Kennedy Jenks

August 27, 2025

Technical Memorandum

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Subject: City of Coburg Water Reclamation Facility
Wastewater Capacity Evaluation
KJ 2476005*00

This technical memorandum summarizes work completed by Kennedy Jenks Consultants Inc. (Kennedy Jenks) to estimate the available capacity of the City of Coburg's (City) existing water reclamation facility (WRF) to accommodate potential growth. Tasks included review of historic flow and loading data for the WRF, calculating per capita flow and mass loading values, determining flow and mass load peaking factors, and projecting flows and mass loads anticipated to occur over a 20-year design period (2025 through 2045). Included in these calculations was the assumed development of the 107-acre light industrial on the east side of Interstate 5. Capacities of the WRF's existing liquid stream unit processes were compared with flow and mass load projections to estimate when improvements would be needed.

Existing Flows

WRF operating data from 2015 through 2023 were analyzed to determine values of per capita wastewater flows and mass loading. Because the City operates a Septic Tank Effluent Pump (STEP) collection system, very little inflow and infiltration occurs into the collection system. Typical methods for determining wet weather flow conditions in western Oregon, which are based on rainfall events and antecedent groundwater conditions, do not apply.

Per capita flow values are presented in Table 1. The average annual per capita flow value was determined to be approximately 116 gallons per capita per day (gpcd).

Table 1: Average Per Capita Influent Flow Values

Year	Population[a]	Avg. Annual Flow (MGD)	Avg. Per Capita Flow (gpcd)[b]
2015	1,055	0.112	106
2016	1,070	0.122	114
2017	1,085	0.142	131
2018	1,195	0.139	116
2019	1,295	0.156	121
2020	1,375	0.171	124
2021	1,322	0.160	121
2022	1,434	0.155	108
2023	1,475	0.153	104
		Average =	116[c]

Notes:

(a) As reported by Portland State University's Population Research Center.
(b) gpcd = gallons per capita per day.
(c) Value rounded to the nearest 1 gpcd.

The same operating data were reviewed to determine peaking factors for the following conditions:

- **Average dry weather flow (ADWF)** is the average flow at the WRF during the dry weather season, defined as May through October.
- **Average wet weather flow (AWWF)** is the average flow at the WRF during the wet weather season, defined as November through April.
- **Maximum month dry weather flow (MMDWF)** is the dry-weather, maximum month flow rate estimated to occur once every 10 years (10% probability of occurrence).
- **Maximum month wet weather flow (MMWWF**) is the wet-weather, maximum month flow estimated to occur once every 5 years (20% probability of occurrence).
- **Peak day flow (PDF)** is the maximum day flow estimated to occur once every 5 years.
- **Peak hour flow (PHF)** is the peak hour flow expected to occur during the peak day flow.

Peaking factors determined for these flow conditions are presented in Table 2.

Table 2: Influent Flow Peaking Factors

Peaking Factor	Value
ADWF[(a)]	0.95
AWWF[(a)]	1.05
MMDWF[(b)]	1.20
MMWWF[(c)]	1.36
Peak Day[(c)]	2.66
Peak Hr[(d)]	3.25

Notes:

(a) Value calculated from influent flow data from years 2015 through 2023.
(b) Maximum value that occurred from years 2015 through 2023.
(c) Maximum value that occurred from years 2019 through 2023.
(d) Maximum value for data available (2021 through 2023).

Flow Projections

Assuming normal growth, future flows within the existing service area were projected based on an annual population growth rate of 1.6 percent (%) as reported by Portland State University's Population Research Center in the Coordinated Population Forecast 2021-2070 for Lane County. In doing so, Kennedy Jenks assumed that the relative flow contributions from residential, commercial, and industrial areas of the City's service area will remain the same and can thus be projected forward based on population. Influent flow values were calculated for a 20-year planning horizon beginning in 2025. Resulting values are presented in Table 3.

Table 3: Influent Flow Projections – Existing Service Area

Year	Population[(a)]	ADWF (MGD)	Avg Annual (MGD)	AWWF (MGD)	MMDWF (MGD)	MMWWF (MGD)	Peak Day (MGD)	Peak Hour (MGD)
2025	1,523	0.17	0.18	0.19	0.21	0.24	0.47	0.57
2035	1,648	0.18	0.19	0.20	0.23	0.26	0.51	0.62
2045	2,091	0.23	0.24	0.26	0.29	0.33	0.65	0.79

Note:

(a) Population values calculated based on an annual population growth rate of 1.6% as reported by Portland State University's Population Research Center in the Coordinated Population Forecast 2021-2070 Lane County.

Flows associated with the anticipated development of the 107-acre light industrial area zoned were calculated assuming an area based average annual flow value of 1,000 gallon per acre per day (gpad). This value was presented in the May 2006 City of Coburg Facilities Plan Update for Wastewater Facilities. Peaking factors were assumed to be the same as those determined for the existing collection system.

The City has said development of the 107-acre area could occur over the next 10 years in 3 to 4 equal phases. For the purposes of this evaluation, development was assumed to occur in 4 phases with the first phase completed in 2027. Projected flows for the proposed development are summarized in Table 4.

Table 4: Influent Flow Projections – Light Industrial Area

Year	Total Developed Area[(a)] (Acres)	ADWF (MGD)	Avg Annual (MGD)	AWWF (MGD)	MMDWF (MGD)	MMWWF (MGD)	Peak Day (MGD)	Peak Hour (MGD)
2025	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2027	27	0.03	0.03	0.03	0.03	0.04	0.07	0.09
2030	54	0.05	0.05	0.06	0.06	0.07	0.14	0.17

Year	Total Developed Area[a] (Acres)	ADWF (MGD)	Avg Annual (MGD)	AWWF (MGD)	MMDWF (MGD)	MMWWF (MGD)	Peak Day (MGD)	Peak Hour (MGD)
2032	80	0.08	0.08	0.08	0.10	0.11	0.21	0.26
2035	107	0.10	0.11	0.11	0.13	0.15	0.28	0.35
2045	107	0.10	0.11	0.11	0.13	0.15	0.28	0.35

Note:

(a) The 107-acre light industrial area is assumed to develop in 4 equal phases over a 10-year period at a rate of approximately 27 acres every 2.5 years.

The projected combined influent flow from the existing service area and the 107-acre light industrial area are presented in Table 5.

Table 5: Influent Flow Projections – Total

Year	ADWF (MGD)	Avg Annual (MGD)	AWWF (MGD)	MMDWF (MGD)	MMWWF (MGD)	Peak Day (MGD)	Peak Hour (MGD)
2025	0.17	0.18	0.19	0.21	0.24	0.47	0.57
2027	0.20	0.21	0.22	0.25	0.28	0.56	0.68
2030	0.23	0.24	0.26	0.29	0.33	0.65	0.80
2032	0.26	0.28	0.29	0.33	0.38	0.74	0.90
2035	0.30	0.31	0.33	0.38	0.43	0.83	1.02
2045	0.33	0.35	0.37	0.42	0.48	0.93	1.14

Existing Mass Loading

WRF operating data from 2015 through 2023 were also analyzed to determine the average annual per capita biochemical oxygen demand (BOD_5) mass loading rate. Results are presented in Table 6. The average annual per capita mass loading rate was determined to be approximately 0.09 pounds per capita per day (ppcd).

Table 6: Per Capita Influent BOD_5 Mass Loading

Year	Population[a]	Avg. Annual BOD_5 Loading (ppd)	Avg. Per Capita BOD_5 Loading (ppcd)[b]
2015	1,055	64	0.06
2016	1,070	89	0.08
2017	1,085	118	0.11
2018	1,195	110	0.09
2019	1,295	124	0.10
2020	1,375	131	0.10
2021	1,322	125	0.09
2022	1,434	155	0.11
2023	1,475	169	0.11
		Average =	0.09

Notes:

(a) As reported by Portland State University's Population Research Center.
(b) ppd = pounds per day.
(c) ppcd = pounds per capita per day.

Peaking factors for maximum month and maximum day loading conditions were determined from the 2015 through 2023 data set. They are presented in Table 7.

Table 7: Influent BOD_5 Mass Loading Peaking Factors[a]

Peaking Factor	Value
Max Month	1.39
Max Day	1.69

Note:

(a) Values determined from influent wastewater data from years 2015 through 2023.

Mass Loading Projections

Future BOD_5 mass loading from the existing service area allowing for normal growth was estimated based on an annual population growth rate of 1.6 %. This was done assuming the relative mass loading contributions from residential, commercial, and industrial users will remain the same going forward and that future BOD_5 mass loading can be calculated based on population. Mass loading values were calculated for a 20-year planning period beginning in 2025. Resulting values are presented in Table 8.

Table 8: BOD_5 Mass Loading – Existing Service Area[a]

Year	Population[b]	Avg. Annual BOD_5 Loading (ppd)[c]	Max Month BOD_5 Loading (ppd)	Max Day BOD_5 Loading (ppd)
2025	1,523	140	200	240
2030	1,648	160	220	265
2045	2,091	200	280	340

Notes:

(a) BOD_5 mass loading values rounded to the nearest 10 lbs.
(b) Population values calculated based on an annual population growth rate of 1.6% as reported by Portland State University's Population Research Center in the Coordinated Population Forecast 2021-2070 Lane County.
(c) ppd = pounds per day.

BOD_5 mass loading from development of the 107-acre light industrial area was calculated based on an average BOD_5 concentration of 98 mg/L as calculated for the existing service area. Mass load peaking factors were assumed to be the same as those determined for the existing service area. BOD_5 mass loading projections for the 107-acre light industrial area are presented in Table 9.

Table 9: BOD_5 Mass Loading – Light Industrial Area[a]

Year	Total Developed Area[b] (Acres)	Avg. Annual BOD_5 Loading (ppd)[c]	Max Month BOD_5 Loading (ppd)	Max Day BOD_5 Loading (ppd)
2025	0	0	0	0
2027	27	20	30	40
2030	54	40	60	70
2032	80	70	90	110
2035	107	90	120	150
2045	107	90	120	150

Notes:

(a) BOD_5 mass loading values rounded to the nearest 10 lbs.
(b) The 107-acrea light industrial area is assumed to develop in 4 equal phases over a 10-year period at a rate of approximately 27 acres every 2.5 years.
(c) ppd = pounds per day.

The projected combined BOD_5 mass loading from the existing service area and the 107-acre light industrial area is presented in Table 10.

Table 10: BOD_5 Mass Loading - Total[a]

Year	Avg. Annual BOD_5 Loading (ppd)[b]	Max Month BOD_5 Loading (ppd)	Max Day BOD_5 Loading (ppd)
2025	140	200	240
2027	170	240	290
2030	200	280	340
2032	230	320	380
2035	260	360	430
2045	290	400	480

Notes:
(a) Values rounded to the nearest 10 lbs/day.
(b) ppd = pounds per day.

Unit Process Capacity Evaluation

Flow and BOD_5 mass loading projections were compared with the capacities of the seven main liquid stream process elements of the WRF: 1) headworks fine screens, 2) mixed liquor (ML) recycle pump, 3) ML feed pumps, 4) aeration basin [including aeration system],5) membrane filters, 6) permeate pumps, and 7) chlorine contact basins (CCBs). The design basis (e.g., flow or mass loading condition) and capacity of each main liquid stream process are presented in Table 11.

Table 11: Unit Process Capacity Summary

Unit Process	Capacity	
	Design Basis	Flow / Mass
Headworks Screens[a]	PHF	1.6 MGD
ML Recycle Pump	AAF	920 gpm
ML Feed Pumps[b]	PDF	800 gpm
Aeration Basin[c]	Max Month Load	560 lbs/day
Membrane Filters	PHF	0.77 MGD
Permeate Pumps[b]	PHF	1,070 gpm
Chlorine Contact Basins	AAF	0.22 MGD

Notes:
(a) Capacity per screen.
(b) Capacity per pump.
(c) Capacity of the biological treatment process (aeration basin and blowers).

The methodology used to determine the capacity values presented in Table 11 is described below. The estimated year in which the capacity of each of the processes is reached is also presented.

Headworks Screens

The WRF has two, rotary drum fine screens with 2-millimeter (mm) screen openings that protect the membranes from debris and stringy material that might otherwise collect on, and damage, the membrane fibers. Capacity of the headworks screens must be equal to or greater than the projected peak hour flow to the plant with one unit out of service. Capacity of each screen is 1.6 MGD.

As shown in Table 5, the projected year 2045 peak hour flow is 1.14 MGD. The existing screens thus have sufficient capacity to meet conditions beyond the 20-year planning horizon of this evaluation.

Mixed Liquor Recycle Pumping

The aeration basin contains one, submersible, axial flow variable speed pump for recycling ML within the aeration basin to improve denitrification performance of the secondary treatment process. The capacity of the existing ML recycle pump is 920 gpm (1.3 MGD).

Typical design capacity of ML recycle pumping systems is recycle ML within the aeration basins at a rate of 4 to 6 times the average annual influent flow rate. Assuming a recycle rate of 4 times the average annual influent flow rate, the existing ML recycle pump can support a maximum average annual influent flow of 0.32 MGD. As shown in Table 5, the existing ML recycled pump has sufficient capacity to meet conditions through the year 2035 when the projected average annual flow rate will be 0.31 MGD.

While the ML recycle pump may not meet typical design rates for ML recycle flow within the next 10 years, additional pumping capacity may not be warranted. Pumping rates for ML recycle are set to maximize the recovery of alkalinity and oxygen both of which are consumed during nitrification (i.e., biological process responsible for conversion of ammonia nitrogen to nitrate). If ML recycle rates are not optimized, the treatment process will continue to perform but may require the addition of more alkalinity (e.g., sodium hydroxide) and increased aeration demand. Because of this, the City should simply monitor the performance of the WRF as flows increase. Although unlikely, if the City notes a marked increase in alkalinity and/or aeration demand, the City may wish to consider evaluating the cost effectiveness of increasing the capacity of the ML recycle pump.

ML Feed Pumping

The aeration basin contains two, submersible, variable speed solids handling pumps that pump ML from the aeration basin into the membrane tanks. The ML feed pumps are controlled such that flow into the membrane tanks exceeds the pumping rate of the permeate pumps. The excess flow sweeps solids removed by the membrane filters from the membrane tanks returning them to the aeration basin. The recycling of flow prevents solids from accumulating within the membrane tanks.

The capacity of the ML feed pumps must be equal to or greater than the peak hour flow with one pump out of service. Each ML feed pump has a capacity of 800 gpm (1.15 MGD) which exceeds the projected year 2045 peak hour flow of 1.14 MGD as shown in Table 5.

The capacity of the ML feed pumps must also be sufficient to maintain the solids concentration within the membrane tanks below 15,000 mg/L during the peak day flow condition with one pump out of service. Assuming a mixed liquor suspended solids (MLSS) concentration of 10,000 mg/L (typical maximum design MLSS for MBRs), the required capacity of the ML feed pumps to meet the projected year 2045 peak day flow condition of 0.93 MGD as shown in Table 5 would be approximately 1,300 gpm. This is approximately 60% greater than the existing pump capacity.

An MLSS concentration of 10,000 mg/L is the maximum design value that should occur during the maximum month BOD_5 mass loading condition while also maintaining a solids retention time (SRT) of at least 12 days (to ensure nitrification). The existing aeration basin was designed for a maximum month loading condition of 560 pounds per day (lbs/day). However, as shown in Table 10, the maximum month BOD_5 mass loading value for the year 2045 is 400 lbs/day.

Assuming a conservative yield value of 1, a maximum month mass loading value of 400 lbs/day and an SRT value of 12 days would result in an MLSS concentration of 6,000 mg/L. Assuming the aeration basin is operated at this lower MLSS concentration, the ML feed pumps can accommodate a peak day flow value of 1.7 MGD. As shown in Table 5, this is more than the projected year 2045 peak day flow 0.93 MGD. The existing ML feed pumps thus have sufficient capacity to meet conditions beyond the 20-year planning horizon of this evaluation.

Aeration Basin

Total volume available for biological treatment within the existing WRF is 121,600 gallons (gal). This includes the volume of the aeration basin (96,000 gal) and two membrane tanks (25,600 gal). Capacity of biological treatment systems is based on their ability to treat maximum month mass loading conditions.

The biological treatment system of the existing WRF inclusive of the aeration basins, membrane tanks, and aeration system was designed to treat a maximum month BOD_5 load of 560 lbs/day. The projected year 2045 maximum month BOD_5 is 400 lbs/day. The existing biological system thus has sufficient capacity to meet conditions beyond the 20-year planning horizon of this evaluation.

Membrane Filtration

The WRF has two membrane tanks. Each tank houses a single membrane cassette, each of which contains 42 membrane modules. The membrane tanks were provided with additional space for the future installation of two membrane cassettes that would effectively double system capacity. There are two, 40-horsepower, air scour blowers that are used to assist in cleaning the membranes.

Membrane filters can typically accommodate peak hour flows that are two times the annual average. When the peaking factor is less than 2, the average annual flow condition controls the number of membranes needed. Likewise, when the peaking factor is greater than 2, the peak hour flow condition controls the number of membranes needed.

As shown in Table 2, the peaking factor for the peak hour flow condition is 3.25. The peak hour flow condition is thus the controlling design condition for the WRF's membrane filters which have a peak hour capacity of 0.77 MGD. As shown in Table 5, the projected peak hour flow in the year 2030 is 0.80 MGD and 1.14 MGD in the year 2045.

The capacity of the existing membranes will be exceeded within the next 5 years and additional membrane cassettes will be needed. Based on original design criteria for the WRF, a third air scour blower will also be needed to accommodate the increased number of membrane cassettes.

Permeate Pumping

The WRF has two, rotary lobe-type, variable speed permeate pumps that draw water through the membrane filters and pump it to the chlorine contact basins for disinfection. The pumps must be capable of delivering the peak hour flow condition with one pump out of service.

The capacity of each permeate pump is 1,070 gpm (1.54 MGD). As shown in Table **5**, the projected year 2045 peak hour flow condition is 1.14 MGD. The permeate pumps thus have sufficient capacity to meet conditions beyond the 20-year planning horizon of this evaluation.

Chlorine Contact Basins

The WRF has two, parallel, chlorine contact basins (CCBs) that are used to disinfect effluent prior to discharge to Muddy Creek. The CCBs can be operated in parallel or in series and can be taken out of service independently from one another allowing for routine maintenance. Each CCB has a volume of approximately 18,000 gal. The disinfection system was designed to produce effluent capable of meeting Class A recycled water requirements.

At a minimum, CCBs must meet Oregon Department of Environmental Quality (DEQ) guidelines for detention time under average annual, peak day, and peak hour flow conditions. These are 60 minutes, 20 minutes, and 15 minutes, respectively. Review of the peaking factors, presented in Table 2, show that the annual average flow condition is the controlling design condition.

The existing CCBs were designed to a stricter level than those required by DEQ and were to provide 120 minutes of detention time under average annual flow conditions with one CCB out of service. While twice the time required by the DEQ, the longer detention time was used in design of the CCBs to provide a greater factor of safety. This was done to help ensure that stringent Class A recycled water disinfection requirements would be met.

Assuming a detention time of 120 minutes, the disinfection system has an average annual flow capacity of 0.22 MGD. As shown in Table 5, the projected average annual flow rate in 2030 is 0.24 MGD. The theoretical capacity of the existing CCBs will thus be exceeded within the next 5 years. At the projected year 2045 average annual flow rate of 0.35 MGD, the CCBs will provide 75 minutes of detention time. While the existing CCBs will not meet the original 120-minute design criteria under average flow conditions projected to occur within the next 5 years, they will still exceed DEQ design guidelines.

Kennedy Jenks believes the CCBs should have sufficient capacity to meet conditions beyond the 20-year planning horizon of this evaluation. However, the City should closely monitor disinfection performance when average annual flows to the WRF approach 0.22 MGD and the detention time within the CCBs begin to fall below 120 minutes to ensure there is no loss of performance.

Conclusions

Based on current growth projections for the WRF's existing service area and the assumed development of the 107-acre light industrial area, three of the WRF's seven main process areas were shown to have potential capacity deficiencies. In order of importance, these include the following:

1. **Membrane Filtration.** The existing membrane filters have a peak hour flow capacity of 0.77 MGD. As shown in Table 5, the projected peak hour flow is 0.80 MGD in the year 2030 and 1.14 MGD in the year 2045. The City should thus consider installing additional membrane cassettes within the next 2 years to help ensure the ability to provide wastewater services to accommodate potential growth and expansion of the City's service area. A third membrane air scour blower will also be needed when additional membrane cassettes are added.

2. **Chlorine Contact Basins (CCBs).** The disinfection system's existing CCBs were designed to provide 120 minutes of detention time during average annual flow conditions. This is twice the 60-minute value required by the DEQ in its disinfection design guidelines. This was done to provide an increased factor of safety to help ensure the system met the strict disinfection requirements associated with Class A recycled water. The existing CCBs will provide 75-minutes of detention time during the projected year 2045 annual average flow condition of 0.35 MGD. Kennedy Jenks believes this should be sufficient to meet disinfection requirements and improvements to the existing CCBs will not be needed. However, the City should closely monitor disinfection performance when the average annual flow to the WRF approaches 0.22 MGD and the detention time falls below 120 minutes. As shown in Table 5, this is projected to occur within the next 5 years.

3. **ML Recycle Pumping.** The ML recycle pump has sufficient capacity to meet projected influent flow conditions through the year 2035. Recycling ML within the treatment process recovers a portion of the alkalinity and oxygen consumed during the biological conversion of ammonia to nitrate. Recycling ML at less-than-optimal rates should not negatively affect performance of the treatment process. However, it may require the addition of more alkalinity (e.g., sodium hydroxide) and result in higher aeration demands which may in turn increase operating costs. Although unlikely, if the City notes a marked increase in alkalinity and/or aeration demand, the City may at that time wish to evaluate the cost effectiveness of increasing the capacity of the ML recycle pump.