CHAPTER 5

EXISTING AND PROJECTED WASTEWATER FLOWS AND CHARACTERISTICS

INTRODUCTION

In this chapter, the existing wastewater characteristics for the service area will be analyzed and projections made for future conditions.

Appropriate design of wastewater treatment and conveyance facilities requires the determination of the current and future quantity and quality of wastewater generated from each of the contributing sources. Typically, wastewater is predominantly domestic in origin with lesser amounts contributed by commercial businesses and by public use facilities such as schools, parks, hospitals, and municipal functions. In addition to these flows, the City of Woodland WWTP also has a significant amount of flow from industrial sources. Additionally, infiltration and inflow (I/I) contributions result from groundwater and surface water entering the sewer system during periods of high groundwater levels and rainfall, respectively, as occurs in many other communities in Washington.

DEFINITIONS OF TERMS

The terms and abbreviations used in the analysis are described below, listed in alphabetical order.

AVERAGE ANNUAL FLOW

Average annual flow is the average daily flow over a calendar year. This flow parameter is used to estimate annual operation and maintenance costs for treatment and lift station facilities.

AVERAGE DRY WEATHER FLOW

Average dry weather flow is wastewater flow during periods when the groundwater table is low and precipitation is at its lowest of the year. The dry weather flow period in much of Washington normally occurs during June through September. During this time, the wastewater strength is highest, due to the lack of dilution with the ground and surface water components of infiltration and inflow. The higher strength coupled with higher temperatures and longer detention times in the sewer system create the greatest potential for system odors during this time. The average dry weather flow is the average daily flow during the three lowest consecutive flow months of the year. For this study, average flows for July, August, and September are used.

BASE FLOW

Base flow is wastewater flow during periods when the groundwater table is low and there is no precipitation. This is the sanitary sewer flow without any inflow or infiltration (defined below). Base flow is determined from the influent flow charts during the driest summer months. Base flow values are slightly lower than the average dry weather flow, because the base flow is not an average over the summer months, but the lowest flow during dry summer days.

BIOCHEMICAL OXYGEN DEMAND (BOD_5)

Biochemical oxygen demand (BOD) is a measure of the oxygen required by microorganisms in the biochemical oxidation (digestion) of organic matter. BOD is an indicator of the organic strength of the wastewater. If significant quantities are discharged untreated to the environment, biodegradable organics will deplete natural oxygen resources and result in the development of septic (anaerobic) conditions. BOD data together with other parameters are used in the sizing of the treatment facilities and provide a measurement for determining the effectiveness of the treatment process. BOD is expressed as a concentration in terms of milligrams per liter (mg/L) and as a load in terms of pounds per day (lb/d). The term BOD typically refers to a 5-day BOD, often written BOD_5, since the BOD test protocol requires 5 days for completion. BOD_5 of a wastewater is composed of two components – a carbonaceous oxygen demand ($CBOD_5$) and a nitrogenous oxygen demand ($NBOD_5$). The use of $CBOD_5$ as a parameter for evaluating wastewater strength removes the influence of nitrogenous components, including ammonia and organic nitrogen.

CHLORINE

Chlorine is a chemical compound that acts as a strong oxidant. Chlorine is widely used as a disinfectant in wastewater treatment, and is available both in gaseous (elemental chlorine) and solution forms (hypochlorite). Chlorine is a toxic chemical and is lethal to aquatic biota if present in too high a concentration. Additionally, some organic constituents may react with the chlorine to interfere with chlorination or form toxic compounds, such as chloroform, that can have long-term adverse effect on the beneficial uses of the waters to which they are discharged. To minimize the effects of potentially toxic chlorine residuals on the environment, it has sometimes been found necessary to dechlorinate wastewater treated with chlorine or substitute alternative disinfection systems such as ultraviolet disinfection, as the City of Woodland uses.

CONTAMINANTS OF CONCERN

Contaminants of concern in wastewater, in addition to chlorine, BOD, and TSS discussed elsewhere in this section, include nutrients, priority pollutants, heavy metals, and dissolved organics.

Nutrients, such as nitrogen and phosphorus along with carbon, are essential requirements for growth. When discharged to the aquatic environment, these nutrients can lead to the growth of undesirable aquatic life. When discharged in excessive amounts on land, they can also lead to the pollution of groundwater. Additionally, in too high a concentration, nutrients, particularly ammonia, can be toxic to aquatic life.

Priority pollutants are organic and inorganic compounds selected on the basis of their known or suspected carcinogenicity, mutagenicity, teratogenicity, or high acute toxicity. Many of these compounds are found in wastewater. Inorganic constituents, including heavy metals, are often present in wastewater due to commercial and industrial activities and may have to be removed if the presence of the metals will adversely affect the receiving water, or if the wastewater is to be reused. Some heavy metals (most notably copper) can be present in wastewater due to leaching from drinking water pipes.

DOMESTIC WASTEWATER

Domestic wastewater is wastewater generated from single- and multi-family residences, permanent mobile home courts, and group housing facilities such as nursing homes. Domestic wastewater flow is generally expressed as a unit flow based on the average contribution from each person per day. The unit quantity is expressed in terms of gallons per capita per day (gpcd).

EQUIVALENT RESIDENTIAL UNIT (ERU)

An equivalent residential unit (ERU) is a baseline wastewater generator that represents the average single-family residential household. An ERU can also express the average annual flow contributed by a single-family household, in units of gallons per day, or an annual average loading (of 5-day biochemical oxygen demand or total suspended solids) contributed by a single-family household, in units of pounds per day.

INFILTRATION

Infiltration is groundwater entering a sewer system by means of defective pipes, pipe joints, or manhole walls. Infiltration quantities exhibit seasonal variation in response to groundwater levels. Storm events or irrigation trigger a rise in the groundwater levels and increase infiltration. The greatest infiltration is observed following significant storm events or prolonged periods of precipitation. Since infiltration is related to the total amount of piping and appurtenances in the ground and not to any specific water use component, it is often expressed in terms of the total land area being served. The unit quantity generally used is gallons per acre per day (gpad) or gallons per capita per day (gcpd).

INFLOW

Inflow is surface water entering the sewer system from yard, roof and footing drains, from cross connections with storm drains, and through holes in manhole covers. Peak inflow occurs during heavy storm events when storm sewer systems are taxed beyond their capacity, resulting in hydraulic backups and local ponding. Inflow, like infiltration, can be expressed in terms of gallons per capita day or gallons per acre per day.

WWTP flow records are utilized to characterize combined infiltration and inflow (I/I) in the Woodland system in terms of peak hour, peak day, maximum month, and average annual I/I.

MAXIMUM MONTH FLOW (TREATMENT DESIGN FLOW)

Maximum month flow is the highest monthly flow during a calendar year. The maximum month flow normally occurs in the winter due to the presence of more I/I. This wintertime flow is composed of the normal domestic, commercial, and public use flows with significant contributions from inflow and infiltration. The predicted maximum month flow at the end of the design period is used as the design flow for sizing treatment processes and selecting treatment equipment.

NON-RESIDENTIAL WASTEWATER

Non-residential wastewater is wastewater generated from commercial activities, such as restaurants, retail and wholesale stores, service stations, and office buildings, and industrial flow (process wastewater, rinse water, and other industrial activities). Non-residential wastewater quantities for commercial and industrial wastewater are expressed in this Plan in terms of equivalent residential units (ERUs).

PEAK HOUR FLOW

Peak hour flow is the highest hourly flow during a calendar year. The peak hour flow usually occurs in response to a significant storm event preceded by prolonged periods of rainfall which have previously developed a high groundwater table in the service area. Peak hour flows are used in sizing the hydraulic capacity of wastewater collection, treatment, and pumping components. Peak hour flow is typically determined from treatment facility flow records and projected future flows.

SUSPENDED SOLIDS

Suspended solids is the solid matter carried in the waste stream. The total suspended solids (TSS) in a wastewater sample are determined by filtering a known volume of the sample, drying the filter paper, and measuring the increase in weight of the filter paper. TSS is expressed in the same terms as BOD; milligrams per liter for concentration and pounds per day for mass load. The amount of TSS in the wastewater is used in the sizing of treatment facilities and provides another measure of the treatment effectiveness. The concentration of TSS in wastewater affects the treatment facility biosolids production rate, treatment and storage requirements, and ultimate disposal requirements.

WASTEWATER

Wastewater is water-carried waste from residential, business, industry, and public use facilities, together with quantities of groundwater and surface water which enter the sewer system through defective piping and direct surface water inlets. The total wastewater flow is quantitatively expressed in millions of gallons per day (mgd).

EXISTING WASTEWATER FLOWS AND LOADING

WWTP records for the 8-year period from 2009 through 2016 were reviewed and analyzed to determine current wastewater characteristics and influent loadings. Current wastewater flows and loadings were then used in conjunction with projected population data to determine projected future wastewater flows and loadings.

WASTEWATER FLOWS AT CITY OF WOODLAND WWTP

Table 5-1 summarizes reported WWTP influent flows for the 8-year period, from 2009 to 2016, in millions of gallons per day (mgd). The monthly average influent WWTP flows ranged from 0.41 mgd to 0.64 mgd.

The 2009 to 2016 dry season average of 0.49 mgd includes dry season infiltration. Base flow (sanitary flow without infiltration and inflow) is estimated to be the minimum monthly average for each year.

The WWTP monitors effluent flow (the flow upstream of the outfall) and influent (the flow entering the WWTP, upstream of the influent screen).

TABLE 5-1

Historical WWTP Influent Flows (2009 to 2013)

Flow Type (mgd)	2009	2010	2011	2012	2013	2014	2015	2016	Average
Average Base Sanitary Flow(1)	0.44	0.42	0.40	0.48	0.47	0.52	0.50	0.51	0.47
Average Dry Weather Flow(2)	0.46	0.45	0.42	0.51	0.51	0.53	0.54	0.52	0.49
Annual Average Flow	0.48	0.48	0.49	0.55	0.52	0.55	0.56	0.58	0.53
Maximum Monthly Flow	0.54	0.52	0.60	0.64	0.57	0.60	0.61	0.68	0.59
Minimum Day Flow	0.38	0.39	0.32	0.34	0.41	0.45	0.45	0.44	0.40
Peak Day Flow	0.78	0.64	0.74	0.77	0.67	0.82	0.94	0.82	0.77

(1) Equal to the sanitary flow without inflow and infiltration, estimated using minimum monthly average influent flow.

(2) Average of July, August, and September.

(3) Peak hour flow of 1.22 mgd (850 gpm) was estimated based on review of influent circular flow charts and recorded on May 11, 2011.

Monthly Discharge Monitoring Report (DMR) data for this period are provided in Appendix D and summarized in Table 5-2. Graphical representations of average monthly WWTP flows, influent BOD_5 loadings, and influent TSS loadings for the period from December 2011 through December 2016 are shown in Figures 5-1, 5-2 and 5-3, respectively.

The estimated peak hour flow is based on review of influent circular flow charts from the WWTP to be 1.22 mgd and occurred on May 11, 2011.

TABLE 5-2

Summary of Discharge Monitoring Reports (DMRs) WWTP Influent Monthly Averages

Month	Average Monthly Flow (mgd)	Min. Daily Flow (mgd)	Max. Daily Flow (mgd)	BOD$_5$ (mg/L)	BOD$_5$ (lb/d)	TSS (mg/L)	TSS (lb/d)
Jan-09	0.54	0.44	0.776	302	1,360	393	1,779
Feb-09	0.50	0.42	0.545	377	1,598	460	1,944
Mar-09	0.49	0.42	0.561	322	1,330	385	1,593
Apr-09	0.48	0.41	0.548	314	1,276	405	1,645
May-09	0.48	0.41	0.541	332	1,369	515	2,140
Jun-09	0.46	0.39	0.516	393	1,540	499	1,967
Jul-09	0.45	0.38	0.491	365	1,378	405	1,535
Aug-09	0.46	0.41	0.553	348	1,366	438	1,720
Sep-09	0.46	0.41	0.505	345	1,341	404	1,566
Oct-09	0.48	0.43	0.525	300	1,229	462	1,887
Nov-09	0.49	0.45	0.559	417	1,703	509	2,078
Dec-09	0.50	0.42	0.583	287	1,221	473	2,009
Jan-10	0.49	0.42	0.584	253	1,027	406	1,694
Feb-10	0.50	0.44	0.576	215	912	248	1,052
Mar-10	0.48	0.42	0.585	227	907	238	948
Apr-10	0.48	0.44	0.541	240	966	272	1,097
May-10	0.46	0.41	0.533	256	998	276	1,081
Jun-10	0.50	0.44	0.575	248	1,047	355	1,499
Jul-10	0.43	0.39	0.486	292	1,059	363	1,317
Aug-10	0.45	0.42	0.531	289	1,068	338	1,251
Sep-10	0.46	0.40	0.500	298	1,158	333	1,292
Oct-10	0.47	0.41	0.549	282	1,113	331	1,331
Nov-10	0.49	0.44	0.635	326	1,343	365	1,516
Dec-10	0.52	0.42	0.638	279	1,213	373	1,609
Jan-11	0.59	0.50	0.735	239	1,230	369	1,928
Feb-11	0.52	0.47	0.627	237	1,029	369	1,596
Mar-11	0.60	0.53	0.680	215	1,083	310	1,567
Apr-11	0.56	0.50	0.652	194	914	299	1,414
May-11	0.49	0.45	0.568	260	1,059	351	1,431
Jun-11	0.49	0.46	0.544	338	1,380	493	1,999
Jul-11	0.43	0.40	0.473	372	1,383	413	1,531
Aug-11	0.41	0.37	0.443	227	783	303	1,042
Sep-11	0.42	0.36	0.486	231	835	299	1,084
Oct-11	0.44	0.32	0.500	269	1,012	315	1,186
Nov-11	0.48	0.43	0.692	275	1,137	324	1,353
Dec-11	0.46	0.37	0.537	224	885	355	1,413
Jan-12	0.51	0.42	0.647	205	898	288	1,265
Feb-12	0.59	0.51	0.647	210	1,038	130	1,232
Mar-12	0.59	0.51	0.760	181	918	237	1,198
Apr-12	0.64	0.55	0.754	173	958	224	1,251
May-12	0.57	0.46	0.677	236	1,139	244	1,176
Jun-12	0.54	0.45	0.619	249	1,146	285	1,313

TABLE 5-2 – (continued)

Summary of Discharge Monitoring Reports (DMRs)
WWTP Influent Monthly Averages

Month	Average Monthly Flow (mgd)	Min. Daily Flow (mgd)	Max. Daily Flow (mgd)	BOD$_5$ (mg/L)	BOD$_5$ (lb/d)	TSS (mg/L)	TSS (lb/d)
Jul-12	0.52	0.34	0.589	257	1,146	265	1,189
Aug-12	0.50	0.44	0.584	281	1,205	291	1,243
Sep-12	0.49	0.40	0.535	241	1,027	270	1,155
Oct-12	0.52	0.46	0.596	277	1,198	330	1,427
Nov-12	0.52	0.44	0.681	258	1,135	310	1,372
Dec-12	0.60	0.48	0.772	192	989	219	1,130
Jan-13	0.57	0.45	0.667	216	1,060	230	1,119
Feb-13	0.54	0.48	0.600	251	1,146	279	1,277
Mar-13	0.52	0.43	0.605	229	1,063	262	1,211
Apr-13	0.50	0.44	0.545	254	1,082	343	1,461
May-13	0.48	0.42	0.555	280	1,148	289	1,186
Jun-13	0.49	0.44	0.535	267	1,127	295	1,239
Jul-13	0.49	0.45	0.533	266	1,098	253	1,047
Aug-13	0.50	0.43	0.544	289	1,256	304	1,317
Sep-13	0.54	0.43	0.642	239	1,095	233	1,071
Oct-13	0.51	0.45	0.593	242	1,046	221	955
Nov-13	0.52	0.44	0.597	278	1,240	277	1,240
Dec-13	0.54	0.41	0.601	274	1,221	280	1,258
Jan-14	0.53	0.45	0.602	224	1,015	239	1,086
Feb-14	0.55	0.45	0.7	229	1,077	241	1,140
Mar-14	0.60	0.48	0.817	207	1,085	207	1,090
Apr-14	0.58	0.51	0.669	197	1,000	222	1,129
May-14	0.53	0.45	0.59	228	1,037	250	1,135
Jun-14	0.53	0.47	0.587	238	1,081	251	1,139
Jul-14	0.53	0.46	0.637	250	1,144	241	1,110
Aug-14	0.54	0.49	0.597	255	1,190	223	1,043
Sep-14	0.53	0.47	0.582	222	1,005	194	879
Oct-14	0.54	0.46	0.637	223	997	253	1,133
Nov-14	0.54	0.00	0.687	227	1,056	190	888
Dec-14	0.56	0.45	0.649	180	871	291	1,377
Jan-15	0.59	0.48	0.752	288	1,409	209	1,034
Feb-15	0.61	0.53	0.724	178	919	222	1,142
Mar-15	0.56	0.48	0.656	205	953	257	1,202
Apr-15	0.55	0.49	0.625	250	1,139	297	1,359
May-15	0.52	0.43	0.604	276	1,228	344	1,528
Jun-15	0.51	0.44	0.595	284	1,231	282	1,226
Jul-15	0.52	0.45	0.57	238	1,057	262	1,165
Aug-15	0.55	0.49	0.615	161	750	239	1,111
Sep-15	0.55	0.48	0.61	194	926	248	1,191
Oct-15	0.55	0.49	0.638	249	1,154	236	1,092
Nov-15	0.58	0.50	0.721	243	1,219	335	1,740
Dec-15	0.66	0.52	0.937	208	1,174	231	1,289

TABLE 5-2 – (continued)

Summary of Discharge Monitoring Reports (DMRs) WWTP Influent Monthly Averages

Month	Average Monthly Flow (mgd)	Min. Daily Flow (mgd)	Max. Daily Flow (mgd)	BOD$_5$ (mg/L)	BOD$_5$ (lb/d)	TSS (mg/L)	TSS (lb/d)
Jan-16	0.65	0.55	0.749	155	874	218	1,255
Feb-16	0.66	0.59	0.762	216	1,194	241	1,330
Mar-16	0.68	0.57	0.818	271	1,592	243	1,449
Apr-16	0.57	0.51	0.667	319	1,574	243	1,201
May-16	0.53	0.43	0.628	353	1,644	268	1,244
Jun-16	0.53	0.46	0.587	347	1,551	293	1,314
Jul-16	0.52	0.46	0.578	379	1,701	359	1,608
Aug-16	0.52	0.47	0.616	327	1,476	281	1,267
Sep-16	0.54	0.46	0.58	344	1,560	319	1,448
Oct-16	0.56	0.42	0.693	330	1,593	318	1,545
Nov-16	0.57	0.50	0.637	320	1,531	319	1,528
Dec-16	0.59	0.46	0.724	343	1,715	328	1,645
Average	0.53	0.44	0.62	264	1170	304	1349
Maximum	0.68	0.59	0.94	417	1715	515	2140
Minimum	0.41	0.38	0.44	155	750	130	879

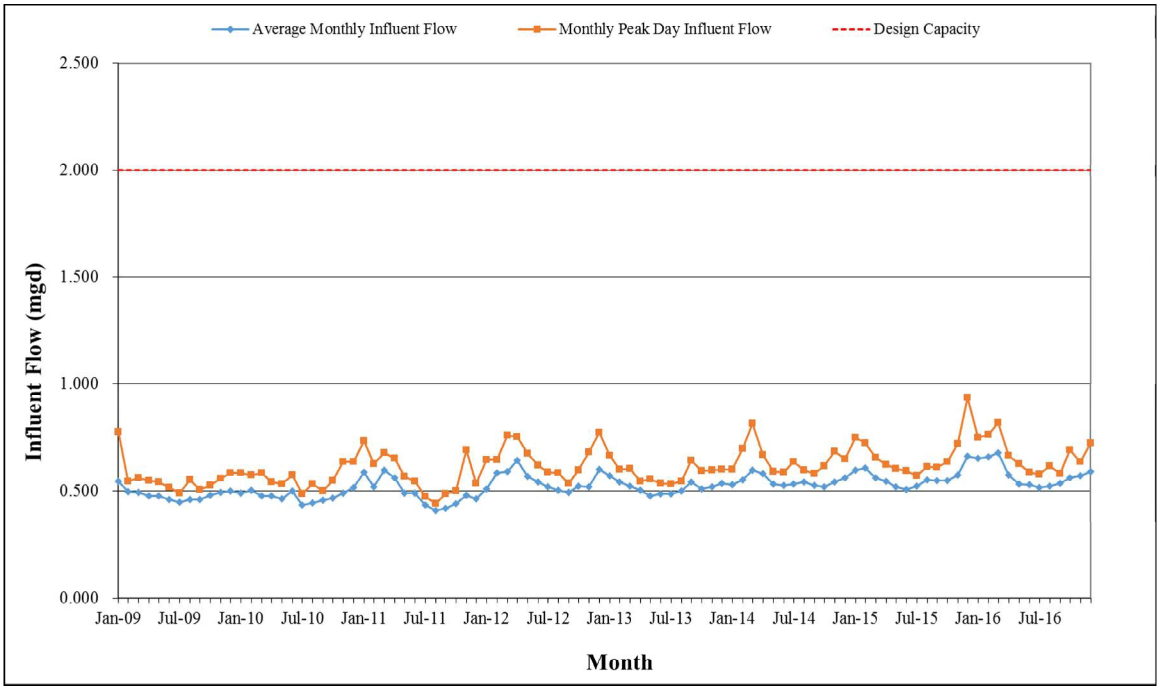

FIGURE 5-1

Recent Historical Influent Flows January 2009 through December 2016

As shown on Figure 5-1, the average wet weather design flow of 0.71 mgd with two basins in operation, or 1.42 mgd with three basins in operation, has not been exceeded. The highest monthly average influent flow over the period of 2009 to 2016 was 0.68 mgd and it occurred in March 2016. The data also indicate that the peak day design flow of 1.62 mgd with two basins in operation, or 3.24 mgd with three basins in operation, has not been exceeded. The peak day flow over the period between 2009 and 2016 was 0.78 mgd.

HISTORICAL INFLUENT LOADING AT WWTP

The annual average and maximum month BOD_5 and TSS mass loading for 2009 through 2016 are listed in Table 5-3.

TABLE 5-3

WWTP Influent Annual Average Flow, BOD_5 and TSS(1)

Year	Annual Average Influent Flow (mgd)	Annual Average BOD_5 (lb/d)	Annual Average TSS (lb/d)	Maximum Month BOD_5 (lb/d)	Maximum Month TSS (lb/d)
2009	0.483	1,392	1,822	1,703	2,140
2010	0.477	1,068	1,307	1,343	1,694
2011	0.492	1,061	1,462	1,383	1,999
2012	0.550	1,066	1,246	1,205	1,427
2013	0.516	1,132	1,199	1,256	1,461
2014	0.547	1,047	1,096	1,190	1,377
2015	0.562	1,097	1,257	1,409	1,740
2016	0.577	1,500	1,403	1,715	1,645
Average(1)	0.525	1,170	1,349	1,401	1,685

(1) Average of monthly averages.

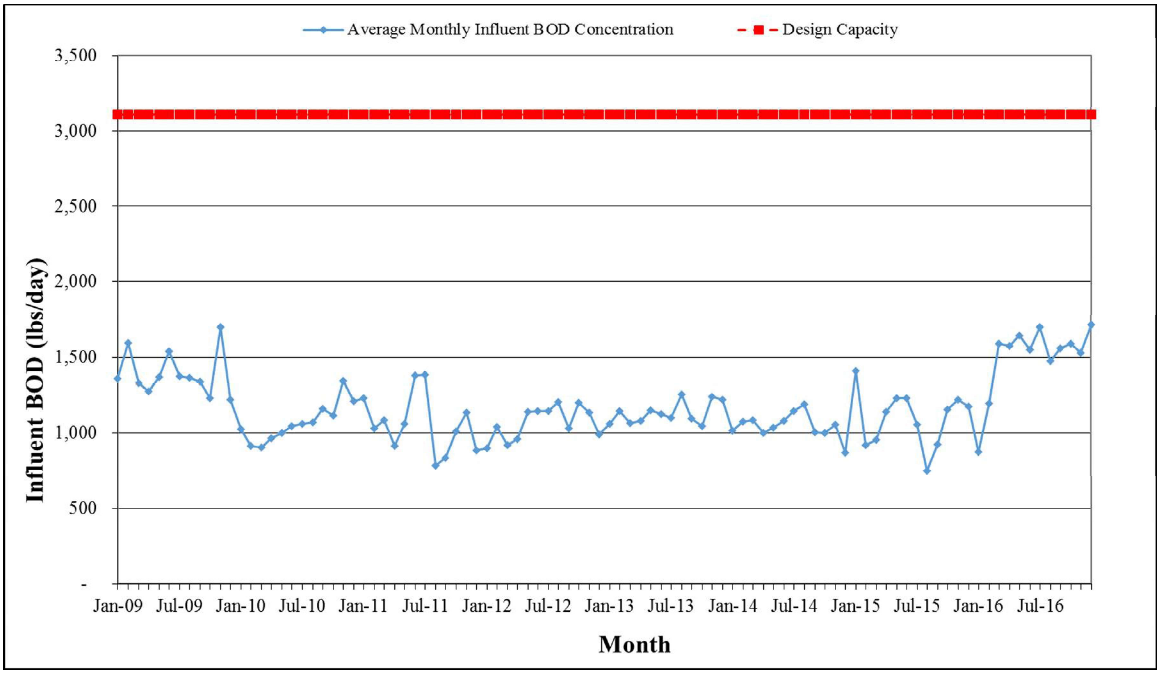

FIGURE 5-2

Influent BOD_5 Loading January 2009 through December 2016

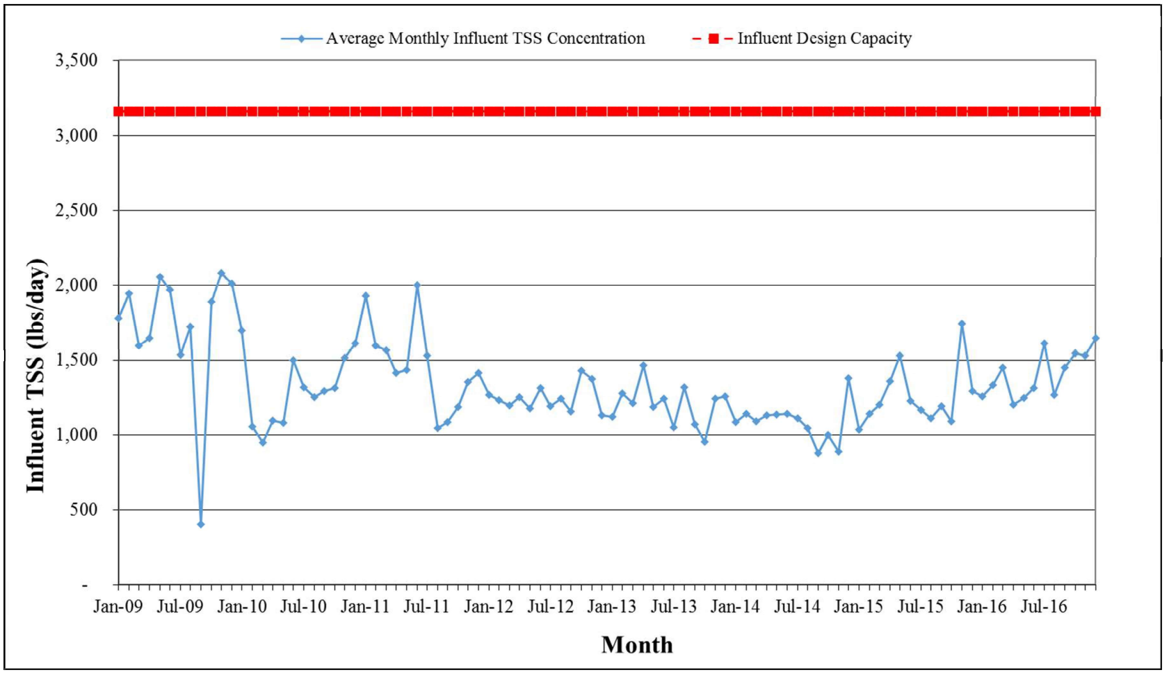

FIGURE 5-3

Influent TSS Loading January 2009 through December 2016

The average influent flow rate is slowly increasing from 0.482 mgd in 2009 to 0.577 mgd in 2016. Annual average BOD_5 and TSS influent loadings significantly decreased in 2010, and then remained relatively steady until January 2016 and have been slowly increasing.

Appendix E shows the effluent BOD_5 and TSS figures from 2009 to 2016. The effluent TSS and BOD_5 never exceeded the NPDES permit weekly limit of 45 mg/L and were well below the monthly limit of 30 mg/L.

EXISTING EQUIVALENT RESIDENTIAL UNITS (ERUS)

To determine the number of residential units with sewer service, water consumption, water billing, and sewer billing records were reviewed.

SEWER CONNECTIONS

Table 3-6 provided the average number of sewer service connections in 2032 by customer class. The majority of the sewer service connections are in the single-family residential customer class. The total number of sewer connections for the City in 2013 was 1,933.

WINTER WATER CONSUMPTION

The Woodland winter water consumption has been increasing at a moderate rate since 2010. The winter water use is used to estimate wastewater volumes entering the collection system because the amount of winter water consumption is typically equal to wastewater base flow except for a minor amount of water that does not enter the sewer system (such as winter irrigation flows, spills, and evaporation).

Winter water consumption records for the period of 2010 through 2014 were provided by the City. Table 5-4 presents the winter water consumption in gallons per day (gpd) by customer class obtained from the City. A more detailed summary of winter water consumption records is provided in Appendix F.

TABLE 5-4

Woodland Winter Water Use by Year and Customer Class

Customer Class	Winter Water Use (gpd)				
	2010-2011	**2011-2012**	**2012-2013**	**2013-2014**	**Average**
Single-Family Residential	182,779	190,422	201,933	205,212	195,086
Multi-Family Residential	62,701	63,129	70,602	78,065	68,624
Commercial	104,545	113,018	108,893(1)	109,115	108,893
Industrial	70,965	78,966	76,848	91,046	79,456
Churches/Schools/City	11,478	13,674	11,433	11,834	12,105
Motels/RV/Mobile Home Parks	29,624	30,173	35,647	31,815(1)	31,815
Total	462,093	489,383	505,355	527,087	495,979

(1) Reported commercial use for the winter of 2011-2012 and RV use for 2013-2014 was unusually high, and was therefore excluded from the calculation of the average commercial winter water use, and replaced with the average of the other three winters.

In Woodland, the water service area and the sewer service area are very similar in size. To determine the winter water use by sewer customers only, the total average winter water use from 2010 to 2014 was divided by the average non-irrigation influent flow at the WWTP. From this comparison, it can be assumed that approximately 95 percent of winter water use in the City of Woodland is discharged into the wastewater system.

TABLE 5-5

Total Winter Water Use and Winter WWTP Influent Flows

Flow Type (gpd)	2010-2011	2011-2012	2012-2013	2013-2014	Average
Average WWTF Influent Flow(1)	529,000	510,000	558,000	534,000	542,000
Base Flow(2)	421,000	451,000	487,000	505,000	466,000
Water Consumption(3)	462,093	489,383	505,355	527,087	496,000

(1) Average of November to February flows from Table 5-2.
(2) Average of base flows from Table 5-1.
(3) Sum of winter water use from Table 5-4.

EQUIVALENT RESIDENTIAL UNITS

Use of ERUs is a way to express the amount of water consumption or sewage produced by non-residential customers as an equivalent number of residential customers.

Table 5-6 summarizes the Woodland winter water consumption ERU value for 2010 to 2014.

TABLE 5-6

Woodland Single-Family Residential (SFR) Winter Water Use and Wastewater Equivalent Residential Units (ERUs) 2010 to 2014

	2010-2011	**2011-2012**	**2012-2013**	**2013-2014**	**Average**
SFR Winter Water Use (gpd)	182,779	190,422	201,933	205,212	195,086
SFR Service Connections(1)	1,288	1,314	1,420	1,466	1,372
Winter Water Use (gpd/SFR)	142	145	142	140	142
Wastewater ERU (gpd/ERU)(2)	**135**	**138**	**135**	**133**	**135**

(1) Number of connections for each winter is an average of the average number of connections in those years.
(2) Equal to 95 percent of winter water use gpd/SFR.

As shown in Table 5-6, the average daily single-family residential winter water use from 2010 to 2014 ranged from a low of 140 gpd/SFR to a high of 145 gpd/SFR. The *wastewater* ERU value is calculated based on *winter* water use (in order to exclude water used for irrigation). Based on the average of historical water use records for the years 2010 to 2014, average winter residential water use is 142 gallons per household. However, based on analysis of the data, it is estimated that only 95 percent of the winter water use makes it into the wastewater system. Thus, the average wastewater ERU value is 135 gpd/ERU.

Table 5-7 summarizes current wastewater ERUs based on an analysis of winter water use during the winter of 2013 to 2014.

TABLE 5-7

Woodland Current Wastewater ERUs

Customer Type	**Average Winter Water Use(1) (gpd)**	**Annual Average Base Flow(2) (gpd)**	**Sewer ERUs(3)**	**% of Total ERUs**
Single-Family Residential	195,086	185,000	1,370	39%
Multi-Family Residential	68,624	65,000	481	14%
Commercial	108,893	103,000	763	22%
Industrial	79,456	75,000	556	16%
Churches/Schools/City	12,105	11,000	81	2%
Motels/RV/Mobile Home Parks	31,815	30,000	222	6%
Total	495,979	471,000	3,474	100%

(1) From Table 5-4.
(2) Equal to 95 percent of Average Winter Water Use.
(3) Equal to Annual Average Base Flow divided by 135 gpd/ERU.

INFILTRATION AND INFLOW

The amount of infiltration and inflow (I/I) can be estimated on an annual average, maximum month, and maximum day basis by subtracting the dry weather flow at the WWTP from the annual average, maximum month, and maximum day flows at the WWTP.

For this report, infiltration and inflow is expressed in units of gallons per acre per day (gpad). The sewer service area within the Woodland city limits is 2,625 acres. The service area outside of the Woodland city limits, but within the Urban Growth Area is approximately 342 acres. Therefore, the total developed sewer service area in Woodland is estimated at 2,967 acres.

Table 5-8 summarizes the infiltration/inflow analysis for Woodland. The data contained in this table is useful as a baseline for evaluating changes in infiltration and inflow in the future. This data is also used to estimate future flows.

TABLE 5-8

Estimated Inflow/Infiltration for Wastewater Flows from the City of Woodland

Flow Type	Influent Flow at WWTP(1) (mgd)	Base Flow(2) (mgd)	I/I(3) (mgd)	Service Area(4) (acre)	I/I(5) (gpad)
Annual Average	0.58	0.47	0.11	2,967	37
Maximum Month	0.68	0.47	0.21	2,967	72
Peak Day	0.94	0.47	0.47	2,967	159
Peak Hour	1.22	0.56(6)	0.66	2,967	222

(1) From Table 5-1, WWTP influent flow charts.
(2) From Table 5-1, Average Base Sanitary Flow.
(3) Equals “Influent Flow at WWTP” minus “Base Flow.”
(4) Developed areas only in the sewer service area (total acreage of 2,967 acres).
(5) Equals “I/I” divided by “Service Area.”
(6) Base flow during time of day peak flow was measured (assumed to be peak hour flow in 2013).

Infiltration and Inflow Analysis Using EPA Criteria

Another analysis of infiltration and inflow was performed to compare estimates of per capita I/I to EPA criteria. These infiltration and inflow rates are summarized in Table 5-9.

The U.S. EPA manual entitled *I/I Analysis and Project Certification* provides recommended guidelines for determining if infiltration and/or inflow is excessive.

1. To determine if excessive *infiltration* is occurring, a threshold value of 120 gallons per capita per day (gpcd) is used. This infiltration value is based on an average daily flow over a seven to 14 day non-rainfall period during seasonal high ground water conditions.

2. To determine if excessive *inflow* is present in a collection system, the U.S. EPA uses a threshold value of 275 gpcd. If the average daily flow (excluding major commercial and industrial flows greater than 50,000 gpd each) during periods of significant rainfall exceeds 275 gpcd, the amount of inflow is considered excessive.

TABLE 5-9

Per Capita Infiltration and Inflow Based on EPA Criteria

Parameter	EPA Criteria for Excessive I/I (gpcd)	Estimated Woodland I/I Value (gpcd)
EPA Excessive Infiltration Criteria	120	57
EPA Excessive Inflow Criteria	275	138

Infiltration

Rainfall records from the City of Woodland Monthly Monitoring Report show a 7-day period, March 28 through April 3, 2013, during which no amounts of rainfall were measured. This would also be a period of relatively high groundwater. The average daily flow recorded during this time period is 0.48 mgd. (The highest daily flow was 0.51 mgd.) Since the intent of the EPA criteria was to only include domestic flows, 0.19 mgd of commercial and industrial flow was neglected (108,893 gpd of commercial flow and 7,945 gpd of industrial flow from Table 5-7). With a total population of sewer users in 2013 of 5,625, and a residential flow of 0.32 mgd (equal to 0.51 mgd minus 0.19 mgd) for this period, the "EPA I/I Infiltration Value" for Woodland is estimated at 57 gpcd (residential flow in gpd divided by sewer population, 320,000/5,625). This value is less than the EPA limit and therefore the system is not designated as having excessive infiltration.

Inflow

The maximum day influent flow at the WWTP over the period of 2009 to 2016 was 0.94 mgd (recorded on December 8, 2015), as shown in Table 5-1. Since the intent of the EPA criteria was to only include domestic (residential) flows, the estimated 0.19 mgd of commercial and industrial flow was neglected. With a total population of sewer users in 2009 of 5,431, and a non-commercial flow of 0.75 mgd (equal to 0.94 mgd minus 0.19 mgd) for this day, the "EPA I/I Inflow Value" for Woodland is estimated at

138 gpcd. Since this value is less than the EPA guideline of 275 gpcd, the sewer collection system is not considered to have excessive inflow by EPA criteria.

INDUSTRIAL FLOWS

As shown in Table 5-4, winter water use by industries in Woodland ranged from 70,965 gpd to 91,046 gpd since the winter of 2009 to 2010. Industrial flows are often significantly different than municipal and commercial flows and often at higher or lower strength. Industrial flows usually contain constituents that are not present in municipal wastewater or present in higher concentrations.

COLUMBIA RIVER CARBONATES

As stated in Chapter 3 of this plan, Columbia River Carbonates (CRC) is the only industry in the City of Woodland to hold an NPDES permit. CRC is a supplier of ground calcium carbonate products and services to industries in the Northwest and Canada. Under the NPDES permit, CRC can discharge waste from their limestone facility to the City sewer system; however, most of their wastewater is treated and discharged straight into the Columbia River. For this reason, winter water use is not a good estimate of CRC's sewer use. This flow is metered and reported in DMRs and data for 2013 is summarized in Table 5-10. The NPDES permit limits them to 100 mg/L of Oil & Grease, a pH range of 5.5 to 9.0, and a Temperature of 150 degrees F. As shown in Table 5-10, CRC discharges very little flow into the sewer system relative to its winter water use and did not exceed any of the specified NPDES permit limits during this period.

TABLE 5-10

Columbia River Carbonates Discharge to Woodland Collection System for 2013

Month	Average Flow (gpd)	Max Day Flow (gpd)	Average pH	Average Oil & Grease (µg/L)	Average Temp (°F)
Feb-13	3	87	8.8	ND	46
Mar-13	80	2,240	8.6	ND	70
May-13	525	1,385	8.3	8.5	58
July-13	470	1,189	8.9	ND	63
Average Flow	**270**				

(1) ND indicates that there was no pollutant detected in the samples.
(2) Average Winter Water Use was calculated to be 36,160 gpd.

NORTHWEST PET PRODUCTS

As described in Chapter 3, Northwest Pest Products is a dog and cat food manufacturing plant located within the city limits of Woodland. A large industrial user of water, the facility has an average winter water use of 9,171 gpd. It is expected that most of this flow is returned to the City sewer system.

PACIFIC SEAFOOD

Pacific Seafood is a family owned seafood processing and distribution company based in Oregon. The Woodland facility is one of over 38 locations along the West Coast of the United States and Canada. The Woodland location is primarily focused on packaging and freezing of the products to be shipped out to market. The limits for quality of wastewater discharged into the City sewer system are listed in Chapter 3. Pacific Seafood has an average winter water use of 12,741 gpd, making them the highest winter water users aside from Columbia River Carbonates. It is expected that most of this flow is returned to the City sewer system.

HAMILTON MATERIALS

Hamilton Materials is a drywall products producer with headquarters located in Woodland. At 10,467 gpd, Hamilton Materials has the third largest average winter water use after Columbia River Carbonates. It is expected that most of this flow is returned to the City sewer system.

WALT'S MEATS

Walt's Wholesale Meats discharges only meat processing wastewater, no sanitary wastewater. This wastewater is pretreated in an aerated pond before being released into the City sewer system. Walt's has a current average month permit limit of 90,000 gpd and max day discharge limit of 100,000 gpd. Walt's Meats is not served by the City water system, but does discharge its processing wastewater to the City sewer system.

CHARACTERISTICS OF COMBINED INDUSTRIAL WASTEWATER

Table 5-11 provides the known characteristics, including conventional parameters, of the major industrial discharges, based on review of DMRs, permit fact sheets, and operating records.

TABLE 5-11

Characteristics of Major Industrial Discharges

	Unit	Columbia River Carbonates	Pacific Seafood	Walt's Meats
Avg. Flow (Year 2013)(1)	gpd	270	11,272	42,191
Avg. Flow (Year 2023)(2)	gpd	5,000	48,000	90,000
BOD_5 (2013 max month)	lb/day	-	51.1	30.5
TSS (2013 max month)	lb/day	-	23.3	39.6

(1) Based on metered wastewater discharge.
(2) Assumed to be equal to the maximum allowed discharge listed in current permits

PROJECTED SEWER SERVICE AREA POPULATION, ERUS AND FLOWS

As discussed in Chapter 3, the Woodland estimated 2013 population is 5,625. Projections in Table 5-12 are based on an average annual growth of 2.25 percent (from Table 3-5).

The current and projected 10-year and 20-year ERUs and flows (without consideration of further expansion of the Urban Growth Area) are summarized in Table 5-12. The 2013 values are based on existing data developed in this chapter and influent flow charts from the WWTP. The projected flows and ERUs are based on use of the growth assumptions applied to all customer classes.

I/I is assumed to be constant throughout the period. (In other words, increases in I/I due to the addition of new pipes and deterioration of old pipes are assumed to be equal to decreases in I/I due to ongoing I/I reduction efforts.)

Future WWTP flows are projected based on a base flow of 135 gpd/ERU. To estimate future annual average, maximum month, and peak day flows, the I/I flow rates were added to the base level wastewater flows derived from the population projections to obtain the respective future WWTP influent flow rates. Peak hour flows were projected by adding current peak hour I/I to projected future peak hour base flow (peak hour sanitary flow). Projected future peak hour base flow was calculated by multiplying the future annual average base flow by the current observed diurnal peaking factor (ratio of peak hour base flow to annual average base flow).

TABLE 5-12

Current and Projected ERUs and Flows

Sewer ERUs			
Customer Type	**2013**	**2023**	**2033**
Single-Family Residential	1,370	1,729	2,180
Multi-Family Residential	481	607	766
Commercial	763	962	1,214
Industrial	556	701	884
Industrial Reserve(1)	0	661	661
Churches/Schools/City	81	103	130
Motels/RV/Mobile Home Parks	222	280	354
Total	3,474	5,043	6,188
Projected Flows (mgd)			
Flow Type	**2013**	**2023**	**2033**
Total Base Flow	0.47	0.68	0.83
Average Annual Flow	0.54	0.75	0.91
Maximum Month	0.60	0.81	0.96
Peak Day	0.69	0.90	1.06
Peak Hour	1.22	1.52	1.72

(1) Assumes growth to current discharge permit limits.

The average design flow of the plant is 0.71 mgd with two basins operating or 1.42 with three, and the peak design flow is 1.62 mgd with two basins and 3.24 with three, which correspond to the annual average flow and the peak day flow, respectively. As shown in Table 5-12, the projected average annual flow and the projected peak day flow are well within the existing treatment plant capacity in 2033, as long as three basins are used when necessary.

EXISTING BOD$_5$ LOADING

Monthly average influent BOD$_5$ loadings ranged from 750 lb/d to 1,715 lb/d for the 8-year period of analysis as shown in Table 5-2 and on Figure 5-2. The monthly average influent BOD$_5$ rated loading of 1,986 lb/d when two basins are operating at the WWTP was never exceeded during the 8-year period of analysis. The average influent BOD$_5$ concentration for the 8-year period is 271 mg/L, which would be considered medium strength domestic wastewater. The average BOD$_5$ loading for the 8 years, as summarized in Table 5-2, was 1,170 lb/d.

With a service population of 5,625 for 2013, and an annual average BOD$_5$ loading of 1,132 lb/d, the 2013 annual average BOD$_5$ loading was 0.201 lb/cap/d. This value is just above the Department of Ecology Criteria for Sewage Works Design of 0.2 lb/cap/d.

To convert the maximum month BOD_5 loading to a per capita and an ERU basis, the 2013 service population of 5,625 and number of ERUs (3,474) and maximum month BOD_5 of 1,256 lb/d for 2013 was used to calculate a maximum month per capita and ERU BOD_5 loading of 0.223 lb/cap/d and 0.362 lb/ERU/d, respectively. The ratio, for 2013, of the maximum month BOD_5 loading to the annual average BOD_5 loading is 1,256:1,132 or 1.11:1. This ratio is used in the development of future flow and loadings to the WWTP later in the chapter.

EXISTING TOTAL SUSPENDED SOLIDS LOADING

A review of Table 5-2 shows that monthly average TSS loadings ranged from 888 lb/d to 2,140 lb/d. The monthly average influent rated TSS loading, for two basins in operation at the WWTP, of 2,071 lb/d was exceeded twice during the 8-year period of analysis. However, never did it exceed the limit for three basin operation of 4,142. TSS loadings have not exceeded 1,500 lbs/day in the past 3 years and therefore the third basin is not expected to be needed in the near future. The 2013 average loading of 1,199 lb/d and a 2013 service population and average ERUs of 5,625 and 3,474, respectively, translate to an annual average TSS loading for 2013 of approximately 0.213 lb/cap/d or 0.345 lb/ERU/d.

The 2013 maximum month TSS loading is 1,461 lb/d. Using the same values for the 2013 service population and average ERUs of 5,625 and 3,474, yields a maximum month value of 0.557 lb TSS/cap/d or 0.421 lb/ERU/d. The ratio of the maximum month TSS loading to the annual average TSS loading is 1,461:1,199 or 1.22:1. This ratio is used in the development of future flow and loadings to the WWTP later in the chapter.

EXISTING NITROGEN LOADING

Nitrification requirements at wastewater treatment facilities are determined based on the influent Total Kjeldahl Nitrogen (TKN) loading. TKN includes soluble ammonia and organic nitrogen. The WWTF began reporting influent ammonia concentration on the DMRs in April 2012 (Appendix D) and the concentrations in 2012 and 2013 were 32 mg/L average and 35 mg/L maximum month. Based on a typical ammonia to TKN ratio of 67 percent and corresponding flow rates, in 2012 and 2013 the average TKN loading was 209 lbs/day and the maximum month TKN loading was 227 lbs/day.

With 3,474 ERUs in the system, the TKN loadings were 0.06 lbs TKN/ERU/d annual average and 0.07 lbs TKN/ERU/d maximum month.

PROJECTED FUTURE WASTEWATER LOADINGS

Future WWTP maximum month BOD_5, TSS and TKN loadings are estimated by multiplying the projected number of ERUs by the respective ERU-based loadings, and adding additional loading for a medium-strength industrial reserve as indicated below. Future ERU-based annual average BOD_5, TSS and TKN loadings are estimated using the ratio of the maximum month to annual average loadings of these parameters. The current maximum month BOD_5 and TSS loadings are 0.362 lb BOD_5/ERU/d, 0.421 lb TSS/ERU/d, and 0.08 lb TKN/ERU/d. The ratio of the maximum month to annual average BOD_5 is 1.11:1. The ratio of the maximum month to annual average TSS is 1.22:1. The ratio of the maximum month to annual average TKN is 1.09:1. Table 5-13 provides a summary of projected future WWTP influent BOD_5 and TSS loadings.

TABLE 5-13

Current and Projected WWTP Loadings

ERUs and Loadings	2013	2023	2033
Total ERUs	3,474	5,043	6,188
Annual Average BOD_5, (lb/d)	1,132	1,643	2,016
Maximum Month BOD_5, (lb/d)	1,256	1,823	2,237
Annual Average TSS, (lb/d)	1,199	1,740	2,135
Maximum Month TSS, (lb/d)	1,461	2,121	2,602
Annual Average TKN, (lb/d)	209	304	373
Maximum Month TKN, (lb/d)	227	330	405

As shown in Table 5-13, the projected years 2023 and 2033, the maximum month design limit for BOD_5 loading of 3,720 lb/d and TSS loading of 4,142 lb/d, with three basins running, are never exceeded.

Analysis of flows within each basin as well as each major sewer line and at each lift station is provided in Chapter 7, Collection System Evaluation and Recommendations.