CHAPTER 3

Flow and Load Analysis

Chapter 3 – Flow and Load Analysis

3.1 Introduction

Influent wastewater to the City of Richland Wastewater Treatment Plant (WWTP) currently consists primarily of residential and commercial dischargers. The City does have industrial dischargers that are regulated through pre-treatment permits – as discussed in **Section 3.5** of this chapter. Data from January 2010 through December 2014 were used for this analysis. Definitions and descriptions of the averaging periods used in this analysis are as follows:

- **Average Day**: The average annual flow rate observed at the facility in a given year. (e.g., total flow for a year divided by 365 days). The average rate is used to estimate annual average pumping and chemical costs, solids production, and organic loading rates.
- **Maximum 3-Month**: The maximum average expected flow or load for three consecutive months in a given year. This condition is typically used to determine when planning for facility upgrades needs to begin (i.e., when this value reaches 85 percent of design capacity).
- **Maximum Month**: The expected flow or load for the peak month in a given year. This condition is typically used to design unit processes for permit compliance.
- **Peak Day**: The expected flow or load for the peak day in a given year. The peak day condition is used to size processes for peak events occurring over a 24-hour period.
- **Peak Hour**: The expected condition occurring during the peak hour in a given year. The peak hour conditions are used to size processes for peak events (e.g. pump stations, oxygen demand).
- **Peaking Factors**: Ratios of maximum events to average events (e.g., a maximum month peaking factor is obtained by dividing the maximum month value for a selected parameter by a baseline value, typically the average day value).

3.2 Existing Influent WWTP Flow & Loads

3.2.1 Flows

Total flow from the City of Richland is measured on the discharge side of the influent pumps with a Panametrics 868 Transient Time Meter. The average day, maximum 3-month average, maximum month, and peak day influent flow for January 2010 through December 2014 are summarized in **Table 3-1**. The daily and monthly average influent flow are shown in **Figure 3-1**.

Table 3-1 – Flow Summary by Year (2010 – 2014)

Item	2010	2011	2012	2013	2014	Probable Existing
Average Day Flow (mgd)	5.76	5.90	5.62	5.48	5.69	5.69 (a)
Maximum 3-Month Flow (mgd)	6.12	6.20	5.94	5.72	5.96	6.20 (b)
Peaking Factor	1.06	1.05	1.06	1.04	1.05	1.09 (c)
Maximum Month Flow (mgd)	6.19	6.25	6.00	5.84	6.07	6.25 (b)
Peaking Factor	*1.08*	*1.06*	*1.07*	*1.07*	*1.07*	*1.10* (c)
Peak Day Flow (mgd)	7.50	7.34	6.18	7.08	6.90	7.50 (b)
Peaking Factor	*1.30*	*1.24*	*1.10*	*1.29*	*1.21*	*1.32* (c)
Peak Hour Flow (mgd)	--	--	--	9.41 (d)	--	9.41
Peaking Factor	--	--	--	*1.72*	--	*1.65* (c)

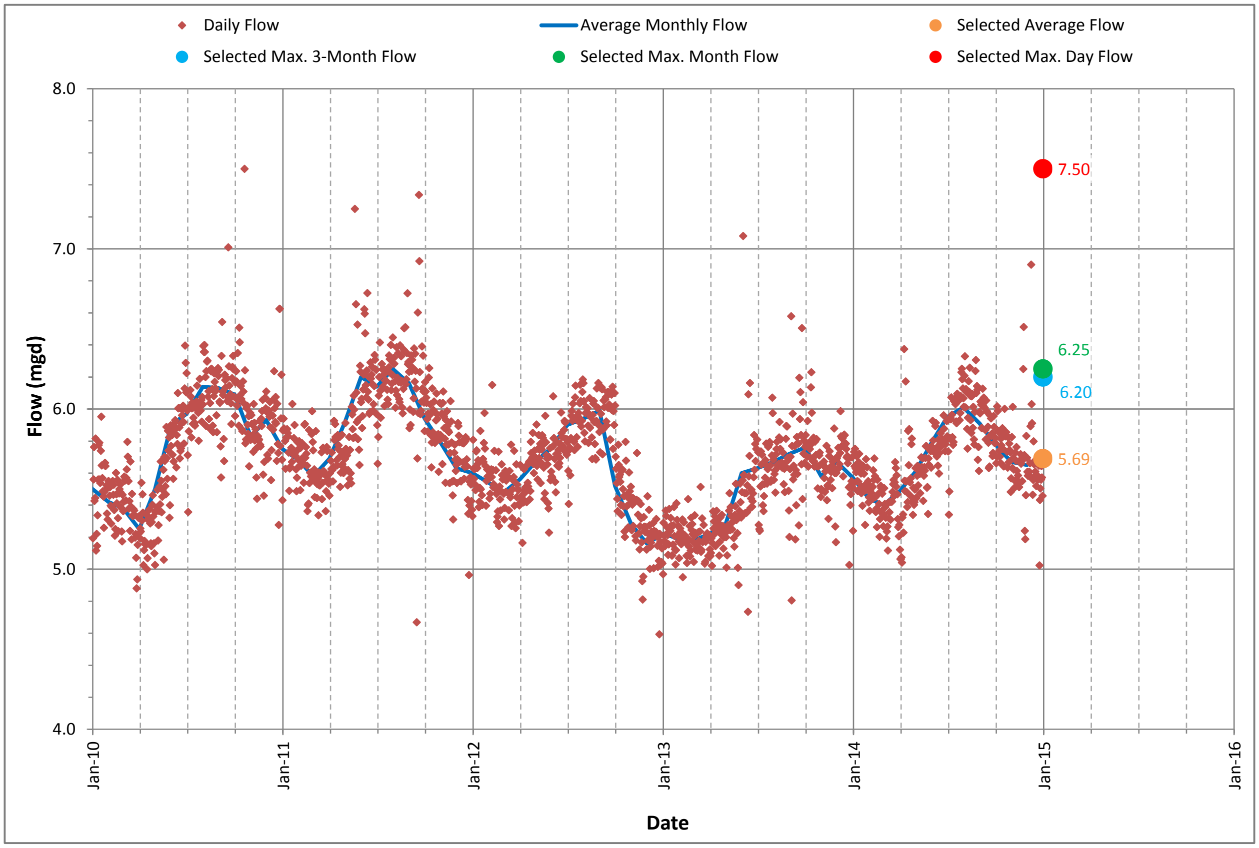
(a) *Selected as the weighted average of data for January 2010 through December 2014.*

(b) *Selected as the observed maximum of the data for January 2010 through December 2014.*

(c) *The peaking factor is calculated as the observed maximum divided by the annual average day condition.*

(d) *Based on hourly flow data available for calendar year 2013, excluding June and September due to construction at the WWTP.*

Figure 3-1 – Flow Summary (2010 – 2014)



The seasonal response of the WWTP flow is likely due to varying degrees of infiltration throughout the year. Higher infiltration rates in late summer and early fall are common in this area and are attributable to irrigation effects. The decrease in flows from 2011 to 2014 is likely due to the ongoing rehabilitation and replacement projects performed each year by the City. A probable existing average flow value of 5.69 mgd was selected for the City of Richland based on the average of average day values for the period of January 2010 through December 2014.

As noted in **Section 2.11**, the 2015 population estimate is 53,054. This results in approximately 107 gallons per capita day (gpcd) using a yearly gross average flow of 5.69 mgd (this does not exclude nonresidential flows). However, during the winter of 2013, flows dropped to approximately 5.20 mgd, or 98 gpcd. The flow per day is slightly higher than a typical range or 50-90 gpcd and is indicative of moderate, year-round infiltration. Infiltration is further discussed in **Section 3.4.**

3.2.2 Biochemical Oxygen Demand (BOD)

The average day, maximum 3-month average, maximum month, and peak day BOD loading for January 2010 through December 2014 are summarized in **Table 3-2**. The daily and monthly average BOD are shown in **Figure 3-2.**

Table 3-2 – BOD Summary by Year (2010 – 2014)

Item	2010	2011	2012	2013	2014	Probable Existing
Average Day Concentration (mg/L)	236	213	243	251	217	232 [(a)]
Average Day Loading (ppd)	11,405	10,503	11,445	11,456	10,352	11,032 [(a)]
Maximum 3-Month Loading (ppd)	12,077	11,410	12,355	13,238	11,373	13,238 [(b)]
Peaking Factor	*1.06*	*1.09*	*1.08*	*1.16*	*1.10*	*1.20* [(c)]
Maximum Month Loading (ppd)	12,847	11,854	14,099	13,802	12,536	14,099 [(b)]
Peaking Factor	*1.13*	*1.13*	*1.23*	*1.20*	*1.21*	*1.28* [(c)]
Peak Day Loading (ppd)	15,093	14,792	25,154 [(d)]	18,870	14,337	18,870 [(b)]
Peaking Factor	*1.32*	*1.41*	*2.20*	*1.64*	*1.29*	*1.71* [(c)]

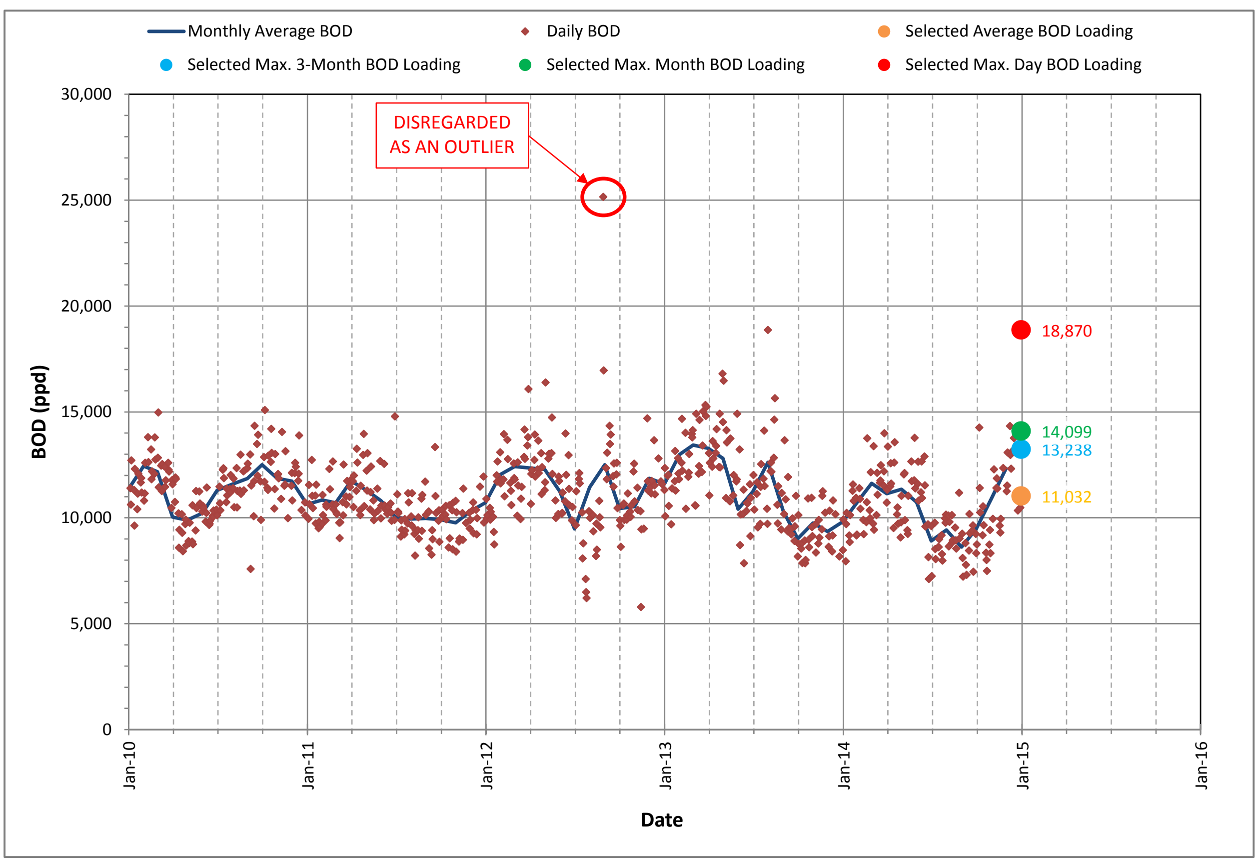
[(a)] *Selected as the weighted average of data for January 2010 through December 2014.*

[(b)] *Selected as the observed maximum of the data for January 2010 through December 2014, excluding outliers.*

[(c)] *The peaking factor is calculated as the observed maximum divided by the annual average day condition.*

[(d)] *Disregarded as an outliner.*

Figure 3-2 – BOD Load Summary (2010 – 2014)



A probable existing average value for influent BOD loading is 11,032 ppd for a period of January 2010 through December 2014. The BOD loading shows day-to-day variations, but a relatively consistent monthly pattern. However, closer review shows a reverse correlation between BOD and flow (i.e., higher BOD loading is recorded during periods of low flow). This was also brought up as an anomaly in the previous General Sewer Plan. Therefore, the accuracy of the sampling data was called into question. The City noticed in July 2014 that water appeared to be stagnating in the sampling channel during periods of low flow. They subsequently made adjustments to maintain a more steady flow through the channel during low-flow conditions and influent BOD dropped noticeably for the period of July 2014 through October 2014, indicating the City likely discovered a sampling issue at the WWTP that was causing erratic influent data. However, BOD loading increased from October through December 2014, similar to previous years\. The increase in loadings during the fall could be attributed to industrial flows – primarily those of wineries. Continued monitoring and assessment of influent conditions for at least one full calendar year (preferably longer) is recommended to ascertain potential seasonal fluctuations and the true impact of this sampling change. Therefore, probable existing values will be based on influent data from January 2010 through December 2014. Probable plant loading can be revisited, and possibly adjusted, if future data indicates a change is warranted.

An average BOD loading of 11,032 ppd equates to 0.21 pounds per capita per day (ppcd) using an estimated 2015 population of 53,054. This is within the typical range of 0.11 to 0.26 ppcd expected for residential loading (Metcalf and Eddy). The corresponding average BOD concentration over the same time period (i.e. January 2010 through December 2014) is 232 milligrams per liter (mg/L), which is within the typical range of 133 to 400 mg/L reported for domestic wastewater (Metcalf and Eddy). This information is summarized in **Table 3-3**.

Table 3-3 – Selected BOD Loading Compared to Literature Values

Item	City of Richland	Typical Value
Average Day Loading per Capita (ppcd)	0.21	0.11 to 0.26 [a]
Average Day Concentration (mg/L)	232	133 to 400 [b]

[a] *Table 3-13 (page 216), Metcalf and Eddy, 5th Edition*

[b] *Table 3-18 (page 221), Metcalf and Eddy, 5th Edition*

3.2.3 Total Suspended Solids (TSS)

The average day, maximum 3-month average, maximum month, and peak day TSS loading for January 2010 through December 2014 are summarized in **Table 3-4**. The daily and monthly average TSS values are shown in **Figure 3-3**.

Table 3-4 – TSS Summary by Year (2010 – 2014)

Item	2010	2011	2012	2013	2014	Probable Existing
Average Day Concentration (mg/L)	269	237	295	298	255	270 [(a)]
Average Day Loading (ppd)	13,016	11,777	13,952	13,635	12,177	12,911 [(a)]
Maximum 3-Month Loading (ppd)	13,673	13,199	14,950	16,547	13,797	16,547 [(b)]
Peaking Factor	*1.05*	*1.12*	*1.07*	*1.21*	*1.13*	*1.28* [(c)]
Maximum Month Loading (ppd)	15,822	14,846	16,134	18,146	16,256	18,146 [(b)]
Peaking Factor	*1.22*	*1.26*	*1.16*	*1.33*	*1.34*	*1.41* [(c)]
Peak Day Loading (ppd)	37,339 [(d)]	21,729	21,297	25,157	23,105	25,157 [(b)]
Peaking Factor	*2.87*	*1.85*	*1.53*	*1.84*	*1.90*	*1.95* [(c)]

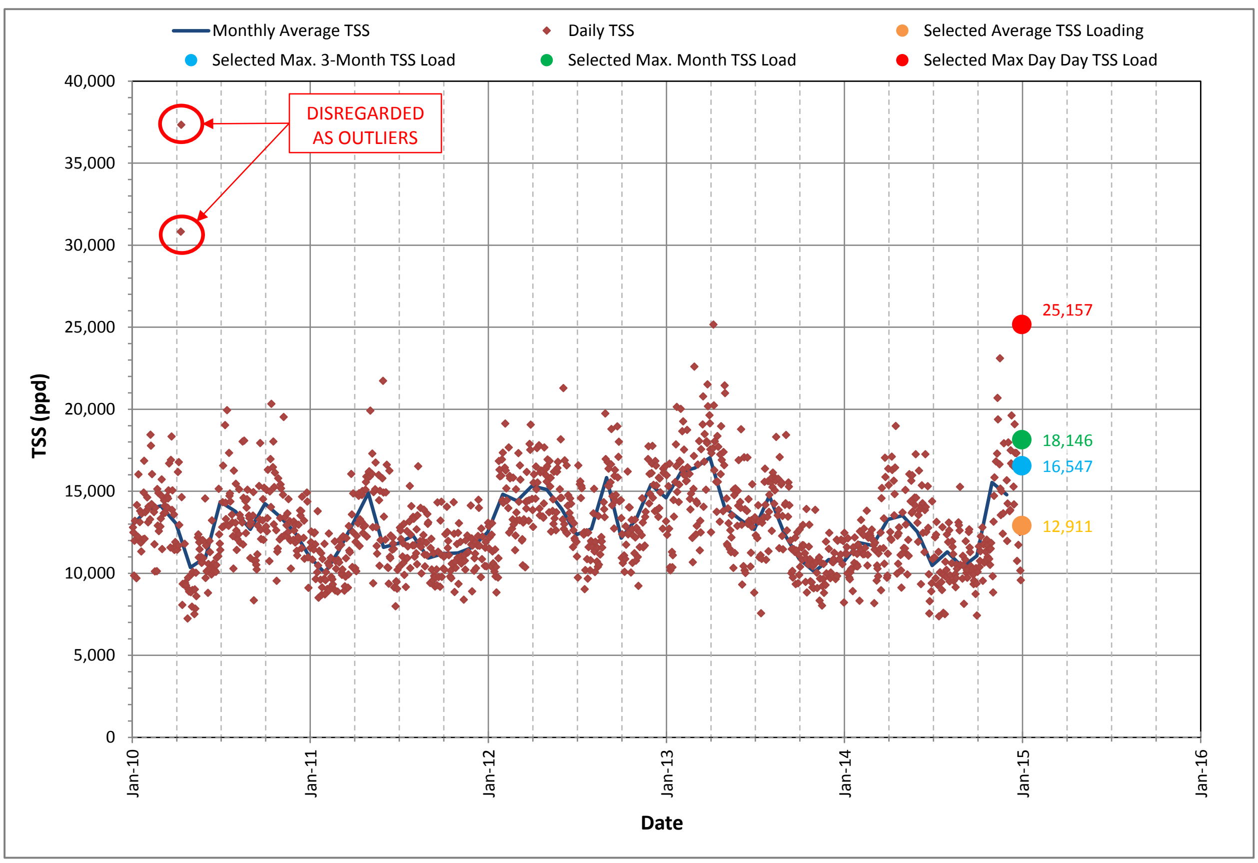
[(a)] *Selected as the weighted average of data for January 2010 through December2014.*

[(b)] *Selected as the observed maximum of the data for January 2010 through December 2014, excluding outliers.*

[(c)] *The peaking factor is calculated as the observed maximum divided by the annual average day condition.*

[(d)] *Disregarded as an outliner.*

Figure 3-3 – TSS Load Summary (2010 – 2014)



A probable existing average value for TSS loading is 12,911 ppd for a period of January 2010 through December 2014. The TSS loading shows day-to-day variations, but a relatively consistent monthly pattern with a slight upward trend at the beginning of each year. Similar to BOD, the City noticed an unusual correlation between flows and loads during low-flow periods. There was a drop in influent loading values in July 2014 after the influent sampling process was adjusted, and an increase in TSS loading from October through December 2014. Therefore, the probable TSS influent loading, like influent BOD, will be based on influent data from January 2010 through December 2014. Probable plant loading can be revisited, and possibly adjusted, if future data indicates a change is warranted.

An average TSS loading of 12,911 ppd equates to 0.24 ppcd using an estimated 2015 population of 53,054. This is within the typical range of 0.13 to 0.33 ppcd expected for residential loading (Metcalf and Eddy). The corresponding average TSS concentration over the same time period (i.e. January 2010 through December 2014) is 270 mg/L, which is within the typical range of 130 to 389 mg/L reported for domestic wastewater (Metcalf and Eddy). This information is summarized in **Table 3-5**.

Table 3-5 – Selected TSS Loading Compared to Literature Values

Item	City of Richland	Typical Value
Average Day Loading per Capita (ppcd)	0.24	0.13 to 0.33 [a]
Average Day Concentration (mg/L)	270	130 to 389 [b]

[a] *Table 3-13 (page 216), Metcalf and Eddy, 5th Edition*

[b] *Table 3-18 (page 221), Metcalf and Eddy, 5th Edition*

3.2.4 Total Kjeldahl Nitrogen (TKN)

The City of Richland WWTP currently collects weekly samples for influent ammonia. Influent ammonia levels for the period January 2010 through December 2014 ranged from 10.0 to 34.0 mg/L, with an average value of 18.1 mg/L. In comparison to typical literature values, this represents a low- to medium-strength wastewater. Unlike BOD and TSS, the July 2014 influent sampling process change at the WWTP does not seem to have affected influent ammonia data.

Influent Total Kjeldahl Nitrogen (TKN) is typically used for process design, nutrient balances, oxygen demand rates, etc., but this data is currently unavailable. Therefore, the influent ammonia values were converted to total nitrogen using a ratio of typical literature values for medium-strength wastewater (i.e., a ratio of 1.75 based on 35 mg/L of TKN to 20 mg/L of ammonia) (Table 3-18, page 221, Metcalf & Eddy 5th Edition). The estimated influent TKN loading, based on the assumed factor of 1.75 to observed ammonia data, are given in **Table 3-6**. The resulting average concentration is slightly lower than typical values, but likely reflects infiltration occurring in the collection system as noted in **Section 3.4**. The daily and monthly average TKN are shown in **Figure 3-4**.

The assumed TKN values should be revisited and replaced with actual values if TKN data is collected for the WWTP.

Table 3-6 – Probable Existing TKN Loading (2010 – 2014)

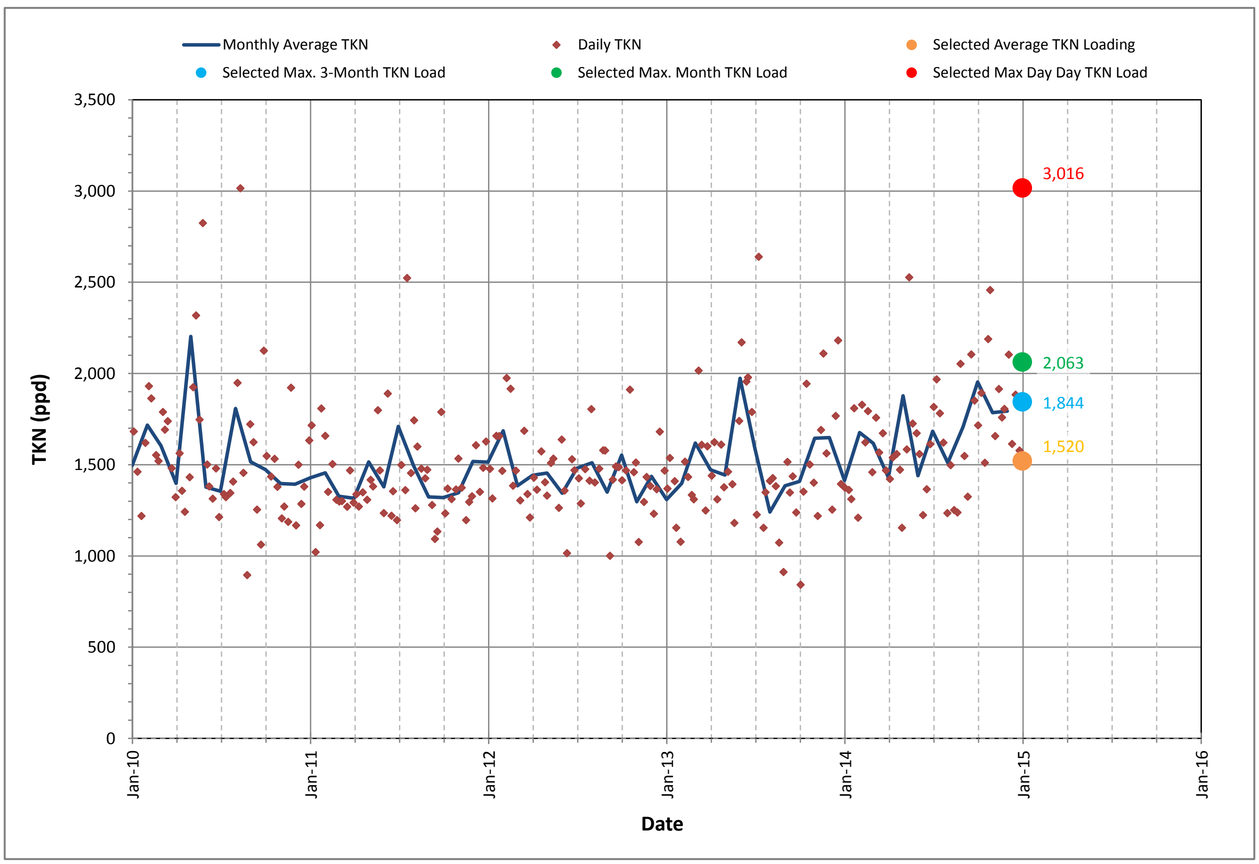
Item	2010	2011	2012	2013	2014	Probable Existing
Average Day Concentration (mg/L)	32.0	28.7	31.0	32.5	34.8	31.8 (a)
Average Day Loading (ppd)	1,560	1,426	1,458	1,500	1,654	1,520 (a)
Maximum 3-Month Loading (ppd)	1,735	1,535	1,572	1,670	1,844	1,844 (b)
Peaking Factor	*1.11*	*1.08*	*1.08*	*1.11*	*1.11*	*1.21* (c)
Maximum Month Loading (ppd)	2,063	1,716	1,734	1,927	1,996	2,063 (b)
Peaking Factor	*1.32*	*1.20*	*1.19*	*1.29*	*1.21*	*1.36* (c)
Peak Day Loading (ppd)	3,016	2,524	1,975	2,640	2,526	3,016 (b)
Peaking Factor	*1.93*	*1.77*	*1.35*	*1.76*	*1.53*	*1.98* (c)

(a) *Selected as the weighted average of data for January 2010 through October 2014.*

(b) *Selected as the observed maximum of the data for January 2010 through October 2014.*

(c) *The peaking factor is calculated as the observed maximum divided by the annual average day condition.*

Figure 3-4 – TKN Load Summary (2010 – 2014)



A probable existing average value of 1,520 ppd for influent TKN loading for the City of Richland was selected based on the average of average day values for the period of January 2010 through December 2014. This equates to 0.029 ppcd using an estimated 2015 population of 53,054. This is within the typical range of 0.020 to 0.040 ppcd expected for residential loading (Metcalf and Eddy). The corresponding average TKN concentration over the same time period (i.e. January 2010 through December 2014) is 31.8 mg/L, which is within the typical range of 23 to 69 mg/L reported for domestic wastewater (Metcalf and Eddy). This information is summarized in **Table 3-7**.

Table 3-7 – Selected TKN Loading Compared to Literature Values

Item	City of Richland	Typical Value
Average Day Loading per Capita (ppcd)	0.029	0.020 to 0.040 [(a)]
Average Day Concentration (mg/L)	31.8	23 to 69 [(b)]

(a) *Table 3-13 (page 216), Metcalf and Eddy, 5th Edition*

(b) *Table 3-18 (page 221), Metcalf and Eddy, 5th Edition*

3.2.5 Total Phosphorus (TP)

Influent Total Phosphorus (TP) loading data is currently unavailable for the City of Richland WWTP. Therefore, existing phosphorus loadings will be based on typical literature values (Metcalf and Eddy), as summarized in **Table 3-8.** These values should be confirmed with sampling prior to detailed design.

Table 3-8 – Probable Existing Phosphorus Loading Conditions

Parameter	Value		Current Average Day [(c)] (ppd)
	Range [(a)] (mg/L)	Typical [(b)] (mg/L)	
Total Phosphorus	4-11	6	285

(a) *Table 3-18 (page 221), Metcalf and Eddy, 5th Edition*

(b) *A lower typical value was selected to account for impacts from inflow and infiltration.*

(c) *Based on a current average day flow of 5.69 mgd*

Typical literature values (Metcalf and Eddy) for peaking factors are recommended until sufficient data is collected to define the phosphorus influent loading variability. The maximum month and peak day peaking factors are 1.25 and 1.75, respectively.

3.2.6 Summary of Current Flows and Loads

The existing flow and load data presented above are summarized in **Table 3-9**.

Table 3-9 – Existing Flows and Loads Summary

Item		Value
Flow (mgd)	Average Day	5.69
	Maximum 3-Month	6.20
	Peaking Factor	1.09
	Maximum Month	6.25
	Peaking Factor	*1.10*
	Peak Day	7.50
	Peaking Factor	*1.32*
	Peak Hour	9.41
	Peaking Factor	*1.65*
BOD (ppd)	Average Day	11,032
	Maximum 3-Month	13,238
	Peaking Factor	1.20
	Maximum Month	14,099
	Peaking Factor	*1.28*
	Peak Day	18,870
	Peaking Factor	*1.71*
TSS (ppd)	Average Day	12,911
	Maximum 3-Month	16,547
	Peaking Factor	1.28
	Maximum Month	18,146
	Peaking Factor	*1.41*
	Peak Day	25,157
	Peaking Factor	*1.95*
TKN (ppd)	Average Day	1,520
	Maximum 3-Month	1,844
	Peaking Factor	1.21
	Maximum Month	2,063
	Peaking Factor	*1.36*
	Peak Day	3,016
	Peaking Factor	*1.98*
TP (ppd)	Average Day	285
	Maximum Month	356
	Peaking Factor	*1.25* [a]
	Peak Day	499
	Peaking Factor	*1.75* [a]

(a) *Per typical literature values*

3.3 Projected Flow and Loads for Year 2035

The Benton County Comprehensive Plan lists a projected 2035 population of 76,533 people for the City of Richland. Based on an estimated population in 2015 of 53,054, this results in a growth rate of approximately 1.849 percent per year over the planning period. The average day flow and loading for 2035 was projected based on the estimated growth rate. Maximum month, peak day, and peak hour conditions were estimated based on observed peaking factors noted previously.

The corresponding projected flows and loads for 2035 are summarized in **Table 3-10**. Projected flows are shown in **Figure 3-5**, projected BOD loading is shown in **Figure 3-6**, projected TSS loading is shown in **Figure 3-7**, and projected TKN loading is shown in **Figure 3-8**.

Table 3-10 – Projected Flows and Loads for 2035

Item		Value
Flow (mgd)	Average Day	8.21
	Maximum 3-Month	8.95
	Peaking Factor	1.09
	Maximum Month	9.03
	Peaking Factor	*1.10*
	Peak Day	10.83
	Peaking Factor	*1.32*
	Peak Hour	13.54
	Peaking Factor	*1.65*
BOD (ppd)	Average Day	15,910
	Maximum 3-Month	19,090
	Peaking Factor	1.20
	Maximum Month	20,360
	Peaking Factor	*1.28*
	Peak Day	27,210
	Peaking Factor	*1.71*
TSS (ppd)	Average Day	18,620
	Maximum 3-Month	23,830
	Peaking Factor	1.28
	Maximum Month	26,250
	Peaking Factor	*1.41*
	Peak Day	36,310
	Peaking Factor	*1.95*
TKN (ppd)	Average Day	2,190
	Maximum 3-Month	2,650
	Peaking Factor	1.21
	Maximum Month	2,980
	Peaking Factor	*1.36*
	Peak Day	4,340
	Peaking Factor	*1.98*
TP (ppd)	Average Day	411
	Maximum Month	514
	Peaking Factor	*1.25* [a]
	Peak Day	719
	Peaking Factor	*1.75* [a]

(a) *Per typical literature values*

Figure 3-5 – Flow Projection (2035)

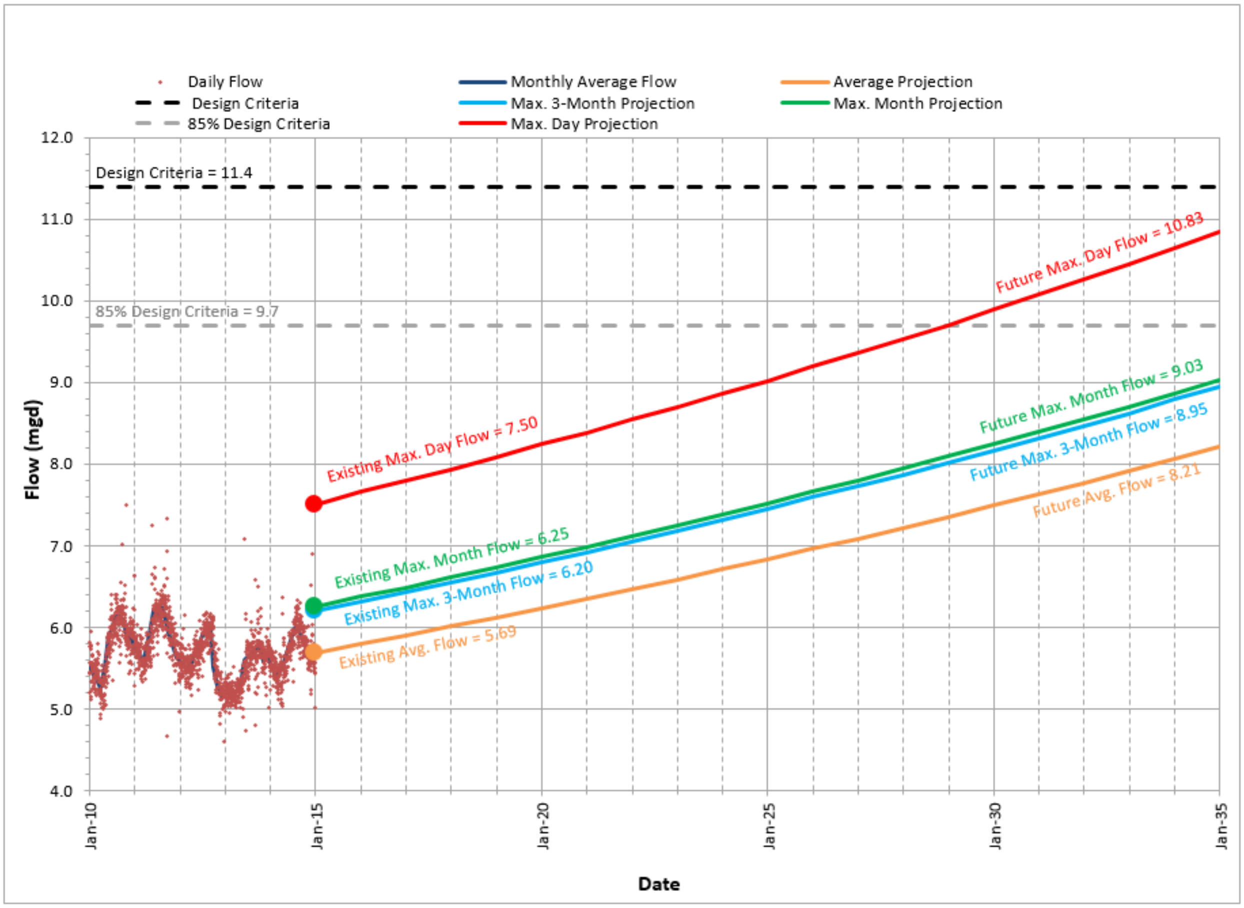


Figure 3-6 – BOD Loading Projection (2035)

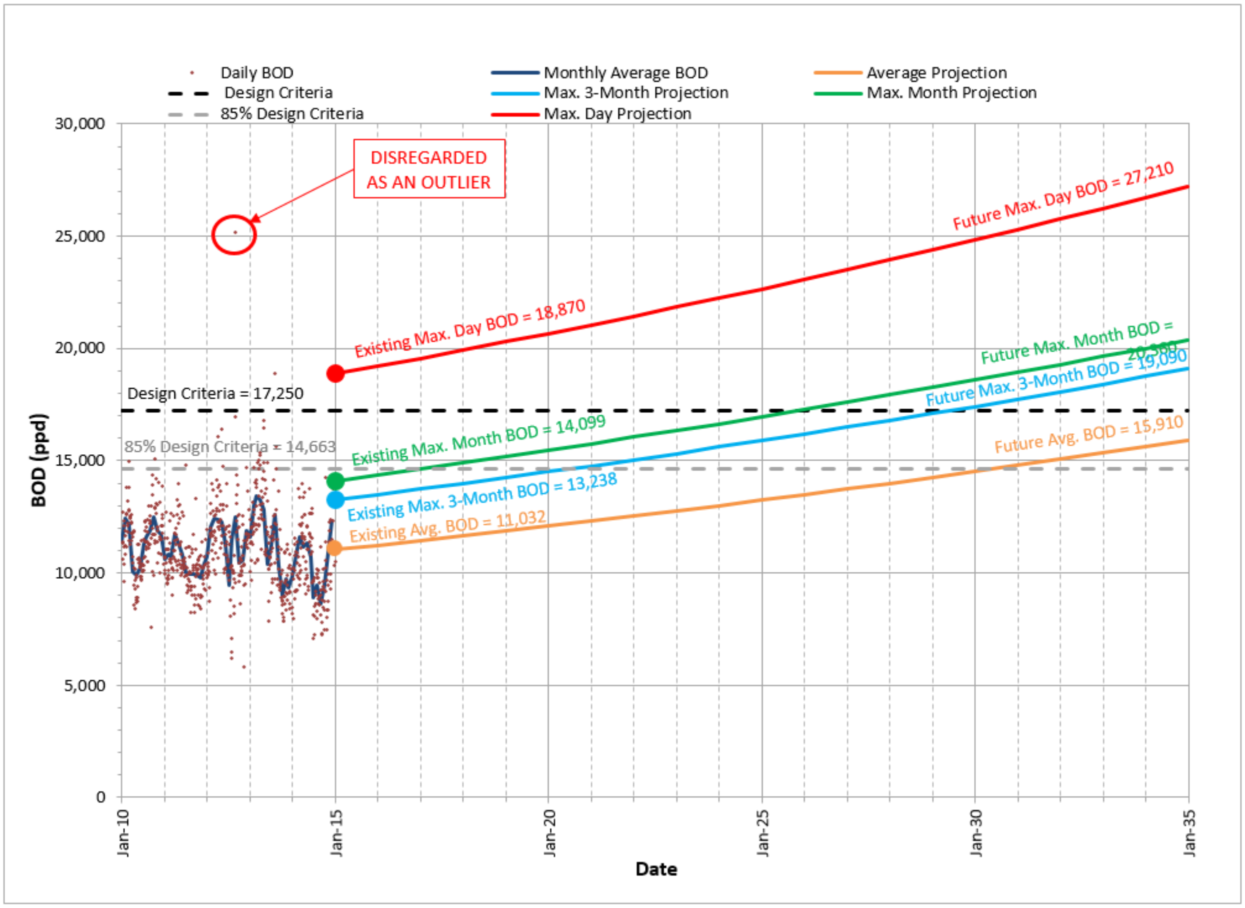


Figure 3-7 – TSS Loading Projection (2035)

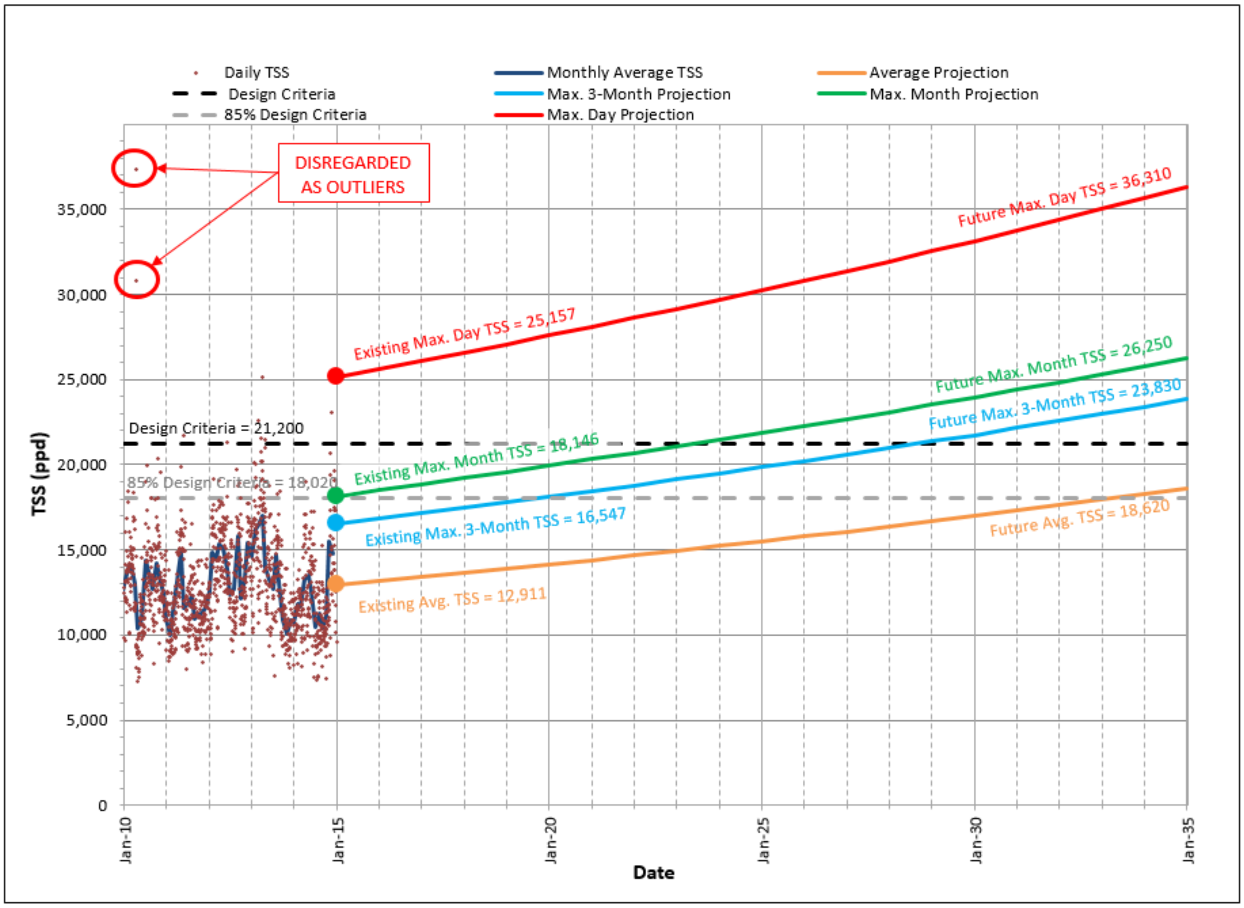
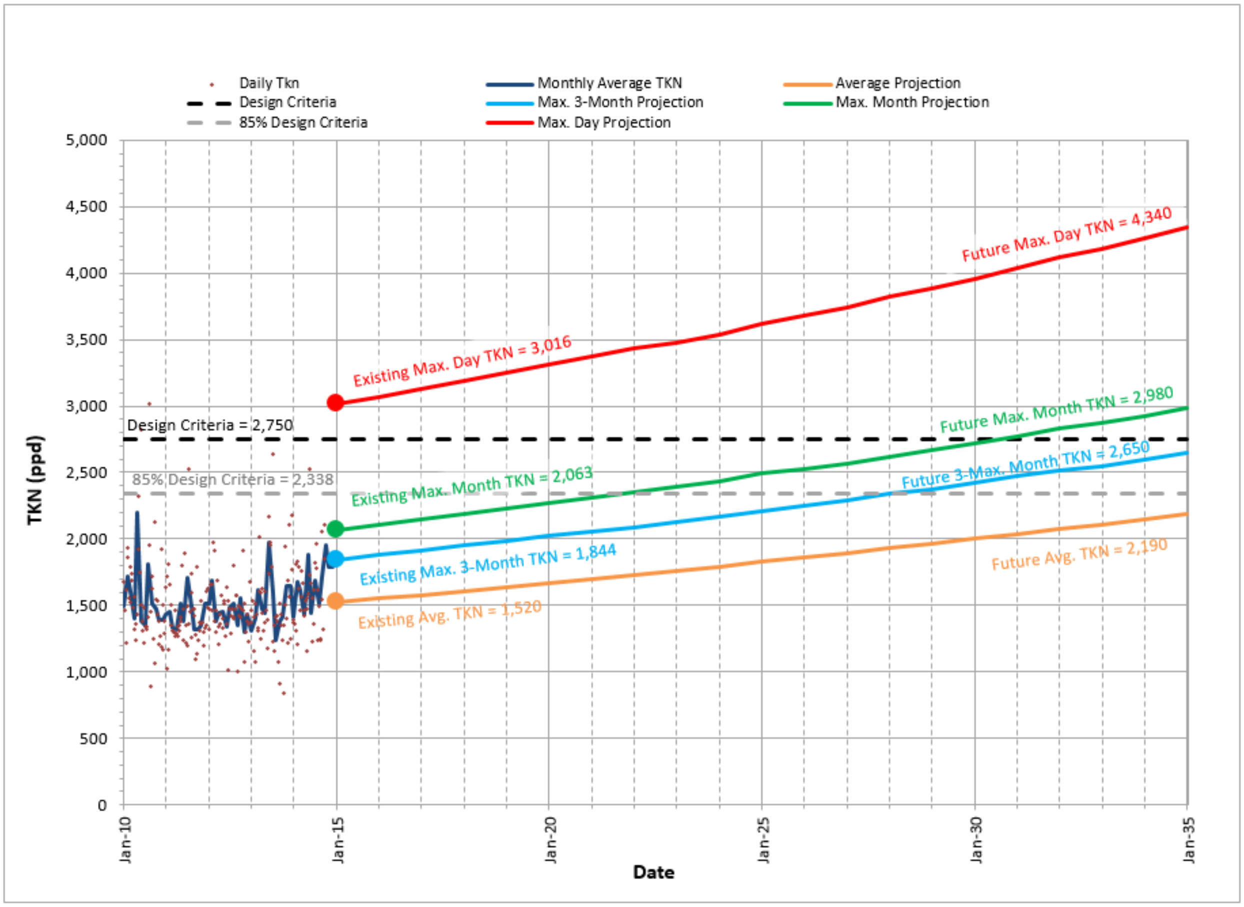


Figure 3-8 – TKN Loading Projection (2035)



3.4 Summary of Flow Contributions and Sources

The City's water service meter billing data from December 2012 through February 2013 was utilized in order to estimate the amount of sewage generated from each parcel within the service area. The parcels were classified according to land use and the summary is provided in **Table 3-11** below.

Table 3-11 – Wastewater Sources & Estimated Flow Contribution (December 2012 – February 2013)

Category	Average Flow (mgd)	Percent of Total
Residential (a)	2.94	49%
Commercial (b)	0.50	8%
Industrial	0.50	8%
Schools (c)	0.07	1%
Other (d)	0.02	<1%
Infiltration (e)	1.91	32%
TOTAL	5.94 (f)	100%

(a) *Includes Low, Medium and High Density Residential land use types, RV and Mobile Home Parks and Assisted Living Facilities.*
(b) *Includes commercial industries, hospitals and hotels*
(c) *Includes colleges/universities, and elementary/middle/high schools*
(d) *"Other" refers to City-owned parks, green spaces, and related facilities*
(e) *Infiltration from calibrated sewer collection system hydraulic model – See Appendix C, Model Assumptions, for more details*
(f) *Average Flow Total is based on the sum of all categories*

The total average flow in **Table 3-11** is based on the sum of all the wastewater categories, including infiltration. This value is slightly greater than the observed WWTP flows shown in **Figure 3-1**, during the same time period, and is a result of calibrating the hydraulic model to individual flow monitor locations throughout the collection system and not directly to the WWTP.

The flow contribution from Residential was further evaluated to identify the unit flow for a single family residence. Based upon the total flow for the Low Density Residential land use type and the amount of single family listings, it was found that that the average daily flow for a single family residence is 160 gpd.

3.5 Large Non-Residential Flows

Industrial and commercial establishments discharging into the City's collection system include: printers, photographic processors, dental and medical facilities, university facilities, industrial laundry facilities, dry cleaners, chemical/biological testing and research laboratories, radiator repair and auto body shops, federal contractors, pesticide applicators, and a nuclear fuel rod manufacturer.

Based on water meter records from winter of 2013, the largest users are presented in **Table 3-12**.

Table 3-12 – Largest Water Users (December 2012 – February 2013)

User	Average Flow (mgd)	Type	Description
Lamb Weston[(a)]	0.52	Industrial	Food Processor
Ingredion	0.15	Industrial	Food Processor
Kadlec Hospital	0.06	Commercial	Medical/Hospital
The Hills Mobile Home Park	0.05	Residential	Residential
ATI – ALLVAC Metal Fabrication	0.04	Industrial	Metal Fabricator
Areva	0.04	Industrial	Nuclear Materials
Richland Mobile Home Park	0.03	Residential	Residential
Red Lion Hotel	0.03	Commercial	Hotel
Washington Closure Hanford	0.03	Industrial	Laboratory/Research
Richland Rehabilitation Center	0.03	Residential	Assisted Living
US Linen	0.03	Industrial	Industrial Laundry
WWTP	0.02	--	City Facility
Alyson Manor Estates	0.02	Residential	Assisted Living
Shilo Inn	0.02	Commercial	Hotel
Battelle	0.02	Industrial	Laboratory/Research
Alterra Assisted Living	0.02	Residential	Assisted Living

(a) *Does not discharge to City sewer system.*

There are currently eleven Significant Industrial Users (SIUs) that are permitted by the City to discharge to the City system:

- Battelle – R & D Lab
- Ingredion (formally Penford Food Ingredients)– Food Processing
- US Linen – Industrial laundry
- Unitech – Nuclear laundry
- Environmental Molecular Sciences Lab – R & D Lab
- Applied Process Engineering Lab – R & D Lab
- ATI-ALLVAC – Titanium Refinery
- AREVA – Nuclear Fuels Manufacturer
- Bioproducts, Science, and Engineering Lab – R & D/Teaching Lab
- 300 Area – R & D Lab
- Physical Sciences Facility – R & D Lab

All flows and loads are projected to grow at the same 1.85% growth rate as projected for the population. No separate growth rates were identified for non-residential flows. The WWTP planning documents in the early 2000s include provisions for a large food processor; however, no such provisions are incorporated into this Plan. The impact of any potential large industrial dischargers should be evaluated on a case by case basis.

3.6 Infiltration and Inflow

Infiltration is the term for groundwater that enters the system through faulty joints, cracks, and service connections as well as through illegal connections of irrigation overflows and foundation drains. Inflow accounts for water that enters the system during a storm event through manhole lids and miscellaneous connections to roof drains and storm drainage structures. Richland experiences a noticeable seasonal variation in infiltration and inflow (I/I) levels that correspond with irrigation season – with peaks occurring in the late summer. The following sources of infiltration have been identified:

- Excessive lawn watering induces percolation into shallow side sewers
- Over-irrigation onto paved areas results in ponding in local drainage ways where it infiltrates
- Perched water tables in areas adjacent to irrigation canals induces infiltration
- The shallow water table in the City's northcentral region (north of McMurray St.), southeasterly region (near the Montana LS) and southcentral region (south of Meadow Springs Golf Course) enters through trunk sewer mains and manholes.

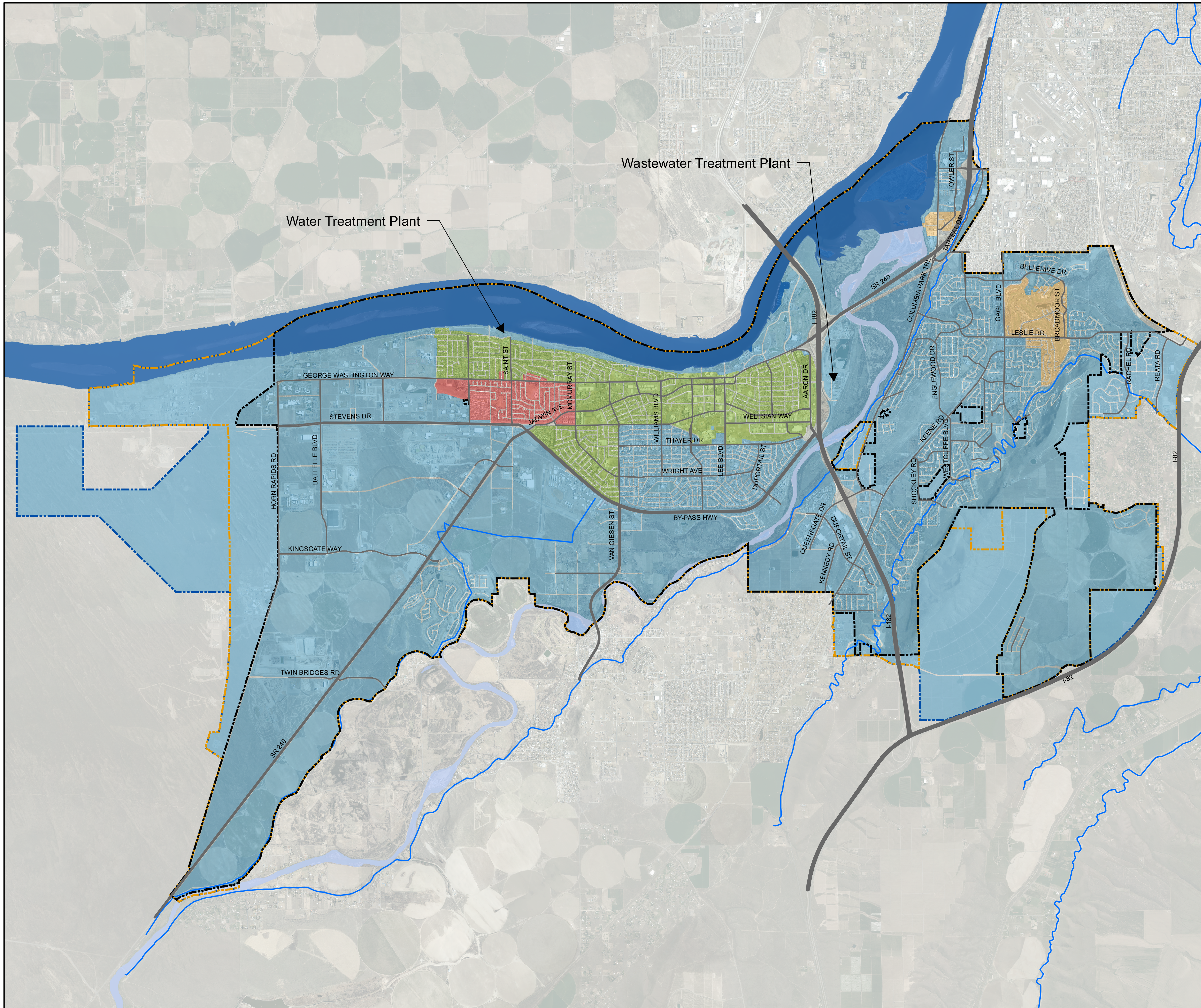
Infiltration and inflow (I/I) affect the sewer system by increasing the volume of flow that must be collected, conveyed, and ultimately treated at the WWTP. This results in reduced efficiency of biological processes and increases the cost of unit processes that are sized based on detention time. Therefore, it is desirable to minimize I/I. The WDOE requires that cities demonstrate that the sewer collection system is not subject to excessive I/I and has established criteria for determining non-excessive I/I.

Special Condition S4.E of the City's NPDES permit requires the annual submission of an I/I Evaluation report. These reports are included in **Appendix O**. This report is a template provided by WDOE that lists average monthly WWTP flows, monthly rainfall amounts, and population served. The difference between the highest and lowest monthly average flow is considered to be the I/I in this report. Although the difference between the highest and lowest monthly average flows indicates a seasonal difference, it does not account for baseline infiltration that may occur throughout the year. As shown in **Table 3-11**, flow monitoring used for calibration of the collection system hydraulic model indicates that infiltration is approximately 1.91 MGD – which is greater than double the 0.83 MGD amount calculated in 2013 using the WDOE template. Therefore, while the WDOE template provides an easy-to-calculate metric that can be used for tracking progress, it is not a true measure of the amount of infiltration in Richland's collection system.

For determining non-excessive infiltration, the City's report references EPA Publication No. 97-03, I/I Analysis and Project Certification. According to the publication, non-excessive infiltration is determined by calculating the average daily flow per capita (excluding major industrial and commercial flows greater than 50,000 gpd). If this value is less than 120 gpcd, the amount of infiltration is considered non-excessive. Using the total average flow listed in **Table 3-11** less the major industrial and commercial flows (totaled as 0.254 mgd) results in a total average flow of 5.69 mgd. Compared to the 2015 population of 53,054, this results in an average daily flow per capita of 107 gpcd, which indicates non-excessive infiltration.

The City has taken aggressive measures to reduce the amount of I/I in recent years. These measures have included inspection of the existing system by both CCTV and manual methods. Based upon the inspections, a prioritized list of rehabilitation projects have been identified which include: storm drainage disconnects, irrigation overflow disconnects, manhole repair/replacement, side service repair, trenchless rehabilitation, and sewer main replacements. This list is designated as the Problems and Maintenance (PM) List and is included in **Appendix K**. Additionally, service area expansion has included gasketed PVC pipe that is pressure tested and inspected by CCTV prior to acceptance. Moreover, care has been taken to ensure that sewer mains are installed within the street right-of-way and outside of areas that are subject to surface water infiltration at the drainage ways. As shown in **Figure 3-9,** calibration of the collection system model indicated there are several areas of relatively high infiltration, while the majority of the system experiences little to no infiltration. The remaining areas believed to be contributing to infiltration seen at the WWTP include the shallow water table in the City's north-central region (north of McMurray St.), southeasterly region (near the Montana LS) and south-central region (south of Gage Boulevard in the Meadow Springs area).

Based on the determination of non-excessive I/I, following the EPA criteria, there is no requirement for the City to engage in a full-scale I/I study. The City should continue its program of flow monitoring, systematically identifying sources of I/I during routine maintenance and inspection, and incorporating repair/replacement projects into the annual budget. However, it would be wise for the City to evaluate addressing the localized areas of medium to high infiltration in an effort to eliminate the nearly 2 mgd of I/I and free up that hydraulic capacity at the WWTP. There is a chance that planned near-term condition rating may preclude the need for this study; however, budget for a future I & I Study has been added to the CIP.



City of Richland
2015 General Sewer Plan

Figure 3-9
Infiltration

Legend

- City Limits
- UGA
- 50-yr Planning
- Interstate/Highway
- Major Streets
- Irrigation Canal/Pipeline
- Columbia River
- Yakima River

Infiltration (gpad)

- None - 0.0
- Low - 175
- Med-High - 1500
- High - 1700

0 6,000 12,000 Feet

N E S W

Date: Apr 1, 2016

J-U-B ENGINEERS, INC.