	500.21	0.001192	478.00	Concrete	24 inch	.46574699	.04875115	.58300417	2.48	48.8	2.47
96	M21	504.31	M18	500.98	0.006633	502.00	Concrete	21 inch	.43599599	.34037451	.90437852	4.13	29.2	4.66
97	M22	504.93	M21	504.51	0.001918	219.00	Concrete	24 inch	.42167487	.40269883	.98102395	2.93	37.8	2.93
98	K1	505.03	M22	505.00	0.000242	124.00	Concrete	24 inch	.41430757	.27410373	.14020384	2.28	106.2	1.26
99	C8	529.82	C7	529.34	0.003902	123.00	PVC	12 inch	.27703934	.86992956	.59289021	2.49	14.8	2.64
100	M12	512.92	M11	502.18	0.110722	97.00	PVC	8 inch	.00335709	.37828874	.37493165	0.84	0.1	2.39
101	M13	515.18	M12	513.12	0.020396	101.00	PVC	8 inch	.00316540	.44995130	.44678590	0.82	0.2	1.30
102	M16	499.76	M11	499.48	0.007368	38.00	Concrete	24 inch	.47884363	.55011494	.07127131	4.02	19.8	4.81
103	D42	502.61	D41	501.64	0.007886	123.00	Concrete	15 inch	.62048869	.70743754	.08694886	0.78	16.7	0.78
104	C11	530.26	C8	529.82	0.001636	269.00	PVC	12 inch	.19750745	.21061871	.01311126	1.76	16.3	1.76
105	C13	530.98	C11	530.26	0.002361	305.00	PVC	12 inch	.18970489	.45436533	.26466043	1.98	13.0	1.98
107	P9	521.39	P6	510.88	0.072483	145.00	PVC	8 inch	.02989800	.73336639	.70346839	1.46	1.1	4.00
109	P6	510.58	P5	494.28	0.126357	129.00	PVC	8 inch	.04290580	.60893815	.56603235	1.61	1.2	5.42
112	S3	484.89	S2	484.52	0.011563	32.00	Concrete	24 inch	.67366026	.72122411	.04756386	4.52	23.4	6.32
113	S13	487.05	S6	486.50	0.001571	350.00	Concrete	24 inch	.68174153	.79572551	.11398398	3.05	63.5	3.02
114	S14	487.42	S13	487.10	0.001531	209.00	Concrete	24 inch	.67649936	.72087333	.04437397	3.05	64.3	2.99
115	R8	524.74	R7	510.46	0.048904	292.00	PVC	8 inch	.00814269	.24519037	.23704768	1.05	0.4	2.34
116	R7	510.06	R6	507.39	0.024495	109.00	PVC	8 inch	.00838530	.58899626	.58061096	1.06	0.5	1.90
117	N32	544.88	N26	528.75	0.068638	235.00	Concrete	12 inch	.30878174	.03249657	.72371483	2.57	5.1	6.24
118	N33	549.73	N32	544.88	0.098980	49.00	PVC	12 inch	.26805700	.41737821	.14932121	2.47	2.8	8.19
119	N34	563.98	N33	549.73	0.089623	159.00	PVC	12 inch	.14917148	.96119759	.81202610	2.11	1.7	6.61
121	J7	524.33	J6	520.85	0.080930	43.00	Concrete	8 inch	.05597184	.22173642	.16576458	1.74	2.5	4.18
122	J8	524.92	J7	524.33	0.005413	109.00	Concrete	8 inch	.05433910	.57457920	.52024010	1.60	9.5	1.60
123	I38	519.91	I30	519.55	0.001032	349.00	Concrete	15 inch	.37429381	.34084652	.96655271	1.45	27.9	1.45
124	I40	522.26	I38	520.21	0.010302	199.00	Concrete	15 inch	.36406221	.23731670	.87325448	2.58	8.6	3.27
125	I41	522.88	I40	522.41	0.007966	59.00	Concrete	15 inch	.35868329	.72617678	.36749350	2.57	9.6	2.97
126	H1	523.56	I41	522.88	0.001399	486.00	Concrete	15 inch	.35648186	.56162536	.20514351	1.60	22.8	1.60
128	G1	527.42	H6	526.71	0.001989	357.00	Concrete	12 inch	.08950397	.02685447	.93735050	1.24	8.7	1.24
129	G13	527.91	G1	527.42	0.002678	183.00	Concrete	12 inch	.06570321	.19147882	.12577561	1.26	5.5	1.26
130	G18	528.65	G13	528.01	0.001860	344.00	Concrete	8 inch	.04406915	.33685881	.29278966	1.03	13.1	1.03
131	H7	527.96	H6	526.61	0.004515	299.00	Concrete	12 inch	.22921680	.54719524	.31797844	2.18	14.8	2.18
133	H8	528.06	H7	528.01	0.001190	42.00	Concrete	8 inch	.22083237	.26946198	.04862961	1.59	82.0	1.33
134	H15	530.85	H8	528.16	0.014158	190.00	Concrete	8 inch	.12548196	.92925837	.80377641	2.17	13.5	2.87
135	R12	540.02	R11	536.90	0.195000	16.00	PVC	8 inch	.00699307	.48329997	.47630691	1.01	0.2	3.62
137	D16	509.31	D15	502.38	0.021193	327.00	PVC	8 inch	.15030659	.47799591	.32768933	0.67	10.2	0.67
139	D46	508.69	D45	507.45	0.003584	346.00	Concrete	15 inch	.60321785	.49927086	.89605301	0.83	24.1	2.59
140	C1	524.27	D64	523.57	0.005983	117.00	Concrete	12 inch	.46901351	.78102461	.31201110	2.90	26.3	2.96
141	D43	503.45	D42	502.61	0.011351	74.00	Concrete	12 inch	.61760036	.45322631	.83562596	1.22	25.2	1.22
142	D47	515.57	D46	508.89	0.015182	440.00	Concrete	15 inch	.59325432	.14401736	.55076303	2.95	11.5	4.32
143	C2	524.70	C1	524.27	0.006825	63.00	PVC	8 inch	.46550782	.83877301	.37326519	3.29	55.5	3.81
144	C3	525.38	C2	524.70	0.005075	134.00	PVC	12 inch	.46447757	.13235368	.66787611	2.89	21.8	3.36
145	C4	526.16	C3	525.38	0.002591	301.00	PVC	12 inch	.40222696	.52377638	.12154942	2.53	26.4	2.53
146	C5	527.82	C4	526.26	0.003312	471.00	PVC	12 inch	.38728281	.72269752	.33541472	2.74	22.5	2.74
147	C6	528.93	C5	527.92	0.006733	150.00	PVC	12 inch	.29159644	.45624815	.16465171	2.53	11.9	3.25
148	D55	519.38	D54	515.89	0.012332	283.00	Concrete	12 inch	.53859915	.55701530	.01841615	3.02	21.1	3.99
149	D62	520.42	D55	519.38	0.013867	75.00	Concrete	12 inch	.49738541	.71143919	.21405378	2.95	18.3	4.07
150	K28	509.31	K23	507.78	0.011418	134.00	Concrete	15 inch	.79077364	.46101669	.67024306	3.21	17.7	4.24
151	S15	488.00	S14	487.42	0.001568	370.00	Concrete	24 inch	.63007372	.78860107	.15852735	3.01	62.7	3.01
152	S16	488.38	S15	488.20	0.000474	380.00	Concrete	24 inch	.62319572	.18203491	.44116081	2.36	113.9	1.78
153	S17	488.76	S16	488.58	0.000602	299.00	Concrete	24 inch	.61395214	.58724587	.02670627	2.41	100.7	2.01
154	S18	489.36	S17	488.76	0.001277	470.00	Concrete	24 inch	.60619280	.22380771	.61761491	2.69	69.0	2.78
155	P1	489.68	S18	489.46	0.001272	173.00	Concrete	24 inch	.53376688	.21373286	.67996597	2.82	67.8	2.76
156	P2	489.91	P1	489.68	0.001022	225.00	Concrete	24 inch	.52926276	.67447827	.14521551	2.65	75.5	2.53
157	D63	522.07	D62	520.42	0.003474	475.00	Concrete	12 inch	.49304379	.35709109	.86404729	2.46	36.3	2.46
158	P3	491.30	P2	490.21	0.002224	490.00	Concrete	21 inch	.52178644	.82981508	.30802863	3.39	72.9	3.39
159	P4	492.45	P3	491.50	0.002043	465.00	Concrete	21 inch	.49823890	.62861033	.13037143	3.27	75.6	3.27
160	P5	492.93	P4	492.65	0.000946	296.00	Concrete	24 inch	.47810060	.49669722	.01859662	2.67	77.3	2.45
161	P26	493.05	P5	492.93	0.001237	97.00	Concrete	24 inch	.42473659	.14239274	.71765615	2.66	66.6	2.71
162	P27	493.95	P26	493.05	0.002088	431.00	Concrete	24 inch	.41275691	.68102513	.26826822	3.31	51.1	3.31
163	P28	494.98	P27	493.95	0.001301	792.00	Concrete	24 inch	.44292708	.27249902	.82957194	2.77	65.3	2.77
164	N1	496.89	P28	495.18	0.003386	505.00	Concrete	21 inch	.34849464	.95892144	.61042680	3.94	56.2	3.94
165	D17	510.42	D16	509.52	0.005625	160.00	PVC	8 inch	.14943454	.76145064	.61201610	0.66	19.6	0.66
166	N2	498.39	N1	496.89	0.003731	402.00	Concrete	18 inch	.36584738	.14689582	.78104844	4.04	81.2	4.04
167	N3	500.45	N2	498.39	0.005296	389.00	Concrete	18 inch	.37833483	.94025460	.56191977	4.66	68.4	4.66
168	N6	503.72	N3	500.45	0.006728	486.00	Concrete	18 inch	.35023822	.56860308	.21836486	4.83	60.2	5.10
169	N7	505.74	N6	503.72	0.005344	378.00	Concrete	18 inch	.29705419	.96272610	.66567191	4.65	66.4	4.65
170	N8	507.52	N7	505.84	0.005122	328.00	Concrete	18 inch	.19955361	.85856750	.65901389	4.54	65.9	4.54
171	N20	507.90	N8	507.54	0.001412	255.00	Concrete	21 inch	.90222754	.84765792	.94543039	2.83	75.4	2.72
172	N22	508.30	N20	508.00	0.001429	210.00	Concrete	24 inch	.56080319	.52600745	.96520426	2.64	46.3	2.67
173	N23	508.82	N22	508.30	0.001394	373.00	Concrete	24 inch	.43958450	.45893272	.01934822	2.18	26.4	2.27
174	N4	503.78	N3	503.35	0.003185	135.00	PVC	8 inch	.01803060	.57299105	.55496045	1.15	3.1	1.15
175	N9	516.48	N8	509.72	0.047273	143.00	PVC	8 inch	.03853260	.20742431	.16889171	1.57	1.7	3.72
176	D18	510.81	D17	510.55	0.003611	72.00	PVC	8 inch	.08076832	.61009985	.52933153	0.36	13.2	0.36
177	N21	517.20	N20	511.17	0.033132	182.00	Concrete	8 inch	.00491400	.42154333	.41662933	0.93	0.3	1.46
178	N24	518.78	N23	509.40	0.023160	405.00	PVC	18 inch	.02477972	.43098245	.40620273	3.32	7.6	6.95
179	N25	527.34	N24	518.78	0.022119	387.00	PVC	18 inch	.57190022	.12548240	.55358218	2.82	4.4	5.75
180	N26	528.75	N25	527.54	0.052609	23.00	Concrete	18 inch	.54773934	.57109982	.02336048	2.79	3.5	6.40
181	D19	517.71	D18	510.81	0.024555	281.00	PVC	8 inch	.08025100	.59093295	.51068195	1.91	5.0	3.68
183	Q8	493.30	Q1	491.82	0.004241	349.00	PVC	8 inch	.04265063	.66114792	.61849729	1.61	6.5	1.65
184	Q9	496.85	Q8	493.30	0.010143	350.00	PVC	8 inch	.03951197	.02249371	.98298174	1.58	3.9	2.19
185	Q10	503.72	Q9	496.85	0.068700	100.00	PVC	8 inch	.03887232	.66108570	.62221338	1.57	1.5	4.25
186	Q11	513.32	Q10	504.62	0.089691	97.00	PVC	8 inch	.02802470	.04056472	.01254001	1.44	0.9	4.22
187	O1	499.26	P28	496.28	0.015851	188.00	PVC	8 inch	.10668095	.27823204	.17155109	2.07	8.3	3.44
188	O2	500.81	O1	499.36	0.009477	153.00	PVC	8 inch	.09796414	.98836823	.89040409	2.02	9.9	2.79
189	O3	502.98	O2	500.81	0.013478	161.00	PVC	8 inch	.09754811	.17868409	.08113598	2.02	8.3	3.16

Scenario: Scenario 3

Gravity Pipe Report

Label	Upstream Node	Upstream Invert Elevation (ft)	Downstream Node	Downstream Invert Elevation (ft)	Constructed Slope (ft/ft)	Length (ft)	Material	Section Size	Total Flow (mgd)	Design Capacity (mgd)	Excess Design Capacity (mgd)	Velocity In (ft/s)	Flow/Full Capacity (%)	Average Velocity (ft/s)
190	J1	517.26	K26	514.24	0.006467	467.00	Concrete	15 inch	.27068825	.35726454	.08657629	3.70	37.8	3.94
191	J2	518.33	J1	517.31	0.024878	41.00	Concrete	15 inch	.25791163	.58489251	.32698088	3.69	19.1	6.40
192	J3	518.50	J2	518.35	0.000974	154.00	Concrete	21 inch	.25622746	.19595432	.93972686	2.08	39.3	1.93
193	R1	489.03	S14	487.92	0.003535	314.00	PVC	10 inch	.04488280	.09446999	.04958720	1.53	4.1	1.53
194	R2	489.34	R1	489.03	0.004366	71.00	PVC	10 inch	.03460287	.21635086	.18174799	1.48	2.8	1.52
195	R3	491.20	R2	489.34	0.003612	515.00	PVC	10 inch	.03295922	.10626724	.07330802	1.40	3.0	1.40
196	R4	494.00	R3	491.20	0.014660	191.00	PVC	8 inch	.00933638	.22925738	.21992100	1.09	0.8	1.61
197	R5	500.67	R4	494.00	0.035860	186.00	PVC	8 inch	.00904763	.92259114	.91354351	1.08	0.5	2.20
198	R6	507.09	R5	500.67	0.027319	235.00	PVC	8 inch	.00874125	.67808546	.66934421	1.06	0.5	2.00
199	R19	504.52	R3	492.35	0.132283	92.00	PVC	8 inch	.02278686	.69259662	.66980976	1.36	0.6	4.54
200	S4	485.60	S3	484.89	0.001455	488.00	Concrete	24 inch	.69585977	.57673168	.88087191	2.94	66.3	2.94
201	S5	486.10	S4	485.75	0.002518	139.00	Concrete	24 inch	.68755759	.33646936	.64891177	3.60	50.3	3.62
202	S6	486.40	S5	486.10	0.001648	182.00	Concrete	24 inch	.69014998	.93588419	.24573421	3.17	62.2	3.08
203	N35	575.78	N34	563.98	0.067429	175.00	PVC	12 inch	.00024500	.77282988	.77258488	0.40	0.0	44.98
204	D44	505.95	D43	503.85	0.009417	223.00	Concrete	12 inch	.61686450	.23445209	.61758758	1.22	27.6	1.22
205	O11	505.30	O8	504.67	0.007975	79.00	PVC	8 inch	.08697411	.90664490	.81967079	1.96	9.6	2.54
206	O12	506.68	O11	505.50	0.006519	181.00	PVC	8 inch	.08648977	.81975148	.73326171	1.95	10.6	2.36
208	M11	499.48	M1	499.35	0.004062	32.00	Concrete	30 inch	.48482744	.89599897	.41117153	3.81	14.7	3.81
209	M2	512.46	M1	505.06	0.180488	41.00	PVC	8 inch	.01171307	.31324794	.30153488	1.15	0.3	4.13
210	M3	525.52	M2	512.96	0.142727	88.00	PVC	8 inch	.01159280	.83560588	.82401308	1.14	0.3	3.77
211	D31	511.68	D17	510.72	0.003840	250.00	PVC	8 inch	.06355374	.62913827	.56558453	0.28	10.1	0.28
212	D32	512.38	D31	511.87	0.006986	73.00	PVC	8 inch	.06307812	.84860219	.78552408	0.28	7.4	0.28
213	L14	528.76	L13	526.61	0.004379	491.00	Concrete	8 inch	.13481905	.51679181	.38197276	1.93	26.1	1.93
214	D33	516.88	D32	512.38	0.024457	184.00	PVC	8 inch	.06273300	.58773434	.52500134	1.78	4.0	3.42
215	D45	507.25	D44	506.35	0.002500	360.00	Concrete	15 inch	.61268515	.08742335	.47473820	0.77	29.4	0.77
216	A1	514.81	D41	501.64	0.193676	68.00	Concrete	8 inch	.10226203	.43696865	.33470662	2.05	3.0	6.80
217	A2	517.32	A1	514.81	0.012488	201.00	Concrete	8 inch	.10019842	.87272210	.77252368	2.04	11.5	2.58
218	D3	512.05	D2	511.13	0.001953	471.00	Concrete	8 inch	.37141001	.34516011	.02624990	1.65	107.6	1.65
219	E1	512.73	D3	512.55	0.003529	51.00	Concrete	8 inch	.35846667	.46396830	.10550162	1.59	77.3	1.59
479	C27	532.84	C17	532.26	0.002257	257.00	PVC	8 inch	.11758525	.48231184	.36472659	1.76	24.4	1.76
484	C33	533.31	C27	532.84	0.004159	113.00	PVC	8 inch	.06294320	.65477215	.59182895	1.79	9.6	1.83
646	B1	508.00	LC	507.00	0.004329	231.00	PVC	8 inch	.04541928	.66799699	.62257771	1.64	6.8	1.69
D1	D15	500.71	WW-1	500.32	0.000894	436.00	Concrete	21 inch	.89903225	.06269926	.16366700	0.58	29.4	0.58
P-222	M1	499.15	WW-3	498.50	0.011818	55.00	Concrete	24 inch	.49881278	.89409555	.39528277	4.03	15.7	5.71
P-223	S2	484.42	O-1	482.00	0.027191	89.00	Concrete	24 inch	.68148616	.10866519	.42717903	4.53	15.3	8.58