WPCC-3095-15

Final Design Summary of Wastewater Treatment System Upgrade & Expansion

(Phase 2)

Allen Harim Foods, LLC.

Harbeson, Delaware

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The Earth is the Lord's...
Reid Engineering
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FINAL DESIGN SUMMARY OF WASTEWATER TREATMENT SYSTEM UPGRADE & EXPANSION
for
ALLEN HARIM, LLC.
Harbeson, Delaware

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FINAL DESIGN SUMMARY OF
WASTEWATER TREATMENT SYSTEM UPGRADE & EXPANSION
for
Allen Harim, LLC.
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A. GENERAL DESIGN REQUIREMENTS

1. Description of Project

   a. Allen Harim is expanding their chicken processing plant in Harbeson, Delaware from the existing production capacity of 175,000 birds/day and 875,000 birds/week over 5 processing days/week up to 393,000 birds/day and 1,965,000 birds/week over 5 processing days/week. The design capacity of the existing on-site wastewater treatment system is approximately 1,250,000 gallons/day of wastewater which is highly treated prior to disposal by direct discharge. The expanded processing plant is expected to generate a maximum volume of 2,000,000 gallon/day of wastewater, 5 days/week. Consequently, the existing wastewater treatment system must be expanded to increase the treatment capacity provided by the wastewater treatment system in order to accommodate this processing plant expansion.

   b. In order to expand the processing plant and discharge the increased volume of treated wastewater, the Allen Harim NPDES permit must be modified for the higher maximum daily design flow capacity of 2,000,000 gpd. At this higher wastewater discharge volume, the NPDES permit limits for BOD, TSS, fecal coliform and especially Total Nitrogen and Total Phosphorus will be reduced vs. the existing permit limits. Consequently, the existing wastewater treatment process must be upgraded to increase the pollutant removal efficiency attained by the wastewater treatment system in order to comply with the new more restrictive discharge permit limits.

2. Wastewater Sources

   a. Processing Facility

      1) Wastewaters discharged from the processing will be treated through a physical chemical pretreatment system; a biological final treatment system; a tertiary filtration system; and UV disinfection system to reduce high concentrations of BOD, Suspended Solids, Oil & Grease, TKN; Ammonia Nitrogen, Total Nitrogen, Total Phosphorus, Fecal Coliform and Enterococcus Bacteria pollutants to comply with NPDES permit limitations before being discharged into Beaver Dam Creek.

b. Sanitary Wastewater

1) Sanitary wastewater generated from the bathroom facilities at the processing plant and wastewater plant will be treated through the upgraded and expanded wastewater treatment system.

3. Production Capacity, Wastewater Flow Volumes and Pollutant Concentrations and Loadings

a. Processing Facility Production Capacity

1) The existing processing plant production capacity is 175,000 chickens/day @ 6.0#LWK/bird over one kill shift and one clean up shift per day, 5 days/week = 875,000 chickens/week @ 6.0 to 7.0 gallons wastewater/bird.

2) The expansion processing plant production capacity is 393,000 chickens/day @ 6.5#LWK/bird over two kill shifts and one clean-up shift per day, 5 days/week = 1,965,000 chickens/week @ 5 gallons wastewater/bird.

b. Wastewater Flows

1) Maximum daily wastewater flow volume for 393,000 birds/day slaughter capacity @ 5 gallons/bird of wastewater = 2,000,000 gallons/day including sanitary fixtures for employees.

2) The wastewater volume generated by the processing plant during the two 8 hour processing shifts = 1.60 MG and during the one 7 hour clean-up shift = 0.40 MG. Wastewater will be generated by the processing plant at a flow rate of approximately 1,667 gpm = 2.40 MGD during the two 8 hour processing shifts and approximately 950 gpm = 1.40 MGD during the one 8 hour clean-up shift.

3) Maximum flow rate during processing shifts ≤ 2,100 gpm

4) Average flow rate during processing shifts = 1,667 gpm

5) Average flow rate during clean-up shift = 950 gpm

6) Feathers and meat offal removed by screening in the processing plant offal room will be disposed to an off-site rendering plant.

c. Wastewater Pollutant Concentrations and Loadings

1) Screened, raw wastewater pollutant concentrations and loadings at the maximum daily wastewater flow volume of 2.00 MGD:

Table #1
Screened Raw Wastewater Pollutant Concentrations and Loadings

Pollutant	Pollutant Concentration		Pollutant Loading	
	Average	Maximum	Average	Maximum
BOD (total)	1,950 mg/L	2,250 mg/L	32,526#/day	37,530#/day
BOD (soluble)	650 mg/L	850 mg/L	10,842#/day	14,178#/day
TSS	1,000 mg/L	1,500 mg/L	16,680#/day	25,020#/day
O&G	400 mg/L	600 mg/L	6,672#/day	10,008#/day
TKN	135 mg/L	175 mg/L	2,252#/day	2,919#/day
Ammonia-N	20 mg/L	30 mg/L	334#/day	500#/day
TP	19 mg/L	22 mg/L	317#/day	367#/day

B. RAW WASTEWATER INFLUENT PUMP STATION (Phase 1 Modification)

1. General Description

a. The Raw Wastewater Pump Station is provided to pump screened raw wastewater into the new DAF Pretreatment System Flow Equalization Basin.

b. The existing Raw Wastewater Pump Station will be modified to expand pump station capacity by installation of two new 10" self-priming pumps to replace the two existing 8" pumps in order to increase pumping capacity out of the existing wet well.

c. The two new pumps will have larger motors than the existing pumps in order to increase the head and capacity of the pumps.

2. Design Assumptions

a. Wastewater Flow Rates

1) Peak flow rate ≤ 2,800 gpm = 4.0 MGD

2) Maximum flow rate ≤ 2,100 gpm = 3.00 MGD during processing shifts

3) Average flow rate = 1,667 gpm = 2.40 MGD during processing shifts

b. Wastewater Pumping Requirements

1) Operation of one pump at reduced speed is required to pump the design average flow rate = 1,667 gpm during processing shifts

2) Operation of one pump at reduced speed is required to pump the design maximum flow rate = 2,100 gpm during processing shifts

3) Operation of one pump at full speed is required to pump the design peak flow rate = 2,800 gpm

4) The second pump is provided as an installed standby.

c. Pump Selection

1) Two new 40 HP, 10" self-priming wastewater pumps are provided to replace the two existing pumps.

2) Each pump is rated at 2,800 gpm @ 60 ft. head when operated at full speed.

d. Variable Speed Drives

1) Each pump is provided with a 60 HP variable speed drive motor controls with automatic pump speed and pumping rate control.

2) Pump speed and pumping rate will be automatically controlled by the liquid level in the pump station wet well.

3) Automatic Lead, Lag and Standby pump operation and sequencing is provided with high liquid level alarm and automatic pump on/off liquid levels.

C. ***FLOW EQUALIZATION BASIN (Phase 1 Existing)***

1. General Description

a. One existing Flow Equalization Basin (FEB) will be installed and operated to collect screened raw wastewater discharged from the processing plant offal room and provide hydraulic flow equalization upstream of the existing DAF Cell wastewater pretreatment system.

b. One existing above grade FEB tank will be provided with a maximum storage volume of approximately 600,000 gallons.

2. Wastewater Volumes and Flow Rates

   a. Average daily wastewater flow volume = ADF = 1,600,000 gpd, 5 days/week

   b. Maximum daily wastewater flow volume = MDF = 2,000,000 gpd, 5 days/week

   c. Average daily flow pumping rate out of the FEB = 1.60 MGD = 1,100 gpm, 24 hours/day

   d. Maximum daily flow pumping rate out of the FEB = 2.00 MGD ≤ 1,400 gpm, 24 hours/day

3. Pollutant Concentrations and Loadings

   a. Maximum and average wastewater pollutant concentrations and loadings in the screened raw wastewater at MDF = 2.00 MGD:

Table #1
Screened Raw Wastewater Pollutant Concentrations and Loadings

Pollutant	Pollutant Concentration		Pollutant Loading	
	Average	Maximum	Average	Maximum
BOD (total)	1,950 mg/L	2,250 mg/L	32,526#/day	37,530#/day
BOD (soluble)	650 mg/L	850 mg/L	10,842#/day	14,178#/day
TSS	1,000 mg/L	1,500 mg/L	16,680#/day	25,020#/day
O&G	400 mg/L	600 mg/L	6,672#/day	10,008#/day
TKN	135 mg/L	175 mg/L	2,252#/day	2,919#/day
Ammonia-N	20 mg/L	30 mg/L	334#/day	500#/day
TP	19 mg/L	22 mg/L	317#/day	367#/day

4. FEB Design

   a. Required volume for 24 hour flow equalization is calculated as follows:

      1) Maximum daily wastewater effluent pumping volume and flow rate = 2.00 MGD = 1,400 gpm.

2) The Maximum influent flow volume over two processing shifts = 2,000,000 gallons (0.80) = 1,600,000 gallons.

   a) Assume the 1,600,000 gallon flow volume is discharged into FEB's over 15 hours during two processing shifts ≤ 1,800 gpm

   b) Required equalization volume over processing shift = (1,800 – 1,400)(15 hr)(60) = 360,000 gallons ≤ 400,000 gallons

3) The Maximum influent flow volume over clean-up shift = 2,000,000 gallons (0.20) = 400,000 gallons.

   a) Assume 400,000 gallons is discharged into the FEB during the first 6 hours of the clean-up shift. The influent flow rate over the first 6 hours = 1,100 gpm.

   b) Required Equalization Volume over clean-up shift = (1,100 – 1,400)(6)(60) = 0 gallons

4) Total Required Equalization Volume:

Processing Shift	= 400,000
Clean-up Shift	= 0
Total Equalization Volume Required	≤ 400,000 gallons

b. Tank Sizes and Flow Equalization Capacity

1) The existing FEB Tank is 64.5 ft. dia. x 24.5 ft. maximum liquid depth x 26 ft. tall with a maximum volume of approximately 600,000 gallons.

2) The minimum operating water level in the FEB is 8.25 feet which provides a residual operating volume of approximately 200,000 gallons.

3) The available equalization volume in the FEB is calculated as follows:

   600,000 gallons – 200,000 gallons = 400,000 gallons

4) The existing FEB tank will provide sufficient surge storage volume to equalize and reduce the average wastewater flow rate that must be pumped into the downstream DAF cell down to approximately 1,100 to 1,400 gpm.

c. FEB Normal Operation and Alternative Operation

1) Screened raw wastewater is discharged from the offal room by gravity flow into the existing Raw Wastewater Pump Station from where it is pumped into the new FEB tank.

2) Two FEB Tank Effluent/DAF Cell Influent Pumps are provided with VFDs, discharge flow meter and automatic pumping rate control to pump equalized and aerated screened raw wastewater at a relatively constant set point flow rate ranging from 1,100 gpm to 1,400 gpm from the FEB Tank into the DAF Cell.

3) If the new FEB Tank must be taken out of service, wastewater can be pumped from the Raw Wastewater Pump Station directly into the DAF Cell and by-pass the FEB tank.

d. Evaluate Mixing and Aeration requirements in the New FEB:

1) bhp required for mixing 1,000 mg/L to 1,500 mg/L TSS concentration = 40 HP/MG

bhp required = 40 HP(0.60) $\leq$ 25 HP

cfm required for mixing $\leq$ 15 scfm/1000ft^3 with FEB @ 80 x 10^{3}ft^3

cfm required = 15 scfm(80) = 1,200 scfm

2) At the average pollutant loading, assume an oxygen uptake rate in the FEB Tank of 0.15#O_2/#BOD. The oxygen demand to maintain aerobic conditions in the FEB Tank is calculated as follows:

$$\text{AOTR} = \frac{0.15\#O_2/\#BOD\ (32{,}526\#BOD/day)}{24}$$

$$\leq 200\#O_2/hr$$

3) At the maximum pollutant loading, assume an oxygen uptake rate in the FEB Tanks of 0.15#O_2/hr/#BOD. The oxygen demand to maintain aerobic conditions in the FEB Tank is calculated as follows:

$$\text{AOTR} = \frac{0.15\#O_2/\#BOD\ (37{,}530\#BOD/day)}{24}$$

$$\leq 233\#O_2/hr$$

e. Calculate the required corresponding maximum standard oxygen transfer rate required:

$$SOTR = AOTR\left[\frac{Css}{(\beta C_{sw} - DO)\alpha(1.024)^{T-20}}\right]$$

Where DO	=	1.0 mg/L (average DO in FEB Tank)
ß	=	0.90
α	=	0.75 @ 1,000 to 2,000 mg/L TSS concentration with subsurface coarse bubble aeration diffusers
$1.024^{(T-20)}$	=	1.209 @ maximum T = 28° C
Cw	=	7.92 mg/L @ sea level, 28° C
Cs	=	9.20 mg/L @ sea level, 20° C
Site Altitude	≤	500 feet
Pressure Correction Factor	≥	0.98

Csw $= 7.92\left[\frac{(0.982)(14.7) + (0.5)(0.433)(24.0)*}{14.7}\right]$

$= 7.92$ mg/L(1.336) = 10.57 mg/L

Css $= 9.20\left[\frac{14.7 + (0.5)(0.433)(24.0)*}{14.7}\right]$

Css = 9.20 mg/L(1.354) = 12.45 mg/L

* 24 foot maximum liquid depth in FEB with the coarse bubble diffusers installed 1.0 above the basin floor.

SOTR $= \frac{12.45}{AOTR[(0.90)(10.57)-2.0]0.75(1.209)}$

SOTR ≤ 1.71 (AOTR)

SOTR ≤ 1.75(233) = 400# O_2/hr

f. Calculate subsurface aeration equipment air sparging requirements:

1) The oxygen available per cfm per hour =

$$x = 0.23\,(0.075\#/ft^3)(60\ min/hr)$$

$$= 1.035\#O_2/cfm/hr\ @\ 68°\ inlet\ air$$

2) e = subsurface diffuser oxygen stripping or transfer efficiency at 16.5 ft. average liquid depth = 13%

3) $$scfm\ required = \frac{SOTR}{(x)(e)}$$

$$scfm_1 = \frac{400\#O_2/hr}{(1.035)(0.13)}$$

$$\leq 3{,}000\ scfm$$

4) Max. design blower pressure with 23.5 ft. max. diffuser air sparge submergence plus 0.50 ft. surge depth in FEB:

= (24.0 ft.)(0.433) + 1.0 psi = 11.4 psi $\leq$ 11.5 psi (pressure loss plus pressure drop in air supply lines and air diffuser sparges)

g. Oxygen transfer and mixing in the new FEB will be provided by a coarse bubble diffuser system with the diffusers installed approximately 1.0 ft. above the basin floor. The design average air sparging rate in the FEB is 1,500 scfm providing an oxygen transfer rate of approximately 200#O_2/hr (AOTR) with one blower in operation @ maximum liquid depth = 24.0 ft. The design maximum air sparging rate in the FEB is 3,000 scfm providing an oxygen transfer rate of approximately 100#O_2/hr (AOTR) with two blowers in operation @ average liquid depth = 16.0 ft. Compressed air is supplied by 2 - 150 HP positive displacement blowers each rated at 1,500 scfm at 12.0 psi. Each blower shall be provided with a manual variable speed drive. Normally one blower will be operated at reduced speed to supply the required minimum air flow for mixing in the FEB, and, one or two blowers operated at reduced speed to supply the required air flow to FEB to meet the oxygen transfer requirements.

D. FEB EFFLUENT/DAF CELL INFLUENT PUMP STATION (Phase 1 Existing)

1. Wastewater Flow Volume and Rates

a. Average daily wastewater flow effluent pumping volume and rate = 1.60 MGD = 1,100 gpm

b. Maximum daily wastewater flow effluent pumping rate = 1,400 gpm = 2.00 MGD

2. Pump Selection

   a. Screened equalized and aerated raw wastewater will normally be pumped from the FEB Tank to the existing DAF Cell wastewater pretreatment system.

   b. Two (2) new 40 HP, 8" self-priming suction lift pumps are provided to pump screened raw wastewater from the FEB tank through a new 10" force main into the existing DAF cell influent pipeline flocculator operated upstream of the DAF Cell wastewater pretreatment system.

   c. Each pump is rated at 1,400 gpm @ 45 feet. Operation of one pump at full speed is required to pump the design maximum flow rate of 1,400 gpm with the second pump provided as an installed standby pump.

3. Variable Speed Drive Controls

   a. Each pump is provided with a 40 HP variable speed drive motor with automatic pump speed and pumping rate control.

   b. The pumps will be normally operated to maintain a constant flow rate pumped from the FEB tank to the DAF Cell. The pumps are provided with variable speed drive motor controls which use the downstream flow meter flow measurement signal and the VFD control panel to automatically control pump operating speed to maintain a manually selected flow rate into the DAF Cell. As the liquid level in FEB Tank rises or falls and the pump head is reduced or increased, the pump speed will be automatically reduced or increased to maintain the desired flow rate into the DAF Cell.

4. Liquid Level Controls

   a. The FEB pumps are manually started. Low liquid level (LLL) automatic pump shut off and alarm level controls are provided in the FEB Tank. Pumps can also be manually operated to pump below the automatic off liquid level in order to drain the FEB.

   b. A high liquid level alarm (HLLA) is provided in the FEB in order to prevent excessive liquid level in the FEB tank.

   c. A high liquid level emergency overflow pipe is also provided in the FEB Tank to discharge overflow into the DAF Cell Effluent Pump Station Wet Well.

5. Flow Meter and Flow Controls

   a. One new 10" dia. magnetic flow meter is provided in the DAF influent line into the Flocculation Tube of the existing DAF Cell.

b. The flow meter is used with the DAF Cell Influent Pump Station Control Panel for automatic control of pump speed and pumping rate from the FEB Tank into the DAF Cell and flow pacing of chemical feed pumps used to dose chemical solutions for coagulation and flocculation of wastewater upstream of the DAF cell.

c. The flow meter has a flow indicator and totalizer and is provided with a downstream valve to optionally manually regulate the flow rate pumped out of the FEB tank into the downstream DAF Cell.

E. DISSOLVED AIR FLOTATION DAF CELL PRETREATMENT SYSTEM (Existing)

1. General

a. Wastewater will be pumped from the new FEB Tank at a relatively constant flow rate 24 hours/day on processing days into the existing DAF Cell for pretreatment of BOD, TSS, Oil and Grease, TKN and TP prior to discharge into the activated sludge final treatment system.

b. The existing DAF Cell has an existing Flocculation Tube.

c. The existing DAF cell will be upgraded by the installation of two new recycle pressurization pumps, recycle flow piping and air control panel in order to improve efficiency and capacity.

2. Design Assumptions

a. Wastewater Flow Rates and Volumes:

1) Average Influent Flow Rate = 1.60 MGD = 1,100 gpm, over 24 hours/day, 5 days/week

2) Maximum Influent Flow Rate = 2.00 MGD = 1,400 gpm, over 24 hours/day, 5 days/week

b. Maximum and average wastewater pollutant concentrations and loadings in the screened raw wastewater at MDF = 2.00 MGD:

Table #1
Screened Raw Wastewater Pollutant Concentrations and Loadings

Pollutant	Pollutant Concentration		Pollutant Loading	
	Average	Maximum	Average	Maximum
BOD (total)	1,950 mg/L	2,250 mg/L	32,526#/day	37,530#/day
BOD (soluble)	650 mg/L	850 mg/L	10,842#/day	14,178#/day
TSS	1,000 mg/L	1,500 mg/L	16,680#/day	25,020#/day
O&G	400 mg/L	600 mg/L	6,672#/day	10,008#/day
TKN	135 mg/L	175 mg/L	2,252#/day	2,919#/day
Ammonia-N	20 mg/L	30 mg/L	334#/day	500#/day
TP	19 mg/L	22 mg/L	317#/day	367#/day

3. DAF System Design

a. General Description

1) One existing 10 ft. wide x 44 ft. long x 10 ft. liquid depth rectangular DAF Cell is provided with two new recycle flow pressurization pumps, a new air dissolving system and one existing pipeline flocculator to provide wastewater pretreatment by chemical coagulation and flocculation and dissolved air flotation. One 12" diameter x 80 ft. long, 500 gallon volume Flocculation Tube is provided with the DAF Cell. The effective flotation area of the DAF Cell > 400 ft^2.

2) The existing 30 HP recycle pressurization pumps each rated at 302 gpm at 205 ft. head are provided with compressed air fed into the pump discharge piping.

3) One existing Air Compressor is provided for air supply to the DAF cell air dissolving system and recycle pressurization pump discharge.

b. Design Calculations

1) Calculate the maximum DAF Cell solids loading rate with upstream chemical coagulation-flocculation @ 1,400 gpm = 2.00 MGD assuming a BOD removal efficiency of 70%, a TSS removal efficiency of 90% and a O&G removal efficiency of 85%.

a) $\frac{[1{,}500 \text{ mg/L TSS})(0.90)\ 8.34\ (2.00 \text{ MGD})]}{24}$

$\leq$ 1,000#/hr

2) Calculate the required air dissolving rate for the maximum solids loading rate of 1,000#/hr, assuming an air to solids ratio = 0.01#air/#solids in the rectangular DAF cell with polymer coagulation/flocculation.

a) $\frac{1{,}000\ (0.01)}{60}$ < 0.17# air/min.

3) Calculate the required air supply rate @ 90°F inlet air density @ ≤ sea level altitude ≥ .071#/ft^3

a) $\frac{0.17\#/\text{min}}{0.071}$ ≤ 2.50 cfm

b) Use air supply rate = 1.0 cfm to 3.0 cfm = 30 to 90 liters/min.

4) The maximum air dissolving capacity of the DAF Cell recycle pressurization system with one 30 HP recycle pressure pump in operation = 100 liters air/min. ≥ 3.5 cfm.

5) Calculate the pressurized flow required @ 90 psi air dissolving pressure @ wastewater temperature = 90°F max., assuming an air dissolving capacity = 0.864# air/min. @ 90 psi

a) QR= $\frac{0.17\#/\text{min}}{0.864\#\ \text{air/min}}$ (1000) ≤ 200 gpm

One 30 HP recycle pressure pump is provided with the DAF Cell rated @ 302 gpm @ 205 psi. A second uninstalled pump is provided as a standby.

6) Calculate the maximum DAF Cell Hydraulic Surface Loading Rate

a) Hydraulic Surface Loading Rate =

$\frac{1{,}400 \text{ gpm}}{400 \text{ ft}^2}$ ≤ 3.5 gpm/ft^2

7) Calculate the maximum DAF Solids Loading Rate =

a) Solids Loading Rate =

$\frac{1{,}000\#/\text{hr}}{400 \text{ ft}^2}$ ≤ 2.5#/ft^2/hr

4. DAF Sludge Production Storage and Pumping

   a. The calculated total skimmings volume produced per day in the DAF Cell when operated with chemical coagulation-flocculation = 18,000# to 24,000# dry solids/day = 12,000 to 22,000 gpd after gravity decanting for approximately 20% solids concentration, assuming approximately 70% BOD removal, 90% TSS removal and 85% Oil & Grease removal, TKN removal of 30% to 50% and TP removal of 30% to 50% in the DAF Cell.

   b. Solids skimmed from DAF Cell will flow into a 2,500 gallon Sludge Holding Compartment at the end of the Flotation Cell from where solids will be pumped to an existing 20,000 gallon portable storage tank or to a tanker truck parked adjacent to the equipment building for further storage prior to hauling to final disposal.

   c. Three new 7.5 HP DAF positive displacement sludge pumps are provided each rated at 100 gpm @ 60 ft. to transfer DAF sludge from the Flotation Cell Sludge holding Compartment to the DAF Sludge Storage Tanker for hauling to an off-site disposal site.

5. Expected DAF Pretreatment System Effluent Quality

   a. The following DAF Pretreatment System effluent quality, as summarized in Table #2, is expected if the DAF Cell is operating with a high efficiency chemical program using aluminum chloride coagulant solution and anionic polymer flocculant solution for chemical coagulation and flocculation in the Flocculation Tube upstream of the DAF Cell. The following pretreatment system effluent quality is expected to be discharged into the downstream activated sludge final treatment system at the 2.00 MGD maximum daily discharge flow volume:

Table #2
DAF Pretreatment System Effluent Pollutant Concentrations Required for Acceptable Performance of Downstream BNR Final Treatment System

Pollutant	Average Concentration	Maximum Concentration
BOD	BOD = 1,950(0.30) ≤ 600 mg/L	BOD = 2,250(0.35) ≤ 800 mg/L
TSS	TSS = 1,000(0.10) ≤ 100 mg/L	TSS = 1,500(0.10) ≤ 150 mg/L
O&G	O&G = 400(0.15) ≤ 60 mg/L	O&G = 600(0.15) ≤ 100 mg/L
TKN	TKN = 135(0.50) ≤ 75 mg/L	TKN = 175(0.70) ≤ 125 mg/L
TP	TP = 19 (0.50) ≤ 10 mg/L	TP = 22(0.70) ≤ 20 mg/L

Table #3
Pollutant Loadings in DAF Pretreatment System
Effluent at 2,000,000 gpd Wastewater Flow Volume

Pollutant	Average Loading	Maximum Loading
BOD	10,000#/day	13,344#/day
TSS	1,668#/day	2,502#/day
O&G	1,000#/day	1,668#/day
TKN	1,251#/day	2,085#/day
TP	167#/day	334#/day

F. *CHEMICAL FEED EQUIPMENT FOR DAF PRETREATMENT SYSTEM*

1. Bulk Coagulant Solution Storage Tank

   a. One existing 10' dia. x 12' tall, 6,000 gallon volume, fiberglass double walled tank is provided for bulk storage of aluminum chloride coagulant solution. The bulk tank is located in the existing wastewater shop.

   b. The existing bulk coagulant solution storage tank is provided with containment and has an ultrasonic level control with high and low level alarm with continuous level indicator.

2. Polymer Solution Mix Tanks

   a. Two existing 6'-6" dia. x 10' tall, 2,400 gallon volume fiberglass tanks each with 2 HP mixer are provided for make-up and storage of wastewater shop anionic polymer flocculant solution. The tanks are located in the existing building.

3. Chemical Solution Pumps

   a. Two coagulant solution pumps are provided each rated at 25 gphr @ 30 psi for dosage of coagulant solution into the wastewater flow into the DAF Cell Flocculation Tube. The coagulant solution pumps are located in the existing wastewater shop building.

   b. Two polymer solution pumps are provided each rated at 90 to 900 gphr @ 40 psi for dosage of anionic flocculant solution into the wastewater flow into the DAF Cell Flocculation Tube. The polymer solution pumps are located in the existing wastewater shop building.

c. The coagulant solution and polymer solution chemical feed pumps have variable speed drives that can be manually controlled; or, automatically controlled by flow pacing from the DAF cell influent flow meter and the chemical feed control system.

G. DAF CELL EFFLUENT PUMP STATION (Phase 1 Modification)

1. General Description

   a. The DAF Cell Effluent Pump Station is provided to pump pretreated wastewater discharged from the DAF cell into the downstream activated sludge biological treatment process Flow Equalization Basin (FEB) Reactor #1A.

   b. The existing DAF Cell Effluent Pump Station will be modified by installation of three new 8" self-priming pumps with increased HP to replace the three existing 8" self-priming pumps in order to increase pumping capacity out of the existing wet well.

   c. The new pumps will have larger motors to increase the head and capacity of the pumps in the pump station.

2. Design Assumptions

   a. Average pumping rate = 1.60 MGD = 1,100 gpm

   b. Maximum pumping rate = 2.00 MGD = 1,400 gpm

   c. Peak pumping rate = 2,800 gpm

3. Pump Selection

   a. Three existing 50 HP, 8" self-priming sewage pumps are provided to pump pretreated wastewater discharged from the existing DAF cell effluent wet well into FEB Reactor #1A; FEB Reactor #1B or Nitrification Reactor #2A of the activated sludge final treatment system.

   b. Each pump is rated at 1,400 gpm @ 70 ft.

4. Variable Speed Drive Controls

   a. New variable speed drive motor controls are provided for each pump.

   b. Pump speed and pumping rate are automatically controlled by the liquid level in the wet well.

c. Operation of one pump at full speed is required to pump the design maximum flow rate = 1,400 gpm = 2.00 MGD. Operation of two pumps at full speed is required to pump the peak flow rate of 2,800 gpm. The new third pump is provided as an installed standby pump.

5. Wet Well Liquid Level Control

   a. One liquid level sensor is provided in the pump station wet well to operate the pump station pump on, pump off and high liquid level alarm controls.

   b. A control system is provided to automatically adjust the pump operating speed and the flow pumping rate to maintain the liquid level in the pump station wet well.

H. 7 DAY FLOW EQUALIZATION BASIN ANOXIC REACTOR #1A & #1B (Existing)

1. Design Assumptions

   a. Wastewater Flows

      1) Maximum daily influent flow volume ≤ 2.00 MGD, 5 days/week.

      2) Weekend flow approximately = 200,000 gpd x 2 days = 400,000 gallons ≤ 0.40 MG

      3) Average daily effluent pumping rate required for 7 day hydraulic flow equalization =

$$\frac{2.00\text{ MGD}(5\text{ days})+0.20\text{ MGD}(2\text{ days})}{7\text{ days}}=1.50\text{ MGD, 7 days/week}$$

   b. Pollutant Concentrations and Loadings

      1) The following influent wastewater pollutant concentrations and loadings are assumed in the design of the 7 Day FEB Anoxic Reactor #1A and FEB Anoxic Reactor #1B at the maximum influent wastewater flow volume ≤ 2.00 MGD from the upstream DAF pretreatment system:

Table #4
Pollutant Loadings in DAF Pretreatment System
Effluent at 2,000,000 gpd Wastewater Flow Volume

Pollutant	**Average**		**Maximum**	
	Concentration	**Loading**	**Concentration**	**Loading**
BOD	600 mg/L	10,000#/day	800 mg/L	13,344#/day
TSS	100 mg/L	1,668#/day	150 mg/L	2,502#/day
O&G	60 mg/L	1,000#/day	100 mg/L	1,668#/day
TKN	75 mg/L	1,251#/day	125 mg/L	2,085#/day
TP	10 mg/L	167#/day	20 mg/L	334#/day

   c. FEB Reactor #1A and #1B are designed to function as anoxic (low DO) reactors operated in parallel to provide combined 7 day hydraulic flow equalization, carbonaceous BOD removal and nitrate nitrogen removal.

d. Emergency Wastewater Storage

In the event of power failure, wastewater can be stored in the 7 Day Flow Equalization Basin Reactors #1A and #1B until normal power is resumed.

2. Equalization Volume and Tank Volume Design Calculations

a. Maximum volume required for 7 day, 24 hour hydraulic flow equalization =

(2.00 MGD – 1.50 MGD)(5 days) = 2.50 MG

b. Residual volume provided in FEB Reactor #1A and #1B at the 5.5 ft. low liquid depth = 0.72 MG(2) = 1.44 MG

c. Maximum volume provided in FEB Reactor #1A and #1B at the 11.5 ft. max. liquid depth = 2.00 MG(2) = 4.00 MG.

3. 7 Day FEB/Reactors #1A & #1B BOD and Nitrate Removal Process Design

a. FEB Reactor #1A and #1B are each constructed of a membrane lined, earthen basin that is 115 ft. long x 115 ft. wide (bottom dimensions) x 3/1 side slope x 13.5 ft. total depth x 12.0 ft. maximum liquid depth, 2.00 MG volume.

b. The total maximum wastewater volume in both FEB Reactor #1A and #1B is approximately 2.00 MG x 2 = 4.0 MG at the 12.0 ft. maximum operating liquid depth.

c. The total minimum wastewater volume in both FEB Reactors #1A and #1B is approximately 0.72 MG x 2 = 1.44 MG at the 5.5 ft. minimum operated liquid depth.

d. 7 Day FEB Reactors #1A & #1B will be used for 7-day hydraulic flow equalization and also be operated in parallel as first stage anoxic activated sludge reactors for biological nitrate removal and carbonaceous BOD removal in a four stage biological nitrogen removal (BNR) system.

4. FEB Anoxic Reactors #1A & #1B Design

a. Assume Anoxic FEB Reactors #1A & #1B will be used as an anoxic activated sludge reactor basin for removal of carbonaceous BOD in the pretreated wastewater discharged from the upstream DAF pretreatment cell, and, for removal of nitrate nitrogen contained in the mixed liquor flow recycled from downstream Nitrification Reactor #2A and #2B.

b. Calculate MLVSS concentration required for carbonaceous BOD removal by biological synthesis in FEB Reactors #1A & #1B at the minimum expected winter season design mixed liquor temperature of 15°C

1) For BOD removal assuming a carbonaceous BOD removal rate of 0.40# BOD/#MLVSS at 15°C and a carbonaceous BOD removal efficiency of 80%

$$\frac{13{,}344\#BOD/day\ (0.80)}{0.40} \leq 27{,}000\#MLVSS\ @\ 15^{\circ}C$$

c. Calculate MLVSS concentration required for removal of nitrate nitrogen in the mixed liquor recycled from Nitrification Reactor #2.

1) Calculate TKN concentration and loading to be nitrified assuming a 3% nitrogen uptake rate for synthesis of carbonaceous BOD = 125 mg/L – 0.03 (800 mg/L) = 101 mg/L; TKN/day to be nitrified = (101 mg/L)(8.34)(2.00 MGD) = 1,685#TKN nitrified/day, 7 days/week.

2) Calculate the nitrate nitrogen in recycled mixed liquor assuming 100% of TKN into Nitrification Reactor #2 is nitrified, assuming a 100% sludge recycle rate from the Final Clarifier; and assuming a maximum nitrate recycle flow rate of 400% which = $\frac{4Q+1Q(RAS)}{1Q+1Q(RAS)+4Q} = \frac{5Q}{6Q}$ = 0.833 = 83% of the total flow rate that would be discharged from Nitrification Reactor #2.

$\#NO_3$-N recycled = 0.83 (1,685#TKN/day)
= 1,399#NO_3-N/day denitrified

3) For NO_3-N removal assuming a denitrification rate $\geq$ 0.06# NO_3-N/#MLVSS at 15°C

$$\frac{1{,}399\#NO_3\text{-}N/day}{0.06} \leq 24{,}000\#\ MLVSS\ @\ 15^{\circ}C$$

;therefore, #MLVSS for BOD removal governs the minimum biomass weight required and therefore the design MLVSS = 27,000# and #MLSS = 27,000/0.70 $\leq$ 39,000# assuming MLVSS/MLSS = 0.70

d. The maximum MLSS concentrations required in FEB Reactors #1A & #1B are calculated as follows at LWL and HWL

1) At LWL = 5.5 ft. when the effective anoxic basin volume is approximately 0.72 MGD(2) = 1.44 MG

$$MLSS = \frac{39{,}000\#\ MLSS}{(1.44\ MG)(8.34)} = 3{,}247\ mg/L$$

$$\leq 3{,}300\ mg/L$$

2) At HWL = 12.0 ft. when the effective anoxic basin volume is approximately 2.00 MG(2) = 4.00 MG

$$\text{MLSS} = \frac{39{,}000\#\ \text{MLSS}}{(4.00\ \text{MG})(8.34)} = 1{,}170\ \text{mg/L}$$

$$\leq 1{,}200\ \text{mg/L}$$

e. Calculate the hydraulic detention time in FEB Anoxic Reactors #1A & #1B at LWL and HWL assuming the total flow volume into the anoxic reactor = 2.00 MGD inflow volume + 1Q RAS rate + 4Q nitrate mixed liquor recycle flow rate = 2.00 MGD + 2.00 MGD (RAS) + 2.00 MGD(4) = 12.0 MGD = 8,333 gpm

1) $$\text{HDT(min)} = \frac{1{,}440{,}000\ \text{gallons}}{8{,}333\ \text{gpm}} = 172\ \text{min @ LWL}$$

$$= 2.9\ \text{hrs @ LWL}$$

2) $$\text{HDT(aver)} = \frac{2{,}720{,}000\ \text{gallons}}{8{,}333\ \text{gpm}} = 326\ \text{min @ LWL}$$

$$= 5.4\ \text{hrs @ LWL}$$

3) $$\text{HDT(max)} = \frac{4{,}000{,}000\ \text{gallons}}{8{,}333\ \text{gpm}} = 480\ \text{min@ HWL}$$

$$= 8.0\ \text{hrs @ HWL}$$

5. <u>FEB Anoxic Reactor #1A & #1B Mixing and Aeration Equipment Design</u>

a. Calculate the mixing requirements in 7 Day FEB Anoxic Reactors #1A & #1B:

1) BHP required for mixing 3,000 mg/L to 5,000 mg/L TSS concentration = 30 HP/MG using floating downpumping mixers.

2) Average normal operating liquid volume in FEB Reactor #1A and FEB Reactor #1B =

$$\frac{0.72\ \text{MG} + 2.00\ \text{MG}}{2} = 1.36\ \text{MG (per basin)} = 2.72\ \text{MG (total)}$$

3) Average BHP required = 30 HP(1.36 MG) $\leq$ 40 HP @ 8.75 ft. SWD

4) Maximum BHP required = 30 HP(2.00 MG) $\leq$ 60 HP @ 12.0 ft. SWD

5) One existing 40 HP floating, downpumping Aqua Aerobics mixer, and, a coarse bubble diffuser system is provided in each FEB Reactor basin for suspension and mixing of mixed liquor biomass solids.

6) One existing 7.5 HP floating, downpumping $AerO_2$ mixers is also provided in each FEB Reactor for additional mixing and oxygen transfer.

b. Calculate the oxygen transfer rate required in FEB Anoxic Reactors #1A & #1B under normal operating conditions when the downstream Nitrification Reactor #2 is in service

1) Calculate the average and maximum oxygen transfer requirement for BOD synthesis assuming an oxygen demand = 0.60#O_2/#BOD and 80% BOD removal

$$AOTR_1 = \frac{0.60\#O_2/\#BOD(13{,}344\#BOD/day)(0.80)}{24} = 267\#O_2/hr\ (max)$$

$$= \frac{0.60\#O_2/\#BOD(10{,}000\#BOD/day)(0.80)}{24} = 200\#O_2/hr\ (aver)$$

2) Calculate the average and maximum oxygen available in recycled nitrate for carbonaceous BOD removal in FEB Anoxic Reactor #1 assuming a nitrate recycle rate of 4Q = 400%; an RAS rate = 1Q = 100%; a recycled nitrate nitrogen fraction = 0.83 or 83%; and an oxygen supply of 2.86#O2/#NO3-N.

$AOTR_2$ = #O_2 /hr available from NO_3-N

$$AOTR_2 = \frac{(1{,}685\#TKN/day\ nitrified)2.86(0.83)}{24} = -167\#O_2/hr\ (max)$$

$$= \frac{(950\#TKN/day\ nitrified)2.86(0.83)}{24} = -94\#O_2/hr\ (aver)$$

3) Calculate the average and maximum oxygen transfer requirement for endogenous respiration where the average volume in FEB Reactors #1A and #1B is approximately 49% of the total activated sludge volume reactor volume calculated as follows:

Reactor	Average Volume	% of Total Volume
FEB Reactors #1A & #1B	2.72 MG	52%
Nitrification Reactor #2	1.64 MG	31%
Anoxic Reactor #3	0.80 MG	15%
Aerobic Reactor #4	0.10 MG	2%
Total Reactor Volume	5.26 MG	100%

$$AOTR_3 = \frac{(13{,}344\#\,BOD/day)(0.80\#\,O_2/\#\,BOD)(0.49)}{24} = 218\#\,O_2/hr(\text{max})$$

$$= \frac{(10{,}000\#\,BOD/day)(0.80\#\,O_2/\#\,BOD)(0.49)}{24} = 163\#\,O_2/hr(aver)$$

4) Calculate the total amount of oxygen required in FEB Reactors #1A and #1B:

$AOTR_{(total)}$ = $AOTR_1 - AOTR_2 + AOTR_3$

= $267\#O_2/hr - 167\#O_2/hr + 218\#O_2/hr = 318\#O_2/hr$ (max)

= $200\#O_2/hr - 94\#O_2/hr + 163\#O_2/hr = 269\#O_2/hr$ (aver)

5) Calculate the required corresponding standard oxygen transfer rate required:

$$SOTR = AOTR\left[\frac{Css}{(\beta C_{sw} - DO)\alpha(1.024)^{T-20}}\right]$$

Where DO $\leq$ 0.30 mg/L (maximum D.O. in FEB Reactor #1A & #1B)

ß = 0.90

α = 0.80 @ 3,000 to 5,000 mg/L MLSS with subsurface coarse bubble aeration diffusers

$1.024^{(T-20)}$ = 1.268 @ T = 30°C

Cw = 7.63 mg/L @ sea level, 30°C @ max. mixed liquor temperature

Cs = 9.20 mg/L @ sea level, @ 20°C

Site Altitude $\leq$ 500 feet

Pressure Correction Factor $\geq$ 0.98

$$Csw = 8.38\left[\frac{(0.98)(14.7)+(0.5)(0.433)(8.75)*}{14.7}\right]$$

$$= 8.38 \text{ mg/L}(1.109) = 9.29 \text{ mg/L}$$

$$Css = 9.20\left[\frac{14.7+(0.5)(0.433)(8.75)*}{14.7}\right]$$

$$= 9.20 \text{ mg/L}(1.129) = 10.39 \text{ mg/L}$$

* Average FEB Reactor basin liquid depth = 8.75 ft.

$$SOTR = AOTR \frac{10.39}{\{(0.90)(9.29)-0.3\}0.80(1.268)\}}$$

$$SOTR = 1.27(AOTR)$$

$$SOTR \leq 1.27(318) \leq 400\#O_2/hr \text{ (max)}$$

$$\leq 1.27(269) \leq 350\#O_2/hr \text{ (max)}$$

6) Calculate subsurface aeration equipment air sparging requirements:

a) The oxygen available per cfm per hour @ 20°C and 1 atm

$x = 0.23\ (0.075\#/ft^3)(60\ min/hr)$

$= 1.035\#O_2/cfm/hr$

b) e = subsurface diffuser oxygen stripping or transfer efficiency at maximum liquid depth = 12.0 ft. = 10%

c) $\text{scfm required} = \frac{SOTR}{(1.035)(0.10)}$

$$\text{scfm} = \frac{400\#O_2/HR}{(1.035)(0.10)} \leq 4{,}000 \text{ scfm (max)}$$

$$= \frac{350\#O_2/HR}{(1.035)(0.10)} \leq 3{,}500 \text{ scfm (aver)}$$

d) The maximum blower pressure for aeration diffusers with maximum air sparge submergence = 12.0 ft. maximum liquid depth – 1.0 ft. diffuser elevation above floor = 11.0 ft. is calculated as follows:

= (11.0 ft.)(0.433) + 1.0 psi = 5.8 ≤ 6.0 psi including pressure loss in air supply lines and in jet nozzle diffusers

7) Oxygen transfer in FEB Reactors #1A & #1B is provided by an existing air-grid coarse bubble diffused aeration headers installed approximately 1.0 ft. above the basin floor. Mixing can be provided in the Reactors with aeration and oxygen transfer by operation of 1 – 40 HP floating mixer in each Reactor basin. The total air sparging capacity of the coarse bubble diffuser system in the two FEB Reactor basins is approximately 5,400 scfm providing an oxygen transfer rate ≥ 400#O_2/hr (AOTR) with air supplied by 3 – 75 HP positive displacement blowers each rated at 1,800 scfm at 5.75 psi.

8) Oxygen in Anoxic Activated Sludge Reactors #1A and #1B will normally be provided by nitrate oxygen contained in the mixed liquor recycle by gravity from the exiting downstream Nitrification Reactor #2B. Normally one air supply blower will be operated to provide compressed air flow to the coarse bubble diffusers in both FEB Reactor to provide supplemental mixing and some oxygen transfer to prevent septic conditions and odors.

6. Gravity Nitrate Recycle Line

a. One new 20" dia. nitrate recycle line is provided to recirculate mixed liquor by gravity flow from Nitrification Reactor #2B back into FEB Reactors #1A and #1B.

b. The gravity nitrate recycle flow capacity =

4Q = 4(2.00 MGD) = 8.0 MGD = 5,600 gpm.

c. Two magnetic flow meter with downstream manual flow control valve are provided in the nitrate recycle flow line to control the nitrate recycle flow rate from Reactor #2B back into FEB Reactor #1A and FEB Reactor #1B.

7. Expected Effluent Quality at the Maximum Discharge Flow Volume = 2.00 MGD

   a. To insure a conservative design approach due to large liquid level variation required in the FEB Anoxic Reactors #1A and #1B to accomplish 7 day hydraulic flow equalization, the following maximum Reactor #1A and #1B effluent pollutant concentrations and loadings are assumed for the design of downstream Nitrification Reactors #2A and #2B at the maximum average daily influent flow volume of 2.00 MGD:

Pollutant	Concentration	Loading
BOD	800(0.20) = 160 mg/L	2,668#/day
O&G	100(0.20) = 20 mg/L	334#/day
TKN	101 mg/L[(1)]	1,685#/day
NH_3-N	50 mg/L[(2)]	834#/day
TP	16.0 mg/L[(3)]	267#/day

[(1)]TKN = 175 mg/L – 0.03(800 mg/L BOD) = 101 mg/L
[(2)]NH_3-N will rise from 20 mg/L up to approximately 50 mg/L in the FEB Reactors
[(3)]TP = 20 mg/L – 0.005(800 mg/L BOD) = 16.0 mg/L

I. FEB ANOXIC REACTOR EFFLUENT PUMP STATION (Phase 1 Existing)

1. Design Assumptions

   a. Maximum Average Wastewater Flow Rate = Q = 1.50 MGD = 1,050 gpm, 24 hours/day, 7 days/week

   b. Maximum Wastewater Flow Rate = Q(max) = 2.00 MGD = 1,400 gpm, 24 hours/day, 5 days/week

   c. Maximum Nitrate Recycle Flow Rate = 400% = 4Q = 4(2.00 MGD) = 8.00 MGD = 5,600 gpm, 24 hours/day

   d. Average Return Activated Sludge Flow Rate = 1Q = 1(1.50 MGD) = 1.50 MGD = 1,050 gpm

   e. Maximum Return Activated Sludge Flow Rate = 1Q = 1(2.00 MGD) = 2.00 MGD = 1,400 gpm

   f. Peak Return Activated Sludge Flow Rate = 2Q = 2(2.00 MGD) = 4.00 MGD = 2,800 gpm

   g. Maximum Total Pumping Rate required = 1Q flow rate + 1Q RAS rate + 4Q nitrate recycle rate = 6Q = 6(2.00 MGD) ≤ 12.0 MGD = 8,400 gpm, 24 hours/day

h. Average Total Pumping Rate required = 6Q = 6(1.50 MGD) = 9.0 MGD = 6,300 gpm, 24 hours/day, 7 days/week

2. Pump Selection

a. Four existing 75 HP, 10" self-priming pumps are provided in the FEB Reactor Effluent Pump Station.

b. Each pump is rated at 2,500 gpm @ 75 ft. total head when operated at full speed.

c. Operation of four 10" self-priming pumps in parallel at reduced speed is required to provide the minimum total feed forward pumping capacity required = 1Q + 1Q(RAS) + 4Q (Nitrate Recycle) = 6Q = 6(2.0 MGD) = 12.00 MGD = 8,400 gpm = 2,100 gpm/pump.

d. The three unused existing 6" self-priming pumps can be operated for standby service to pump out of FEB Reactor #1B in the event that one of the 10" pumps is out of service.

3. Variable Speed Drive Controls

a. Each pump is provided with variable speed drive motor controls operated by a manually adjustable constant flow sensor-controller for the effluent pumping rate from FEB Reactors #1A and #1B into the Nitrification Reactor #2A.

b. The operator can manually select and set the desired effluent pumping rate and rely on the flow controller to automatically control and maintain the required pump speed to provide the selected flow pumping rate measured by the downstream magnetic flow meter.

4. Discharge Flow Meter

a. Two 14" dia. magnetic flow meter is provided in the new pump station discharge header to accurately measure, indicate, totalize, and allow manual control of the flow rate and volume pumped from FEB Anoxic Reactors #1A and #1B to Nitrification Reactor #2A.

b. The flow meter can be used in combination with downstream flow control valve to maintain a desired set point flow rate from FEB Anoxic Reactors #1A and #1B into Nitrification Reactor #2A in the event automatic flow control is out of service, or manual flow control is preferred.

5. Emergency High Liquid Level Overflow

a. One emergency high liquid level overflow channel is provided for gravity flow capability from FEB Reactor #1A into the adjacent stormwater collection lagoon in the event of FEB Reactor#1A and #1B Effluent Pump Failure, or, in the event of an inadequate pumping rate from FEB Reactor #1B into Reactor #2A.

J. NITRIFICATION REACTOR #2A & #2B (Existing & New)

1. General Description

   a. One existing 100 ft. dia. x 28 ft. liquid depth, 1.64 MG volume above grade bolted carbon steel tank, and, one new 60 ft. dia. x 26 ft. liquid depth, ≥ 0.5 MG volume, above grade concrete tank are provided to be operated in series as a second stage, aerobic, activated sludge Nitrification Reactors #2A and #2B to provide ammonia removal by biological nitrification.

   b. Nitrification Reactors #2A & #2B can also be operated to provide complete single stage BOD and Ammonia removal in the event that FEB Reactors #1A and #1B must be taken out-of-service if the upstream DAF Pretreatment System is operated with higher efficiency chemical coagulation and flocculation to reduce BOD down to ≤ 350 mg/L and TKN down to ≤ 75 mg/L.

2. Design Assumptions

   a. Wastewater Flow

      1) Maximum average daily influent wastewater flow volume = 1.50 MGD, 7 days/week

      2) Maximum daily influent wastewater flow volume = 2.00 MGD

   b. Pollutant Concentrations and Loadings

      1) Influent pollutant concentrations and loadings in the FEB Reactor #1B effluent wastewater flow volume @ 2.00 MGD:

Pollutant	Concentration	Loading
BOD	160 mg/L	2,668#/day
TSS (MLSS)	3,000 to 5,000 mg/L	-
O&G	20 mg/L	334#/day
TKN	101 mg/L	1,685#/day
NH3-N	50 mg/L	834#/day
TP	16.0 mg/L	267#/day

3. Nitrification Reactors #2A and #2B Process Design (Winter Conditions)

   a. Calculate MLVSS and MLSS concentrations required for BOD and ammonia removal at the expected minimum winter season design mixed liquor temperature in Reactors #2A and #2B = 12°C

1) For BOD removal assuming a carbonaceous BOD removal rate = 0.33#BOD/# MLVSS @ 12°C:

$$\frac{2{,}668\#BOD/day}{0.33} \leq 8{,}085\#\ MLVSS\ @\ 12^{\circ}C$$

2) For TKN removal assuming a nitrification rate of 0.04#TKN/# MLVSS at 12°C:

$$\frac{1{,}685\#TKN/day}{0.04} \leq 42{,}125\#MLVSS\ @\ 12^{\circ}C$$

3) The required MLVSS and MLSS concentrations in the total reactor volume for BOD removal and nitrification at the 12°C minimum winter season operating temperature assuming MLVSS/MLSS = 0.70

$$\frac{8{,}085\# + 42{,}125\#}{(8.34)(1.64\ MG + 0.50\ MG)} =$$

$$\frac{50{,}210\#MLVSS}{(8.34)(2.14\ MG)} = 2{,}813\ mg/L\ MLVSS$$

$$\frac{2{,}813\ mg/L}{0.70} = 4{,}019\ mg/L\ MLSS$$

$$\leq 5{,}000\ mg/L \pm MLSS$$

Assume MLSS ≤ 5,000 mg/L in Nitrification Reactor #2A and #2B during **winter season** for conservative design approach.

4) If the MLSS concentration in Nitrification Reactors #2A and #2B is 5,000 mg/L, then the MLSS concentration in FEB Anoxic Reactors #1A and #1B will be approximately 5,000 mg/L if return sludge is pumped back into FEB Reactors #1A and #1B

4. Nitrification Reactors #2A and #2B Process Design (Summer Conditions)

   a. Calculate MLVSS and MLSS concentrations required for BOD and ammonia removal at the expected average summer season design mixed liquor temperature in Reactors #2A & #2B = 22°C

1) For BOD removal assuming a carbonaceous BOD removal rate = 0.45# BOD/# MLVSS @ 22°C:

$$\frac{2{,}668\#\ BOD/day}{0.45} \leq 5{,}929\#\ MLVSS\ @\ 22^{\circ}C$$

2) For TKN removal assuming a nitrification rate of 0.06 #TKN/# MLVSS at 22°C:

$$\frac{1{,}685\#TKN/day}{0.06} \leq 28{,}083\#\ MLVSS\ @\ 22^{\circ}C:$$

3) The required MLVSS and MLSS concentrations in the total reactor volume for BOD removal and nitrification at the 22°C average summer season operating temperature assuming MLVSS/MLSS = 0.70

$$\frac{5{,}929\# + 28{,}083\#}{(8.34)(1.64\ MG + 0.50\ MG)} =$$

$$\frac{34{,}012\#MLVSS}{(8.34)(2.14\ MG)} = 1{,}905\ mg/L\ MLVSS$$

$$\frac{1{,}905\ mg/L}{0.70} = 2{,}722\ mg/L\ MLSS$$

$$\leq 3{,}000\ mg/L \pm MLSS\ @\ 22^{\circ}C$$

Assume MLSS ≤ 3,000 mg/L in Nitrification Reactor #2 during **summer season** for conservative design approach.

4) If the MLSS concentration in Nitrification Reactor #2 is 3,000 mg/L then the MLSS concentration in FEB Anoxic Reactor #1 will be approximately 3,000 mg/L if return sludge is pumped back into FEB Reactors #1A and #1B.

5. Calculations indicate that the existing 1.64 MG volume Reactor #2A plus the new 0.50 MG volume Reactor #2B will be of adequate total volume for accomplishing the required winter season BOD and TKN (ammonia) removal. The use of subsurface jet aeration equipment in Reactor #2A and coarse bubble diffusers in Reactor #2B will insure maximum operating temperatures in the activated sludge treatment process during the winter season. If winter season aeration basin mixed liquor temperatures cannot be maintained at approximately 12°C, then to achieve adequate TKN removal efficiency, the MLSS concentration can be increased above 5,000 mg/L and/or upstream pretreatment efficiency must be improved by increased chemical dosage in DAF Cell to reduce the TKN loading on the downstream multi-stage activated sludge treatment system.

6. <u>Nitrification Reactors #2A and #2B Mixing Equipment Design</u>

   a. Evaluate mixing requirements in Nitrification Reactors #2A and #2B:

      1) bhp required for mixing a 3,000 to 5,000 mg/L MLSS concentration = 40 HP/MG using directional mix jet aeration manifold in Reactor #2A.

      bhp required = 40 HP (1.64) ≤ 65 HP in Reactor #2A

2) One existing 75 HP jet recirculation pump and one directional mix jet aeration header is provided in Nitrification Reactor #2A tank for suspension and mixing of mixed liquor biomass solids. One existing 60 HP self-priming jet recirculation pump and one directional mix jet aeration header is provided in Nitrification Reactor #2A for supplemental mixing and oxygen transfer capacity.

3) cfm required for complete mixing of Reactor #2B at 3,000 mg/L to 5,000 mg/L MLSS concentration = 15 to 20 scfm/1,000 ft^3 with reactor volume = 0.50 MG = 67 x $10^3 ft^3$

scfm = (67)(15 to 20 scfm) $\leq$ 1,000 to 1,400 scfm in Reactor #2B

4) One new coarse bubble diffuser system with 88 diffusers is provided in Nitrification Reactor #2B for diffusing air for suspension and mixing of mixed liquor biomass solids.

7. <u>Nitrification Reactor #2A & #2B Aeration Equipment Design</u>

a. Calculate the maximum and average oxygen transfer rate required in Nitrification Reactors #2A and #2B:

1) Calculate the oxygen transfer requirement for BOD synthesis assuming 80% BOD removal in FEB upstream Anoxic Reactors #1A & #1B:

$$AOTR_1 = \frac{(0.60\#O_2/\#BOD/day)(2{,}668\#BOD/day)}{24} = 67\#O_2/hr \text{ (max)}$$

$$AOTR_1 = \frac{(0.60\#O_2/\#BOD/day)(2{,}000\#BOD/day)}{24} = 50\#O_2/hr \text{ (aver)}$$

2) Calculate the oxygen transfer requirement for nitrification:

$$AOTR_2 \leq \frac{(4.57\#O_2/\#TKN)(1{,}685\#TKN/day \text{ nitrified})}{24} = 321\#O_2/hr \text{ (max)}$$

$$AOTR_2 \leq \frac{(4.57\#O_2/\#TKN)(950\#TKN/day \text{ nitrified})}{24} = 181\#O_2/hr \text{ (aver)}$$

3) Calculate the oxygen transfer requirement for endogenous respiration where Nitrification Reactor #2A and #2B total volume is approximately 39% of the total activated sludge volume:

$$AOTR_3 = \frac{(13{,}344\#BOD/day)(0.80\#O_2/\#BOD)(0.39)}{24} = 173\#O_2/hr \text{ (max)}$$

$$AOTR_3 = \frac{(10{,}000\#BOD/day)(0.80\#O_2/\#BOD)(0.39)}{24} = 130\#O_2/hr \text{ (max)}$$

4) Calculate the total maximum and average oxygen transfer rate required in Nitrification Reactors #2A & #2B:

AOTR(total) $\leq AOTR_1 + AOTR_2 + AOTR_3$

$= 67\#O_2/hr + 321\#O_2/hr + 173\#O_2/hr = 561\#O_2/hr < 600\#O_2/hr$ (max)

$= 50\#O_2/hr + 181\#O_2/hr + 130\#O_2/hr = 361\#O_2/hr < 400\#O_2/hr$ (aver)

Assume 80% to 90% of total oxygen demand occurs in Reactor #2A, and, 10% to 20% of total oxygen demand occurs in Reactor #2B

AOTR #2A $\leq 600\#O_2/hr(0.90) \leq 540\#O_2/hr$ (max)

AOTR #2B $\leq 600\#O_2/hr(0.20) \leq 120\#O_2/hr$ (max)

AOTR #2A $\leq 400\#O_2/hr(0.90) \leq 360\#O_2/hr$ (aver)

AOTR #2B $\leq 400\#O_2/hr(0.20) \leq 80\#O_2/hr$ (aver)

5) Calculate the required corresponding maximum standard oxygen transfer rate required:

$$SOTR = AOTR\left[\frac{Css}{(\beta C_{sw} - DO)\alpha(1.024)^{T-20}}\right]$$

Where DO	$\leq$	2.0 mg/L (average DO in Reactor #2)
ß	=	0.90
α	=	0.80 @ 3,000 to 5,000 mg/L MLSS with subsurface jet aeration manifolds
Maximum MLSS temperatures	=	30˚C
$1.024^{(T-20)}$	=	1.2677 @ T = 30˚C
Cw	=	7.63 mg/L @ sea level, 30˚C
Cs	=	9.20 mg/L @ sea level, 20˚C
Site Altitude	$\leq$	500 feet

Pressure Correction Factor $\geq$ 0.98

$$Csw = 7.63\left[\frac{(0.98)(14.7) + (0.5)(0.433)(28)*}{14.7}\right]$$

$$= 7.63\,(1.392) = 10.62\ mg\ /\ L$$

$$Css = 9.20\left[\frac{(14.7) + (0.5)(0.433)(28)*}{14.7}\right]$$

$$= 9.20\,(1.412) = 12.99\ mg\ /\ L$$

* Reactor liquid depth = 28 ft.

$$SOTR = AOTR\frac{12.99}{[(0.90)(10.62) - 2.0]0.80(1.2677)}$$

$$SOTR = 1.68(AOTR)$$

SOTR #2A $\leq$ 1.70(540#O_2/hr) $\leq$ 925#O_2/hr (maximum)

SOTR #2B $\leq$ 1.70(120#O_2/hr) $\leq$ 225#O_2/hr (maximum)

SOTR #2A $\leq$ 1.70(360#O_2/hr) $\leq$ 625#O_2/hr (average)

SOTR #2A $\leq$ 1.70(80#O_2/hr) $\leq$ 150#O_2/hr (average)

b. Calculate subsurface aeration equipment air sparging requirements:

1) The oxygen available per cfm per hour =

x = 0.23 (.075#/ft^3)(60 min/hr)

= 1.035#0_2/cfm/hr @ 68°C inlet air

2) e = subsurface coarse bubble diffuser oxygen stripping or transfer efficiency at 28 ft. liquid depth = 37% in Reactor #2A

e = subsurface coarse bubble diffuser oxygen stripping or transfer efficiency at 26 ft. liquid depth = 22% in Reactor #2B

3) scfm required $= \frac{\text{SOTR}}{(x)(e)}$

$$\text{scfm \#2A} = \frac{925\#O_2/\text{hr}}{(1.035)(0.37)} = 2{,}415 \text{ scfm} \leq 2{,}500 \text{ scfm (max)}$$

$$\text{scfm \#2B} = \frac{225\#O_2/\text{hr}}{(1.035)(0.22)} = 988 \text{ scfm} \leq 1{,}000 \text{ scfm (max)}$$

$$\text{scfm \#2A} = \frac{625\#O_2/\text{hr}}{(1.035)(0.37)} = 1{,}632 \text{ scfm} \leq 1{,}700 \text{ scfm (aver)}$$

$$\text{scfm \#2B} = \frac{150\#O_2/\text{hr}}{(1.035)(0.22)} = 658 \text{ scfm} \leq 700 \text{ scfm (aver)}$$

4) Max. design blower pressure in Reactor #2A at 28.0 – 3.50 = 24.5 ft. jet diffuser air sparge submergence with existing jet manifold located 42" above the reactor floor:

   = (24.5 ft.) (0.433) + 1.00 psi = 11.6 psi ≤ 11.6 psi including pressure drop in air supply lines and in jet nozzle diffusers

   Max. design blower pressure in Reactor #2B at 27.0 – 1.00 = 26.0 ft. diffuser air sparge submergence with coarse bubble diffusers located approximately 1.0 ft. above the reactor floor:

   = (26.0 ft.)(0.433) + 1.00 psi = 12.2 psi ≤ 13.0 psi including pressure drop in air supply lines and in diffusers to match blower pressure capacity in Reactor #2B

c. Oxygen transfer and mixing is provided in Nitrification Reactor #2A by operation of one existing directional mix subsurface jet aeration manifold with 22 jet nozzles. Flow recirculation for the jet manifold is provided by one existing 75 HP end suction sewage pump rated at 8,000 gpm at 25 ft. The jet pump has a constant speed drive motor. The design air sparging capacity of the jet aeration manifold is approximately 2,475 scfm providing an oxygen transfer rate = 500#O_2/hr (AOTR) = 800#O_2/hr (SOTR) with air supplied by one existing 250 HP centrifugal blower rated at approximately 3,000 scfm at 11.5 psi. A second 250 HP centrifugal blower is provided as an installed standby.

d. One existing drop in, wet installed directional mix slot jet aeration manifold will be installed in Nitrification Reactor #2A to provide additional oxygen transfer capacity. The slot jet aeration manifold includes one new 60 HP self-priming pump for jet flow recirculation rated at 2,800 gpm @ 50 ft. One new 125 HP positive displacement blower is also provided with the jet manifold for compressed air supply. The new blower is rated at 1,244 scfm @ 12.5 psi. Operation of the jet manifold at 1,244 scfm will provide an additional oxygen transfer capacity = 350#O_2/hr (AOTR) = 530#O_2/hr (SOTR).

e. **Oxygen transfer and mixing is provided in Nitrification Reactor #2B by one new coarse bubble diffuser system. The maximum air sparging capacity of the diffusers is approximately 2,000 scfm providing an oxygen transfer rate ≥ 250#O_2/hr (AOTR) with air supplied by two new 100 HP positive displacement (PD) blowers in operation each rated at 1,000 scfm at 13 psi. The average air sparging capacity of the diffusers is approximately 1,000 scfm providing an oxygen transfer rate ≥ 125#O_2/hr (AOTR) with air supplied by one new 100 HP PD blower in operation.**

f. If Nitrification Reactor #2A is removed from services, air can be supplied to the Anoxic Reactor No. 3 jet mixing system to operate the reactor as a second stage aerobic reactor. A third installed spare 125 HP blower can supply 1,200 scfm to the jet mixing system providing an oxygen transfer rate of ≥ 225#O_2/hr (AOTR).

g. In Reactor #2A:

   1) The maximum oxygen transfer rate provided in Reactor #2A by operation of 1-75 HP jet pump and 1-200 HP centrifugal blowers ≥ 800#O_2/hr (SOTR) = 500#O_2/hr (AOTR).

   2) The maximum additional oxygen transfer capacity provided in Reactor #2A by operation of the new directional mix slot jet header with 1-60 HP jet pump and 1-125HP blower in operation = 650#O_2/hr (AOTR). The total maximum oxygen transfer capacity provided in Reactor #2A = 500#O_2/hr + 350#O_2/hr = 850#O_2/hr (AOTR).

h. In Reactor #2B:

   1) The maximum oxygen transfer rate provided in Reactor #2B by operation of 2-100 HP positive displacement blowers = 250#O_2/hr (AOTR).

   2) The average oxygen transfer rate provided in Reactor #2B by operation of 1 - 100 HP positive displacement blower = 125#O_2 (AOTR).

i. The maximum total oxygen transfer capacity provided by operation of the existing jet aeration manifold and one 250 HP centrifugal blower, the new jet aeration manifold and one 125 HP positive displacement blower for Reactor #2A; and, the new diffusers and two blowers for Reactor #2B = 550#O_2/hr + 250#O_2/hr ≥ 1,000#O_2/hr.

j. The average total oxygen transfer capacity provided by operation of the existing jet aeration manifold and one centrifugal blower for Reactor #2A; and, the new diffusers and one PD blower for Reactor #2B = 500#O_2/hr + 125#O_2/hr ≥ 600#O_2/hr.

K. ANOXIC REACTOR #3 (New)

1. Design Assumptions

a. Wastewater Flow

1) Maximum average daily influent wastewater flow volume = 1.50 MGD, 7 days/week

2) Maximum daily influent wastewater flow volume = 2.00 MGD

b. Pollutant Concentrations & Loadings

1) Influent pollutant concentration and loadings in the Reactor #2 effluent wastewater flow volume = 2.00 MGD:

Pollutant	Concentration	Loading
BOD	$\leq$ 10 mg/L	168#/day
TSS (MLSS)	= 3,000 to 5,000 mg/L	-
TKN	$\leq$ 3.0 mg/L	50#/day
NH3-N	$\leq$ 1.0 mg/L	17#/day
TP	$\leq$ 16 mg/L	267#/day
NO_3-N	$\leq$ 36 mg/L[1]	600#/day[2]

[1] The design mixed liquor recycle flow rate from Nitrification Reactor #2 back to Anoxic Reactor #1 is 400% of the maximum throughput wastewater flow rate = 4Q. This nitrate recycle flow rate will result in removal of over 83% of the nitrate produced in Nitrification Reactor #2 assuming the RAS flow is also pumped back into Reactor #1. The calculated maximum concentration of NO_3-N produced in Nitrification Reactor #2 = 175 mg/L TKN - 0.03 (800 mg/L BOD) = 101 mg/L NO_3-N = (2.00 MGD)(8.34)(101 mg/L NO_3-N) = 1,685#NO_3-N produced/day of which over 83% is removed by denitrification in Anoxic Reactor #1 leaving 0.17 (1,685#NO_3-N) = approx. 286#NO_3-N/day $\leq$ 18 mg/L in the mixed liquor discharged to Anoxic Reactor #3.

[2]For conservative design approach assume the maximum NO_3-N concentration and loading discharged into Anoxic Reactor #3 $\leq$ 36 mg/L = 600#/day (100% safety factor).

c. Nitrate Removal Requirement

1) Nitrate nitrogen concentration must be reduced to approximately 1.0 mg/L or less in order for the final effluent total nitrogen concentration to be $\leq$ 4.0 mg/L including approximately 1.0 mg/L ammonia nitrogen and approximately 2.0 mg/L of organic nitrogen in the final effluent TSS.

2. Anoxic Reactor #3 Nitrate Removal Process Design

   a. **One new 66 ft. dia. x 24 ft. liquid depth, 0.60 MG volume above grade concrete tank is provided for Anoxic Reactor #3. Anoxic Reactor #3 is operated as a third stage anoxic activated sludge reactor for final nitrate nitrogen removal by biological denitrification using supplemental carbon source dosage.**

   b. Calculate MLVSS and MLSS concentrations required in the 0.60 MG reactor for nitrate removal at the minimum expected winter season design mixed liquor temperature in Reactor #4 of 12°C when treated wastewater is discharged by gravity from Nitrification Reactor #2B.

      1) For NO_3-N removal assuming a nitrate removal rate = 0.05#NO_3-N/#MLVSS at 12°C using a supplemental organic carbon food source:

$$\frac{600\#NO_3\text{-}N}{0.05} \quad \leq \quad 12{,}000\#MLVSS\ @\ 12°C$$

      2) The required total MLVSS and MLSS concentrations in the 0.60 MG reactor basin volume for NO_3-N removal at the 12°C winter season operating temperature assuming MLVSS/MLSS = 0.70

$$\frac{12{,}000\#\ MLVSS}{(8.34)(0.60\ MG)} \quad = \quad 2{,}400\ mg/L\ MLVSS$$

$$\frac{2{,}400\ mg/L}{0.70} \quad \leq \quad 3{,}500\ mg/L\ MLSS\ @\ 12°C$$

      Assume MLSS ≥ 4,000 ± mg/L during winter season to achieve complete nitrification and denitrification using carbon source dosage into Anoxic Reactor #3. The design winter season MLSS concentration for denitrification of nitrate in Reactor #3 is 3,500 vs. 4,000 to 5,000 mg/L for nitrification in Reactors #2A and #2B; therefore, biomass requirements for nitrification = 5,000 mg/L govern.

   c. Calculate the hydraulic detention time in Reactor #3

$$HDT = \frac{600{,}000\ gallons}{(2.00\ MGD)(1.5)(694\ gpm/MGD)} \quad = 288\ min = 4.8\ hours$$

@ 50% return sludge rate from the Final Clarifier

$$HDT = \frac{600{,}000\ gallons}{(2.00\ MGD)(2.0)(694\ gpm/MGD)} \quad = 216\ min = 3.6\ hours$$

@ 100% return sludge rate from the Final Clarifier

$$\text{HDT} = \frac{600{,}000 \text{ gallons}}{(2.00 \text{ MGD})(3.0)(694 \text{ gpm/MGD})} = 144 \text{ min} = 2.4 \text{ hours}$$

@ 200% return sludge rate from the Final Clarifier

d. Calculations indicate that the proposed new 0.60 MG Anoxic Reactor #3 activated sludge basin will provide adequate volume for accomplishing the required winter season final stage NO_3-N removal down to an activated sludge basin temperature of 12°C. If winter season aeration basin mixed liquor temperatures cannot be maintained above 12°C in Reactor #3, then to achieve adequate nitrate removal efficiency, the MLSS concentration must be increased above 4,000 mg/L.

3. <u>Anoxic Reactor #3 Mixing Equipment Design</u>

   a. Evaluate Mixing requirements in Anoxic Reactor #3:

      1) bhp required for mixing 4,000 mg/L to 6,000 mg/L TSS concentration = 60 HP/MG with jet manifold mixing

         bhp required = 60 HP (0.60) $\leq$ 40.0 HP

      2) One new 40 HP jet flow recirculation pump and one directional mix jet manifold with 10 jet nozzles is provided in the reactor tank for mixing of mixed liquor suspended solids. The jet mixing pump is rated at 4,400 gpm @ 23 ft. total head.

4. <u>Carbon Source Dosage Requirements</u>

   a. Calculate the theoretical carbon source dosage requirement in Anoxic Reactor #3 assuming the maximum reactor influent NO_3-N concentration contained in the mixed liquor discharged from upstream Nitrification Reactor #2B $\leq$ 36 mg/L

      1) Methanol requirement =

         2.47 (NO_3-N concentration) +
         1.53 (NO_2-N concentration) +
         0.87 (DO concentration)

         where NO_3-N $\leq$ 36 mg/L
         NO_2-N $\leq$ 3 mg/L
         DO $\leq$ 2.5 mg/L

2) CH_3OH =

= 2.47 (36 mg/L) + 1.53 (3 mg/L) + 0.87 (2.5 mg/L)

= 89 + 4.6 + 2.2

= 96 mg/L $\leq$ 100 mg/L

3) #CH_3OH/day required $\leq$

(100 mg/L)(8.34)(2.00 MGD) = 1,668#/day

4) @ 6.5#/gal the calculated gpd of methanol required =

$$\frac{1{,}668\#/\text{day}}{6.5\#/\text{gallon}} = 257 \text{ gpd} \quad \leq 11.0 \text{ gphr}$$

5) Assuming methanol contains approximately 720,000 mg/L of BOD and assuming alternative non-flammable carbon source (CS) solution BOD concentration is approximately 600,000 mg/L, the required gpd of alternate carbon source solution =

$$257\ gpd\ methonal\left(\frac{720}{600}\right) = 300\ gpd \leq 12.5 gphr$$

b. Two new carbon source (CS) solution pumps will be provided each rated at 1.50 to 15 gphr @ 60 psi. Each pump will have a variable speed drive motor which can be manually adjusted to control the CS dosage rate. The second pump is provided as an installed standby.

L. *AEROBIC REACTOR #4 (New)*

1. Design Assumptions

   a. Wastewater Flow

      1) Maximum average daily influent wastewater flow volume = 1.50 MGD, 7 days/week.

      2) Maximum daily influent wastewater flow volume = 2.00 MGD

   b. Pollutant Concentrations & Loadings

      1) Influent pollutant concentrations and loadings in the Reactor #3 effluent wastewater flow volume = 2.00 MGD:

Pollutant	Concentration	Loading
BOD	$\leq$ 10 to 20 mg/L	334#/day
TSS (MLSS)	= 4,000 to 5,000 mg/L	-
O&G	$\leq$ 2.0 mg/L	33.4#/day
NH3-N	$\leq$ 3.0 mg/L	50#/day
NO_2-N	$\leq$ 1.0 mg/L	17#/day
TP	$\leq$ 16 mg/L	27#/day

      2) For conservative design approach assume the maximum BOD concentration and loading discharged into Aerobic Reactor #4 $\leq$ 20 mg/L = 334#/day

   c. Soluble BOD Removal Requirement

      1) Soluble BOD concentration should be reduced to approximately 2 mg/L or less.

      2) Any ammonia nitrogen produced in upstream Anoxic Reactor #3 by the denitrification process or by cell lysing due to endogenous respiration will be reduced to < 1 mg/L by nitrification in Aerobic Reactor #4.

2. Aerobic Reactor #4 BOD and Ammonia Removal Process Design

   a. **One new 31 ft. dia. x 23 ft. liquid depth, 0.10 MG volume concrete tank is provided for Aerobic Reactor #4. Aerobic Reactor #4 to be operated as a fourth stage aerobic activated sludge polishing reactor for final removal of any soluble BOD and ammonia nitrogen in the effluent of Anoxic Reactor #3 by simultaneous carbonaceous BOD removal by aerobic synthesis and ammonia removal by nitrification.**

b. Calculate MLVSS and MLSS concentrations required in the 0.10 MG basin for BOD and ammonia removal at the minimum expected winter season design mixed liquor temperature in Reactor #4 of 12°C when treated wastewater is discharged by gravity from Anoxic Reactor #3.

1) For BOD removal assuming a BOD removal rate = 0.30#BOD/#MLVSS @ 12°C:

$$\frac{334\#BOD/day}{0.35} \leq 954\#MLVSS \ @ \ 12°C$$

2) For final ammonia removal assuming a nitrification rate = 0.035# NH_3-N/#MLVSS @ 10°C and assuming a maximum ammonia nitrogen concentration of 3 mg/L and loading in the Anoxic Rector #3 effluent = 22.5#/day

$$\frac{50\#NH_3\text{-}N/day}{0.035} \leq 1{,}429\#MLVSS \ @ \ 12°C$$

3) The required total MLVSS and MLSS concentrations in the 0.10 MG aeration basin volume for BOD removal and nitrification at the 12°C winter season operating temperature assuming MLVSS/MLSS = 0.70

$$\frac{954\# + 1{,}429\#}{(8.34)(0.10\ MG)}$$

$$\frac{2{,}383\#\ MLVSS}{(8.34)(0.10\ MG)} = 2{,}856\ mg/L\ MLVSS$$

$$\frac{2{,}856\ mg/L}{0.70} \approx 4{,}000\ mg/L\ MLSS \ @ \ 10°C$$

Assume a MLSS ≥ 4,000 mg/L will be used during winter season which will provide complete carbonaceous soluble BOD removal and ammonia nitrogen removal in Reactor #4.

c. Calculate the hydraulic detention time in Reactor #4

$$HDT = \frac{100{,}000\ gallons}{(2.00\ MGD)(1.5)(694\ gpm/MGD)} = 48\ min = 0.80\ hours$$

@ 50% return sludge rate from the Final Clarifier

$$HDT = \frac{100{,}000\ gallons}{(2.00\ MGD)(2.0)(694\ gpm/MGD)} = 36\ min = 0.60\ hours$$

@ 100% return sludge rate from the Final Clarifier

$$\text{HDT} = \frac{100{,}000 \text{ gallons}}{(2.00 \text{ MGD})(3.0)(694 \text{ gpm/MGD})} = 24 \text{ min} = 0.40 \text{ hours}$$

@ 200% return sludge rate from the Final Clarifier

d. Calculations indicate that the proposed new 0.10 MG Aerobic Reactor #4 Activated Sludge Basin will provide adequate volume for accomplishing the required, winter season polishing step of BOD and ammonia removal down to an activated sludge basin temperature of 12°C. The use of subsurface coarse bubble aeration equipment in the aeration basin will insure maximum operating temperatures in the aerobic activated sludge treatment process during the winter season. If winter season aeration basin mixed liquor temperatures cannot be maintained above 12°C in Reactor #4, then to achieve adequate BOD Ammonia removal efficiency, the MLSS concentration must be increased above 4,000 mg/L.

3. <u>Aerobic Reactor #4 Aeration and Mixing Equipment Design</u>

a. Evaluate mixing requirements in Aerobic Reactor #4:

1) bhp required for mixing 4,000 mg/L to 5,000 mg/L TSS concentration = 40 HP/MG

bhp required = 40 HP (0.10) $\leq$ 5.0 HP

2) cfm required for complete mixing of Reactor #4 at 3,000 mg/L to 5,000 mg/L MLSS concentration = 15 to 20 scfm/1,000 ft^3 with reactor volume = 0.10 MG = 13.4 x $10^3 ft^3$

cfm = (13.4)(15 to 20 scfm) = 260 cfm $\leq$ 300 scfm

3) A new coarse bubble diffused aeration system is provided in Reactor #4 for oxygen transfer and mixing. Compressed air will normally be supplied to the diffusers by operation of one new blower at reduced speed to provide an air flow rate ranging from 150 scfm to 400 scfm as required to achieve the required reactor tank mixing liquor suspended solids mixing and oxygen transfer.

b. Evaluate aeration requirements in Aerobic Reactor #4

1) Calculate the oxygen transfer rate required in Aerobic Reactor #4 for BOD removal assuming excess BOD from carbon source dosage $\leq$ 20 mg/L = 334#/day and an oxygen demand of 1.0#O_2/#BOD

$$AOTR_1 = \frac{1.0\#O_2/\#BOD(334\#BOD/day)}{24}$$

$$\leq 14.0\#O_2/hr$$

2) Calculate the oxygen transfer rate required in Aerobic Reactor #4 for ammonia removal assuming an oxygen demand of $4.57\#O_2/\#NH_3\text{-}N$

$$AOTR_2 = \frac{(4.57\#O_2/\#NH_3\text{-}N)(50\#NH_3\text{-}N/day)}{24}$$

$$= 9.5\#O_2/hr$$

3) Calculate the oxygen transfer rate required in Aerobic Reactor #4 for endogenous respiration assuming a total endogenous demand of $0.80\#O_2/\#BOD$ in the total reactor volume

a) % of total reactor volume in Aerobic Reactor #4 = 2%

b) The calculated endogenous oxygen demand in Aerobic Reactor #4 =

$$AOTR_3 = \frac{13{,}344\#BOD/day(0.80\#O_2/\#BOD)(0.02)}{24}$$

$$\leq 9.0\#O_2/hr$$

4) Calculate the total oxygen transfer requirement in Aerobic Reactor #4 for excess BOD synthesis, ammonia removal and plus endogenous respiration $AOTR_1 + AOTR_2 + AOTR_3 = 14.0\#O_2/hr + 9.5\#O_2/hr + 9.0\#O_2/hr \leq 35\#O_2/hr$ (AOTR).

c. Calculate the required corresponding maximum standard oxygen transfer rate required:

$$SOTR = AOTR\left[\frac{Css}{(\beta C_{sw} - DO)\alpha(1.024)^{T-20}}\right]$$

Where DO	=	2.0 mg/L (average DO in Aerobic Reactor #4)
ß	=	0.90
α	=	0.80 @ 4,000 to 5,000 mg/L MLSS with subsurface coarse bubble aeration diffusers
$1.024^{(T-20)}$	=	1.209 @ maximum T = 28° C
Cw	=	7.92 mg/L @ sea level, 28° C
Cs	=	9.20 mg/L @ sea level, 20° C
Site Altitude	≤	500 feet

Pressure Correction Factor $\geq$ 0.98

Csw $= 7.92\left[\frac{(0.98)(14.7)+(0.5)(0.433)(18.5)*}{14.7}\right]$

$= 7.92$ mg/L(1.253) = 9.92 mg/L

Css $= 9.20\left[\frac{14.7+(0.5)(0.433)(18.5)*}{14.7}\right]$

Css $= 9.20$ mg/L(1.273) = 11.71 mg/L

* 18.5 foot deep aeration basin with the airgrid coarse bubble diffusers installed 1.0 above the basin floor.

$$\text{SOTR} = \text{AOTR}\ \frac{11.71}{[(0.90)(9.92)-2.0]0.80(1.209)}$$

SOTR = 1.74 (AOTR)

SOTR $\leq$ 1.75(35) $\leq$ 65# O_2/hr (average)

d. Calculate subsurface aeration equipment air sparging requirements:

1) The oxygen available per cfm per hour =

x = 0.23 (0.075#/ft3)(60 min/hr)

= 1.035# O_2/cfm/hr @ 68° inlet air

2) e = subsurface diffuser oxygen stripping or transfer efficiency at 23.0 liquid depth = 19.0%

3) scfm required $= \frac{\text{SOTR}}{(x)(e)}$

scfm (average) $= \frac{65\#O_2/HR}{(1.035)(0.19)} = 330$ scfm

$\leq$ 400 scfm

4) Max. design blower pressure with 22.0 ft. max. diffuser air sparge submergence:

= (22.0 ft.)(0.433) + 1.5 psi = 11.03 psi $\leq$ 11.5 psi (pressure loss plus pressure drop in air supply lines and in coarse bubble air diffuser sparges)

e. One new coarse bubble diffused aeration system with 14 diffusers is provided in Reactor #4 for oxygen transfer and mixing. Two new blowers rated at 400 scfm @ 11.5 psi will be operated at reduced speed will provide diffused aeration in Reactor #4. Alternatively, the standby blower for Reactor #2B can be optionally operated at low speed; or, approximately 200 to 400 scfm of compressed air will be throttled from the discharge of the Nitrification Reactor #2B blowers to provide a low air flow rate into the coarse bubble diffusers in Reactor #4.

M. CLARIFIER INFLUENT FLOW SPLITTER & FLOCCULATION TANK FOR CLARIFIERS #1 & #2 (New)

1. Design Assumptions

a. Wastewater Flow

1) Maximum daily throughput flow volume = 2.00 MGD

2) Maximum inflow rate with 100% sludge recycle rate = (2.00 MGD)(2) $\leq$ 4.00 MGD

3) Maximum inflow rate with 200% sludge recycle rate = (2.00 MGD)(3) $\leq$ 6.00 MGD

b. Mixed Liquor Suspended Solids Concentrations

1) Minimum MLSS = 3,000 mg/L

2) Maximum MLSS = 6,000 mg/L

2. General Description

a. One new clarifier influent flow splitter tank is provided in the outlet at new Reactor #4 to split flow into existing Final Clarifier #1 and Final Clarifier #2 (Existing Phase 1).

b. The downstream side of the flow splitter for each clarifier will function as a flocculation tank for dosage and mixing of coagulant and flocculant chemical solutions with the clarifier influent mixed liquor flow.

3. Flocculation Tank Design Calculations

a. Flocculation Tank Sizing

1) One 6.0 ft. wide x 12 ft. long x 13.0 ft. side water depth Flocculation Tank is provided for mixing of chemical coagulant and flocculant solutions and the mixed liquor influent flow into Final Clarifiers #1 and #2.

2) Tank volume ≥ 7,000 gallons

3) Calculated Hydraulic Detention Times:

a) @ 2.00 MGD maximum design flow through rate plus 100% sludge return flow rate = 4.00 MGD = 2,800 gpm total flow rate = 2.00 MGD/clarifier = 1,400 gpm/clarifier

$$\text{HDT} = \frac{7{,}000 \text{ gallons}}{1{,}400 \text{ gpm}} = 5.0 \text{ minutes}$$

b) @ 2.00 MGD maximum design flow through rate plus 200% sludge return flow rate = 6.00 MGD = 4,200 gpm total flow rate = 3.00 MGD/clarifier = 2,100 gpm/clarifier

$$\text{HDT} = \frac{7{,}000 \text{ gallons}}{2{,}100 \text{ gpm}} = 3.3 \text{ minutes}$$

N. *FINAL CLARIFIER (Existing & Phase 1 Existing)*

1. Design Assumptions

a. Wastewater Flow Volumes

a. Average throughput flow = 1.50 MGD 7 days/week

b. Maximum throughput flow = 2.00 MGD

c. Average inflow rate with 100% sludge recycle rate = (1.50 MGD)(2) ≤ 3.00 MGD

d. Maximum inflow rate with 200% sludge recycle rate = (2.00 MGD) (3) ≤ 6.00 MGD

b. MLSS Solids Concentrations

1) Average MLSS Concentration $\leq$ 3,000 mg/L

2) Maximum MLSS Concentration $\leq$ 6,000 mg/L

2. General Description

a. One existing 81 ft. diameter x 10.5 ft. side water depth Final Clarifier #1; and, one existing 81 ft. dia. x 12 ft. side water depth Final Clarifier #2, each with hydraulic suction sludge pickup mechanism, surface skimmer and two scum boxes are provided to operate in parallel for final clarification.

b. Each clarifier has an effective surface overflow diameter = 78 feet, effective surface overflow area = 4,700 ft^2; and, effective clarifier floor area = 5,100 ft^2.

3. Calculate Clarifier Loading Rates

a. Clarifier #1 volume = 404,000 gallons; and, Clarifier #2 volume = 460,000 gallons.

b. Hydraulic Surface Loading Rate:

$$= \frac{1{,}500{,}000 \text{ gpd}}{4{,}700 \text{ ft}^2(2)} \quad \leq 160 \text{ gpd/ft}^2 \text{ @ avg. 7 day throughput flow rate} = 1.50 \text{ MGD}$$

$$= \frac{2{,}000{,}000 \text{ gpd}}{4{,}700 \text{ ft}^2(2)} \quad \leq 215 \text{ gpd/ft}^2 \text{ @ max. throughput flow rate} = 2.00 \text{ MGD}$$

c. Average solids loading rate assuming an influent flow rate = 1.50 MGD and a 100% sludge recycle rate with a MLSS concentration $\leq$ 5,000 mg/L:

$$= \frac{(1.50)(2)(8.34)(5{,}000 \text{ mg/L})}{5{,}100 \text{ ft}^2(2)}$$

= 13.0#/ft^2/day @ average inflow rate = 3.00 MGD including 100% sludge recycle flow

d. Maximum solids loading rate assuming an influent flow rate = 2.00 MGD and a 100% sludge recycle rate with a MLSS concentration $\leq$ 5,000 mg/L:

$$= \frac{(2.0)(2)(8.34)(5{,}000 \text{ mg/L})}{5{,}100 \text{ ft}^2(2)}$$

$\leq$ 17.0#/ft^2/day@ max. inflow rate = 4.00 MGD including 100% sludge recycle flow

e. Average hydraulic detention time at 1.50 MGD average throughput flow volume assuming a 100% sludge recycle rate:

$$= \frac{(404{,}000 \text{ gal} + 460{,}000 \text{ gal})(24)}{(1{,}500{,}000)(2)}$$

= 6.9 hrs. @ average inflow rate = 3.00 MGD including 100% sludge recycle flow

Minimum hydraulic detention time @ 2.00 MGD maximum throughput flow volume assuming a 100% sludge recycle rate:

$$= \frac{(404{,}000 \text{ gal} + 460{,}000 \text{ gal})(24)}{(2{,}000{,}000)(2)}$$

= 5.2 hrs. @ max. inflow rate = 4.00 MGD including 100% sludge recycle flow.

O. ***RETURN ACTIVATED SLUDGE (RAS) PUMP STATION (Phase 1 Modification)***

1. Flow Pumping Requirements

   a. The average RAS pumping rate required from Clarifier #1 = 50% of the maximum daily throughput flow volume = (0.50)(2.00 MGD) = 1.00 MGD = 700 gpm with one RAS pump in operation for Clarifier #1.

   b. The maximum RAS pumping rate required from Clarifier #1 = 150% of the maximum daily throughput flow volume = (1.50)(2.00 MGD) = 3.00 MGD = 2,100 gpm with two RAS pumps in operation for Clarifier #1.

   c. The average RAS pumping rate required from Clarifier #2 = 50% of the maximum daily throughput flow volume = (0.50)(2.00 MGD) = 1.00 MGD = 700 gpm with one RAS pump in operation for Clarifier #1.

   d. The maximum RAS pumping rate required from Clarifier #2 = 150% of the maximum daily throughput flow volume = (1.50)(2.00 MGD) = 3.00 MGD = 2,100 gpm with two RAS pumps in operation for Clarifier #1.

2. Pump Selection

   a. Two existing 20 HP self-priming sludge return pumps are provided in the existing Sludge Return Pump Station enclosure building located adjacent to the Final Clarifier #1. The pumps are provided to recycle activated sludge from the two clarifiers to either FEB Reactors #1A and #1B or Nitrification Reactor #2A. Each pump is currently rated at 470 gpm @ 35 feet head which is equivalent to a sludge recycle rate ≥ 33% of the maximum throughput flow rate.

b. Each RAS pump has been upgraded by installation of new larger 40 HP motor with new belts and sheaves in order to increase the pump rated flow capacity up to 1,400 gpm @ 47 feet which is equivalent to a sludge recycle rate = 75% of the maximum throughput flow rate = (0.75)(2.00 MGD) = 1.50 MGD = 1,050 gpm.

c. Each upgraded RAS pump will normally be operated at reduced speed to provide a separate sludge recycle rate from each clarifier = 25% to 50% of the maximum throughput flow rate = 0.25 (2.00 MGD) to 0.50 (2.00 MGD) = 0.50 MGD to 1.00 MGD = 350 gpm to 700 gpm per clarifier. Two RAS pumps can be operated at full speed in parallel to provide a total maximum sludge recycle rate from either Clarifier #1 or Clarifier #2 up to 150% of the maximum throughput flow rate = 1.50(2.00 MGD) = 3.00 MGD = 2,100 gpm if one clarifier is out of service.

d. RAS Pump #1 will normally be operated to provide sludge recycle from Clarifier #1 and RAS Pump #2 to provide sludge recycle from Clarifier #2.

e. RAS Pump #1 and Pump #2 can be operated in parallel to provide sludge recycle from one Clarifier if the second Clarifier is out of service.

3. Variable Speed Drive Controls

a. Each existing RAS Pump is provided with new variable speed drive motor controls to allow manual control of pump operating speed and pumping rate.

b. The speed of each pump can be manually adjusted to provide an RAS flow rate ranging from 50% to 150%.

4. RAS Flow Meters

a. One existing 8" magnetic flow meter is provided in the RAS Pump Station to accurately measure and indicate the sludge recycle flow from Final Clarifier #1. RAS Flow Meter #1 is provided with a digital flow indicator and with a downstream flow control valve to allow the sludge recycle flow from the Clarifier #1 to be throttled and controlled.

b. One existing 8" magnetic flow meter is provided in the RAS Pump Station to accurately measure and indicate the sludge recycle flow from Final Clarifier #2. RAS Flow Meter #2 is provided with a digital flow indicator and with a downstream flow control valve to allow the sludge recycle flow from the Clarifier #2 to be throttled and controlled.

P. WASTE ACTIVATED SLUDGE (WAS) PUMP (Phase 1 Existing)

1. WAS Pump for Clarifier #1 and Clarifier #2 (Phase 1 Existing)

   a. Flow Pumping Requirements

      1) The average WAS pumping rate required = approximately 30 gpm

      2) The maximum WAS pumping rate required = approximately 100 gpm

   b. Pump Selection

      1) One existing 7.5 HP positive displacement WAS pump is provided rated at 100 gpm @ 60 ft. to pump WAS from the RAS suction line of Clarifier #1 and/or Clarifier #2. The new WAS pump is installed in the existing RAS Pump Station enclosure building.

   c. Variable Speed Drive Controls

      1) The pump is provided with variable speed drive motor controls to allow manual control of pump operated speed and pumping rate.

   d. WAS Flow Meter

      1) One existing 4" WAS magnetic Flow Meter is provided to measure, indicate and totalize the WAS pumping rate and volume from the RAS suction line of either of the two Final Clarifiers.

Q. TERTIARY FILTRATION SYSTEM (New)

1. General Description

   a. In order to provide further reduction in treated wastewater nitrogen and phosphorus nutrient concentrations, the Final Clarifier effluent will receive tertiary filtration through two traveling bridge sand filters.

   b. The new Tertiary Sand Filters are located in the new Wastewater Equipment Building.

2. Design Assumptions

   a. Wastewater Flows

      1) Average Influent Flow Volume = 1.50 MGD = 1,050 gpm

      2) Maximum Inflow Flow Rate = 2.00 MGD = 1,400 gpm

3) 24 hour hydraulic flow equalization is provided upstream of the filters

4) Effluent from existing Final Clarifier #1 and new Final Clarifier #2 will flow by gravity into the new tertiary filters

b. Wastewater Pollutant Concentrations

Pollutant	Concentration	
	Average	Maximum
TSS	5 – 15 mg/L	20 mg/L
BOD	2 – 10 mg/L	15 mg/L
Total Phosphorus	0.3 – 0.5 mg/L	0.50 mg/L
Total Nitrogen	4 - 6 mg/L	8 mg/L

3. Automatic Backwash Filter Design

a. Number of filters = Two (2) for parallel operation

b. Filter bed size = 9' x 40' = 360 ft^2 each; total bed area = 720 ft^2 for two filters in service

c. Design filtration rates:

1) With two filters in service;

a) @ 1.50 MGD the average filtration rate ≤ 1.50 gpm/ft^2

b) @ 2.00 MGD the maximum filtration rate ≤ 2.00 gpm/ft^2

2) With one filter in service;

a) @ 1.50 MGD the average filtration rate ≤ 3.00 gpm/ft^2

b) @ 2.00 MGD the maximum filtration rate = 4.00 gpm/ft^2

d. Design solids loading rates:

1) With two filters in service;

a) @ 1.50 MGD with TSS = 10 mg/L, the solids loading rate = 62#/filter/day = 0.173#/ft^2/day

b) @ 2.00 MGD with TSS = 20 mg/L, the solids loading rate = 250#/filter/day = 0.70#/ft^2/day

2) With <u>one</u> filter in service;

a) @ 1.50 MGD with TSS = 10 mg/L, the solids loading rate = 125#/filter/day = 0.46#/ft^2/day

b) @ 2.00 MGD with TSS = 20 mg/L, the solids loading rate = 334#/filter/day = 0.93#/ft^2/day

e. <u>Filter Bed Specifications</u>

1) 11" deep high grade silica sand bed complying with Sections 1, 2.2 and 5 of the Standard Specifications for Filtering Material (AWWA Designation B100-72). The sand effective size will be between 0.55 – 0.65 mm. The uniformity coefficient shall not exceed 1.50.

2) The single media filters have been designed to:

a) Provide 24 hour average filtered effluent ≤ 2.0 NTU.

b) Provide a filtered effluent not to exceed 5 NTU for more than 5% of the time within a 24 hour period.

c) Provide a filtered effluent not to exceed 10 NTU at any time.

3) A chemical feed system is provided for the dosage of coagulant into the filter influent flow to precipitate phosphorus solids and improve filtration efficiency.

4) One existing bulk storage tank with containment is provided for the storage of coagulant.

5) Two (2) new coagulant solution feed pumps are provided in the new chemical equipment room for the dosage of coagulant into the filter influent. Each pump is capable of dosing the required coagulant dosage; therefore, one pump shall operate while the other is provided as an installed standby.

f. <u>Backwash Supply Water Pumping Requirements</u>

1) One backwash pump is provided on each filter capable of pumping a backwash rate of up to 25 gpm/ft^2 at a 20' TDH using filtered effluent water. One identical spare backwash pump is provided for installation in either of the two filters.

2) The backwash rate per filter cell shall be manually adjustable between 100 - 200 gpm (12.5 – 25 gpm/ft^2)

3) The estimated backwash water consumption and backwash wastewater production = 2% to 4% of the design maximum daily throughput flow volume = 2.00 MGD.

4) Filter operating head rate = 6-10 inches; backwash cycle can be manually or automatically initiated; automatic backwash cycle can be manually selected for timer or headloss initiation.

g. Backwash Wastewater Pumping Requirements

1) One backwash wastewater pump is provided on each filter capable of pumping the identical flow rate pumped by the backwash supply water pump. The backwash wastewater pump is identical to the backwash supply water and is also capable of pumping up to 25 gpm/ft^2 at a 20' TDH. One identical spare backwash wastewater pump is provided for installation in either of the two filters.

2) Backwash wastewater shall be pumped to the washwater launder from where it will be discharged by gravity flow into the existing DAF Cell Effluent Pump Station for pumping back to FEB Reactor #1A.

4. Expected Final Effluent Quality After Tertiary Filtration

a. The following pollutant concentrations are expected in the effluent of the traveling bridge tertiary filters:

Pollutant	Concentration	
	Average	Maximum
TSS	< 2 mg/L	< 4 mg/L
BOD	< 2 mg/L	< 5 mg/L
Total Phosphorus	< 0.20 mg/L	< 0.30 mg/L
Total Nitrogen	2 - 4 mg/L	< 5 mg/L

R. ULTRAVIOLET (UV) FINAL EFFLUENT DISINFECTION SYSTEM (Phase 1 Existing)

1. Design Assumptions

a. Wastewater Flows

1) Average daily throughput flow rate ≤ 1.50 MGD = 1,050 gpm

2) Maximum daily throughput flow rate ≤ 2.00 MGD = 1,400 gpm

b. Monthly Average Influent Pollutant Concentrations

TSS	$\leq$	2.0 mg/L
O&G	$\leq$	1.0 mg/L
NH_3N	$\leq$	1.0 mg/L

c. Monthly Average Effluent Limitations

Enterococcus	$\leq$	33 col/100 ml (Monthly Average)

2. In order to comply with the enterococcus bacteria limitations, final effluent is disinfected by ultraviolet light (UV) to replace the existing chlorination and dechlorination system.

3. One existing UV contact basin is provided for final effluent disinfection. The UV contact channel structure has the following dimensions and volume:

   a. Concrete Channel Structure

1) Total Length	=	30.0 ft.
2) Width	=	1 ft.
3) Depth	=	4.5 ft.

   b. UV Lamp Bank Contact Zone

      1) Number of UV Banks = 2
      2) Contact Length/UV Bank = 8.60 ft.
      3) Channel Width = 12 inches
      4) Maximum Liquid Depth = 18 inches
      5) Contact Zone Volume/UV Bank = 16.125 ft^3 = 120 gallons

4. UV System Components and Design Features

   a. UV Transmission = 65% minimum

   b. Minimum Detention Time through UV Contact Banks $\geq$ 5.4 seconds

   c. UV Dose - 62,800 microWatts/cm2 at 60% minimum transmission.

   d. Uniform Lamp Array - 3 Banks each with 5 Modules per Bank and 6 lamps per module providing a total of 36 UV Lamps

   e. The UV system will have one Power Distribution Centers and one System Control Center.

   f. The discharge end of the UV Contact Channel will be provided with one fixed weir plate level controller

g. The UV system is provided with an Automatic Chemical/Mechanical Cleaner

h. Automatic Power Dose Pacing System Control is provided.

5. Emergency Disinfection

a. If the UV equipment is out of service; or, if emergency effluent break point chlorination and dechlorination is required for ammonia removal, the existing chlorine contact basin can be operated for final effluent disinfection using sodium hypochlorite solution dosage for chlorination and sodium bisulfite solution dosage for dechlorination.

S. WASTE ACTIVATED SLUDGE PRODUCTION

1. Calculation of F/M_T Ratio of BNR Activated Sludge Treatment Process

a. Calculate F/M_T ratio at the design BOD loading rate based on the total activated sludge reactor volume = 2.72 MG average + 1.64 MG + 0.50 + 0.60 MG + 0.10 MG = 5.56 MG average, and, average MLSS concentration = 5,000 mg/L.

1) $F/M_T = \dfrac{13{,}344\#BOD/day}{(5{,}000mg/L)(5.56\ MG)(8.34)}$

$= 0.06\#BOD/\#MLSS$ @ 5,000 mg/L

2) Y = Expected activated sludge production rate @ 0.06 F/M ratio ≤ 0.60# Sludge/#BOD applied

2. Calculation of Waste Sludge Production

a. At the expected F/M ratio of 0.06#BOD/#MLSS, biosolids sludge must be wasted at a rate of under 0.60#TSS/#BOD applied from the activated sludge treatment system. At the design maximum BOD load of 13,344#BOD/day approximately 13,344(0.60#TSS/#BOD) = 8,000#/day (dry basis) of activated sludge biosolids must be wasted from the activated sludge process each day to maintain the correct MLSS concentration in the multi-stage activated sludge treatment process. Activated sludge will be wasted by being pumped from the Final Clarifier sludge return pump station to the new WAS Storage Tank (SST) for aerobic digestion, gravity thickening, decanting and storage prior mechanical dewatering and being hauled to a land application site for ultimate disposal.

b. The dosage of aluminum chloride or aluminum sulfate coagulant solution into the Final Clarifier influent mixed liquor flow is required to achieve phosphorus removal by chemical precipitation of orthophosphate contained in the wastewater followed by sedimentation of precipitated solids in the Final Clarifiers. This continuous chemical precipitation process will result in the production of additional chemical sludge solids that must be pumped to the SST. To provide the high efficiency phosphorus removal required to comply with permit TP limits, over 99% TP removal efficiency is required in the wastewater chemical precipitation/clarification process used in this treatment system. This phosphorus removal process is anticipated to result in the production of additional sludge solids that will be mixed with the waste activated sludge biological solids. The total alum sludge/biological sludge mixture to be produced by the combined activated sludge and chemical phosphorus removal process is calculated as follows:

1) Calculate biological solids from BOD removal;

   Biological Solids = 0.60#Solids/#BOD(800 mg/L) = 480 mg/L

2) Calculate organic P in biological solids, assuming organic P in biological solids removed is 2% by weight with biological phosphorus removal;

   P in biological solids = 480 mg/L x 0.02 = 9.6 mg/L

3) Calculate P removed by alum precipitation with average influent TP $\leq$ 16.0 mg/L in the pretreated wastewater discharged from the DAF cell.

   P removed by alum = P in (influent - biological solids - effluent)

   = (16 – 9.6 – 0.1) = 6.3 mg/L $\leq$ 7.0 mg/L

4) Assume an alum dose of 12 mg Alum/L : 1 mg P/L will be necessary to meet the very high efficiency phosphorus removal requirements specified by the discharge permit:

   Alum dosage = 7 mg P/L x 12 mg Alum/mg P = 84 mg/L $\leq$ 100 mg/L
   Al dosage = 100 mg/L (2 x 27/594) $\leq$ 10 mg/L

5) Calculate $AlPO_4$ precipitate

   $$AlPO_4 \text{ precipitate} = \frac{(\text{P removed by alum})(\text{Mol. wt. of } AlPO_4)}{\text{Mol. wt. of P}}$$

   $$= \frac{(7.0 \text{ mg/L})[(27 + 31 + (16 \times 4)]}{31}$$

   $$= 27.5 \text{ mg/L}$$

6) Calculate unused alum

   $$Al_2(SO_4)_3 \bullet 14H_2O + 2PO_4^{-3} \rightarrow 2AlPO_4 + 3SO_4^{-2} + 14H_2O$$

   1 mole Alum/2 mole P

Alum used = $\frac{\text{(P removed) (Mol. wt. of alum)}}{\text{Mol. wt. of P}}$

= $\frac{(7.0 \text{ mg/L})(594)}{2 \times 31}$

= 67 mg/L

Unused Alum = Alum dosed - Alum used

= 100 mg/L - 67 mg/L

= 33 mg/L

7) Calculate $Al(OH)_3$ precipitate

$Al_2(SO_4)_3 \bullet 14H_2O + 6HCO_3^- \rightarrow 2Al(OH)_3 + 3SO_4^- + 6CO_2 + 14H_2O$

1 mole Alum/2 mole $AL(OH)_3$

$Al(OH)_3$ precipitate = $\frac{\text{(unused Alum) (Mol. wt. of } Al(OH)_3)}{\text{Mol. wt. of alum}}$

= $\frac{(33 \text{ mg/L}) (2 \times [(27 + (17 \times 3)]}{594}$

= 8.6 mg/L $\leq$ 9.0 mg/L

8) Calculate chemical and biological sludge production

Total Sludge = 480 mg/L + 27.5 mg/L + 9.0 mg/L = 516.5 mg/L $\leq$ 525 mg/L

Chemical Sludge = 27.5 mg/L $ALPO_4$ + 9.0 mg/L $Al(OH)_3$ = 36.5 mg/L $\leq$ 40 mg/L

9) Calculate volume of sludge produced assuming 1.00% solids in return sludge from the final clarifier:

Dry solids produced = (525 mg/L)(2.00 MGD)(8.34) = 8,757#/day

$\leq$ 9,000#/day

Sludge Volume = $\frac{9{,}000\#/\text{day}}{(0.01)8.34}$

$\leq$ 110,000 gpd @ 1.0% solids concentration

The total maximum dry weight and volume of waste sludge to be produced by the treatment system is therefore calculated to be approximately 110,000 gpd @ 75 gpm over 24 hours/day; or, 150 gpm over 12 hours/day assuming a 1.0% waste sludge solids concentration with aluminum sulfate dosage.

T. *WASTE ACTIVATED SLUDGE STORAGE TANKS (Existing & New)*

1. General Description

   a. The existing CMAS #2 Aeration Basin will be retrofitted into a new Waste Activated Sludge (WAS) Storage Tank #3 (SST) for aerobic digestion, gravity thickening, and decanting of WAS solids generated by the BNR treatment process.

   b. Accumulated sludge solids contained in the old, out of service, anaerobic lagoon will be gradually pumped into the two existing Sludge Storage Tanks #1 and #2 for mixing and aerobic digestion with WAS pumped from SST #3 prior to dewatering and disposal with WAS.

   c. Aerobically digested and gravity thickened sludge solids will be pumped from the SST's to a new screw press for mechanical dewatering prior to hauling off site for ultimate disposal.

2. Sludge Storage Tank Design

   a. Two existing 40 ft. dia. X 12 ft. maximum liquid depth, 0.115 MG (15.4 x $10^3 ft^3$) volume above grade bolted, glass coated, carbon steel tanks will continue to be used as SST #1 and SST #2 for WAS digestion, storage and gravity thickening.

   b. One existing 81 ft. dia., 13 ft. maximum liquid depth 0.50 MG volume (67 x $10^3 ft^3$) above grade bolted, glass coated, carbon steel CMAS #2 tank will be retrofitted into SST #3 for additional sludge storage; aerobic digestion and thickening of WAS.

   c. WAS will be pumped from the RAS suction lines from the two Final Clarifiers into the SSTs.

   d. Accumulated solids will also be pumped at a low flow rate and daily volume from the old unused anaerobic lagoon into SST #1 and SST #2 for mixing and disposal with WAS.

   e. A floating pipe, manual operated, decanting system is provided in each existing SST for drawing off clarified decant liquid from the surface of the SST at the end of gravity sludge thickening periods.

   f. Gravity thickened sludge will normally be pumped from the bottom of SST #1 and SST #2 to the new Screw Press Sludge Dewatering System.

3. Sludge Storage Tank Aeration and Mixing Equipment Design

   a. Evaluate mixing requirements in the Sludge Storage Tanks:

      1) SST #1 and SST #2

         a) One existing _____ HP floating surface aerator is provided in each SST #1 and SST #2 tank for biomass sludge mixing and aeration.

         b) HP/MG = _______/0.115 MG = ________

      2) SST #3

         a) cfm required for mixing 15,000 mg/L to 25,000 TSS concentration = 20 to 30 scfm/1,000 ft^3

            cfm = (67 x $10^3 ft^3$)(20 to 30 scfm) $\leq$ 2,010 cfm @ maximum liquid depth

         b) Max. design blower pressure with 12.0 ft. max. diffuser air sparge submergence:

            = (12.0 ft.)(0.433) + 1.5 psi = 6.7 psi $\leq$ 7.0 psi (pressure loss plus pressure drop in air supply lines and in coarse bubble air diffuser sparges)

   b. Evaluate Oxygen Transfer Requirements in the new Sludge Storage Tank #3:

      1) Assume $0.15\#O_2/\#BOD$ is required in the aerobic sludge digester tanks based on the average BNR process BOD loading

$$\text{AOTR} = \frac{(0.15\#O_2/\#BOD)(10{,}000\#BOD/day)}{24} = 63\#O_2/hr \leq 65\#O_2hr \text{ total}$$

      2) Oxygen transfer capacity is provided in the new SSTs by an existing coarse bubble diffuser system with compressed air supplied by two existing positive displacement blowers.

4. Diffused Aeration and Mixing Equipment in SST #3

   a. An existing coarse bubble diffused aeration pipe header system is provided in the SST for oxygen transfer and mixing using diffused aeration. The diffusers are installed approximately 1.0 ft. above the basin floor.

   b. Two existing ____ HP positive displacement (PD) blowers each rated at ____ scfm @ 7.0 psi are provided for compressed air supply to the coarse bubble diffusers in SST #3.

c. The maximum oxygen transfer rate provided in SST #3 at the maximum liquid depth of 13 ft. when sparging approximately 2,000 scfm provided by operation of the two existing PD blowers = 90#O_2/hr (AOTR). The oxygen transfer rate provided with one PD blower in operation at maximum liquid depth = 45#O_2/hr (AOTR).

U. CLARIFIER SCUM PUMP STATION (Existing)

1. General Description

   a. One existing Scum Pump Station is provided for collection of scum skimmings removed from each of the two Final Clarifiers.

   b. Each Final Clarifier has a gravity scum discharge line that discharges into the Scum Pump Station Wet Well.

   c. Scum liquid is automatically pumped from the Scum Pump Station through an existing force main into existing Reactor #2A or through a force main into the Sludge Storage Tank #3.

2. Design Assumptions

   a. Scum Flow Volumes and Rates

      1) Design average scum volume ≤ 20,000 gpd

      2) Peak scum volume ≤ 100,000 gpd

   b. Wastewater Pumping Requirements

      1) Design average discharge flow rate = 100 gpm with one scum pump in operation

      2) Design peak discharge flow rate = 200 gpm with two scum pumps in operation

3. Pump Selection

   a. Two constant speed drive submersible sewage pumps are to be provided each rated at 100 gpm @ 40 feet total head with a 4" PVC scum force main.

   b. Operation of one pump is required to pump the design average flow rate = 100 gpm.

   c. Operation of two pumps in parallel is required to pump the peak discharge flow rate = 200 gpm.

d. The second pump is provided as an installed standby. Automatic Lead and Standby pump operation with automatic pump sequence alternator is provided.

e. Both pumps will be provided with automatic on-off liquid level controls for the Scum Pump Station wet well.

V. SCREW PRESS SLUDGE DEWATERING SYSTEM (New)

1. Waste Activated Sludge (WAS) Dewatering and Disposal

a. Biosolids waste activated sludge (WAS) is pumped from the Final Clarifier Return Activated Sludge (RAS) Pump Station suction lines through a WAS force main line to the new Sludge Storage Tanks (SST). Aerated, gravity thickened WAS will be pumped from the SSTs to the new Screw Press for mechanical dewatering prior to ultimate disposal by land application. WAS can also be pumped directly from the Final Clarifier RAS suction lines to the new Screw Press for mechanical dewatering if the new Sludge Storage Tanks are out of service.

b. The maximum daily dry weight and liquid volume of biosolids sludge to be pumped to the new Screw Press under normal operating conditions with the Sludge Storage Tanks in service to provide gravity thickened aerated waste activated sludge to over 1.0% solids concentration = 9,000#ds/day @ 110,000 gpd @ 10,000 mg/L.

c. If both the Sludge Storage Tanks are out of service so that the WAS cannot be gravity thickened to approximately 1.0 to 1.5% solids concentration, the maximum daily dry weight and liquid volume of biosolids sludge to be pumped to the new Screw Press for dewatering assuming a solids concentration of approximately 0.8% in the WAS sludge pumped from the Final Clarifier RAS flow ≤ 9,000#ds/day @ 135,000 gallons/day @ 8,000 mg/L.

2. Screw Press (New)

a. One new Screw Press is provided for sludge dewatering. The sludge inflow capacity rating of the Screw Press = 200 gpm of the WAS sludge @ 1.0% solids concentration and 750#ds/hr. Operation of the Screw Press for two shifts for approximately 12 hours/day is required to dewater the maximum daily sludge volume of approximately 110,000 gpd assuming a flow rate into the Screw Press of approximately under 150 gpm, and, a solids loading rate of approximately 750#ds/hour at 1.0% average solids concentration.

b. The calculated screw press operation times and sludge feed rate:

1) @ maximum WAS production rate ≤ 9,000#ds/day

$$\text{time} = \frac{9{,}000\text{\#dry solids/day}}{750\text{\#ds/hour}} = 12.0 \text{ hrs/day}$$

@ maximum WAS volume @ 1.0% solids concentration ≤ 110,000 gpd

$$\text{gpm} = \frac{110{,}000 \text{ gpd}}{12.0 \text{ hrs/day}(60)} = 150 \text{ gpm sludge feed rate required}$$

2) @ average WAS production rate ≤ 6,000#ds/day

$$= \frac{6{,}000\text{\# dry solids/day}}{12 \text{ hrs/day}} = 500\text{\#ds/hour for 12 hrs/day}$$

@ average for WAS volume @ 1.0% solids concentration

$$= \frac{6{,}000\text{\#ds/day}}{(0.01)(8.34)} = 72{,}000 \text{ gpd}$$

assume the screw press is operated for one 8.0 hour shift/day under average loading conditions

$$\frac{72{,}000 \text{ gpd}}{8 \text{ hrs/day}(60)} = 150 \text{ gpm sludge feed rate required}$$

@ average volume for WAS @ 1.0% solids concentration

3. WAS/Screw Press Sludge Feed Pumps (New)

a. Three existing 7.5 HP progressive cavity sludge pumps are provided each rated at 400 gpm to pump sludge from the two existing Sludge Storage Tanks #1 and #2 to the Screw Press for dewatering.

b. One magnetic flowmeter with flow indicator and totalizer is provided in the screw press sludge feed line to accurately measure, indicate and totalize the sludge waste flow pumped to the Screw Press.

4. Dewatered Solids Discharge Conveyor

a. Dewatered sludge will discharge by gravity from the Screw Press into a new conveyor auger to transfer sludge into an open top dump truck.

5. Screw Press Filtrate Recycle

   a. Filtrate wastewater discharged from the new Screw Press will drain by gravity into the DAF Cell Effluent Pump Station Wet Well to be recycled back into the activated sludge treatment system.

6. Chemical Storage Feed Equipment for Screw Press Sludge Dewatering System

   a. For polymer flocculation of sludge being pumped into the Screw Press the following chemical feed equipment is provided:

      1) One Polymer Solution Preparation Unit including a Polymer Solution Mixing Chamber, Neat Polymer Metering Pump, Dilution Water Inlet and Solution Outlet Assembly and Control Panel.

      2) One progressive cavity Neat polymer solution metering pump is provided rated at 0.5 to 5 gphr @ 40 psi to pump Neat polymer solution from drums or totes into the Polymer Mixing Chamber of the Screw Press Polymer Feed Solution Preparation Unit for dosing into the screw press sludge feed line.

7. Dewatered Sludge Volume and Water Content

   a. The estimated maximum sludge volume of 110,000 gpd @ 1.0% solids concentration will be dewatered by the Screw Press to 15% or greater solids concentration depending upon sludge temperature, polymer flocculant dosage efficiency, and solids dewatering characteristics.

   b. The calculated average dewatered sludge volume and weight to be transferred to the hauling truck and removed for ultimate disposal assuming a screw press solids capture efficiency of 97%, a dewatered sludge solids content of over 15% and an average dewatered sludge weight of 9.5#/gal = 71#/ft^3 = approximately 2,000#/Yd^3.

      1) Dewatered Sludge Volume:

$$= \frac{(9{,}000\#ds/day)(0.97)}{(0.15)(9.8\#/gal)}$$

$$\leq 6{,}000 \text{ gpd} \leq 800 \text{ ft}^3\text{/day} \leq 30 \text{ Yd}^3\text{/day, 5 days/week}$$

      2) Dewatered Sludge Weight = 30 Yd^3/day x 2000#/Yd^3 = 60,000#/day = 30 wet tons/day, 5 days/week @ 15% dewatered solids content.

W. EFFLUENT FLOW METER (Existing)

1. One existing 9" throat x 30" max. liquid depth Parshall Flume Flow Meter with a maximum flow capacity = 2,400 gpm = 3.4 MGD is provided to measure the total flow discharging from the existing chlorine contact basin.

2. One existing flow indicating, recording, totalizing flow meter is provided with the Parshall Flume. The flow meter uses a 30-day continuous indicating-recording strip chart located in the existing Pretreatment Building control room.

3. A staff gauge is also provided for manual flow measurement if the automatic Parshall Flume flow meter is out-of-service. The staff gauge can also be used to check calibration of the automatic flow meter.

X. CHEMICAL STORAGE-FEED EQUIPMENT FOR ACTIVATED SLUDGE PROCESS (Existing & New)

1. Cationic polymer flocculant solution mixing, storage and pumping equipment is provided for dosing settling aid polymer solution into the final clarifier influent mixed liquor when required.

   a. One existing 1,600 gallon fiberglass tank with a 2.0 HP mixer is provided for make-up and storage of cationic polymer flocculant solution. Up to 133# of liquid cationic polymer can be weighed and manually added to the 1,600 gallon tank two times/day, filled with water and mixed to make up a 1% by weight cationic polymer solution to be pumped to the injection point in the clarifier influent lines.

   b. Two existing cationic polymer solution pumps are provided each rated @ 90 to 900 gphr of solution. Operation of one pump @ 90 to 900 gphr @ 60 psi can provide a dosage capacity of 5 to 50 mg/L in the maximum clarifier influent mixed liquor inflow of 4.00 MGD = 2.00 MGD plus 100% sludge recycle rate. Lower dosage rates can be pumped if a lower solution strength is made up in the mix tank. The second polymer solution pump is provided as an installed standby.

2. Magnesium hydroxide (MgOH) solution storage, mixing and pumping equipment is provided for dosing MgOH solution into the activated sludge treatment process influent flow for mixed liquor alkalinity and pH control in the biological nitrification process.

   a. One existing 5,000 gallon bulk storage tank is provided for storage of commercially purchased pre-mixed 62% strength magnesium hydroxide solution. Magnesium hydroxide solution is dosed into the DAF Cell Effluent Pump Station Wet Well prior to pumping of pretreated wastewater to FEB Anoxic Reactor #1A in order to maintain mixed liquor pH above 6.8 units in the biological nitrification process by pumping magnesium hydroxide solution into an injection point in Nitrification Reactor #2A.

b. Two existing magnesium hydroxide (MgOH) solution pumps are provided each rated at 10 - 100 gphr @ 60 psi to dose MgOH solution into the 2.00 MGD design flow volume. One pump @ 10 - 100 gphr will inject MgOH at a rate of over 18,000#/day ≥ 1,000 mg/L (dry basis). The normal MgOH dosage requirement is expected to be between 10 to 30 gphr or 100 to 300 mg/L (dry basis). A second MgOH pump is provided as an uninstalled standby.

1) Calculated MgOH dosage rate for nitrification of 1,685# of Ammonia Nitrogen @ 7.0# alk/#TKN when biological denitrification is achieved in FEB/Reactors #1A and #1B:

a) (1,685# NH_3 -N) nitrified/day x 7.0# alk/#TKN

≤ 12,000# alk/day

b) estimated alkalinity available from denitrification of over 83% of the nitrified TKN assuming 3.0# alk/#TKN denitrified,

= (1,685#TKN/day)(0.83)3.0#alk/#TKN

= 4,200#alk/day < 4,000#alk/day

c) estimated alkalinity available in partially pretreated wastewater = (200 mg/L)(8.34)(2.00 MGD) ≥ 3,000#/day

d) estimated alkalinity in the final effluent = 100 mg/L = (100 mg/L)(8.34)(2.00 MGD) ≥ 1,500#/day

e) @ 1.4# $CaCO_3$ alk/# MgOH solution

$$= \frac{12{,}000\# - 4{,}000\# - 3{,}000\# + 1{,}500\#}{1.4\#\ \text{MgOH}/\#\text{alk}}$$

$$= \frac{6{,}500\#\text{alk/day}}{1.4\#\text{MgOH}/\#\text{alk}}$$

= 4,642#MgOH/day   < 5,000#alk/day

f) @ 62% maximum MgOH solution strength the MgOH solution volume required per day and solution pumping rate required/hr =

$$\frac{5{,}000\#/day}{0.62(12.4\#/gal)} = 650 \text{ gpd}$$

$$\leq 30 \text{ gal/hr}$$

vs. 100 gal/hr pumping capacity provided by one MgOH solution pump in operation.

Y. ***CHEMICAL STORAGE-FEED EQUIPMENT FOR PHOSPHORUS REMOVAL (Existing)***

1. Coagulant solution storage and pumping equipment is provided for aluminum sulfate or aluminum chloride solution into the mixed liquor flow into the Final Clarifier for phosphorous removal by precipitation in the Final Clarifier.

   a. For dosage of aluminum sulfate coagulant solution into Clarifier influent mixed liquor flow for phosphorous removal:

      1) Maximum chemically treatable total phosphorous concentration in Final Clarifier influent ≤ 16.0 mg/L; 267#/day @ 2.00 MGD.

      2) Assume ≤ 12 mg/L aluminum sulfate solution per mg/L phosphorous is required to reduce final effluent TP to < 0.10 mg/L

         Maximum alum. dosage ≤ 16.0 mg/L(12 mg/L) ≤ 200 mg/L = 3,336# alum/day

      3) Calculated aluminum sulfate solution dosage

         $$= \frac{3{,}336\#/day}{5.4\#/gal^{(1)}} \leq 617 \text{ gpd} \leq 25 \text{ gphr}$$

         (1) 50% liquid alum solution @ 5.4# alum/gal

      4) The existing 4,500 gallon fiberglass bulk tank will continue to be used for storage of 40% strength aluminum sulfate solution. The bulk tank is located in the existing Wastewater Pretreatment Equipment Building. Aluminum sulfate solution can be pumped into the Final Clarifier Floc Tank upstream of each Final Clarifier.

5) Two existing coagulant solution pumps with manual stroke drive are provided each rated at 3 to 30 gphr @ 60 psi to dose coagulant solution into the 2.00 MGD design flow rate. One pump @ 3 to 30 gphr can inject aluminum sulfate or aluminum chloride solution at a rate of over 3,500#/day ≥ 200 mg/L (dry basis). The normal alum dosage requirement is expected to be between 10 to 20 gphr or 75 to 150 mg/L (dry basis). A second alum pump is provided for parallel operation and as an installed standby

Z. CHEMICAL STORAGE-FEED EQUIPMENT FOR NITROGEN REMOVAL (New)

1. The following equipment will be provided for dosage of organic Carbon Source Solution for carbonaceous BOD feed into Anoxic Reactor #3 for denitrification process control and final removal of nitrate nitrogen.

   a. Non-Flammable carbon source (CS) solution make up and pumping equipment is provided for dosage of CS into the mixed liquor influent flow into new Anoxic Reactor #3.

   b. One 6,650 gallon double walled Bulk Storage Carbon solution Tank is provided for non-flammable organic carbon source (CS) storage. The carbon source solution storage totes are located in the new Wastewater Equipment Building. Carbon source solution is pumped into the Anoxic Reactor #3 influent line.

   c. Two new carbon source solution pumps with manual variable speed drives are provided each rated at 1.5 – 15 gphr @ 60 psi to dose organic carbon solution into the 2.00 MGD maximum daily flow rate. One pump @ 1.5 – 15 gphr can inject organic carbon source at a rate of over 2,500#CS/day ≥ 150 mg/L @ 2.00 MGD. The normal organic carbon source dosage requirement is expected to be between 5 to 10 gphr. A second organic carbon source pump is provided for parallel operation and as an installed standby.

AA. CHEMICAL STORAGE-FEED EQUIPMENT FOR FINAL EFFLUENT PH CONTROL (Existing)

1. The following equipment is provided for storage and pumping chemical solution necessary for final effluent pH control:

   a. For pH adjustment of effluent from UV contact basin to maintain final effluent pH above 6.0 units:

      1) Two existing 2,500 gallon fiberglass tank is provided for bulk storage of magnesium hydroxide solution.

2) One existing magnesium hydroxide solution pump with variable speed drive is provided each rated at ___ to ____ gphr @ 60 psi to inject magnesium hydroxide solution into the final effluent wastewater discharge flow. One pump operated at ____ gphr will inject caustic at a rate up to 400 mg/L (dry basis) into the 2.00 MGD final effluent maximum discharge flow rate; the normal caustic dosage requirement is expected to be between ____ to ____ gphr or ____ to _____ mg/L (dry basis).

BB. *EXPECTED FINAL EFFLUENT QUALITY AND FINAL EFFLUENT NPDES PERMIT LIMITATIONS*

1. After treatment by flow equalization, dissolved air flotation first stage pretreatment; 7 day flow equalization and four stage activated sludge biological treatment; final clarification; tertiary filtration and UV disinfection, the following effluent quality is expected under normal operating conditions:

Parameter	Expected Effluent Quality	Effluent Limitations						
		Load			Concentrations			
		Daily Average	Daily Max	Units	Daily Avg(3)	Daily Max(3)	Max Instant	Units
BOD_5	< 5 mg/L	114.0	227.0	#/day	6.8	13.6	---	mg/L
TSS	< 5 mg/L	152.0	228.0	#/day	9.1	13.6	---	mg/L
O&G	< 2 mg/L	68.0	99.0	#/day	4.0	5.9	---	mg/L
Total Phosphorus	< 0.30 mg/L	15.0	23.0	#/day	0.90	1.37	---	mg/L
Ammonia-N (Apr-Oct)	< 1 mg/L	20.5	32.0	#/day	1.22	1.91	---	mg/L
Ammonia-N (Nov-Mar)	< 2 mg/L	35	70.0	#/day	2.09	4.2	---	mg/L
Total Nitrogen	< 4 mg/L	467.0	574.0	#/day	28	34	---	mg/L
Enterococcus Bacteria	< 30	---	---	#/day	33.0	---	---	col/100 ml
pH	6.7 – 6.9	The pH shall be between 6.0 S.U. and 9.0 S.U. at all times						S.U.
TMDL Annual Load Allocation Effluent Limitations								
Total Nitrogen TMDL	< 67#/day	73(1)	NL	#/day	NL	NL	NL	mg/L
Total Phosphorus TMDL	< 5#/day	5.21(2)	NL	#/day	NL	NL	NL	mg/L
Enterococcus Bacteria TMDL	< 30 col/100 ml	4.73E + 09 CFU/day						col/100 ml

(1)Annual Load Allocation for TN = 26,645#TN/year
(2)Annual Load Allocation for TP = 1901.6#TP/year
(3)@ 2.00 MG based on Load Limit