APPENDIX A

DETERMINATION OF ESTIMATED VOLUME OF UNTREATED SEWAGE DISCHARGED

INTRODUCTION

As part of the Water Board's investigation for the December 19-20, 2010 sewer overflow (hereafter, December 2010 sewer overflow), Water Board staff conducted a detailed technical analysis of the information submitted by the Discharger to determine the adequacy of the Discharger's Methodologies employed for estimating the total volume of untreated sewage discharged, including the Discharger's final preferred Hydraulic Grade Line (HGL) methodology submitted to the Water Boards for this investigation.

Water Board staff have determined that the HGL methodology is inappropriate and unreliable for estimating the total volume of untreated sewage discharged for the December 2010 sewer overflow primarily for the following reasons:

1. Due to localized flooding conditions and the inherent "open" collection system design, all possible locations where sewage could have escaped the collection system are unknown (e.g., sewer backflow prevention devices designed to allow sewage to escape the collection, other openings unable to be observed during localized flooding, etc.). In addition, six sewer backups into residential homes were reported by the Discharger, supporting evidence of the inappropriateness of the HGL Methodology assuming all overflow points were accounted for during and after the December 2010 sewer overflow.

2. The Discharger failed to appropriately apply the cited industry guidelines recommending that individual collection agencies should "establish and utilize your agency's approved standardized templates, tables, and or pictures[1] to estimate the SSO volume discharged." Instead, the Discharger relied on the "example" flow rates and reference pictures included in the industry guidelines in applying the HGL Methodology to estimate the final overflow volume of the December 2010 sewer overflow. Numerous unknown and assumed site-specific information including manhole structural characteristics such as cover geometry, weight, installed grade, etc., were not considered by the Discharger in use of its HGL Methodology, rendering the results of the HGL Methodology inappropriate, inaccurate and unreliable.

This appendix provides the methods and details Water Board staff used in estimating the December 2010 sewer overflow.

[1] See section 5(iv)(E)(1) [page 22] and Appendix D (pages 45-51) of "Best Practices for Sanitary Sewer Overflow Prevention and Response Plan," published by CWEA http://www.cwea.org/members/publications/SSORP-CWEA.pdf

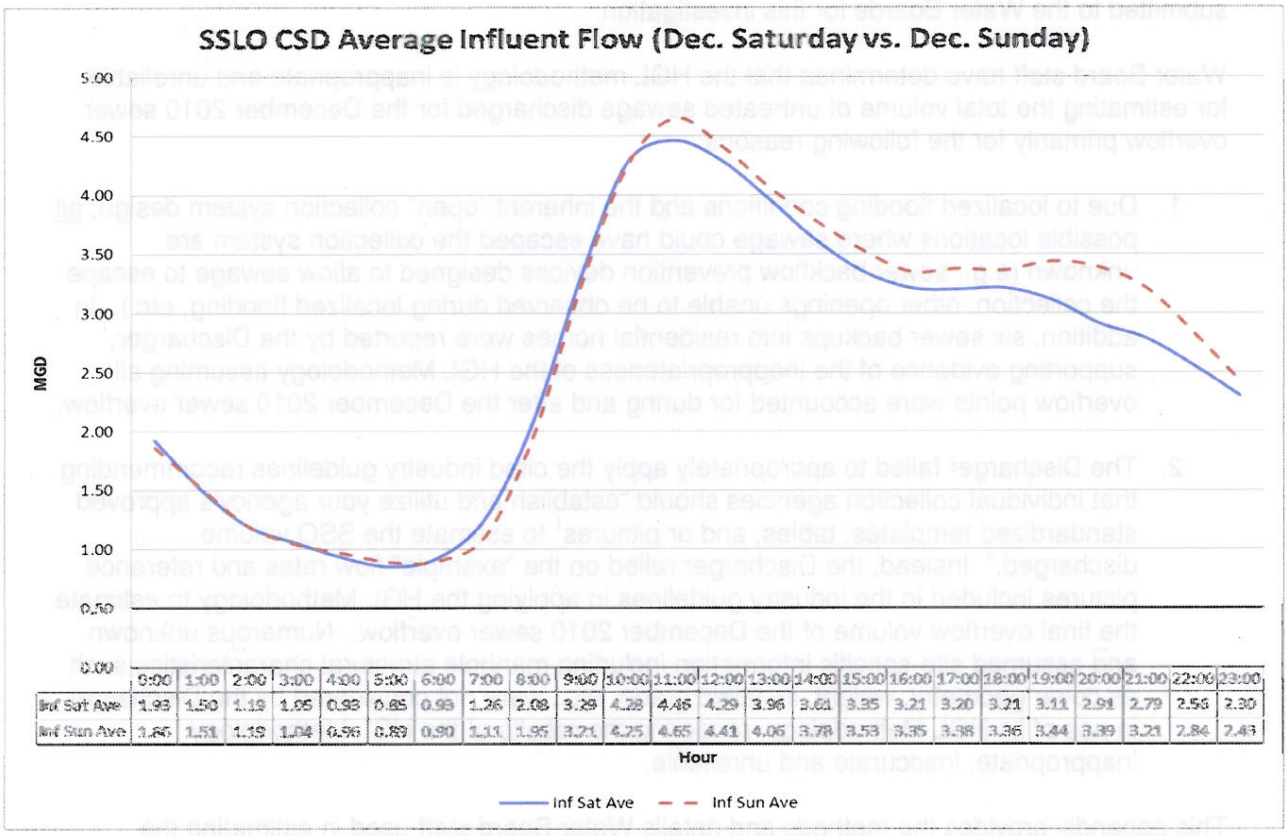
METHODS

On August 29, 2011, the Discharger provided flow data from the influent flow meter for December 2008-2010 and monthly effluent flow data for 2008-2011.

Dry weather flow

Hourly diurnal flow variations typically impact operational performance of unit operations in wastewater treatment plants and therefore provide critical information (e.g., peaking factors) for unit operation designs. The flow variations also provide information on the characteristics of existing collection system (e.g., collection system parameters such as, average flow vs. population, industrial discharge, inflow/infiltration).

Based on the historical influent flow data for the month of December, Water Board staff compared the hourly average diurnal flow variations of the plant during dry weather weekends (Saturday versus Sunday) using monitored flow data for years 2008-2009. The following graph shows the hourly average flow variations for both days:



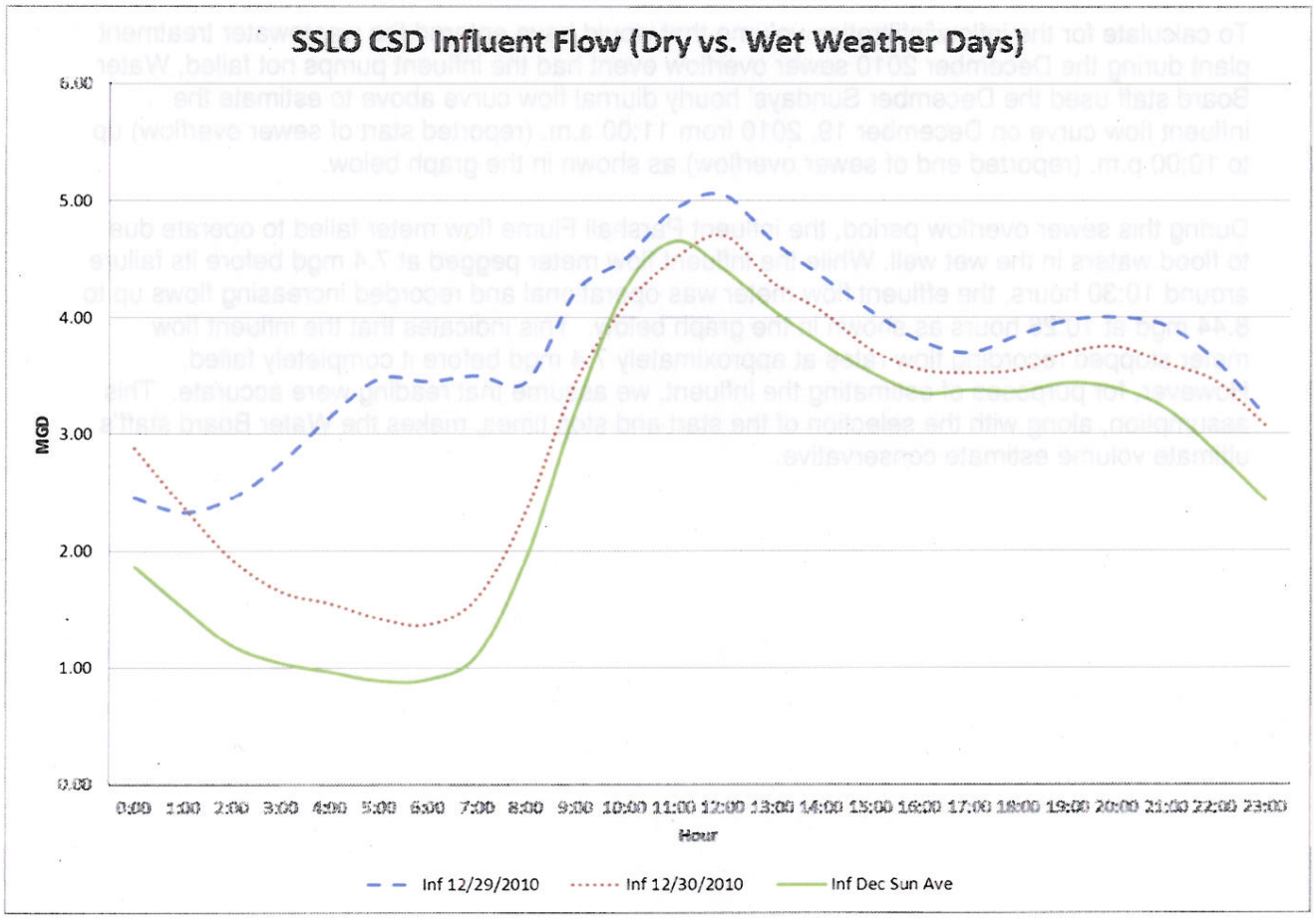
	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Inf Sat Ave	1.93	1.50	1.19	1.05	0.93	0.85	0.93	1.26	2.08	3.29	4.28	4.46	4.29	3.96	3.61	3.35	3.21	3.20	3.21	3.11	2.91	2.79	2.55	2.30
Inf Sun Ave	1.86	1.51	1.19	1.04	0.96	0.89	0.90	1.11	1.95	3.21	4.25	4.65	4.41	4.06	3.78	3.53	3.35	3.38	3.36	3.44	3.39	3.21	2.84	2.43

The hourly diurnal flow variations for Sunday correlate well with the Saturday flow curve, with both days having peak flows around 11:00-12:00 a.m. A slight flow increase on Sunday afternoon is observed, possibly due from recreational and/or social activities (e.g., restaurants and bars, special events, tourism) within the Discharger's service area.

Wet weather flow

Since the December 2010 sewer overflow event occurred on a wet-weather day, Water Board staff also examined if comparable flow pattern exists during wet-weather days by using the available influent flow data for wet-weather days on December 29, 2010 and December 30, 2010. Both days registered rain amounts that subjected the wastewater treatment plant to increased flows due to inflow/infiltration.

The graphical presentation below shows an initial wide variation in influent flow pattern during the early morning hours of the wet-weather days as compared to the average dry-weather day due mainly to inflow/infiltration. However, the wet-weather flow pattern for both wet days replicates similar downward flow pattern from its peak flow at noon towards midnight, which is also similar to the average dry-weather flow curve. This comparison also suggests that the unit operations at the plant respond similarly for both dry and wet weather days.



Since the sewer overflow event on December 19, 2010, occurred from peak flows around 11:00 a.m. through 10:00 p.m., the hourly average diurnal flow variations on a dry weather day can be used to estimate the December 2010 sewer overflow discharge volume.

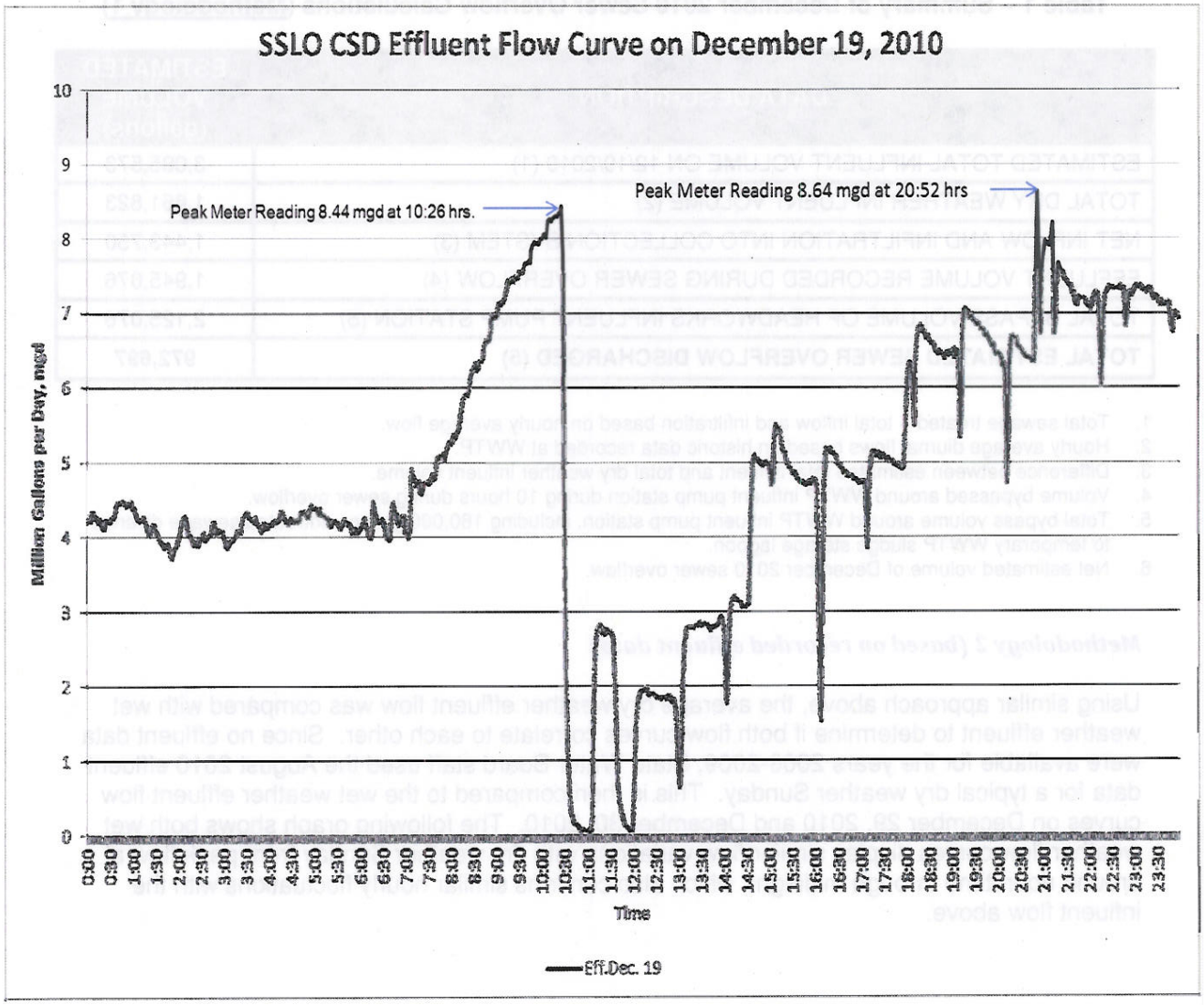
According to the Discharger's August 13, 2011 inflow/infiltration technical report, the inflow/infiltration flow at the plant ranged from 0.5 million gallons per day (mgd) to 3.6 mgd depending mainly on the intensity and duration of precipitation and existing groundwater conditions within its service basin. Additional graphical comparison of dry and wet weather flows is presented in Figure 2 on page 20 of the Discharger's inflow/infiltration technical report and shows comparable flow curves from peak flows at noon through midnight. Furthermore, the Discharger's inflow/infiltration technical report states that in evaluating flow monitoring data for inflow/infiltration response to rain events, there is no linear correlation between rainfall depth and inflow/infiltration volume/flow in its collection system (page 20).

To determine the estimated volume discharged from the Discharger's collection system during the December 2010 sewer overflow, Water Board staff relied on available historical electronic telemetry data recorded at the Discharger's WWTP and the Discharger's information submitted on May 31, 2011 (response to the NOV/13267 letter),

Methodology 1 (based on recorded influent data)

To calculate for the inflow/infiltration volume that would have entered the wastewater treatment plant during the December 2010 sewer overflow event had the influent pumps not failed, Water Board staff used the December Sundays' hourly diurnal flow curve above to estimate the influent flow curve on December 19, 2010 from 11:00 a.m. (reported start of sewer overflow) up to 10:00 p.m. (reported end of sewer overflow) as shown in the graph below.

During this sewer overflow period, the influent Parshall Flume flow meter failed to operate due to flood waters in the wet well. While the influent flow meter pegged at 7.4 mgd before its failure around 10:30 hours, the effluent flow meter was operational and recorded increasing flows up to 8.44 mgd at 10:26 hours as shown in the graph below. This indicates that the influent flow meter stopped recording flow rates at approximately 7.4 mgd before it completely failed. However, for purposes of estimating the influent, we assume that reading were accurate. This assumption, along with the selection of the start and stop times, makes the Water Board staff's ultimate volume estimate conservative.



Note that the Discharger adjusted the influent flow data for December 19, 2010, to one hour early since the data submitted was not adjusted for daylight savings time (data adjusted by Discharger on October 26, 2011 meeting). A summary of calculation is also provided with an estimated total sewer overflow volume of 972,697 gallons (includes 2,200 gallons sewer overflow spilled next day).

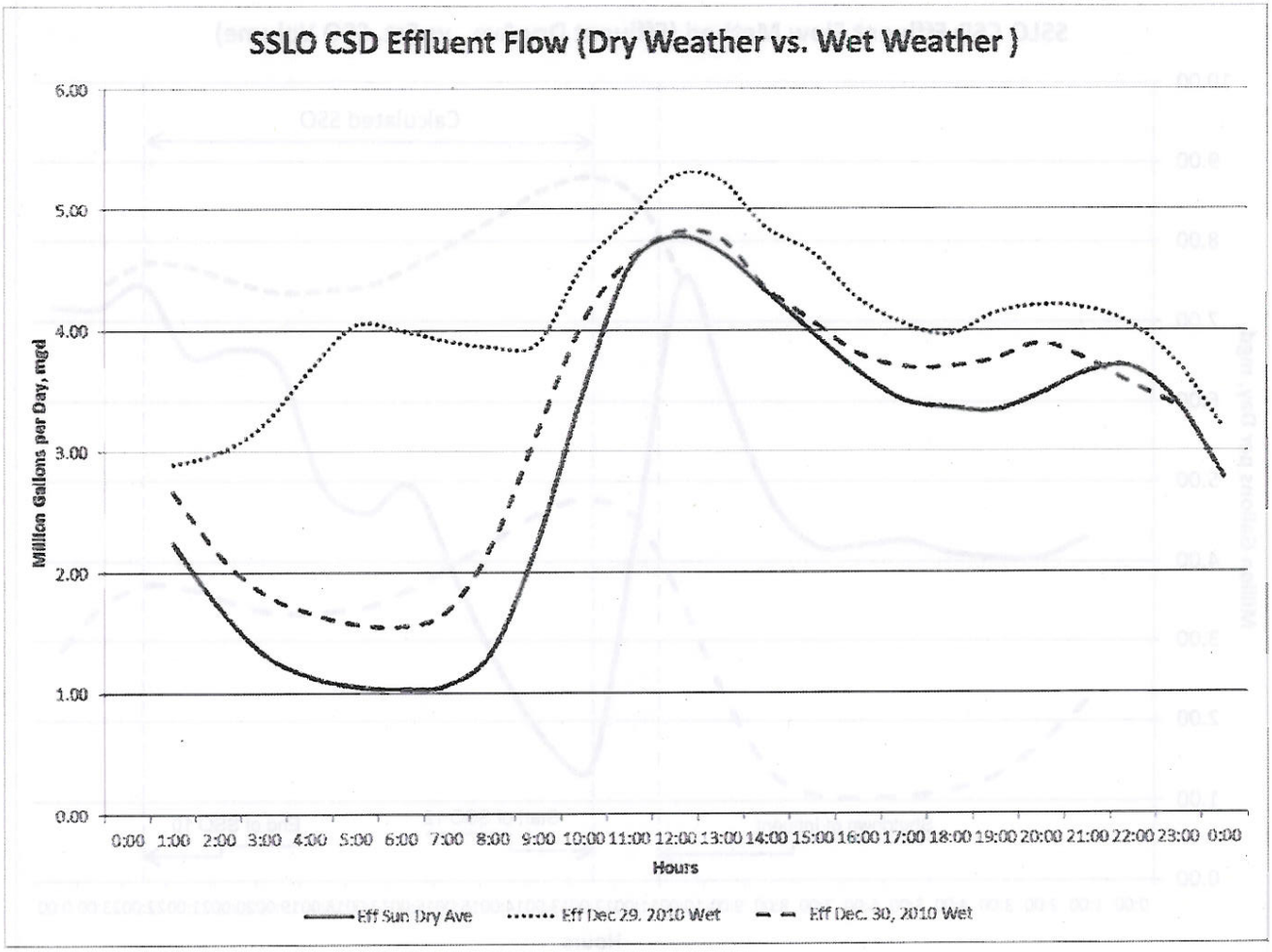
Table 1 – Summary of December 2010 Sewer Overflow Calculations (Methodology 1)

DATA DESCRIPTION	ESTIMATED VOLUME (gallons)
ESTIMATED TOTAL INFLUENT VOLUME ON 12/19/2010 (1)	3,095,573
TOTAL DRY WEATHER INFLUENT VOLUME (2)	1,651,823
NET INFLOW AND INFILTRATION INTO COLLECTION SYSTEM (3)	1,443,750
EFFLUENT VOLUME RECORDED DURING SEWER OVERFLOW (4)	1,945,076
TOTAL BYPASS VOLUME OF HEADWORKS INFLUENT PUMP STATION (5)	2,125,076
TOTAL ESTIMATED SEWER OVERFLOW DISCHARGED (5)	**972,697**

1. Total sewage treated + total inflow and infiltration based on hourly average flow.
2. Hourly average diurnal flows based on historic data recorded at WWTP.
3. Difference between estimated total influent and total dry weather influent volume.
4. Volume bypassed around WWTP influent pump station during 10 hours during sewer overflow.
5. Total bypass volume around WWTP influent pump station, including 180,000 gallons untreated sewage diverted to temporary WWTP sludge storage lagoon.
6. Net estimated volume of December 2010 sewer overflow.

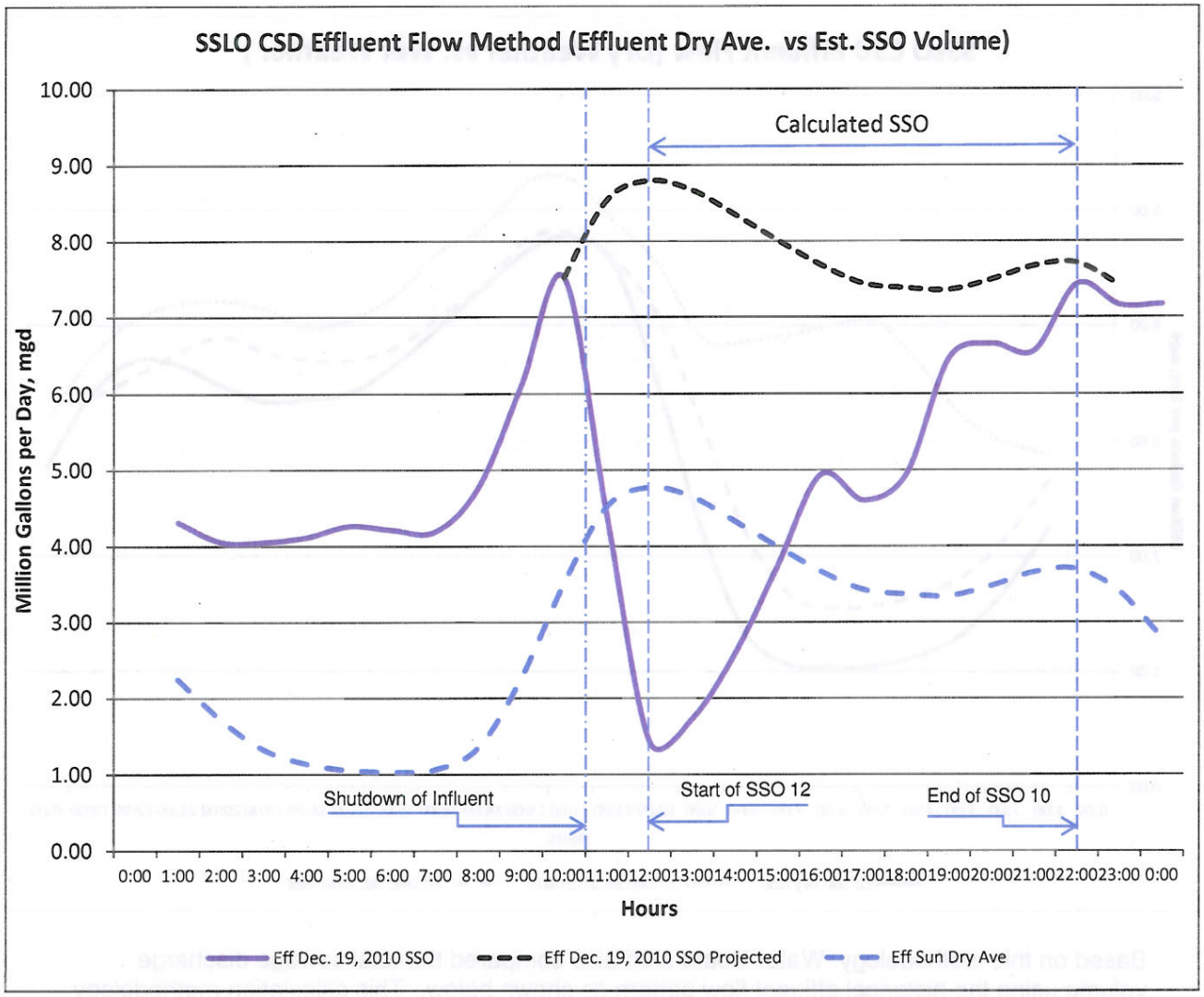
Methodology 2 (based on recorded effluent data)

Using similar approach above, the average dry weather effluent flow was compared with wet weather effluent to determine if both flow curves correlate to each other. Since no effluent data were available for the years 2008-2009, State Water Board staff used the August 2010 effluent data for a typical dry weather Sunday. This is then compared to the wet weather effluent flow curves on December 29, 2010 and December 30, 2010. The following graph shows both wet weather flow curves display similar flow variations with dry weather Sunday from peak flow at around noon time through midnight, which also confirms similar hourly fluctuations with the influent flow above.



Based on this methodology, Water Board staff also compared the total sewage discharge volume using the historical effluent flow pattern as shown below. This calculation methodology takes into consideration; 1) the Discharger's average residence time at the wastewater treatment plant of one hour based on effluent flow rates of 7-8 mgd, and, 2) decreasing influent volume from 9:00-10:00 p.m. (excluded in volume calculation as reflected in effluent meter from 10:00- 11:00 p.m.)

The following graph shows the projected effluent flow as compared to the average dry effluent flow of a typical December Sunday based on a 10-hour spill period.



Using the same influent flow methodology discussed above, the following table shows the summary of sewage discharge volume (gallons) based on the plant's hourly diurnal effluent flow variations. In this case, the estimated total sewer overflow volume is 1,139,825 gallons which accounts for the residence or detention time at the plant and the decreasing discharge flow at the end of the spill event.

In comparing the estimated volumes using both influent and effluent flow data, Water Board staff used the effluent diurnal flow calculation methodology to determine the estimated total sewer overflow discharged for the December 2010 sewer overflow is 1,139,825 gallons supported by the following reasons:

1. Unlike the influent flow meter, the effluent flow meter was fully functional throughout the December 2010 sewer overflow event;

2. The influent flow meter stopped recording flow rates at approximately 7.4 mgd due to wet well flooding. However, the effluent flow continued to record flow data which showed

increasing flow rates as high as 8.44 mgd (at 10:26 AM). This provides evidence that the actual influent flow was higher than recorded by the influent meter;

3. The effluent flow data provide further evidence that the collection system and the WWTP sustained heavy inflow and infiltration flows throughout the December 2010 sewer overflow event; and,

4. The effluent flow calculation has taken into account the Discharger's reported WWTP hydraulic residence time as well as the decreasing sewer overflow volume in the last hour (10 p.m.) of the sewer overflow on December 19, 2010.

Table 2 – Summary of December 2010 Sewer Overflow Calculations (Methodology 2)

DATA DESCRIPTION	ESTIMATED VOLUME (gallons)
ESTIMATED TOTAL EFFLUENT VOLUME ON 12/19/2010 (1)	3,262,701
TOTAL DRY WEATHER VOLUME (2)	1,588,569
NET INFLOW AND INFILTRATION INTO COLLECTION SYSTEM (3)	1,674,132
EFFLUENT VOLUME RECORDED DURING SEWER OVERFLOW (4)	1,945,076
TOTAL BYPASS VOLUME OF HEADWORKS INFLUENT PUMP STATION (5)	2,125,076
TOTAL ESTIMATED SEWER OVERFLOW DISCHARGED (6)	**1,139,825**

(1) Total sewage treated + total inflow and infiltration based on hourly average flow.
(2) Estimated dry weather volume based on effluent meter recorded data.
(3) Difference between estimated total influent and total dry weather influent volume.
(4) Volume bypassed around WWTP influent pump station during 10 hours during sewer overflow.
(5) Total bypass volume around WWTP influent pump station, including 180,000 gallons untreated sewage diverted to temporary WWTP sludge storage lagoon.
(6) Net estimated volume of December 2010 sewer overflow.

CONCLUSION

Based on the above determination, State Water Board staff estimated the sewer overflow discharge volume using both monitored influent and effluent flow data. The estimated total sewer overflow discharged for the December 2010 sewer overflow is 1,139,825 gallons. This calculation methodology is well supported by historical flow data at the plant and therefore is the most appropriate methodology to use in calculating total spill volume during the December 2010 sewer overflow.