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MEMORANDUM

DATE:	June 27, 2023
TO:	Nora Gamino, Director Bishop Area Wastewater Authority
FROM:	Lumos & Associates, Inc.
SUBJECT:	Bishop Area Wastewater Agency (BAWA) Wastewater Treatment Plant Flow Assessment
CC:	Walt Pachucki, Chairman Bishop Area Wastewater Authority

07/05/23

Introduction

The Bishop Area Wastewater Agency (BAWA), operating under a joint power authority (JPA) between the City of Bishop (City) and the Eastern Sierra Community Service District (ESCSD), is investigating the viability and economic feasibility of a future joint treatment plant. Prior to investigating a joint treatment plant, a design flow rate for existing and future conditions must be established. BAWA has engaged Lumos & Associates, Inc., (Lumos), to investigate flow and precipitation data, perform growth analyses, and develop recommendations for BAWA to consider regarding design flow rates under existing and future conditions.

Both the City and ESCSD currently each operate municipal lagoon wastewater treatment plants located adjacent to one another in Bishop, California, in the Owens River Valley. The City presently has a permitted capacity of 1.6 million gallons per day (MGD) and ESCSD has a permitted capacity of 0.85 MGD.

Existing Conditions

Both ESCSD and the City provide wastewater collection, treatment, and disposal services to residential and non-residential customers within their respective service areas of the City of Bishop and surrounding areas. ESCSD also provides wastewater collection, treatment, and disposal to the Bishop Paiute Tribe (BPT or Tribe) by contract. Total existing connection counts (and EDUs) for ESCSD (District-only) and the City as of April 2022 are provided below in Table 1. Estimated EDU counts and capacity agreements for the Tribe are presented in Table 2.

Table 1: City and ESCSD Residential and Commercial Connections/EDU Counts

Connection Type	ESCSD Connections (EDUs)[1,2]	City Connections (EDUs)[1]
Residential[3]	2,514 (2,514)	850 (1,055.2)
Commercial[4]	60 (166.3)	443 (2,302.4)
RV Park[5]	1 (63)	-
TOTAL	2,575 (2,743.3)	1,293 (3,357.6)

[1]EDU = Equivalent Dwelling Unit
[2]Connection/EDU counts for ESCSD are as of 2022 (Lumos & Associates, 2022)
[3]Residential connections/EDU counts include single-family residential (SFR) units, accessory dwelling units, multi-family residential (MFR), trailers, apartments, and mobile homes.
[4]Commercial connections/EDU counts include commercial, institutional, and industrial connections.
[5]For ESCSD service area, assume 1.0 EDU per RV space, 63 occupied spaces on average = 63 EDUs (Lumos & Associates, 2022). For City of Bishop service area, RV connections counts (and EDUs) included as Residential

Table 2: Bishop Paiute Tribe EDUs and Capacity Agreements

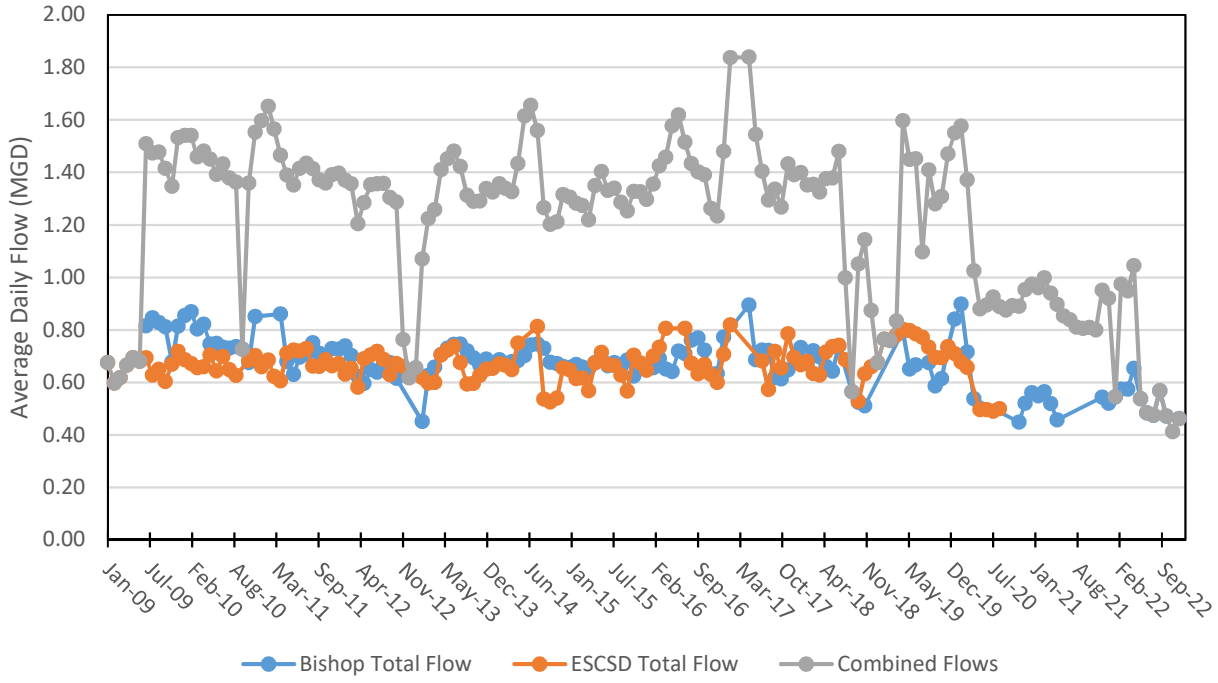
Bishop Paiute Tribe Connection	Estimated EDUs[1]	Allotted Capacity by Contract (gpd)
Metered Connections	698	315,000
Unmetered Connection[2]	40	10,000
TOTAL	738	325,000

[1]Count as of 2018 (R.O. Anderson, 2018); current count unknown
[2]For 40 unmetered connections

Existing Flows

The City and ESCSD provided Lumos with historical flow data from January 2009 through December 2022. Outliers were removed and the flows were combined as shown in Figure 1. Note that in 2022, ESCSD's flow meters malfunctioned and flow data was only available for January 2022, and parts of March 2022, April 2022, and May 2022. It should be noted that total flows for ESCSD, as presented throughout this memo, are inclusive of flows from the Tribe.

Figure 1: City of Bishop, ESCSD, and Combined Existing Flows



Using statistical analysis, the average daily flow (ADF), peak hour flow (PHF), and maximum month flow (MMF) were determined as detailed below.

Average Daily Flow

Monthly flow data was provided from July 2009 through December 2022 for the City and ESCSD. Outliers were determined using calculated lower and upper bound values for each data set. Any flow above the upper bound or below the lower bound were removed from the data set as these could skew the calculated average. The lower and upper bound values for the City, ESCSD, and combined flows are provided in Table 3.

Table 3: Lower and Upper Bounds for Outlier Analysis

Parameter	Lower Bound (MGD)	Upper Bound (MGD)
City of Bishop Flows	0.3	1.0
ESCSD Flows	0.5	0.8
Combined Flows	0.4	2.1

After removing the outliers, the ADF calculated for each month (monthly flows divided by days) were averaged together to determine the ADF over the period of July 2009 through December 2022 (Table 4). As shown in Table 4, the ADFs for City of Bishop and ESCSD average out to the same amount at 0.67 MGD each.

Table 4: Combined Average Daily Flow

Parameter	Average Daily Flow (MGD)[1]
City of Bishop	0.67
ESCSD	0.67
Combined Flows (Jul 2009-Dec 2022)[2]	1.35
Combined Flows (Jul 2009-Dec 2021)[2,3]	1.38

[1]Outliers were determined and removed prior to calculating average flow
[2]All City and ESCSD (including outliers) were combined and outliers were determined and removed prior to calculating the combined average flow
[3]This range was selected to exclude 2022 as the ESCSD flow meters did not record flow for most of this time period

The ADF for ESCSD (0.67 MGD) and City (0.67 MGD) is below the ADF identified in the *Feasibility Report for Joint Treatment and Nutrient Removal* (2016 Report) which identified the ADF for ESCSD and the City as 0.703 MGD and 0.697 MGD, respectively (RO Anderson Engineering, 2016). The ADF values recommended in the 2016 report are based on the 2015 *Summary of Recommended Flows and Concentrations for Joint Treatment* Report. Given that this report encompasses more recent data, the ADF for ESCSD and the City differs from that recommended in the 2015 report.

Peak Hour Flow

PHF represents the maximum flow rate that can occur in one (1) hour. The PHF can be determined via flow studies, or calculated using Equation 1 from Ten States Standards. The population used in Equation 1 includes only the population for City of Bishop and ESCSD and does not include the population for the Bishop Paiute Tribe as the exact population is unknown and excluding the tribe population results in a more conservative (higher) peaking factor.

Equation 1: Peaking Factor

$$\frac{\text{Q Peak Hourly}}{\text{Q Design Average}} = \frac{18 + \sqrt{\text{Population}}}{4 + \sqrt{\text{Population}}}$$

Using a population of 3,820 for the City of Bishop (U.S. Census Bureau, n.d.), according to Equation 1, the peaking factor (Q Peak Hourly/Q Design Average) is 3.4, equating to a PHF of 4.5 MGD for the combined City and ESCSD flows.

In the 2018 *Final Plant Expansion and Nutrient Removal* Report (R.O. Anderson, 2018), ESCSD established a PHF (instantaneous peak daily flow) and an ADF of 1.36 MGD and 0.703 MGD, respectively. The ADF and PHF identified in the 2018 report equate to a peaking factor of 1.9, which is lower than that calculated using the Ten States Standards. Given that 2018 report values were established for ESCSD, a peaking factor of 1.9 will be used to determine the PHF of the combined City and ESCSD flows as documented in Table 5.

Table 5: Combined Peak Hour Flow

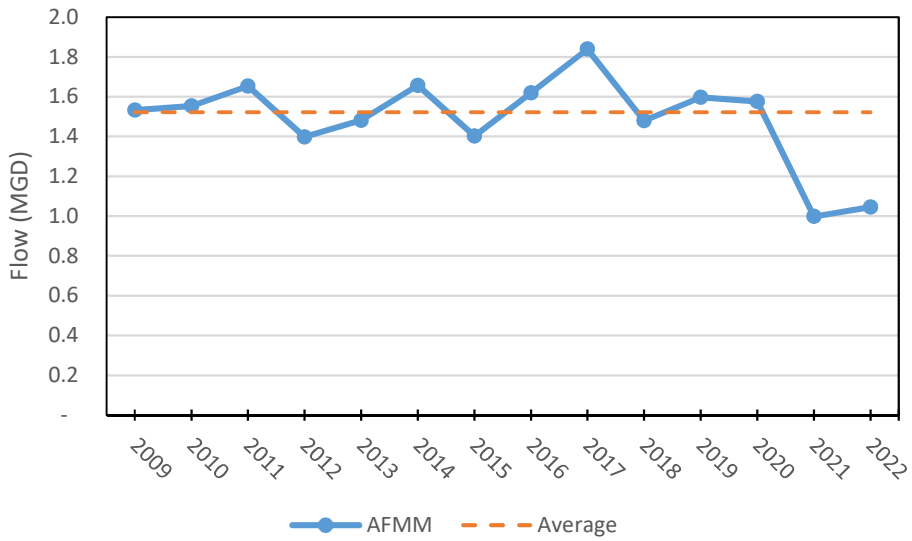
Parameter	Value
Peaking Factor[1]	1.9
Combined ADF (MGD)[2]	1.38
Combined Peak Hourly Flow (MGD)	2.60

[1]The peaking factor was determined based on flows established for ESCSD in the 2018 *Final Plant Expansion and Nutrient Removal* Report (R.O. Anderson, 2018)
[2]Combined ADF (Jul 2009-Dec 2021) from Table 4

Average Maximum Month Flow

The average flows during the maximum month for the combined City and ESCSD flows from 2009 through 2022 are plotted below in Figure 2 along with an average across the time period reviewed.

Figure 2: Combined Maximum Month Flow



As shown in Figure 2, the maximum monthly flow ranges from 1.0 to 1.8 MGD with an average of 1.5 MGD from 2009-2022. The maximum month flow by year and percent differences from the 2009-2022 average (1.5 MGD) are provided in Table 6.

Table 6: Combined Maximum Month Flows 2009-2022

Year	Maximum Month Flow (MGD)[1]	% Difference from 2009-2022 Average Maximum Month Flow[1]
2009	1.5	0.7
2010	1.6	2.1
2011	1.7	8.6
2012	1.4	-8.2
2013	1.5	-2.7
2014	1.7	8.8
2015	1.4	-7.8
2016	1.6	6.4
2017	1.8	20.4
2018	1.5	-2.7
2019	1.6	5.0
2020	1.6	3.6
2021	1.0	-34.4
2022	1.0	-31.3

[1]The 2009-2022 average maximum month flow is 1.5 MGD

As shown in Table 6, the largest difference above the average maximum month flow occurred in 2017, which had a maximum month flow of 1.8 MGD that occurred in February. The largest difference

below the average maximum month flow occurred in 2021, which had a maximum month flow of 1.0 MGD.

Inflow and Infiltration

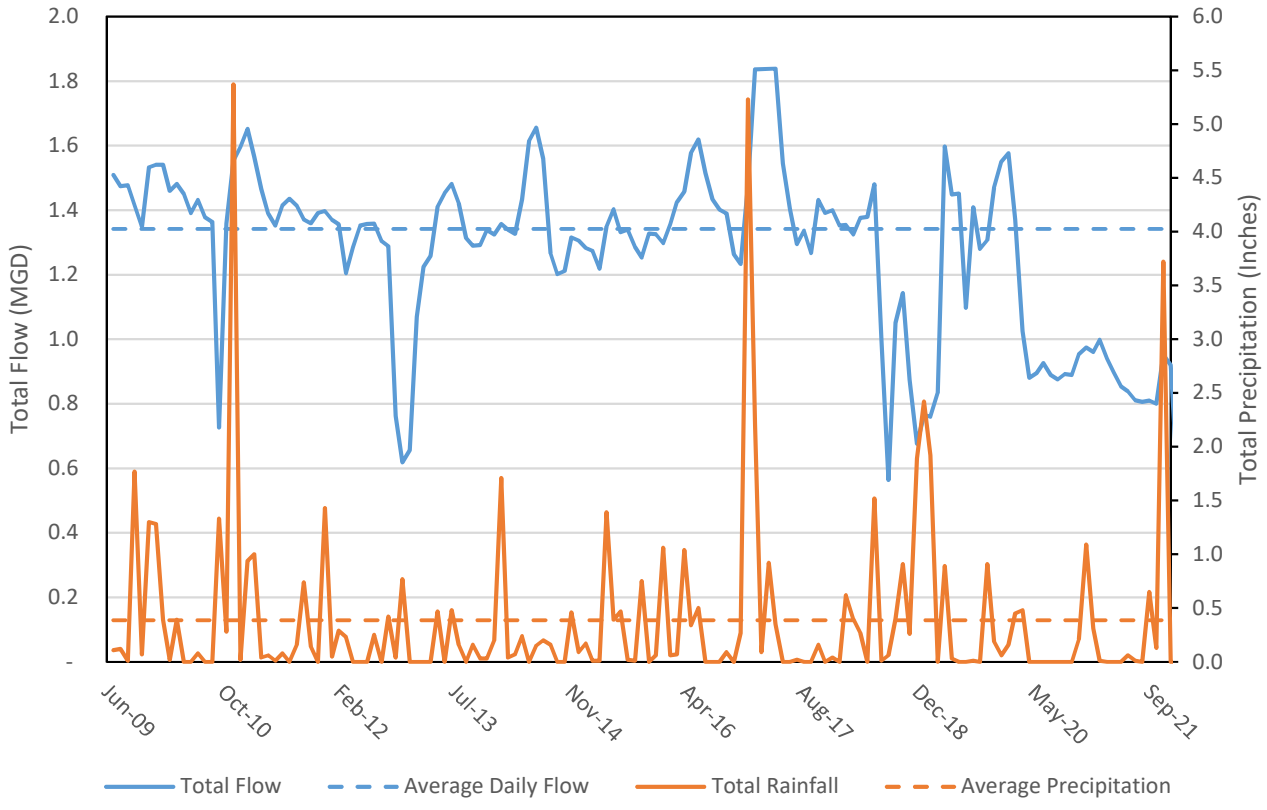
Precipitation

Lumos identified two (2) precipitation gages, referred to as "precipitation gage 1" and "precipitation gage 3", in the Bishop area to analyze the presence of inflow and infiltration (I&I) due to precipitation and groundwater levels.

Precipitation gage 1 is located near South Highway 395, north of the Bishop Country Club and is operated by the City of Los Angeles Department of Water and Power. Manually collected monthly precipitation data is available dating back to January 1905. Precipitation gage 3 is located in the Bishop Airport and the data is provided by the National Oceanic and Atmospheric Administration (NOAA). Daily precipitation data is available dating back to September 1943. For both gages, the last 15 years of data was used in the analysis to correlate precipitation trends to the available flow data.

The monthly precipitation data, monthly combined wastewater flows, average precipitation, and average combined flows, are each shown in Figure 3. Given that the precipitation data collected at precipitation gages 1 and 3 were nearly identical and that gage 3 is a nationally administered gage, only precipitation data from precipitation gage 3 is shown in Figure 3.

Figure 3: Total Flow and Precipitation



As shown in Figure 3, periods experiencing above average total rainfall typically also experience above average flow, indicating a relationship between wastewater flow and precipitation. For example, the maximum total monthly precipitation in 2017, 5.23 inches, occurred in January 2017, which is considered one of the wettest months in the history of Inyo County (NOAA, n.d.). The maximum combined average daily flow, 1.84 MGD, occurred in April 2017, following this incredibly wet period. To further analyze the relationship between wastewater flow and precipitation, a correlation analysis was conducted in Microsoft Excel. The calculated correlation coefficient is provided in Table 7.

Table 7: Correlation Coefficients for Precipitation and Flow 2009-2022

Flow	Correlation Factor
Precipitation & Total Flow, July 2009 – January 2022[1]	0.20

[1]October 2010, December 2012, September 2018, January 2019 – March 2019, and February 2022 – December 2022 were all excluded from the correlation analysis as these time periods were missing either ESCSD or City of Bishop flow data which resulted in lower combined flows.

A correlation coefficient of 0.2 indicates a positive linear relationship between wastewater flow and precipitation, implying that periods of higher precipitation typically also experience higher wastewater flows. The correlation coefficient does not indicate a perfect linear relationship (a correlation coefficient of 1.0 indicates a perfect linear relationship), and given that the correlation coefficient is below 0.5, the linear relationship is not strong.

To further determine the impacts of I&I due to precipitation, average daily wet weather flow and average daily dry weather flow were calculated. Based on review of precipitation data from January 2008 to December 2022, October through April were deemed wet weather months as these months typically saw higher levels of precipitation. May through September were deemed "dry weather" months, as these months typically experienced little to no precipitation. The average flow rate for the wet weather months and dry weather months for the combined average daily flow is provided in Table 8.

Table 8: Wet Weather and Dry Weather Average Flows

Flow Type	Average Flow (MGD)[1] Combined
Wet Weather Flow[2]	1.36
Dry Weather Flow[3]	1.30
Percent Difference	4.4%

[1]Outliers were removed prior to calculating the average flow rate as described previously for in Table 3
[2]Wet Weather Months = October through April
[3]Dry Weather Months = May through September

As shown in Table 8, there is little difference (4.4%) between the wet weather month flow and dry weather month flows, further indicating that precipitation does not strongly influence wastewater flow rate as observed with the correlation coefficient analysis in Table 7.

Groundwater

To further analyze the potential impacts of I&I, quarterly groundwater elevations from City operated monitoring wells were compared to wastewater flows. Monitoring Wells 2 (MW-2), 6 (MW-6), and 7

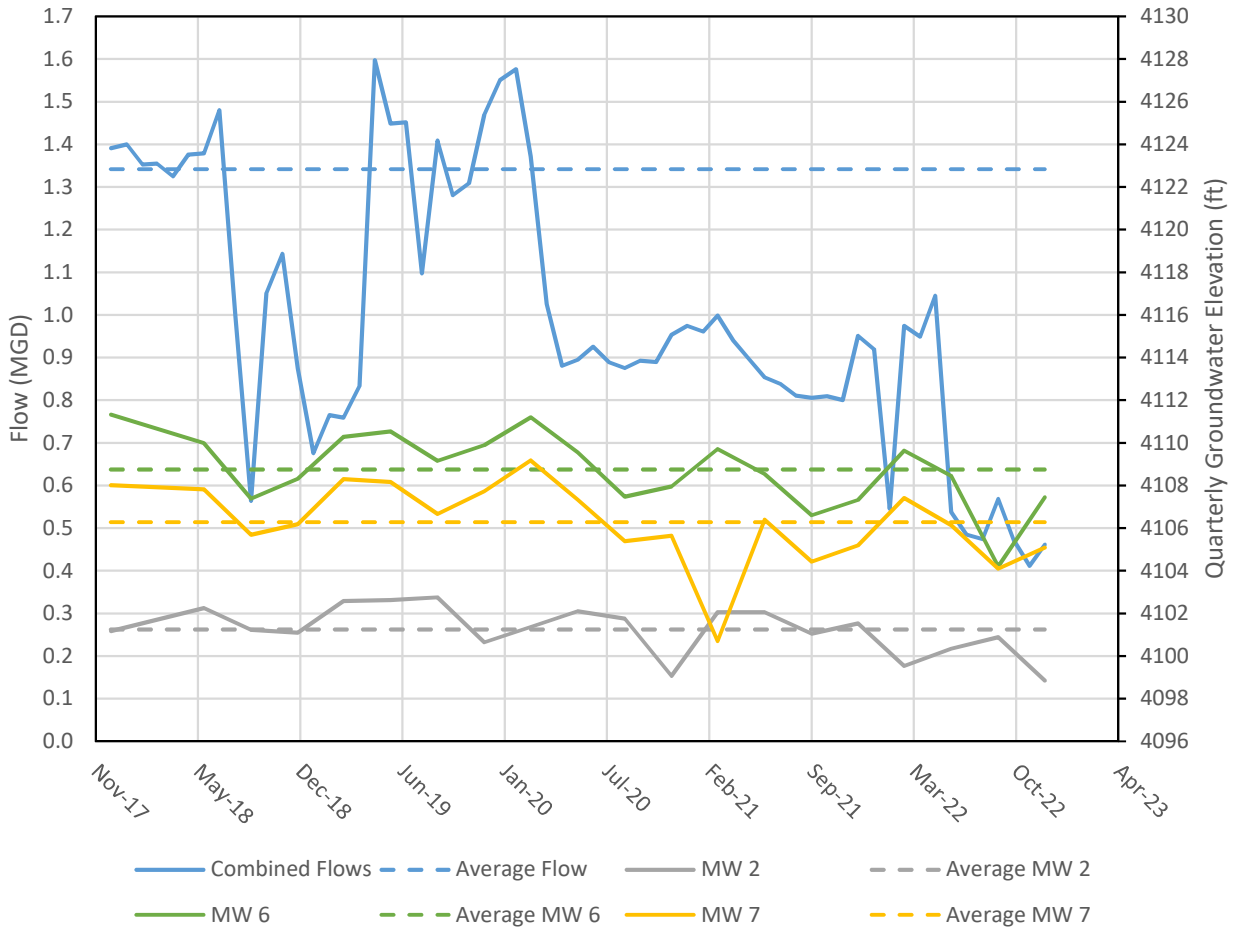
(MW-7) were selected for analysis to determine the relationship between wastewater flow and groundwater elevations. Information on MW-2, MW-6, and MW-7 is provided in Table 9.

Table 9: Groundwater Monitoring Well Details

Monitoring Well ID	Location Description	Well Depth (ft bgs)
MW-2	Directly south of ESCSD's wastewater treatment plant on the north edge of the irrigation area	Approximately 20
MW-6	West of ESCSD Treatment Plant	19.5
MW-7	South of the City of Bishop's wastewater treatment facility outside the irrigation area.	20

Quarterly groundwater elevations at all three (3) monitoring wells and the combined ADF for ESCSD and the City are provided in Figure 4.

Figure 4: Total Flow and Groundwater Elevation



As shown in Figure 4, typically periods with above average groundwater levels correspond to periods with above average wastewater flows. The correlation coefficient was calculated based on the total combined plant flow and averaged groundwater elevation as provided in Table 10.

Table 10: Correlation Coefficient for Groundwater Elevation and Combined ADF

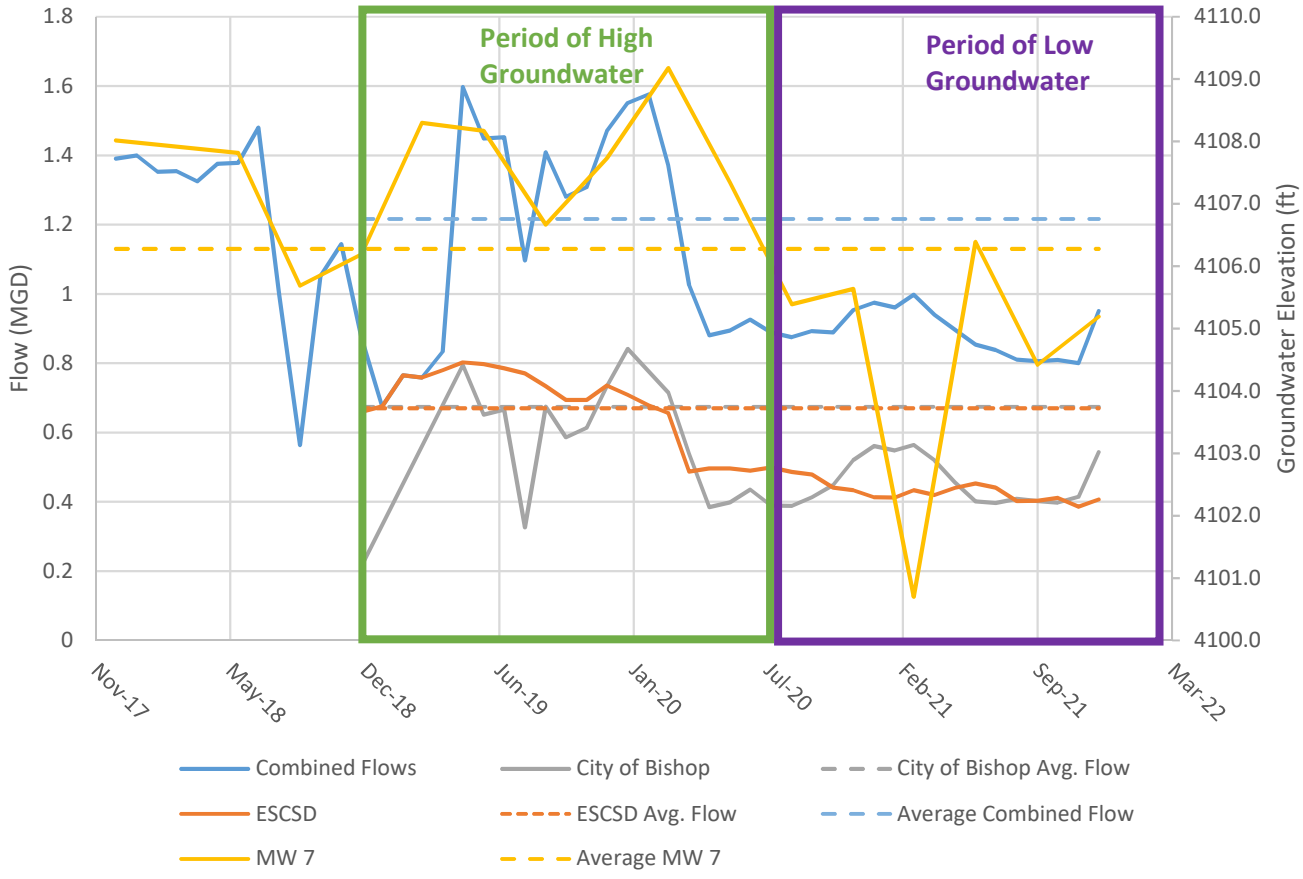
Time Period[1]	Correlation Coefficient
December 2017 – December 2022	0.86

[1]To calculate the correlation, quarterly groundwater elevations from MW 2, MW 6, and MW 7 were compared to total monthly wastewater flows, averaged by quarter.

As shown in Table 10, there is a strong correlation, 0.86, between the combined wastewater flows and groundwater levels. This correlation coefficient indicates that periods of higher groundwater levels typically also experience higher wastewater flows, indicating that potentially groundwater is infiltrating the system.

Similar to analyzing flows for wet weather months and dry weather months, flows were averaged for periods of high and low groundwater. High groundwater periods were from December 2018 through July 2020, and low groundwater periods were from July 2020 through December 2021 based on the groundwater elevations observed in MW-7 as the trends were most clearly evident in MW-7. Groundwater levels in MW-7, combined flows, ESCSD flows, and City of Bishops flow with their respective averages are shown in Figure 5 for periods of high and low groundwater.

Figure 5: Flows during Periods of High and Low Groundwater



As shown in Figure 6, periods with high groundwater (as indicated by the green box), all correspond to flow rates above average. Likewise, periods with low groundwater (as indicated by the purple box) all correspond to flow rates below average.

The average flows for periods of high and low groundwater are provided in Table 11.

Table 11: High and Low Groundwater Average Flows

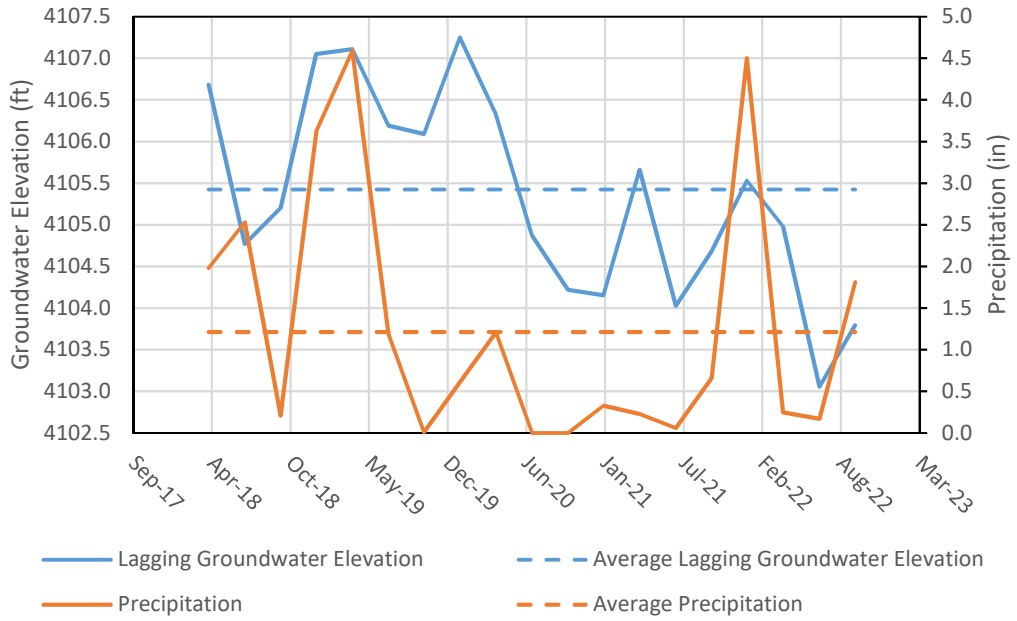
Flow Type	Average Flow (MGD)[1]		% Difference
	High Groundwater[2]	Low Groundwater[3]	
Combined	1.16	0.89	30%

[1]Outliers were removed prior to calculating the average flow rate
[2]High Groundwater Period = December 2018 through July 2020
[3]Low Groundwater Period = July 2020 through December 2021

As shown in Table 11, groundwater appears to significantly influence plant flow as periods of high groundwater are correlated with an average flow that is 30% higher than flows during periods of low groundwater. During this time, it was noted that water consumption did not increase, indicating that the higher wastewater flows are not due to an increase in water consumption but rather potentially an increase in the groundwater level.

Typically, groundwater levels are influenced by precipitation; however, the change in groundwater levels is often delayed from the precipitation event due to a number of factors such as soil types and properties including soil percolation rates, infiltration capacities, and the unsaturated depth to the aquifer. To determine the relationship between groundwater levels and precipitation, the precipitation and groundwater data were plotted against each other (Figure 6). Please note that the groundwater data was offset by two (2) months from precipitation events to account for the delayed effects of precipitation.

Figure 6: Relationship between Precipitation and Groundwater Elevation



As shown in Figure 6, increases in precipitation typically correspond with lagging increases in groundwater levels, indicating that precipitation influences groundwater elevation. The correlation coefficient between groundwater elevation and precipitation is 0.45, indicating that a positive linear relationship exists between precipitation and groundwater elevation.

Despite the low correlation coefficient relating precipitation and wastewater flows (0.2 per Table 7), and the small percent difference between wet weather and dry weather flows (4.4% per Table 8), it was concluded that I&I contributes to wastewater flows, primarily via groundwater infiltration, potentially by as much as 30%. This conclusion was based on the following:

- Observed graphical relationship between precipitation and wastewater flows as shown in Figure 3 and between groundwater levels and wastewater flows as shown in Figure 4.
- Correlation coefficient between groundwater levels and wastewater flow is 0.86, indicating a strong linear relationship between groundwater levels and wastewater flows (i.e. periods of high groundwater levels also experience high wastewater flows).
- Wastewater flows increased by 30% during periods of high groundwater compared to periods of low groundwater without an associated increase in wastewater production either from growth or occupancy. During this time period (2018 through 2020) the City's water usage was lower than previous quarters, indicating that the increase in wastewater flows was not resulting from an increase in water consumption. See Figure 5 and Table 11.
- Correlation coefficient between groundwater levels and precipitation is 0.45, indicating that high levels of precipitation typically results in elevated groundwater elevations.

Generation Factor

Ideally, metered water usage data for each connection in the system would be available as a means to estimate sewer generation factors by user-type. This is typically done by reviewing winter water demands and assuming that sewer flows are 80% of the water demand during this time of year (i.e., months with little to no irrigation demand). Using the estimated sewer generation rates, EDU conversion factors can be determined between user-types to estimate total EDU counts in the service area. The sewer generation factors and EDU conversions can then serve as a basis for projecting future flows.

Unfortunately, water meter data for the City and ESCSD is only available for a very limited and select set of customers. For the City, this includes 42 commercial connections, 26 multi-family residential connections, and 10 single-family residential connections from 2010 through 2019. For ESCSD, this includes eight (8) commercial connections and 10 single-family residential connections. Because water meter data is not available for all customers (or at least from a larger set of customers), it is difficult to estimate sewer generation factors that can reliably be applied system-wide. Even so, the limited meter data available was evaluated for comparison with previously established generations rates and industry standards. Further details are provided below.

ESCSD

In 2022, ESCSD completed a treatment capacity evaluation to assess treatment plant capacity available for existing and future connection commitments and growth potential in the ESCSD service area (Lumos & Associates, 2022). As part of the evaluation, sewer generation factors were reassessed, which included evaluation of existing water demand data. A recap of that analysis is provided below.

As mentioned for the ESCSD service area, water meter data is only available for a select set of residential customers (10 connections, located in the Indian Creek Water Association) and commercial customers (8 connections). Commercial water demand data varies too drastically between customers to use as an average for non-residential user types, especially for such a small sample size. Based on the monthly meter records for the 10 residential connections, winter water usage (months with little to no irrigation) from December to February 2021 was calculated at an average day demand (ADD) of 180 gpd/EDU. Assuming sewer flows are 80% of the water demand (Crites & Tchobanoglous, 1998)[1], the estimated average sewer flow is only 145 gpd/EDU (ADF). This sewer flow estimate is significantly lower than ESCSD's previously adopted rate of 250 gpd/EDU (Bartle Wells Associates, 2014) and is difficult to justify with data from only 10 connections over a one-year period. It should also be noted that estimating a factor from water usage data does not take into account the impacts of I&I. Even with these limitations to the water usage analysis, the results warranted additional consideration for lowering the District's wastewater generation factor. Without system-wide water demand data for sewer flow estimates, typical industry standard sewer flow rates were used for non-residential/commercial connections by customer type to estimate total flows and corresponding EDU counts. As a result, the ADF and average estimated number of EDUs from 2013 to 2019 were used to recommend a reduced wastewater generation factor of 202 gpd/EDU, which was subsequently adopted by the ESCSD Board in 2022.

To validate the adopted wastewater generation factor of 202 gpd/EDU, the previous analysis was updated as part of the memo using an extended data range from 2007-2021. The estimated wastewater generation factor based on existing total plant flows and estimated EDUs is shown in Table 12 (assuming all residential units and RV Park spaces at 1.0 EDUs each per the 2022 evaluation). With an existing ADF of 670,000 gpd (2007-2021 average) and an estimated count of 3,481.3 EDUs (2022 average), the equivalent wastewater generation factor is estimated at 192.5 gpd/EDU.

Table 12: ESCSD Estimated EDUs and Updated Generation Factor

Parameter	Value
Total ADF, gpd (2007-2021)	670,000
No. Existing Residential EDUs (2022)	2,514
No. Existing Commercial & RV Park EDUs[1] (2022)	229.3
Subtotal District-Only EDUs	2,743.3
Estimated No. Tribe EDUs (2018)[2]	738
Total EDUs (District + Tribe)	3,481.3
Total WW Generation Factor (gpd/EDU)	**192.5**

[1]Includes 166.3 commercial EDUs and 63 RV Park EDUs (Lumos & Associates, 2022) [1]
[2]Count as of 2018 per (Lumos & Associates, 2022) and (Bartle Wells Associates, 2014)

The generation factor provided in Table 12 (192.5 gpd/EDU) is lower but very comparable to that calculated in the 2022 evaluation (202 gpd/EDU). Given that the ESCSD Board has already adopted the sewer generation factor of 202 gpd/EDU, and the adopted factor is more conservative, it will continue to be used as the established wastewater generation factor for this report.

City of Bishop

Evaluation of sewer generation factors for City of Bishop considering industry standard and water usage data is discussed further below.

[1] Typically ranges from 60-80% (Crites & Tchobanoglous, 1998).

Considering industry standard sewer generation rates, single-family homes typically generate 40-80 gpd/person of wastewater (Tchobanoglous, et al., 2014). According to Department of Finance (DoF), Inyo County has 2.25 persons per household. Assuming that each person generates 40-80 gpd of wastewater, it would be expected that a single family would produce approximately 90-180 gpd, which equates to a wastewater generation factor for a single-family home at 90-180 gpd/EDU (one single-family home equals one EDU).

As discussed previously, water meter data for City of Bishop is available for only 42 commercial connections, 26 multi-family residential connections, and 10 single-family residential connections from 2010 through 2019. The number of connections, metered water demand data, estimated wastewater generation rates, and equivalent EDU/connection factors are detailed in Table 13. As shown in Table 13, based on winter water meter data and assuming that sewer flows are 80% of water demand (Crites & Tchobanoglous, 1998), a single-family home has an estimated wastewater generation factor of 308 gpd/EDU, significantly higher than the industry standard for a single-family home (90-180 gpd/EDU). While the residential wastewater generation factor calculated based upon water meter data is much higher than should be expected, it is not surprising considering the limited data set of only 10 residential connections. Even so, the calculations from limited data set are still useful to determine EDU conversion factors for non-residential/commercial connection types for the City of Bishop service area. However, for planning purposes and future flow projections (especially in residential areas), it is recommended that the City use a more reasonable sewer generation factor comparable to that adopted by ESCSD (202 gpd/EDU).

Table 13: Water Demands and EDU Conversion Factors for Commercial Connections within City of Bishop Service Area

Connection Type	Number of Connections	Quarterly Water Demand Range (gpd/connection)[1]	Average Wastewater Generation (gpd/connection)[2]	EDU per Connection Conversion Factors[3]
Bar	1	426 – 1,370[2]	523	1.7
Beauty Shop	1	0 – 87	36	0.1
Brewery[4]	1	--	--	11.7
Carwash	2	2,395 – 3,655	2,469	8.0
Church	5	624 – 1,391	709	2.3
Fairgrounds[5]	1	--	7,514	24.4
Gas Station	2	2,504 – 5,191	3,068	10.0
Hall	3	270 – 680	359	1.2
Hospital	2	2,570 – 9,093	5,263	17.1
Hotel	5	3,587 – 4,469	3,233	10.5
Laundry Mat	2	1,700 – 2,092	1,533	5.0
Multi-Family	26	551 – 826	524	1.7
Other/General Commercial	12	835 – 2,104	1,359	4.4
Restaurant	3	2,153 – 3,125	2,117	6.9
School	2	1,089 – 7,150	3,291	10.7
Single-Family Home	10	266 – 510	308	1.0
Storage Unit	2	6 – 3,016	670	2.2

[1]Water demand range is based on winter water meter data (Dec-Feb) available from Jan 2017 through Mar 2019
[2]Wastewater flows were assumed to be 80% of winter water demand data (Crites & Tchobanoglous, 1998)
[3]EDU were determined based on one single-family home = one EDU = 308 gpd
[4]Brewery EDUs were calculated assuming 2.375 EDU/1,000 ft^2 (Broward County, 2017)
[5]Fairground flow rates were assumed to be 2.0 gpd/visitor (Crites & Tchobanoglous, 1998). The number of visitors at the fairgrounds was estimated to be 3,757 based on maximum seated capacity

Using the EDUs for the various commercial types (Table 13), the average residential and commercial connection counts from 2007 through 2021 were determined and summed together to calculate the average total connection counts in the City service area from 2007 through 2021. The total connection count was used to determine a system-wide wastewater generation factor based on the ADF. A system-wide wastewater generation factor (on the basis of an EDU), rather than separate generation factors for commercial and residential, was determined due to the varying flowrates between connections. As shown in Table 14, with an existing ADF of 670,000 gpd (2007-2021 average) and an estimated count of 3,557.6 EDUs (2007-2021 average), the equivalent wastewater generation factor for the City is estimated at 199.5 gpd/EDU, which is very similar to the wastewater generation factor for ESCSD (202 gpd/EDU).

Table 14: City of Bishop Estimated EDUs and Wastewater Generation Factor

Parameter	Value
Total ADF, gpd (2007-2021)	670,000
No. Existing Residential EDUs (2007-2021)	1,055.2
No. Existing Commercial EDUs (2007-2021)	2,302.4
Total EDUs	3,357.6
Total WW Generation Factor (gpd/EDU)	**199.5**

Future Flows

Future flow rates were projected over a 20-year planning horizon for low, hybrid, and high population growth rates accounting for I&I influence. For reference, a low growth rate projection will be based on the Department of Finance's (DoF) growth rate, a hybrid growth rate will be based on a 2% commercial growth rate and DoF residential growth rate, and a high growth rate will be based on a uniform 2% growth rate for both residential and commercial growth.

Low Growth Projections

Annual DoF population projections and equivalent growth rates for Inyo County over the next 20 years are provided in Table 15. As shown in Table 15, a population decline is projected over the majority of the period, ranging from a low of -0.94% (population decline) to a high of 0.07% (population increase). Applying the DoF growth rates to the estimated EDU counts for ESCSD (Table 12) and for the City (Table 14) would result in a total decline of 114.6 and 140.7 EDUs, respectively, over the next 20-years. Based on recent and anticipated trends for ESCSD and the City, the DoF growth rates may not be realistic nor do they provide a conservative approach for capacity planning.

Table 15: DoF Low Growth Rate Projections

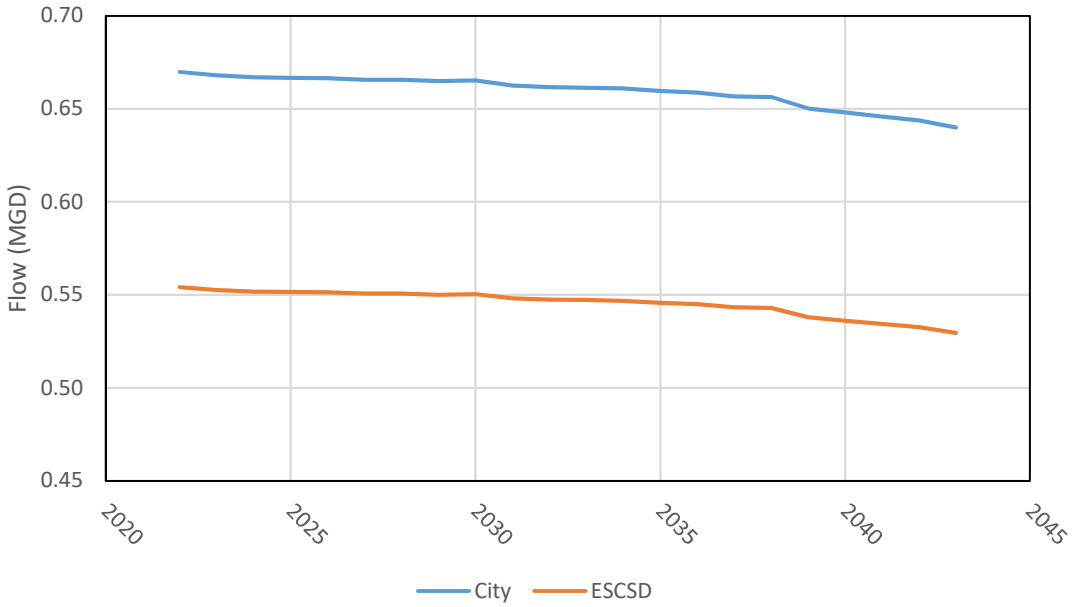
Year	DoF Inyo County Population Projections[1]	Calculated Annual Growth Rate	Projected EDUs		Annual Change in EDUs	
			ESCSD (District Only)	City of Bishop	ESCSD (District Only)	City of Bishop
2022 (past)	18,142	-	2,743.3[2]	3,357.6	-	-
2023 (base)	18,094	-0.26%	2,736.0	3,348.7	-7.3	-8.9
2024	18,065	-0.16%	2,731.6	3,343.3	-4.4	-5.4
2025	18,055	-0.06%	2,730.1	3,341.4	-1.5	-1.9
2026	18,053	-0.01%	2,729.8	3,341.0	-0.3	-0.4
2027	18,029	-0.13%	2,726.2	3,336.6	-3.6	-4.4
2028	18,029	0.00%	2,726.2	3,336.6	0.0	0.0
2029	18,008	-0.12%	2,723.0	3,332.7	-3.2	-3.9
2030	18,020	0.07%	2,724.8	3,334.9	1.8	2.2
2031	17,944	-0.42%	2,713.3	3,320.9	-11.5	-14.0
2032	17,922	-0.12%	2,710.0	3,316.8	-3.3	-4.1
2033	17,914	-0.04%	2,708.8	3,315.3	-1.2	-1.5
2034	17,902	-0.07%	2,707.0	3,313.1	-1.8	-2.2
2035	17,864	-0.21%	2,701.3	3,306.1	-5.7	-7.0
2036	17,843	-0.12%	2,698.1	3,302.2	-3.2	-3.9
2037	17,785	-0.33%	2,689.3	3,291.4	-8.8	-10.8
2038	17,778	-0.04%	2,688.2	3,290.1	-1.1	-1.3
2039	17,610	-0.94%	2,662.8	3,259.0	-25.4	-31.1
2040	17,552	-0.33%	2,654.0	3,248.2	-8.8	-10.8
2041	17,494	-0.33%	2,645.2	3,237.4	-8.8	-10.8
2042	17,438	-0.32%	2,636.7	3,227.0	-8.5	-10.4
2043	17,336	-0.59%	2,621.4	3,208.0	-15.5	-19.0
20-YR Change[3]	**-758**	**-**	**-114.6**	**-140.7**	**-114.6**	**-140.7**

[1]Projections per CA DOF Report P-2A: Total Estimated and Projected Population for California and Counties: July 1, 2010 to 2060 (7/19/21), www.dof.ca.gov/Forecasting/Demographics/Projections/.
[2]Total estimated existing EDUs as of 2022 (District-only, excludes Tribe): 2,514 residential EDUs (assuming 1 EDU per connection) + 166.3 commercial EDUs + 63 RV Park EDUs = 2,743.3 (Lumos & Associates, 2022).
[3]Change from 2023 to 2043

Based on the projected annual changes in EDUs provided in Table 15, ESCSD and City of Bishop would expect to experience a growth of approximately -5.7 EDUs/yr and -7.0 EDUs/yr, respectively. In ESCSD, a total of 16 EDUs have been added to the system over the past 10 years, which equates to 1.6 new EDUs per year. Please note that historical connection data from 2008 through 2011 was not as specific as it is today, so the connection count changes from those years were excluded from the average change in EDUs. For the City of Bishop, an average of 14 EDUs per year have been added to the system over the past 12 years. The historic change in EDUs for both ESCSD and the City exceed that of the DoF growth rates, especially considering historic trends show a steady increase in EDUs, whereas DoF rates show a decline.

Using the calculated wastewater generation factors for ESCSD of 202 gpd/EDU (Lumos & Associates, 2022), and the factor for the City at 199.5 gpd/EDU (per Table 14), future flows based on DoF growth rates were projected as shown in Figure 7.

Figure 7: DoF Low Growth Rate Flow Projections



Hybrid Growth

The hybrid growth model assumes DoF growth rates for residential connections and a 2% growth rate for commercial connections. Future EDU projections for both the City and ESCSD are provided in Table 16 below.

Table 16: Hybrid Growth Projections

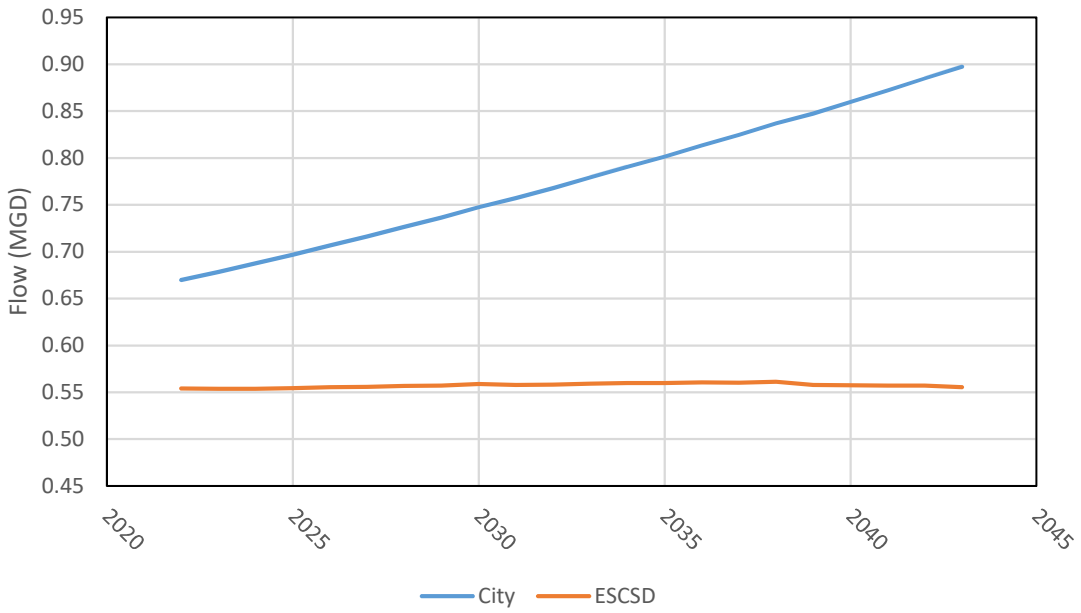
Year	ESCSD Projected EDUs (District Only)			City of Bishop Projected EDUs			Annual Change in Combined EDUs	
	Residential[1]	Commercial[2]	Combined	Residential[1]	Commercial[2]	Combined	ESCSD (District Only)	City of Bishop
2022 (past)	2,514.0	229.3	2,743.3	1,055.2	2,302.4	3,357.6	-	-
2023 (base)	2,507.3	233.9	2,741.2	1,052.4	2,348.5	3,400.9	-2.1	43.3
2024	2,503.3	238.6	2,741.9	1,050.7	2,395.5	3,446.2	0.7	45.3
2025	2,501.9	243.4	2,745.3	1,050.1	2,443.4	3,493.5	3.4	47.3
2026	2,501.6	248.3	2,749.9	1,050.0	2,492.3	3,542.3	4.6	48.8
2027	2,498.3	253.3	2,751.6	1,048.6	2,542.1	3,590.7	1.7	48.4
2028	2,498.3	258.4	2,756.7	1,048.6	2,592.9	3,641.5	5.1	50.8
2029	2,495.4	263.6	2,759.0	1,047.4	2,644.8	3,692.2	2.3	50.7
2030	2,497.1	268.9	2,766.0	1,048.1	2,697.7	3,745.8	7.0	53.6
2031	2,486.6	274.3	2,760.9	1,043.7	2,751.7	3,795.4	-5.1	49.6
2032	2,483.6	279.8	2,763.4	1,042.4	2,806.7	3,849.1	2.5	53.7
2033	2,482.5	285.4	2,767.9	1,041.9	2,862.8	3,904.7	4.5	55.6
2034	2,480.8	291.1	2,771.9	1,041.2	2,920.1	3,961.3	4.0	56.6
2035	2,475.5	296.9	2,772.4	1,039.0	2,978.5	4,017.5	0.5	56.2
2036	2,472.6	302.8	2,775.4	1,037.8	3,038.1	4,075.9	3.0	58.4
2037	2,464.6	308.9	2,773.5	1,034.4	3,098.9	4,133.3	-1.9	57.4
2038	2,463.6	315.1	2,778.7	1,034.0	3,160.9	4,194.9	5.2	61.6
2039	2,440.3	321.4	2,761.7	1,024.2	3,224.1	4,248.3	-17.0	53.4
2040	2,432.3	327.8	2,760.1	1,020.8	3,288.6	4,309.4	-1.6	61.1
2041	2,424.3	334.4	2,758.7	1,017.4	3,354.4	4,371.8	-1.4	62.4
2042	2,416.5	341.1	2,757.6	1,014.1	3,421.5	4,435.6	-1.1	63.8
2043	2,402.3	347.9	2,750.2	1,008.1	3,489.9	4,498.0	-7.4	62.4
20-YR Change[3]	**-105.0**	**114.0**	**9.0**	**-44.3**	**1,141.4**	**1,097.1**	**9.0**	**1,097.1**

[1]Residential EDU projections were determined using DoF growth rates
[2]Commercial EDU projections were determined using a 2% growth rate. The commercial EDU counts for ESCSD include RV Park spaces per Table 12.
[3]Change from 2023-2043

Using a hybrid growth scenario, the ESCSD service area sees a change of 9.0 EDUs in 20 years, which equates to approximately 0.5 EDUs added per year. This is less than the observed growth of approximately 1.6 EDUs/year for the past 10 years. The City service area sees a large change in EDUs over 20 years, 1,097.1 EDUs, which is mostly due to commercial growth. This growth rate, which equates to approximately 55 EDUs/year, far exceeds the observed growth rate of 14 EDUs/year over the past 12 years.

Using the wastewater generation factors for ESCSD (202 gpd/EDU) and the City (199.5 gpd/EDU), the future flow rates were calculated as shown in Figure 8.

Figure 8: Hybrid Growth Rate Flow Projections



Under the hybrid growth scenario, the City flows increase by 34% over 20 years due to their greater presence of commercial connections compared to ESCSD.

High Growth

The high growth model assumes that both residential and commercial connections will experience a 2% annual growth rate. Future EDU projections for both the City and ESCSD are provided in Table 17 below.

Table 17: High Growth Projections

Year	ESCSD Projected EDUs (District Only)			City of Bishop Projected EDUs			Annual Change in Combined EDUs	
	Residential[1]	Commercial[2]	Combined	Residential[1]	Commercial[2]	Combined	ESCSD (District Only)	City of Bishop
2022 (past)	2,514.0	229.3	2,743.3	1,055.2	2,302.4	3,357.6	-	-
2023 (base)	2,564.3	233.9	2,798.2	1,076.3	2,348.5	3,424.8	54.9	67.2
2024	2,615.6	238.6	2,854.2	1,097.8	2,395.5	3,493.3	56.0	68.5
2025	2,667.9	243.4	2,911.3	1,119.8	2,443.4	3,563.2	57.1	69.9
2026	2,721.3	248.3	2,969.6	1,142.2	2,492.3	3,634.5	58.3	71.3
2027	2,775.7	253.3	3,029.0	1,165.0	2,542.1	3,707.1	59.4	72.6
2028	2,831.2	258.4	3,089.6	1,188.3	2,592.9	3,781.2	60.6	74.1
2029	2,887.8	263.6	3,151.4	1,212.1	2,644.8	3,856.9	61.8	75.7
2030	2,945.6	268.9	3,214.5	1,236.3	2,697.7	3,934.0	63.1	77.1
2031	3,004.5	274.3	3,278.8	1,261.0	2,751.7	4,012.7	64.3	78.7
2032	3,064.6	279.8	3,344.4	1,286.2	2,806.7	4,092.9	65.6	80.2
2033	3,125.9	285.4	3,411.3	1,311.9	2,862.8	4,174.7	66.9	81.8
2034	3,188.4	291.1	3,479.5	1,338.1	2,920.1	4,258.2	68.2	83.5
2035	3,252.2	296.9	3,549.1	1,364.9	2,978.5	4,343.4	69.6	85.2
2036	3,317.2	302.8	3,620.0	1,392.2	3,038.1	4,430.3	70.9	86.9
2037	3,383.5	308.9	3,692.4	1,420.0	3,098.9	4,518.9	72.4	88.6
2038	3,451.2	315.1	3,766.3	1,448.4	3,160.9	4,609.3	73.9	90.4
2039	3,520.2	321.4	3,841.6	1,477.4	3,224.1	4,701.5	75.3	92.2
2040	3,590.6	327.8	3,918.4	1,506.9	3,288.6	4,795.5	76.8	94.0
2041	3,662.4	334.4	3,996.8	1,537.0	3,354.4	4,891.4	78.4	95.9
2042	3,735.6	341.1	4,076.7	1,567.7	3,421.5	4,989.2	79.9	97.8
2043	3,810.3	347.9	4,158.2	1,599.1	3,489.9	5,089.0	81.5	99.8
20-YR Change[3]	**1,246.0**	**114.0**	**1,360.0**	**522.8**	**1,141.4**	**1,664.2**	**1,360.0**	**1,664.2**

[1]Residential EDU projections were determined using a 2% growth rate
[2]Commercial EDU projections were determined using a 2% growth rate. The commercial EDU counts for ESCSD include RV Park spaces per Table 12.
[3]Change from 2023-2043

Under the high growth scenario, the ESCSD service area would see an additional 1,360.0 EDUs in 20 years, which equates to approximately 68 EDUs added per year. This greatly exceeds historically observed growth of approximately 1.6 EDUs/year over the past 10 years and is very unlikely considering this level of growth also significantly exceeds the growth potential in the existing ESCSD service area. Per the 2022 capacity evaluation, the following has been identified for potential growth within the service area boundaries (Lumos & Associates, 2022):

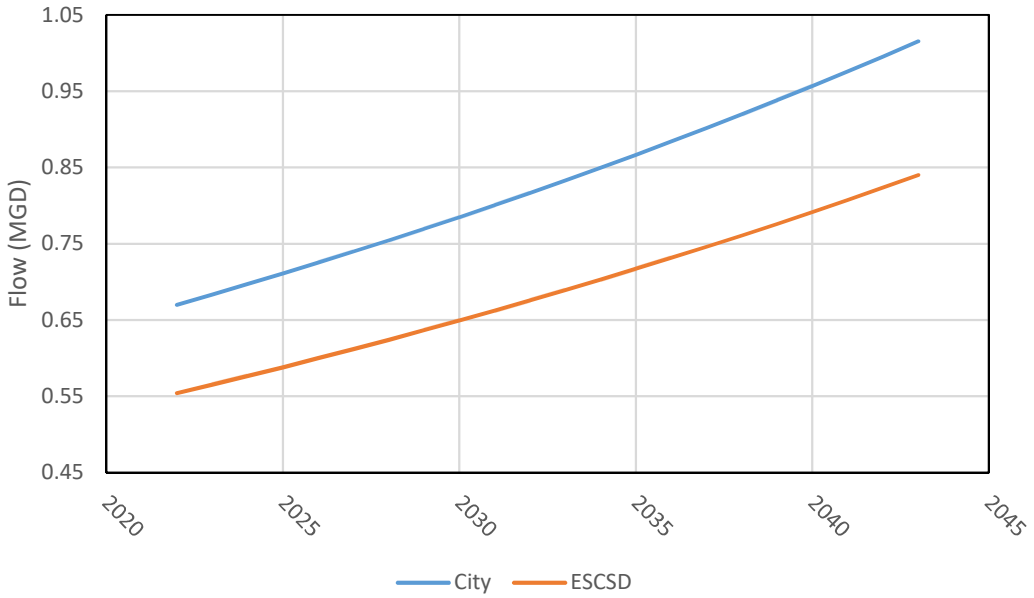
- District Active Standby: 124 vacant parcels with purchased capacity.
- District Inactive Standby: 6 vacant parcels without purchased capacity.
- Larger parcels with potential to subdivide:
    - APN 010-350-11: 3.18 acre lot with an estimated potential for 12 additional EDUs.
    - APN 011-250-01: 3.83 acre lot with an estimated potential for 13 additional EDUs.
- Potential for additional ADUs on existing SFR properties: not projected.
- Future Tribe flows/growth: not projected.

The growth potential above accounts for only 155+ EDUs. Any growth beyond the existing service area would require policy changes and land releases from Los Angeles Department of Water and Power's (LADWP) land holdings, which is also unlikely.

Using the high growth scenario, the City service area would also see a large change in EDUs over 20 years, 1,664.2 EDUs, which is mostly due to commercial growth. This growth rate, which equates to approximately 83 EDUs/year, far exceeds the observed growth rate of 14 EDUs/year. The possibility of this level of growth needs to be confirmed against the buildout growth potential for the City service area.

Using the projected EDUs from the high growth model, the future flow rates for ESCSD and the City were calculated using their respective wastewater generation factors (Figure 9).

Figure 9: High Growth Projected Flows



Recommended Growth Rate and Future Flow

As discussed previously, three (3) growth scenarios were used to project future EDUs for both the City and ESCSD service areas. The projected future flow rates are summarized in Table 18. The currently contracted flow allowance was used for the Tribe at 0.325 MGD, but does not account for potential future growth beyond the amount.

Table 18: Future Flow Rates for Various Growth Scenarios

Growth Rate Scenario	20-YR Projected Flow Rate (ADF)			
	ESCSD, District-Only (MGD)[1]	Tribe Contracted Flows (MGD)	City of Bishop (MGD)[2]	Combined (MGD)
Low Growth[3]	0.530	0.325	0.640	1.5
Hybrid Growth[4]	0.556	0.325	0.897	1.8
High Growth[5]	0.840	0.325	1.015	2.2

[1]ESCSD future flow rate calculated based on a wastewater generation factor =202.0 gpd/EDU
[2]City future flow rate calculated based on a wastewater generation factor = 199.5 gpd/EDU
[3]Low Growth = DoF growth rates for residential and commercial connections
[4]Hybrid growth = DoF growth rate for residential connections and 2% growth for commercial connections
[5]High growth = 2% growth for residential and commercial connections

As shown in Table 18, future flows range from 1.50-2.2 MGD based on flow projection scenarios. For both ESCSD and the City, there are potential future developments and additional flows to be accounted for that are detailed below.

ESCSD Future Developments

In the past, the Bishop Paiute Tribe requested an additional 270,000 gallons of treatment capacity (R.O. Anderson, 2018). Further communication with the Tribe has not occurred recently, and the status of this requested additional capacity is presently unknown. It is recommended any requests the Bishop Paiute Tribe has for additional capacity be confirmed as part of the planning process.

Within the ESCSD service area, the maximum anticipated growth consists of the potential development of 76 vacant lots that ESCSD is committed to serve (R.O. Anderson, 2018). Assuming each vacant lot is equivalent to 1 EDU, the development of the 76 vacant lots would result in approximately an additional 15,400 gallons of flow.

Bishop Future Developments

Within the City's service area, there are a number of potential projects on the 10-year planning horizon that the City is tracking. These potential projects are detailed in Table 19.

Table 19: Potential Projects on the 10-Year Planning Horizon within City of Bishop Service Area

Project Name	Number of Units and Project Description	Number of EDUs	Wastewater Flow Generated (gpd)
Pivot Place	12 single-family homes	12.0	2,394
Silver Peaks	72 multi-family units	122.4	24,419
MacIver and Spruce Development	120 multi-family units	204.0	40,698
Homewood Suites Hotel	70 key hotel	10.5	2,095
TOTAL	**-**	**348.9**	**69,606**

Additionally, an environmental impact report (EIR) for the City was completed in May 2022 to assess the development of downtown Bishop. In the EIR, three growth scenarios were assessed and are summarized below in Table 20 (City of Bishop Planning Department, 2022). Using the calculated wastewater generation factor for the City (199.5 gpd/EDU), the corresponding wastewater flows are provided in Table 20 as well.

Table 20: Future Wastewater Flows based on the Environmental Impact Report for City of Bishop

Development Scenario[1]	Development Description[1]	EDUs[1]	Wastewater Flows (gpd)[2]
Restricted Height Development	This scenario assumes that 25% of all parcels within the downtown area would be developed to include two additional units on each parcel.	346	69,027
Medium Development	This scenario assumes that 15% of all parcels within the downtown area would be developed to include an additional two units per parcel and that 25% of all parcels within the Mixed-Use Overlay zone would be developed to include an additional two residential units per parcel over the next 20 years.	261	52,070
Low Development	This scenario assumes that 5% of all parcels within the downtown area would be developed to include two additional units on each parcel and that 15% of all parcels within the Mixed-Use Overlay Zone would be developed to include two additional units on each parcel.	123	24,540

[1] (City of Bishop Planning Department, 2022)
[2]Wastewater flows calculated assuming 1 EDU = 199.5 gpd

Assuming that the potential projects listed in Table 19 are part of the developments identified by the EIR (provided in Table 20), there is potential for an additional 24,540 to 69,027 gpd of wastewater flows from the downtown area alone.

The combined calculated wastewater flows for the potential future developments in the ESCSD and City service area equates to an additional 0.38-0.42 MGD of wastewater flows. Given that the current ADF is 1.38 MGD (2009-2021 average from Table 4), this brings future flow rates based on currently known potential developments to 1.76-1.80 MGD. The flow rates for these potential future developments would be accounted for using a hybrid or high growth scenario, therefore the recommended future design flowrate for the combined system ranges from 1.8 to 2.2 MGD.

The 2016 Report identified a combined flowrate of 2.25 MGD, however a small factor of safety was applied incase growth is more than anticipated, bringing the design monthly average flow to 2.45 MGD (RO Anderson Engineering, 2016). The future design flow rate identified in this report (1.8 to 2.2 MGD) is below that identified in the 2016 Report as more recent data has been incorporated.

Summary

Based on wastewater flow data for ESCSD and the City, the existing ADF was estimated to be 1.38 MGD for the combined ESCSD and City flows. Looking at rainfall data and groundwater levels in nearby monitoring wells, it was found that I&I contributes to 30% of flows via infiltration.

Using three different growth scenario (low, hybrid, and high), as well potential future developments, future flow rates could range from 1.50-2.18 MGD. A joint treatment plant should be sized to accommodate the combined existing ADF (1.38 MGD) with the ability to accommodate 20-year flow projections (1.50-2.2 MGD) or easily be able to be expanded to accommodate future flows.

Lumos recommends that the following items be considered as part of the planning process:

- As more detailed wastewater flow data from the new ESCSD flow meters becomes available (installed winter of 2023), it is recommended that these flows be taken into account for the design flow of a joint treatment plant. Once 12 months of data is available, the peaking factor should be reassessed as well.
- Plan and budget for a Preliminary Engineering Report (PER) to evaluate appropriate treatment technologies for the combined flow rate.
- Confirm expectations from the Bishop Paiute Tribe regarding level of service and capacity requests prior to planning and designing the combined treatment process.
- Establish an anticipated level of wastewater flow generation from potentially high producers (such as the brewery and fairground in City of Bishop) and establish pre-treatment standards.

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Appendix

Abbreviation List

ADD	Average Day Demand
ADF	Average Daily Flow
BAWA	Bishop Area Water Agency
BPT	Bishop Paiute Tribe
DoF	Department of Finance
EDU	Equivalent Dwelling Unit
EIR	Environmental Impact Report
ESCSD	Eastern Sierra Community Service District
gpd	gallons per day
JPA	Joint Power Authority
LADWP	Los Angeles Department of Water and Power's
MGD	Million Gallons per Day
MMF	Maximum Month Flow
MW	Monitoring Well
NOAA	National Oceanic and Atmospheric Administration
PER	Preliminary Engineering Report
PHF	Peak Hour Flow