Inland Empire Brine Line Water Quality Monitoring & Solids Formation Recovery Formula Report April 2018 through March 2019

Prepared for:

Santa Ana Watershed Project Authority

September 5, 2019

Santa Ana Watershed Project Authority

SAWPA

Trussell

TECHNOLOGIES INC

TECHNICAL MEMORANDUM

Prepared for the
Santa Ana Watershed Project Authority

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Authors: Emily L. Owens-Bennett, P.E.
Liana Olivas
Andrew Rudchenko

Reviewer: Rhodes Trussell, Ph.D., P.E., BCEE
Bryan Trussell, P.E., BCEE

Subject: Inland Empire Brine Line Water Quality Monitoring and Solids Formation Recovery Formula Report – April 2018 through March 2019

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1 Introduction

The Inland Empire Brine Line (Brine Line) is owned and operated by the Santa Ana Watershed Project Authority (SAWPA) and conveys a mixture of brine concentrate, domestic, and industrial wastewaters from its upper reaches in Riverside and San Bernardino Counties to Orange County. Once the Brine Line crosses into Orange County (County Line), ownership of the wastewater is transferred from SAWPA to the Orange County Sanitation District (OCSD). SAWPA pays OCSD a fee to dispose of the wastewater in the Brine Line at the County Line. The fee is determined each month using the hydraulic flow and the level of total suspended solids (TSS) and biochemical oxygen demand (BOD_5) measureds in the Brine Line at the County Line. Both agencies assess the County Line water quality using the Canyon RV Park S-01 (S-01) monitoring location, which is owned and maintained by OCSD. The suspended solid load calculated from measurements at the County Line have historically exceeded the cumulative suspended solids loads to the Brine Line calculated from each of the dischargers, suggesting solids formation through the system.

Trussell Technologies, Inc. (Trussell Tech) was first retained by SAWPA in mid-2011 to characterize the suspended solids at the County Line and assess the nature of the suspended solids formed in the Brine Line. SAWPA recovers costs paid to OCWD by charging each discharger a fee for discharging into the Brine Line using a billing formula for allocating the costs related to the solids formed. In response to an increase in Brine Line solids formation from 2014 through 2015, Trussell Tech worked with SAWPA to develop a monitoring program aimed at characterizing all discharger inputs and downstream water quality at S-01 (Trussell Tech, 2016a). System-wide concurrent monitoring of the major dischargers, reach-by-reach locations, and the County Line was completed between April 25 and 28, 2016. From the monitoring data, Trussell Tech developed a scientifically-based revision of the billing formula to allocate the cost of suspended solids formation according to known formation mechanisms of the observed solids composition. A monitoring program was recommended to provide ongoing sampling, routine assessment of the suspended solids in the Brine Line, and a mechanism for regularly updating the formula in response to system changes.

Data collected from April 2018 through March 2019 were evaluated for the current Brine Line suspended solids assessment. However, discharger Inland BioEnergy released an uncharacteristically high suspended solids load from late January into early March 2019, resulting in nonrepresentative suspended solids measurements from both discharger loading and from the County Line results from January to March of 2019. Because these last three months of the reporting period did not reflect a typical mass balance that would be expected in the Brine Line system, analysis for the current reporting period described throughout the remainder of the report only reflects data collected from April 2018 through December 2018. This is further discussed and illustrated in Section 3.1.

This technical memorandum (TM) provides an updated summary and analysis of the water quality results based on system-wide monitoring and characterization of the suspended solids entering and leaving the Brine Line from April through December 2018. The TM includes recommendations for next steps, including potential updates to the solids characterization methodology, building on the water quality assessments from 2016 to present.

1.1 Objectives

Primary objectives for this TM include:

- Provide an annual water quality review for the S-01 County Line monitoring station for the recent monitoring period (April 2018 - March 2019).
- Characterize the organic and inorganic constituents present in the suspended solids at the S-01 County Line monitoring station.
- Develop loading rates for all 36 individual dischargers directly connected to the Brine Line using water quality parameters from the billing formula (monitoring plan constituents).
- Assess suspended solids loading within the Brine Line system – including the combined dischargers and the downstream County Line monitoring station at S-01.
- Assess solids formation in the Brine Line system for the recent monitoring period (August 2018 – March 2019) and its impact to the current billing formula.
- Compare results from the recent monitoring period with data generated from past monitoring periods (April 2016, August 2016 – March 2017, & April 2017 – March 2018) to re-assess the recommended monitoring frequencies for the individual dischargers and update, as needed (Trussell Tech, 2016e; Trussell Tech, 2017; Trussell Tech, 2018).

2 Methodology

In order to allocate costs associated with suspended solids and solids formation within the Brine Line, characterization of the upstream combined discharger inputs and downstream water quality at the County Line was required. The formed suspended solids through the system were determined using the mass balance, shown in Figure 1. This methodology is consistent with Trussell Tech's 2016 Proposed Solids Formation Recovery Formula for the Inland Empire Brine

Line (Trussell Tech, 2016e), with updates from subsequent reports from 2017 and 2018 (Trussell Tech, 2017 and 2018).

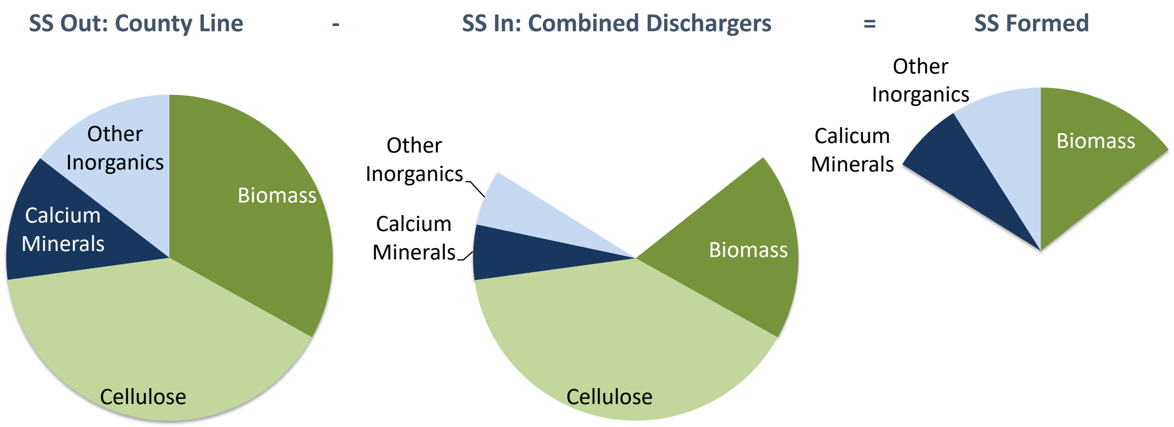

Figure 1. Characterization of solids formation through the Brine Line

County Line monitoring data is based on both weekly water quality monitoring and quarterly solids characterization analyses. To increase the representativeness of the solids characterization data, the frequency of these monitoring events was increased from quarterly to monthly (the analyses by Camet Research remained on a quarterly frequency), beginning in September of 2018. For simplicity, all solids characterization events for the current reporting period at the County Line will be referred to as "monthly." Dischargers into the Brine Line were monitored for water quality parameters associated with solids formation mechanisms in the Brine Line at a frequency determined based on loading values for each of the billing parameters determined from the 2018 Brine Line Study.

3 Results and Discussion

3.1 Historical Data Review

Trussell Technologies has been involved in the investigation of solids within the Brine Line since 2011, as documented in previous reports (Trussell Tech, 2011, 2012, 2013, 2015, 2016c, 2017, 2018). Throughout this time, the TSS load observed at the County Line has exceeded the TSS load contributed by the combined dischargers, as shown for the period since 2016 in Figure 2. TSS loading for an individual discharger is determined by multiplying the average TSS concentration for a particular month by their total measured flow for that month. If TSS concentration data is missing for a month when flow was contributed, it is estimated as the average concentration of surrounding months. Similarly, the County Line TSS load is determined by multiplying the monthly average TSS concentration from weekly sampling events by the monthly flow measured at the S-01 metering station.

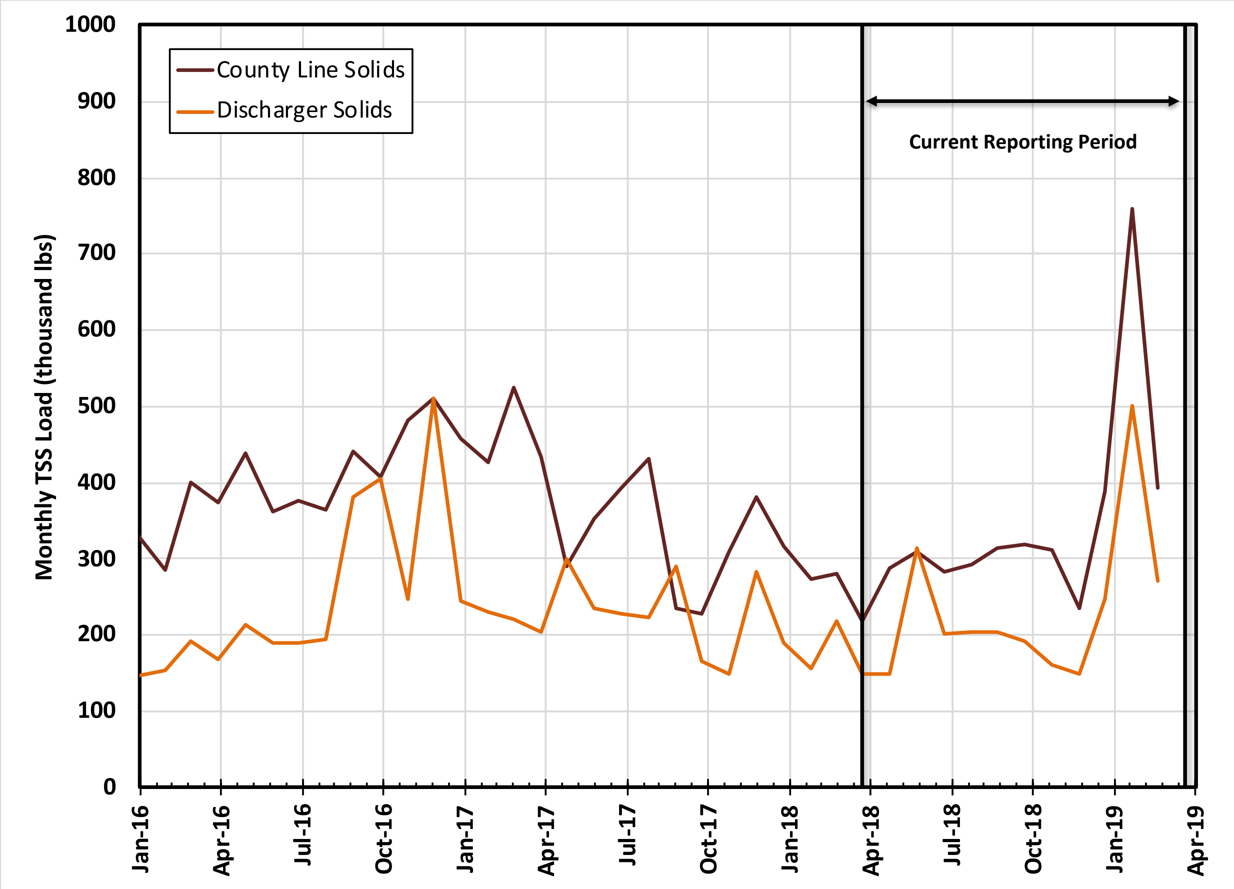

Figure 2. Total suspended solids from all dischargers compared with measured total suspended solids at S-01 from January 2016 – March 2019.

A gradual decline in the magnitude of suspended solids was generally observed for both 'County Line Solids' and 'Discharger Solids' from late 2016 through early 2018, followed by more consistent monthly loading through the end of 2018. A dramatic spike in TSS load for both 'County Line Solids' and 'Discharger Solids' occurred between January 2019 and March 2019, which was attributed to a sudden increase in the discharge of high TSS effluent from Inland Bioenergy. Because the TSS load in January through March 2019 was significantly influenced by an isolated discharge event that was not representative of the remainder of the reporting period (April – December 2018), those months were eliminated from the analysis. Subsequent to this period, Inland Bioenergy was disconnected from the Brine Line and required to pay fines to SAWPA. This report is thus focused on the results from April through December 2018.

In addition to the suspended solids loading, flow through the Brine Line can be good indicator of changes through the system over time. Unlike suspended solids loading, flow demonstrates a high degree of uniformity between 'County Line Solids' and 'Discharger Solids', as shown in Figure 3. While flow from January 2016 through December 2018 was relatively stable, seasonal trends are observed (lower flows in the wintertime).

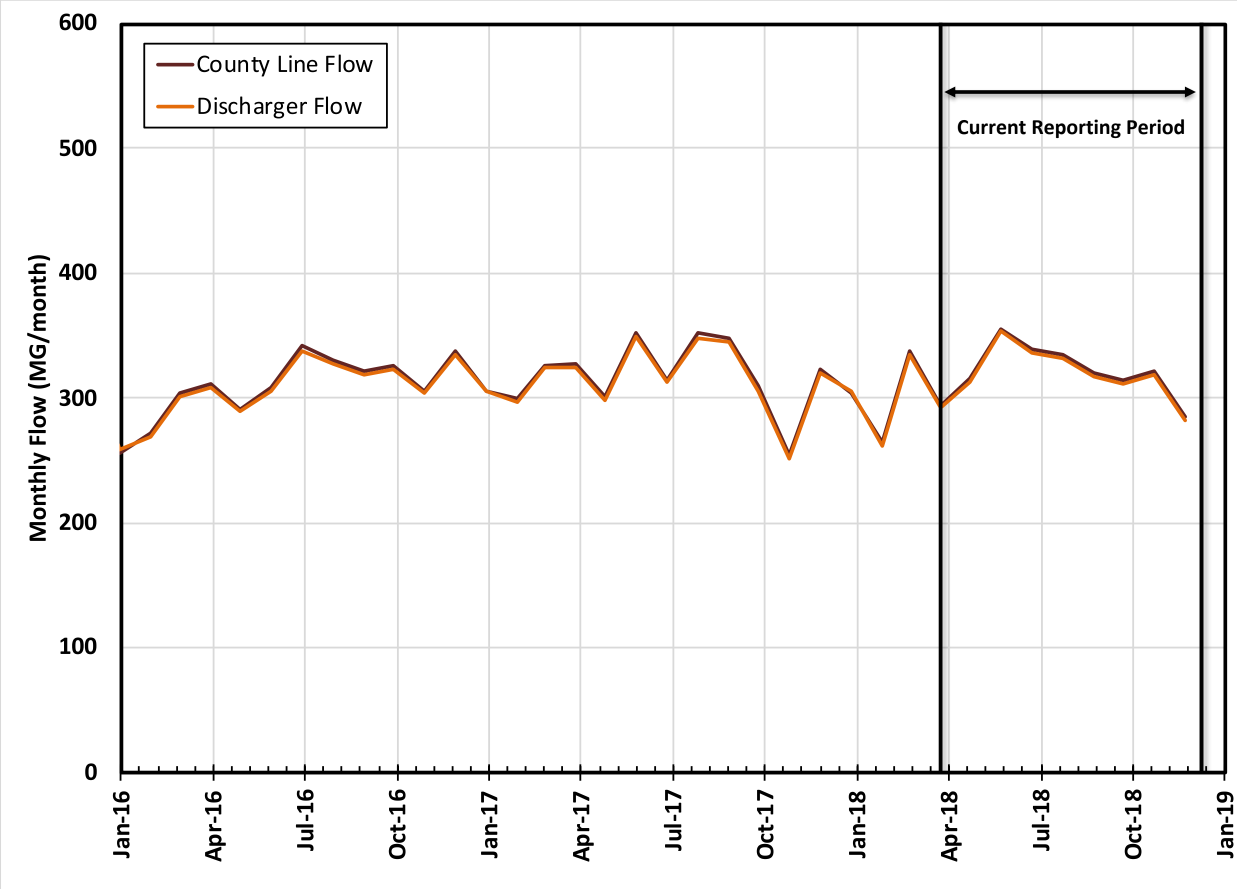

Figure 3. Cumulative flow from all dischargers compared with flow measured at S-01 from January 2016 – December 2018.

Note: The "current reporting period" for the remainder of the report will include the months of April 2018 - December 2018 only.

It is insightful to illustrate the difference in suspended solids loading in Figure 2 as a ratio, to visualize solids formation in the Brine Line independent of overall magnitude. Averaged on a fiscal calendar basis, the solids observed at Canyon RV Park S-01 station divided by solids input from the dischargers is provided in Figure 4. A ratio of 1 means the solids loading observed at the County Line equals that of the combined dischargers (*i.e.*, no solids formation) whereas a ratio greater than 1 means that the solids loading at the County Line exceeded the suspended solids discharged to the system (*i.e.*, solids formation). The suspended solids formation ratio for the current fiscal (2018/19) year was 1.5, which is approximately equal to the two preceding fiscal years (2016/17, 2017/18). The consistency observed over the past three fiscal years, as well as the decrease in observed solids formation from the 2015/16 fiscal year, coincides with increased monitoring frequency as part of the billing formula development (early 2016). The resolution of month-to-month discharger solids loading has been improved, contributing to increased stability in the formed solids within the Brine Line.

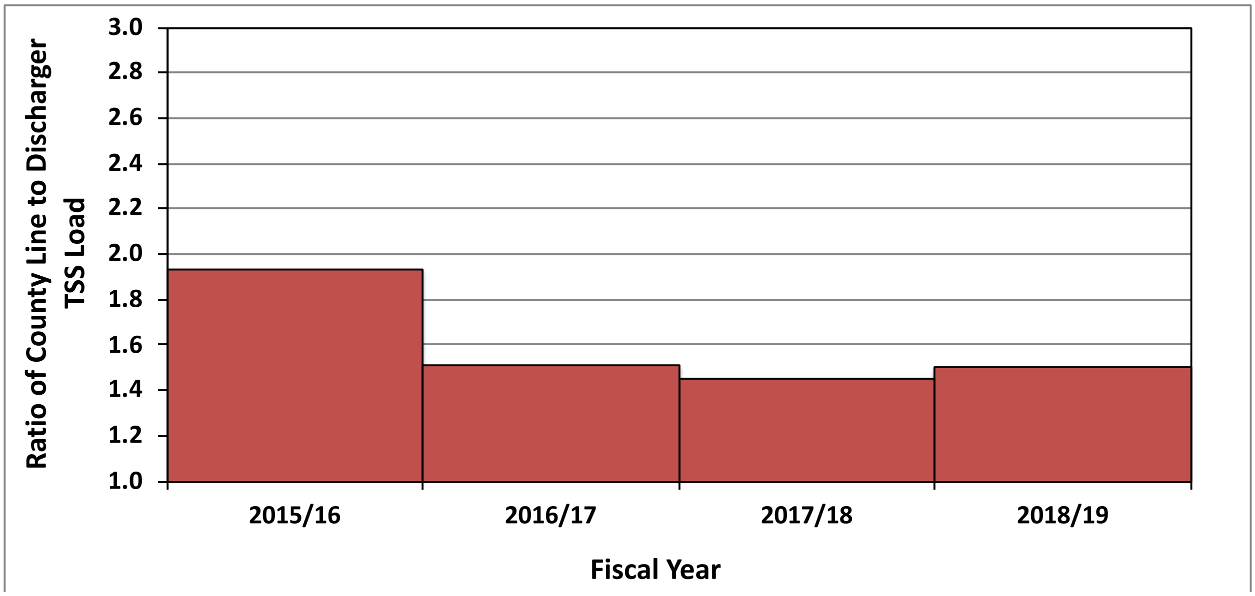

Figure 4. Relative increase in TSS in the Brine Line from the points of discharge to the County Line monitoring station on a calendar year basis (January 2015 through December 2018).

3.2 County Line Solids Characterization

Suspended solids characterization for the County Line monitoring samples has been the basis of understanding the solids formation in the Brine Line since the beginning of Trussell Tech's involvement with the project. This characterization includes an analysis of TSS measurements and a breakdown of the organic and inorganic fractions of the solids, as will be discussed for the current reporting period in this section.

3.2.1 TSS Analysis

Triplicate analysis of TSS is completed on a weekly basis from 24-hour composite samples at the County Line monitoring station (Trussell Tech, 2016a). Figure 5 shows all replicate TSS measurements from S-01 for the current reporting period. The variability of TSS measurements in the Brine Line becomes evident by comparing Figure 5 with the resulting weekly average TSS measurement, shown in Figure 6. For example, on April 13, 2018, one triplicate TSS measurement was 129 mg/L, while the remaining two measurements were 97 mg/L and 92 mg/L. Taking the average of the three measurements yields a weekly TSS concentration of 106 mg/L, decreasing week-to-week variability.

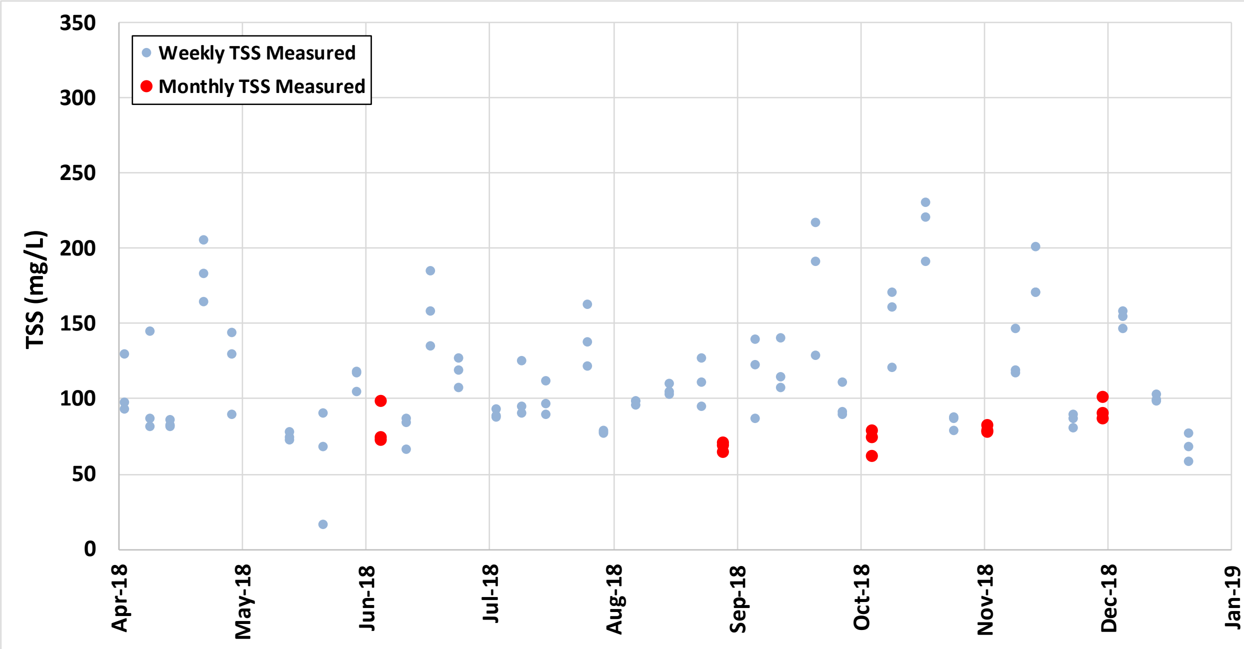

Figure 5. All replicate TSS results from weekly samples at the Canyon RV Park S-01 station (April 2018 – December 2018). Quarterly measurements are indicated with red dots.

Individual TSS measurements from S-01 ranged from 16 to 230 mg/L with a standard deviation of 39.7 mg/L, whereas the averaged values ranged from 58 to 213 mg/L with a standard deviation of 38.1 mg/L. The overall average of the weekly TSS measurements from S-01 was 109 mg/L. This comparison reaffirms that analyzing TSS measurements in triplicate reduces variability in the data. Figure 7 provides a comparison of historical weekly average TSS measurements since January of 2016, which can be compared to the current reporting period (Figure 6).

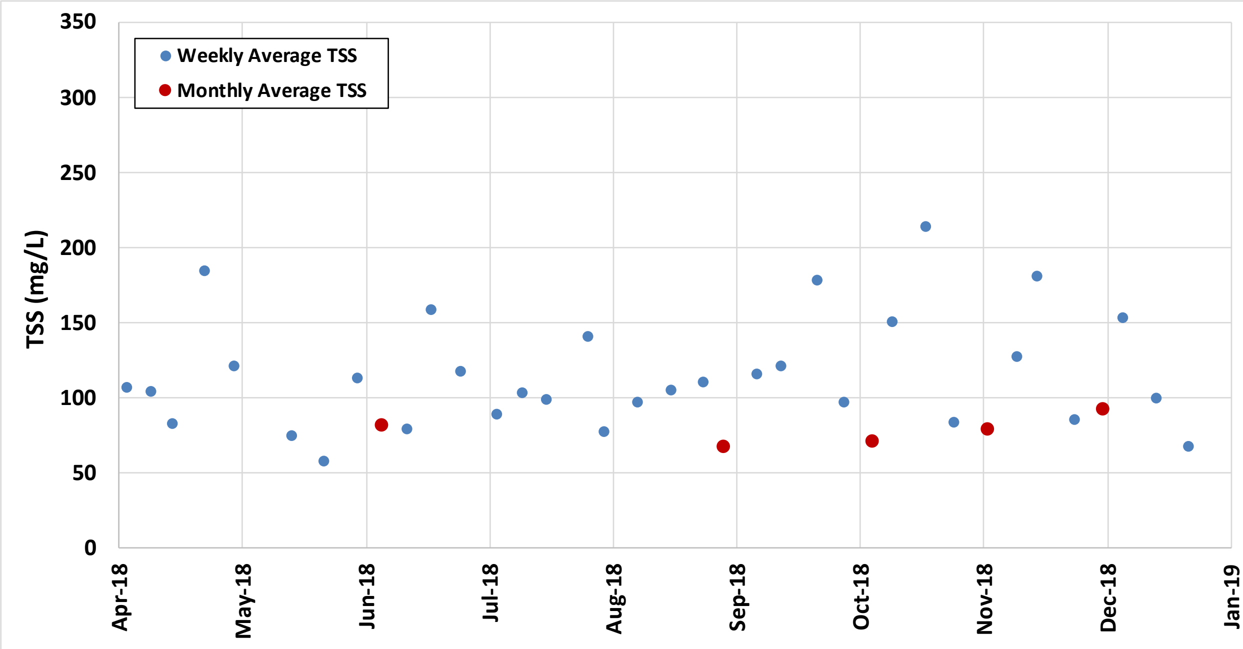

Figure 6. Average TSS results from weekly samples at the Canyon RV Park S-01 station (April 2018 – December 2018). Monthly measurements are indicated with red dots.

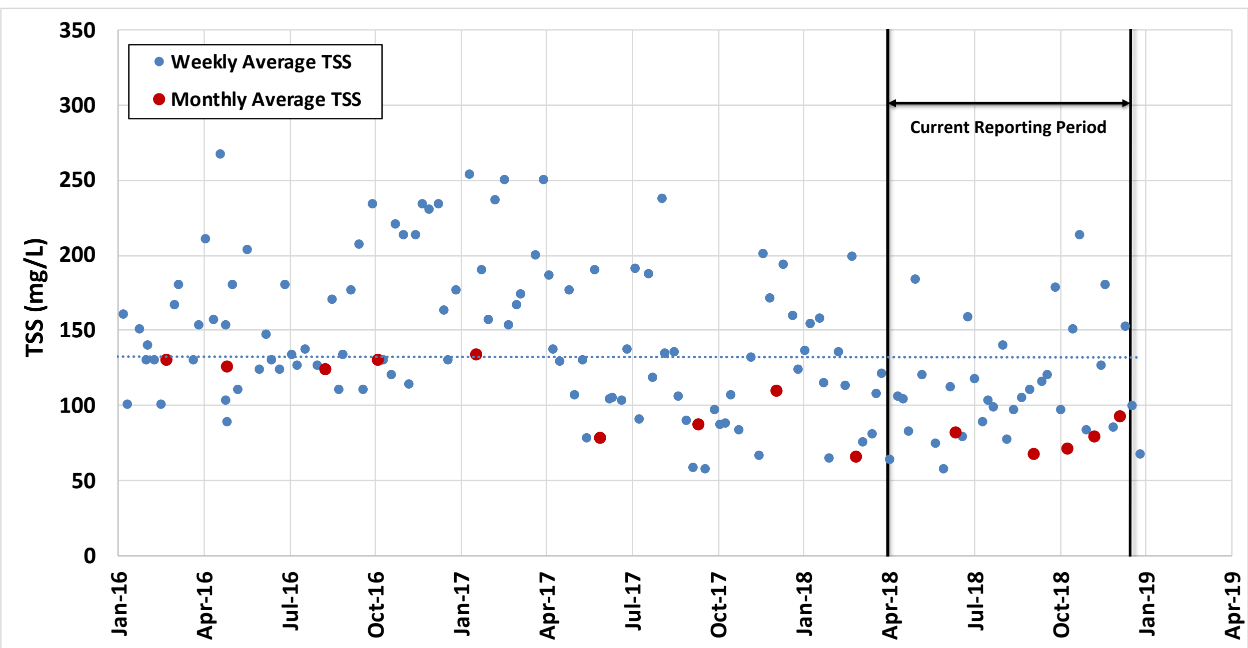

Figure 7. Weekly TSS results at the Canyon RV Park S-01 station (January 2016-December 2018). Monthly measurements are indicated with red dots.

The trendline shown in Figure 7 (dotted blue line) shows that weekly average TSS measurements at S-01 have been consistent since January 2016. However, both weekly and monthly (associated with the solids characterization events) measurements decreased slightly over the current reporting period, as indicated by a majority of data point below the trendline. Monthly assessments were also consistently lower than surrounding weekly assessments, suggesting a difference in sampling procedure may have influenced the results. This trend is most dramatically observed from April 2017 through the current reporting period.

The weekly and monthly TSS sampling procedures have two main differences. The first difference is in the volume of sample collected. Monthly samples are greater in volume than weekly samples, 8-10 gallons verse ~2.5 gallons, respectively. A past study discovered no discernable difference between the TSS values based on the volume of samples collected (Trussell Tech, 2016b). ***Given the consistent trend in lower TSS measurements with larger sample volume, this may bear repeating.*** Secondly, during monthly events, a mechanical mixer is used in combination with a portable autosampler to pump and distribute sample aliquots. The mixer was implemented to improve the uniformity of samples sent to multiple laboratories for analyses (Babcock and Camet). This method is not used for weekly samples.

3.2.2 Organic Analysis

The composition of the organic fraction of suspended solids from County Line samples was estimated using monthly and quarterly analytical results from March 2018 through December 2018. As previously noted, the frequency of solids characterization events was increased from quarterly to monthly during the reporting period to achieve more representative results. The following subsections discuss the results of the organics analysis.

3.2.2.1 VSS/TSS Ratio

Volatile suspended solids (VSS) represent the fraction of TSS of a given sample that volatilizes at 550 °C, and is used as a surrogate for the organic material. A small portion of non-organics can contribute to VSS, including waters of hydration, ammonia, and mass loss due to mineral transformation. TSS and VSS measurements were taken in triplicate from S-01 on a weekly basis. Table 1 shows the average of the triplicate values for TSS, VSS, and the TSS/VSS ratio for the monthly samples associated with the solids characterization events.

Table 1. VSS/TSS ratios from monthly solids characterization events at the County Line

Date	TSS (mg/L)	VSS (mg/L)	VSS/TSS Ratio
6/14/18	81	62	77%
9/5/18	67	48	72%
10/11/18	71	53	74%
11/8/18	79	52	66%
12/6/18	92	69	75%
Period Average:	**75**	**54**	**72%**

*VSS and TSS results are average values of triplicate analyses from each sample.

The TSS/VSS ratio ranged from 66% to 77% for the reporting period (Table 1), with an average of 72%. This average value is slightly lower than average for the last reporting period of 74% (Trussell Tech, 2018). The TSS/VSS ratios for both weekly and monthly samples have followed a consistent trend since October 2016, as shown in Figure 8. The estimated concentration of organic material present at the County Line was 78 mg/L, determined by multiplying the overall average TSS concentration by the average VSS/TSS ratio. This value is notably less than the organic concentration for the previous reporting period of 92 mg/L (Trussell Tech, 2018).

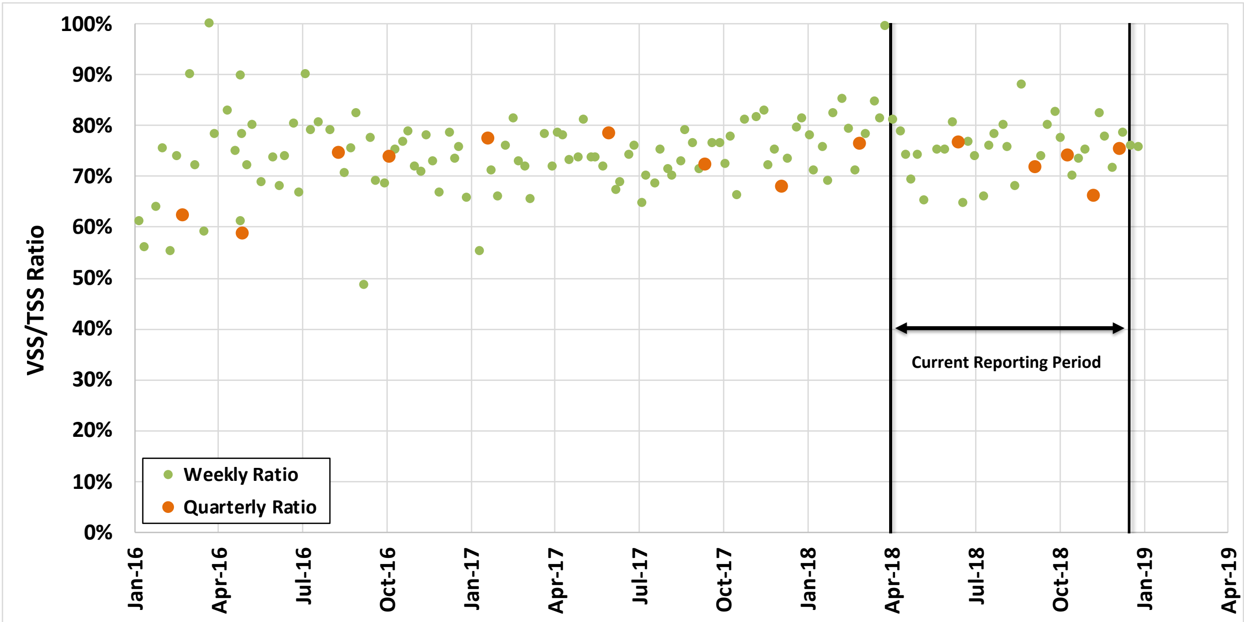

Figure 8. VSS/TSS ratio from weekly measurements at Canyon RV Park S-01 (January 2016 – December 2018). Monthly/Quarterly measurements are indicated with orange dots.

3.2.2.2 Other Organics Analysis

To provide a more comprehensive picture of the organic fraction of the suspended solids at S-01, monthly samples are sent to Babcock Laboratories for direct and indirect measurement of Particulate Organic Carbon (POC) and Camet Research for Thermogravimetric Analysis (TGA). POC is a direct measurement of the organic carbon present in sample, while the results from TGA can be applied to understand the mass of cellulosic material within the suspended solids.

The average value for direct POC over the current reporting period was 35%, or 38 mg/L as C. This fraction can be further partitioned into cellulosic material (*e.g.*, paper and cloth fiber) and microbial biomass using TGA results for cellulose in the suspended solids from S-01. During TGA, the mass loss associated with a large burn off of solids between 200 – 300°C is attributed to cellulosic material. The fraction of cellulose at S-01 was 40% of the TSS, or 44 mg/L for the current reporting period. The cellulosic fraction of POC was calculated by dividing the cellulose fraction obtained using TGA by the ratio of organic carbon to organic mass. This ratio is between 0.4 and 0.6 for most organics, depending on the type of organic material. Cellulose is typically on the lower end of this range and a value of 0.44 – derived from the cellulose formula of $(C_6H_{10}O_5)_n$ – was used in this analysis. The remainder of the POC was assumed to be biomass (i.e., $C_5H_7O_2N$) and was calculated using the ratio of 0.53, yielding a value of 32% of the TSS, or 34 mg/L for the current reporting period. Finally, the cellulose and biomass fractions were summed to obtain a total organics fraction of the suspended solids. The ratio of the total organics fraction to the VSS was used to normalize the fraction of cellulosic material present in the suspended solids.

3.2.3 Inorganic Analysis

Several analytical techniques were used to characterize the inorganic fraction of the suspended solids from monthly solids samples collected at Canyon RV Park S-01 station. The results are discussed in the following subsections.

3.2.3.1 Inductively Coupled Plasma Mass Spectroscopy

Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) was performed by Babcock Laboratories to measure calcium, iron, potassium, magnesium, sodium, silicon, and aluminum present in the solid fraction (mg/kg) of each monthly sample collected at S-01. The monthly samples were averaged for the current reporting period and presented in Table 2. Calcium was the most dominant analyte present, accounting for 5% of the TSS, which is consistent with historical values. For this reason, total and dissolved calcium are also measured in the liquid fraction (mg/L) of the monthly composite samples. Particulate calcium was calculated indirectly by subtracting dissolved calcium from total calcium for each sample. These values were averaged and converted to a percent of TSS at the County Line (Table 2). A large discrepancy was observed in the fraction of calcium in the County Line suspended solids measured directly using ICP-MS results (5% of TSS) versus calculated using the difference of total and dissolved calcium concentrations (47% of TSS). Assuming calcium accounts for all the inorganics at the County Line, the theoretical maximum percent of TSS it could be is 28% (1-TSS/VSS ratio), suggesting that the fraction of calcium calculated indirectly was erroneously high. This is likely because the total and dissolved calcium concentrations measured at the County Line are close, so the difference between the two values is sensitive to small measurement errors. For this reason, the direct method is used for the County Line samples.

An error was identified in two calcium values from the 2018 assessment (Trussell Tech, 2018), where the ICP-MS results were reported as a percentage of wet solids instead of as a percentage of TSS, which are solids dried at 105°C. This error was corrected and any reference to the prior analysis in this TM will reflect that correction.

Particulate calcium, based on direct measurement using ICP-MS results, has decreased from the 2017 and 2018 reporting period values of 14% and 8% of TSS, respectively (Trussell Tech, 2017, Trussell Tech, 2018). Several factors could contribute to the observed decrease in particulate calcium, including changes in the water quality of the Brine Line, seasonal or temporal changes in the discharged calcium, increases in the addition of threshold inhibition antiscalant from the dischargers that suppress calcium precipitation, or issues associated with the analytical measurements. ***It is recommended to confirm the observed changes in calcium composition of the suspended solids through additional study of the ICP-MS, in combination with the analyses by Camet Research (Section 3.2.3.2).***

Table 2. Average ICP Metals Results from the County Line Monthly Sampling Events (April 2018-December 2018)

Element	Total (mg/L)	Dissolved (mg/L)	Solids (mg/kg)	Particulate (Calculated) (mg/L)	Fraction of TSS (Calculated) (%)	Fraction of TSS (Direct) (%)
Calcium	659	621	50491	38	47%	5%
Iron	-	-	2986	-	-	0.3%
Potassium	-	-	4121	-	-	0.4%
Magnesium	155	-	4913	-	-	0.5%
Sodium	-	-	4889	-	-	0.5%
Silicon	-	-	2590	-	-	0.3%
Aluminum	-	-	1690	-	-	0.2%

The ICP results shown in Table 2 suggest a number of inorganic elements besides calcium are present at the County Line in small fractions. These elements have been combined and categorized as "other inorganics," representing the sum of all uncharacterized non-volatile suspended solids (nVSS) present at the County Line. The "other nVSS" fraction of TSS was calculated by subtracting the fraction of calcium minerals (12.6%) from the fraction of non-volatile suspended solids (27.2%) and was estimated at 14.5% for the current reporting period. As the fraction of calcium has decreased from the previous two reporting periods, "other nVSS" fraction has increased from 4.3% in 2017 to 7% in 2018. Magnesium and sodium constitute the largest fractions (0.5% each) of non-calcium inorganics that were investigated by ICP-MS. Assuming aluminum and silicon were present as the clay mineral kaolinite, which is typically found in dirt and can be introduced to the Brine Line through sewer infiltration, approximately 5% of the suspended solids can also be attributed to aluminum silicates. Continuing the increased monthly frequency solids characterization events at S-01 is expected to help confirm the trend in decreasing calcium and increasing "other inorganics".

3.2.3.2 Other Inorganics Analysis

Along with ICP-MS analysis, the monthly samples collected at S-01 are sent to Camet Research for further solids analysis using scanning electron microscopy/x-ray spectroscopy (SEM/EDX) and x-ray diffraction (XRD) techniques. As SEM/EDX and XRD are semi-quantitative in nature, results from these tests provide a double check for the quantitative measurements that are incorporated in the billing formula. Using these methods of analysis Camet produced a composition of dried solids at 50°C for each monthly sample, which included calcium carbonate and amorphous calcium phosphate (ACP) minerals. Values for calcium minerals as a percent of dried solids at 50°C using this data ranged from 14.2% to 22.5% for the current reporting period. Given this range, the fraction of calcium minerals as a percent of TSS should be at least 14.2%, as more water would evaporate at the higher temperature required for TSS determination (105°C). These results can be compared with the calcium mineral fraction as a percent of TSS determined using ICP-MS parameters, which is 12.6% (using a 0.4 ratio of calcium in both calcium carbonate and ACP minerals – those identified by Camet Research). While these methods do not agree, they are consistent in identifying calcium as the dominant inorganic mineral.

Previous solids characterizations at the County Line have identified several water quality parameters as dominant controlling factors of inorganic solids formation in the Brine Line. These parameters, measured from the liquid fraction of the weekly composite samples and averaged over the current reporting period, are shown in Table 3. The Langlier Saturation Index (LSI) was included in Table 3 as an indicator of the degree of calcium carbonate saturation, where a positive LSI indicates calcium carbonate is over saturated and scaling is likely to occur.

Table 3. Summary of water quality parameters related to inorganic solids formation measured weekly at Canyon RV Park S-01 station (April 2018 - December 2018)

Constituent/ Analyst	Average	Standard Deviation	Range
Alkalinity (mg/L)	1044	89	757-1190
pH	7.69	0.07	7.5-7.8
Total Calcium (mg/L)	645	56	549-887
Dissolved Calcium (mg/L)	613	60	304-706
Orthophosphate (mg/L)	1.9	1.1	0.35-3.49
BOD (mg/L)	40	13	20-84
Temperature (°C)	23.8	1.7	20.5-27.8
Langelier Saturation Index	1.77	--	1.64-1.86

As shown in Table 3, the total and dissolved calcium concentrations for this reporting period were 645 mg/L and 613 mg/L (respectively), compare to 623 mg/L and 610 mg/L for the last reporting period (respectively). This increase in magnitude of total calcium concentration and difference between total and dissolved calcium concentrations from last reporting period would suggest an increase in particulate calcium, however a decrease from 24 mg/L to 14 mg/L was observed. This observation further suggests the weakness of using the difference between total and dissolved calcium measurements to determine particulate calcium concentrations. The average LSI of 1.77 for the current reporting period was equal to that of the last reporting period and indicates conditions of calcium carbonate saturation – scale-forming conditions – in the Brine Line. The decrease in calcium carbonate observed in the Brine Line could be explained by the increase in threshold inhibiting antiscalant or other water quality changes, as mentioned in section 3.2.3.1.

Orthophosphate decreased from 2.5 mg/L for the prior analysis to 1.9 mg/L for the current analysis. This decrease could account for the decrease in calcium minerals observed at S-01 as orthophosphate is required for ACP formation. Furthermore, ACP accounted for approximately 80% of the calcium minerals present at S-01 in the Camet Research analysis. This suggests that the small decrease in orthophosphate may indicate a significant change in the Brine Line water quality.

Summary tables reporting monthly data from the current reporting period are provided in Appendix A (A1-A3). References to corresponding lab results are provided in Appendix A.

3.2.4 Comprehensive Analysis

The components of the suspended solids discussed in sections 3.2.2 and 3.2.3 were partitioned into four categories: (1) microbial biomass, (2) cellulose, (3) calcium minerals, and (4) other inorganics. Each fraction, expressed as a percent of the TSS at the County Line, was multiplied by the average TSS from the liquid fraction of weekly composite samples to obtain the breakdown by concentration (mg/L) shown in Table 4. The components were also expressed as a loading (lbs/month) by multiplying the concentrations by the monthly flow rate measured at S-01, as shown in Figure 9.

Table 4. County Line solids composition based on quarterly solids characterizations (April 2018 - December 2018)

S-01 Results		
Component	%	Concentration (mg/L)
Microbial Biomass	33%	36.0
Cellulosic Material	40%	43.3
Calcium Minerals	13%	13.7
Other Inorganics	15%	15.8
Total	**100%**	**108.9**

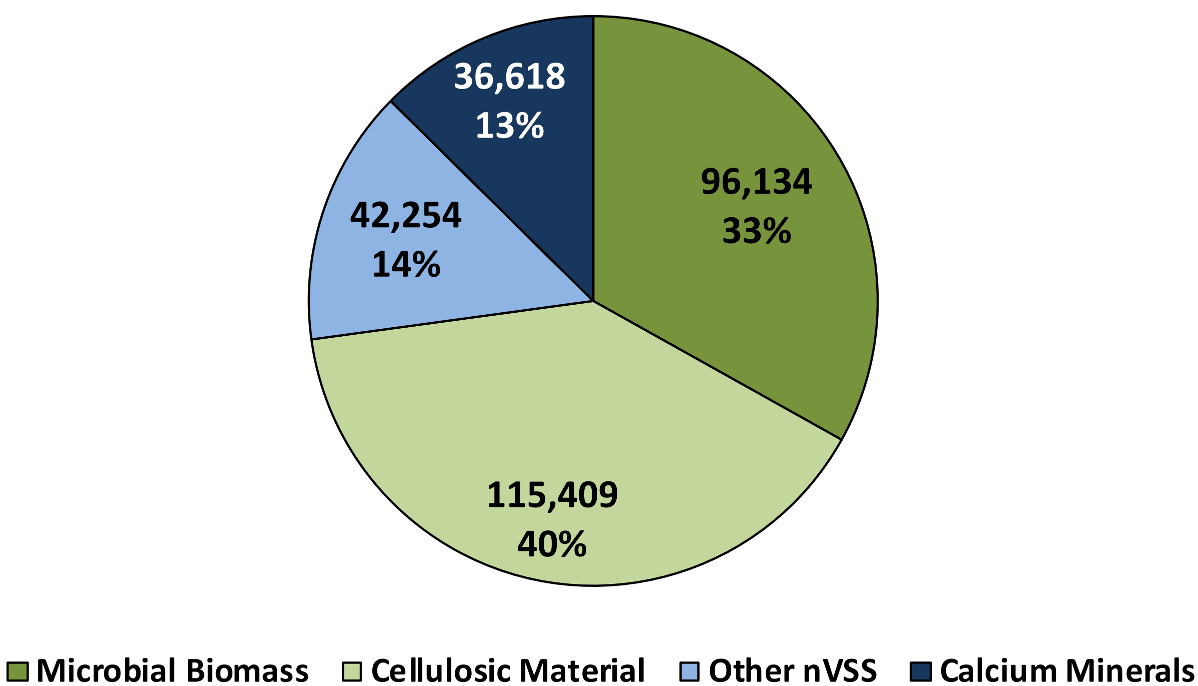

Figure 9. Overall composition of the S-01 County Line suspended solids for April 2018 - December 2018 (loading represented as lbs/month)

The overall composition of suspended solids at the County Line for the current reporting period (Figure 9) was compared to historical results since April 2016, as shown in Figure 10.

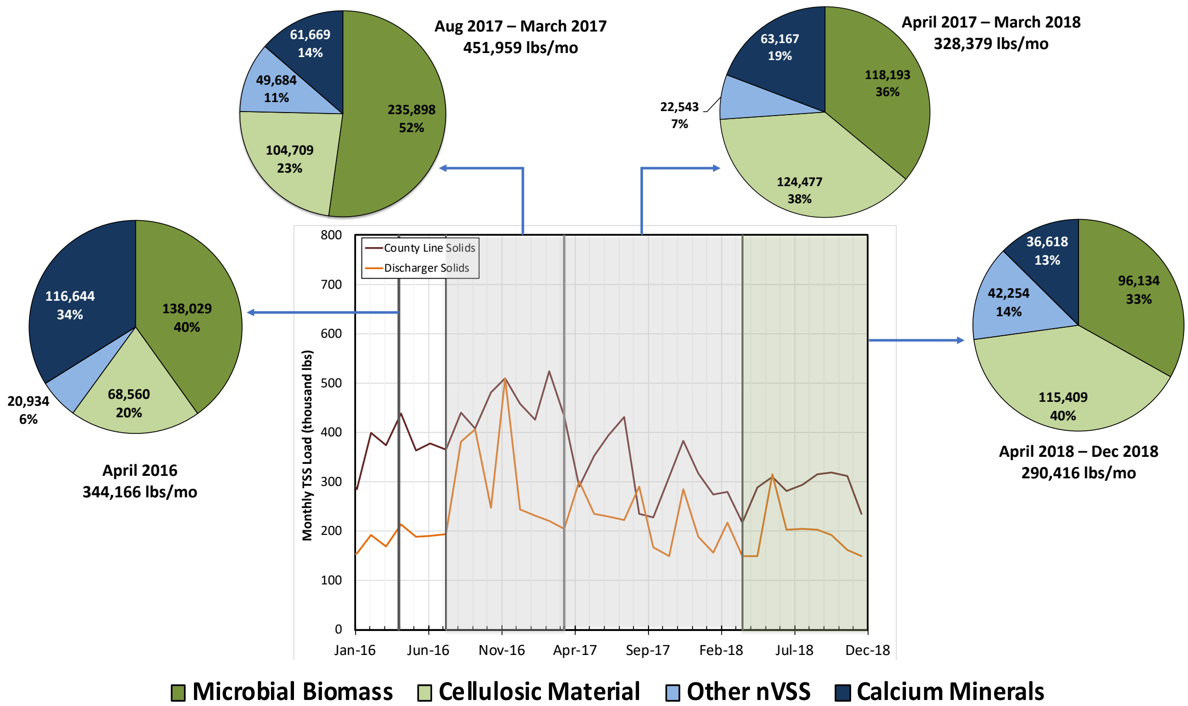

Figure 10. Suspended solids characterizations from samples collected at the S-01 County Line monitoring station (2016-2018).

Note: Loading represented as lbs/month and consistent with methodology from 2016 Billing Formula Report.

In terms of composition, the overall fraction of organic material (cellulosic material and microbial biomass) has been relatively stable over the past three reporting, accounting for 73% of the TSS for the current reporting period. The proportional breakdown of this organic material between cellulosic material and microbial biomass was likewise consistent from the 2018 reporting period to the present analysis. In terms of loading, cellulosic material decreased from 124,500 pounds per month for the prior analysis to 115,000 pounds per month discharged to the Brine Line over the current reporting period. The microbial biomass loading decreased from 118,000 pounds per month discharged for the prior analysis to 96,000 pounds per month discharged for the current analysis. The same trends (decrease in microbial biomass and steady cellulosic material loading over time) do not apply to the April 2016 study, which was conducted over a short 3-day timeframe as compared with the more temporal data incorporated in the subsequent analysis.

Combined inorganic material (calcium minerals and other nVSS) accounted for 27% of the TSS, consistent with the fraction of combined inorganic minerals for the prior study of 26%. The composition changed considerably, with an increase in other nVSS from 7% for the prior analysis to 14% for the current analysis and a decrease in calcium minerals from 19% for the prior analysis to 13% for the current analysis. In terms of loading, other inorganics increased from 22,500 pounds per month for the prior analysis to 42,200 pounds per month for the current analysis. Conversely, calcium minerals decreased from 63,200 pounds per month for the prior analysis to 36,600 pounds per month for the current analysis.

It should be noted that overall loading has decreased steadily since the August 2017-March 2017 study, as the 'County Line Solids' graph indicates (Figure 10). Compared to the prior analysis, the current reporting period saw a decrease in combined inorganic material and combined organic material of 7,000 pounds per month and 31,000 pounds per month, respectively.

3.3 Discharger Loading

In the 2016 Billing Formula Report (Trussell Tech 2016e), a more frequent discharger monitoring plan was recommended. This plan was established to collect consistent data for characterization of the wastewater entering the Brine Line from each discharger. As with the last two reporting period since 2016, the recommended monitoring frequency for each discharger was determined based on their respective contribution to the loading of the following billing formula parameters: dissolved BOD, dissolved calcium, dissolved alkalinity, as well as flow.

The discharger data set this reporting period, as well as the last two reporting periods, included less frequent monitoring than recommended for some of the high flow contributors. When data is unavailable for a specific discharger during a given month, data is extrapolated and averaged from surrounding months. This process inhibits the ability to characterize loading values in real time. Additionally, total and dissolved parameters (i.e., calcium, alkalinity, BOD) were not always analyzed together from a single sample or even consistently for each month. This makes it difficult to establish a correlating relationship between total and dissolved measurements to determine a representative measurement of the particulate fraction. Considering the importance of the particulate measurements for understanding the solid fraction of the discharger loading, it is especially important to use correlating total and dissolved measurements for each of the billing parameters.

3.3.1 Changes within the Brine Line System and Dischargers

As previously mentioned in Section 3.1, Inland BioEnergy discharged a large quantity of suspended solids into the Brine Line system in the January and February 2019, including approximately 2.5 million gallons and 343,000 pounds of suspended solids. This resulted in a spike in suspended solids observed from the dischargers sum as well as at S-01 during the last three months of the reporting period, as previously shown in Figure 2. Therefore, January, February and March of 2019 were removed from this year's analysis, as the data from these three months are not representative of typical loadings observed in the Brine Line system.

Other notable changes in the system include the removal of the Bonview development (Lewis Homes) from the Brine Line in September 2018. Bonview contributed 16% of the volatile suspended solids (VSS) during the 2018 reporting period, the second highest below JCSD Etiwanda (Trussell Tech, 2018).

3.3.2 Discharger Loading Rates

The available data for each parameter from each discharger was averaged on a monthly basis, then converted to a monthly loading using monthly flow data. Each discharger's monthly loading was then averaged over the reporting period and summed to determine the total average Brine Line loading rate associated with each water quality parameter.

A profile of monthly suspended solids loading through the Brine Line is subdivided between brine, commercial, and domestic dischargers, as shown below in Figure 11. The data shown below is consistent with previous assessments, in which the domestic dischargers contribute the most suspended solids loading. A notable change from last year's reporting period to the current period is the consistently low contribution that brine dischargers had to the overall solids loading. In last year's report, the relative contribution from brine dischargers varied throughout the reporting period, whereas this year experienced more consistency (Trussell Tech, 2018). The loading from the domestic dischargers does vary slightly from month to month, with the highest contribution taking place in June 2018 – coinciding with an increase in both commercial and domestic discharger contributions.

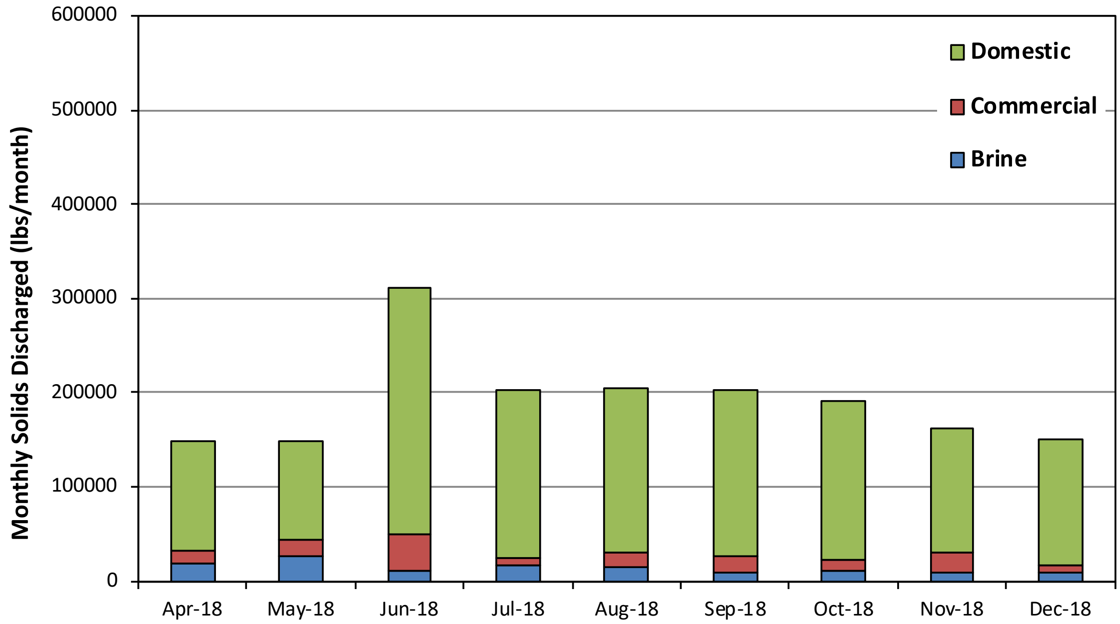

Figure 11. Brine Line discharger suspended solids loading (April 2018 - December 2018)

The dischargers are ranked in Table 5 according to the average monthly flow for the reporting period. The table also lists the average monthly loading rates for the primary water quality parameters identified as surrogates for suspended solids formation mechanisms (i.e., TSS, VSS, BOD_5, calcium, and alkalinity).

Table 5. Summary of discharger average flow (million gallons per month) and suspended solids loading rates (lbs/month) from April 2018 through December 2018

Top 3	75% of loading	95% of loading

Flow Rank	Industrial Discharger	Monthly Flow	Total Solids	Volatile Solids	BOD (lbs/month)		Alkalinity (lbs/month)		Calcium (lbs/month)		
		(MG/month)	(lbs/month)	(lbs/month)	Total	Dissolved	Total	Dissolved	Total	Dissolved	Particulate
1	Perris and Menifee Desalter	68	2324	2324	2359	1765	391626	391626	493826	488976	-
2	Chino Desalter	63	5186	1037	1611	1099	751749	-	-	-	-
3	Temescal Desalter	49	1871	1360	1018	963	656223	656223	404958	391005	204
4	Arlington Desalter	33	6477	2459	888	617	374115	374115	219030	215540	1607
5	Chino Desalter II East	23	1327	762	1101	453	22832	15359	54608	30945	226
6	JCSD-Etiwanda	17	106920	103825	114245	47611	221575	186107	41372	62598	1238
7	Bonview	14	24236	22024	25984	9686	16851	11850	2828	2721	107
8	Mountainview Power Plant	13	1086	444	1188	1129	11889	11472	15242	12900	257
9	YVWD - Henry Wochholz Plant	12	676	529	520	520	49204	-	-	-	-
10	CIW/Womens Prison	7.4	14438	13205	12089	4348	-	-	2847	2577	270
11	Mission Linen	7.3	6684	4333	26864	22973	32243	31884	2427	2257	227
12	Stringfellow	3.1	164	156	1694	1210	5648	5036	5648	5200	3.1
13	CIM/Mens Prison	2.2	619	90	50	50	-	-	25050	18409	211
14	Chino Desalter II West	1.7	166	99	92	61	11045	-	895	895	-
15	JCSD-Wineville	1.6	9064	6707	3721	606	14976	25034	1607	1209	511
16	Inland Empire Energy Center	1.3	168	154	198	73	389	373	3179	3167	5.5
17	OLS	1.3	51	49	46	35	1015	1015	818	816	0.8
18	JCSD Hamner	1.3	4400	4100	2832	484	4689	4689	508	469	39
19	Dart Container	0.69	165	49	46	20	1595	1397	2680	2584	47
20	Repet	0.44	4812	2682	13392	10765	5793	5566	284	187	109
21	JCSD Scholar Way Metering Station	0.43	633	584	4415	4256	1871	1558	415	308	-
22	Wellington Foods	0.36	266	233	733	20	1321	-	40	39	20
23	Eastside Water Treatment Plant	0.29	600	530	860	-	-	-	-	-	19
24	JCSD Harrison	0.18	63	16	23	5.3	603	-	172	62	-
25	Inland Bioenergy	0.17	-	-	-	-	-	-	-	-	1.2
26	Flavor Specialities	0.14	271	235	1066	629	653	584	57.1	45	12
27	Giuliano and Sons Briners	0.12	72	66	211	-	-	-	-	-	1455.0
28	JCSD Chandler	0.12	-	-	-	-	-	-	-	-	-
29	Green River Golf Course	0.11	-	-	-	-	-	-	-	-	17.8
30	Rubidoux CSD	0.11	11280.6	3988.0	7308.1	7308.1	2256	2252	1409	439	1.8
31	Agua Mensa Power Plant	0.08	-	-	-	-	-	-	-	-	0.78
32	JCSD Archibald	0.06	305	243	332	104	230	210	50	32	-
33	EMWD Railroad Canyon Pipeline	0.05	6.6	4.6	7.7	1.3	140	140	82	81	-
34	WRCRWA	0.05	6.5	2.0	5.9	1.7	3067	1733	68	60	-
35	City of Corona Ion Exchange Treatment Plant	0.03	42	40	87	-	-	-	-	-	-
36	Temporary Discharge	0.02	41	-	48	-	-	-	-	-	-

A summary of average discharger loadings into the Brine Line for each monitoring parameter is shown below in Table 6. The table compares the current reporting period with the preceding three. Appendix C includes pie charts identifying the top dischargers representing at least 75% of the overall loading for each monitoring parameter from the current and prior reporing periods.

Table 6. Summary of discharger loadings for the current reporting period (April - December 2018) and last reporting period (August 2017-March 2018)

Parameter	April 2016	August 2016 - March 2017	April 2017 - March 2018	April - December 2018
Flow (MG/mo)	313	317	313	314
TSS (lbs/mo)	265,200	307,200	217,500	202,100
VSS (lbs/mo)	175,300	189,600	177,800	170,000
BOD_5 (lbs/mo)	268,400	249,500	261,000	222,700
Dissolved BOD_5 (lbs/mo)	113,300	113,400	125,400	115,000
Alkalinity (lbs/mo)	2,501,500	1,871,400	2,598,400	2,192,000
Dissolved Alkalinity (lbs/mo)	2,395,100	2,418,700	2,363,700	1,336,600
Calcium (lbs/mo)	1,818,600	1,759,800	1,631,300	786,300
Dissolved Calcium (lbs/mo)	1,746,500	1,598,500	1,560,300	754,500

Comparing the results from the current reporting period with the previous discharger loadings in Table 6, flow has remained relatively consistent, fluxuating less than four million gallons per month over the last three years. All the parameters have decreased since last reporting period. Slight decreases were observed in the loading of TSS (-7.1%), VSS (-4.1%), BOD_5 (-14.7%), dissolved BOD_5 (-8.3%), and alkalinity (-15.6%). More dramatic decreases were observed in the loading of dissolved alkalinity (-43%), calcium (-52%), and dissolved calcium (52%). The organic fraction of suspended solids load, estimated using VSS/TSS, remained consistent at 84% during last year's reporting period as well as the current reporting period.

3.4 Mass Balance Calculations

A mass balance of the suspended solids characterization between the discharger loading and the County Line is used to calculate the suspended solids formed through the Brine Line system. A summary of the full suspended solids mass balance is provided below in Table 7.

Table 7. Brine Line system suspended solids composition based on mass balance (April - December 2018).

Component	S-01 Results	Combined Discharger Results	Estimated Formed Solids
	Concentration mg/L	Concentration mg/L	Concentration mg/L
Microbial Biomass	36.0	20.4	15.6
Cellulosic Material	43.3	43.3	0.0
Calcium Minerals	13.7	6.0	7.7
Other Inorganics	15.8	6.0	9.8
Total	**108.9**	**75.7**	**33.1**

The estimated formed suspended solids are partitioned into the four categories shown in Table 7. Cellulose is measured at the County Line and is assumed to remain constant throughout the system. Any suspended solids growth through the system that is not attributed to microbial biomass or calcium minerals is assumed to be non-caclium inorganic matierial (i.e., "other inorganics). Microbial biomass makes up a majority of the formed solids and can be attributed to biological growth. The rest of the formed solids is made up of calcium minerals and other inorganics.

Figure 12 consists of three pie charts representing the water quality characterization of the suspended solids loading at the County Line, of the cummulaitve dischargers and of the estimated formed suspended solids withing the Brine Line.

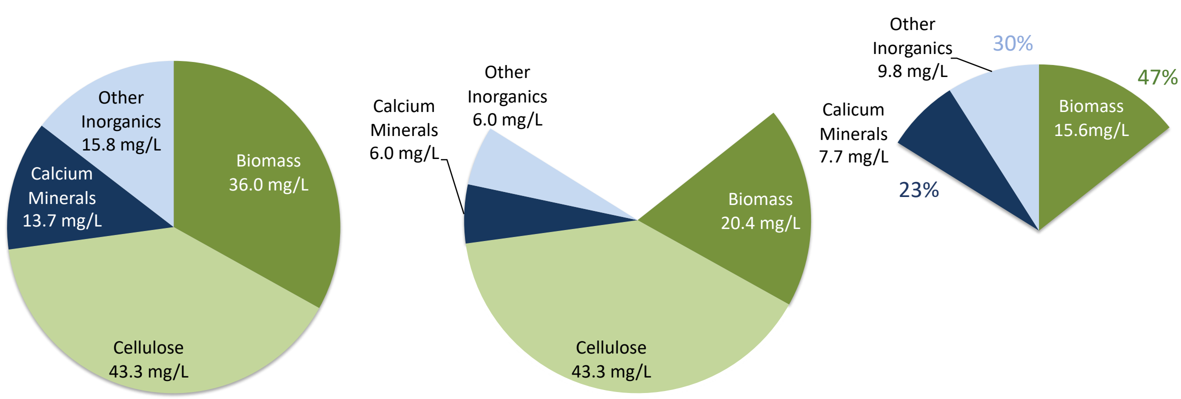

Figure 12. Overall composition of discharged suspended solids for April – December 2018

As shown in the pie chart to the very right in Figure 12, other inorganics makes up 30% of the formed suspended solids. Based on the April 2016 study of the Brine Line system, other non-calcium inorganics were not accounted for in the formed suspended solids, and only made up 7.6% of the suspended solids at the County Line. This category was believed to be composed of silica, silt, and other deposits that have made their way into the Brine Line system (Trussell Tech, 2016e). However, in both the current analysis, as well as last year's, the "other inorganics" portion of the formed suspended solids has become more significant. Despite the growing significance of this category, there is no known formation mechanism for the 'other inorganics', so an alternative approach to apportioning these formed suspended solids is recommended, as explained further in Section 4.

4 Billing Formula

Characterization of the total suspended solids formed in the Brine Line system are shown below in Table 8, Figure 13, and Figure 14 during the following reporting periods:

1) April 2016: values established in 2016 Billing Formula Report (Trussell Tech, 2016e)
2) April 2017-March 2018: values established in 2018 Billing Formula Report (Trussell Tech, 2018)
3) April-December 2018: values established for the current monitoring period, as discussed in Section 3

Consistent with the previously established methodology, the calcium minerals are allocated between the dissolved calcium and components of the dissolved alkalinity (carbonates and phosphates) contributing to the precipitation reactions. The pie charts in Figure 14 include sub-divisions of the pie charts in Figure 13, reflecting the separate contributions that calcium and alkalinity make to the formation of these minerals. The formula uses BOD as a surrogate for biological growth, as well as dissolved calcium and dissolved alkalinity for calcium precipitation. A "service charge" parameter has been added, using flow as a surrogate to partition the costs associated with increases in non-calcium/"other" inorganics.

Table 8. Composition of solids formed in the Brine Line for April 2016, April 2017-March 2018 and April-December 2018

Component	Percent of Total Suspended Solids			Cost Allocation Parameter
	April 2016	April 2017 - March 2018	April 2018 - December 2018	
Microbial Biomass	31%	59%	47%	Dissolved BOD5
Calcium Minerals	69%	24%	23%	Dissolved Calcium (40%) Alkalinity (60%)
Other Inorganics	0%	17%	30%	Flow-based maintenance charge
Total	**100%**	**100%**	**100%**	

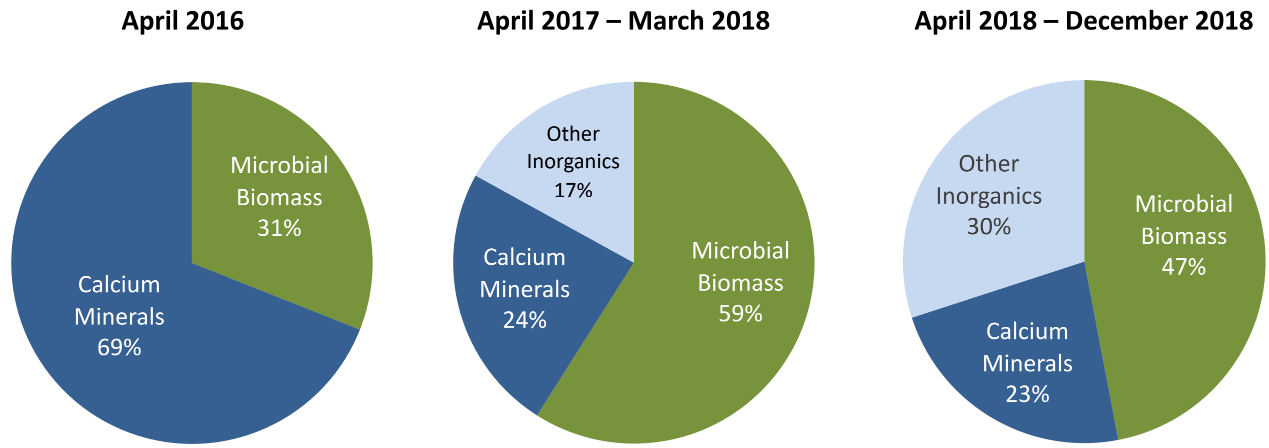

Figure 13. Overall composition of formed suspended solids for April 2016, April 2017 – March 2018, and April – December 2018 Estimates

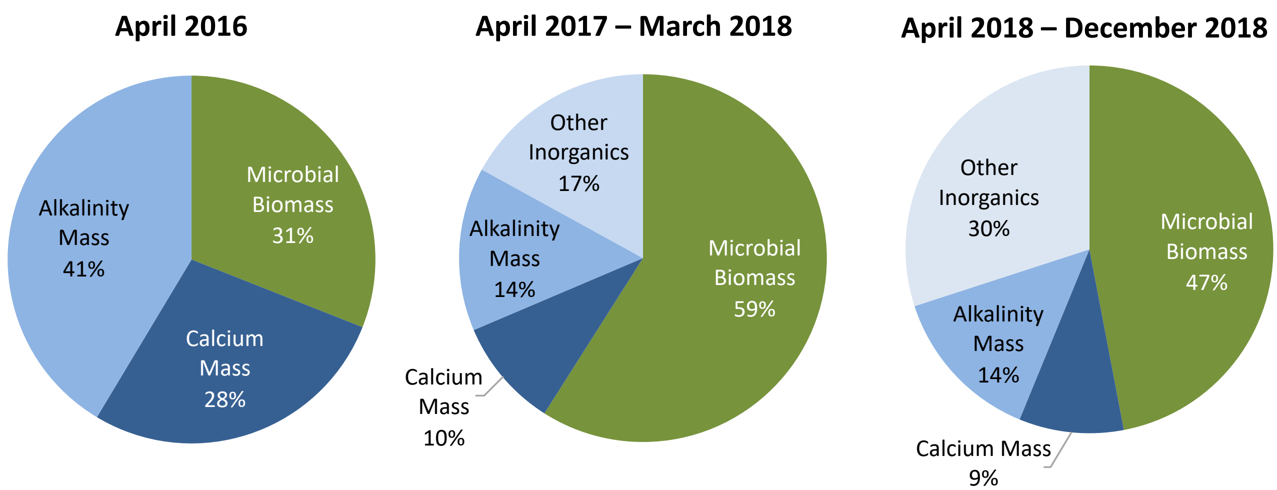

Figure 14. Overall composition of formed suspended solids for April 2016, April 2017-March 2018, and April – December 2018 estimates, by monitoring surrogate.

The billing formula allocates the formed suspended solids in the Brine Line according to the identified composition in Figure 14. The corresponding monitoring surrogates (further explained in Section 4.1) are used as the cost allocation parameters. The formation factor (FF_i) defines the charge assigned to an individual discharger (i), based on their contributions to the overall loading of the identified surrogate parameters (e.g., dissolved BOD_5, dissolved calcium, dissolved alkalinity, flow), discussed in the following section.

4.1 Billing Formula Surrogates

Dissolved BOD_5 measured from each discharger is used as a surrogate for microbial biomass formation. When calcium minerals are found to be formed through the Brine Line system, as they were in the current reporting period, two surrogates are used to allocate the contributing factors in the discharges that lead to precipitation of calcium carbonate and ACPs: 40% to dissolved calcium and 60% to dissolved alkalinity. A flow-based service charge is used to apportion formed solids composed of non-calcium inorganics. These "other inorganic" solids are not well characterized from individual dischargers, due to limitations in the monitoring program. Solids related to inflow and infiltration have been associated with general operations and maintenance of the Brine Line, hence a surrogate of flow is assigned for the 'other inorganics.' As mentioned in Section 3.4, the contribution of other inorganics to the overall formed suspended solids has increased over last three reporting periods. ***Therefore, further investigation of the methodology for characterizing the formed suspended solids is recommended, as discussed further in Section 6.***

4.2 Brine Line Billing Formula

Currently, SAWPA uses the billing formula proposed in 2016 (Trussell Tech, 2016e) to allocate the costs associated with the OCSD treatment and disposal fee to its dischargers, shown below. The billing formula that would result from the current reporting period is also shown below.

2016 Billing Formula (April 2016)

$$FF_{TSS} = \left[\frac{Calcium_m}{Calcium_t} \times (0.28) + \frac{Alkalinity_m}{Alkalinity_t} * (0.41) + \frac{dBOD_m}{dBOD_t} * (0.31)\right]$$

2019 Billing Formula (April 2018 – December 2018)

$$FF_{TSS} = \left[\frac{Calcium_m}{Calcium_t} \times (0.094) + \frac{Alkalinity_m}{Alkalinity_t} * (0.140) + \frac{dBOD_m}{dBOD_t} * (0.471) + \frac{Flow_m}{Flow_t} \times (0.295)\right]$$

Where:

FF_{TSS} = Formation factor for discharger's estimated share of the TSS formation load
$Calcium_m$ = The dissolved calcium load measured for the discharger
$Calcium_t$ = The sum of the dissolved calcium loads measured for all dischargers
$Alkalinity_m$ = The dissolved alkalinity load measured for the discharger
$Alkalinity_t$ = The sum of the dissolved alkalinity loads measured for all dischargers
$dBOD_m$ = The dissolved BOD_5 load measured for the discharger
$dBOD_t$ = The sum of the dissolved BOD_5 loads measured for all dischargers
$Flow_m$ = The individual flow contribution for the discharger
$Flow_t$ = The combined flow for all dischargers to the Brine Line

5 Monitoring Program

Consistent discharger monitoring of the water quality parameters defined in the following subsections per the recommended frequencies is essential for maintaining accurate data that reflects real-time changes in the Brine Line system. The monitoring program established as part of the 2016 Billing Formula Report (Trussell Tech, 2016e) has been updated to reflect the findings from the current reporting period.

5.1 Discharger Solids Characterization Sampling

The loading rates for each discharger for the current reporting period are summarized in

Table 5. Consistent with the methodology from the 2016 report, those loading rates have been classified into three tiers: 1) the top 3 dischargers, 2) the largest dischargers comprising 75% of the total overall loading, 3) the largest dischargers comprising 95% of the total overall discharge, and 4) all remaining dischargers. The monitoring frequencies are determined based on the tiers, summarized below in Table 9. All water quality parameters in Table 9 should be monitored on a quarterly basis, at minimum. Industries that discharge up to 95% of the billing parameters were assigned a monthly sampling frequency, at minimum.

Table 9. Recommended on-going sampling frequency for Brine Line Dischargers (M=monthly, Q=quarterly)

Top 3	75% of loading	95% of loading

Flow Rank	Industrial Discharger	Total Solids	Volatile Solids	BOD		Alkalinity		Calcium		
				Total	*Dissolved*	*Total*	*Dissolved*	*Total*	*Dissolved*	*Particulate*
1	Perris and Menifee Desalter	M	M	M	M	M	M	M	M	M
2	Chino Desalter	M	M	M	M	M	M	M	M	M
3	Temescal Desalter	M	M	M	M	M	M	M	M	M
4	Arlington Desalter	M	M	M	M	M	M	M	M	M
5	Chino Desalter II East	M	M	M	M	M	M	M	M	M
6	JCSD-Etiwanda	M	M	M	M	M	M	M	M	M
7	Bonview*	-	-	-	-	-	-	-	-	-
8	Mountainview Power Plant	M	M	M	M	M	M	M	M	M
9	YVWD - Henry Wochholz Plant	M	M	M	M	M	M	M	M	M
10	CIW/Womens Prison	M	M	M	M	M	M	M	M	M
11	Mission Linen	M	M	M	M	M	M	M	M	M
12	Stringfellow	M	M	M	M	M	M	M	M	M
13	CIM/Mens Prison	M	M	M	M	M	M	M	M	M
14	Chino Desalter II West	Q	Q	Q	Q	Q	Q	Q	Q	Q
15	JCSD-Wineville	M	M	M	M	M	M	M	M	M
16	Inland Empire Energy Center	Q	Q	Q	Q	Q	Q	Q	Q	Q
17	OLS	Q	Q	Q	Q	Q	Q	Q	Q	Q
18	JCSD Hamner	M	M	M	M	M	M	M	M	M
19	Dart Container	Q	Q	Q	Q	Q	Q	Q	Q	Q
20	Repet	M	M	M	M	M	M	M	M	M
21	JCSD Scholar Way Metering Station	M	M	M	M	M	M	M	M	M
22	Wellington Foods	Q	Q	Q	Q	Q	Q	Q	Q	Q
23	Eastside Water Treatment Plant	Q	Q	Q	Q	Q	Q	Q	Q	Q
24	JCSD Harrison	Q	Q	Q	Q	Q	Q	Q	Q	Q
25	Inland Bioenergy*	-	-	-	-	-	-	-	-	-
26	Flavor Specialities	Q	Q	Q	Q	Q	Q	Q	Q	Q
27	Giuliano and Sons Briners	M	M	M	M	M	M	M	M	M
28	JCSD Chandler	Q	Q	Q	Q	Q	Q	Q	Q	Q
29	Green River Golf Course	Q	Q	Q	Q	Q	Q	Q	Q	Q
30	Rubidoux CSD	M	M	M	M	M	M	M	M	M
31	Agua Mensa Power Plant	Q	Q	Q	Q	Q	Q	Q	Q	Q
32	JCSD Archibald	Q	Q	Q	Q	Q	Q	Q	Q	Q
33	EMWD Railroad Canyon Pipeline	Q	Q	Q	Q	Q	Q	Q	Q	Q
34	WRCRWA	Q	Q	Q	Q	Q	Q	Q	Q	Q
35	City of Corona Ion Exchange Treatment Plant	Q	Q	Q	Q	Q	Q	Q	Q	Q
36	Temporary Discharge	Q	Q	Q	Q	Q	Q	Q	Q	Q

* Discharger has been taken offline, no sampling frequency recommendation required

The dissolved parameters are the priority for billing purposes. However, it is essential to monitor both total and dissolved species (BOD_5, calcium, and alkalinity) from the same sample. Total and dissolved species should not be measured from separate samples. This is a crucial aspect that allows a representative correlation between total and dissolved species, resulting in a reliable calculation of solids species. Reliable data on solids species allow for a complete understanding of the inputs into the Brine Line system, and therefore a dependable correlation between discharger solids loading and formation mechanisms.

Furthermore, it is understood that limitations in staffing may result in lower sampling frequencies than recommended for various dischargers. However, if a discharger contributes up to 95% of the total load for any of the billing parameters, at a minimum it is best to measure all parameters from a single sample to allow for ease of implementation of the recommended monitoring program.

5.2 County Line Solids Characterization Sampling

In the 2018 Annual Water Quality and Billing Formula Report, it was recommended that samples from the County Line be analyzed for both metals via ICP and particulate organic carbon (POC) on a monthly basis, rather than quarterly (Trussell Tech, 2018). These changes are outlined below in Table 10, as are the rest of the parameters and frequencies of measurement at S-01.

Table 10. Summary of Monitoring Plan at S-01 Sampling Station

Constituent/Analysis	Test Method	Frequency	Notes
Flow	-	Online monitoring	
pH	-	Online monitoring	
BOD_5	SM 5210B	Weekly	Total and dissolved (TSS filter); Total analysis in triplicate
TSS	SM 2540D	Weekly	Analysis in triplicate; Expedited analysis (<24h hold)
VSS	EPA 160.4	Weekly	Analysis in triplicate; Expedited analysis (<24h hold)
Alkalinity	SM 2320B	Weekly	Total and dissolved (TSS filter)
pH	-	Weekly	Field measurement
Temperature	-	Weekly	Field measurement
Calcium	EPA 200.7	Weekly	Total and dissolved (TSS filter)
TDS	SM 2540C	Monthly	
Metals via ICP *(on suspended solids)*	EPA 6010B	Monthly	Ca, Mg, Na, K, Fe, Si, Al; Trussell Tech to separate solids via centrifugation
Orthophosphate	SM 4500P E	Monthly	Total and dissolved (TSS filter)
Particulate Organic Carbon (POC)	EPA 9060	Monthly	Trussell Tech to separate solids via centrifugation
Dissolved Organic Carbon (DOC)	SM 5310B	Monthly	Using TSS filter paper substitution
X-ray diffraction (XRD)	XRD	Quarterly	Provides mineral characterization
Scanning electron microscopy (SEM) with energy dispersive x-ray spectroscopy (EDX)	SEM/EDX	Quarterly	Provides elemental characterization
Thermogravimetric analysis (TGA)	TGA	Quarterly	Provides cellulose identification and quantification

The current method for monthly sample collection at the County Line monitoring station S-01 is as follows. The 24-hour composite sample is mixed on-site, using a mechanical mixer, and then distributed into bottles for subsequent analysis per the monitoring plan defined in Table 10. The sample bottles are sent to both Babcock Laboratories and the Trussell Tech Lab. Trussell Tech takes the brine sample and separates the suspended solids from the sample using centrifugation, and then ships the resulting wet solids to Babcock Laboratories for metals (ICP-MS) and POC. Quarterly samples follow the same process, but extra sampled is collected, processed for wet solids, and sent to 1) Babcock Laboratories for metals (ICP-MS) and POC, as well as 2) Camet Research for XRD, SEM/EDX, and TGA. Babcock Laboratories also receives splits of the quarterly liquid composite sample and analyzes orthophosphate and dissolved organic carbon (DOC).

It should be noted that aluminum was omitted from the ICP-MS analysis by Babcock for the current monitoring period. This parameter is still desired for the monthly solids analysis and should be included on subsequent monthly frequency chain of custody (COC) documents for monitoring at S-01.

6 Findings and Recommendations

Principal findings from this assessment include the following:

County Line

- **Decrease in Brine Line suspended solids loading:** Continuing a trend from the past two reporting periods, the monthly average suspended solids loading further decreased at the County Line to 286,000 lbs/month this reporting period compared with 328,400 lbs/month in 2018 and 451,700 lbs/month in 2017.
- **The composition of the solids has shifted from the 2016 analysis:** The solids partitioning over the past three reporting periods has consistently been roughly 75% organic and 25% inorganic material, marking an increase over the 60% organic fraction from the 2016 analysis. Of the organic fraction for this year (73% of the TSS), approximately 40% was identified as cellulosic material and the remaining 33% was microbial biomass. On the inorganic side, the fraction of calcium minerals present has decreased to approximately 13% of the suspended solids, with "other inorganics" accounting for the remaining 14%.
- **A consistent trend of lower TSS measurements was observed with collection of larger sample volumes:** Larger sample volumes of 8-10 gallons are collected with the monthly and quarterly solids characterization events and have consistently yielded lower TSS concentrations over the past two reporting periods, as compared with the typical weekly results associated with sample volumes of 2.5 gallons.

Dischargers

- **Data set can be improved**
    - As previously noted, the existing monitoring practice inadequately supports estimation of particulate inputs – to improve the understanding of the particulate loading for the mass balance, the total and dissolved fractions of each monitoring parameter should be analyzed from a single sample. This applies to the measurements of BOD, calcium, and alkalinity, as well as the VSS and TSS.
    - The data collection frequency was insufficient for some of the top loading dischargers for certain parameters (e.g., dissolved calcium), which resulted in poor resolution for the month-to-month loading values due to averaging between data points.

Suspended solids formation

- **The suspended solids formation has decreased:** The net solids formation through the Brine Line has decreased for the current period to 94,000 pounds per month, compared with an average 107,000 pounds per month for the 2018 reporting period. These average solids formation numbers are provided as a point of reference for comparing the changes over time. For billing purposes, SAWPA incorporates a 12-month rolling average of the suspended solids formation.
- **Shifted composition of formed solids:** The suspended solids formed through the Brine Line were partitioned between biomass, calcium minerals, and "other inorganics". While similar to the partitioning from the 2018 analysis, this is a significant shift from the composition determined from the 2016 analysis.

Known changes in the Brine Line system:

- **Chino II Desalter:** The Chino II Desalter Concentrate Reduction Facility became fully operational in February 2018, thus the current reporting period reflects the impact of the facility's removal of dissolved calcium from the Chino II brine discharge.
- **Inland Bioenergy:** This discharger stopped discharging to the Brine Line from August 2017 to August 2018, and then resumed discharging from September 2018 to early March 2019. The facility discharged a large volume of high-TSS waste from its anerobic digesters in January and February 2019, resulting in a large spike in total suspended solids loading and downstream solids formation observed at the County Line. This unusual activity is considered to be non-representative and the Brine Line monitoring data from January through March 2019 was thus eliminated from the current analysis. Inland Bioenergy was removed from the Brine Line in March 2019 and has gone out of business.
- **Bonview:** The Lewis Homes development (Bonview) diverted its flows to the IEUA Regional Plant in August 2018 and will no longer discharge to the Brine Line.

In light of these findings and known changes, the following recommendations are proposed:

- **Adopt a new billing formula:** It is recommended to adopt the proposed billing formula to reflect changes in the Brine Line solids composition observed over the past two reporting periods.

2019 Billing Formula (April 2018 – December 2018)

$$FF_{TSS} = \left[\frac{Calcium_m}{Calcium_t} \times (0.094) + \frac{Alkalinity_m}{Alkalinity_t} * (0.140) + \frac{dBOD_m}{dBOD_t} * (0.471) + \frac{Flow_m}{Flow_t} \times (0.295)\right]$$

- **Continue to implement existing monitoring program:** To continue tracking changes in the Brine Line water quality and suspended solids, it is recommended to maintain the existing monitoring program for both the County Line and individual dischargers to the Brine Line (Section 5).
- **Continue monthly solids characterization at the County Line:** Monthly characterization of suspended solids is recommended for the County Line, as introduced during the 2018-2019 monitoring period. This improves the understanding of seasonal variability in the composition.

- **Review solids formation methodology:** The observed trend of an increasing fraction of non-calcium inorganics at the County Line, merits further investigation. The understanding of the solids is strongest at the County Line, based on the routine monitoring (weekly) and the thorough analysis of the solids fraction of the samples collected. However, reconsideration of the methodology for determining the partitioning of both the discharged and formed solids may result in a more stable assessment that is less vulnerable to the challenge of paired analysis of total and dissolved parameters and analytical challenges discerning between the two parameters. It is recommended to build on the existing methodology and accumulated water quality data to consider an alternative assessment of the discharged solids.

References

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A. Appendix A – Summary Tables of Results from County Line Monthly Samples, April 2018-December 2018

Table A1. Results from the County Line quarterly sampling events

Sample Date	Average TSS (mg/L)	Average VSS (mg/L)	Average Total BOD (mg/L)	Total Alkalinity (mg/L)	Bicarbonate (mg/L)	Total Calcium (mg/L)	Adjusted Dissolved Calcium 1.5um (mg/L)	pH	Temp. (°C)
6/14/18	81	62	33	1110	1110	676	658	7.6	23.9
9/5/18	67	48	28	1160	1160	649	649	7.7	24.7
10/11/18	71	53	22	1110	1110	658	616	7.8	23.7
11/8/18	79	52	30	1000	1000	640	580	7.6	22.7
12/6/18	92	69	32	1000	1000	670	600	7.8	21.2

Table A2. Orthophosphate Results

Sample Date	Ortho-phosphate (mg/L)	
	Total	Dissolved
6/14/18	3.5	-
9/5/18	1.9	-
10/11/18	1.9	1.9
11/8/18	1.9	1.9
12/6/18	0.4	0.4

Table A3. POC results from solids separated by centrifugation

Sample Date	POC % of total mass
6/14/18	33%
9/5/18	33%
10/11/18	37%
11/8/18	37%
12/6/18	32%

B. Appendix B – April 2017-March 2018 Laboratory Report Index

Laboratory	Sample Date	Work Order No.
E.S. Babcock	4/4/18	B8D0470
E.S. Babcock	4/4/18	B8D0472
E.S. Babcock	4/13/18	B8D1490
E.S. Babcock	4/19/18	B8D2055
E.S. Babcock	4/24/28	B8D2406
E.S. Babcock	5/2/18	B8E0232
E.S. Babcock	5/2/18	B8E0236
E.S. Babcock	5/9/18	B8E1052
E.S. Babcock	5/23/28	B8E2480
E.S. Babcock	5/31/18	B8E3166
E.S. Babcock	6/8/18	B8F0862
E.S. Babcock	6/8/18	B8F0865
E.S. Babcock	6/14/18	B8F1495
E.S. Babcock	6/14/18	B8F1497
E.S. Babcock	6/14/18	B8F1578
E.S. Babcock	6/20/28	B8F2065
E.S. Babcock	6/26/18	B8F2584
E.S. Babcock	7/3/18	B8G0267
E.S. Babcock	7/3/18	B8G0268
E.S. Babcock	7/12/18	B8G1517
E.S. Babcock	7/18/18	B8G2210
E.S. Babcock	7/24/18	B8G2894
E.S. Babcock	8/3/18	B8H0438
E.S. Babcock	8/3/18	B8H0443
E.S. Babcock	8/7/18	B8H0767
E.S. Babcock	8/15/18	B8H1990
E.S. Babcock	8/23/18	B8H3025
E.S. Babcock	8/31/18	B8H3992
E.S. Babcock	9/5/18	B8I0387
E.S. Babcock	9/5/18	B8I0394
E.S. Babcock	9/5/18	B8I0399
E.S. Babcock	9/5/18	B8I0602
E.S. Babcock	9/13/18	B8I1645
E.S. Babcock	9/19/18	B8I2308
E.S. Babcock	9/28/18	B8I3518
E.S. Babcock	10/4/18	B8J0875

Laboratory	Sample Date	Work Order No.
E.S. Babcock	10/11/18	B8J1871
E.S. Babcock	10/11/18	B8J1935
E.S. Babcock	10/11/18	B8J2065
E.S. Babcock	10/16/18	B8J2358
E.S. Babcock	10/24/18	B8J3487
E.S. Babcock	10/31/18	B8J4429
E.S. Babcock	11/8/18	B8K1069
E.S. Babcock	11/8/18	B8K1077
E.S. Babcock	11/8/18	B8K1197
E.S. Babcock	11/15/18	B8K1838
E.S. Babcock	11/20/18	B8K2279
E.S. Babcock	11/29/18	B8K3221
E.S. Babcock	12/6/18	B8L0761
E.S. Babcock	12/6/18	B8L0761
E.S. Babcock	12/6/18	B8L0891
E.S. Babcock	12/6/18	B8L0931
E.S. Babcock	12/6/18	B8L0992
E.S. Babcock	12/11/18	B8L1362
E.S. Babcock	12/19/18	B8L2463
E.S. Babcock	12/27/18	B8L3172
E.S. Babcock	1/4/19	B9A0461
E.S. Babcock	1/10/19	B9A1274
E.S. Babcock	1/10/19	B9A1302
E.S. Babcock	1/10/19	B9A2167
E.S. Babcock	1/18/19	B9A2330
E.S. Babcock	1/24/19	B9A2964
E.S. Babcock	2/15/19	B9B1958
E.S. Babcock	2/21/19	B9B2523
E.S. Babcock	2/26/29	B9B2988
E.S. Babcock	2/26/29	B9B3049
E.S. Babcock	3/6/19	B9C0625
E.S. Babcock	3/6/19	B9C0742
E.S. Babcock	3/14/19	B9C1769
E.S. Babcock	3/14/19	B9C2008
E.S. Babcock	3/19/19	B9C2259
E.S. Babcock	3/28/19	B9C3461

C. Appendix C – Top Dischargers Representing Top 75% of Overall Loading for Each Monitoring Parameter

The following pie charts (Figure C1 through Figure C10) identify the top dischargers representing at least 75% of the overall loading for each monitoring parameter from the current reporting period (2019) compared with the results from the previous reporting period (2018).

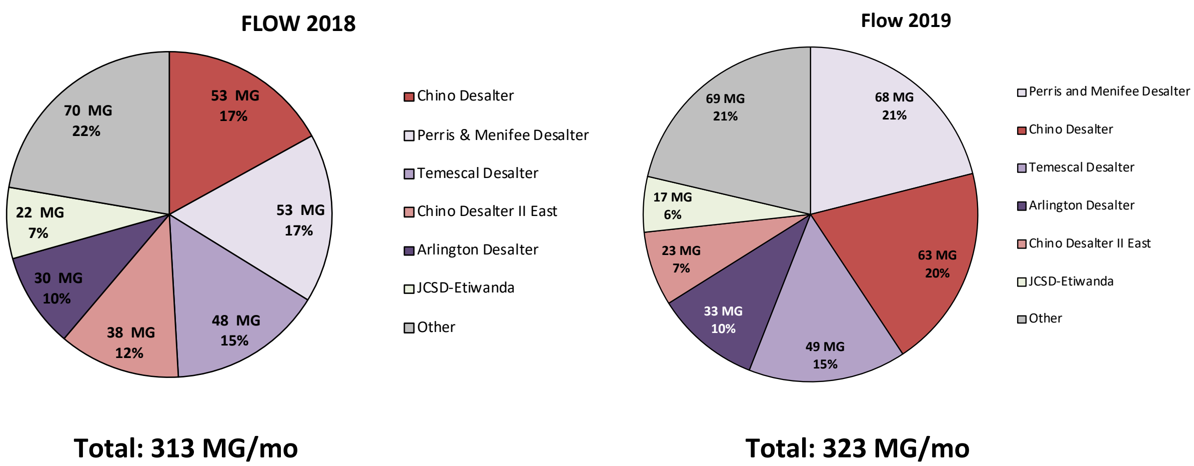


Figure C1. Flow Pie Charts for 2018 and 2019, including top dischargers contributing 75% or greater

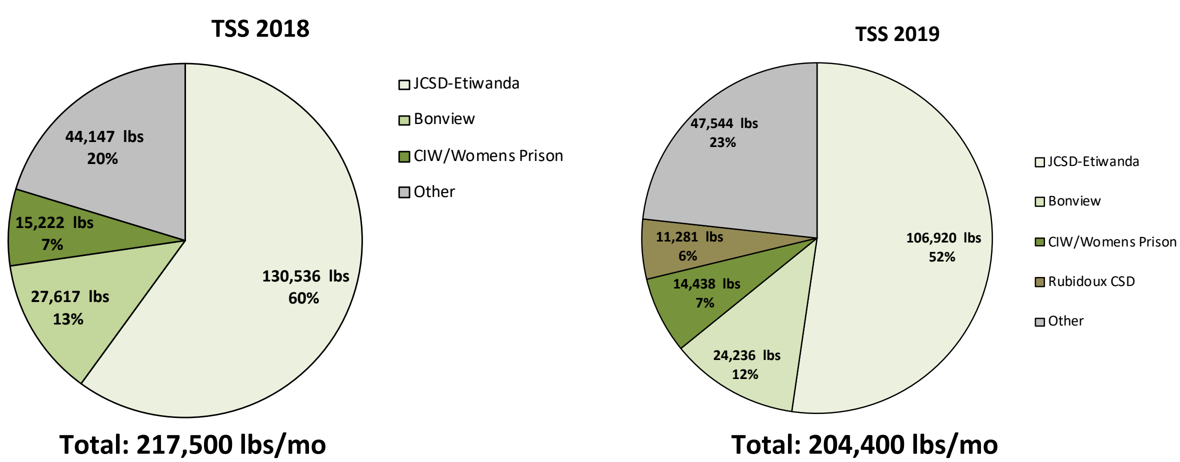


Figure C2. TSS Loading Pie Charts for 2018 and 2019, including top dischargers contributing 75% or greater

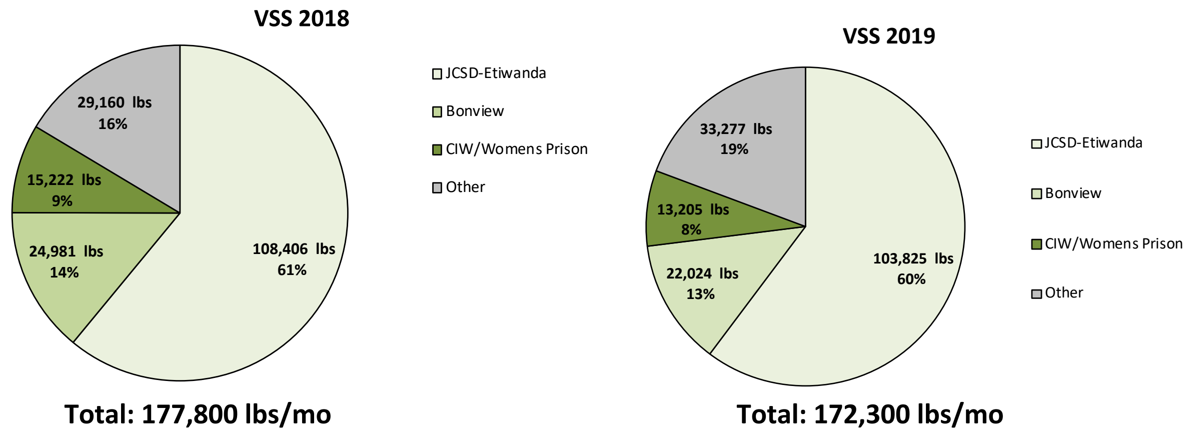


Figure C3. VSS Loading Pie Charts for 2018 and 2019, including top dischargers contributing 75% or greater

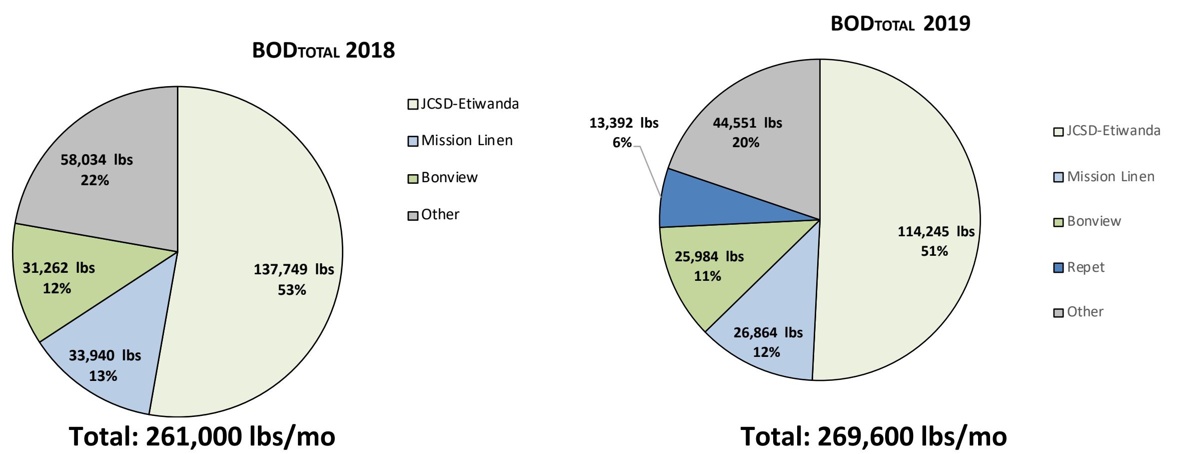


Figure C4. Total BOD_5 Loading Pie Charts for 2018 and 2019, including top dischargers contributing 75% or greater

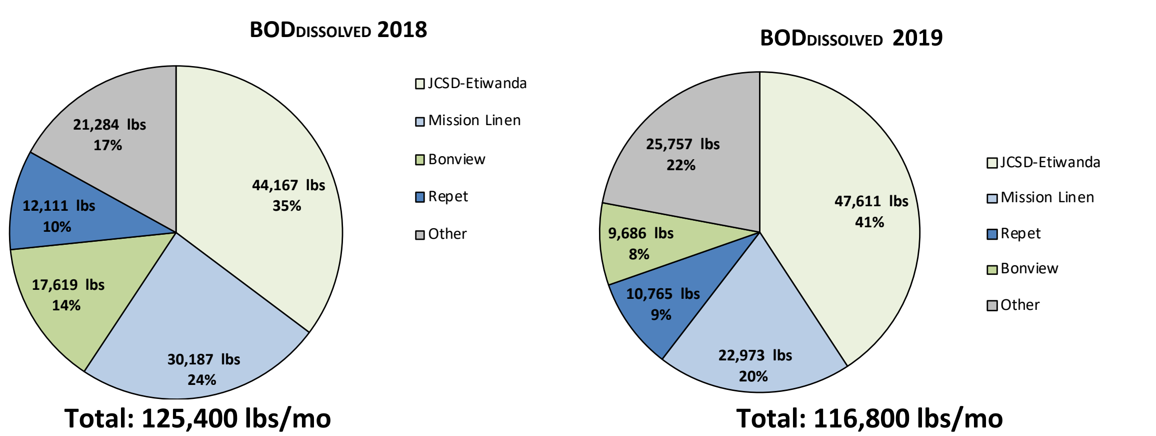


Figure C5. Dissolved BOD_5 Loading Pie Charts for 2018 and 2019, including top dischargers contributing 75% or greater

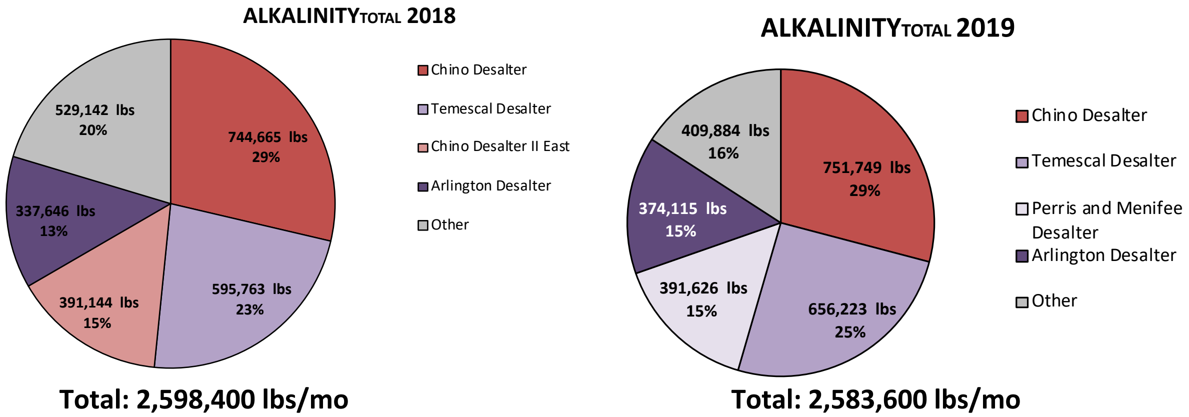


Figure C6. Total Alkalinity Loading Pie Charts for 2018 and 2019, including top dischargers contributing 75% or greater

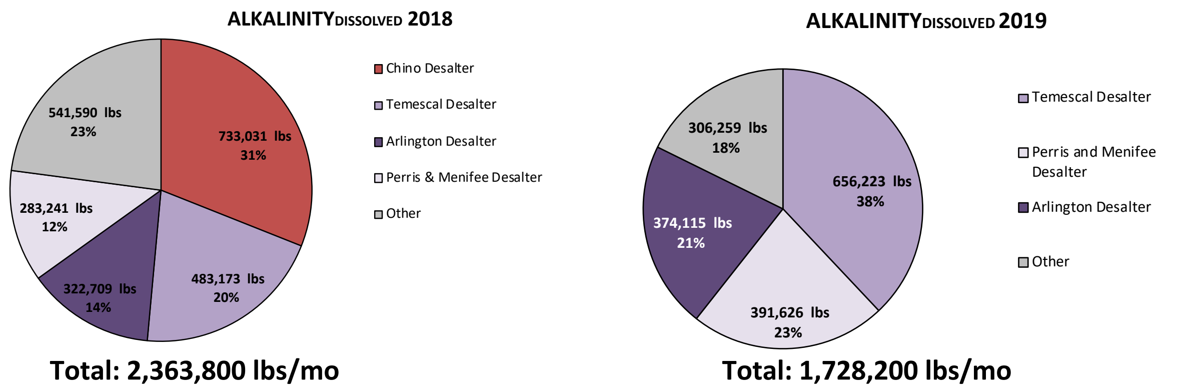


Figure C7. Dissolved Alkalinity Loading Pie Charts for 2018 and 2019, including top dischargers contributing 75% or greater

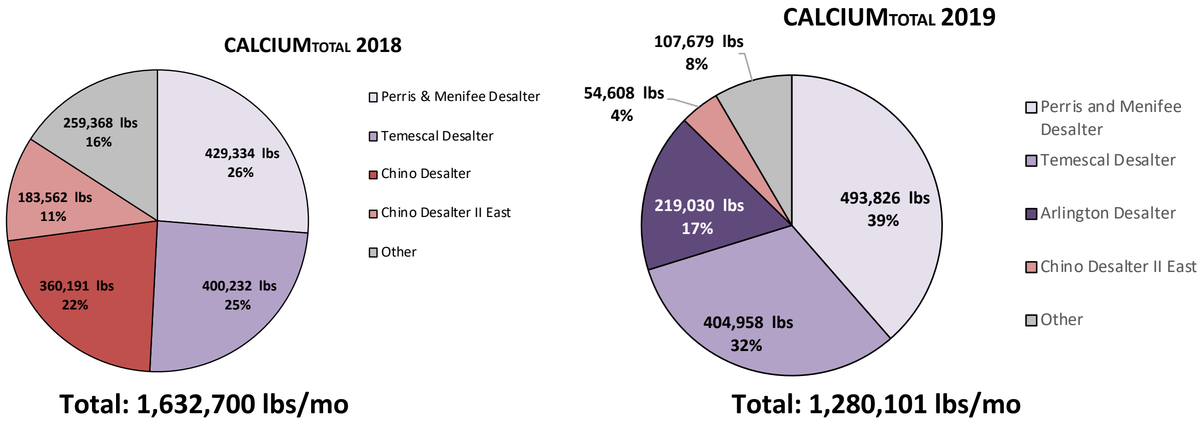


Figure C8. Total Calcium Loading Pie Charts for 2018 and 2019, including top dischargers contributing 75% or greater

The mass load for Chino II West exceeded that of the downstream JCSD-Wineville. Thus, the upstream contribution from JCSD was assumed to be zero.

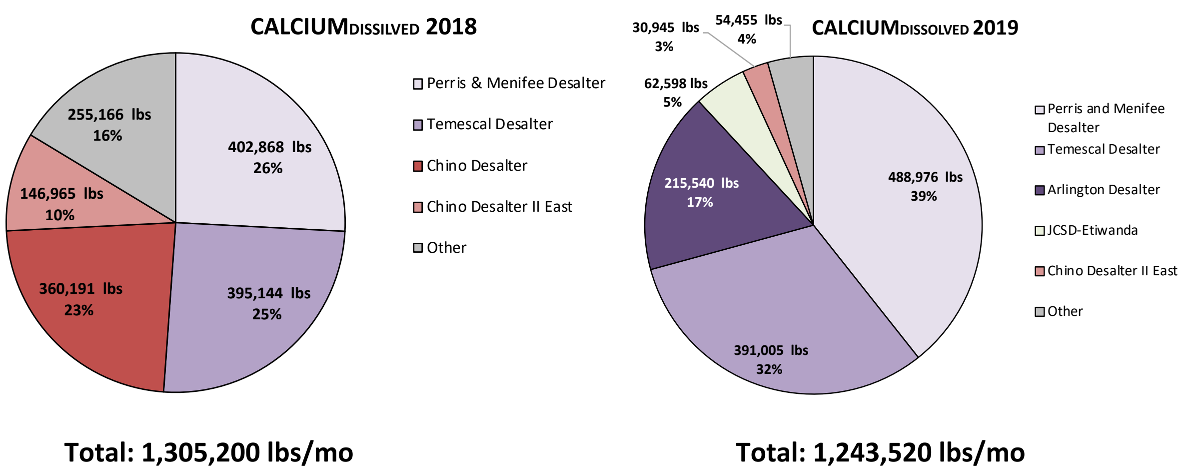
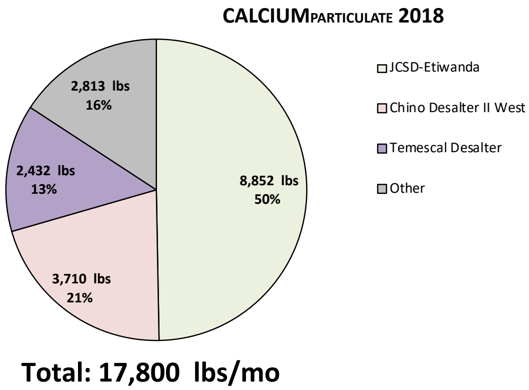


Figure C9. Dissolved Calcium Loading Pie Charts for 2018 and 2019, including top dischargers contributing 75% or greater



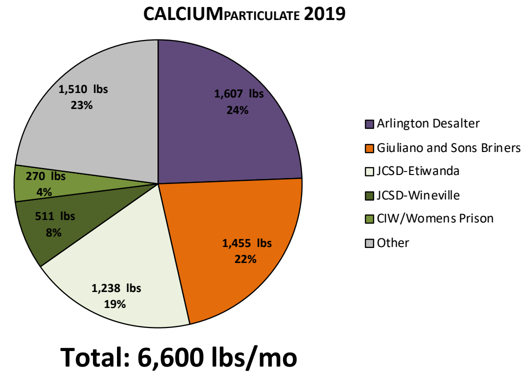


Figure C10. Particulate Calcium Loading Pie Charts for 2018 and 2019, including top dischargers contributing 75% or greater

The mass load for Chino II West exceeded that of the downstream JCSD-Wineville. Thus, the upstream contribution from JCSD was assumed to be zero.