City of Pinole

Pinole/Hercules WPCP Project

Technical Memorandum 1

Flows and Loads

February 20, 2013

PRELIMINARY
FOR REVIEW ONLY

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Contents

Figures

Tables

TM 1 - Flows And Loads

Pinole/Hercules WPCP Project ***February 20, 2013***

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Executive Summary

Purpose

The objective of this technical memorandum (TM) is to review establish the projected design flows and loads that will serve as the basis of design for upgrades at the Pinole/Hercules Water Pollution Control Plant (WPCP).

Background

The WPCP's National Pollutant Discharge Elimination System (NPDES) permit was renewed in August 2012. The new treatment and discharge provisions require upgrades to the WPCP. This TM presents a review of previous flow and load estimates and historical data, and projected flows and loads to be used for the design of the WPCP upgrades.

Conclusions

HDR reviewed four years of historical data from the WPCP (2008 through 2011) and developed projected flows and loads and peaking factors, which are presented in Table 1-1 below.

Table 1-1. Summary of Projected Flows and Loads

Condition	Flow (mgd)	Influent Concentrations (mg/L)		Influent Loads (lb/d)	
		BOD	TSS	BOD	TSS
Average Dry Weather Flow (ADWF)	4.06	310	310	10,500	10,500
Average Annual (AA)	4.51	288	303	10,830	11,410
Maximum Month (MM)	6.09	242	261	12,300	13,260
Maximum Week (MW)	8.94	204	272	15,190	20,290
Maximum Day (MD)	11.33	197	275	18,630	26,020
Peak Wet Weather Flow (PWWF)	20.00	--	--	--	--
Minimum Flow	1.75	--	--	--	--

BOD – Biological Oxygen Demand
TSS – Total Suspended Solids
lbs/day – pounds per day
mg/L – milligram per liter
mgd – million gallons per day

Introduction

The Pinole/Hercules Water Pollution Control Plant's (WPCP) National Pollutant Discharge Elimination System (NPDES) permit (Permit No. CA0037796) was renewed in August 2012. The renewed permit contains new treatment and discharge provisions which are described in detail in Technical Memorandum (TM) 2. The purpose of this TM is to review previous flow and load calculations, analyze historical WPCP data, and develop design flows and loads that will become the basis of design for the WPCP upgrades.

Background

The WPCP treats municipal wastewater flow from the City of Pinole (Pinole) and the City of Hercules (Hercules). Hercules' and Pinole's wastewater flows are separately metered at the WPCP prior to being combined and entering the WPCP's influent pump station. Combined flows are also measured at the chlorine contact basin effluent weir. Composite samples are collected for each city's wastewater (upstream of the influent pump station), and composite samples of the combined influent are collected in the influent screen channel (upstream of the influent pumps) and analyzed three times per week. Currently, the WPCP does not routinely analyze the influent wastewater for ammonia, total Kjeldahl nitrogen (TKN), or phosphorus. As part of previous studies, composite samples of influent wastewater (combined) and primary effluent were collected and analyzed for ammonia and TKN over a two week period in August 2009.

Combined flows and loads that enter the WPCP are currently treated to meet or exceed discharge permit limits. Currently, the WPCP provides secondary treatment for influent flows up to 11 million gallons per day (mgd). Flows that exceed 11 mgd, bypass secondary treatment, are blended with secondary effluent, disinfected and discharged to San Pablo Bay via Rodeo Sanitary District's outfall (Deep Water Outfall) or the WPCP's Emergency Outfall. Discharge requirements for select pollutants are summarized in Table 1-2. Ammonia limits are included in the new permit, but upgrades are not required to address ammonia removal at this time. The newly adopted NPDES permit requires the WPCP to provide secondary treatment for peak wet weather flows up to 20 mgd (i.e., no bypass of secondary treatment) by 2017.

Table 1-2. Summary of Discharge Limits for Select Pollutants[1]

Parameter	Unit	Average Monthly	Average Weekly	Maximum Daily
Carbonaceous Biological Oxygen Demand (CBOD)	mg/L	25	40	--
Total Suspended Solids (TSS)	mg/L	30	45	--
Oil & Grease	mg/L	10	--	20
Total Coliform	MPN/100mL	240		10,000
Enterococcus Bacteria	MPN/100mL	35		
Ammonia as Nitrogen	mg/L	113		182

1 – Based on NPDES Permit No. CA0037796 issued in August 2012.
mg/L – milligrams per liter
MPN/100 mL – Most Probable Number per 100 milliliters
" – " No limit in NPDES permit

Averaging Periods

The adopted NPDES permit has limits based on various averaging periods as shown in Table 1-2 (e.g., average month limits). The development of design of flows and loads to meet the discharge permit is based on meeting the averaging periods identified within the permit as well as defining other key loading conditions important in unit process dimensioning. Descriptions of the averaging periods that either must be met for compliance with the adopted permit or are useful in design are as follows:

- Average Dry Weather Flow (ADWF): ADWF is defined as the average monthly flow over the three driest consecutive months of the year. Historically, the driest months occur in June, July, August, and September, where the groundwater table is typically at its lowest elevation. As a result, the amount of inflow and infiltration (I&I) from the groundwater is low, and the flows are principally from residential and commercial areas. The ADWF design flow (4.06 million gallons per day (mgd)) serves as the stated capacity basis for the WPCP in the NPDES permit.
- Average Annual (AA): AA establishes the average flow and load that is used to assess annual operational costs. It is calculated as the total volume in million gallons (MG) entering the WPCP over the year divided by 365 days.
- Maximum Month (MM): MM is defined as the month at which maximum flows and loads occur over the course of a year. Historically, this occurs in January or February. This condition establishes the critical performance loading to the biological processes. For example, the aeration system must meet this loading condition at all times in order to ensure proper biological growth while simultaneously meeting discharge limits. Anaerobic digesters are another example of a process where the maximum month loading determines the process requirements. Compliance with the permits limits apply to maximum month conditions since this is typically the most stressed condition for the WPCP.
- Maximum Week Flow (MW): MW is defined as the week during which maximum flows and loads occur over the course of a year. Historically, this occurs during the winter months.
- Maximum Day Flow (MD): MD is defined as the maximum daily flow throughout the year. MD is expected to occur during the winter months, typically, during the maximum month of flows.
- Peak Wet Weather Flow (PWWF): The PWWF flow is a function of precipitation, I/I into the sewer system, and the hydraulics of the sewer system. PWWFs typically have a short duration, and are less critical to biological processes. The hydraulic capacity of the WPCP will need to accommodate the maximum PWWF.
- Minimum Flow: Minimum flow is considered the lowest diurnal flow which typically occurs during the early morning hours. Minimum flow is necessary for designing turn down capacity of influent pumps, and hydraulics of influent sewers.

The NPDES permit provides two design requirements: (1) the WPCP must have the capacity to provide secondary treatment and disinfection of ADWFs up to 4.06 mgd, and (2) the WPCP must provide secondary treatment and disinfection of PWWFs up to 20 mgd. These flows serve as the basis for the ADWF and PWWF projections.

Previous Work

In 2007, Brown and Caldwell prepared an evaluation to develop conceptual upgrade alternatives.[1] As part of this evaluation, industry standards for per capita flows and loads were used in conjunction with projected buildout population data to develop annual average flows.[2, 3] MM, MD, and PWWF peaking factors were calculated from historical data (years 2000 through 2003) and these factors to were used calculate the peak design flow. Table 1-3 provides a summary of the flows and load estimates from the 2007 evaluation.

Table 1-3. Brown and Caldwell WPCP Evaluation 2030 Flow and Load Projection

Item	Unit	ADWF	AA	MM	MW	MD	PWWF
Flow Peaking Factor	n/a	1.0	1.0	1.6	2.0	2.6	--
2030 Flow	mgd	4.1	4.1	6.5	8.3	10.5	18.2
Load Peaking Factor	n/a	1.0	1.0	1.3	--	1.5	--
2030 BOD Load	lbs/day	11,200	11,200	14,600	--	16,800	--
2030 TSS Load	lbs/day	12,800	12,800	16,600	--	19,200	--

BOD – biological oxygen demand
TSS – total suspended solids
lbs/day – pounds per day
mgd – million gallons per day

In 2009, Dodson-Psomas developed a Facilities Plan based on selected alternatives developed in the Brown and Caldwell evaluation. The Facilities Plan used more recent population projections[4] and the same per capita flow and loads to predict the average dry weather flows and loads to the WPCP. The design flows and loads from the Dodson-Psomas Facilities Plan are presented in Table 1-4. The Facilities Plan references the WPCP's 2007 NPDES permit for selection of the 14.6 mgd MD flow. This value represents the maximum PWWF over a 24-hour period (maximum day PWWF). The AA, MM, and MW flows were not included in the Facilities Plan.

[1] Brown and Caldwell Technical Memorandum 7 Pinole/Hercules Wastewater Treatment Plant Expansion Alternative Evaluation. (2007)
[2] Tchobanoglous, G.; Burton, F.L.; Stensel, D. Wastewater Engineering: Treatment Disposal and Reuse Metcalf & Eddy 4th Ed. (2003)
[3] Flow = 80 gal/day per capita, BOD Load = 0.22lbs/day per capita, and TSS Load = 0.25 lbs/day per capita.
[4] 2030 Population Served by the WPCP 21,800 City of Pinole, 28,000 City of Hercules 2009 EIR.

Table 1-4. Dodson-Psomas Facilities Plan Flow and Load Projection

Item	Unit	ADWF	AA	MM	MW	MD	PWWF
Flow	mgd	4.06	--	--	--	14.60	20.0
BOD Load	lbs/day	11,000	--	--	--	--	--
TSS Load	lbs/day	12,500	--	--	--	--	--

mgd – million gallons per day
lbs/day – pounds per day
BOD – biological oxygen demand
TSS – total suspended solids

Data Analysis

There are several approaches for calculating flows and loads over a given averaging period. The language in the adopted discharge permit defines ADWF at the WPCP as the average daily flow over the three lowest consecutive dry weather months. HDR analyzed flow and load data on a year to year calendar basis. An overview of the steps associated with calculating flows and loads using a year to year calendar approach are as follows:

1. Calculate the ADWF, AA, MM, MW, and MD flow and load for each year in the data set (2008 - 2011).
    a) The average dry weather load (ADWL), will coincide with the ADWF because the permit language is based on flow.
    b) The AA, MM, MW, and MD flow and loads are determined independently of each other. For example, the MM flow and load might occur during different months of the calendar year. This offers a more conservative approach.
2. Calculate the peaking factors for each year in the data set (2008 - 2011) (AA:ADWF; MM:ADWF, MW:ADWF, MD:ADWF, PWWF:ADWF) using the values determined in Step #1.
    a) Take the average peaking factor for AA:ADWF, and MM:ADWF across all years in the dataset (2008 – 2011).
    b) Take the maximum peaking factor for MW:ADWF, MD:ADWF, PWWF:ADWF across all years in the dataset (2008 - 2011).
3. Calculate the historic ADWF concentration (i.e., average ADWF for years 2008-2011) by back calculating (e.g., ADWF biological oxygen demand (BOD) load divided by the ADWF flow).
4. Calculate the ADWL at 4.06 mgd using the concentration determined in Step #3.
5. Determine the design flows and loads for AA, MM, MW, MD and PWWF averaging periods. To calculate, apply the peaking factors determined in Steps #2a and 2b to the ADWF flow and load for the 4.06 mgd design flow (Step #4).

6. Calculate the design flow concentrations for each averaging period by back calculating (e.g., MM BOD load divided by the MM flow).

HDR performed an independent evaluation of recent WPCP data to validate and update flow and load projections presented in the Dodson-Psomas Facilities Plan. The four year period between January 2008 and December 2011 was selected because it provided an uninterrupted time-frame with no changes in the WPCP composite flow sample location and type. Because the City of Hercules and the City of Pinole are residential communities, standard per capita flow and load values were used to verify the projected flows and loads developed with the approach outlined above.

After an initial review of the data and flow and load projections, data inconsistencies/potential data outliers were identified. HDR reviewed the potential data outliers with WPCP Staff and updated the flow and load projections. A detailed discussion of the adjustments made to correct for data outliers is provided in Appendix A Flow and Load Revisions, and a summary of adjustments is provided below. A summary of historical flows and loads is presented in Appendix B and Appendix D respectively.

Flows

Discussions with WPCP staff indicated that the combined influent flow provided in the data set is often inaccurate because the City of Pinole's influent meter measurements can be erroneous during low flow/dry weather conditions due to back flow in the City of Pinole's gravity line. The City of Hercules' flow measurements are believed to be accurate. WPCP staff currently use effluent flow measurements (at the chlorine contact basin effluent weir) to determine daily treated flows and the flow contribution from the City of Pinole. WPCP staff recommended that HDR use effluent flow data for flow and load calculations.

Figure 1-1 plots the daily average influent and effluent flow on the primary vertical axis (left-hand axis). The daily measured rainfall is provided on the secondary vertical axis (right-hand axis).[5] The key observations of the historical flow data are:

- The dry season typically occurs from June through September.
- The wet seasons typically occurs from October through May.
- Peak day flow typically occurs in December and January.
- Peak day flow of 11.7 mgd occurred on January 20, 2010.
- Influent flow measurements are consistently higher than effluent flow measurements
- Influent flow measurements in May through June 2010 appear skewed and significantly higher that the effluent flow measurements.

[5] Rain gage data measured at the Rodeo Fire Department (CDEC Station ID: ROF http://cdec.water.ca.gov/)

Due to the discrepancies with the influent flow measurement HDR used the following approach to address (1) the difference between influent and effluent flow measurements that are likely the result of flow dampening, and (2) the May through July 2010 time period where influent flow measurements were categorized as outliers:

1. The influent: effluent flow ratio was calculated for using average daily flow measurements collected in 2008, 2009, and 2011. The influent: effluent flow ratio was determined to be 1.10. Because flow measurements collected in 2010 contained outliers, the 2010 data set was not included in the ratio calculation.
2. Adjusted influent flows were calculated by applying the influent: effluent ratio to the average daily effluent flow measurement for the entire data set (2008 through 2011). The adjusted influent flows were used to calculate loading to the treatment facility.

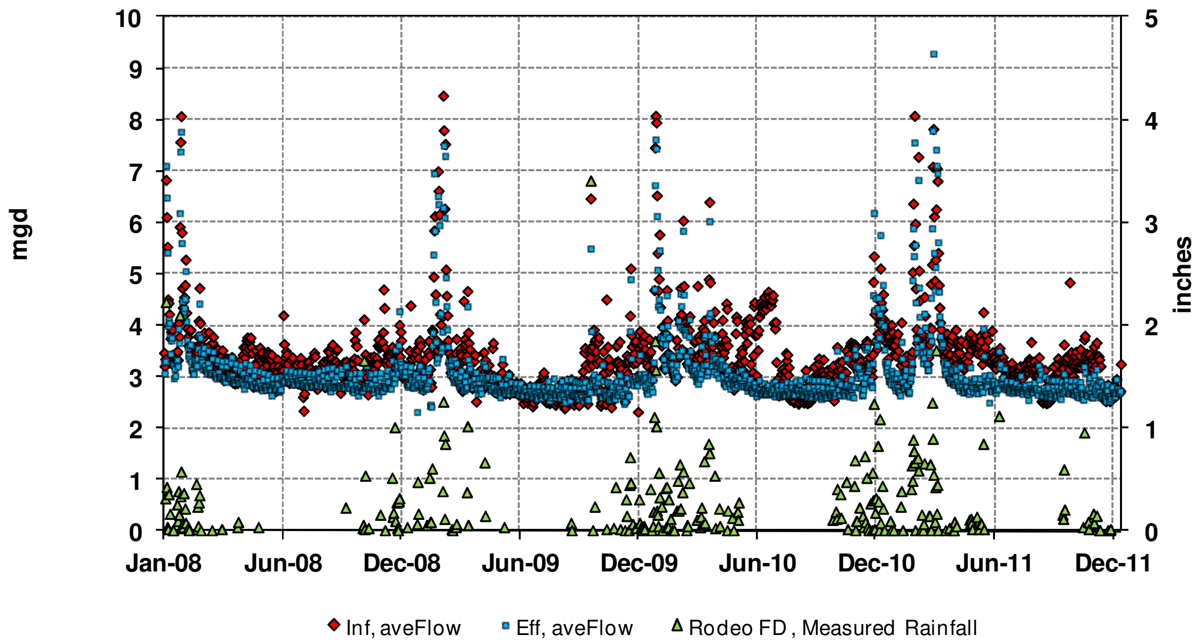


Figure 1-1. Daily Average Influent and Effluent Flow and Daily Measured Rainfall

Average Dry Weather Flow (ADWF)

ADWF is the average daily flow during the dry season with the smallest influence of rainfall or rainfall induced infiltration over the calendar year. ADWF is considered the normal wastewater flow generated from all water users in the service area, including residential, commercial and industrial dischargers.

ADWF based on the permit definition is equal to average daily flow occurring over three consecutive lowest months of the year. The ADWF is determined by averaging the dry month flow rates as shown in Table 1-5.

Table 1-5. 2008-2011 Monthly Flow Comparison

Month	Average Monthly Flow[6]			
	2008	2009	2010	2011
January	4.66	3.21	4.27	3.45
February	3.91	4.25	3.85	4.21
March	3.47	4.06	3.77	5.04
April	3.32	3.23	3.80	3.37
May	3.20	3.16	3.25	3.08
June	3.11	3.03	3.07	3.20
July	3.24	2.94	2.99	3.09
August	3.19	2.98	3.00	3.06
September	3.18	2.97	2.98	2.98
October	3.14	3.16	3.04	3.04
November	3.14	3.00	3.17	3.05
December	3.39	3.27	4.01	2.97
ADWF	**3.15**	**2.96**	**2.99**	**3.02**
			2008-2011 ADWF	**3.03**

*ADWF months are highlighted and used for ADWF calculation.

Population-based projections were used to validate the projected ADWF. Table 1-6 provides the 2010 population of both cities and population projections from the City of Pinole General Plan and the Hercules Redevelopment Agency. During the July 10th, 2012 Predesign meeting, City of Pinole Staff noted that approximately 70 percent of the population in Pinole discharges sewage to the WPCP. The historical data predicts a per capita ADWF of 82 gallons per day per capita (gpdc). This is within the industry standard of 80-120 gpdc. The 82 gpdc was used as the design basis because it is consistent with the NPDES permitted ADWF and historical per capita flows.

Table 1-6. Historical Population and Flow Projections

Year	Population Served	Per Capita Flow (gpdc)	ADWF (mgd)
2010	36,900	82	3.03
2030	49,800	82	4.06

Loads

HDR performed an independent BOD and total suspended solids (TSS) load evaluation based on discussions presented in Appendix A. Daily loads were calculated using the effluent flow multiplied by the influent:effluent flow ratio and the measured constituent concentration. ADWLs coincide with the months that ADWFs occur. Table 1-7 and Table 1-8 present the monthly average load for BOD and TSS, respectively.

[6] Flows presented in the table are effluent measured flows multiplied by the influent:effluent flow ratio of 1.10.

Table 1-7. 2008-2011 Monthly BOD Loads*

Month	Average BOD Load (lbs/d)			
	2008	2009	2010	2011
January	7,720	8,390	10,450	8,690
February	6,480	7,730	8,130	8,290
March	7,660	7,560	7,840	8,800
April	7,840	6,780	9,620	8,050
May	7,240	6,600	9,080	8,540
June	8,120	7,170	8,570	8,440
July	7,540	7,270	8,300	8,530
August	8,400	6,990	8,190	7,590
September	8,170	7,710	7,910	8,020
October	7,640	8,130	7,570	7,210
November	7,980	8,600	8,390	8,130
December	8,670	8,500	8,880	8,710
ADWF	**7,930**	**7,320**	**8,130**	**7,790**
			2008-2011 ADWF	**7,790**

*ADWF months are highlighted, and used for ADWF calculation.
lbs/day – pounds per day

Table 1-8. 2008-2011 Monthly TSS Loads*

Month	Average TSS Load (lbs/d)			
	2008	2009	2010	2011
January	9,800	9,090	10,900	8,580
February	8,070	8,810	9,170	8,640
March	8,380	9,080	9,730	8,960
April	8,430	8,230	9,860	7,140
May	8,800	7,780	8,580	8,230
June	8,220	7,470	8,080	8,990
July	7,750	7,400	8,670	9,000
August	8,820	8,010	7,900	8,000
September	8,290	7,930	7,380	7,430
October	7,660	9,280	7,090	7,300
November	7,420	8,350	9,040	7,290
December	9,870	8,040	9,100	7,900
ADWF	**7,790**	**7,780**	**7,980**	**7,340**
			2008-2011 ADWF Load Average	**7,730**

*ADWF months are highlighted, and used for ADWF calculation.
lbs/day – pounds per day

Figure 1-2 and Figure 1-3 present the measured BOD and TSS loads entering the WPCP during the 2008-2011 timeframe. A 30-day moving average (black line) and daily measured rainfall (green triangles) are also plotted for reference.

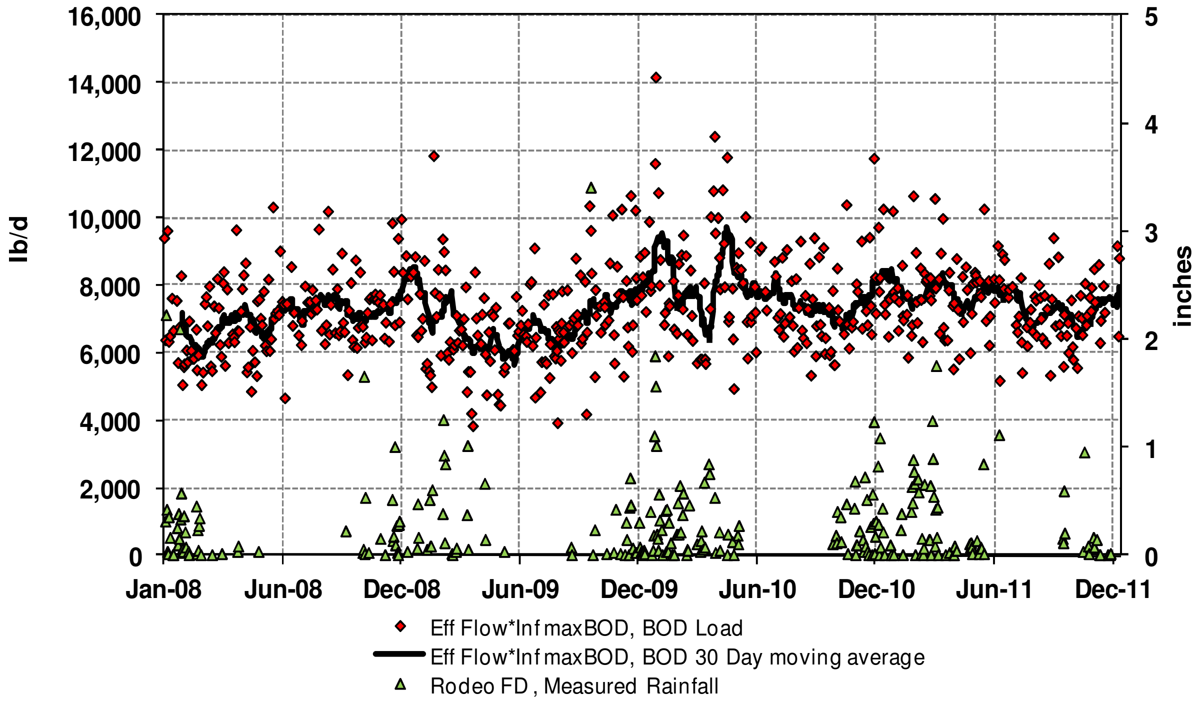


Figure 1-2. Daily Influent BOD Loads and Measured Rainfall

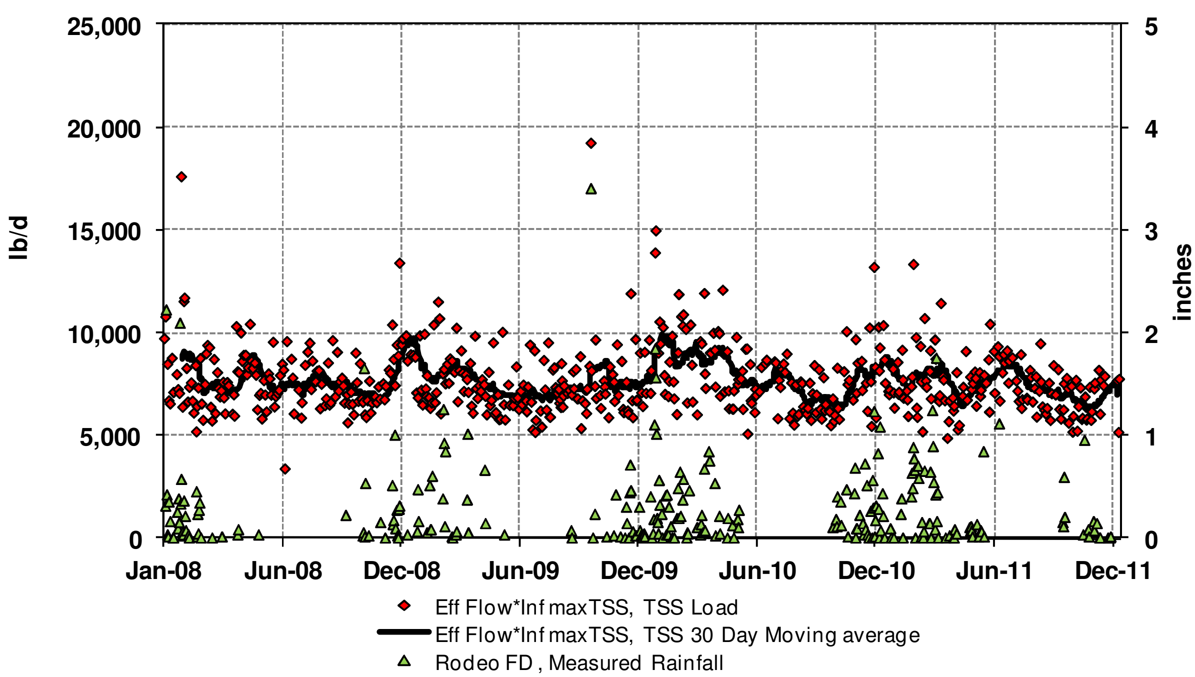


Figure 1-3. Daily Influent TSS Loads and Measured Rainfall

Key observations from the historical load data are as follows:

- The influent BOD and TSS loads fluctuate within the range of 3,750 -21,120 lbs/day, with ADWLs of 7,790 lbs/d BOD and 7,730 lbs/d TSS.
- Peak BOD and TSS loads appear to occur after the first significant rain event of the year. During this time, a considerable amount of grit and solids that have settled out in the collection system are conveyed to the WPCP during high flows.

Historical data was used to estimate projected BOD and TSS loads and concentrations during each averaging period.

Population Based Load Projections

The ADWL is not influenced by rainfall or I/I, and is considered the base TSS and BOD load generated from dischargers in the service area, including residential, commercial and industrial dischargers.

Population-based analysis was performed to validate the projected ADWLs. Based on the ADWLs presented in Table 1-7 and

Table 1-8, the unit loading rates were determined to be 0.211 lbs of BOD/day/capita and 0.209 lbs of TSS/day/capita, respectively. These values are within the range of industry standard per capita loading rates for residential communities. Therefore the loading rate of 0.21 lbs BOD/day/capita and 0.21 lbs TSS/day/capita were used to project 2030 wastewater loading characteristics. This results in an ADWL of 10,500 lbs BOD per day and 10,500 lb TSS per day.

Table 1-9. Historical Population Based Load Projections

Parameter	Population Served	ADWL (lbs/day)	Per Capita Load (lbs/day)
BOD Existing	36,900	7,790	0.211
BOD Projection	49,800	10,500	0.210
TSS Existing	36,900	7,730	0.209
TSS Projection	49,800	10,500	0.210

Peaking Factors

Peaking factors were developed by comparing the historic AA, MM, MW and MD flows and loads to the ADWF (see example below). The historic peaking factors were then applied to the projected ADWF and ADWL to develop flow and load projection for AA, MM, MW and MD conditions.

$$AA\ Peaking\ Factor = Historical\ AA\ Flow \div Historical\ ADWF$$

Flow

Table 1-10 below provides the calculated peaking factors and projected flows for each averaging period as outlined previously. Historical flows and annual peaking factors are provided in Appendix B. The ADWF and AA peaking factors in Table 1-10 are the average of the four peaking factors (one peaking factor is calculated for each year). For the MM, MW, and MD peaking factors in the Table 1-10, the second highest value of the four year data set was used as opposed to the highest (or maximum) value. The second highest value was selected because the highest value was not believed to be representative of actual conditions. Despite the use of adjusted influent flows and the removal of data outliers, the MM, MW, and MD peaking factors varied over the four year period, with three of the four values being comparable and one of the four values being significantly higher than the other three. For this reason, the second highest peaking factor was determined to be representative of actual conditions.

Table 1-10. Projected Flows at Pinole/Hercules WPCP

Condition	Peaking Factor	Projected Flow (mgd)
ADWF	1.00	4.06
AA	1.11	4.51
MM	1.48	6.00
MW	2.20	8.94
MD	2.79	11.33
PWWF (peak hour)	--	20.00
Minimum Flow	0.43	1.75

(a) MM, MW, and MD peaking factors are the second highest value of the four year data set. The ADWF and AA are the average of the four year data set.

(b) Historical flows are provided in Appendix B.

Diurnal Flow

The diurnal flow pattern and peaking factor is critical for hydraulic design. A typical diurnal flow pattern is provided in Appendix C. WPCP records the daily minimum flow during the 2008-2011 time period; the arithmetic average minimum flow is 1.31 mgd. The diurnal peaking factor is calculated by dividing the average minimum flow by the ADWF. Using this methodology the diurnal peaking factor was calculated to be approximately 0.43 (1.31 mgd divided by 3.03 mgd). A diurnal peaking factor of 0.43 will be used.

Loads

The peaking factors for loads are calculated using the same methodologies presented for flows. The ADWF values for 2008-2011 are taken from the average dry weather flow periods, highlighted in Table 1-7 and Table 1-8 averaging periods for MW and MD are the maximum values for the 2008-2011 time-frame. As with the flows, Table 1-11 and Table 1-12 present the projected AA, MM, MW, and MD loads and peaking factors for BOD and TSS respectively. Historical loads and annual peaking factors are provided in Appendix D.

Table 1-11. Projected BOD Loads

Condition	Peaking Factor	Projected Load (lbs/day)
ADWF	1.00	10,500
AA	1.03	10,830
MM(a)	1.18	12,340
MW(a)	1.45	15,190
MD(a)	1.77	18,630

(a) MM, MW, and MD peaking factors are the second highest value of the four year data se. The ADWF and AA are the average of the four year data set.

(b) Historical loads are provided in Appendix D.

Table 1-12. Projected TSS Loads

Condition	Peaking Factor	Projected Load (lbs/day)
ADWF	1.00	10,500
AA	1.09	11,410
MM(a)	1.27	13,290
MW(a)	1.93	20,290
MD(a)	2.48	26,020

(a) MM, MW, and MD peaking factors are the second highest value of the four year data se. The ADWF and AA are the average of the four year data set.

(b) Historical loads are provided in Appendix D.

Projected Concentrations

The projected BOD and TSS loads are used in conjunction with the ADWF, AA, MM, and MW flows to calculate BOD and TSS concentrations for each averaging period. The result is a concentration that is more dilute as flow increases. The equation used to calculate average day annual concentration is as follows.

$$2030\ Concentration = \frac{ADWL\ \times (AA{:}\ ADWL\ Peaking\ Factor)}{2030\ ADWF\ \times (AA{:}\ ADWF\ Peaking\ Factor) \times 8.34}$$

Table 1-13. Projected BOD Concentrations

Condition	Projected Flow		Projected BOD Load		BOD Conc.
	Peaking Factor	mgd	Peaking Factor	lbs/d	mg/L
ADWF	1.00	4.06	1.00	10,500	310
AA	1.11	4.51	1.03	10,830	288
MM	1.48	6.00	1.18	12,340	247
MW	2.20	8.94	1.45	15,190	204
MD	2.79	11.33	1.77	18,630	197

Table 1-14. Projected TSS Concentrations

Condition	Projected Flow		Projected TSS Load		TSS Concentration
	Peaking Factor	mgd	Peaking Factor	lb/d	mg/L
ADWF	1.00	4.06	1.00	10,500	310
AA	1.11	4.51	1.09	11,410	303
MM	1.48	6.00	1.27	13,290	266
MW	2.20	8.94	1.93	20,290	272
MD	2.79	11.33	2.48	26,020	275

Nutrients

Earlier NPDES permits did not require monitoring of nutrients (i.e., ammonia, TKN, nitrate, nitrite or phosphorus). As a result, there is minimal data available to evaluate these constituents. Effluent ammonia monitoring is performed on a monthly basis and effluent ammonia is plotted in Figure 1-4. The WPCP's new permit includes concentration based limits for ammonia, however the limits are such that at this time ammonia removal is not required. Nutrient concentrations play a considerable role in the design of the activated sludge system and disinfection process selection. For this reason as well as consideration for future permit conditions (e.g., tighter regulations on ammonia), ammonia removal is considered in the secondary treatment upgrades. The evaluation of this will be presented in subsequent TMs.

In 2004 Brown and Caldwell conducted wastewater characterization sampling of the WPCP influent, primary effluent, and secondary effluent over a one-week period. TKN was measured in the primary effluent and secondary effluent. Nitrate and nitrite were measured in the secondary effluent. The one-week sample period did not provide sufficient data for analysis of nitrogen loads and transformation within the treatment system. Therefore, this data will not be used for design criteria. In late August 2009, influent ammonia and TKN samples were collected over a two-week period. The results are presented in Figure 1-5. The average influent TKN is approximately 46 milligrams as nitrogen per liter (mg-N/L) and the average influent ammonia concentration is approximately 31 mg N/L. The data suggests approximately 30 percent of the influent nitrogen is organic.

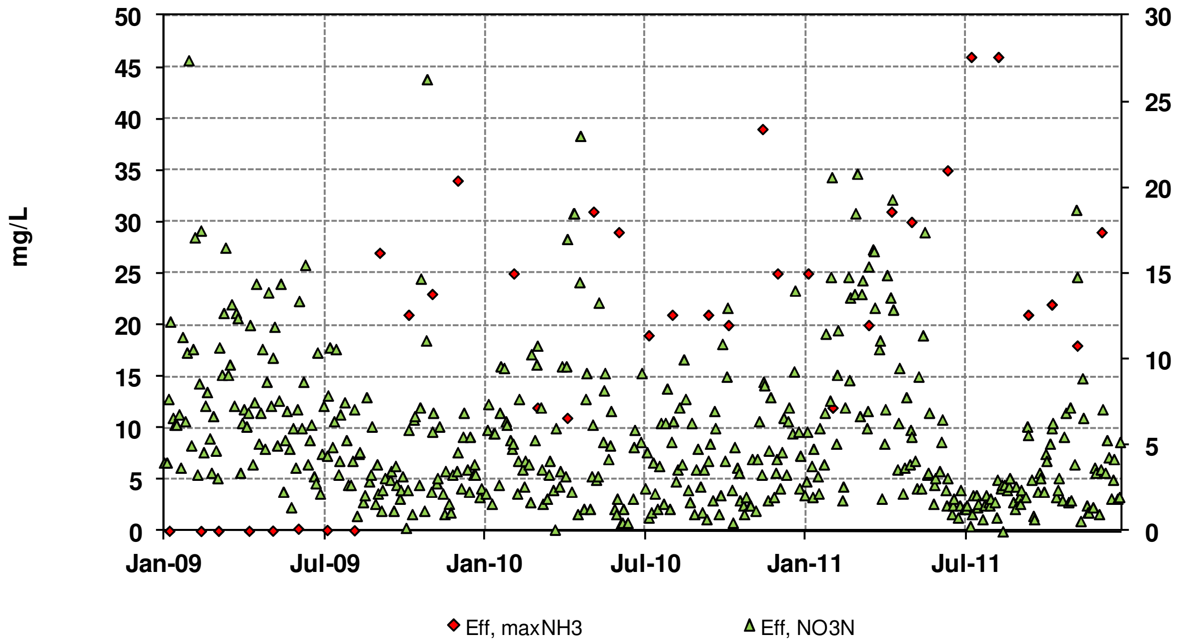


Figure 1-4. Effluent Ammonia and Nitrate Concentrations

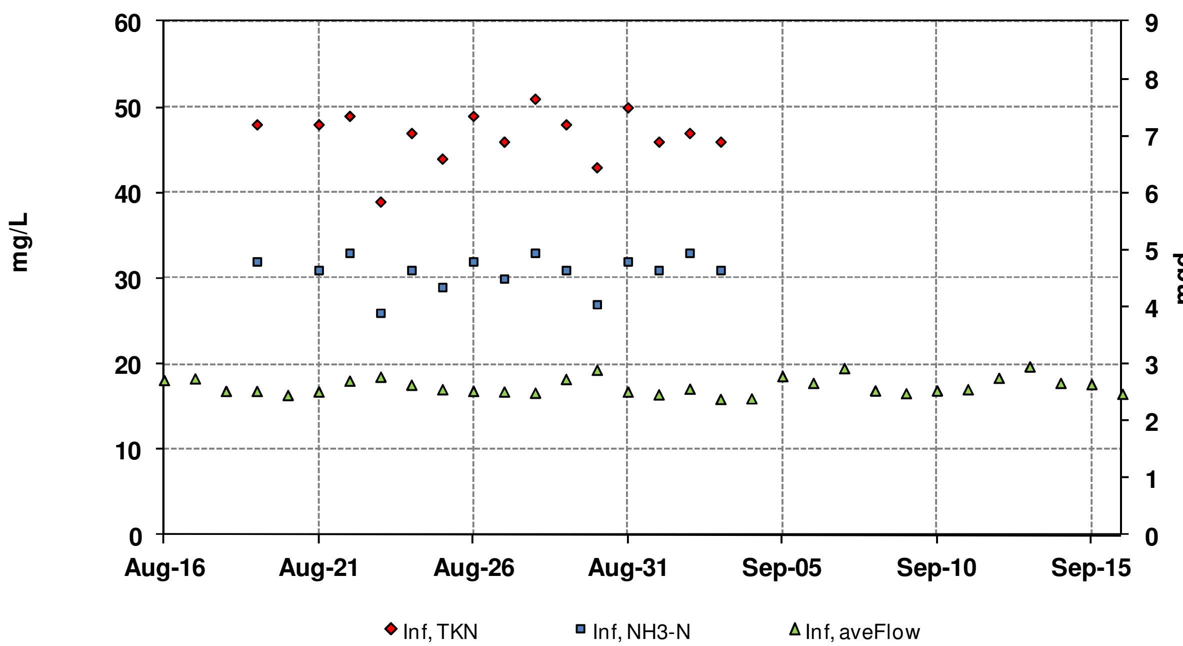


Figure 1-5. Ammonia and TKN Concentrations August 2009

Temperature

Temperature affects the growth rate of nitrifying bacteria, and how quickly these bacteria can convert ammonia to nitrate. Thus, temperature plays a significant role in the design and efficiency of biological removal systems. Selection of a biological nutrient removal system will be further evaluated in subsequent TMs.

Figure 1-6 plots the seasonal temperature variations over the historical data set. In the winter effluent temperatures average around 18 degrees Celsius (°C) and in the summer they average around 25°C.

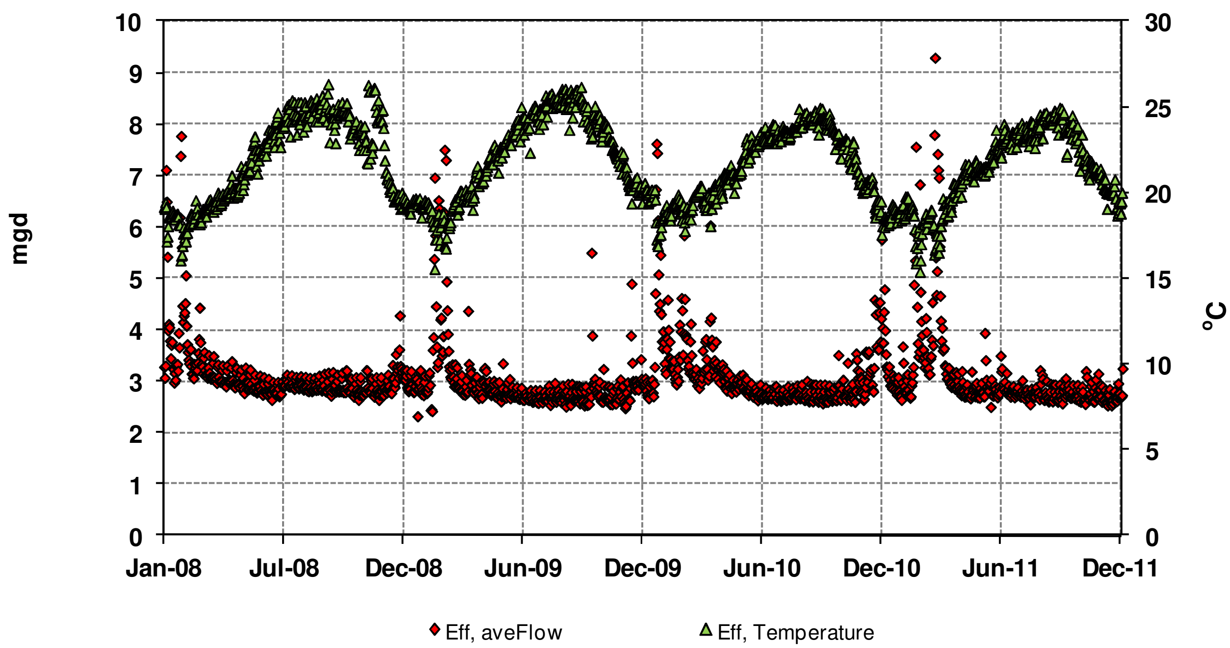


Figure 1-6. Seasonal Effluent Temperature Variation

Summary of Projected Flows and Wastewater Characteristics

Annual average flows and loads were projected based on future population and historic per capita flow and loading rates. To estimate MM and MD loads, peaking factors were applied. The load peaking factors were calculated using historical flows and loads as described in previous sections.

Table 1-15 presents a summary of current and projected flows and loads. Calculations showing the methodology for these flow and load projections are presented in the previous sections and following appendices. The ADWF, AA, and MM flows and loads will be used as the design basis for the majority of treatment facilities. The peak hour flows will be used as design basis for the WPCP headworks and pumping equipment, and flow equalization basins.

Table 1-15. Summary of Projected Flows and Loads

Condition	Flow (mgd)	Influent Concentrations (mg/L)		Influent Loads (lbs/d)	
		BOD	TSS	BOD	TSS
ADWF	4.06	310	310	10,500	10,500
AA	4.51	288	303	10,830	11,410
MM	6.09	242	261	12,300	13,260
MW	8.94	204	272	15,190	20,290
MD	11.33	197	275	18,630	26,020
PWWF	20.00	--	--	--	--
Minimum Flow	1.75	--	--	--	--

Appendix A. Flows and Loads Revision

APPENDIX A. FLOWS & LOADS REVISIONS

Pinole/Hercules WPCP ***August 30, 2012***

Reviewed by: Mallika Ramanathan, P.E., Michael Falk, Ph.D., P.E.

Prepared by: Jennifer Shore, E.I.T.

Flows and Loads Calculations

Flows and loads have been revised based on comments received at the Predesign Workshop on August 14, 2012. This document summarizes modifications made to the analysis and the resulting flow and load projections for the predesign effort.

The following steps were taken to update the flows and loads and remove outliers from the data set.

1) The Pinole/Hercules Water Pollution Control Plant (WPCP) Staff provided a series of dates where total suspended solids (TSS) data was considered inaccurate. The outliers occurred when the combined influent TSS load (collected at point D in Figure A-1) was greater than the sum of the individual TSS loads of Hercules and Pinole wastewaters ($TSS_{combined} > TSS_{Hercules} + TSS_{Pinole}$).

2) Biological oxygen demand (BOD):TSS ratios were reviewed to identify other outlier data. The typical BOD:TSS ratio for domestic wastewater is approximately 1. Data with a BOD:TSS ratio equal to or greater than 1.5 were categorized as outliers.

3) WPCP staff indicated that the influent flow provided in the data set is believed to be inaccurate. The City of Pinole's flow meter provides inaccurate measurements due to back flow in the gravity line during low flow/dry weather conditions. The City of Hercules flow measurements are accurate. WPCP staff currently use effluent flow measurements (point D in Figure A-1) to determine daily treated flows, loads into the WPCP and the flow contribution from the City of Pinole. WPCP staff recommended that HDR use effluent flow data for load calculations.

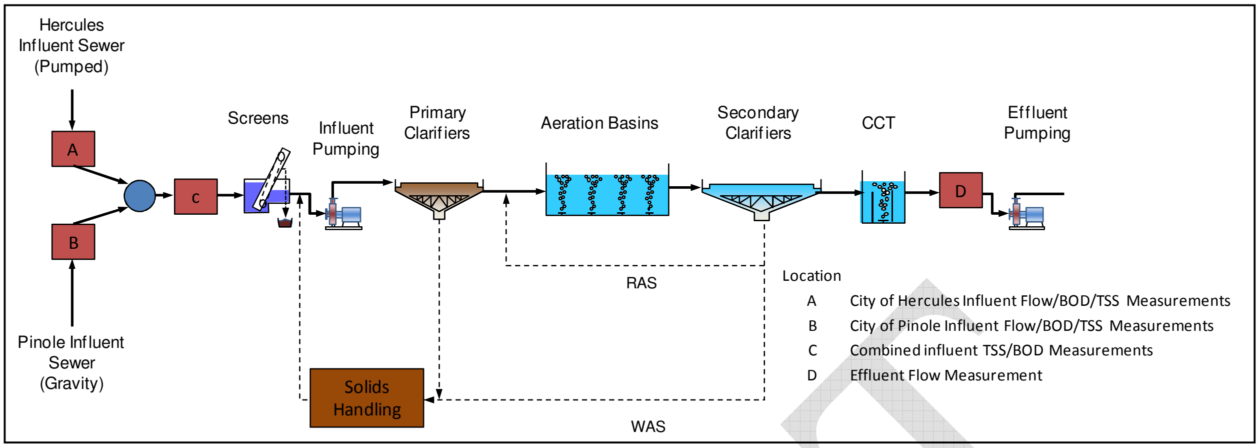


Figure A-1. WPCP Flow, BOD, and TSS Measurement Locations

Based on this information, HDR evaluated the influent and effluent flow data in more detail. Figure A-2 provides the average daily measurements for influent and effluent flow from 2008 through 2011. Influent flow measurements were consistently higher than effluent flow measurements. This may be due to flow dampening through the treatment process. From May through July 2010, influent flow measurements were observed to be significantly higher than in previous years and significantly higher than effluent flow measurements. Effluent flow measurements from May through July 2010 appear to be consistent with the effluent flow measurements taken in 2008, 2009, and 2011. It was determined that influent flow measurements from May through July 2010 are potential data outliers.

The following approach was taken to address (1) the difference between influent and effluent flow measurements that are likely the result of flow dampening, and (2) the May through July 2010 time period where influent flow measurements were categorized as outliers:

a. The influent: effluent flow ratio was calculated for using average daily flow measurements collected in 2008, 2009, and 2011. The influent: effluent flow ratio was determined to be 1.10. Because flow measurements collected in 2010 contained outliers, the 2010 data set was not included in the ratio calculation.

b. Adjusted influent flows were calculated by applying the influent: effluent ratio to the average daily effluent flow measurement for the entire data set (2008 through 2011). The adjusted influent flows were used to calculate loading to the treatment facility.

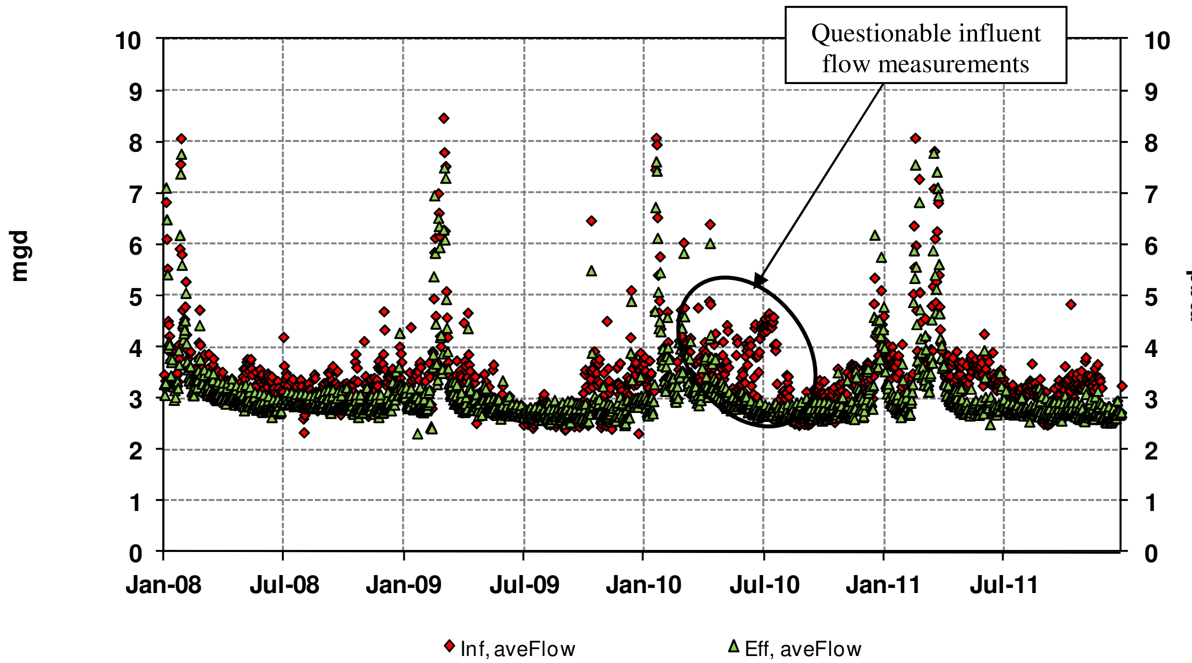


Figure A-2. Pinole/Hercules WPCP Influent and Effluent Flows

Peaking Factors

After making the modifications to the data set, peaking factors for existing flows and loads were calculated using the calendar approach described in the TM[7]. Peaking factors for flow, BOD, and TSS are provided in Tables A-1, A-2, and A-3 respectively. The projected flows and loads from the 2007 Brown & Caldwell Technical Memorandum and the 2009 Dodson-Psomas Facilities Plan are provided for comparison.

Peaking factors for average dry weather flow (ADWF), average annual (AA), maximum month (MM), maximum week (MW), and maximum day (MD) flows and loads are calculated for each calendar year. The ADWF and AA peaking factors in Tables A-1 through A-3 are the average of the four peaking factors (one peaking factor is calculated for each year). For the MM, MW and MD peaking factors in Tables A-1 through A-3, the second highest value of the four year data set was used as opposed to the highest (or maximum) value. The second highest value was selected because the highest value was not believed to be representative of actual conditions. Despite the use of adjusted influent flows and the removal of data outliers, the MM, MW and MD peaking factors varied over the four year period, with three of the four values being comparable and one of the four values being significantly higher than the other three. For this reason, the second highest peaking factor was determined to be representative of actual conditions.

[7] DRAFT TM 1-Flows and Loads, submitted August 8th 2012.

Table A-1. Projected Flows at Pinole/Hercules WPCP

Condition	2012 Predesign Flow		2007 Alternative Evaluation[8]		2009 Facilities Plan[9]
	Peaking Factors	Flow Projection (mgd)	Peaking Factors	Flow Projection (mgd)	Flow Projection (mgd)
Average Dry Weather Flow	1.00	4.06	1.00	4.1	4.06
Average Annual Flow	1.11	4.51	--	--	--
Maximum Month Flow (a)	1.48	6.00	1.59	6.5	--
Maximum Week Flow (a)	2.20	8.94	2.02	8.3	--
Maximum Day Flow(a)	2.79	11.33	2.95	12.1	14.60
Peak Wet Weather Flow	--	20.00	20.20	--	20.00
Minimum Flow	0.43	1.75	--	--	--

(a) MM, MW, and MD peaking factors are the second highest value of the four year data set. The ADWF and AA are the average of the four year data set.

"--" represent values not provided in reference reports.

Table A-2. Projected BOD Loads

Condition	2012 Predesign BOD Load		2007 Alternative Evaluation[8]		2009 Facilities Plan[9]
	Peaking Factors	Load Projection (lbs/day)	Peaking Factors	Load Projection (lbs/day)	Load Projection (lbs/day)
Average Dry Weather Flow	1.00	10,500	1.00	11,200	11,000
Average Annual Flow	1.03	10,830			--
Maximum Month Flow(a)	1.18	12,340	1.30	14,600	--
Maximum Week Flow(a)	1.45	15,190			--
Maximum Day Flow(a)	1.77	18,630	1.50	16,800	--

a) MM, MW, and MD peaking factors are the second highest value of the four year data set. The ADWF and AA are the average of the four year data set.

"--" represent values not provided in reference reports.

[8] 2007 Technical Memorandum 7 Pinole-Hercules Wastewater Treatment Plant Expansion Alternatives Evaluation Brown and Caldwell, June 4, 2007.

[9] 2009 Dodson-Psomas Facilities Plan

Table A-3. Projected TSS Loads

Condition	2012 Predesign TSS Load		2007 Alternative Evaluation[8]		2009 Facilities Plan[9]
	Peaking Factors	Load Projection (lbs/day)	Peaking Factors	Load Projection (lbs/day)	Load Projection (lbs/day)
Average Dry Weather Flow	1.00	10,500	1.00	12,800	12,500
Average Annual Flow	1.09	11,410		12,800	--
Maximum Month Flow[(a)]	1.27	13,290	1.30	16,600	--
Maximum Week Flow[(a)]	1.93	20,290			--
Maximum Day Flow[(a)]	2.48	26,020	1.50	19,100	--

a) MM, MW, and MD peaking factors are the second highest value of the four year data set. The ADWF and AA are the average of the four year data set.

"--" represent values not provided in reference reports.

ADWF load projections presented in Tables A-2 and A-3 are based on a per capita loading of 0.21 pounds per capita per day (lbs/capita/day) for both BOD and TSS. These values are based on historical data collected, removal of outliers, and population based analysis. The projected flows and loads correspond to an ADWF concentration of 310 milligrams per liter (mg/L) for BOD and TSS. This concentration is slightly higher than the historical ADWF concentrations of 306 mg/L for BOD, and 304 mg/L for TSS. For comparison, the 2007 Alternative Evaluation load projections are based on the industry standard per capita loading of 0.22 lbs/capita/day and 0.25 lbs/capita/day for BOD and TSS respectively. These loads correspond to an ADWF concentration of 328 mg/L BOD and 374 mg/L TSS. The 2007 Alternative Evaluation loads provided in Tables A-2 and A-3 are higher than the ADWF, AA, and MM developed by HDR. This may be attributed to the use of more recent and reliable data collected from the WPCP and analysis of the flow measurement errors in the HDR projections.

The 2030 projected MD loads are higher than previous studies and higher than typical peaking factors for residential communities. The MD loads were reviewed in more detail and the higher loads may be attributable to a "first flush" event. Based on rainfall data, the MD events were observed to occur after the first significant rain event of the year or after a significant dry period when solids settled in the collection system.

Discussions with WPCP Staff indicated that after the first significant rain event of the year, a considerable amount of grit and solids enter the WPCP from the collection system. Thus, the higher loads to the WPCP appear to be reflective of actual conditions and not data errors. Figure A-3 provides the TSS load and the measured rainfall for 2009. As indicated on the graph there was a large mass of solids brought to the WPCP during the first major rain event of the year (October 13, 2009).

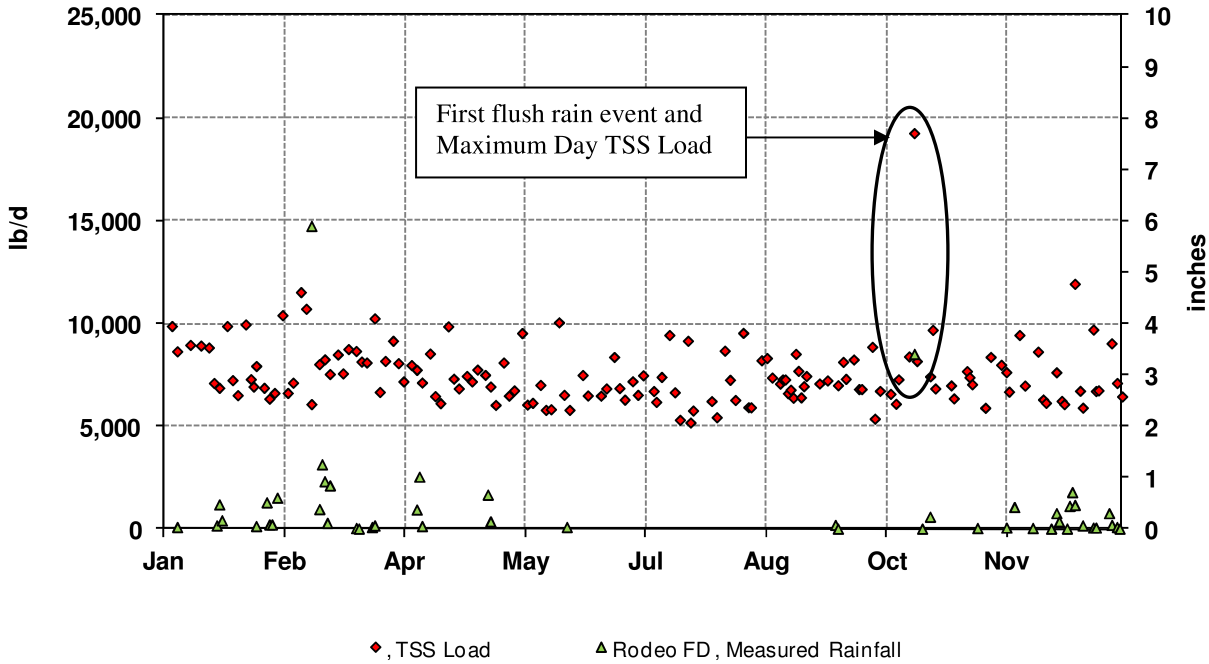


Figure A-3. 2009 Influent TSS Load (lb/d) and Rainfall (in)

Table A-4 provides the revised flows and loads that will be used to model the future WPCP. The ADWF, AA, and MM loads will be used to design the majority of the treatment facilities including the biological system. The MD and peak wet weather flows (PWWF) are used as the design basis for the WPCP headworks, pumping equipment, and flow equalization basin.

Table A-5. Summary of Projected Flows and Loads

Condition	Flow (mgd)	Influent Concentrations (mg/L)		Influent Loads (lbs/day)	
		BOD	TSS	BOD	TSS
Average Dry Weather Flow	4.06	310	310	10,500	10,500
Average Annual Flow	4.51	288	303	10,830	11,410
Maximum Month Flow	6.09	242	261	12,300	13,260
Maximum Week Flow	8.94	204	272	15,190	20,290
Maximum Day Flow	11.33	197	275	18,630	26,020
Peak Wet Weather Flow	20.00	--	--	--	--
Minimum Flow	1.75	--	--	--	--

Appendix B. Annual Flows and Peaking Factors

Table B - 1. 2008-2011Influent Flows (mgd)

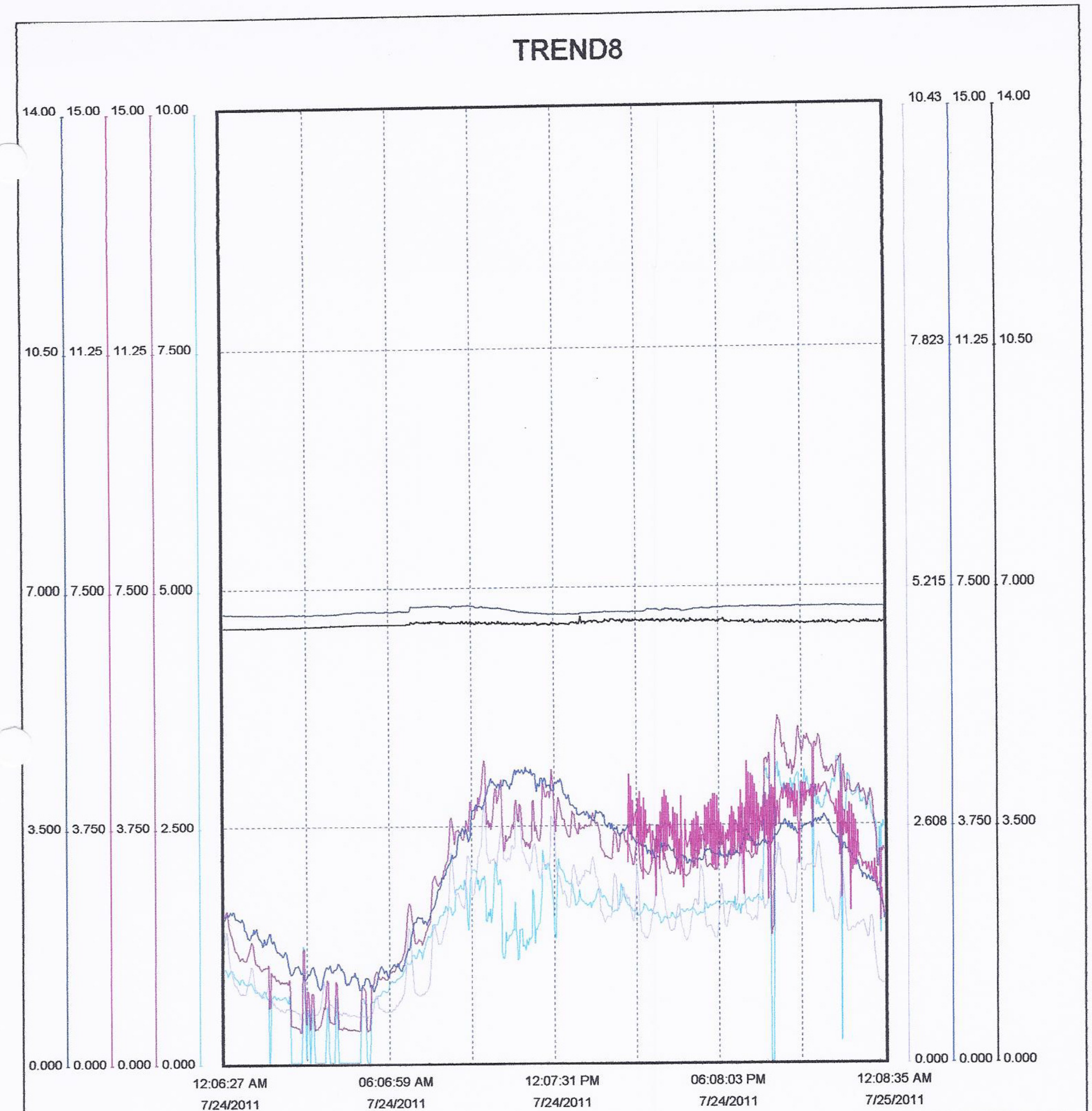
Year	ADWF	AA	MM	MW	MD
2008	3.15	3.41	4.66	6.24	8.52
2009	2.96	3.27	4.25	6.33	8.22
2010	2.99	3.43	4.27	6.59	8.35
2011	3.02	3.37	5.04	7.33	10.18

Table B - 2. 2008-2011 Flow Peaking Factors

Year	ADWF/ADWF	AA/ADWF	MM/ADWF(a)	MW/ADWF(a)	MD/ADWF(a)
2008	1.00	1.08	1.48	1.98	2.70
2009	1.00	1.10	1.43	2.14	2.77
2010	1.00	1.15	1.43	2.20	2.79
2011	1.00	1.12	1.67	2.43	3.37
Peaking Factors	1.00	1.11	1.48	2.20	2.79

(a) MM, MW, and MD peaking factors are the second highest value of the four year data set. The ADWF and AA are the average of the four year data set.

Appendix C. Diurnal Flow Pattern



Legend	Trend Name	Comment	Min.	Max.	Avg.	Min. Scale	Max. Scale	Eng. Units
	PIN_INFL_FLOW		0.002	3.194	1.507	0.000	10.00	MGD
	HERC_FLOW_MEM		0.496	2.818	1.499	0.000	10.43	MGD
	INFLU_FLOW_COMB		0.498	5.444	3.006	0.000	15.00	MGD
	EFFL_FLOW_COMB		1.142	4.664	3.027	0.000	15.00	MGD
	EFFL_FLOW_P		2.301	4.737	3.697	0.000	15.00	HRS
	EFFL_PH		6.444	6.587	6.485	0.000	14.00	FT
	EFFL_PH_2		6.611	6.752	6.673	0.000	14.00	FT

Appendix D. Annual Loads and Peaking Factors

Table D- 1. 2008-2011 Influent BOD Loads (lbs/day)

Year	ADWF	AA	MM	MW	MD
2008	7,930	7,770	8,670	9,600	11,310
2009	7,320	7,590	8,600	10,360	12,990
2010	8,130	8,560	10,450	14,140	15,530
2011	7,780	8,220	8,800	11,260	11,690

Table D - 2. 2008-2011 BOD Peaking Factors

Year	ADWF/ADWF	AA/ADWF	MM/ADWF(a)	MW/ADWF(a)	MD/ADWF(a)
2008	1.00	0.98	1.09	1.21	1.43
2009	1.00	1.04	1.18	1.42	1.77
2010	1.00	1.05	1.29	1.74	1.91
2011	1.00	1.06	1.13	1.45	1.50
Peaking Factor	1.00	1.03	1.18	1.45	1.77

a) MM, MW, and MD peaking factors are the second highest value of the four year data set. The ADWF and AA are the average of the four year data set.

Table D - 3. 2008-2011 Influent TSS Loads (lbs/day)

Year	ADWF	AA	MM	MW	MD
2008	7,790	8,470	9,870	13,000	19,310
2009	7,780	8,270	9,280	15,040	21,120
2010	7,980	8,730	10,910	15,850	16,440
2011	7,340	8,120	9,000	11,350	14,640

Table D - 4. 2008-2011 TSS Peaking Factors

Year	ADWF/ADWF	AA/ADWF	MM/ADWF(a)	MW/ADWF(a)	MD/ADWF(a)
2008	1.00	1.09	1.27	1.67	2.48
2009	1.00	1.06	1.19	1.93	2.71
2010	1.00	1.09	1.37	1.99	2.06
2011	1.00	1.11	1.23	1.55	1.99
Peaking Factor	1.00	1.09	1.27	1.93	2.48

a) MM, MW, and MD peaking factors are the second highest value of the four year data set. The ADWF and AA are the average of the four year data set.