

Potential impacts of City of Morro Bay Collection System Condition on the WRF Project

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Introduction

The poor condition of Morro Bay's sewage collection system has not been adequately considered in the development of capacity requirements for the new WRF. Existing flow levels have been used in WRF design, as stated in the draft document, which says,

“To develop the flows and loads, past studies, historical population, and flow and water quality data at the existing WWTP were used to provide baseline information in addition to further analysis to confirm the numbers. The flows developed in this Chapter do not consider flows from the Cayucos Sanitary District.”

and,

“Historical wastewater data provided by the City was reviewed, along with previous studies and planning work, to confirm design characteristics are consistent with previous estimates. Design flows and loads were developed for the average wet weather daily flow, peak month dry weather flow, peak month wet weather flow, peak day wet weather flow, and peak hour wet weather flow

As will be demonstrated in this document, existing WWTP flow level data is not reliable. At issue are the exfiltration (leaking) of sewage into the soil during dry periods, and infiltration of large amounts of rainwater into the system during wet weather. It is simply not possible to determine how much sewage the existing plant would be processing if the collection system were in good condition.

It has already been proven that Morro Bay's sewage collection system is in very poor condition, and that sewage is leaking from the system into the ground water. In the past, concerned residents have focused primarily on the extensive evidence contained in video inspections that show widespread and severe damage in sewer lines all over the City, and on evidence, in the form of laboratory testing results, that sewage is contaminating Morro Bay's Morro Basin drinking water wells.

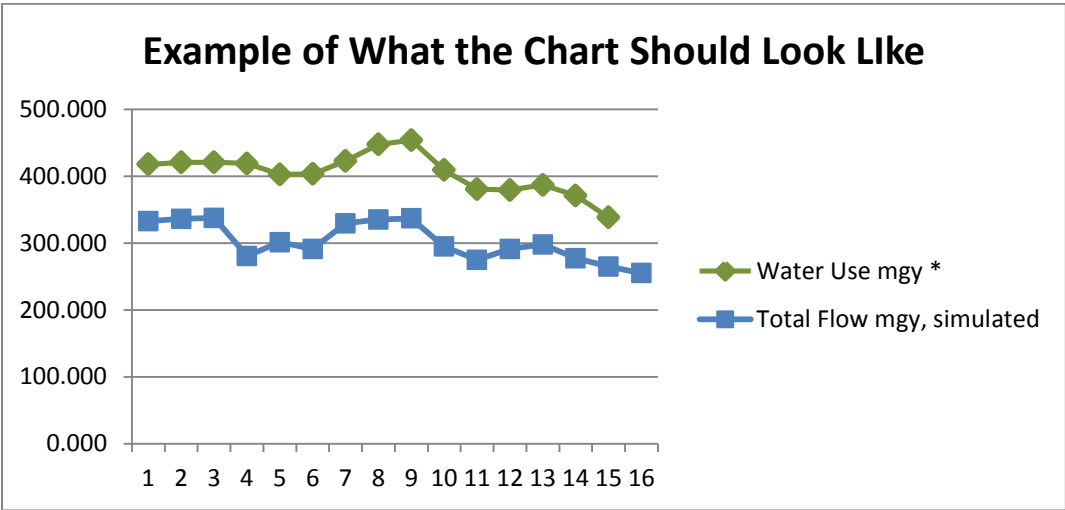
This report focuses on additional evidence including City water use records, wastewater treatment plant (WWTP) flow records, and local rainfall records compiled by the Cal Poly weather station. The data has been compiled and charted to demonstrate how Morro Bay's sewer collection system problems could impact the WRF project.

The evidence presented here demonstrates that is not what is happening. It is clear that WWTP flow data is not a reliable indicator of actual WRF capacity needs.

Wastewater Flows do not Correlate to Water Usage

Were the sewage collection system in good condition, the only water entering it under most conditions should be coming from the users of City water. With the exception of water used for outdoor irrigation and in WWTP processing, water used in the City should go into the collection system and be transported to the WWTP for treatment.

When we map the water use and WWTP flow data on a graph, we SHOULD see something like the graph below. Although the curves would not be expected to match exactly, there should be a close correlation between the annual water use and WWTP flow amounts, and hence a close correlation between the curves on the chart.



* Water sold plus City use/loss. Does not include unaccounted for water loss

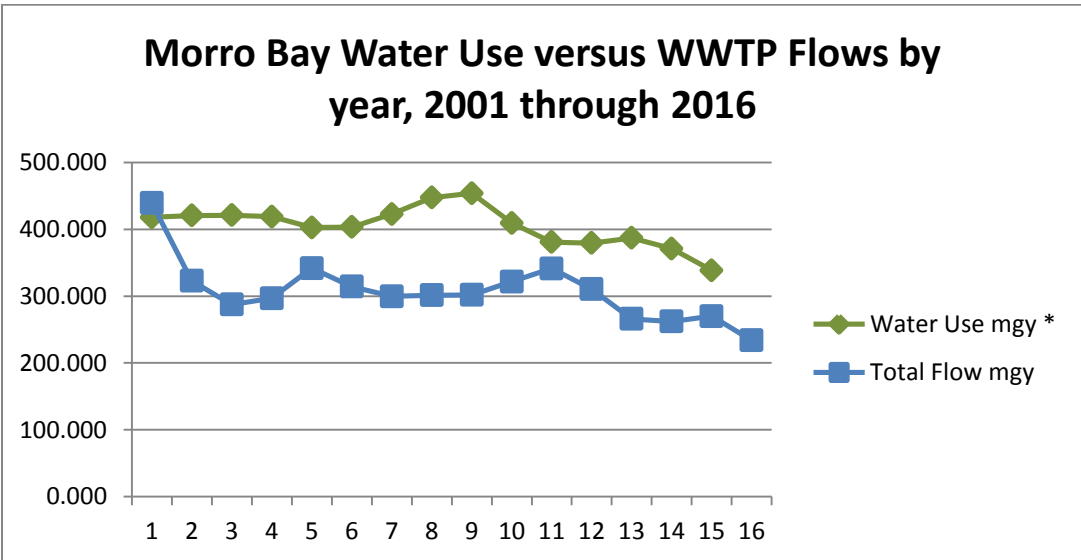
However, that is not the case. Instead of seeing the strong correlation demonstrated above with simulated WWTP flow data, the actual flow data produces a chart that looks very different.

Following is actual City WWTP flow data (Appendix A) and water use data (Appendix B) for the years 2001 through 2016. Water use data was provided in acre feet, and has been converted to gallons.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Water Use mgy *	417.900	420.674	421.000	419.044	402.752	403.469	422.824	447.491	453.956	409.399	380.822	379.421	387.013	371.177	338.461	
Total Flow mgy	439.618	323.01	287.396	296.757	341.959	314.405	299.762	301.478	301.925	321.763	341.435	310.502	265.862	262.097	270.037	233.78

* Water sold plus City use/loss. Does not include unaccounted for water loss

Following is the graph of the data:



* Water sold plus City use/loss. Does not include unaccounted for water loss

The chart shows that something is amiss. The peaks and valleys in the charted lines representing WWTP flows and water usage should match up, but they do not.

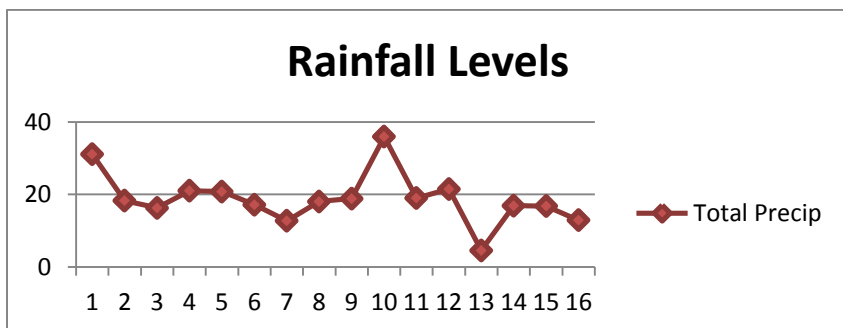
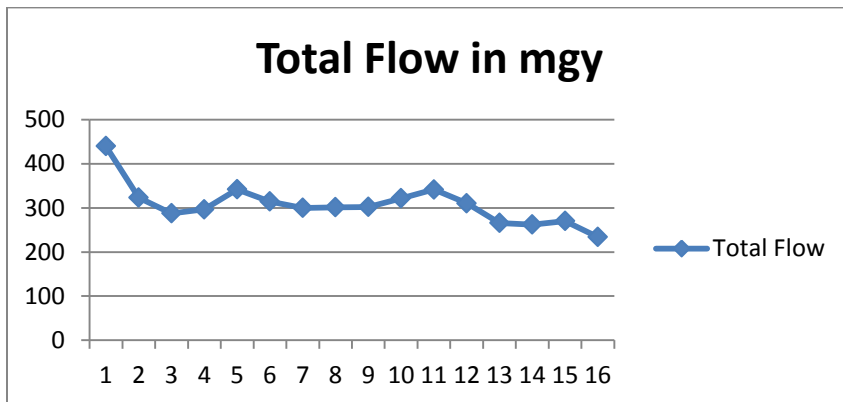
There is no apparent correlation at all between annual water use and WWTP flows. In fact, there seems to be an “inverse correlation”. This mismatch appears to indicate that some additional influence must have a major impact on the WWTP flow levels.

Wastewater Flows do Correlate to Rainfall Levels

Rainfall levels were investigated as a possible explanation for lack of correlation between WWTP flow data and water use data. Cal Poly weather station rainfall for the years 2001 through 2016 was charted, and a strong correlation between the WWTP flows and rainfall data was immediately obvious from the following data.

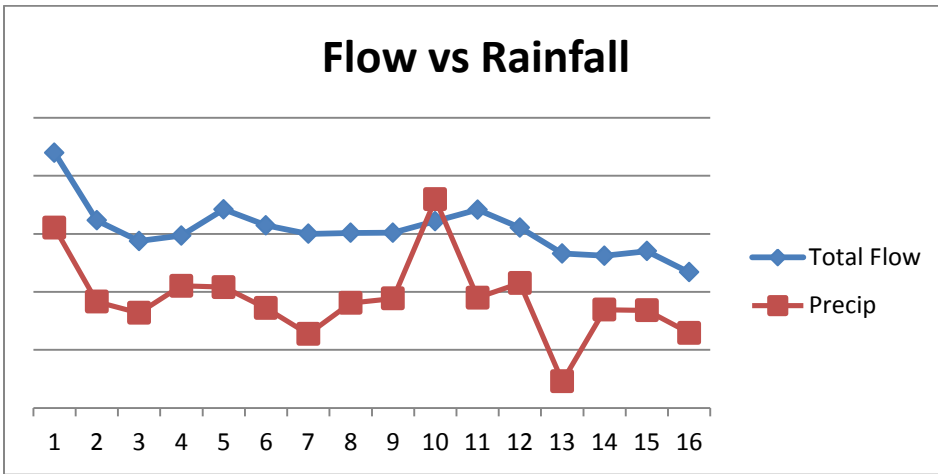
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total Flow in mgy	439.618	323.005	287.396	296.757	341.959	314.405	299.762	301.478	301.925	321.763	341.435	310.502	265.862	262.097	270.037	233.78
Total Rainfall in inches	31.07	18.29	16.316	21.03	20.82	17.19	12.72	18.07	18.85	35.95	18.99	21.51	4.56	16.91	16.8	12.92

Charting the data, we have the following:



Placing both curves on the same chart, we have the following:

Flow vs Rainfall



Note: rainfall Nov.2000 was 5.47; Dec.2000 was 3.03

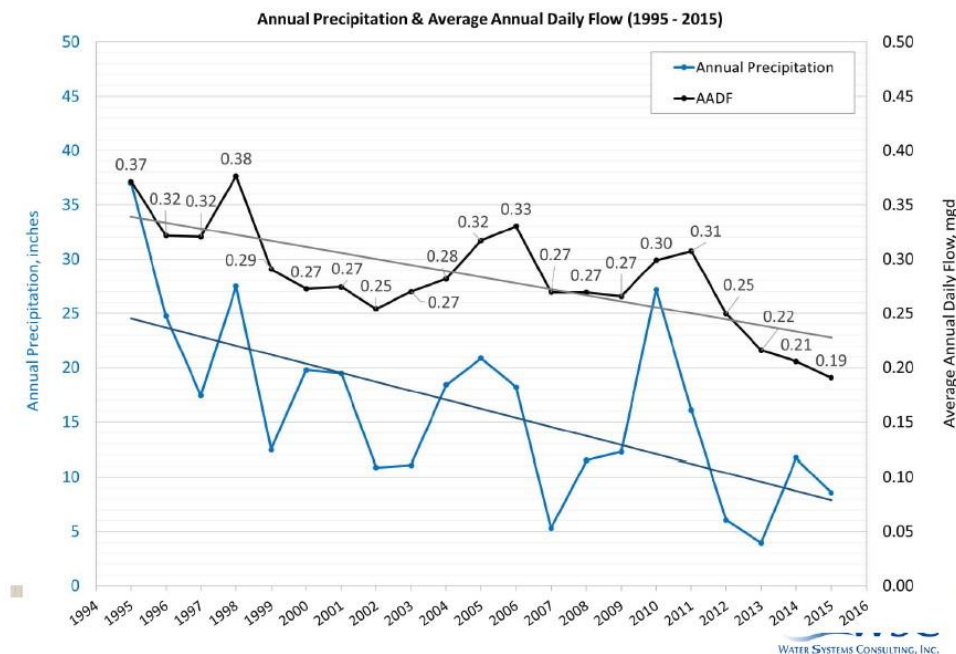
Given the close correspondence between the peaks and valleys in the curves, it appears that the dominant factor influencing WWTP flows is rainfall level.

If rainwater is, in fact, entering the sewer lines during the winter, we should see an increase in rainfall level just before an increase in WWTP flows, as the ground must become saturated in order for infiltration to occur. In fact, that is just what the graph shows.

As demonstrated by the data, the influence of rainfall levels on WWTP flows is so strong that water usage appears to have no influence on those levels at all. When rainfall is up, WWTP flows are up. When rainfall is down, flows are down, regardless of water usage levels.

Interestingly, this same pattern is echoed by data found in a Cayucos Sanitary District document, Cayucos Sustainable Water Project Flows and Loading Update, dated May 19, 2016 (Appendix C).

The following chart from the Cayucos document maps, for the years 1994 through 2016, average daily Cayucos wastewater flows and annual precipitation in inches



Data Suggests Sewer Infiltration and Exfiltration

The data clearly shows that precipitation, not water usage, is the dominant influence on wastewater flows in Morro Bay as well as its neighbor, Cayucos. This is strong evidence that significant infiltration (entry of water into the sewer lines during wet weather) and exfiltration (leaking of sewage from the lines during dry weather) are occurring.

Morro Bay’s sewer system, like that of Cayucos, is known to be in very poor condition. A September, 2007 City of Morro Bay publication, Water and Wastewater News, made the following statements:

“Most of our Collection System is now over 50 years old and is showing it’s age. The vast majority of the system is comprised of vitrified clay piping. A number of pipeline segments are now too small or have cracks, offsets and similar problems. Many of the problems can be attributed to land movement.”

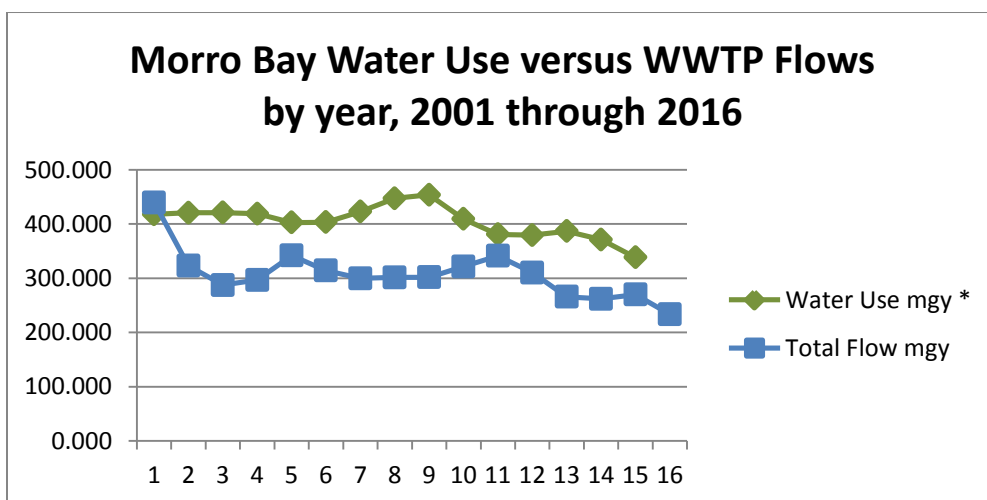
and,
“The Master Plan’s computer model identified a number of sewer pipeline segments as being currently over capacity during highest wet weather flow conditions. The major pipe segment identified in this condition is along Main Street from Vashon to Atascadero Road and on Atascadero Road from Main Street to Park Street. We have started design on the upgrade of this pipeline and plan to construct it in Fall 2008. This is also a costly project but it promises to reduce the risk of raw sewage spills.”

The promised repairs were never made, and recent video inspections of the lines show serious defects throughout the system.

In a January 28, 2014 KQED news article, Peter Bodstrom, of the California Department of Water Resources, was quoted as saying, “There are large variations across the state. Outdoor use could be 25 percent of a household’s use in Santa Cruz and 80 percent is Coachella ... 15 percent of users account for 60 percent of overuse in landscape irrigation.”

In Morro Bay, where the climate is mild, lots are small, and many residents do not have lawns, it seems reasonable to assume that the percent of water used outdoors would be on the lower end of the scale, closer to 25%, and it may be significantly less given current watering restrictions.

Returning to the data for water use versus WWTP flows for the years 2001 through 2016, it is clear that the differences between water usage and flows are inconsistent over the years, and that the inconsistencies appear to be driven by rainfall levels, which means that infiltration and exfiltration are occurring.



* Water sold plus City use/loss. Does not include unaccounted for water loss

For example, as the data shows, in 2001, when there was significant winter rainfall, the total flow measured at the WWTP was greater than the amount of water used in the City. This is a sign of infiltration of ground water into the damaged sewer lines after the soil became saturated.

Under these conditions, Morro Bay residents don't just pay for the treatment of sewage. They also pay for the unnecessary treatment of ground water that has gotten into the sewer lines.

The data also shows that sewage is leaking out of the system. For example, 2009 was preceded by several other dry years, ensuring that the soil around nearly all of Morro Bay's sewer lines would be very dry.

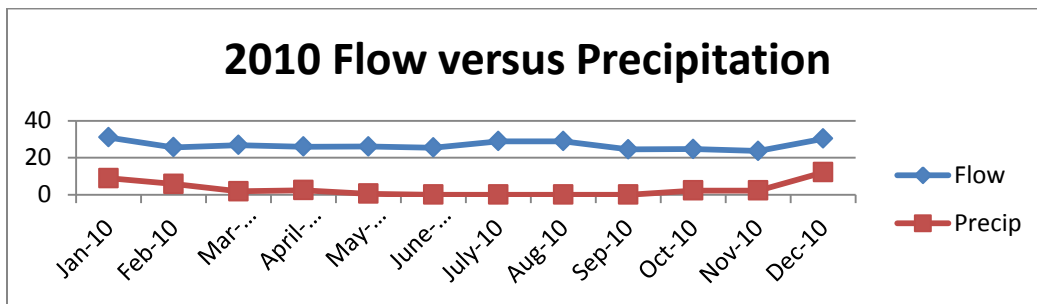
Water use in 2009 was 453.956 mg, and the WWTP total flow was 301.925 mg. The difference between the two, 152.031mg, is 33% of total water use. This is more than would be expected, and a likely indicator of leaking of sewage into the soil, as it is highly unlikely that in Morro Bay, outside watering could account for that amount.

Further evidence of infiltration and exfiltration in Morro Bay sewer lines is found in monthly WWTP data. This evidence takes the form of anomalies in the timing of peak WWTP flows.

We would expect WWTP flows to peak significantly during the summer when thousands of tourists cause a major increase in water usage, and to drop noticeably in winter when there are significantly fewer water users in town. However, that is not what the data shows.

For eight of the years from 2001 through 2016, (2001, 2002, 2004, 2005, 2006, 2010, 2011, and 2016) the highest flows were in winter, providing further evidence of the strong influence of precipitation on flow levels.

The effect of precipitation levels on expected summer season peaks in WWTP flows is illustrated by this chart for 2010. In 2010, the highest flow levels were in January and December. They should have occurred in summer.



While outdoor irrigation would expect to reduce summer WWTP flows somewhat, since irrigation water would not enter the sewer system, Morro Bay has a temperate climate and has been in prolonged draught. During recent years, outdoor irrigation has been necessary in both summer and winter. For that reason, while outdoor irrigation would be expected to be a factor in WWTP flow levels, it would not likely be a major one.

This leaves rainfall levels as the primary influence on both yearly and monthly WWTP flows, indicating that infiltration and exfiltration are occurring and demonstrating that historical WWTP flow data cannot be relied upon in estimating flows for the new WRF.

Cayucos Reporting not Adequately Verified

A final factor potentially impacting the reliability of WWTP flow data is Morro Bay's dependence on Cayucos to determine Morro Bay's flow levels. Morro Bay's flow is determined by taking the total flow into the WWTP, and subtracting Cayucos flow as reported by Cayucos. Morro Bay does not manage and control the flow meters at lift station 5 at the northern border of Morro Bay. That is left to Cayucos.

If the metering is incorrect, calculated Morro Bay flow levels are incorrect. Inaccurate flow data would impact not only WRF capacity calculations, but also the amount that Morro Bay ratepayers are charged.

Appendices

Appendix A. Sewer flow data obtained from City of Morro Bay

**MORRO BAY/CAYUCOS WWTP FLOW DATA
2001 - 2013**

MONTH	TOTAL FLOW		CAYUCOS			MORRO BAY			Cayucos Monthly Flow Data		Morro Bay Flow Data
	Total Flow	Daily Flow	Total Flow	Daily Flow	%	Total Flow	Daily Flow	%	# of days	Dates	# of days
2001											
JAN	51.655	1.666	8.554	0.285	16.6%	43.101	1.390	83.4%	30	Jan 2 - Jan 31, 2001	31
FEB	52.291	1.868	10.385	0.358	19.9%	41.906	1.497	80.1%	29	Feb 1 - Mar 1, 2001	28
MAR	54.222	1.749	10.496	0.328	19.4%	43.726	1.411	80.6%	32	Mar 1 - Apr 2, 2001	31
APR	49.298	1.643	8.142	0.271	16.5%	41.157	1.372	83.5%	30	Apr 2 - May 1, 2001	30
MAY	46.178	1.490	7.772	0.251	16.8%	38.406	1.239	83.2%	31	May 1 - May 31, 2001	31
JUNE	47.919	1.597	7.883	0.254	16.5%	40.036	1.335	83.5%	31	June 1 - July 2, 2001	30
JULY	47.691	1.538	8.372	0.262	17.6%	39.320	1.268	82.4%	32	July 2 - Aug 1, 2001	31
AUG	38.810	1.252	8.497	0.250	21.9%	30.313	0.978	78.1%	34	Aug 1 - Sept 4, 2001	31
SEPT	34.239	1.141	7.440	0.276	21.7%	26.799	0.893	78.3%	27	Sept 5 - Oct 1, 2001	30
OCT	37.196	1.200	6.426	0.214	17.3%	30.770	0.993	82.7%	30	Oct 2 - Oct 31, 2001	31
NOV	38.746	1.292	9.069	0.275	23.4%	29.677	0.989	76.6%	33	Nov 1 - Dec 3, 2001	30
DEC	41.305	1.332	6.888	0.238	16.7%	34.417	1.110	83.3%	29	Dec 4 - Jan 1, 2002	31
ANNUAL AVERAGES	44.963	1.481	8.327	0.272	18.7%	36.636	1.206	81.3%			
2002											
JAN	43.448	1.402	7.373	0.246	17.0%	36.076	1.164	83.0%	30	Jan 2 - Feb 1, 2002	31
FEB	38.307	1.368	6.670	0.238	17.4%	31.637	1.130	82.6%	28	Feb 1 - Feb 28, 2002	28
MAR	40.070	1.293	7.457	0.233	18.6%	32.614	1.052	81.4%	32	Feb 28 - Mar 31, 2002	31
APR	38.761	1.292	6.840	0.228	17.6%	31.921	1.064	82.4%	30	Apr 1 - Apr 30, 2002	30
MAY	34.410	1.110	7.249	0.234	21.1%	27.161	0.876	78.9%	31	May 1 - May 31, 2002	31
JUNE	33.275	1.109	7.588	0.253	22.8%	25.687	0.856	77.2%	30	June 1 - June 30, 2002	30
JULY	35.539	1.146	10.619	0.343	29.9%	24.920	0.804	70.1%	31	July 1 - July 31, 2002	31
AUG	33.050	1.066	11.091	0.336	33.6%	21.959	0.708	66.4%	33	Aug 1 - Sept 2, 2002	31
SEPT	28.384	0.946	6.596	0.236	23.2%	21.788	0.726	76.8%	28	Sept 3 - Sept 30, 2002	30
OCT	28.965	0.934	5.940	0.192	20.5%	23.025	0.743	79.5%	31	Oct 1 - Oct 31, 2002	31
NOV	28.794	0.960	7.018	0.226	24.4%	21.776	0.726	75.6%	31	Nov 1 - Dec 2, 2002	30
DEC	32.916	1.062	8.475	0.292	25.7%	24.441	0.788	74.3%	29	Dec 2 - Dec 31, 2002	31
ANNUAL AVERAGES	34.660	1.141	7.743	0.255	22.7%	26.917	0.886	77.3%			
2003											
JAN	31.464	1.015	8.105	0.261	25.8%	23.359	0.754	74.2%	31	Dec 31 - Jan 31, 2003	31
FEB	28.362	1.013	8.149	0.291	28.7%	20.214	0.722	71.3%	28	Feb 1 - Feb 28, 2003	28
MAR	32.922	1.062	6.967	0.225	21.2%	25.955	0.837	78.8%	31	Mar 1 - Mar 31, 2003	31
APR	31.136	1.038	6.674	0.222	21.4%	24.462	0.815	78.6%	30	Apr 1 - Apr 30, 2003	30
MAY	32.735	1.056	9.023	0.291	27.6%	23.712	0.765	72.4%	31	May 1 - 31, 2003	31
JUNE	33.029	1.101	8.282	0.276	25.1%	24.747	0.825	74.9%	30	June 1 - June 30, 2003	30
JULY	37.784	1.219	10.375	0.335	27.5%	27.409	0.884	72.5%	31	July 1 - July 31, 2003	31
AUG	36.679	1.183	9.941	0.321	27.1%	26.738	0.863	72.9%	31	Aug 1 - Aug 31, 2003	31
SEPT	30.236	1.008	7.275	0.242	24.1%	22.961	0.765	75.9%	30	Sept 1 - Sept 30, 2003	30
OCT	29.875	0.964	7.170	0.231	24.0%	22.705	0.732	76.0%	31	Oct 1 - Oct 31, 2003	31
NOV	29.718	0.991	7.792	0.260	26.2%	21.926	0.731	73.8%	30	Nov 1 - Nov 30, 2003	30
DEC	32.036	1.033	8.828	0.285	27.6%	23.208	0.749	72.4%	31	Dec 1 - Dec 31, 2003	31
ANNUAL AVERAGES	32.165	1.057	8.215	0.270	25.5%	23.950	0.787	74.5%			
2004											
JAN	32.400	1.045	8.738	0.282	27.0%	23.662	0.763	73.0%	31	Jan 1 - Jan 31, 2004	31
FEB	33.827	1.166	8.838	0.305	26.1%	24.989	0.862	73.9%	29	Feb 1 - Feb 29, 2004	29

**MORRO BAY/CAYUCOS WWTP FLOW DATA
2001 - 2013**

MONTH	TOTAL FLOW		CAYUCOS			MORRO BAY			Cayucos Monthly Flow Data		Morro Bay Flow Data
MAR	32.849	1.060	8.145	0.263	24.8%	24.705	0.797	75.2%	31	Mar 1 - Mar 31, 2004	31
APR	32.449	1.082	7.657	0.255	23.6%	24.792	0.826	76.4%	30	Apr 1 - Apr 30, 2004	30
MAY	32.358	1.044	7.665	0.247	23.7%	24.693	0.797	76.3%	31	May 1 - 31, 2004	31
JUNE	30.665	1.022	8.212	0.274	26.8%	22.453	0.748	73.2%	30	June 1 - June 30, 2004	30
JULY	36.471	1.176	10.986	0.354	30.1%	25.485	0.822	69.9%	31	July 1 - July 31, 2004	31
AUG	34.896	1.126	9.596	0.310	27.5%	25.300	0.816	72.5%	31	Aug 1 - Aug 31, 2004	31
SEPT	30.717	1.024	7.600	0.253	24.7%	23.117	0.771	75.3%	30	Sept 1 - Sept 30, 2004	30
OCT	33.157	1.070	7.928	0.256	23.9%	25.230	0.814	76.1%	31	Oct 1 - Oct 31, 2004	31
NOV	32.163	1.072	7.372	0.238	22.9%	24.791	0.826	77.1%	31	Nov 1 - Dec 1, 2004	30
DEC	37.980	1.225	10.440	0.326	27.5%	27.540	0.888	72.5%	32	Dec 2 - Jan 2, 2005	31
ANNUAL AVERAGES	33.328	1.093	8.598	0.280	25.7%	24.730	0.811	74.3%			
2005	Total Flow	Daily Flow	Total Flow	Daily Flow	%	Total Flow	Daily Flow	%	# of days	Dates	# of days
JAN	47.517	1.533	13.017	0.449	27.4%	34.500	1.113	72.6%	29	Jan 3 - Jan 31, 2005	31
FEB	41.125	1.469	11.278	0.403	27.4%	29.847	1.066	72.6%	28	Feb 1 - Feb 28, 2005	28
MAR	44.186	1.425	11.325	0.365	25.6%	32.861	1.060	74.4%	31	Mar 1 - Mar 31, 2005	31
APR	36.893	1.230	8.907	0.297	24.1%	27.987	0.933	75.9%	30	Apr 1 - Apr 30, 2005	30
MAY	38.818	1.252	8.467	0.273	21.8%	30.351	0.979	78.2%	31	May 1 - May 31, 2005	31
JUNE	36.365	1.212	9.055	0.302	24.9%	27.310	0.910	75.1%	30	June 1 - June 30, 2005	30
JULY	41.746	1.347	12.045	0.389	28.9%	29.701	0.958	71.1%	31	July 1 - July 31, 2005	31
AUG	38.702	1.248	10.086	0.325	26.1%	28.616	0.923	73.9%	31	Aug 1 - Aug 31, 2005	31
SEPT	34.054	1.135	8.320	0.277	24.4%	25.734	0.858	75.6%	30	Sept 1 - Sept 30, 2005	30
OCT	32.808	1.058	8.166	0.263	24.9%	24.642	0.795	75.1%	31	Oct 1 - Oct 31, 2005	31
NOV	31.626	1.054	7.308	0.244	23.1%	24.318	0.811	76.9%	30	Nov 1 - Nov 30, 2005	30
DEC	33.752	1.089	7.660	0.247	22.7%	26.092	0.842	77.3%	31	Dec 1 - Dec 31, 2005	31
ANNUAL AVERAGES	38.133	1.254	9.636	0.320	25.1%	28.497	0.937	74.9%			
2006	Total Flow	Daily Flow	Total Flow	Daily Flow	%	Total Flow	Daily Flow	%	# of days	Dates	# of days
JAN	38.579	1.244	11.914	0.372	30.9%	26.665	0.860	69.1%	32	Dec 31, 05 - Jan 31, 06	31
FEB	30.543	1.091	7.747	0.277	25.4%	22.796	0.814	74.6%	28	Feb 1 - Feb 28, 2006	28
MAR	40.876	1.319	11.386	0.367	27.9%	29.490	0.951	72.1%	31	Mar 1 - Mar 31, 2006	31
APR	41.715	1.391	13.150	0.438	31.5%	28.565	0.952	68.5%	30	Apr 1 - Apr 30, 2006	30
MAY	39.050	1.260	10.610	0.342	27.2%	28.440	0.917	72.8%	31	May 1 - May 31, 2006	31
JUNE	36.183	1.206	10.126	0.338	28.0%	26.057	0.869	72.0%	30	June 1 - June 30, 2006	30
JULY	41.100	1.326	12.553	0.405	30.5%	28.547	0.921	69.5%	31	July 1 - July 31, 2006	31
AUG	37.466	1.209	10.728	0.346	28.6%	26.738	0.863	71.4%	31	Aug 1 - Aug 31, 2006	31
SEPT	32.873	1.096	8.343	0.278	25.4%	24.530	0.818	74.6%	30	Sept 1 - Sept 30, 2006	30
OCT	32.343	1.043	8.090	0.261	25.0%	24.253	0.782	75.0%	31	Oct 1 - Oct 31, 2006	31
NOV	31.435	1.048	7.918	0.264	25.2%	23.517	0.784	74.8%	30	Nov 1 - Nov 30, 2006	30
DEC	32.993	1.064	8.186	0.264	24.8%	24.807	0.800	75.2%	31	Dec 1 - Dec 31, 2006	31
ANNUAL AVERAGES	36.263	1.191	10.063	0.329	27.5%	26.200	0.861	72.5%			
2007	Total Flow	Daily Flow	Total Flow	Daily Flow	%	Total Flow	Daily Flow	%	# of days	Dates	# of days
JAN	34.779	1.122	7.870	0.262	22.6%	26.909	0.868	77.4%	30	Jan 2 - Jan 31, 2007	31
FEB	32.292	1.153	8.210	0.293	25.4%	24.082	0.860	74.6%	28	Feb 1 - Feb 28, 2007	28
MAR	33.556	1.082	8.208	0.265	24.5%	25.348	0.818	75.5%	31	Mar 1 - Mar 31, 2007	31
APR	33.134	1.104	7.595	0.253	22.9%	25.539	0.851	77.1%	30	Apr 1 - Apr 30, 2007	30
MAY	33.019	1.065	7.693	0.248	23.3%	25.326	0.817	76.7%	31	May 1 - May 31, 2007	31
JUNE	33.694	1.123	8.243	0.275	24.5%	25.451	0.848	75.5%	30	June 1 - June 30, 2007	30

**MORRO BAY/CAYUCOS WWTP FLOW DATA
2001 - 2013**

MONTH	TOTAL FLOW		CAYUCOS			MORRO BAY			Cayucos Monthly Flow Data		Morro Bay Flow Data
JULY	38.686	1.248	10.303	0.332	26.6%	28.383	0.916	73.4%	31	July 1 - July 31, 2007	31
AUG	35.927	1.159	8.608	0.278	24.0%	27.319	0.881	76.0%	31	Aug 1 - Aug 31, 2007	31
SEPT	31.412	1.047	7.931	0.264	25.2%	23.481	0.783	74.8%	30	Sept 1 - Sept 30, 2007	30
OCT	31.070	1.002	7.202	0.232	23.2%	23.868	0.770	76.8%	31	Oct 1 - Oct 31, 2007	31
NOV	29.426	0.981	7.424	0.247	25.2%	22.002	0.733	74.8%	30	Nov 1 - Nov 30, 2007	30
DEC	30.402	0.981	8.348	0.269	27.5%	22.054	0.711	72.5%	31	Dec 1 - Dec 31, 2007	31
ANNUAL AVERAGES	33.116	1.089	8.136	0.268	24.6%	24.980	0.821	75.4%			
2008	Total Flow	Daily Flow	Total Flow	Daily Flow	%	Total Flow	Daily Flow	%	# of days	Dates	# of days
JAN	38.697	1.248	11.592	0.374	30.0%	27.105	0.874	70.0%	31	Jan 1 - Jan 31, 2008	31
FEB	35.276	1.216	9.823	0.339	27.8%	25.453	0.878	72.2%	29	Feb 1 - Feb 29, 2008	29
MAR	34.424	1.110	8.782	0.283	25.5%	25.642	0.827	74.5%	31	Mar 1 - Mar 31, 2008	31
APR	31.865	1.062	7.988	0.266	25.1%	23.877	0.796	74.9%	30	Apr 1 - Apr 30, 2008	30
MAY	32.930	1.062	7.715	0.257	23.4%	25.215	0.813	76.6%	30	May 1 - May 30, 2008	31
JUNE	33.048	1.102	8.311	0.268	25.1%	24.737	0.825	74.9%	31	May 31 - June 30, 2008	30
JULY	37.636	1.214	10.166	0.328	27.0%	27.470	0.886	73.0%	31	July 1 - July 31, 2008	31
AUG	37.089	1.196	9.155	0.295	24.7%	27.934	0.901	75.3%	31	Aug 1 - Aug 31, 2008	31
SEPT	31.884	1.063	6.837	0.228	21.4%	25.047	0.835	78.6%	30	Sep 1 - Sep 30, 2008	30
OCT	30.625	0.988	6.470	0.216	21.1%	24.155	0.779	78.9%	30	Oct 1 - Oct 30, 2008	31
NOV	29.277	0.976	7.333	0.237	25.0%	21.944	0.731	75.0%	31	Oct 31 - Nov 30, 2008	30
DEC	29.988	0.967	7.179	0.232	23.9%	22.809	0.736	76.1%	31	Dec 1 - Dec 31, 2008	31
ANNUAL AVERAGES	33.562	1.100	8.446	0.277	25.0%	25.116	0.823	75.0%			
2009	Total Flow	Daily Flow	Total Flow	Daily Flow	%	Total Flow	Daily Flow	%	# of days	Dates	# of days
JAN	30.468	0.983	7.585	0.237	24.9%	22.883	0.738	75.1%	32	Jan 1 - Feb 1, 2009	31
FEB	33.479	1.196	8.968	0.332	26.8%	24.511	0.875	73.2%	27	Feb 2 - Feb 28, 2009	28
MAR	33.975	1.096	7.973	0.257	23.5%	26.002	0.839	76.5%	31	Mar 1 - March 31, 2009	31
APR	33.841	1.128	7.341	0.245	21.7%	26.500	0.883	78.3%	30	April 1 - April 30, 2009	30
MAY	33.558	1.083	7.495	0.242	22.3%	26.063	0.841	77.7%	31	May 1 - May 31, 2009	31
JUNE	32.980	1.099	7.849	0.262	23.8%	25.131	0.838	76.2%	30	June 1-30, 2009	30
JULY	39.578	1.277	10.034	0.324	25.4%	29.544	0.953	74.6%	31	July 1 - July 31, 2009	31
AUG	35.664	1.150	8.843	0.285	24.8%	26.821	0.865	75.2%	31	Aug 1 - Aug 31, 2009	31
SEPT	30.367	1.012	7.219	0.241	23.8%	23.148	0.772	76.2%	30	Sept 1 - Sept 30, 2009	30
OCT	31.338	1.011	7.873	0.254	25.1%	23.465	0.757	74.9%	31	Oct 1 - Oct 31, 2009	31
NOV	30.237	1.008	7.181	0.239	23.7%	23.056	0.769	76.3%	30	Nov 1 - Nov 30, 2009	30
DEC	33.261	1.073	8.260	0.266	24.8%	25.001	0.806	75.2%	31	Dec 1 - Dec 31, 2009	31
ANNUAL AVERAGES	33.229	1.093	8.052	0.265	24.2%	25.177	0.828	75.8%			
2010	Total Flow	Daily Flow	Total Flow	Daily Flow	%	Total Flow	Daily Flow	%	# of days	Dates	# of days
JAN	42.053	1.357	11.058	0.357	26.3%	30.995	1.000	73.7%	31	Jan 1-Jan 31, 2010	31
FEB	35.432	1.265	9.845	0.352	27.8%	25.587	0.914	72.2%	28	Feb 1-Feb 28, 2010	28
MAR	36.204	1.168	9.396	0.303	26.0%	26.808	0.865	74.0%	31	March 1 - 31, 2010	31
APR	34.481	1.149	8.560	0.285	24.8%	25.921	0.864	75.2%	30	April 1 - April 30, 2010	30
MAY	34.141	1.101	8.059	0.260	23.6%	26.082	0.841	76.4%	31	May 1 - 31, 2010	31
JUNE	33.550	1.118	8.109	0.270	24.2%	25.441	0.848	75.8%	30	June 1-30, 2010	30
JULY	39.626	1.278	10.695	0.345	27.0%	28.931	0.933	73.0%	31	July 1-31, 2010	31
AUG	37.919	1.223	8.993	0.290	23.7%	28.926	0.933	76.3%	31	August 1-31, 2010	31
SEPT	31.984	1.066	7.510	0.250	23.5%	24.474	0.816	76.5%	30	September 1-30, 2010	30
OCT	32.144	1.037	7.490	0.242	23.3%	24.654	0.795	76.7%	31	October 1-31, 2010	31

MORRO BAY/CAYUCOS WWTP FLOW DATA
2001 - 2013

MONTH	TOTAL FLOW		CAYUCOS			MORRO BAY			Cayucos Monthly Flow Data		Morro Bay Flow Data
NOV	31.512	1.050	7.885	0.263	25.0%	23.627	0.788	75.0%	30	November 1-30, 2010	30
DEC	44.378	1.432	14.061	0.454	31.7%	30.317	0.978	68.3%	31	December 1-31, 2010	31
ANNUAL AVERAGES	36.119	1.187	9.305	0.306	25.6%	26.814	0.881	74.4%			
2011	Total Flow	Daily Flow	Total Flow	Daily Flow	%	Total Flow	Daily Flow	%	# of days	Dates	# of days
JAN	42.338	1.366	12.089	0.390	28.6%	30.249	0.976	71.4%	31	Jan 1-Jan 31, 2011	31
FEB	35.600	1.271	9.674	0.346	27.2%	25.926	0.926	72.8%	28	Feb 1-Feb 28, 2011	28
MAR	47.887	1.545	13.770	0.444	28.8%	34.117	1.101	71.2%	31	March 1 - 31, 2011	31
APR	38.937	1.298	9.117	0.304	23.4%	29.820	0.994	76.6%	30	April 1 - April 30, 2011	30
MAY	37.092	1.197	8.704	0.281	23.5%	28.388	0.916	76.5%	31	May 1 - 31, 2011	31
JUNE	37.769	1.259	9.381	0.313	24.8%	28.388	0.946	75.2%	30	June 1-30, 2011	30
JULY	43.654	1.408	11.186	0.361	25.6%	32.468	1.047	74.4%	31	July 1-31, 2011	31
AUG	38.518	1.243	9.080	0.293	23.6%	29.438	0.950	76.4%	31	August 1-31, 2011	31
SEPT	33.263	1.109	7.526	0.251	22.6%	25.737	0.858	77.4%	30	September 1-30, 2011	30
OCT	33.454	1.079	7.597	0.245	22.7%	25.857	0.834	77.3%	31	October 1-31, 2011	31
NOV	33.240	1.108	7.589	0.253	22.8%	25.651	0.855	77.2%	30	November 1-30, 2011	30
DEC	32.378	1.044	6.982	0.225	21.6%	25.396	0.819	78.4%	31	December 1-31, 2011	31
ANNUAL AVERAGES	37.844	1.244	9.391	0.309	24.6%	28.453	0.935	75.4%			
2012	Total Flow	Daily Flow	Total Flow	Daily Flow	%	Total Flow	Daily Flow	%	# of days	Dates	# of days
JAN	34.443	1.111	7.444	0.240	21.6%	26.999	0.871	78.4%	31	Jan 1-Jan 31, 2012	31
FEB	30.478	1.051	6.440	0.222	21.1%	24.038	0.829	78.9%	29	Feb 1-Feb 29, 2012	29
MAR	33.971	1.096	7.711	0.249	22.7%	26.260	0.847	77.3%	31	March 1 - 31, 2012	31
APR	35.523	1.184	8.573	0.286	24.1%	26.950	0.898	75.9%	30	April 1 - April 30, 2012	30
MAY	33.393	1.077	7.390	0.238	22.1%	26.003	0.839	77.9%	31	May 1 - 31, 2012	31
JUNE	40.101	1.337	7.687	0.256	19.2%	32.414	1.080	80.8%	30	June 1-30, 2012	30
JULY	46.989	1.516	9.832	0.317	20.9%	37.157	1.199	79.1%	31	July 1-31, 2012	31
AUG	34.343	1.108	8.191	0.264	23.9%	26.152	0.844	76.1%	31	August 1-31, 2012	31
SEPT	28.167	0.939	6.825	0.228	24.2%	21.342	0.711	75.8%	30	September 1-30, 2012	30
OCT	27.793	0.897	6.788	0.219	24.4%	21.005	0.678	75.6%	31	October 1-31, 2012	31
NOV	26.892	0.896	6.295	0.210	23.4%	20.597	0.687	76.6%	30	November 1-30, 2012	30
DEC	29.608	0.955	8.023	0.259	27.1%	21.585	0.696	72.9%	31	December 1-31, 2012	31
ANNUAL AVERAGES	33.475	1.097	7.600	0.249	22.9%	25.875	0.848	77.1%			
2013	Total Flow	Daily Flow	Total Flow	Daily Flow	%	Total Flow	Daily Flow	%	# of days	Dates	# of days
JAN	31.654	1.021	8.141	0.263	25.7%	23.513	0.758	74.3%	31	Jan 1-Jan 31, 2013	31
FEB	27.890	0.962	6.431	0.222	23.1%	21.459	0.740	76.9%	29	Feb 1-Feb 29, 2013	29
MAR	30.827	0.994	7.341	0.237	23.8%	23.486	0.758	76.2%	31	March 1 - 31, 2013	31
APR	28.201	0.940	7.122	0.237	25.3%	21.079	0.703	74.7%	30	April 1 - April 30, 2013	30
MAY	28.627	0.923	6.310	0.204	22.0%	22.317	0.720	78.0%	31	May 1 - 31, 2013	31
JUNE	29.489	0.983	6.493	0.216	22.0%	22.996	0.767	78.0%	30	June 1-30, 2013	30
JULY	34.606	1.116	10.289	0.332	29.7%	24.317	0.784	70.3%	31	July 1-31, 2013	31
AUG	30.808	0.994	8.119	0.262	26.4%	22.689	0.732	73.6%	31	August 1-31, 2013	31
SEPT	27.756	0.925	6.769	0.226	24.4%	20.987	0.700	75.6%	30	September 1-30, 2013	30
OCT	27.480	0.886	6.529	0.211	23.8%	20.951	0.676	76.2%	31	October 1-31, 2013	31
NOV	27.351	0.912	6.628	0.221	24.2%	20.723	0.691	75.8%	30	November 1-30, 2013	30
DEC	27.685	0.893	6.340	0.205	22.9%	21.345	0.689	77.1%	31	December 1-31, 2013	31

**MORRO BAY/CAYUCOS WWTP FLOW DATA
2001 - 2013**

MONTH	TOTAL FLOW	CAYUCOS	MORRO BAY	Cayucos Monthly Flow Data	Morro Bay Flow Data
ANNUAL AVERAGES	29.365 0.963	7.209 0.236 24.4%	22.155 0.726 75.6%		

MORRO BAY/CAYUCOS WWTP FLOW DATA
2014 - Present

MONTH	TOTAL FLOW		CAYUCOS			MORRO BAY			Cayucos Monthly Flow Data	Morro Bay Flow Data	
ANNUAL AVERAGES	29.365	0.963	7.209	0.236	24.4%	22.155	0.726	75.6%			
2014	Total Flow	Daily Flow	Total Flow	Daily Flow	%	Total Flow	Daily Flow	%	# of days	Dates	# of days
JAN	27.535	0.888	6.380	0.206	23.2%	21.155	0.682	76.8%	31	Jan 1-Jan 31, 2014	31
FEB	25.884	0.893	6.560	0.226	25.3%	19.324	0.666	74.7%	29	Feb 1-Feb 29, 2014	29
MAR	27.825	0.898	7.020	0.226	25.2%	20.805	0.671	74.8%	31	March 1 - 31, 2014	31
APR	27.489	0.916	6.733	0.224	24.5%	20.756	0.692	75.5%	30	April 1 - April 30, 2014	30
MAY	28.532	0.920	6.369	0.205	22.3%	22.163	0.715	77.7%	31	May 1 - 31, 2014	31
JUNE	29.581	0.986	6.520	0.217	22.0%	23.061	0.769	78.0%	30	June 1-30, 2014	30
JULY	34.093	1.100	8.565	0.276	25.1%	25.528	0.823	74.9%	31	July 1-31, 2014	31
AUG	28.821	0.930	6.987	0.225	24.2%	21.834	0.704	75.8%	31	August 1-31, 2014	31
SEPT	25.770	0.859	5.546	0.185	21.5%	20.224	0.674	78.5%	30	September 1-30, 2014	30
OCT	25.543	0.824	5.665	0.183	22.2%	19.878	0.641	77.8%	31	October 1-31, 2014	31
NOV	28.042	0.935	5.728	0.191	20.4%	22.314	0.744	79.6%	30	November 1-30, 2014	30
DEC	32.795	1.058	7.740	0.250	23.6%	25.055	0.808	76.4%	31	December 1-31, 2014	31
ANNUAL AVERAGES	28.493	0.934	6.651	0.218	23.3%	21.841	0.716	76.7%			
2015	Total Flow	Daily Flow	Total Flow	Daily Flow	%	Total Flow	Daily Flow	%	# of days	Dates	# of days
JAN	30.242	0.976	6.137	0.198	20.3%	24.105	0.778	79.7%	31	Jan 1-Jan 31, 2015	31
FEB	27.533	0.949	5.758	0.199	20.9%	21.775	0.751	79.1%	29	Feb 1-Feb 29, 2015	29
MAR	29.511	0.952	5.808	0.187	19.7%	23.703	0.765	80.3%	31	March 1 - 31, 2015	31
APR	28.041	0.935	5.554	0.185	19.8%	22.487	0.750	80.2%	30	April 1 - April 30, 2015	30
MAY	28.553	0.921	5.575	0.180	19.5%	22.978	0.741	80.5%	31	May 1 - 31, 2015	31
JUNE	29.205	0.974	5.656	0.189	19.4%	23.549	0.785	80.6%	30	June 1-30, 2015	30
JULY	33.870	1.093	7.618	0.246	22.5%	26.252	0.847	77.5%	31	July 1-31, 2015	31
AUG	29.979	0.967	6.339	0.204	21.1%	23.640	0.763	78.9%	31	August 1-31, 2015	31
SEPT	27.044	0.901	5.235	0.175	19.4%	21.809	0.727	80.6%	30	September 1-30, 2015	30
OCT	26.832	0.866	5.156	0.166	19.2%	21.676	0.699	80.8%	31	October 1-31, 2015	31
NOV	25.476	0.849	5.516	0.184	21.7%	19.960	0.665	78.3%	30	November 1-30, 2015	30
DEC	23.560	0.760	5.457	0.176	23.2%	18.103	0.584	76.8%	31	December 1-31, 2015	31
ANNUAL AVERAGES	28.321	0.929	5.817	0.191	20.6%	22.503	0.738	79.4%			

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MORRO BAY/CAYUCOS WWTP FLOW DATA
2014 - Present

MONTH	TOTAL FLOW		CAYUCOS			MORRO BAY			Cayucos Monthly Flow Data		Morro Bay Flow Data
	Total Flow	Daily Flow	Total Flow	Daily Flow	%	Total Flow	Daily Flow	%	# of days	Dates	# of days
2016											
JAN	27.828	0.898	7.494	0.242	26.9%	20.334	0.656	73.1%	31	Jan 1-Jan 31, 2016	31
FEB	24.218	0.835	5.874	0.203	24.3%	18.344	0.633	75.7%	29	Feb 1-Feb 29, 2016	29
MAR	30.707	0.991	8.434	0.272	27.5%	22.273	0.718	72.5%	31	March 1 - 31, 2016	31
APR	24.330	0.811	6.039	0.201	24.8%	18.291	0.610	75.2%	30	April 1 - April 30, 2016	30
MAY	24.630	0.795	6.281	0.203	25.5%	18.349	0.592	74.5%	31	May 1 - 31, 2016	31
JUNE	25.016	0.834	6.689	0.223	26.7%	18.327	0.611	73.3%	30	June 1-30, 2016	30
JULY	28.570	0.922	8.529	0.275	29.9%	20.041	0.646	70.1%	31	July 1-31, 2016	31
AUG	25.386	0.819	6.618	0.213	26.1%	18.768	0.605	73.9%	31	August 1-31, 2016	31
SEPT	22.731	0.758	6.003	0.200	26.4%	16.728	0.558	73.6%	30	September 1-30, 2016	30
OCT	23.699	0.764	6.081	0.196	25.7%	17.618	0.568	74.3%	31	October 1-31, 2016	31
NOV	23.462	0.782	6.439	0.215	27.4%	17.023	0.567	72.6%	30	November 1-30, 2016	30
DEC	27.684	0.893		0.000	0.0%	27.684	0.893	100.0%	31	December 1-31, 2016	31
ANNUAL AVERAGES	25.688	0.842	6.207	0.204	24.3%	19.482	0.638	75.7%			
2017											
JAN		0.000		0.000	#DIV/0!	0.000	0.000	#DIV/0!	31	Jan 1-Jan 31, 2016	31
FEB		0.000		0.000	#DIV/0!	0.000	0.000	#DIV/0!	29	Feb 1-Feb 29, 2016	29
MAR		0.000		0.000	#DIV/0!	0.000	0.000	#DIV/0!	31	March 1 - 31, 2016	31
APR		0.000		0.000	#DIV/0!	0.000	0.000	#DIV/0!	30	April 1 - April 30, 2016	30
MAY		0.000		0.000	#DIV/0!	0.000	0.000	#DIV/0!	31	May 1 - 31, 2016	31
JUNE		0.000		0.000	#DIV/0!	0.000	0.000	#DIV/0!	30	June 1-30, 2016	30
JULY		0.000		0.000	#DIV/0!	0.000	0.000	#DIV/0!	31	July 1-31, 2016	31
AUG		0.000		0.000	#DIV/0!	0.000	0.000	#DIV/0!	31	August 1-31, 2016	31
SEPT		0.000		0.000	#DIV/0!	0.000	0.000	#DIV/0!	30	September 1-30, 2016	30
OCT		0.000		0.000	#DIV/0!	0.000	0.000	#DIV/0!	31	October 1-31, 2016	31
NOV		0.000		0.000	#DIV/0!	0.000	0.000	#DIV/0!	30	November 1-30, 2016	30
DEC		0.000		0.000	#DIV/0!	0.000	0.000	#DIV/0!	31	December 1-31, 2016	31
ANNUAL AVERAGES	0.000	0.000	0.000	0.000	#DIV/0!	0.000	0.000	#DIV/0!			

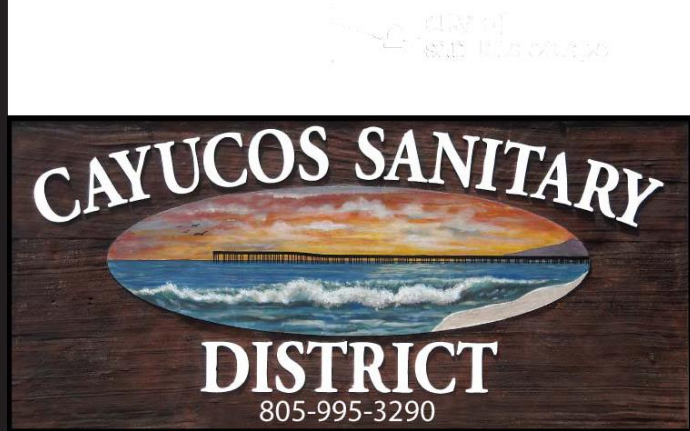
Appendix B. Annual Water Usage data obtained from City of Morro Bay

Year	Water Produced Ac/Ft	Water Sold Ac/Ft	Difference Ac/Ft	City Water Use/Loss Ac/Ft	Unaccounted for Water Loss Ac/Ft	Percent of Production
1985	1690	1411	280	73	207	12.2%
1986	1610	1330	281	69	212	13.1%
1987	1655	1370	259	70	189	11.4%
1988	1641	1386	255	71	184	11.2%
1989	1559	1343	216	47	170	10.9%
1990	1527	1249	279	47	232	15.2%
1991	1256	1008	248	45	203	16.2%
1992	1319	1068	250	36	215	16.3%
1993	1391	1178	213	0.8	213	15.3%
1994	1414	1194	220	33	187	13.2%
1995	1418	1173	245	60	184	13.0%
1996	1501	1194	307	33	274	18.2%
1997	1535	1247	288	49	239	15.6%
1998	1326	1131	195	17	178	13.4%
1999	1393	1185	208	17	191	13.7%
2000	1400	1206	194	27	167	11.9%
2001	1410	1251	159	29	130	9.2%
2002	1453	1267	186	24	162	11.2%
2003	1428	1267	162	25	137	9.6%
2004	1477	1260	217	26	192	13.0%
2005	1362	1214	147	22	125	9.2%
2006	1371	1219	152	19.2	133	9.7%
2007	1410	1276	135	21.6	113	8.0%
2008	1386	1306	80	67.3	13	0.9%
2009	1373	1253	120	84.9	35	2.5%
2010	1252	1255	-3	1.4	-5	-0.4%
2011	1243	1167	76	1.7	74	6.0%
2012	1204	1163	40.97	1.4	39.57	3.3%
2013	1273	1186	86.93	1.7	85.23	6.7%
2014	1181	1137	44.23	2.1	42.13	3.6%
2015	1088	1037	51	1.7	49.3	4.6%



Cayucos Sustainable Water Project

Flows and Loading Update



May 19, 2016

Annual Precipitation & Average Annual Daily Flow (1995 - 2015)

