PREPARED FOR: Western Wake Partners

FROM: CDM/Hazen and Sawyer

PREPARED BY: Jonathan Treadway, K. Richard Tsang

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SUBJECT: Western Wake Regional Wastewater Management Facilities
Western Wake Water Reclamation Facility
PER Technical Memorandum No. 20 – Filtrate/ Centrate Treatment Facilities

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INTRODUCTION

The purpose of this technical memorandum (TM) is to discuss the nutrient content of and handling process for sidestreams at the proposed Western Wake Water Reclamation Facility (WRF). Sidestreams are produced from processing waste activated sludge (WAS) with gravity belt thickeners (GBTs) and centrifuges decant from aerobic holding tanks.

Waste activated sludge will be thickened on GBTs as described in TM 16. The thickened waste activated sludge will be stored in aerated holding tanks as described in TM 17. The holding tanks will be operated in anoxic/aerobic mode to reduce nitrate nitrogen that is produced under aerobic conditions. Provision will be made to decant the tanks; however, this operation will not be the standard protocol. If the aerated sludge holding tanks are operated in decant mode the supernatant would also be considered a sidestream. Effluent solids from the holding tanks will be dewatered in centrifuges as described in TM 18.

Filtrate and centrate from the GBTs and centrifuges, respectively, will drain by gravity to a filtrate/centrate storage tank, which will be used to equalize the return of this sidestream into the aeration basins over 24 hours. The biological treatment system is sized such that sidestream treatment is not necessary to meet the anticipated permit limits of 6 mg/L total nitrogen and 2 mg/L of total phosphorus and can be deferred until effluent limits are reduced to 3.5 mg/L of total nitrogen and 0.5 mg/L of total phosphorus.

PROPERTIES OF WASTE ACTIVATED SLUDGE

Projections on waste activated sludge characteristics were obtained from a BioWin simulation of the liquid processes. BioWin output provided information on the average and maximum month conditions without chemical addition of ferric chloride for enhanced phosphorus removal. Table 20-1 provides characteristics of waste activated sludge for the design condition – maximum month flow – without chemical addition for enhanced phosphorus removal, as well as the average day.

TABLE 20-1
CHARACTERISTICS OF WASTE ACTIVATED SLUDGE

	No Chemical Addition for Enhanced Phosphorus Removal	
	Maximum Month	Average Day
Flow (mgd)	0.575	0.575
Concentration (mg/L)		
Total suspended solids	7,055	5,757
Volatile suspended solids	5,487	4,466
Total nitrogen	414	337
Total phosphorus	248	202

Almost all of the nitrogen and phosphorus species occur as suspended material.

MASS BALANCE

Using the characteristics of the influent WAS from which all the sidestreams are derived; a mass balance on the thickening, aeration, and dewatering processes was conducted. The sidestreams resulting from centrate and filtrate collection are described in Table 20-2.

TABLE 20-2
SUMMARY OF ANALYSIS FOR TREATMENT OF FILTRATE AND CENTRATE

	No Chemical Addition for Enhanced Phosphorus Removal	
	Maximum Month	Average Day
Nitrogen Recycled		
lb/d	259	212
as a percent N in WAS	14%	14%
Phosphorus Recycled		
lb/d	66	54
as a percent P in WAS	6%	6%

The solids mass balance utilized the following assumptions:

1. For thickening
   a. Solids capture of 95 percent.
   b. Thickened sludge concentration of 4 percent.

2. For aerated sludge holding
   a. Destruction of 4 percent of volatile suspended solids.
   b. Solubilization and nitrification of 38 percent of the total kjeldahl nitrogen (TKN). Operating the digesters in alternating aerobic and anoxic phases will reduce 70 percent of the nitrate. This estimate is based on laboratory testing by Warner, Ekama, and Marais (Water Research, Vol. 20, p. 943, 1986).
   c. Solubilization of approximately 5 percent of phosphorus. BioWin simulations estimate higher values. Alkalinity will have to be added to avoid excessive solubilization of phosphorus.

3. For dewatering
   a. Solids capture of 95 percent.
   b. Dewatered cake concentration of 20 percent.

SIDESTREAM HANDLING OF PROPOSED FACILITIES

The proposed facilities for sidestream handling include a storage tank to equalize the return flows to the aeration basin and submersible solids handling pumps to pump the flow. The design and worst-case sidestream flow conditions were discussed in TM No. 16 and are summarized in Table 20-3. In addition, estimated quantities of belt washwater, flushing water, and perimeter drainage for the Thickening/Dewatering Building quantities for the GBTs and centrifuges, which would also flow to the filtrate/centrate storage tank, have been included.

TABLE 20-3
FLOWS TO FILTRATE AND CENTRATE WASTEWATER PUMP STATION

	Condition	
	Maximum Month[1]	**Worst-Case**[2]
Constant Flows during Thickening/Dewatering (gpm)	1,020	1,640
Intermittent Flows (gpm)[3,4]	500	500
Total (gpm)	**1,520**	**2,140**

1 GBTs and centrifuges operating at 500 gpm/GBT and 120 gpm/centrifuge.
2 GBTs and centrifuges operating at 800 gpm/GBT and 150 gpm/centrifuge.
3 Centrifuge flushing is estimated to be 300 gpm for 30 minutes a day to clean centrifuges.
4 GBT washdown water flows are assumed to occur for 30 minutes a day as a result of hose washdown of the solids processing
area below GBTs.

The recommended centrate/filtrate storage tank size is approximately 650,000 gallons. This volume will be sufficient to handle the worst-case sidestream quantities described in Table 20-3 assuming that the storage tank discharge rate to the aeration basins is constant over 24 hours. The following calculations show how this volume was derived.

Maximum daily volume generated (worst-case):
16 hrs*1,640 gpm*60 min/hr + 300 gpm*30 min + 200 gpm*30min =1,589,000 gal

Equalization discharge rate to aeration basins:
1,589,000 gal/24 hrs = 1,100 gpm

Required storage volume:
(1,640 gpm – 1,100 gpm)*16 hrs/day*60 min/hr + 300 gpm*30 min + 200 gpm*30min =
540 gpm*16 hrs/day*60 min/hr + 15,000 gal = 533,000 gal

Factor of Safety of 1.2:
533,000 gal*1.2 = 650,000 gal

Not discharging sidestreams into the aeration basins for an extended period of time will require a larger storage tank. The estimates of sidestream flows to the aeration basins and the required storage volume under worst-case and maximum month conditions was discussed further in TM No. 16.

Electrical Requirements

The electrical requirements of the sidestream treatment system include power for the transfer pumps and power for controls and area lighting. It is recommended the motor control and starters for this equipment be included in the Thickening/Dewatering Building.

Instrumentation & Controls

It is recommended the controls for the sidestream treatment facilities be incorporated into the overall facility control system. All equipment should be capable of automatic and manual operation. Additionally, local start/stop controls should be provided for the transfer pumps and clarifier mechanism.

Estimated Capital Costs

The estimated cost of the equipment and facilities described in this TM are shown in Table 20-4. These costs include the structural, mechanical, and instrumentation costs associated with sidestream handling. These costs expressed with contingencies, engineering and construction administration, and legal and financial fees total to $751,900.

Table 20-4

PRELIMINARY COST ESTIMATE

Structure	$	325,000
Pumps	$	140,000
Piping	$	90,000
Instrumentation	$	27,750
Subtotal	***$***	***582,750***
Construction Contingencies	$	87,400
Engineering and Construction Services	$	67,000
Legal and Financial	$	14,750
Total Construction Cost	**$**	**751,900**