Re-rating Study

Salmon Creek Wastewater Treatment Plant

Prepared for

Clark County, Washington

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Contents

Re-rating Study

This Re-rating study amends the *2004 Wastewater Facilities Plan/General Sewer Plan* (Facilities Plan) prepared for the Salmon Creek Wastewater Treatment Plant (SCTP). This study meets the requirements laid out in the Criteria for Sewage Works Design, Section G1-5.4.2, pp G1-42 to G1-46 for a Standard Facility Re-rating process.

Background

The design of the Phase 4 expansion at the SCTP was based on influent flow and load design criteria established in the NPDES permit. As part of startup activities, influent flows and loads observed from January 2004 through December 2007 were reviewed and a significant change in the influent loading characteristics, including a rate of increase in biochemical oxygen demand (BOD) load that was significantly higher than other characteristics, was observed. From 2003 to 2007, dry weather average BOD loading to the plant apparently increased by 54% while total suspended solids (TSS) only increased by 22%. Although this abrupt change in BOD loading could be caused by a high strength contributor, discussions with the plant personnel indicated that laboratory procedures were modified in February 2006 to more closely follow standard procedures as outlined in the Standard Methods for the Examination of Water and Wastewater, 20th Edition.

The procedures outlined in Standard Methods recommend measurement of initial dissolved oxygen (DO) concentration within 30 minutes after preparing dilutions to determine BOD concentrations in order to minimize the rapid reactivity of the influent samples with DO. Prior to February 2006, this requirement was not being met. The results due to the change in laboratory procedures is clearly illustrated in Figure 1, which shows a significant "step" increase in the influent BOD load from January 2006 to April 2006.

To further confirm that the change in the laboratory procedures was the cause of inconsistencies in the BOD, SCTP data were compared to Ridgefield WWTP influent data since their lab analysis is performed at the SCTP lab. Data presented in Figure 2 indicate that both plants experienced similar changes in their influent BOD/TSS ratio. The ratio at the SCTP prior to February 2006 was 78% and increased to 94% after the change in lab procedures. Ridgefield data shows a similar increase with the ratio increasing from 69% to 86%.

Based on the available data, it appears that the change in lab procedures created an apparent increase in influent BOD of 21-23%. This results in a change to the required SCTP Phase 4 load capacity. The revised BOD load associated with the Phase 4 maximum month design flow of 14.95 mgd is 25,400 lb/d, as compared to the 20,900 lb/d Phase 4 design value.

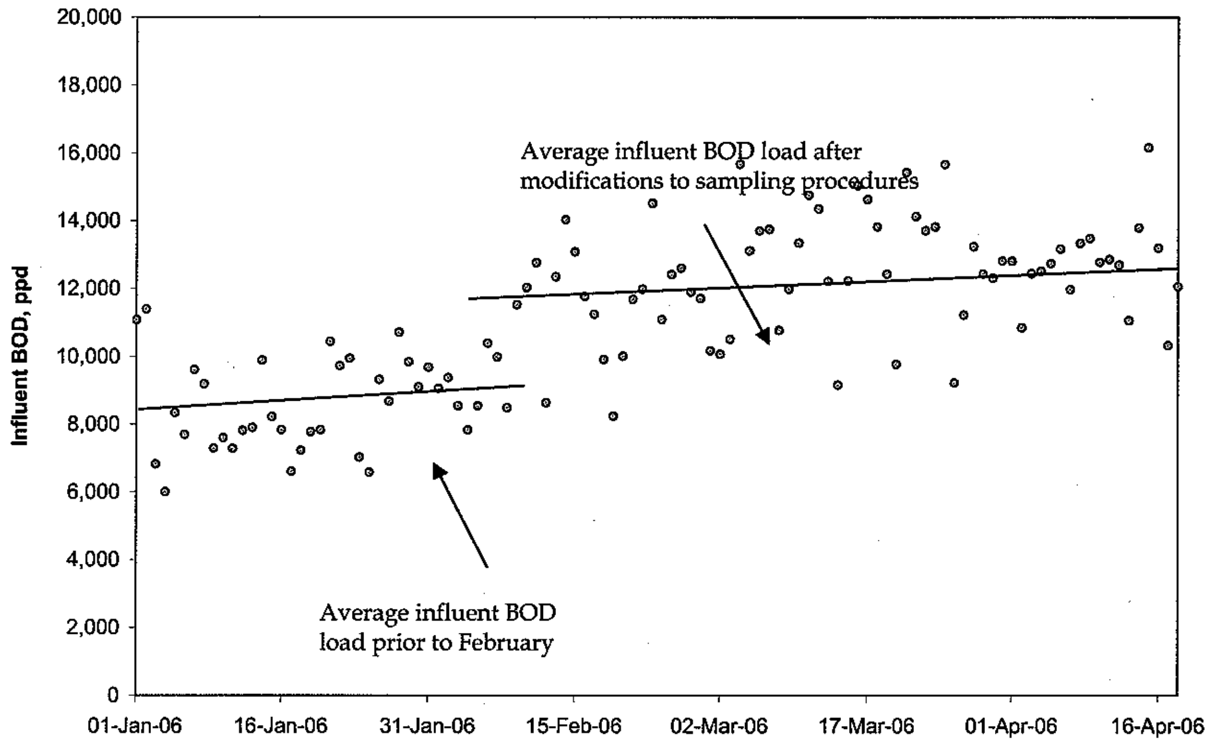

FIGURE 1. INFLUENT BOD LOAD TREND: JANUARY 06 - APRIL 06

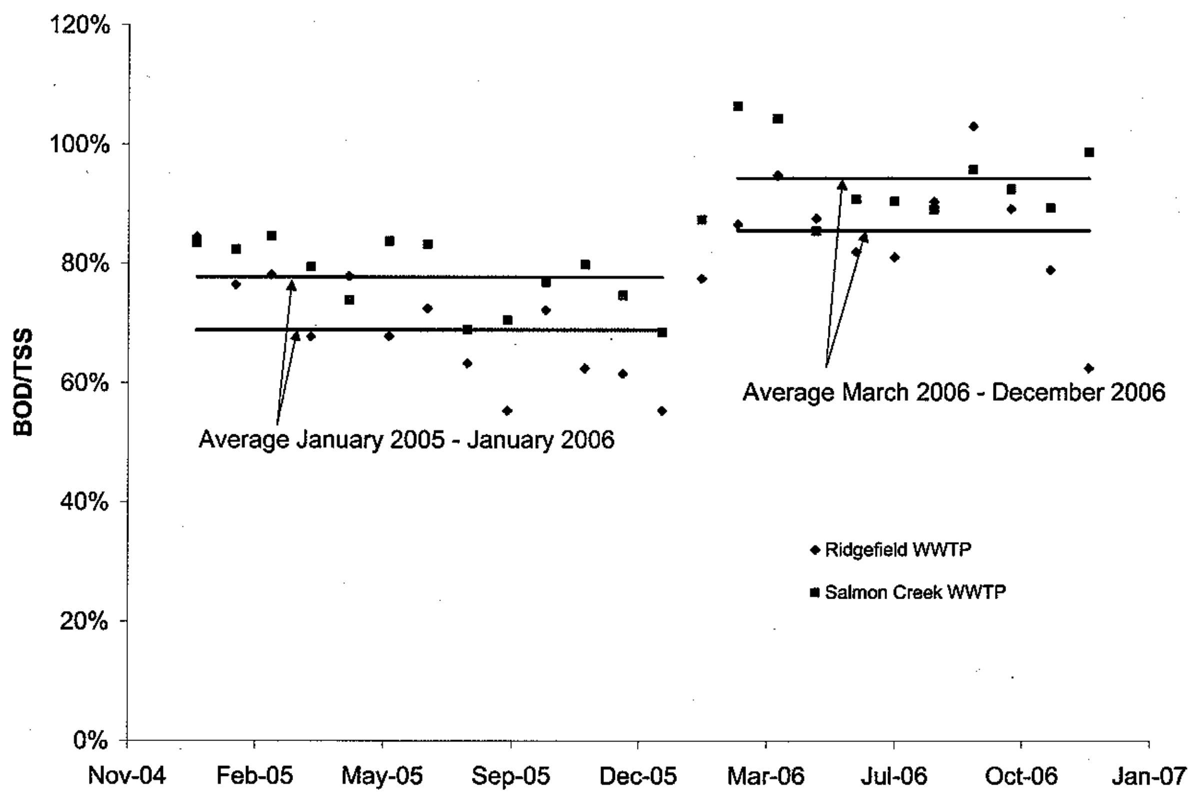

FIGURE 2. COMPARISON OF RIDGEFIELD WWTP AND SCTP INFLUENT BOD LOADS

Technical Basis for Proposed Re-rating

The proposed basis for the re-rating is well within acceptable design parameters. For the most part, design values are unchanged from those presented in the Facilities Plan. Design values specific to the secondary process that have changed are still well within acceptable and established design parameters. Based on this, a standard facility re-rating process is applicable.

Unit Process Re-rating Evaluation

A capacity analysis was completed for the SCTP including all Phase 4 improvements and revised BOD values. The capacity analysis also took into account the effect of the new NPDES permit effluent ammonia limitation, which becomes effective once the Phase 4 construction is complete.

Key process sizing and design criteria were defined in Appendix F of the 2004 Wastewater Facilities Plan/General Sewer Plan. These calculations were based on process data collected in 2003 and assumed a non-nitrifying condition. Subsequent to completion of the Phase 4 planning effort, a new NPDES permit was issued, including an effluent ammonia permit limit of 18.7 mg/L average monthly, and 37.5 mg/L maximum daily average. The new ammonia limits are required to be met year round and require some nitrification in the secondary process.

Preliminary – Screening and Grit Removal

Design criteria for raw screening and grit removal are based on peak flow conditions, and are not impacted by load considerations. Therefore, the changes in the BOD loads do not affect the capacity of the raw screening and grit removal unit processes as they are designed on a hydraulic basis.

Primary Clarification

The design criterion for primary clarification is based on peak flow conditions, and is not impacted by load considerations. Sizing of the primary sludge pumping units are based on peak flow and peak TSS load values, and are not impacted by BOD loading. Therefore, the changes in the BOD loads do not affect the capacity of the primary clarifier unit processes.

Secondary Process – Aeration Basins, Secondary Clarifiers and Blowers

These changes in BOD loads and permit limits affect two key secondary process design criteria - Solids Retention Time (SRT) and Yield. Nitrification also increases air demand within the aeration basin. The implications of the changes and suggested revised criteria are discussed below.

Nitrification and SRT

The nitrification requirement was addressed by increasing the design SRT of the activated sludge system. SRT controls aeration basin capacity along with yield by dictating the minimum mass of bacteria that need to be stored in the aeration basin to meet treatment requirements. The higher the SRT, the more aeration basin volume is needed. Nitrification requires maintaining a sufficient SRT to allow the nitrifying bacteria to reduce the ammonia. The SRT required for nitrification is longer than what is required for BOD treatment. The Phase 4 planning effort utilized an SRT of 4 days. This current capacity evaluation utilizes 5.5 days.

During 2007, the secondary process was operated for the entire year at an SRT of approximately 5 days, which is below the design SRT of 5.5 days. Figure 3 shows effluent ammonia concentrations for the year. During the winter months, the plant was able to meet the new permit limits consistently. During the summer months, there was a much greater variation in effluent ammonia, some of which was close to the monthly permit limits. Periods of poor nitrification appear to be a result of sustained DO concentrations at 1.5 mg/L or less within the aeration basins. Based on observed 2007 data, it appears that the plant will be safely able to meet daily and monthly permit requirements for ammonia by maintaining an SRT of 5.5 days and DO concentrations greater than 1.5 mg/L.

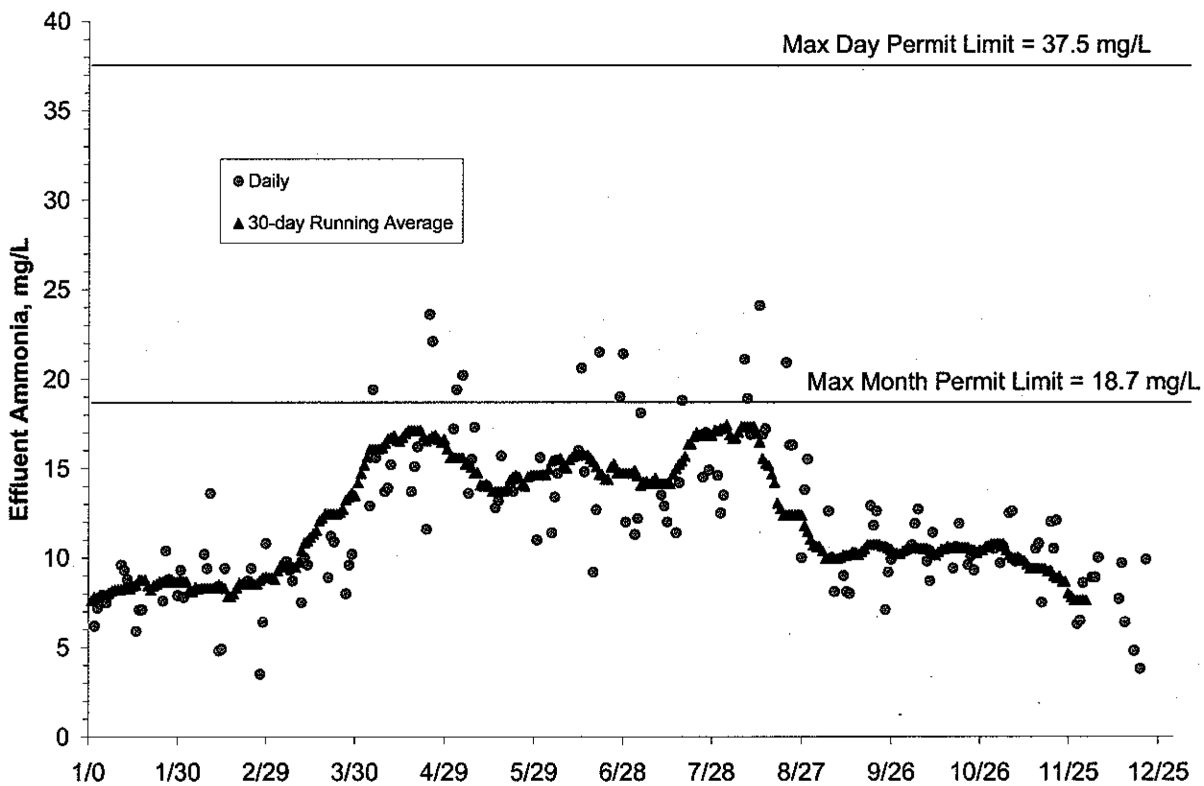

FIGURE 3. EFFLUENT AMMONIA CONCENTRATIONS

Yield

Yield is the mass of bacteria grown per pound of BOD removed. Yield controls aeration basin sizing by dictating the mass of BOD that can be treated without exceeding the mass of bacteria that can be stored in the aeration basin. Due to the change in lab procedures, the yield of solids from the removal of BOD would be expected to be reduced by 20% (i.e. waste sludge remains the same while BOD increases by 20%).

The yield used in the 2004 Wastewater Facilities Plan/General Sewer Plan was 1.3 lbs TSS/lb BOD. This yield was based on plant process data from the first 6 months of 2003 and therefore was based on BOD estimates produced by the old lab procedures. A new whole plant model was calibrated to plant process data from 2007. The whole plant model was then used to estimate yields based on an SRT of 5.5 days in the colder months. The resulting yield was 1.08 lbs TSS/lb BOD. This is consistent with what was expected based on the 20% increase in BOD observed based on the change in lab procedures and is more conservative than the recommended yield in the *Department of Ecology Criteria for Sewage Works Design.*

Aeration Capacity

Air demand is controlled by several factors including both BOD and ammonia load to the secondary process, temperature, and diffuser design (type, density, submergence, and flow per diffuser). The calculations for the 2004 Wastewater Facilities Plan/General Sewer Plan did not account for nitrification, which requires a significant amount of air.

Average air demand was calculated based average conditions at the SCTP. To establish a peaking factor for peak air demand, 2007 data for airflow was evaluated. During 2007 the peak day to average annual air demand was 1.56. For design purposes, a safety factor of 1.1 was applied to this peaking factor, resulting in a peaking factor of 1.70.

Appendix F includes revised calculations for the aeration system. The results of the aeration capacity analysis are summarized in Table 1. *Department of Ecology Criteria for Sewage Works Design* requires that aeration systems be designed to provide capacity with the largest blower out of service (i.e. Firm Capacity). Based on the estimated air demands for Phase 4, one new blower is needed for aeration basins 1-4. The blower system for aeration basins 5-6 will be sufficient based on a minimum design DO value of 1.5 mg/L on a peak day (with largest blower out of service).

TABLE 1
Summary of Aeration Capacity Analysis

	Revised Phase 4 Air Demand (scfm)	Current Installed Firm Capacity (scfm)	Currently Installed Total Capacity (scfm)
Aeration Basins 1-4	9,000	6,000	9,000
Aeration Basins 5-6	6,900	6,900	11,400

Based on the aeration capacity analysis, it is recommended that one new blower identical to the existing blowers be added to serve Aeration Basins 1-4. No additional blowers are recommended to serve aeration basins 5-6.

Disinfection

Design criteria for disinfection are based on peak flow conditions, and are not impacted by load considerations. Therefore, the changes in the BOD loads do not affect the capacity of the disinfection unit process as it is designed on a hydraulic basis.

WAS Thickening

WAS production is calculated as a function of influent BOD and Net Yield in the secondary process. The impact to the Net Yield is described in detail above. As a result of the increase in reported RS BOD, WAS production is expected to be on the order of 5-6% higher than estimated in the Facilities Plan. The thickening units were sized in Phase 3 based on a 20-year capacity. A slight increase in WAS production results in a slightly longer run time for the gravity belt thickeners. The thickening units are well within their design capacity to accommodate this slight increase.

Anaerobic Digestion

Digester feed is a function of Primary Sludge and WAS production. The impact of an increase in reported RS BOD is described above. Primary sludge quantities are a function of removal of TSS across the primary clarifiers and as such, not impacted by the change in laboratory procedures (specific to BOD). As a result, digester feed quantities are expected to be on the order of 1-2% higher than estimated in the Facilities Plan. The anaerobic digestion facilities were sized in Phase 3 based on a 20-year capacity. A slight increase in WAS production results in a slightly reduced SRT and increased VS loading rate. The digestion facilities are well within their design capacity to accommodate this slight change.

Dewatering

The slight increase in digester feed, described above, translates to a slight increase is biosolids to be dewatered. As a result of the increase in reported RS BOD, biosolids production is expected to be on the order of 1-2% higher than estimated in the Facilities Plan. The dewatering units were sized in Phase 3 based on a 20-year capacity. A slight increase in biosolids production results in a slightly longer run time for the belt filter presses. The belt filter press units are well within their design capacity to accommodate this slight increase.

Summary

Appendix F in the Facilities Plan provided unit process sizing calculations. These calculations are updated as applicable with the revised BOD values and nitrification requirement and included in Appendix A. The criteria used for this evaluation are the same as those used in the 2004 Wastewater Facilities Plan/General Sewer Plan with the exception of SRT and Yield, as discussed above as well as the accounting for nitrification in the calculations for blower demand. The results of the analysis are summarized in Table 2.

TABLE 2
Summary of Capacity Analysis

Design Assumptions	Updated Analysis	2004 Facility Plan
Flow Rates, mgd		
Average Annual	11.3	11.3
Maximum Month	14.95	14.95
Max Month Loads, lb/d		
BOD	25,400	20,900
TSS	28,200	28,200
TKN	3,900	3,900
Headworks		
Number of Screens	2	2
Screening Capacity, mgd	34	34
Number of Vortex Grit units	2	2
Grit Removal Capacity, mgd	50	50
Primary Clarifiers		
Number of Clarifiers	4	4
Peak Hour Wet Weather Surface Overflow Rate, gpd/sf (Max 3,000)	2,210	2,210
BOD Removal, %	30	30
Aeration Basins		
Number of Basins	6	6
Number in Service	6	6
Volume (mgal) [1]	3.62	3.44
Yield, lb TSS/lb BOD	1.08	1.30
MLSS, mg/L	3,500	3,500
Total SRT, days	5.5	4.0
F/M, lb BOD Appl./lb MLVSS-day (Max = 0.4)	0.28	0.24
Volumetric Loading, lb BOD/1,000 cf-day (Max = 40)	36.7	31.8
Aeration Systems		
Aeration Basins 1-4		
Peak Day Air Demand, scfm	9,000	6,200
Number of Blowers	4	3
Number of Blowers in Service	3	2
Firm Capacity, scfm[2]	9,000	6,000

TABLE 2
Summary of Capacity Analysis

Design Assumptions	Updated Analysis	2004 Facility Plan
Aeration Basins 5-6		
Peak Day Air Demand, scfm	6,900	5,400
Number of Blowers	3	3
Number of Blowers in Service	2	2
Firm Capacity, scfm	6,900	6,900
Secondary Clarifiers		
Number of Basins	4	4
Number in Service	4	4
MMWW Surface Overflow Rate, gpd/sf (Max = 600)	500	500
MMWW Solids Loading Rate, lb/day-sf (Max = 35)	19	19
UV Disinfection		
Number of Channels	1	1
Number of Modules	20	20
Capacity, mgd	34	34
Thickening		
Number of Units	2	2
MMWW Loading rate, gpm/meter	250	250
Average Daily Operation, hours	10.0	9.4
Anaerobic Digestion		
Number of Units	2	2
SRT, days (Min = 15 days)	20.3	20.6
VS Loading, lb VS/cf/d (Max = 0.16)	0.13	0.12
Dewatering		
Number of Units	2	2
MMWW Loading rate, lb/hr/meter	600	600
Average Daily Operation, hours	5.8	5.7

[1] Value in 2004 Facilities Plan was in error. Actual basin volume = 2.75 mgal.
[2] Value in 2004 Facilities Plan should have been reported as 6,900 inlet cfm (icfm). Firm capacity = 6,000 scfm.

Although the reported influent BOD increased due to changes in lab procedures, the results of the capacity analysis, incorporating the increase in SRT and the reduction in yield, indicate that the SCTP will be able to treat the maximum month flow of 14.95 MGD stated in the permit. Under this condition, the plant should be able to maintain an SRT of 5.5 days without overloading the secondary clarifiers, and meet the effluent ammonia permit limit of 18.7 mg/L. With the addition of a fourth blower to serve Aeration Basins 1-4, the blower capacity will be sufficient to maintain the minimum DO necessary for nitrification.

Tier II Antidegradation Analysis

While the increase in loading does have a minimal impact on the treatment process, the expected effluent quality is expected to remain relatively unchanged. The SCTP reliably produces reclaimed water of a quality significantly higher than its discharge permit. No measurable change is anticipated as a result of a facility re-rating.

APPENDIX A

Revised Process Sizing and Design Criteria

SCTP Design Flows & Loads

	Flows (mgd)			BOD (ppd)		TSS (ppd)	
	Average Annual	Maximum Month	Peak Hour	Average Annual	Maximum Month	Average Annual	Maximum Month
Phase 4 (2013)	11.3	14.95	28.32	21,299	25,400	21,500	28,100
Phase 5 (2018)	13.67	18.04	34.18	25,766	30,727	26,000	34,000
Phase 6 (2028)	19.97	26.36	49.92	37,640	44,888	37,900	49,600

Screens/Washers/Compactors

Assumptions

All new match existing, 6 mm openings
Manual bar screen (2.5" openings) provides back-up

Criteria

PHWW Capacity/screen **17** mgd

	Flows (mgd)	# of Units			
	PHWW	Existing	New	Total	Screening Capacity
Phase 4 (2013)	28	2	0	2	34
Phase 5 (2018)	34	2	0	2	34
Phase 6 (2028)	50	2	1	3	51

Grit Removal

Assumptions

2 vortex units provided

Criteria

PHWW Capacity/grit unit **25** mgd 1/2 of Equipment Rating

	Flows (mgd)	# of Units			
	PHWW	Existing	New	Total	Grit Removal Capacity
Phase 4 (2013)	28	2	0	2	50
Phase 5 (2018)	34	2	0	2	50
Phase 6 (2028)	50	2	0	2	50

Primary Clarifiers

Assumptions

All new match existing

Because there are always a min of 3 units, redundancy requirements do not control

Criteria

AA SOR	**1200**	gpd/ft^2	per Ecology T2-2.1.1
PHWW SOR	**3000**	gpd/ft^2	per Ecology T2-2.1.1
AA Max Dt	**2.5**	hrs	per Ecology T2-2.1.3
Weir Loading Rates	**10,000 - 40,000**	gpd/lf	per Ecology T2-2.1.2
Length	160	ft	
Width	20	ft	
Depth	11	ft	
Weir Length	210	ft	

	Flows (mgd)		# of Units			Capacity (mgd) - All Units in		Detention Time (hrs)	Weir Loading Rate (gpd/lf)	
	AA	PHWW	Existing	New	Total	AA	PHWW	AA	AA	PHWW
Phase 4 (2013)	11	28	3	1	4	15	38	2.2	13488	33714
Phase 5 (2018)	14	34	3	1	4	15	38	1.8	16274	40690
Phase 6 (2028)	20	50	3	3	6	23	58	1.9	15849	39619

Capacity = Length x Width x SOR x # of Units / 10^6
SOR = Surface overflow rate

Peak Hour Wet Weather SOR 2210

Basin Volume = Length x Width x Depth
Detention Time = Basin Volume x # of Units / (Flow x 1.547 x 3600)

Weir Loading Rate = Flow x 10^6 / (Weir Length x # of Units)

Aeration Basins

Assumptions:

AB 1-4 Volume, Total (MG)	**1.88**	
AB 5 and Future Vol, ea (MG)	**0.87**	
% Aerated	**75%**	
Primary Clarifier BOD removal	**30%**	per 5/27/04 DOE letter
Net Yield (lb WAS/lb BOD)	**1.08**	reduced by 20% from Fac Plan
MLVSS/MLSS	**80%**	per 2003 data

Criteria:

SRT (days)	**5.5**	Per Design Criteria in Drawings
Max MLSS (mg/L)	**3500**	per Ecology T3-3.1.1
Volumetric Loading (lb BOD/1000 cf/d)	**40**	MOP 8
F/M (lb BOD/lb MLVSS/d)	**0.4**	MOP 8

Basin Capacity (ppd of BOD_5)

	Based on SRT	Based on Volumetric Loading	Based on F/M	Est. Capacity
Aeration Basins 1-4:				
MMWW Capacity (total)	9,244	10,053	13,171	9,244
Aeration Basin 5 & Future Basins				
MMWW Capacity (each)	4,278	4,652	6,095	4,278

	Flow & Loads			Existing Aeration Basins				Future Basins		Total	
				Aeration Basins 1-4		Aeration Basin 5		Aeration Basin 6		(All Units Online)	
	AA RS Flow (mgd)	MMWW RS BOD (ppd)	MMWW PE BOD (ppd)	No.	Capacity (ppd of BOD)	No.	Capacity (ppd of BOD)	No.	Capacity (ppd of BOD)	No.	Capacity (ppd of BOD)
Revised Phase 4	11.30	25,400	17,780	1	9,244	1	4,278	1	4,278	3	17,800

Capacity Based on SRT = (8.345 x Volume x MLSS) / (Yield x SRT)
Capacity Based on Volumetric Loading = (Volume x 1000 / 7.48) x Volumetric Loading
Capacity Based on F/M = (% Aerated x Volume) x (Max MLSS x MLVSS/MLSS) x 8.345 x F/M
MMWW = Max Month Wet Weather
RS = Raw Sewage
PE = Primary Effluent

F/M	0.28
Volumetric Loading	36.78

Aeration Capacity - Blowers

Assumptions:

Total capacity assumes largest blower out of service for each train

Cw	**1.5**	per 2007 data
lb O_2/lb BOD	**1.25**	per 5/27/04 DOE letter
lb O_2/lb TKN removed	**4.6**	Orange Book
TKN/NH_3	**1.2**	per 2007 data
alpha	**0.5**	M&E
beta	**0.95**	M&E
Cs	**10.53**	M&E
Cs20	**9.08**	M&E
T	**13**	
theta	**1.024**	M&E

AB 1-4

Volume	**1.88**	MG
SOTE	**25%**	(based on Sanitaire literature and basin config.)
Blower Capacity	**3,000**	scfm

AB 5-6

Volume (total)	**1.74**	MG
SOTE	**35%**	(based on Sanitaire literature and basin config.)
Blower Capacity (Large)	**4,500**	scfm
Blower Capacity (Small)	**2,400**	scfm

Criteria:

Effluent BOD	**15**	mg/l
PE NH_3	**35**	mg/l per 2007 data
SE Ammonia	**15**	mg/L
Primary Clarifier BOD Removal	**30%**	per 5/27/04 DOE letter
Peaking Factor	**1.70**	

	Flows and Loads				Oxygen Transfer Rates		
	AA Flow (mgd)	AA RS BOD (ppd)	AA PE BOD (ppd)	AA PE NH_3 (ppd)	AOR (ppd)	AOR/ SOR	SOR (ppd)
Revised Phase 4	11.30	21,299	14,909	3,298	27,274	0.3966	116,899

	AB 1-4					AB 5-6						
								# of Blowers		# of New Blowers		
	Flow Split	Air Req'd (scfm)	# of Blowers	# of New Blowers	Total Capacity (scfm)	Flow Split	Air Req'd (scfm)	Large	Small	Large	Small	Blower Capacity (scfm)
Revised Phase 4	48%	9,000	3	1	9,000	52%	6,900	2	0	0	1	6,900

AOR = PE BOD x lb O_2/lb BOD + (PE NH3 - SE NH_3)* lb O_2/lb TKN*TKN/NH_3
AOR/SOR = theta^(T-20) x alpha x (beta x Cs - Cw) / Cs20
SOR = Peaking Factor x AOR / AOR/SOR
Air Required = Flow Split x SOR x 0.04 / SOTE
0.04 = conversion of lb O_2/d to scfm

MMWW = Max Month Wet Weather
RS = Raw Sewage
PE = Primary Effluent

AOR = actual oxygen water transfer rate in process (ppd)
SOR = standard oxygen transfer rate (ppd)
alpha = Kla(wastewater) / Kla(cleanwater)
beta = field / standard condition saturation ratio
Cs = oxygen saturation concentration for tap water at field operating conditions, mg/L
Cw = operating oxygen concentration, mg/L
Cs20 = oxygen saturation concentration for tap water at 20 deg C, mg/L
T = temperature of wastewater in design conditions (deg C)
theta = temperature and pressure correction for Kla
Psite = operating ambient pressure (psia)
Psc = standard condition ambient pressure (psia)
SOTE = O_2 transfer efficiency

Secondary Clarifiers

Assumptions

SC 1&2 abandoned when AB 7 constructed,

MLSS	**3500** mg/L
RAS Rate	**70%**

Because there are always a min of 3 units, redundancy requirements do not control

Criteria

MMWW SOR	**600**	gpd/ft^2	
PHWW SOR	**1200**	gpd/ft^2	per Ecology T2-2.1.1
MMWW SLR	**35**	lbs/d/ft^2	
MMDW SLR	**25**	lbs/d/ft^2	

Basin Capacity

			Capacity per Clarifier (mgd)			
			SOR		SLR	
	Diam. (ft)	Area (ft^2)	MMWW	PHWW	MMWW	MMDW
Clarifier 1 & 2	90	6,362	3.8	7.6	4.5	3.2
Clarifier 3 & 4	105	8,659	5.2	10.4	6.1	4.4

	Flows (mgd)			# of Units				Capacity (mgd)- All Units in Service		
Year	**MMWW**	**MMDW**	**PHWW**	**Existing Clarifiers 1&2**	**Existing Clarifier 3**	**New 105' Diam.**	**Total**	**MMWW**	**MMDW**	**PHWW**
Revised Phase 4	15.0	11	28	2	1	1	4	18	15	36

Capacity = ***Minimum of*** (SOR x pi x d^2 / 4) / 1000000 ***OR*** (SLR x pi x d^2 / 4) / (8.345 x (1 + RAS rate) x MLSS)

UV Disinfection

Assumptions

Per Trojan:

Average Intensity	**124,080**	mW/cm^2
Sleeve Length	**25**	cm
Sleeve Diam	**7.65**	cm
Lamps/Module	**6**	
Lamp Area	**136.93**	cm^2

Criteria

Dose	**22,800**	$mW\text{-}sec/cm^2$	per Trojan
PHWW Headloss	**34**	inches	per Trojan
Weekly average fecal coliform	**400**	MPN/100 ml	per Ecology permit
Monthly average fecal coliform	**200**	MPN/100 ml	per Ecology permit

Disinfection

	Flows (mgd) PHWW	# of Channels	# of Modules/ Channel	Capacity (mgd)
Phase 4 (2013)	28	1	20	34
Phase 5 (2018)	34	1	20	34
Phase 6 (2028)	50	2	20	68

Hydraulic

	Flows (mgd) PHWW	k*	# of Channels	X-Sec. Area* (sf)	Capacity (mgd)
Phase 4 (2013)	28	2	1	5.96	37
Phase 5 (2018)	34	2	1	5.96	37
Phase 6 (2028)	50	2	2	5.96	74

*k values and areas from Trojan

Disinfection Capacity = average intensity x (gross reactor volume-quartz sleeve volume) x # of channels / dose x 22.8
gross reactor volume = lamps per module x modules per channel x sleeve length x lamp area
quartz sleeve volume = (pi x sleeve diameter^2 / 4) x sleeve length x lamps per module x modules per channel

Hydraulic Capacity = area x # of channels x sqrt (2 x g x max headloss / k) x 0.646
g = gravitational constant = 32.2 fps^2

GBTs

Assumptions

7 day a week operation

BOD Removal in Primaries **30%** per 5/27/04 DOE letter
Net Yield (lb WAS/lb BOD) **1.1** per 2003 data
WAS Solids **0.85%**

Criteria

AA Loading **200** gpm/m Per MOP No. 8, typical performance for
MMWW Loading **250** gpm/m GBTs thickening WAS is 100 - 250 gpm/meter

	RS BOD (ppd)		WAS Production (gpm)		# of Units		Belt Width (m)		Total Belt Width (m)	Capacity (gpm) - All Units in Service		Average Daily Hours of Operation w/All Units Service (hrs)	
	AA	MMWW	AA	MMWW	Exist.	New	Exist.	New		AA	MMWW	AA	MMWW
Revised Phase 4	21,299	25,400	333	397	2	0	2	0	4	800	1000	9.99	9.53

WAS production = RS BOD x (1-BOD removal in primaries) x WAS/BOD yield / (8.345 x WAS Solids x 694.4)

Capacity = Total Belt Width x Loading Criteria

Daily Hours of Operation = WAS production / Capacity x 24

Digesters

Assumptions

Active Volume (each)	**0.825**	MG
Active Volume (each)	**110,294**	cf
TSS Removal in Primaries	**55%**	per 5/27/04 DOE letter
BOD Removal in Primaries	**30%**	per 5/27/04 DOE letter
Net Yield (lb WAS/lb BOD)	**1.1**	
PS Solids	**4.3%**	
Thickening Capture Rate	**90%**	
TWAS Solids	**5.5%**	
%VSS	**80%**	

Criteria

Mesophillic Anaerobic

MMWW HRT	**15**	days	10-20 days per Ecology S-2.2.1
VSS MM Loading	**0.16**	lb/cf/day	0.03-0.30 per Ecology S-2.2.1

	MMWW RS Loads (ppd)		Digester Feed Production		# of Units			Capacity All Units in Service	
	TSS	BOD	(ppd of VSS)	(gpd)	Existing	New	Total	(ppd of VSS)	(gpd)
Revised Phase 4	28,100	25,400	28,010	81,421	2	0	2	35,294	110,000

Digester Feed Production (ppd) = (TSS x TSS Removal in Primaries + BOD x (1-BOD Removal in Primaries) x WAS/BOD Yield) x %VSS

Digester Feed Production (gal/d) = (TSS x TSS Removal in Primaries)/(8.345 x PS Solids) +
(BOD x (1-BOD Removal in Primaries) x WAS/BOD Rate x Thickening Capture Rate)/(8.345 x TWAS Solids)

Capacity (ppd of VSS) = Active Volume (cf) x # of Units x VSS Loading Criteria

Capacity (gpd) = Active Volume (gal) x # of Units / MMWW HRT

Dewatering

Assumptions

7 day a week operation

TSS Removal in Primaries	**55%**	per 5/27/04 DOE letter
BOD Removal in Primaries	**30%**	per 5/27/04 DOE letter
Net Yield (lb WAS/lb BOD)	**1.1**	per 2003 data
PS Solids	**4.3%**	
Thickening Capture Rate	**90%**	
TWAS Solids	**5.5%**	
%VSS	**80%**	
VSS Destruction in Digesters	**50%**	

Criteria

Loading Rate **600** lbs/hr/m — Per MOP No. 8, typical performance for BFPs dewatering anaerobically digested sludge of combined primary and WAS is 400 to700 lbs/hr/meter

	MMWW RS Loads (ppd)		Digested Sludge Production	# of Units		Belt Width (m)		Total Belt Width (m)	Capacity All Units in Service - 24 hrs	Average Daily Operation w/All Units Service
	TSS	BOD	(ppd)	Exist.	New	Exist.	New		(ppd)	(hrs)
Revised Phase 4	28,100	25,400	14,005	2	0	2	0	4	57,600	5.8

Digester Feed Production (ppd) = (TSS x TSS Removal in Primaries + BOD x (1-BOD Removal in Primaries) x WAS/BOD Rate) x %VSS
Digested Sludge production = (1- VSS Destruction in Digesters) x Digester Feed Production

Capacity = Belt Width x Loading Rate x # of Units x 24

Daily Hours of Operation = Digested Sludge Production / Capacity x 24