**Attachment 6**

**Preliminary Design Report**

**DRAFT**

# CITY OF ALTAMONTE SPRINGS
# ONSITE SEWAGE TREATMENT AND DISPOSAL SYSTEM REMEDIATION PLAN
# AND
# WASTEWATER TREATMENT PLAN

**FEBRUARY 2024**

ATKINS

# Process Improvements for Advanced Treatment Regional Water Reclamation Facility

950 Keller Rd, Altamonte Springs, FL 32714

# Preliminary Design Report

July 2022 Revision

Prepared for:

CITY OF ALTAMONTE Springs

RAJ SINGH LICENSE No 41210 STATE OF FLORIDA PROFESSIONAL ENGINEER

Prepared by:

Atkins North America, Inc.
Orlando, Florida

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# 1.0 INTRODUCTION

The Altamonte Springs Regional Water Reclamation Facility (ASRWRF) is located at 950 Keller Road, north of the intersection of SR 414 and Keller Road, and is an advanced wastewater treatment facility with a Modified Ludzack Ettinger (MLE) process configuration, which includes two biological treatment trains. The current plant configuration was constructed in the late 1980s as part of the City's APRICOT Project with a new headworks that is currently operating with final construction expected to be complete in fall 2017. The major unit processes and/or improvements include a new headworks structure (two new mechanical screens, screenings washer and compactor, grit removing and classification system, screening and grit handling building, odor control system, influent pump station (six submersible pumps with VFD located in two wet wells), and return activated sludge (RAS) pump station, yard piping electrical/controls, instrumentation/SCADA, and new electrical building, Additionally, the project also included demolition of the former headworks (screenings and grit), raw influent pump station, primary effluent lift station and anoxic feed channel, dewatering (in-plant drain) station, underground piping and associated electrical systems. From the new headworks, the screened and de-gritted sewage flows to the influent channel for the anoxic basins. Treatment continues via anoxic/aeration activated sludge processes, clarification, filtration, and disinfection by chlorination. Effluent is beneficially reused for irrigation throughout the city limits via the reclaimed water system throughout the City (known as Project APRICOT), with almost every property connected to the system to irrigate lawns and landscaping.

In 2015, the City completed construction of the A-FIRST (Altamonte-FDOT Integrated Reuse and Stormwater Treatment) Project. This project involves pumping stormwater from the City's Cranes Roost stormwater facility to a 3.0 mgd Reuse Augmentation Facility (RAF) consisting of prescreening, cloth media disk filters, 200,000-gallon ground storage tank, chlorine chemical feed system, and four high service pumps with a capacity of 3.0 mgd with one pump out of service. The RAF pumps water directly into the City's reuse distribution network. The A-FIRST project also includes an interconnection of the City's reuse system with the City of Apopka via an approximate 6-mile 24-inch diameter pipeline. Excess reclaimed water that cannot be reused within the City of Altamonte Springs is sent to ground storage tanks at the City of Apopka water reclamation facility. These tanks are owned and operated by the City of Apopka where they can use the reclaimed water for reuse or groundwater recharge.

In 2016, the City began operating a 20-gallon-per-minute (gpm) potable reuse pilot demonstration project called pureALTA to evaluate the treatment of reclaimed water to drinking water quality. The pilot plant pumps filtered reclaimed water from the reaeration tank to the pureALTA room housed in the Chlorine Building. The reclaimed water is purified through a process consisting of the following treatment components: ozone, biofiltration, ultrafiltration, granular activated carbon, ultraviolet light disinfection, and advanced oxidation. The purified water is then returned to the reaeration tank downstream of the withdrawal point, where it is mixed with the City's reclaimed water for disinfection and reuse within the City's APRICOT reclaimed water system.

## 1.1 BACKGROUND

Recently Atkins was retained to provide design and construction phase services for the Headworks Improvements project. Under the same contract, Atkins performed a process evaluation to determine

maximum capacity of the plant with existing tankage that will meet 5 mg/l (BOD); 5 mg/l (TSS); 3 mg/l (N); 1 mg/l (P) effluent limit and alternatively developed recommendations for upgrade to meet these effluent limits at a defined minimum flow level. Project Description

## 1.2 PROJECT DESCRIPTION

Under this amendment, Atkins will update the existing process model and develop a preliminary design report for reconfiguration of the existing plant without additional tankage to meet 5 mg/l (BOD); 5 mg/l (TSS); 3 mg/l (N); 1 mg/l (P) effluent limits for an 9.0 MGD average annual daily flow (AADF) capacity in Phase I. The Phase II design will include the additional reactor volumes required and site layouts to meet the design criteria for 12.5 MGD AADF capacity.

The plant operating data from August 2014 through December 2016 will be reviewed and analyzed to develop influent loadings for use as the basis of design. This will be used to validate the previously calibrated model and identify potential alternatives to achieve the effluent quality for advanced treatment, and recommend a cost-effective alternative which can reliably treat the wastewater to effluent design criteria for the Phase I and Phase II improvements.

Based on the updated model, conceptual site layouts will be developed to show the process configuration to facilitate future improvements including process flow diagrams for each phase, plant hydraulic profile and site plans. The layouts developed for Phase I and Phase II improvements are considered at 30% design level and will serve the basis for the ultimate design. The existing site plan showing the improvements that are under construction as part of the Headworks Improvement Project is Illustrated in Figure 1-1.

## 1.3 PROPOSED PHASING PLAN

The existing plant capacity of 12.5 MGD will remain unaffected and the plant will continue to operate per the operating permit limits as included in the 2017 permit renewal. The proposed improvements for the advanced treatment will be implemented in two phases as described below.

### 1.3.1 Phase I Improvements

The Phase I improvements will include minor modifications to the existing aeration reactors to achieve the effluent design criteria to treat an average daily flow of 9.0 mgd. A portion of the nitrification tank (existing aeration zone) will be modified to a 2nd anoxic and reaeration zones by partitioning the existing aeration tanks with baffle walls. Existing submersible mixers will be used for mixing in the 2nd anoxic zone. The existing internal recirculation pumps will be reused in their current location; however, a 48-inch suction pipe will be extended to the discharge end of the reconfigured aeration tanks. Existing clarifiers 1a, 1b and 1c will remain in service and existing clarifiers 2a, 2b, and 2c will be replaced with two new 90-foot-diameter circular clarifiers with 16-foot side water depth. A new chemical feed facility for Alum and Carbon Source will be provided.

NORTH

0 40 80

GRAPHIC SCALE
SCALE: 1" = 40'-0"

AUTOMATIC ACCESS CONTROL GATE

EFFLUENT HOLDING TANK

RECLAIMED WATER STORAGE TANK

RECLAIMED WATER STORAGE TANK

REUSE PUMP AND OFFICE BUILDING

LAB

MAINTENANCE BUILDING

STORAGE SHED

STORAGE SHED

SUBMERSIBLE INFLUENT PUMP STATION AND FINE MECHANICAL SCREENS

NEUTRALIZATION TANK

RAW SEWAGE INFLUENT STRUCTURE

VACTOR DUMP STATION

NEUTRALIZATION BUILDING

EFFLUENT METERING WEIR

CHLORINE CONTACT TANK

PLANT WATER PUMPING STRUCTURE

REAERATION TANKS

AEROBIC DIGESTION TANKS

ODOR CONTROL

SLUDGE THICKENING TANK NO. 1

SLUDGE THICKENING TANK NO. 2

COVERED PARKING

ASPHALT

WAREHOUSE

COVERED STORAGE

DPR AND HYPOCHLORITE BUILDING

FILTER BACKWASH HOLDING TANK

FILTERS

SLUDGE HANDLING BUILDING

PORTABLE BUILDING

FUEL/TANK

COVERED STORAGE

AUTOMATIC ACCESS CONTROL GATE

GENERATOR AND POWER DISTRIBUTION BUILDING

HEADCELL (GRIT REMOVAL)

BLOWER BUILDING

RAS PUMP STATION

EQUIPMENT STORAGE BUILDING

OPERATIONS BUILDING

CHEMICAL HANDLING FACILITY

ANOXIC TANK NO. 1

NITRIFICATION TANK NO. 1

ANOXIC TANK NO. 2

NITRIFICATION TANK NO. 2

SECONDARY SETTLING TANK NO. 1A

SECONDARY SETTLING TANK NO. 1B

SECONDARY SETTLING TANK NO. 1C

FLOCCULATION MIX TANKS

SECONDARY SETTLING TANK NO. 2A

SECONDARY SETTLING TANK NO. 2B

SECONDARY SETTLING TANK NO. 2C

COVERED CONCRETE

KELLER RD

GATEWAY DR

| REV | DATE | ISSUED FOR |
|---|---|---|
| | | |

| REV | DATE | ISSUED FOR |
|---|---|---|
| | | |

RAJ SINGH, P.E.
FLORIDA REG. NO.41210

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CLIENT: CITY OF ALTAMONTE SPRINGS

PROJECT: REGIONAL WATER RECLAMATION FACILITY

SHEET TITLE: EXISTING OVERALL SITE PLAN

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| | |
|---|---|
| JOB NO.: | 100046130 |
| PROJECT ENG: | R.S. |
| DRAWN: | G.G. |
| CHECKED: | R.S. |
| APPROVED: | R.S. |
| SHEET NO. | REV. |

FIG. 1-1

PLOT DATE: Mar 13, 2017 - 4:29pm
FILE NAME: C:\Users\gyuri.f.991\appdata\local\temp\AcPublish_13972\01_EXISTING_OVERALL_SITE_PLAN.dwg

### 1.3.2 Phase II Improvements

The Phase II improvements will include modifications to the existing plant and Phase I improvements to provide reactors that will achieve the effluent design criteria to treat an average daily flow of 12.5 mgd. The baffle walls constructed inside nitrification tanks during Phase I to create 2nd anoxic and reaeration zones will be removed to return the nitrification tank to their original configuration. The existing internal recirculation pumps will be reused in their current location; and the 48-inch suction pipe extended in Phase I will be removed. Existing clarifiers 1a, 1b and 1c will be repurposed into 2nd anoxic and reaeration tanks by replacing all internal equipment, walls, etc., with new walls and mixers, etc., to provide two complete parallel 2nd anoxic and reaeration reactors. Two new 90-foot-diameter circular clarifiers with 16-foot side water depth will be constructed.

# 2.0 BASIS OF DESIGN

## 2.1 DATA EVALUATION

Based on the data (from August 2014 to December 2016) evaluation, the average and maximum month values for different influent characteristics were determined. Table 2-1 summarizes the existing influent criteria and the observed peaking factors for different influent constituents.

Table 2-1. Existing Influent Characteristics for Design Criteria – Altamonte Springs RWRF

| Influent Parameter | Units | Average (AD) | Max. Month (MM) | Peaking Factor (MM/AD) |
|---|---|---|---|---|
| Flow | mgd | 5.82 | 6.4 | 1.08 |
| BOD | lb/d | 11,407 | 14,259 | |
| | mg/L | 235 | 294 | 1.25 |
| TSS | lb/d | 13,348 | 15,884 | |
| | mg/L | 275 | 327 | 1.19 |
| $NH_3$ | lb/d | 1,468 | 1,585 | |
| | mg/L | 30.25 | 33 | 1.08 |
| TKN | lb/d | 2,451 | 2,745 | |
| | mg/L | 50.5 | 56.6 | 1.12 |
| TP | lb/d | 393 | 447 | |
| | mg/L | 8.1 | 9.2 | 1.14 |

The above design criteria will be used to calibrate the existing MLE process reactors, and setup process models for proposed alternatives using BioWin 5 process modeling software. The design criteria for the operating mixed liquor concentration will be 3,000–4,000 mg/L.

As stated in the previous technical memorandum (included in Appendix A), the MLE process is currently in use at the ASRWRF. The existing reactor was modelled based on the existing structural dimensions and operational conditions/parameters as follows:

- Anoxic Tank- 113.5’ (L) x 50.33’ (W) x 15.83’ (D); 0.667 million gallons (MG)
- Nitrification Tank- 257.5’ (L) x 50.33’ (W) x 15.83’ (D); 1.53 MG
- For the purposes of the aeration control each Nitrification Tank is divided into three equal size zones (0.51 MG) equipped with diffused aeration equipment.
  - Aeration Zone 1 - 2,706 diffusers
  - Aeration Zone 2 - 1,640 diffusers
  - Aeration Zone 3 - 1,092 diffusers
- The plant recycles from the Gravity Thickener and Belt Filter Press.

- Returned Activated Sludge from the Clarifier is estimated at about 6 mgd (1Q).
- The nitrated mixed liquor, internal recycle (IR) is estimated at about 18 mgd (4Q)

A Schematic of the existing MLE process reactor configuration is presented in Figure 2-1.

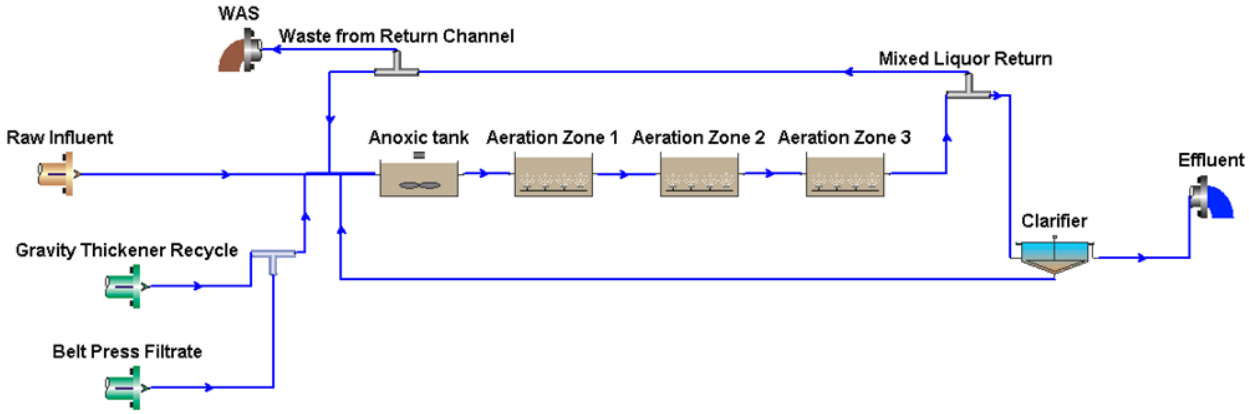


Figure 2-1. Schematic of Existing MLE Process Configuration at Altamonte Springs RWRF

## 2.2 INFLUENT BASIS OF DESIGN

### 2.2.1 Phase I – 9.0 mgd Average Daily Flow

The influent loading criteria for the biological process design was developed using the peaking factors for the influent Parameters determined from the existing data evaluation. The recommended influent basis of design for the Phase I improvements of ASRWRF is presented in Table 2-2.

Table 2-2. Phase I – Influent Basis of Design for Altamonte Springs RWRF

| Influent Parameter | Units | Average (AD) | Max. Month (MM) | Peaking Factor (MM/AD) |
|---|---|---|---|---|
| Flow | mgd | 9.0 | 9.72 | 1.08 |
| BOD | lb/d | 17,639 | 23,833 | |
| | mg/L | 235 | 294 | 1.25 |
| TSS | lb/d | 20,642 | 26,508 | |
| | mg/L | 275 | 327 | 1.19 |
| $NH_3$ | lb/d | 2,270 | 2,676 | |
| | mg/L | 30.25 | 33 | 1.08 |
| TKN | lb/d | 3,790 | 4,588 | |
| | mg/L | 50.5 | 56.6 | 1.12 |
| TP | lb/d | 608 | 746 | |
| | mg/L | 8.1 | 9.2 | 1.14 |

### 2.2.2 Phase II – 12.5 mgd Average Daily Flow

The recommended influent basis of design for the Phase II improvements of ASRWRF is presented in Table 2-3.

Table 2-3. Phase II – Influent Basis of Design for Altamonte Springs RWRF

| Influent Parameter | Units | Average (AD) | Max. Month (MM) | Peaking Factor (MM/AD) |
|---|---|---|---|---|
| Flow | mgd | 12.5 | 13.50 | 1.08 |
| BOD | lb/d | 24,499 | 33,101 | |
| | mg/L | 235 | 294 | 1.25 |
| TSS | lb/d | 28,669 | 36,817 | |
| | mg/L | 275 | 327 | 1.19 |
| $NH_3$ | lb/d | 3,154 | 3,715 | |
| | mg/L | 30.25 | 33 | 1.08 |
| TKN | lb/d | 5,265 | 6,372 | |
| | mg/L | 50.5 | 56.6 | 1.12 |
| TP | lb/d | 844 | 1,036 | |
| | mg/L | 8.1 | 9.2 | 1.14 |

## 2.3 EFFLUENT BASIS OF DESIGN

The effluent basis of design for both the Phase I and Phase II improvements are same in terms of the concentration. The major difference is associated with the average daily flow. A summary of the effluent basis of design is presented in Table 2-4.

Table 2-4. Phase I and Phase II – Effluent Basis of Design for Altamonte Springs RWRF

| Effluent Parameter | Units | Phase I | Phase II |
|---|---|---|---|
| Flow | mgd | 9.0 | 12.5 |
| BOD | mg/L | 5 | 5 |
| TSS | mg/L | 5 | 5 |
| $NH_3$[1] | mg/L | <0.5 | <0.5 |
| TKN | mg/L | 3 | 3 |
| TP[2] | mg/L | 1 | 1 |

1. Not mandated by the permit. However, effluent ammonia concentration below 0.5 mg/L represent complete nitrification.

2. Includes phosphorus removal through tertiary treatment.

# 3.0 PROCESS DESIGN

The goal of the Process Modeling for the purposes of this report was to use the calibrated model of the existing process configuration (after aeration system upgrade) and validate it using the current data and evaluate the projected performance for the Phase I and Phase II improvements based on the design criteria established. An industry-accepted biological process modeling software, BioWin 5, was used to model both the existing process and the proposed alternatives.

To achieve enhanced nutrient removal for upgrading the plant to 9.0 mgd in Phase I and 12.5 mgd in Phase II, effluent total nitrogen needs to be reduced from the current 8 mg/L concentration to about 3 mg/L concentration. This can be achieved by modifying the existing MLE process configuration to a 4-stage Bardenpho configuration. A detailed process evaluation summary is presented in Appendix A- Technical Memorandum - ASRWRF Process Evaluation.

The configuration of the aeration basins for the 4-stage Bardenpho process configuration is shown on Figure 3-1. This is a single sludge process with a four-stage sequence for nitrogen removal. The process includes dual anoxic and aerobic zones. The function of each zone in this process configuration can be briefly described as follows:

- First Anoxic Zone
  - Internal recycle returns activated sludge and nitrates/nitrites to the beginning of the process for denitrification
  - Organic carbon consumed by bacteria converting nitrates and nitrites to nitrogenous gas
- First Aerobic Zone
  - Oxidation of influent organic carbon
  - Nitrification of influent ammonia
- Second Anoxic Zone
  - Endogenous respiration to remove remaining nitrates/nitrites
- Second Aerobic Zone
  - Re-aeration of wastewater prior to discharge to secondary clarifiers

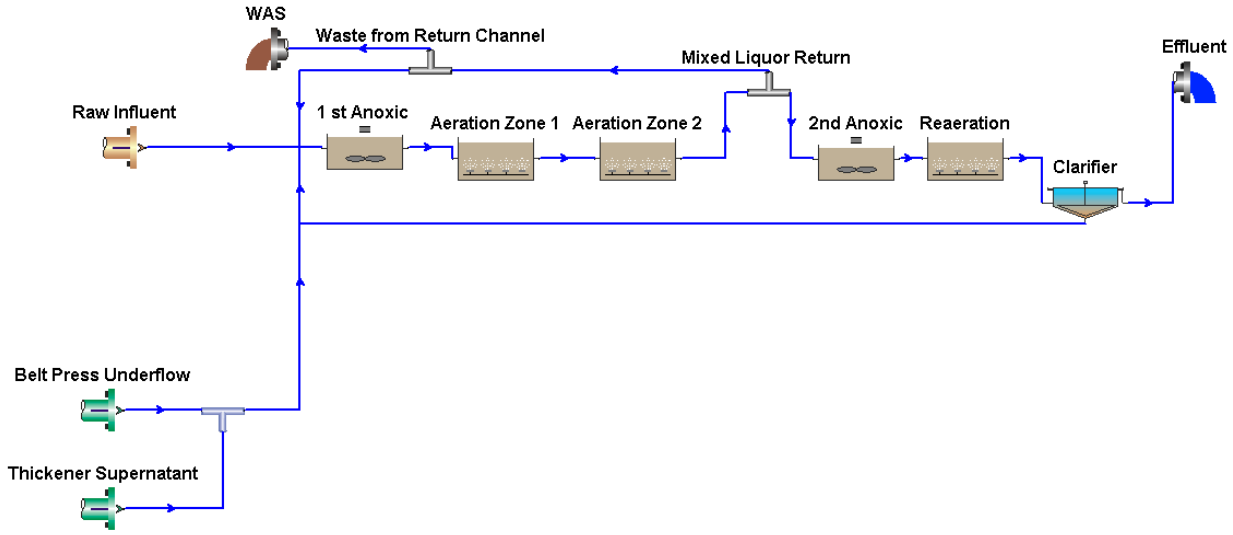


Figure 3-1. Schematic of 4-stage Bardenpho Process Configuration

## 3.1 PROPOSED IMPROVEMENTS FOR PHASE I

The Phase I improvements include minor modifications to the existing reactor without any additional reactor volume to achieve the effluent design criteria to treat an average daily flow of 9.0 mgd. There will be no major modifications to the existing anoxic tanks, a portion of the nitrification tank (aeration zone) will be modified to a 2nd anoxic and reaeration zones. A process flow diagram for the modified Phase I process is illustrated in Figure 3-2. Reconfiguration of the existing aeration basins will require partitioning of the existing aeration tanks with baffle walls as illustrated in figures 3-6 and 3-7. Existing submersible mixers will be used for mixing in the 2nd anoxic zone. The existing air diffusers in the 2nd anoxic zone will be isolated such that in Phase II they can be re-incorporated in the process scheme. The existing internal recirculation pumps will be reused in their current location; however, a 48-inch suction pipe will be extended to the discharge end of the reconfigured aeration tanks.

The reliability of the process configuration is largely dependent on the secondary clarifier performance. At ASRWRF the existing secondary rectangular clarifiers are nearing the end of their useful life and lack modern sludge control means. Clarification/sedimentation is a critical process for the successful performance of an advanced wastewater treatment process. The performance of the secondary clarifier limits the operating mixed liquor concentration in the aeration tank. A higher operating mixed liquor concentration in the aeration tank can be maintained without sludge thickening and sludge settleability issues in the Secondary clarifiers. Therefore, as recommended below, state of the art new circular clarifiers are required.

The existing secondary rectangular clarifiers 1a, 1b, 1c, 2a, 2b and 2c were designed for a 12.5 MGD AADF capacity; however, sludge withdrawal and rate control is inadequate. These clarifiers and the mechanisms have been in service over 25 years and need major concrete and mechanism rehabilitation, which is estimated to cost well over $1.0M for each set of the clarifiers. In lieu of spending the money in rehabilitating the old and outdated clarifiers, a phased approach is recommended to replace these clarifiers with more modern and efficient circular clarifiers. Therefore, it is recommended, in Phase I, the existing secondary clarifiers 2a, 2b, and 2c be demolished to provide space for two new 90-foot-diameter-circular secondary clarifiers with a side

water depth of 16 feet. A demolition plan for Phase I upgrades is illustrated in figures 3-3 thru 3-5. An overall site layout showing the Phase I improvements is shown in Figure 3-6.

Class I Reliability and existing Plant Operation during construction: Upon completion of the Phase I improvements, there will include two 90-foot-diameter new clarifiers with 16-foot side water depth (SWD) and three old rectangular clarifiers (33' x 150' x 13.5 SWD). Based on this the loading rates will be as follows:

- At the current permitted average daily flow (ADF) capacity of 12.5 mgd the loading rates will be 452 gallons per day per square foot (gpd/ft$^2$) at ADF and 904 gpd/ft$^2$ at peak flow.
- With the largest unit, out of service, i.e., 1-90' out of service (1-90' in service and (3) old rectangular clarifiers in service, flow = 75% of peak flow of 25 MGD peak flow)) the loading rate for class I reliability will be 884 gpd/ft$^2$, which is well within typical range of 800–1,000 gpd/ft$^2$ for peak flow conditions.
- During construction of Phase I improvements, the Average Daily Flow is projected to be in 7.0 mgd range, which will be handled by the three old rectangular clarifiers (33' x 150' x 13.5 SWD) with a loading rate of 471 gpd/ft$^2$. Therefore, the TSS loading and fecal coliform count to the downstream processes (filters, chlorine contact tanks) would remain unaffected.

By constructing new baffle walls in the nitrification tank, the tanks will be reconfigured to include 2nd anoxic zone and reaeration zones with revised aeration zones. Since downstream end of the existing oxic zone would be converted to an anoxic zone, the IR pump suction would be moved to the point furthest downstream in the oxic zones. There will be no physical reconfiguration of the existing aeration system in the Nitrification Tank. The existing oxic zone 3a will be converted to the second anoxic zone by constructing baffle walls in Nitrification Tank. The diffusers will be turned off and mixers will be installed. The existing oxic zone 3b will be converted to the reaeration zone by constructing baffle walls in Nitrification Tank. No diffuser clogging issues are anticipated by turning off the membrane type diffusers. The effluent total phosphorus concentration is achieved using chemical precipitation using alum. Figure 3-7 shows the reactor modifications associated with the Phase I improvements.

The model application was developed to determine the ability of the biological process for achieving the targeted nutrient removal. It was observed, the total nitrogen values in the secondary effluent predicted by the model slightly exceed the 3 mg/L criteria and total phosphorus effluent criteria of 1 mg/L. The reason for increase in the effluent TN could be variation in the refractory organic nitrogen in the influent and the role of influent BOD in the denitrification of $NO_x$. The observed BOD/TKN ratio is less than the normal. Model simulations were developed to determine the external carbon source dosage to reduce the TN to the effluent goal of 3 mg/L and alum dosage to meet effluent TP goal of 1 mg/L as presented in Table 3-1.

12" REUSE AUGMENTATION FROM STORM PONDS

EFFLUENT HOLDING TANK

ULTRASONIC FLOW METER FOR PLANT RECYCLES

48"/42" RAW SEWAGE

48" PLANT EFFLUENT TO WEKIVA RIVER

24" EFFLUENT DIVERSION

42" EFFLUENT DIVERSION

SUBMERSIBLE INFLUENT PUMP STATION AND FINE MECHANICAL SCREENS

48" PLANT EFFLUENT

pH CONTROL RAPID MIX CHAMBER

DECHLORINATION MIX CHAMBER

NEUTRALIZATION METERING STRUCTURE

pH CONTROL SLOW MIX CHAMBER

SULFUR DIOXIDE SUPPLY

SULFUR DIOXIDE STORAGE

ACID SUPPLY

ACID PUMPS

ACID STORAGE

NEUTRALIZATION BUILDING

RAW SEWAGE INFLUENT STRUCTURE

30" RAW SEWAGE

36" RAW SEWAGE FM

RAW SEWAGE FLOW METER

HEADCELL (GRIT REMOVAL)

30" HEADCELL BYPASS

DEGRITTED EFFLUENT

TO PROJECT "APRICOT" GROUND STORAGE TANKS

36" EFFLUENT PUMPING STATION BY-PASS

EFFLUENT METERING WEIR

EFFLUENT PUMPING STATION

CHLORINE

CONTACT TANK

SCUM PUMP

PLANT AIR

TO PLANT DISTRIBUTION SYSTEM

CHLORINE INJECTION

PLANT WATER PUMPING STRUCTURE

DIRECT POTABLE REUSE PROCESS

REAERATION TANKS

No. 1

No. 2

FILTER EFFLUENT

12" DIGESTER SUPERNATANT DRAIN

AEROBIC DIGESTION TANKS

No. 1

No. 2

No. 3

BELT PRESS FEED PUMPS

6" DIGESTED SLUDGE

20" AIR SUPPLY

6" SCUM LINE

4" THICKENER DILUTION WATER

3" BELT PRESS SPRAY WATER

3" CHLORINE SOLUTION

20" BACKWASH SUPPLY

6" FILTER BACKWASH RETURN

FILTER BACKWASH WASTE PUMPS

BACKWASH SUPPLY FLOW ELEMENT

6" FILTER RESEED

FILTERS

No. 1

No. 2

No. 3

No. 4

No. 5

No. 6

No. 7

24" BACKWASH WATER

FILTER BACKWASH HOLDING TANK

BACKWASH AIR BLOWERS

POLYMER FEEDERS

POLYMER ADDITION

BELT PRESSES

SCUM REMOVAL

SCUM SCREEN

SLUDGE CAKE

TRUCK

8" THICKENED SLUDGE

PLANT AIR

THICKENED SLUDGE PUMPS

SLUDGE THICKENING TANK No. 1

SLUDGE THICKENING TANK No. 2

SODIUM HYPOCHLORITE FEED PUMPS AND STORAGE

8" AIR SUPPLY

20" AIR SUPPLY

8" WASTE ACTIVATED SLUDGE

12" BELT PRESS UNDER FLOW

12" SUPERNATANT

24" SUPERNATANT □ DEWATERING DRAIN

FILTER INFLUENT FLOW METER (METHANOL FEED CONTROL)

SCUM

BLOWER BUILDING

BLOWERS

8" WASTE ACTIVATED SLUDGE

8" OPTIONAL WASTE ACTIVATED SLUDGE

RAS PUMP STATION

48" FILTER INFLUENT

CHEMICAL HANDLING FACILITY

CHEMICAL FEED PUMPS

1" ALUM FEED

SECONDARY TANK SCUM PUMP

6" SECONDARY SCUM

RAS FLOW METER

30" RETURN ACTIVATED SLUDGE

24" RAS

METHANOL ADDITION

MIXED LIQUOR RETURN (CHANNEL)

1st ANOXIC TANKS

NO. 1

NO. 2

NITRIFICATION TANKS

NO. 1

NO. 2

2nd ANOXIC TANKS

IR PUMP SUCTION

NO. 1

IR PUMP SUCTION

NO. 2

24" AIR SUPPLY

MIXED LIQUOR RETURN PUMPS (TYP.)

RE-AERATION TANKS NO.1 AND NO.2

SECONDARY SETTLING TANKS

NO. 1A

NO. 1B

NO. 1C

FLOCCULATION □ MIX TANKS

NO. 1

NO. 2

SECONDARY INFLUENT

SECONDARY INFLUENT (CHANNEL)

24" CLARIFIER INFLUENT

CLARIFIER INFLUENT FLOW SPLITTER BOX

36" SECONDARY EFFLUENT

NO. 1

NO. 2

24" EFF

24" RAS

6" SECONDARY SCUM

SECONDARY CLARIFIERS

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CLIENT: CITY OF ALTAMONTE SPRINGS

PROJECT: REGIONAL WATER RECLAMATION FACILITY

SHEET TITLE: PROCESS FLOW DIAGRAM- PHASE I

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FIG. 3-2

PLOT DATE: Mar 13, 2017 - 1:34pm
FILE NAME: C:\Users\gonz136\appdata\local\temp\AcPublish_13872\09_Process Flow diagram-PPDR-PHASE I.dwg

NORTH

0 40 80

GRAPHIC SCALE
SCALE: 1" = 40'-0"

AUTOMATIC ACCESS CONTROL GATE

EFFLUENT HOLDING TANK

RECLAIMED WATER STORAGE TANK

RECLAIMED WATER STORAGE TANK

REUSE PUMP AND OFFICE BUILDING

LAB

MAINTENANCE BUILDING

STORAGE SHED

STORAGE SHED

SUBMERSIBLE INFLUENT PUMP STATION AND FINE MECHANICAL SCREENS

NEUTRALIZATION TANK

RAW SEWAGE INFLUENT STRUCTURE

VACTOR DUMP STATION

NEUTRALIZATION BUILDING

EFFLUENT METERING WEIR

CHLORINE CONTACT TANK

PLANT WATER PUMPING STRUCTURE

REAERATION TANKS

AEROBIC DIGESTION TANKS

ODOR CONTROL

SLUDGE THICKENING TANK NO. 1

SLUDGE THICKENING TANK NO. 2

COVERED PARKING

ASPHALT

WAREHOUSE

COVERED STORAGE

DPR AND HYPOCHLORITE BUILDING

FILTER BACKWASH HOLDING TANK

FILTERS

SLUDGE HANDLING BUILDING

KELLER RD

PORTABLE BUILDING

FUEL/TANK

COVERED STORAGE

AUTOMATIC ACCESS CONTROL GATE

GENERATOR AND POWER DISTRIBUTION BUILDING

HEADCELL (GRIT REMOVAL)

BLOWER BUILDING

EQUIPMENT STORAGE BUILDING

OPERATIONS BUILDING

CHEMICAL HANDLING FACILITY

RELOCATE CHEMICAL FEED FACILITY- PHASE I

RAS PUMP STATION

DEMOLISH SECONDARY SETTLING TANKS- PHASE I (SEE DEMOLITION PLAN)

ANOXIC TANK NO. 1

NITRIFICATION TANK NO. 1

ANOXIC TANK NO. 2

NITRIFICATION TANK NO. 2

SECONDARY SETTLING TANK NO. 1A

SECONDARY SETTLING TANK NO. 1B

SECONDARY SETTLING TANK NO. 1C

FLOCCULATION MIX TANKS

SECONDARY SETTLING TANK NO. 2A

SECONDARY SETTLING TANK NO. 2B

SECONDARY SETTLING TANK NO. 2C

COVERED CONCRETE

DEMOLISH INTERNAL WALLS AND EQUIPMENT-PHASE II (SEE DEMOLITION PLAN)

GATEWAY DR

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CLIENT: CITY OF ALTAMONTE SPRINGS

PROJECT: REGIONAL WATER RECLAMATION FACILITY

SHEET TITLE: EXISTING SITE -PHASE I AND PHASE II DEMOLITION PLAN

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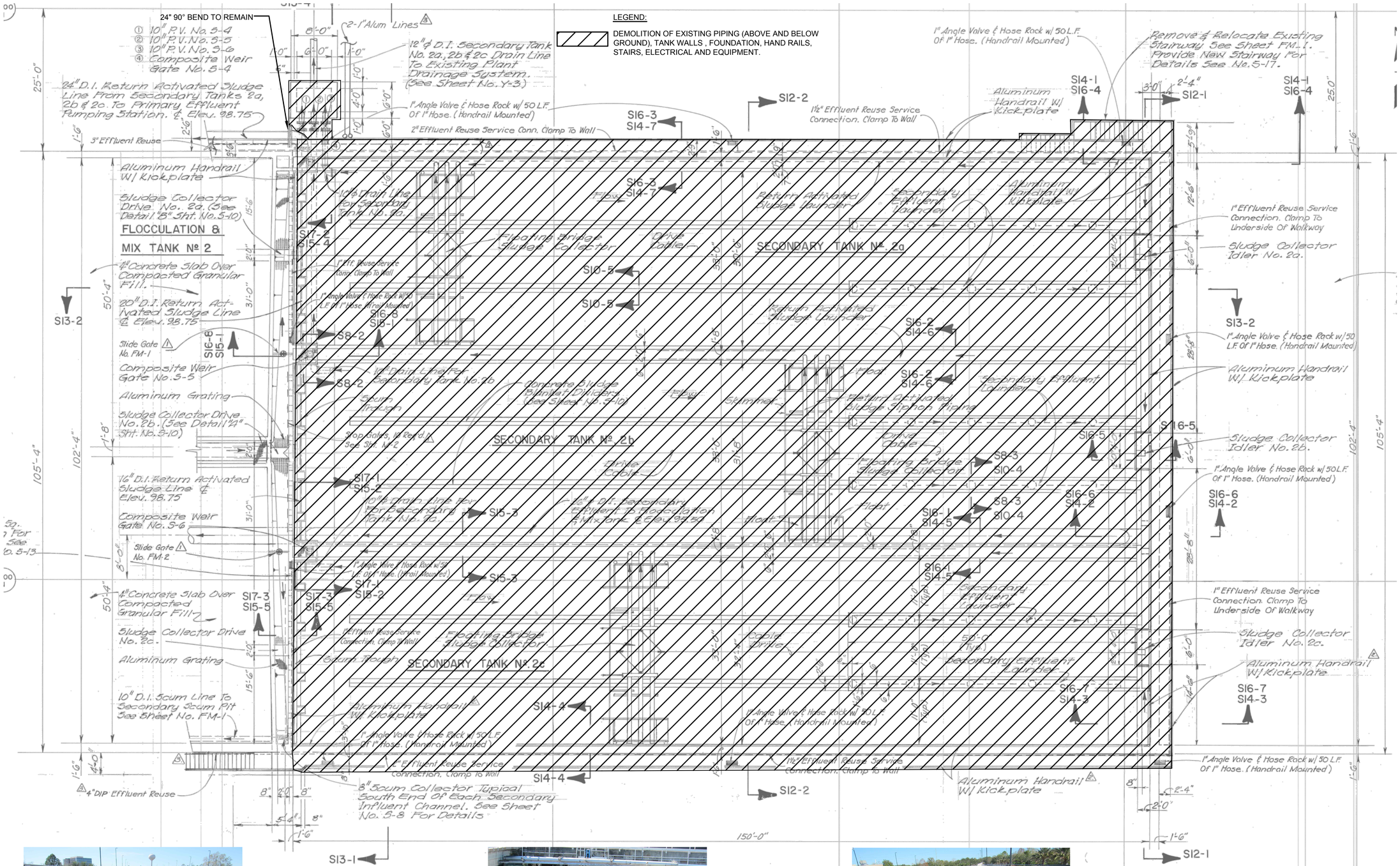
FIG. 3-3

PLOT DATE: Mar 13, 2017 - 5:21pm
FILE NAME: C:\Users\gyuri.1991\appdata\local\temp\AcPublish_13972\02_EXISTING_OVERALL_SITE_PLAN_DEMOLITION.dwg




SECONDARY CLARIFIER 1c (1a AND 1b SIMILAR)

SECONDARY CLARIFIER 1c LOOKING WEST
EFFLUENT LAUNDER BLOW-UP

SECONDARY CLARIFIER 1c LOOKING EAST
FLOATING BRIDGE SLUDGE COLLECTOR BLOW-UP

LEGEND:

DEMOLITION OF EXISTING PIPING (ABOVE AND BELOW GROUND), TANK WALLS , FOUNDATION, HAND RAILS, STAIRS, ELECTRICAL AND EQUIPMENT.

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PROJECT: REGIONAL WATER RECLAMATION FACILITY

SHEET TITLE: SECONDARY CLARIFIERS No. 2 a, 2 b and 2 c DEMOLITION PLAN- PHASE I

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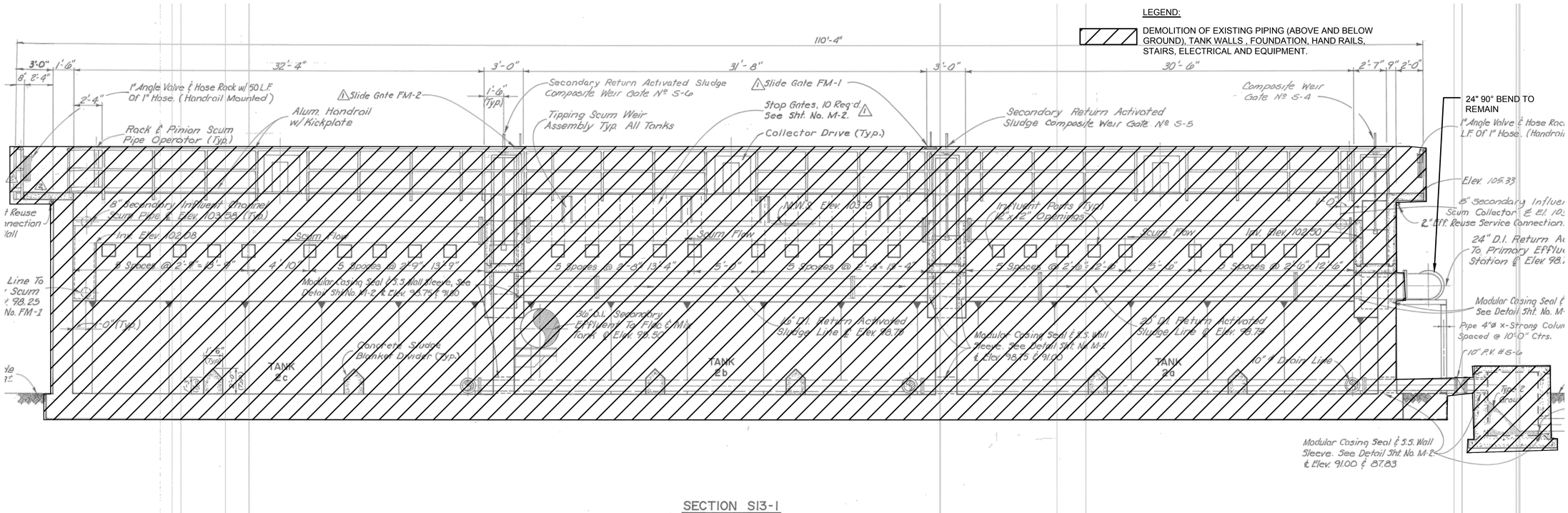
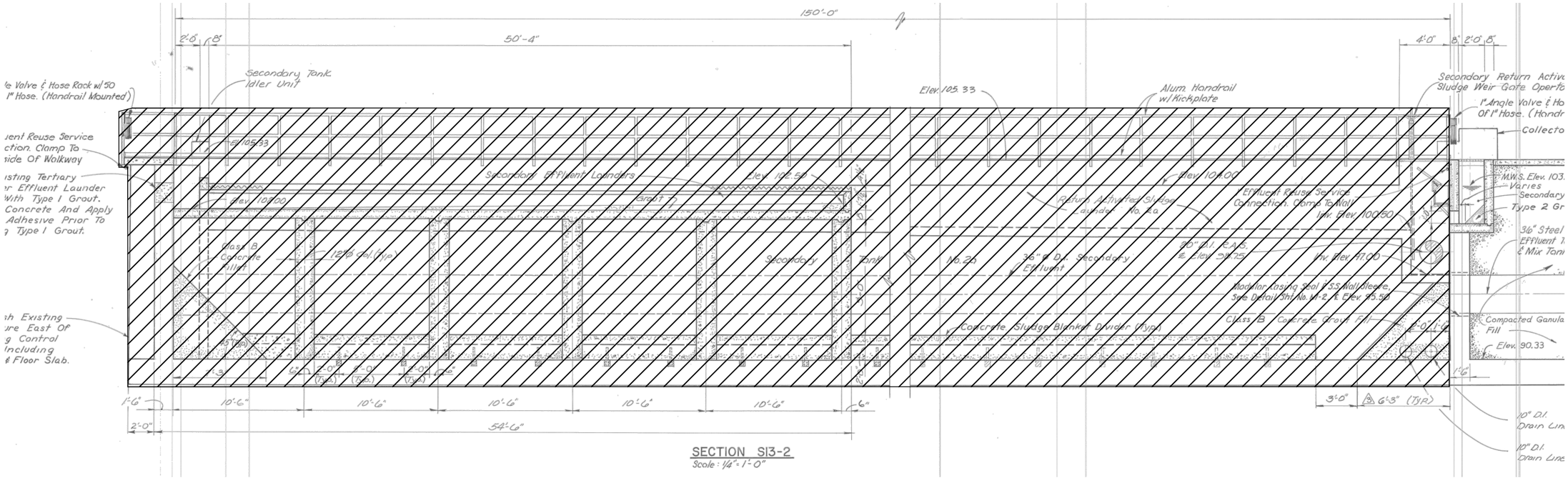
FIG. 3-4

PLOT DATE: Mar 13, 2017 - 5:24pm
FILE NAME: C:\Users\gord.fish\appdata\local\temp\AcPublish_13872\02_Existing Secondary Clarifier Tank No 2a 2b 2c_Demolition plan_Phase I.dwg




SECTION S13-1
Scale: 1/4"=1'-0"




SECTION S13-2
Scale: 1/4"=1'-0"

PLOT DATE: Mar 13, 2017 - 1:45pm
FILENAME: C:\Users\gcox1391\appdata\local\temp\AcPublish_13972\04_Existing Secondary Clarifier Tank No 2a 2b 2c sections_Demolition_Phase I.dwg

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CLIENT: CITY OF ALTAMONTE SPRINGS

PROJECT: REGIONAL WATER RECLAMATION FACILITY

SHEET TITLE: SECONDARY CLARIFIERS 2a 2b 2c SECTIONS-DEMOLITION PHASE I

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FIG. 3-5

NORTH

0 40 80

GRAPHIC SCALE
SCALE: 1" = 40'-0"

AUTOMATIC ACCESS CONTROL GATE

EFFLUENT HOLDING TANK

RECLAIMED WATER STORAGE TANK

RECLAIMED WATER STORAGE TANK

REUSE PUMP AND OFFICE BUILDING

LAB

MAINTENANCE BUILDING

STORAGE SHED

STORAGE SHED

SUBMERSIBLE INFLUENT PUMP STATION AND FINE MECHANICAL SCREENS

NEUTRALIZATION TANK

RAW SEWAGE INFLUENT STRUCTURE

VACTOR DUMP STATION

NEUTRALIZATION BUILDING

EFFLUENT METERING WEIR

PLANT WATER PUMPING STRUCTURE

REAERATION TANKS

CHLORINE CONTACT TANK

AEROBIC DIGESTION TANKS

ODOR CONTROL

COVERED PARKING

ASPHALT

WAREHOUSE

COVERED STORAGE

DPR AND HYPOCHLORITE BUILDING

FILTER BACKWASH HOLDING TANK

FILTERS

SLUDGE HANDLING BUILDING

SLUDGE THICKENING TANK NO. 1

SLUDGE THICKENING TANK NO. 2

KELLER RD

PORTABLE BUILDING

FUEL/TANK

COVERED STORAGE

AUTOMATIC ACCESS CONTROL GATE

GENERATOR AND POWER DISTRIBUTION BUILDING

HEADCELL (GRIT REMOVAL)

RELOCATED CHEMICAL HANDLING FACILITY

BLOWER BUILDING

EQUIPMENT STORAGE BUILDING

OPERATIONS BUILDING

RAS PUMP STATION

RE-AERATION TANK NO.1

SECONDARY CLARIFIER NO. 1

FUTURE SECONDARY CLARIFIER NO. 3

FLOW SPLITTER BOX

SLUDGE COLLECTION BOX

1st ANOXIC TANK NO. 1

NITRIFICATION TANK NO. 1

2nd ANOXIC TANK NO.1

EXISTING SECONDARY CLARIFIER 1a

EXISTING SECONDARY CLARIFIER 1b

EXISTING SECONDARY CLARIFIER 1c

SECONDARY CLARIFIER NO. 2

FUTURE SECONDARY CLARIFIER NO. 4

1st ANOXIC TANK NO. 2

NITRIFICATION TANK NO. 2

2nd ANOXIC TANK NO.2

RE-AERATION TANK NO.2

COVERED CONCRETE

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CLIENT: CITY OF ALTAMONTE SPRINGS

PROJECT: REGIONAL WATER RECLAMATION FACILITY
PHASE I PLANT IMPROVEMENTS

SHEET TITLE: PROPOSED PHASE I MODIFICATIONS
OVERALL SITE PLAN


ATKINS

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PLOT DATE: Sep 28, 2017 - 1:25pm
FILE NAME: c:\Users\gary.k.191\appdata\temp\AcPublish_15084\C-5_PROPOSED_Phase I_OVERALL_SITE_PLAN.dwg

Table 3 1 summarizes the predicted performance of 4-stage Bardenpho Process configuration at 20 and 30 °C including necessary addition of external Carbon source and Alum.

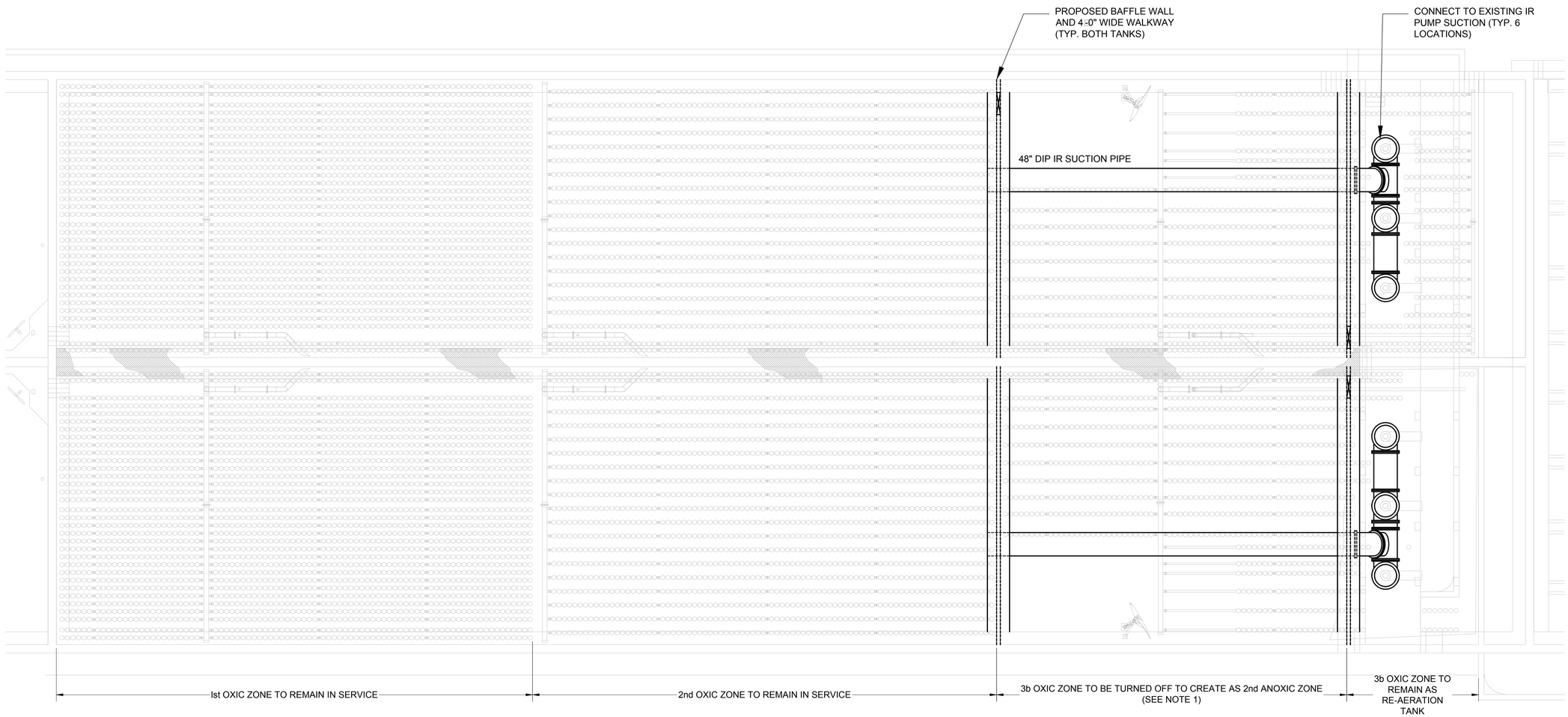
Table 3-1. Model Predicted Performance – Phase I

| Process Parameters | 20°C | 30°C |
|---|---|---|
| Influent Flow (mgd) (two trains), Q | 9.00 | 9.00 |
| MLSS (mg/L) | 3500 | 3500 |
| IR (mgd), 4.5Q | 40.50 | 40.50 |
| SRT (days) | 9.98 | 10.57 |
| RAS (mgd) | 5.40 | 5.40 |
| WAS (mgd) | 0.56 | 0.52 |
| VSS/TSS | 0.67 | 0.65 |
| Yield (lb TSS/lb BOD) | 0.91 | 0.86 |
| Anoxic Volume (MG) | 0.67 | 0.67 |
| Aeration Volume (MG) | 1.02 | 1.02 |
| Post-Anoxic Volume (MG) | 0.41 | 0.41 |
| Re-Aeration Volume (MG) | 0.09 | 0.09 |
| Effluent $NH_3$ (mg N/L) | 0.35 | 0.15 |
| Effluent $NO_3$ (mg N/L) | 0.58 | 0.92 |
| Effluent $NO_2$ (mg N/L) | 0..32 | 0.08 |
| Effluent TKN (mg N/L) | 1.77 | 1.54 |
| Effluent TN (mg N/L) | 2.95 | 2.78 |
| Effluent TP (mg P/L) | 0.74 | 1.0 |
| Effluent BOD, TSS (mg/L) | <5 | <5 |
| Methanol dosage to reduce TN to <3 mg/L (gpd) | 104 | 74 |
| Alum (metal) dosage to reduce TP to <1 mg/L (gpd) | 200 | 358 |

The storage volume for 30-day feed requirement will require about 3,120-gallon storage tank for methanol and 10,750-gallon storage tank for alum. Neat methanol is stored in the tank which can be diluted to 20% using dilution water pumps to the feed point. Alternative carbon sources such as MicroC® will also be considered to mitigate safety concerns.

A 5-Stage Bardenpho process was evaluated for biological phosphorus (Bio-P) removal. However, chemical phosphorus removal was more effective at this plant due to the following considerations:

- At high temperature, the phosphorus accumulating organisms (PAOs) are characterised by relatively low reaction rate there by reducing the effective Bio-P accumulation.
- The PAOs compete with glycogen accumulating organisms and heterotrophic denitrifying organisms for readily biodegradable organic matter in the influent wastewater.




NOTES:

1. REMOVE AND PROPERLY STORE DIFFUSERS IN ZONE 3a THAT ARE IN CONFLICT WITH THE BAFFLE WALL AND 48" IR PUMP SUCTION PIPE.
2. REMOVE AND RE-INSTALL DIFFUSERS IN 2nd OXIC AND 3b OXIC ZONE THAT INTERFERES WITH NEW BAFFLE WALL.

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PROJECT: REGIONAL WATER RECLAMATION FACILITY

SHEET TITLE: PROPOSED PHASE I NITRIFICATION TANK MODIFICATION PLAN

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FIG. 3-7

PLOT DATE: Mar 13, 2017 - 1:57pm
FILE NAME: U:\WO\Projects\City of Altamonte Springs\ASR\WF Plant Expansion\5_Plans\Design\14_Proposed_Nitrification Tank Phase I modifications.dwg

The operation of a 4-stage Bardenpho process will be optimized by use of oxidation-reduction potential (ORP) sensors, ammonia ($NH_4$) and nitrate ($NO_3$) sensors. The purpose of these sensors is to provide a continuous feedback to the blowers by monitoring the ORP (equivalent to dissolved oxygen concentration) and the ammonia and nitrate concentration change in the reactor. This will be helpful to achieve a reliable and repeatable performance, hence are recommended to be included in the design. ORP sensors will be located at the end of the Pre-Anoxic and Aerobic Zones which control the amount of air added thereby controlling the nitrification and denitrification. The set-points on the ORP will be revised based on feedback information from the NH4 and NO3 sensors located at the end of the Aerobic Zone and at the end of Re-Aeration Zone.

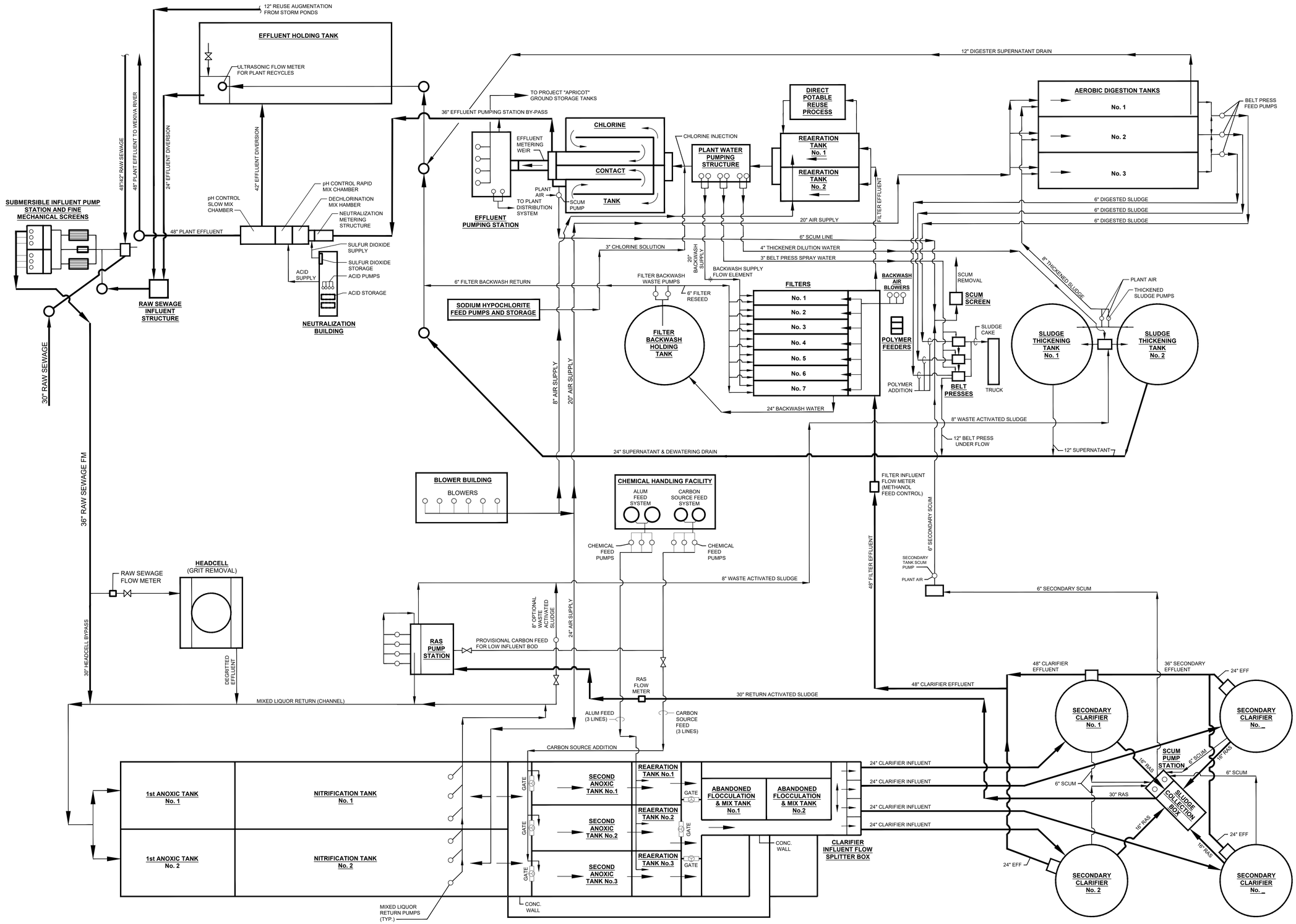
## 3.2 PROPOSED IMPROVEMENTS FOR PHASE II

For the required additional reactor volume to treat an average flow of 12.5 mgd, modeling iterations were performed by adding the anoxic and reaeration volumes required to meet the desired effluent criteria. Post anoxic and reaeration volumes will be provided by converting existing rectangular clarifiers 1a,1b and 1c. The effluent total phosphorus concentration is achieved using chemical precipitation using alum. The total reactor volume for each train provided is 2.96 MG. Each train of the existing MLE reactor is about 2.21 MG; additional reactor volume of about 0.75 MG will be provided by converting the existing rectangular clarifiers as mentioned previously. A process flow diagram for the modified Phase II process is illustrated in Figure 3-8. The reliability of the process configuration is largely dependent on the secondary clarifier performance. The existing secondary clarifiers at the ASRWRF are nearing the end of their useful life and will be demolished as illustrated in figures 3-9 and 3-10. An overall site layout showing the improvements associated with Phase II is shown in Figure 3-11.

As part of the Phase II improvements no additional modifications of the existing 1$^{st}$ anoxic tank and nitrification tank will be required. As the existing clarifiers are currently near end of their useful life, reusing them to provide additional reactor volume was evaluated. The post anoxic and re-aeration reactor volumes will be provided by modifying the existing secondary clarifiers. The modifications to the existing rectangular secondary clarifiers are shown in Figure 3-11.

In Phase II, 2nd set of the existing rectangular secondary clarifiers will be repurposed as 2nd anoxic and reaeration tanks and replaced with two new 90-foot-diamerter-circular secondary clarifiers to provide a total of four 90-foot-diameter clarifiers (two 90-foot-diameter-circular clarifiers will be added as part of Phase I). The new clarifiers are recommended to be equipped with a spiral scraper mechanism, covers over the effluent launder for algae control, density current baffles for more efficient performance and telescoping valves for controlled sludge withdrawal from each clarifier. All the telescoping valves will be located inside a common sludge box which will be connected to the RAS pump station currently under construction.

Class I Reliability: Upon completion of the Phase II improvements, there will be four 90-foot-diameter new clarifiers with 16-foot side water depth (SWD). Based on this the loading rates will be as follows:

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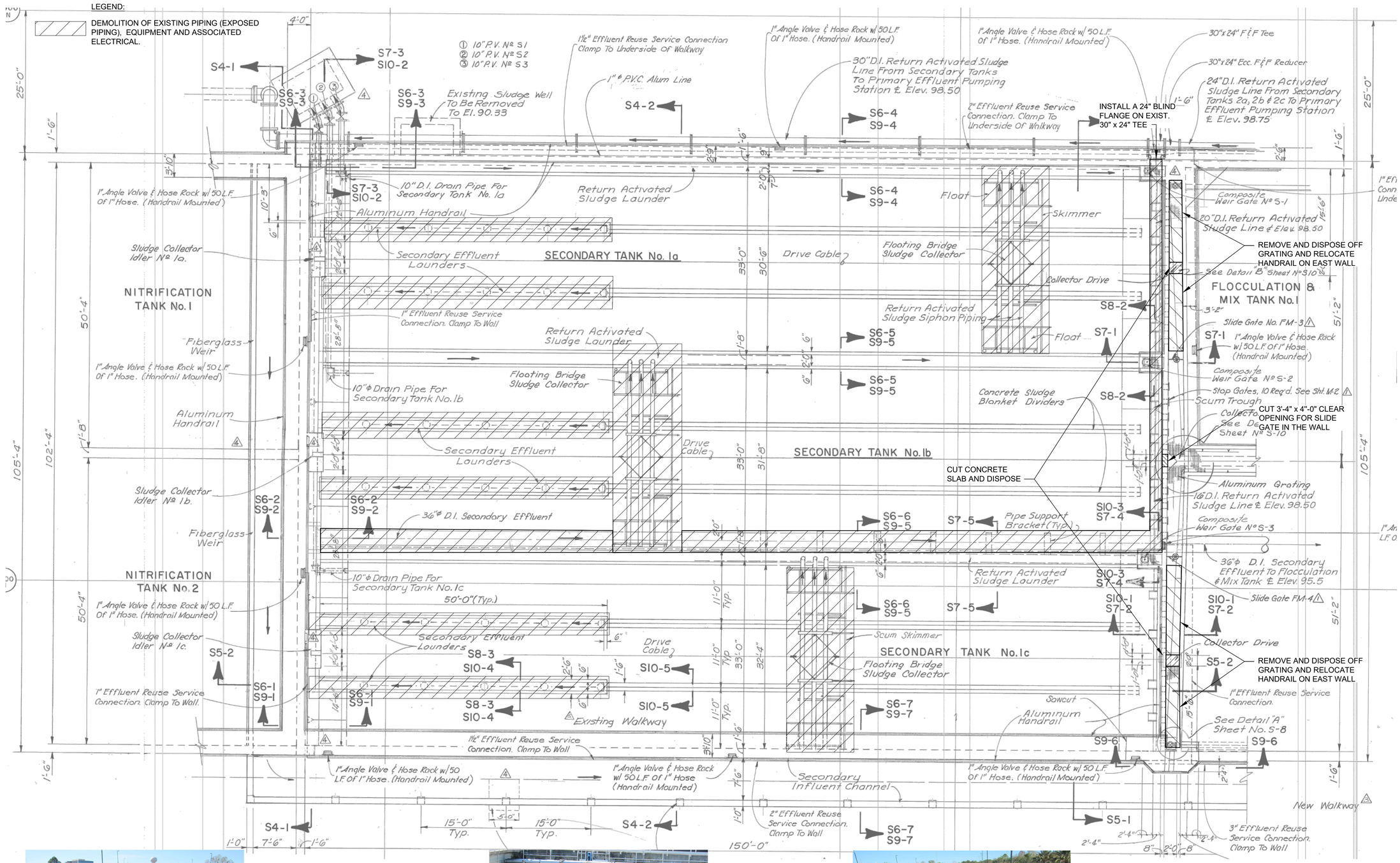
LEGEND:

DEMOLITION OF EXISTING PIPING (EXPOSED PIPING), EQUIPMENT AND ASSOCIATED ELECTRICAL.



SECONDARY CLARIFIER 1c (2a, 2b, 2c SIMILAR)

SECONDARY CLARIFIER 1c LOOKING WEST
EFFLUENT LAUNDER BLOW-UP (2a, 2b, 2c SIMILAR)

SECONDARY CLARIFIER 1c LOOKING EAST
FLOATING BRIDGE SLUDGE COLLECTOR BLOW-UP (2a, 2b, 2c SIMILAR)

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CLIENT: CITY OF ALTAMONTE SPRINGS

PROJECT: REGIONAL WATER RECLAMATION FACILITY
PHASE I PLANT IMPROVEMENTS

SHEET TITLE: SECONDARY CLARIFIERS NO. 1 a, 1 b and 1 c
DEMOLITION PLAN- PHASE II

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| APPROVED: | R.S. |
| SHEET NO. | FIG 3-9 |
| REV. | △ |

PLOT DATE: Aug 05, 2020 - 7:40pm
FILENAME: U:\WOP\Projects\City of Altamonte Springs\ASR\WRF Plant Expansion\15_Plant\Design\Phase I Drawings\C-7.dwg

LEGEND:

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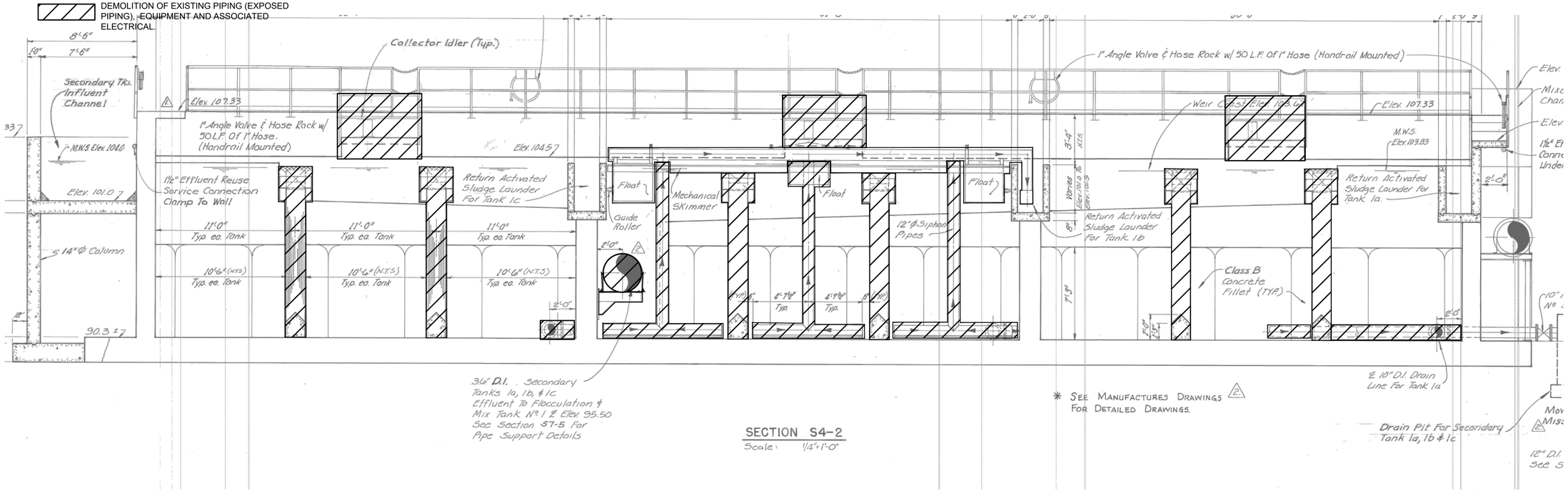
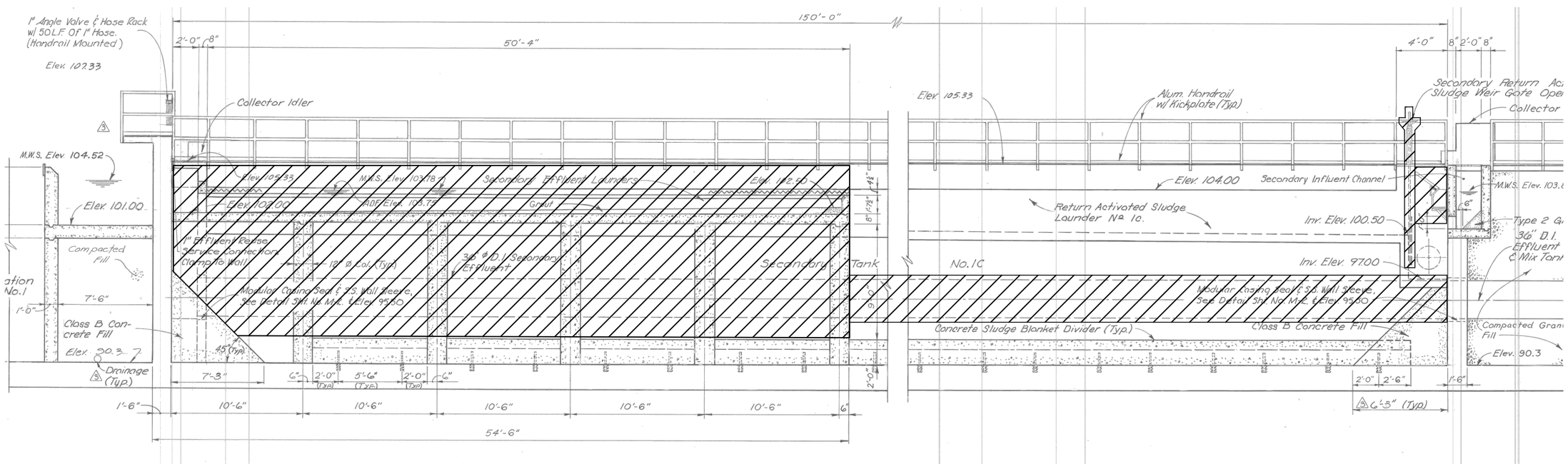



SECTION S4-2
Scale: 1/4"=1'-0"




PLOT DATE: Feb 12, 2020 - 1:48pm
FILE NAME: U:\WO\Projects\City of Altamonte Springs\ASR\WF Plant Expansion\15_Plant\Design\Phase I Drawings\C-8.dwg

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CLIENT: CITY OF ALTAMONTE SPRINGS

PROJECT: REGIONAL WATER RECLAMATION FACILITY PHASE I PLANT IMPROVEMENTS

SHEET TITLE: SECONDARY CLARIFIERS 1a 1b 1c SECTIONS-DEMOLITION PHASE II


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| APPROVED: | R.S. |
| SHEET NO: | FIG 3-10 |
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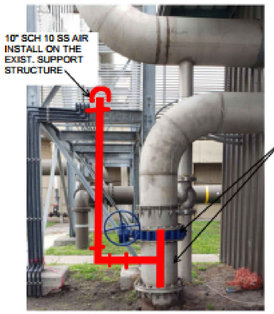


10" REAERATION AIR SUPPLY CONNECTION DETAIL 1 C-6

AUTOMATIC ACCESS CONTROL GATE

EFFLUENT HOLDING TANK

RECLAIMED WATER STORAGE TANK

RECLAIMED WATER STORAGE TANK

REUSE PUMP AND OFFICE BUILDING

LAB

MAINTENANCE BUILDING

STORAGE SHED

STORAGE SHED

NORTH

APPARENT RIGHT OF-WAY

0 40 80

GRAPHIC SCALE
SCALE: 1" = 40'-0"

EX. GATE

ELEC.

ODOR CONTROL

EX. 8" WM

SUBMERSIBLE INFLUENT PUMP STATION AND FINE MECHANICAL SCREENS

NEUTRALIZATION TANK

RAW SEWAGE INFLUENT STRUCTURE

VACTOR DUMP STATION

NEUTRALIZATION BUILDING

EX. 8" WM

EFFLUENT METERING WEIR

CHLORINE CONTACT TANK

PLANT WATER PUMPING STRUCTURE

REAERATION TANKS

AEROBIC DIGESTION TANKS

COVERED PARKING

ASPHALT

WAREHOUSE

ASPHALT

COVERED STORAGE

ASPHALT

REMOVE PLUG ON EX. 8" PW AND CONNECT

8" MJ DIP CAP OR PLUG

EX. 8" WM

EX. SAN

8" 90° MJ DIP TEE (RJ)

8" MJ GATE VALVE W/VALVE BOX

DPR AND HYPOCHLORITE BUILDING

FILTER BACKWASH HOLDING TANK

FILTERS

SLUDGE HANDLING BUILDING

ODOR CONTROL

SLUDGE THICKENING TANK NO. 1

SLUDGE THICKENING TANK NO. 2

EX. FENCE

EX. R/W

KELLER RD

AUTOMATIC ACCESS CONTROL GATE

INSTALL FIXED FENCE PANEL TO MATCH GATE

NEW FENCE POST WITH GATE GUIDE (RELOCATE EXIST.)

RELOCATE EXIST. AUTOMATIC ACCESS CONTROL GATE AND OPERATOR

NEW BLOCK WALL

GATE IN OPEN POSITION

DEMOLISH EXIST. 8' HIGH BLOCK WALL AND INSTALL NEW BLOCK WALL

3'-0"

TAPPING SADDLE

EXISTING FIXED POST TO REMAIN

EX. WALL

EX. RWM LINE

WWTP ENTRANCE ROAD

EX. SAN MH

RELOCATED CHEMICAL HANDLING FACILITY

1 - REMOVE 6" PLUG
1 - INSTALL 8" x 6" REDUCER (RJ)

1 - 6" x 6" TAPPING SADDLE W/VALVE

8" PW

20" AIR (EXIST. SS) SEE CONNECTION DETAIL 1 SHEET C-6.

BLOWER BUILDING
CHEMICAL LINES - SUPPORT FROM EX. BRIDGE

ALUM.

CARBON

EQUIPMENT STORAGE BUILDING

ELEC. TRANS.

OPERATIONS BUILDING

EX. 6" PW

MH

FH ASSEMBLY

EX. 24" CONC. SAN

RAS PUMP STATION

10" SCH. 10 SS AIR - INSTALL ON THE WALL WITH SUPPORTS EVERY 10'-0"

3" SCH. 10 SS CA - INSTALL ON THE WALL WITH SUPPORTS EVERY 10'-0"

RELOCATE EXISTING IRRIGATION CONTROLLER

SECONDARY CLARIFIER NO. 1

SECONDARY CLARIFIER NO. 3

SECONDARY CLARIFIER NO. 2

SECONDARY CLARIFIER NO. 4

SLUDGE COLLECTION BOX

FLOW SPLITTER BOX

INSTALL A 4" 90° BEND AND 4" x 3" RED. AND CONNECT NEW 3" SCH. 10 SS-CA

FENCE

EX. FENCE

EX. R/W

HEADCELL (GRIT REMOVAL)

PORTABLE BUILDING

FUEL TANK

COVERED STORAGE

GENERATOR AND POWER DISTRIBUTION BUILDING

ASPHALT

1st ANOXIC TANK NO. 1

NITRIFICATION TANK NO. 1

1st ANOXIC TANK NO. 2

NITRIFICATION TANK NO. 2

SECOND ANOXIC TANK No.1

SECOND ANOXIC TANK No.2

SECOND ANOXIC TANK No.3

RE-AERATION TANK

RE-AERATION TANK

STAIRS

FLOCULATION AND MIX TANKS

COVERED CONCRETE

EX. R/W

FENCE

SEE SHEET M-3

GATEWAY DR

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CLIENT: CITY OF ALTAMONTE SPRINGS

PROJECT: REGIONAL WATER RECLAMATION FACILITY
PHASE I PLANT IMPROVEMENTS

SHEET TITLE: PROPOSED PHASE I/II MODIFICATIONS
OVERALL YARD PIPING PLAN

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PLOT DATE: Sep 20, 2020 - 8:09pm
FILE NAME: U:\WP\Projects\City of Altamonte Springs\ASRWRF Plant Expansion\15_Plans\Design\Phase I Drawings\C-6.dwg,dwg

30'-0"

EXISTING CONCRETE WALKWAY

INSIDE SURFACE
OF EXISTING WALL

DOWNWARD
OPENING
SLIDE GATE

SECOND ANOXIC TANK No.1

33'-1"

RE-AERATION TANK

SEE PARTIAL PLAN "A"
SHEET M-14

EXISTING GATE TO REMAIN

C
M-15

EXISTING WALL

DOWNWARD
OPENING
SLIDE GATE

BLOCK (10) EXISTING 12"x12"
OPENINGS IN THIS TANK

SECOND ANOXIC TANK No.2

33'-2"

RE-AERATION TANK

CONCTETE
CLOSURE WALL

EXISTING WALL

EXISTING GATE TO REMAIN

SECOND ANOXIC TANK No.3

DOWNWARD
OPENING
SLIDE GATE

33'-1"

RE-AERATION TANK

INSIDE SURFACE
OF EXISTING WALL

CONCTETE
CLOSURE WALL

A
M-15

CORE DRILL CHANNEL FLOOR
TO DRAIN RAIN WATER
(TYP. 2 LOCATIONS).

B
M-15

CORE DRILL CHANNEL FLOOR
TO DRAIN RAIN WATER
(TYP. 2 LOCATIONS).

# PLAN

SCALE: 1/8"=1'-0"

NORTH

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- At the current permitted average daily flow (ADF) capacity of 12.5 mgd the loading rates will be 491 gpd/ft$^2$ at ADF and 982 gpd/ft$^2$ at peak flow.
- With the largest unit out of service, i.e., 1-90' out of service (3-90' in service, flow =75% of peak flow of 25 MGD peak flow)), the loading rate for class I reliability will be 982 gpd/ft$^2$, which is well within typical range of 800–1,000 gpd/ft$^2$ for peak flow conditions.
- The new clarifiers will be equipped with density current baffles for enhanced performance and the 16-ft SWD would allow higher than typical loading rates.

The model application was developed to determine the ability of the biological process for achieving the targeted nutrient removal. It was observed, the total nitrogen values in the secondary effluent predicted by the model slightly exceed the 3 mg/L criteria and total phosphorus effluent criteria of 1 mg/L. The reason for increase in the effluent TN could be variation in the refractory organic nitrogen in the influent and the role of influent BOD in the denitrification of $NO_x$. The observed BOD/TKN ratio is less than the normal. Model simulations were developed to determine the external carbon source dosage to reduce the TN to the effluent goal of 3 mg/L and alum dosage to meet effluent TP goal of 1 mg/L as presented in Table 3-2.

Table 3-2 summarizes the predicted performance of 4-stage Bardenpho Process configuration at 20 and 30 °C including necessary addition of external Carbon source and Alum.

Table 3-2. Model Predicted Performance – Phase II

| Process Parameters | 20°C | 30°C |
|---|---|---|
| Influent Flow (mgd) (two trains), Q | 12.5 | 12.5 |
| MLSS (mg/L) | 3,690 | 3,960 |
| IR (mgd), 4.5Q | 56.25 | 56.25 |
| SRT (days) | 8 | 9 |
| RAS (mgd) | 8.75 | 8.75 |
| WAS (mgd) | 0.74 | 0.66 |
| VSS/TSS | 0.62 | 0.60 |
| Yield (lb TSS/lb BOD) | 0.93 | 0.89 |
| Anoxic Volume (MG) | 1.36 | 1.36 |
| Aeration Volume (MG) | 3.08 | 3.08 |
| Post-Anoxic Volume (MG) | 1.2 | 1.2 |
| Re-Aeration Volume (MG) | 0.3 | 0.3 |
| Effluent $NH_3$ (mg N/L) | 0.34 | 0.2 |
| Effluent $NO_3$ (mg N/L) | 0.60 | 0.62 |
| Effluent $NO_2$ (mg N/L) | 0.10 | 0.04 |
| Effluent TKN (mg N/L) | 1.69 | 1.54 |
| Effluent TN (mg N/L) | 2.80 | 2.60 |
| Effluent TP (mg P/L) | 0.98 | 0.96 |
| Effluent BOD (mg/L) | <5 | <5 |
| Effluent TSS (mg/L) | 8.9 | 9.2 |

| Process Parameters | 20°C | 30°C |
|---|---|---|
| MicroC™ dosage to reduce TN to <3 mg/L (gpd) | 160 | 200 |
| Alum (metal) dosage to reduce TP to <1 mg/L (gpd) | 1,300 | 1,480 |

*Biowin 6.2 used for June 2022 Revisions

The storage volume for a 30-day feed requirement of MicroC™ will be about 6,000 gallons at the buildout capacity of 12.5 MGD, which will be provided by using two stainless steel tanks each with a capacity of 5000 gallons. Two storage tanks with a nominal capacity of 6,100-gallon each will provide over 8 days of storage for alum at the buildout capacity of 12.5 MGD.

# 4.0 HYDRAULIC PROFILE

The hydraulic profile throughout the liquid process treatment unit processes was developed. A detailed hydraulic profile showing the water surface elevation at the peak influent flow is shown if Figures 4-1 through 4-3.

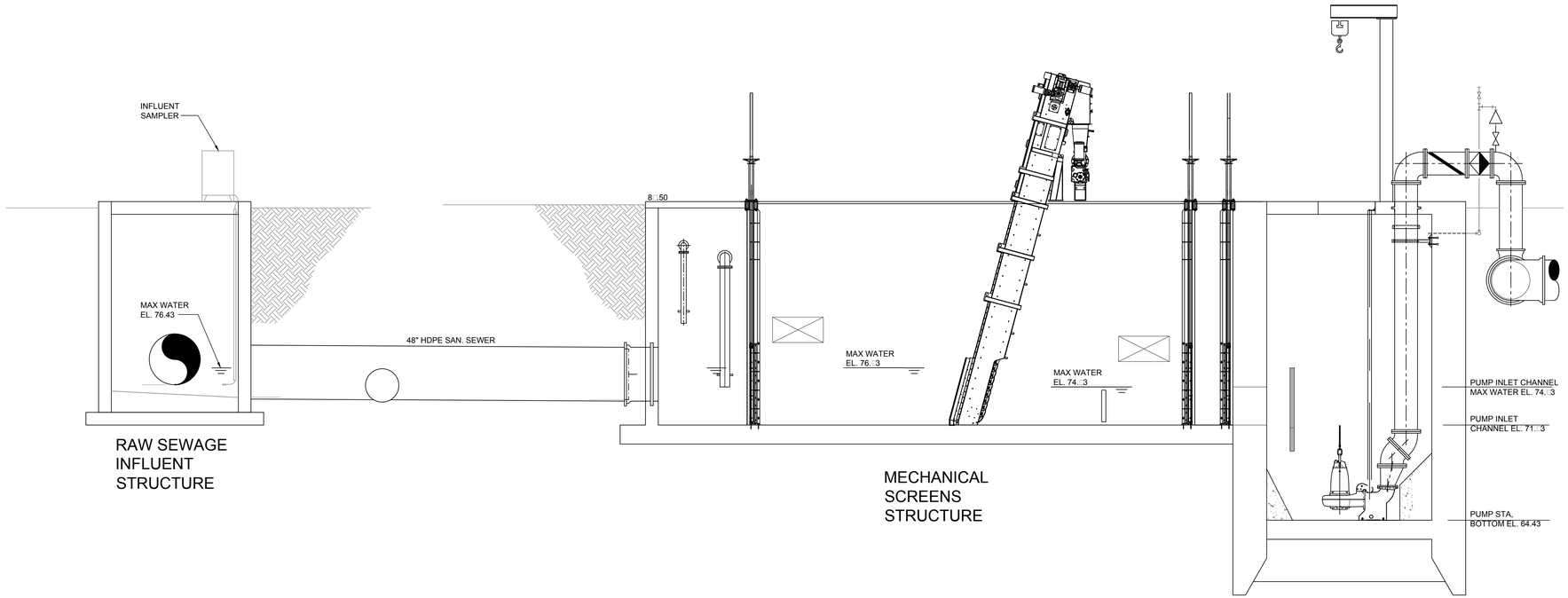


FIG. 4-1

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PROJECT: REGIONAL WATER RECLAMATION FACILITY

SHEET TITLE: PROCESS HYDRAULIC PROFILE- SHEET 1

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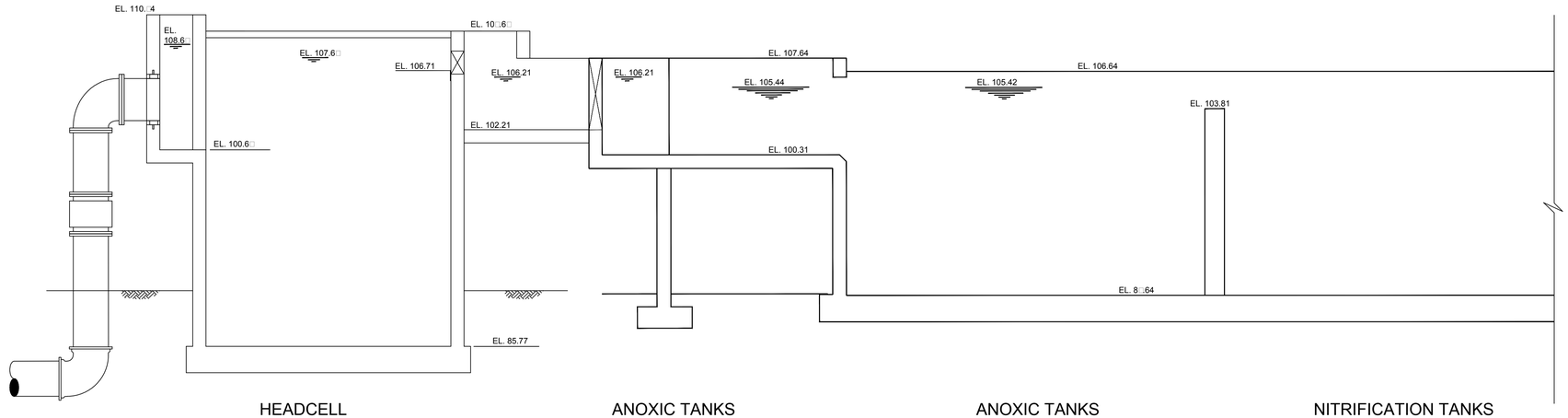
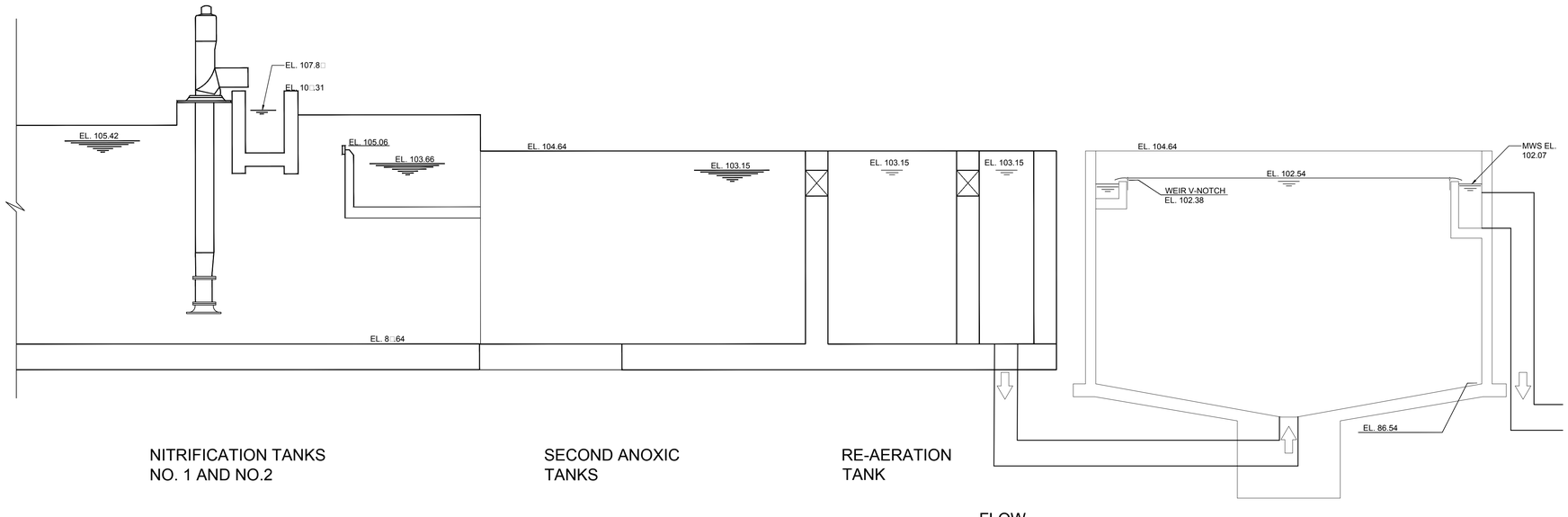
PLOT DATE: Mar 08, 2017 - 6:15pm
FILE NAME: C:\Users\gcox1391\appdata\local\temp\AcPublish_14524\11_Proposed_Process Hydraulic Profile.dwg

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PROJECT: REGIONAL WATER RECLAMATION FACILITY

SHEET TITLE: PROPOSED PROCESS HYDRAULIC PROFILE-SHEET 2

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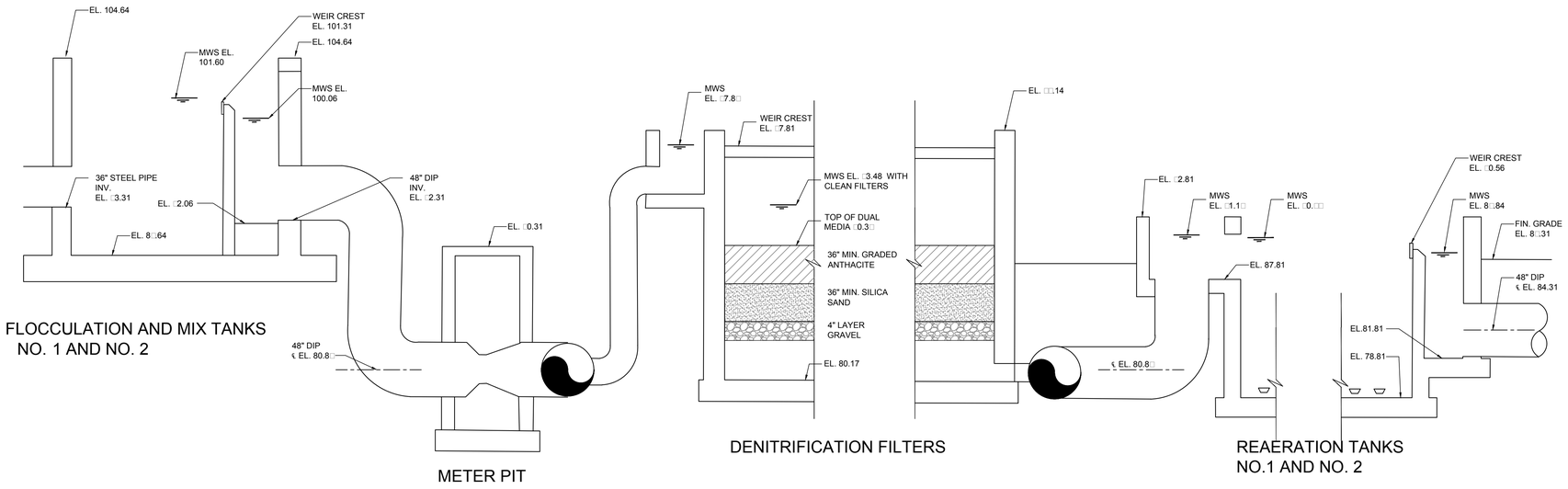
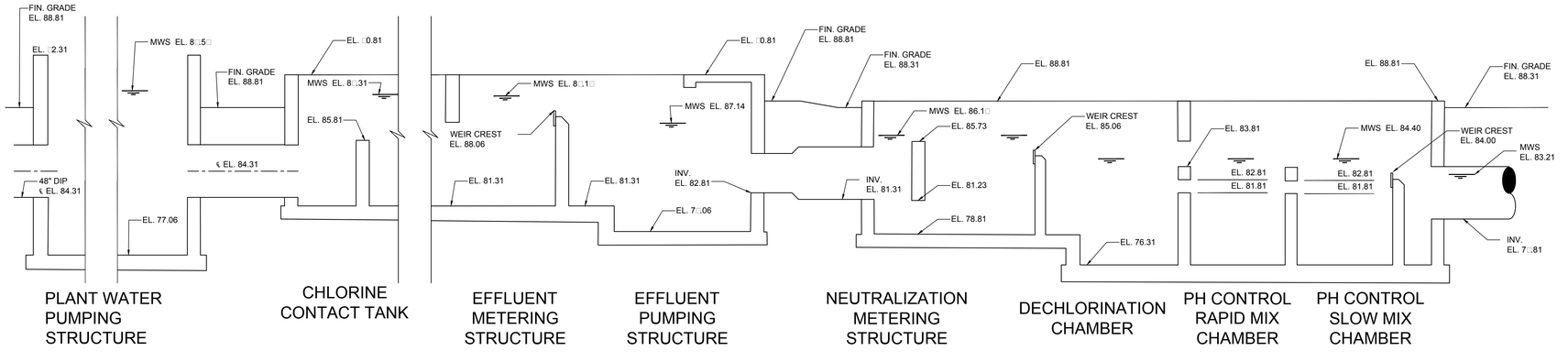
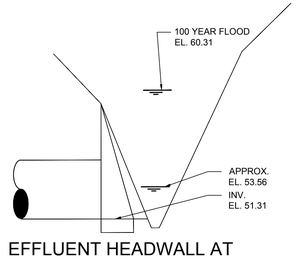
| JOB NO.: | 100046130 |
| PROJECT ENG: | R.S. |
| DRAWN: | G.G. |
| CHECKED: | R.S. |
| APPROVED: | R.S. |
| SHEET NO. | REV. |

FIG. 4-2

PLOT DATE: Mar 08, 2017 - 6:16pm
FILE NAME: C:\Users\grace1391\appdata\local\temp\AcPublish_14324\12_Proposed_Process Hydraulic Profile.dwg




EFFLUENT HEADWALL AT
LITTLE WEKIVA RIVER

PLOT DATE: Mar 08, 2017 - 6:17pm
FILE NAME: U:\WO\Projects\City of Altamonte Springs\ASR\WF Plant Expansion\15_Plant\Design\13_Proposed_Process Hydraulic Profile.dwg

| REV | DATE | ISSUED FOR |
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RAJ SINGH, P.E.
FLORIDA REG. NO.41210

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CLIENT: CITY OF ALTAMONTE SPRINGS

PROJECT: REGIONAL WATER RECLAMATION FACILITY

SHEET TITLE: PROCESS HYDRAULIC PROFILE-SHEET 3

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FIG. 4-3

# 5.0 COST OPINION

A preliminary opinion of probable construction cost for the improvements to the aeration tanks to convert the existing MLE process configuration to a 4-stage Bardenpho process configuration for both Phase 1 (8.5 mgd) and Phase 2 (10.27 mgd) is presented in Tables 5-1 and 5-2. The estimate is based on budgetary vendor quotations for equipment and engineering judgement from experience on similar projects for unit prices. Costs are in 2017 dollars and carry a 20% contingency consistent with the level of detail available at this stage of project development.

Table 5-1. Preliminary Opinion of Probable Construction Cost – Phase I

| Item | Cost |
|---|---|
| **General Requirements** | |
| Mobilization, Demobilization, Environmental | $200,000 |
| **New Clarifiers** | |
| Demolition of Existing Clarifier 2a, 2b, and 2c Equipment and Structures | $150,000 |
| 2-New 90-ft diameter clarifiers | $2,200,000 |
| Channel Modification and Clarifiers Splitter Box with gates | $150,000 |
| Sludge Collection Box and telescoping valves | $100,000 |
| Influent, effluent and RAS Piping, Valves, and Appurtenances | $500,000 |
| **Nitrification Tanks Modifications** | |
| Baffle walls, walk way and rails for both tanks | $150,000 |
| Internal Recirculation Pumps Suction modifications | $150,000 |
| **Chemical Feed System Relocation** | |
| Chemical Feed System Relocation | $250,000 |
| **Miscellaneous** | |
| Site Work | $100,000.00 |
| ***Subtotal*** | $3,950,000 |
| Contractor's overhead, profit, insurance @ 15% | $592,500 |
| ***Subtotal*** | $4,542,500 |
| Contingencies @ 20% | $913,000 |
| ***Total Preliminary Construction Cost Opinion*** | **$5,455,500** |

Table 5-2. Preliminary Opinion of Probable Construction Cost – Phase II

| Item | Cost |
|---|---|
| **General Requirements** | |
| Mobilization, Demobilization, Environmental | $150,000 |
| **New Clarifiers** | |
| Demolition of Existing Clarifier 1a, 1b, and 1c Equipment and Structures | $100,000 |
| 2-New 90-ft diameter clarifiers | $2,200,000 |
| Influent, effluent and RAS Piping, Valves, and Appurtenances | $250,000 |
| **Nitrification Tanks Modifications** | |
| Reinstallation of diffusers etc. removed in Phase I | $25,000 |
| Internal Recirculation Pumps Suction pipe removal | $25,000 |
| **Clarifiers 1a, 1b and 1c Conversion to 2nd Anoxic and reaeration tanks** | |
| 2nd Anoxic tank wall, walkway etc. | $350,000 |
| Existing tanks rehab and coatings | $500,000 |
| **Miscellaneous** | |
| Site Work | $50,000 |
| ***Subtotal*** | $3,650,000 |
| Contractor's overhead, profit, insurance @ 15% | $547,500 |
| ***Subtotal*** | $4,197,500 |
| Contingencies @ 20% | $844,000 |
| ***Total Preliminary Construction Cost Opinion*** | **$5,041,500** |

# Appendix A
# Technical Memorandum | ASRWRF Process Evaluation

ATKINS
Member of the SNC-Lavalin Group

# Technical Memorandum

| | | | |
|---|---|---|---|
| **To:** | Raj Singh, PE | | |
| **From:** | Karthik Manchala, PE, PMP | **Email:** | Karthik.manchala@atkinsglobal.com |
| **Phone:** | 301-210-6800 | **Date:** | 11-10-2014 |
| **Ref:** | 100040698 | **cc:** | City of Altamonte Springs |
| **Subject:** | Altamonte Springs Regional Water Reclamation Facility – Process Evaluation | | |

## 1.1. Background

The Altamonte Springs Regional Water Reclamation Facility (ASRWRF) has a permitted wastewater treatment capacity of 12.5 million gallons per day (mgd) annual average daily flow (AADF). Existing treatment uses a Modified Ludzack Ettinger (MLE) process configuration (two-stage process; anoxic-denitrification/aerobic-nitrification), followed by secondary clarification, flocculation, denitrification, filtration, a chemical feed system, post aeration, chlorination, dechlorination/ neutralization. Effluent is beneficially reused for irrigation throughout the City limits.

Currently, the excess reclaimed water that cannot be reused is discharged to the Little Wekiva River (Outfall D-001 to the Little Wekiva River). Permitted River discharge effluent limit are: BOD-5 mg/l; TSS-20 mg/l; Nitrogen, N as nitrate- no max limit (1,092 lbs/yr); and phosphorous, P no max limit (312 lbs/yr). Similarly the reuse and land use application permitted discharge effluent limit are: BOD-20mg/l; TSS-5 mg/L; Nitrogen, N as 10 mg/l; and phosphorous, P no max limit. The City retained Atkins North America Inc. to perform a process evaluation to determine maximum capacity of the plant with existing tankage that will meet 5 mg/l (BOD); 5 mg/l (TSS); 3 mg/l (N); 1 mg/l (P) effluent quality and alternatively develop recommendations for upgrade to meet these effluent limits at a defined minimum flow level.

The purpose of this technical memorandum is to summarize the influent loading design criteria, review the calibrated process model outputs, and to identify potential alternatives for modifying the existing tanks to achieve the effluent quality for advanced treatment, and recommend a cost effective alternative which can reliably treat the wastewater to effluent design criteria.

## 1.2. Data Collection and Evaluation

A review of the existing information was performed. These documents include:

- *Discharge Monitoring Reports from April 2013 through August 2014.*
- *Special Sampling Data - May 2014 through June 2014.*
- *Altamonte Springs RWRF Aeration System Blower Replacement Project - Contract Documents* (June,2014)
- *Altamonte Springs RWRF Process Blower Evaluation - Technical Memorandum* (July 14,2014)

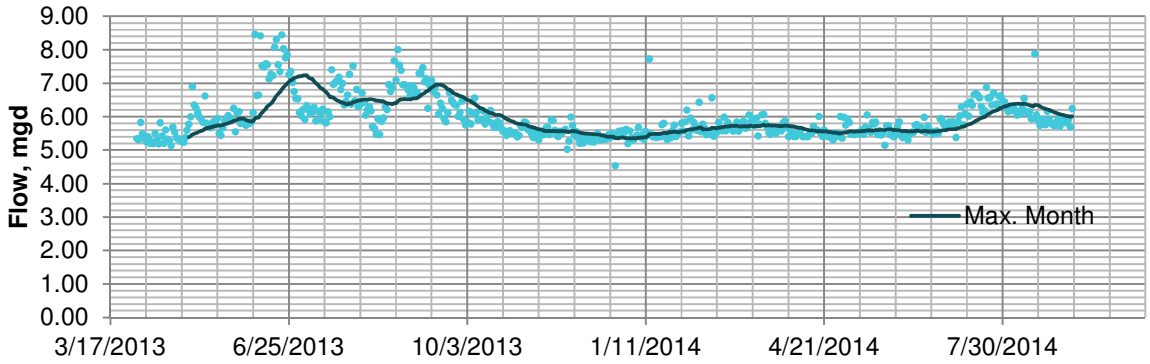
Data evaluation was conducted using moving average plots, which smooths out short-term fluctuations and highlights longer-term trends or cycles while providing an accurate representation of the true maximum month conditions. Hence the values from the plots are influenced by all data points. Likewise the average concentrations are determined by calculating an arithmetic mean of all concentrations within the considered time frame. The observed maximum month load is the maximum value on the 30-day rolling average curve within the considered time period.

### 1.2.1. Discharge Monitoring Reports Data Evaluation

Data Analysis was performed to identify trends of the raw water influent characteristics, including flow, biochemical oxygen demand (BOD), total suspended solids (TSS), and ammonia, total Kjeldahl nitrogen (TKN), and total phosphorus (TP).

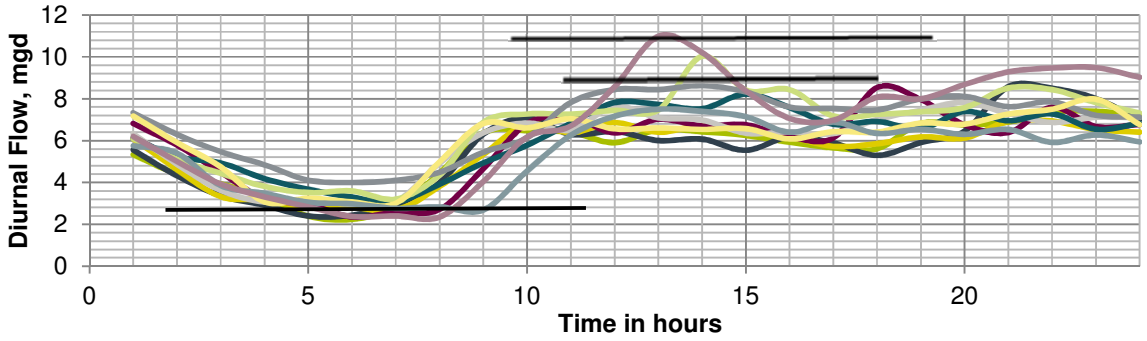
Although the plant is rated for a 12.5 mgd capacity, as shown in Figure 1, current maximum month flow is about 6.4 mgd. The average influent flow is about 5.9 mgd.

**Figure 1. Raw Influent Flow**



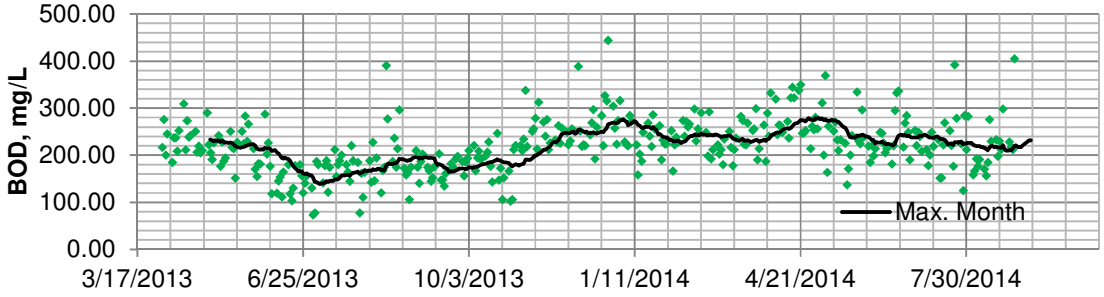

The diurnal flow variation was considered for time period of May 2013 through May 2014, to identify a potential impact of influent flow to the process reactors, as shown in Figure 2, the diurnal flow varied from 2 mgd to 11 mgd. It can be observed that maximum diurnal flow is about 8 mgd on a frequent basis.

**Figure 2. Raw Influent Flow Diurnal Curve**



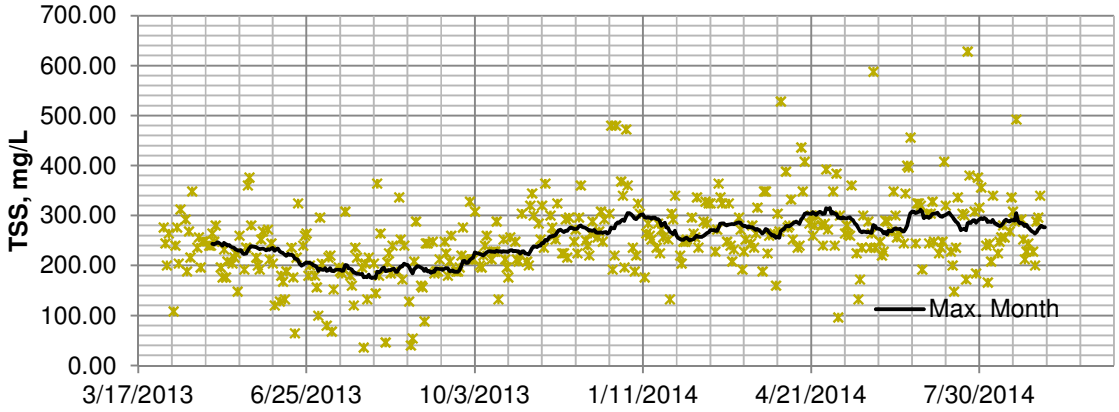

The raw influent BOD was consistent over the considered time frame of April 2013 through August 2014, as shown in Figure 3; the maximum month concentration is about 275 mg/L. The average BOD is about 220 mg/L. There is an increase in average BOD from 2013 to 2014, the average BOD in 2013 was about 210 mg/l whereas average BOD in 2014 was about 240 mg/L. The reason for such an increase is to be investigated further as the higher BOD will potentially enhance the plant performance by providing additional substrate for more efficient denitrification.

**Figure 3. Raw Influent BOD**



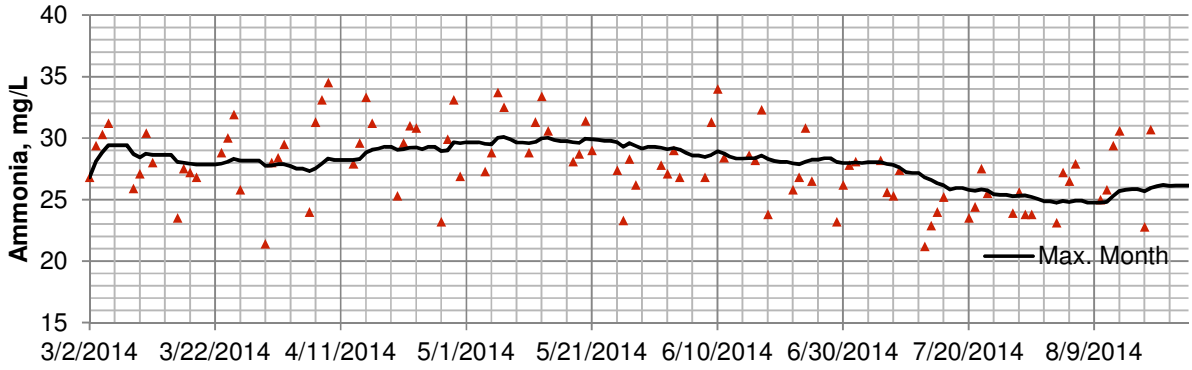
The raw influent TSS was consistent over the considered time frame of April 2013 through August 2014, as shown in Figure 4, the maximum month TSS is about 300 mg/L. The average TSS is about 253 mg/L. There is an increase in average TSS from 2013 to 2014, the average TSS in 2013 was about 227 mg/l where as average BOD in 2014 was about 281 mg/L. The reason for such an increase is to be investigated further.

**Figure 4. Raw Influent TSS**



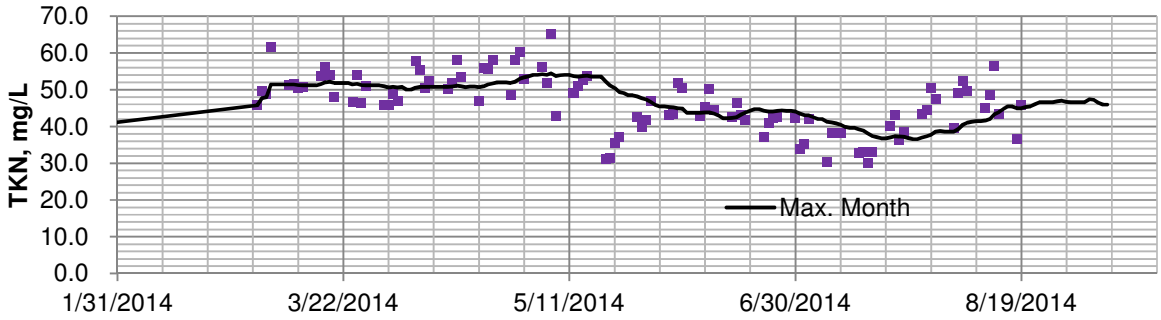

The raw influent ammonia was consistent over the considered time frame of March 2014 through August 2014, as shown in Figure 5; the maximum month ammonia is 30 mg/L. The average ammonia is about 28 mg/L. The influent ammonia has a direct correlation to the effluent nitrogen levels and the level of treatment required., The sampling for this parameter has been included recently in year 2014.

**Figure 5. Raw Influent Ammonia**



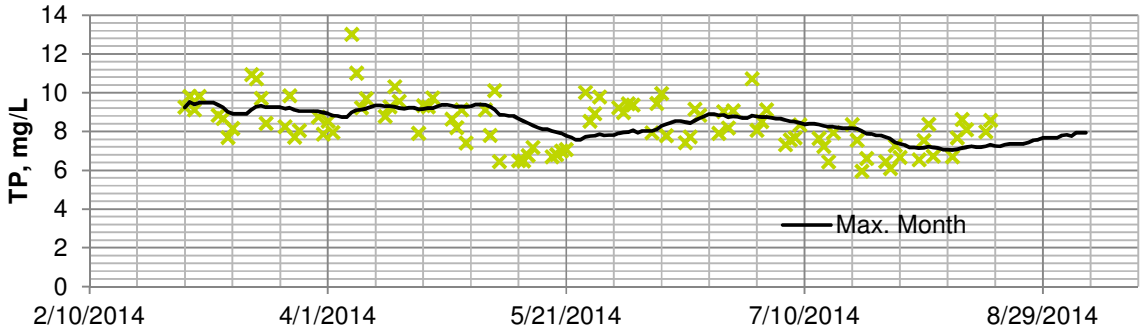

The raw influent TKN over the considered time frame of March 2014 through August 2014 is shown in Figure 5; the maximum month TKN is 52 mg/L. The average TKN is about 46 mg/L. Although there is slight decrease in influent TKN during July 2014, the maximum month TKN observed during April 2014 is considered for the design criteria. The sampling for this parameter has been included recently in year 2014.

**Figure 6. Raw Influent TKN**




The raw influent TP over the considered time frame of March 2014 through August 2014 is shown in Figure 5; the maximum month TP is 9.6 mg/L. The average TP is about 8.4 mg/L. Although there is slight decrease in influent TP during May and July 2014, the maximum month TP observed during March 2014 is considered for the design criteria. The sampling for this parameter has been included recently in year 2014.

**Figure 7. Raw Influent TP**




## 1.3. Design Criteria

Based on the data evaluation, the average and maximum month values for different influent characteristics were determined, Table 1 summarizes the recommended design criteria for the ASRWRF. It is assumed that the hydraulic peak and concentration peak do not occur simultaneously, therefore, average flow with a maximum month concentration was used to determine the maximum month loading.

**Table 1. Recommended Design Criteria for Altamonte Springs RWRF**

| Influent Parameter | Units | Average (AD) | Max. Month (MM) | Peaking Factor (MM/AD) |
|---|---|---|---|---|
| Flow | mgd | 5.93 | 6.4 | 1.08 |
| BOD | lb/d | **10,880** | **13,600** | |
| | mg/L | 220 | 275 | 1.25 |
| TSS | lb/d | **12,512** | **14,889** | |
| | mg/L | 253 | 300 | 1.19 |
| $NH_3$ | lb/d | **1,375** | **1,485** | |
| | mg/L | 27.8 | 30 | 1.08 |
| TKN | lb/d | **2,295** | **2,570** | |
| | mg/L | 46.4 | 52 | 1.12 |
| TP | lb/d | **415** | **473** | |
| | mg/L | 8.4 | 9.6 | 1.14 |

The above design criteria will be used to calibrate the existing MLE process reactors, and setup process models for proposed alternatives using BioWin 3 process modeling software.

### 1.3.1. Reactor Operating Conditions

The wastewater temperature and the mixed liquor concentration in the reactor is critical to the reactor performance, Figures 8 and 9 show the temperature and mixed liquor concentration in year 2014. The temperature varied from 23℃ to 30℃, with an average of 28℃. It is noted the temperature recording during September 2013? through January 2014 is not available which are typically the cold months. The mixed liquor concentration in the reactor varied from 2,500 mg/L to 5,000 mg/L with an average of 3,136 mg/L. Based on the observed data and discussion with the plant operations, the design criterion for temperature is selected to be minimum of 20℃ and maximum of 30℃. The design criteria for the operating mixed liquor concentration will be 3,200 mg/L.

**Figure 8. Wastewater Temperature**

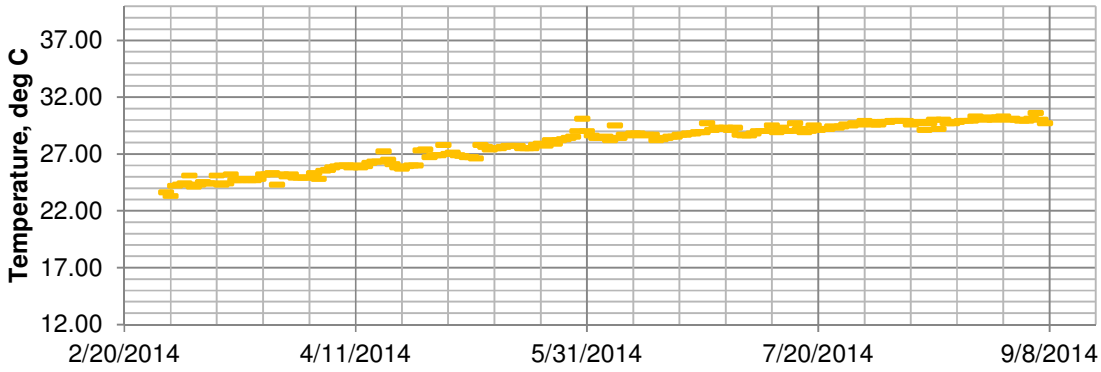
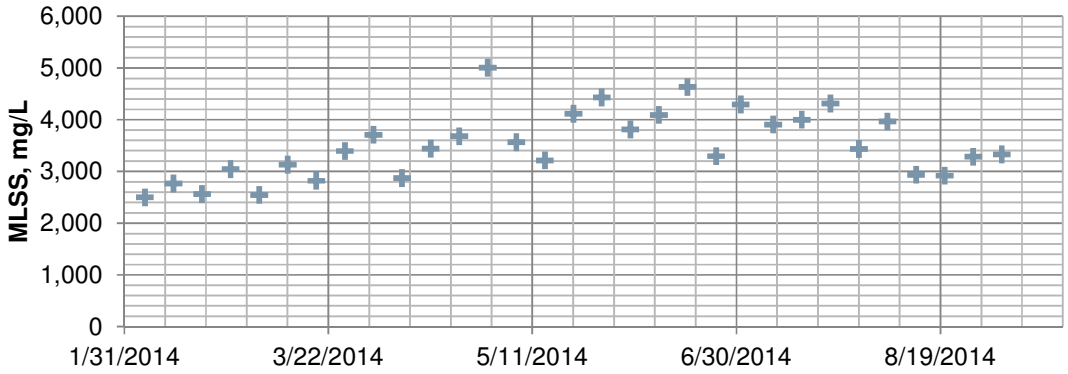


Figure 9. Reactor Mixed Liquor Concentration




## 1.4. Process Evaluation

The goal of the Process Modeling is to develop a calibrated model of the existing process configuration and identify the modifications required to achieve enhanced nutrient removal. As the effluent total nitrogen from the DMRs is about 8 mg/L there is a need to reduce effluent Nitrate & Nitrite to about 2 mg/L to achieve the effluent limit of TN 3 mg/L. To achieve additional denitrification post- anoxic zone is required, this can be achieved by modifying the existing MLE process configuration to a 4-stage Bardenpho or a 5-stage Bardenpho process. Other process configurations like anoxic step feed process, modified University Cape town (MUCT) process, and Johannesburg (JHB) process could be considered but will result in either adding more internal recirculation streams or significant change to the raw influent feed point to the reactor.

Process modeling was completed to evaluate the projected performance of the two process alternatives, based on the design criteria established. An industry-accepted biological process modeling software, BioWin 3, was used to model both the existing process and the proposed alternatives. The process modelling analysis included the following steps:

- Configuration of model to existing treatment process
- Calibrattion of the model using data from discharge monitoring reports of the existing treatment process
- Development of models for each recommended process alternative.

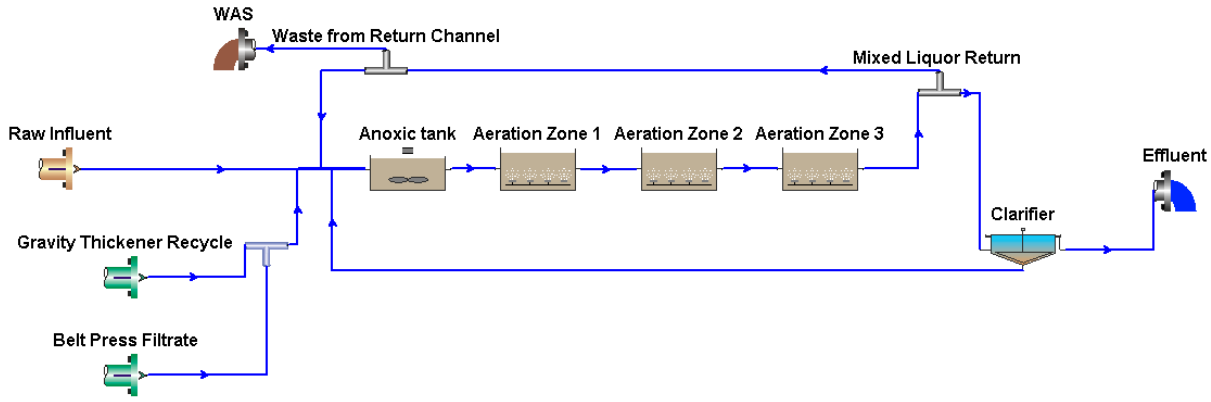
### 1.4.1. Model Configuration

As stated above, the MLE process is currently in use at the ASRWRF. The existing reactor was modelled based on the existing structural dimensions and operational conditions/parameters as follows:

- **Anoxic Tank-** 100’ (L) X 50.33’ (W) X15.83’ (D); 0.59 million gallons (MG)
- **Nitrification Tank-** 257.5’ (L) X 50.33’ (W) X15.83’ (D); 1.53 MG
- For the purposes of the aeration control each Nitrification Tank is divided into three (3) equal size zones (0.51 MG) equipped with diffused aeration equipment.
  - Aeration Zone 1 - 2,707 diffusers
  - Aeration Zone 2 - 1,643 diffusers
  - Aeration Zone 3 - 1,098 diffusers
- The plant recycles from the Gravity Thickener and Belt Filter Press.
- Returned Activated Sludge from the Clarifier is estimated at about 6 mgd (1Q).
- The nitrated mixed liquor is estimated at about 24 mgd (4Q)

A Schematic of the existing MLE process reactor configuration is presented in Figure 10 below.

**Figure 10. Schematic of Existing MLE Process Configuration at Altamonte Springs RWRF**




## 1.4.2. Model Calibration

Calibration was performed using the historical data from the discharge monitoring reports, Type II Calibration efforts as specified in WERF Report - Methods for Wastewater Characterization of Activated Sludge Modeling were used. The following approach was used to calibrate the model to match existing performance:

- Establish design criteria based on historical data
- Undertake additional sampling to identify the influent COD and VSS
- Adjust the influent and kinetic parameters in the  to match field observations

BioWin model uses COD as the measure of organic carbon. This is the industry standard for modeling. The model requires the input of various fractions of COD measured in the influent wastewater. These fractions characterize the influent COD based on whether the COD is biodegradable, how quickly the COD can be oxidized, and whether the COD is soluble or particulate.

### 1.4.2.1. Design Criteria based on historical Data

The influent design criteria developed in previous section was used for the raw influent obtained based on the historical data from the DMRs as the model input. The Raw Influent Parameters and Plant Recycles from the Gravity Thickener and Belt Filter Press are presented in Tables 2 and 3 respectively.

**Table 2. Influent Design Criteria**

| Raw Influent Parameter | Value | Units |
|---|---|---|
| Flow | 5.93 | mgd |
| Total Carbonaceous BOD | 220 | $mgO_2/L$ |
| Total suspended solids | 253 | mg TSS/L |
| Total Kjeldahl Nitrogen | 46.4 | mg N/L |
| Total P | 8.4 | mg P/L |
| Nitrate N | 0 | mg N/L |
| pH | 7.3 | |
| Alkalinity | 5.1 | mmol/L |
| Calcium | 80 | mg/L |
| Magnesium | 15 | mg/L |
| Dissolved Oxygen | - | mg/L |

**Table 3. Recycles**

| Gravity Thickener Recycle | Value | Units |
|---|---|---|
| Flow | 0.29 | mgd |
| Total Kjeldahl Nitrogen | 3.03 | mg N/L |
| Total P | 3.69 | mg P/L |
| **Belt Press Filtrate** | **Value** | **Units** |
| Flow | 0.09 | mgd |
| Total suspended solids | 500 | mg TSS/L |
| Total Kjeldahl Nitrogen | 24 | mg N/L |
| Total P | 20 | mg P/L |

### 1.4.2.2. Additional Sampling

A six-week sampling effort was undertaken to collect data for the model calibration. Grab samples of the raw influent was collected to test the following parameters:

- Chemical Oxygen Demand (COD)
- Volatile suspended solids (VSS)

The Discharge Monitoring Reports do not require any sampling of the chemical oxygen demand and volatile suspended solids; however the influent COD and VSS are required to understand the characterization of the wastewater. An additional sampling protocol was suggested to the City to collect grab samples for over couple of months from May 2014 through June 2014.

Figure 11 shows the VSS data collected through additional sampling. To get a better understanding the composite TSS samples for those particular days were plotted from the discharge monitoring reports. It can be observed that couple of VSS data points are higher than the TSS data points which is not possible, however direct comparison of grab to composite samples cannot be done. Standard deviation of the VSS samples collected is about 59 mg/L, this about 27% of the average value of 223 mg/L, this shows that there is high variability in VSS data collected.

**Figure 11. Raw Influent VSS and TSS**

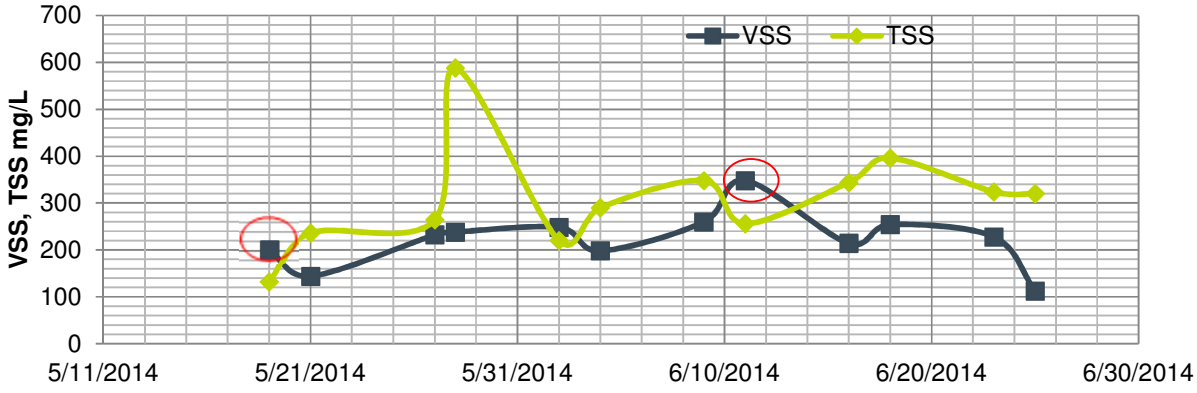
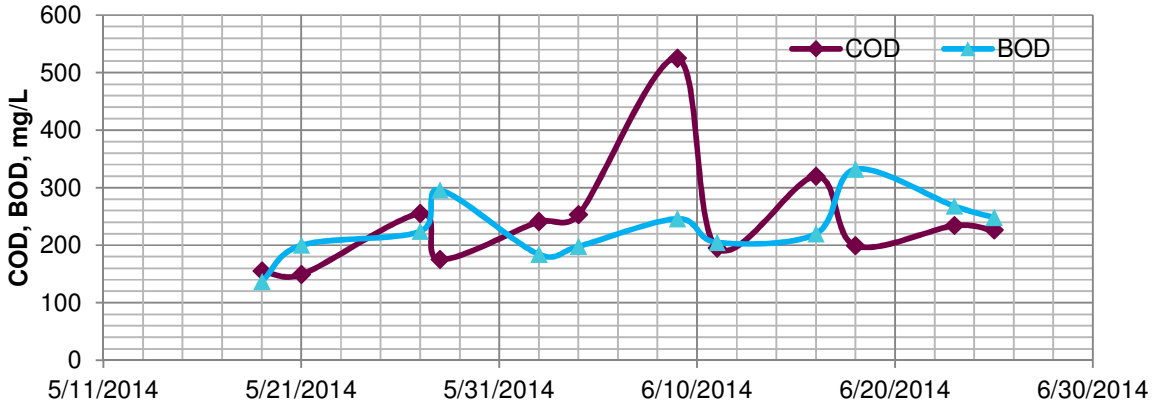


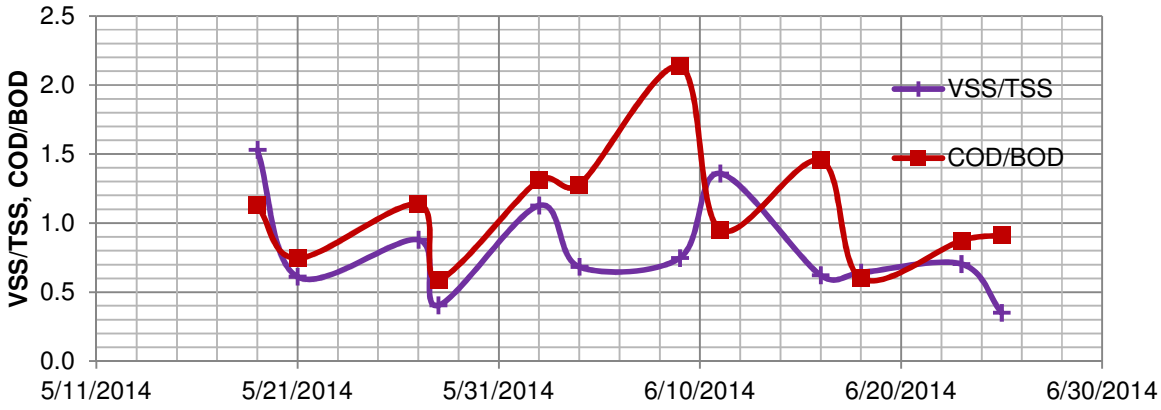

Figure 12 shows the COD data collected through additional sampling. To get a reference the composite BOD samples for those particular days were plotted from the discharge monitoring reports. It can be observed that three COD data points are lower than the BOD data points which is not possible, however direct comparison of grab to composite samples cannot be done. The average COD data points about 244 mg/L with standard deviation of 101 mg/L which is about 41% of the average value, this shows high variability in the COD data collected during additional sampling.

**Figure 12. Raw Influent COD and BOD**




As the additional COD and VSS data is highly variable, and the standard deviation is greater than 25% of the average, the COD/BOD and VSS/TSS ratios were plotted to compare with typical municipal wastewater. Figure 13 shows high variability of COD/BOD ratios ranging from 0.6 to 2.1; VSS/TSS ratio ranging from 0.4 to 1.5.

**Figure 13. VSS/TSS and COD/BOD Ratios**




Based on the results from the additional sampling and the discharge monitoring reports, the influent characterization is compared to typical municipal raw wastewater using the ratios of influent pollutant concentrations. Table 4 summarizes the observed and typical ratios. Based on the data, it is reasonable to assume that the COD and VSS is on the higher side of spectrum and therefore based on engineering judgment, and the modified fractions for COD/BOD and VSS/TSS ratios used for the design are 2.1 and 0.85 respectively that were used in the model. The observed BOD/TKN is about 4.74 which is less than the typical range of 4.8 to 5.8. Low BOD/TKN ratio generally indicates substrate limitation for enhanced nitrogen removal treatment. Supplemental carbon is required to meet the effluent nitrogen about 3 mg/L at any temperature.

**Table 4. Summary of Influent Characteristics at Altamonte Springs RWRF**

| Influent Parameter | Observed Value | Typical Range | Design Value |
|---|---|---|---|
| COD/BOD | 0.6 - 2.1 | 1.9 - 2.2 | 2.1 |
| BOD/TKN | 4.74 | 4.8 - 5.8 | 4.74 |
| TKN/$NH_3$ | 1.67 | 1.4 - 1.6 | 1.67 |
| VSS/TSS | 0.4 - 1.5 | 0.75 - 0.85 | 0.85 |

### 1.4.2.3. Adjust the influent and kinetic parameters to match field observations

The next step in the calibration process was to adjust the influent wastewater characterization kinetic parameters of the biological process reactions so that the model results matched performance data from the field. Model projections and field data for secondary effluent quality, solids yield, mixed liquor concentration in the reactor were compared.

Additional sampling on the fractionation of the COD and BOD was not conducted. Typical values were estimated based on the fractionation of total COD and total BOD. A summary of the estimated parameters are presented in Table 5.

**Table 5. Summary of Influent Characteristics at Altamonte Springs RWRF**

| Additional Parameters | Value | Units | Notes |
|---|---|---|---|
| COD | 460 | mg COD/L | COD/BOD = 2.1 |
| Volatile suspended solids | 215 | mg VSS/L | VSS/TSS = 0.85 |
| Effluent filtered COD | 4 | mg COD/L | COD/BOD = 2 |
| Influent filtered COD (GFC) | 210 | mg COD/L | 50% of COD |
| Influent Flocculated and Filtered COD | 180 | mg COD/L | 45% of COD |
| Influent Acetate | 30 | mg COD/L | 8% of COD |
| Influent Ammonia | 28 | mg N/L | DMR valve |
| Influent Ortho-phosphate | 4 | mg P/L | DMR valve |
| Influent filtered $cBOD_5$ | 144 | $mgO_2$/L | 65% of BOD |

In the process of model calibration, the wastewater fractions were modified in an attempt to make the model solids yield and solids retention time to match existing solids yield. Table 6 compares these fractions used in the model calibration with the default model values.

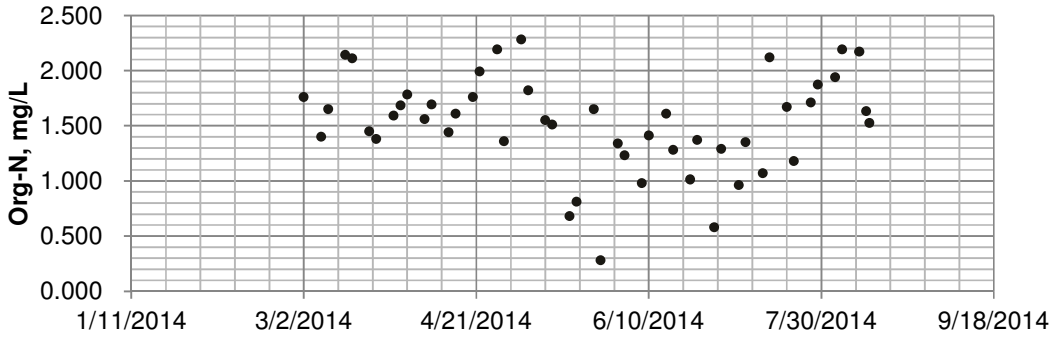
**Table 6. Comparison of the Calibrated Model Parameters with Default Model**

| Wastewater Fractions | Default Model | Calibrated Model |
|---|---|---|
| Fbs - Readily biodegradable (including Acetate) [g COD/g of total COD] | 0.16 | 0.20 |
| Fac - Acetate [g COD/g of readily biodegradable COD] | 0.15 | 0.32 |
| Fxsp - Non-colloidal slowly biodegradable [g COD/g of slowly degradable COD] | 0.75 | 0.8474 |
| Fus - Unbiodegradable soluble [g COD/g of total COD] | 0.05 | 0.051 |
| Fup - Unbiodegradable particulate [g COD/g of total COD] | 0.13 | 0.14 |

No variation of the default kinetic parameters was used except that the ammonification rate was increased from model default value of 0.04 (mg-N/L d)$^{-1}$ to 0.10 (mg-N/L d)$^{-1}$ this was done to align the organic nitrogen in the effluent from the DMR data to the model prediction. As shown in Figure 14, the organic nitrogen

ranged from 0.5 mg/L - 2.3 mg/L, with an average of 1.43 mg/L. It is to be noted that the organic nitrogen in the effluent cannot be reduced by any enhanced nutrient removal improvements, the only other forms of nitrogen which can be reduced in the effluent are the ammonia, and nitrate (including nitrite). To achieve a total nitrogen in the effluent to 3 mg/L, the ammonia and nitrate (including nitrite) should be less than or equal to 2.5 mg/L

**Figure 14. Effluent Organic Nitrogen**




The operational parameters and effluent quality predicted by the model and observed data matched closely. Tables 7 and 8 present the model predicted operational parameters and secondary effluent quality in comparison to the actual data. The solids residence time calculated includes the mass in the bioreactor and the secondary clarifier.

Thus, the default kinetic parameters and modified ammonification rate were used for the subsequent evaluations. Results from the model, therefore, can be considered predictive of absolute future performance.

**Table 7. Model Predicted Process Operational Parameters in Comparison to Actual Data**

| Operational Parameters | Actual Value | Model Value | Units |
|---|---|---|---|
| WAS Flow | 0.316 | 0.323 | mgd |
| WAS MLSS | 3,135 | 3,161 | mg/L |
| Solids Residence Time | 8.38 | 8.20 | days |
| DO Aeration Zone 1 | 3.0-5.5 | 4 | mg/L |
| DO Aeration Zone 2 | 1.5-4.0 | 3 | mg/L |
| DO Aeration Zone 3 | 0.5-2.5 | 2 | mg/L |
| Temperature | 27.8 | 28 | deg. C |

**Table 8. Model Predicted Secondary Effluent Quality in comparison to Actual (DMR) Data**

| Effluent Parameter | Units | Actual (DMR) Value | | | Model Predicted Value |
|---|---|---|---|---|---|
| | | Avg. | Max. | Min. | |
| $NH_3$ | mg/L | 0.16 | 0.28 | 0.10 | 0.17 |
| ORG-N | mg/L | 1.53 | 2.28 | 0.28 | 1.43 |
| TKN | mg/L | 1.70 | 2.86 | 0.46 | 1.60 |
| $NO_3$ | mg/L | 5.85 | 7.52 | 3.87 | 5.49 |
| $NO_2$ | mg/L | 0.12 | 0.24 | 0.01 | 0.05 |
| TN | mg/L | 7.66 | 9.93 | 5.66 | 7.54 |
| TP | mg/L | 3.77 | 5.86 | 1.80 | 5.43 |

## 1.4.3. Process Alternatives

Based on the calibration and validation of the existing MLE configuration, it is inferred that the existing tankage consisting of two (2) trains with a volume of 2.125 MG each can reliably achieve TN concentrations of about 8 mg/L at a rated flow of 11.86 mgd (5.93 mgd through each train). To get an understanding of the effluent at the design rated flow, the existing MLE configuration was operated at 12.5 mgd in both 20 deg C and 30 deg C temperatures.

Figure 15 shows a schematic of the existing process operated at 12.5 mgd with two trains in operation.

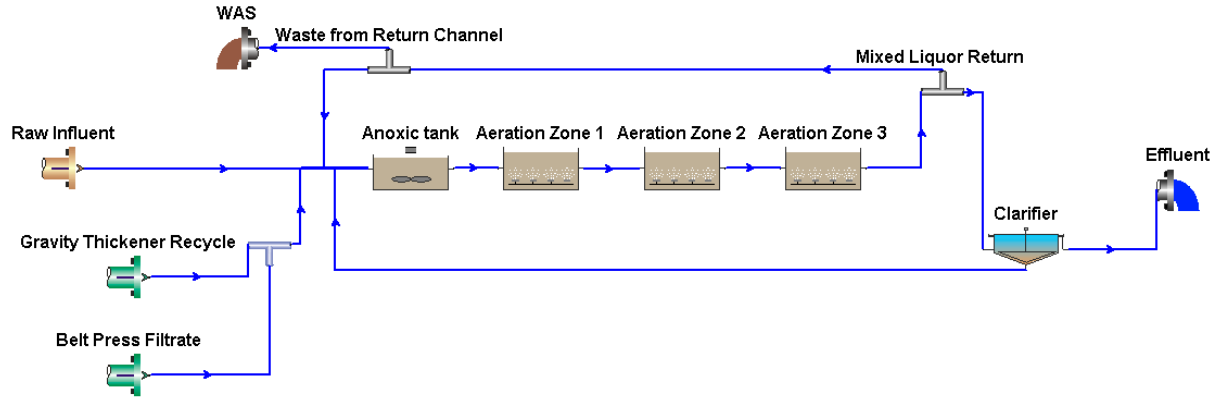



**Figure 15. Schematic of Existing MLE Process (12.5 mgd avg. flow two trains in operation)**

Table 9 presents the model prediction of the process operational and secondary effluent parameters.

**Table 9. Model Predicted Output - 12.5 mgd Average Flow (2 trains in operation)**

| Operational/Effluent Parameters | Model Value (20 deg C) | Model Value (30 deg C) | Units |
|---|---|---|---|
| Influent Flow | 12.5 | 12.5 | mgd |
| WAS Flow | 0.34 | 0.34 | mgd |
| WAS MLSS | 3,331 | 3,131 | mg/L |
| Solids Residence Time | 7.82 | 7.82 | days |
| DO Aeration Zone 1 | 2 | 2 | mg/L |
| DO Aeration Zone 2 | 2 | 2 | mg/L |
| DO Aeration Zone 3 | 2 | 2 | mg/L |
| $NH_3$ | 0.31 | 0.17 | mg/L |
| TKN | 1.76 | 1.59 | mg/L |
| $NO_3$ | 5.29 | 5.61 | mg/L |
| $NO_2$ | 0.18 | 0.05 | mg/L |
| TN | 7.68 | 7.67 | mg/L |
| TP | 5.18 | 5.46 | mg/L |

Based on the results from the Table 9, if no modification to the process reactors is anticipated then use of denitrification filters with supplemental carbon addition and alum addition for phosphorus removal is required to achieve an effluent goal of 5 mg/l (BOD); 5 mg/l (TSS); 3 mg/l (N); 1 mg/l (P).

As the current average flow is about 6 mgd, a simulation was performed with both trains in operation. Table 10 presents the model prediction of the process operational and secondary effluent parameters.

**Table 10. Model Predicted Output - 6 mgd Average Flow (2 trains in operation)**

| Operational/Effluent Parameters | Model Value (20 deg C) | Model Value (30 deg C) | Units |
|---|---|---|---|
| Influent Flow | 6 | 6 | mgd |
| WAS Flow | 0.16 | 0.16 | mgd |
| WAS MLSS | 3,147 | 3,001 | mg/L |
| Solids Residence Time | 16.10 | 16.11 | days |
| DO Aeration Zone 1 | 2 | 2 | mg/L |
| DO Aeration Zone 2 | 2 | 2 | mg/L |
| DO Aeration Zone 3 | 2 | 2 | mg/L |
| $NH_3$ | 0.09 | 0.06 | mg/L |
| TKN | 1.66 | 1.62 | mg/L |
| $NO_3$ | 6.14 | 6.19 | mg/L |
| $NO_2$ | 0.02 | 0.02 | mg/L |
| TN | 8.00 | 7.99 | mg/L |
| TP | 5.86 | 6.06 | mg/L |

A review of the model results from Table 10 reveals that there is significant aeration volume available at an average flow of 6 mgd (both trains in operation); and there is scope for denitrification within the reactor.

A model simulation was performed to verify if reducing the aeration volume will result in any reduction in effluent total nitrogen. The Aeration Zone 2 was operated as un-aerated without any modifications to any other operational parameters. Figure 16 shows a schematic of existing MLE process with Aeration Zone 2 (Ox-2) operated in un-aerated mode.

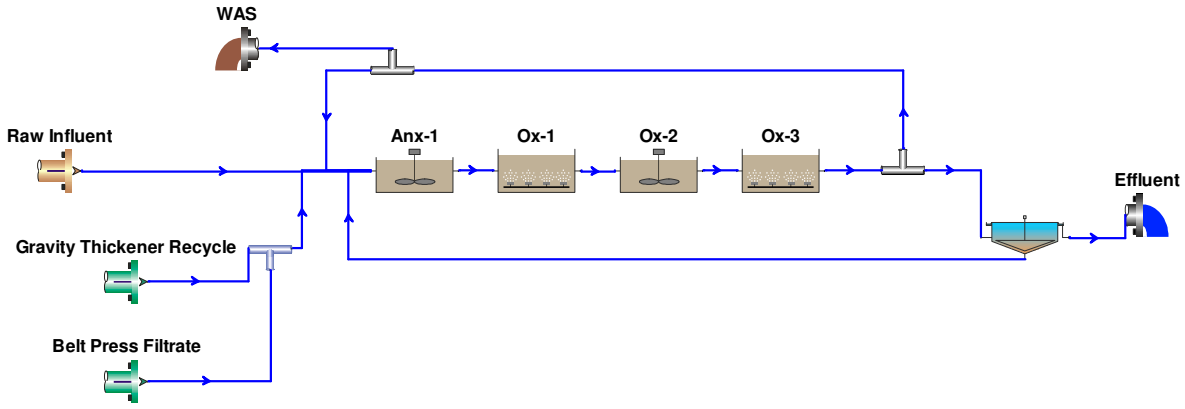



**Figure 16. Schematic of Existing MLE Process with Ox-2 turned off (6 mgd avg. flow, 2 trains)**

The model predictions show about 2.5 mg/L reduction in total nitrogen, which is attributed to the denitrification in the Aeration Zone 2 (Ox-2). Table 11 summarizes the model output for the simulation of 6 mgd average flow with both trains in operation and Ox-2 operated as un-aerated zone.

**Table 11. Model Predicted Output - 6 mgd Avg. Flow (2 trains in operation) - Ox-2 turned off**

| Operational/Effluent Parameters | Model Value (20 deg C) | Model Value (30 deg C) | Units |
|---|---|---|---|
| Influent Flow | 6 | 6 | mgd |
| WAS Flow | 0.16 | 0.16 | mgd |
| WAS MLSS | 3,313 | 3,146 | mg/L |
| Solids Residence Time | 16.09 | 16.10 | days |

| | | | |
|---|---|---|---|
| DO Aeration Zone 1 | 2 | 2 | mg/L |
| DO Aeration Zone 2 | 0 | 0 | mg/L |
| DO Aeration Zone 3 | 2 | 2 | mg/L |
| $NH_3$ | 0.32 | 0.09 | mg/L |
| TKN | 1.85 | 1.62 | mg/L |
| $NO_3$ | 3.47 | 3.72 | mg/L |
| $NO_2$ | 0.20 | 0.03 | mg/L |
| TN | 5.70 | 5.55 | mg/L |
| TP | 5.00 | 5.31 | mg/L |

Based on the results of 6 mgd average flow simulation, it can be observed that optimizing the anoxic/ aeration zones and relocating the internal recirculation feed point can result in further reduction in the total nitrogen to about 3 mg/L, any additional TP in the effluent can be removed using alum addition for chemical precipitation.

In order to achieve the required denitrification to reduce the nitrate and nitrate in the secondary effluent additional anoxic/anaerobic volume is to be provided. Two approaches as listed below, were taken to identify the capacity of the existing reactor and additional volume requirements based on the desired effluent quality:

- De-rating analysis was performed on the existing tanks to a lower flow rather than providing additional tankage (No additional volume).
- Determination of additional reactor volume based on the average flow of 12.5 mgd (both trains in service).

Two process alternatives were identified to achieve the required effluent goal as listed below:

1. 4-stage Bardenpho Process Configuration, enhanced nitrogen removal and phosphorus removal using chemical addition as required.
2. 5-stage Bardenpho Process Configuration, enhanced nitrogen and phosphorus removal.

Preliminary modeling was performed to determine the secondary effluent quality at two design conditions, one at a minimum temperature of 20 deg C and the other at a maximum temperature of 30 deg C. The mixed liquor suspended solids in the reactor was maintained at an average of 3,000 mg/L. The process evaluation for the de-rating analysis was performed using average raw influent flow of 8 mgd.

#### 1.4.3.1. 4-stage Bardenpho Process - Without any Additional Reactor Volume

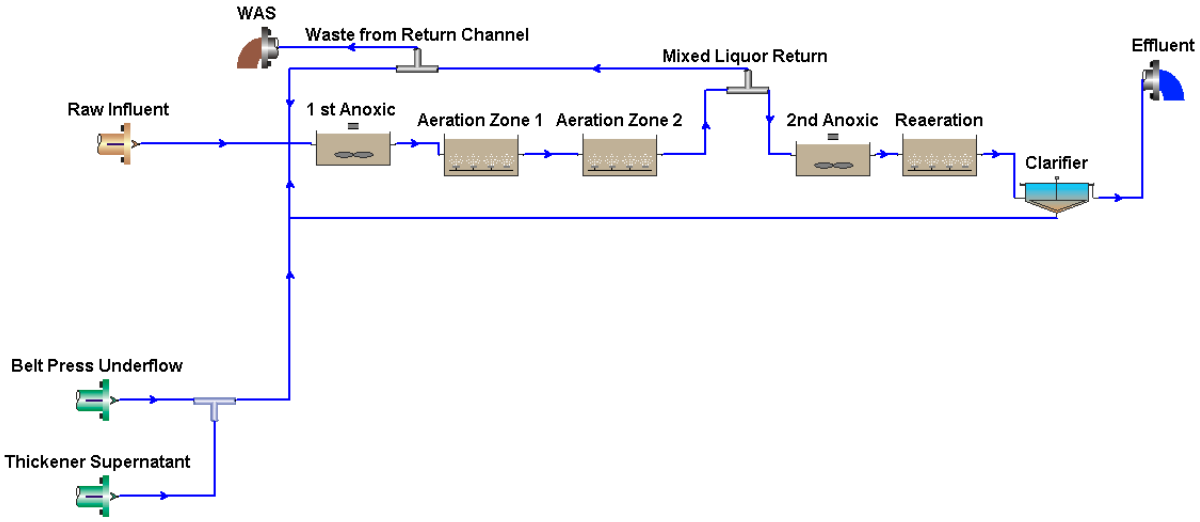
The four-stage Bardenpho process is a single sludge process with a four-stage sequence for nitrogen removal. The process includes dual anoxic and aerobic zones. The second set of anoxic zones would be located in Nitrification Tank using baffles.

The function of each zone is as follows:

- First Anoxic Zone
  - Internal recycle returns activated sludge and nitrates/nitrites to the beginning of the process for denitrification
  - Organic carbon consumed by bacteria converting nitrates and nitrites to nitrogenous gas
- First Aerobic Zone
  - Oxidation of influent organic carbon
  - Nitrification of influent ammonia
- Second Anoxic Zone
  - Endogenous respiration to remove remaining nitrates/nitrites
- Second Aerobic Zone
  - Re-aeration of wastewater prior to discharge to secondary clarifiers

The four stage system would require reconfiguration of the existing aeration system in Nitrification Tank. The configuration of the aeration basins for the 4-stage Bardenpho alternative is shown on Figure 17.

**Figure 17. Schematic of 4-stage Bardenpho Process Configuration**




The Nitrification tank modifications include incorporation of an anoxic zone with revised aeration zones. Since downstream end of the existing oxic zone would be converted to an anoxic zone, the IR pump would be moved to the point furthest downstream in the oxic zones.

Table 12 summarizes the preliminary runs with 4-stage Bardenpho Process configuration at 20 and 30 deg C.

**Table 12. Model Predicted Secondary Effluent Quality - 4 stage Bardenpho Process**

| Process Parameters | 20 deg C | 30 deg C |
|---|---|---|
| Influent Flow per train (mgd) | 4 | 4 |
| MLSS (mg/L) | 3,185 | 3,125 |
| IR (mgd) | 18 | 18 |
| SRT (days) | 11.11 | 12.02 |
| RAS (mgd) | 2.4 | 2.4 |
| WAS (mgd) | 0.24 | 0.22 |
| VSS/TSS | 0.69 | 0.69 |
| Yield (lb TSS/lb BOD) | 0.86 | 0.80 |
| Anoxic Volume (MG) | 0.70 | 0.72 |
| Aeration Volume (MG) | 0.92 | 0.90 |
| Post Anoxic Volume (MG) | 0.43 | 0.44 |
| Re-aeration Volume (MG) | 0.07 | 0.06 |
| Effluent $NH_3$ (mg N/L) | 0.50 | 0.20 |
| Effluent $NO_3$ (mg N/L) | 0.51 | 1.03 |
| Effluent $NO_2$ (mg N/L) | 0.53 | 0.10 |
| Effluent TKN (mg N/L) | 1.89 | 1.54 |
| Effluent TN (mg N/L) | 3.16 | 2.89 |
| Effluent TP (mg P/L) | 2.70 | 4.60 |
| Effluent BOD, TSS (mg/L) | <5 | <5 |

It can be observed that the total nitrogen value in the secondary effluent slightly exceeds the 3 mg/L criteria at 20 deg C. Based on the effluent nitrite at 20 deg C, it shows that there is indication of simultaneous nitrification and denitrification and moreover that phosphorus uptake is higher, this is attributed to the high

volatile fatty acid portion in the COD. The influent BOD plays a crucial role in the denitrification of NOx. The observed BOD/TKN ratio is less than the normal. In 2013 the influent BOD averaged about 210 mg/L and in 2014 there was an increase to 240 mg/L. A simulation was performed using influent BOD concentration of 240 mg/L, the total nitrogen in the effluent predicted was less than 3 mg/L, therefore further evaluation to confirm the influent BOD value is required. Addition of alum (9.09% pure) of about 534 lb/d (544 gpd) is required to achieve a secondary effluent of 1 mg/L TP.

The operation of a 4-stage Bardenpho process is relatively easy compared to a 5-stage Bardenpho process; however use of oxidation-reduction potential (ORP) sensors and ammonia ($NH_4$) and nitrate ($NO_3$) sensors will achieve reliable and repeatable performance is recommended. ORP sensors will be located at the end of the Pre-Anoxic and Aerobic Zones which control the amount of air added there by controlling the nitrification and denitrification. The set-points on the ORP will be revised based on feedback information $NH_4$ and $NO_3$ sensors are located at the end of the Aerobic Zone and at the end of Re-Aeration Zone.

#### 1.4.3.1.1. 4-stage Bardenpho Process- With Additional Reactor Volume

The purpose of this model simulation is to determine the required additional reactor volume in a 4-stage Bardenpho Process configuration to treat an average flow of 12.5 mgd. Iterations were done by increasing the anoxic and aerobic volume required to achieve desired effluent total nitrogen. Increase in the anoxic volume was done based on the effluent total nitrogen. The effluent total phosphorus concentration is removed using chemical precipitation using alum. The total reactor volume for each train was determined at 3.14 MG. Each train of the existing MLE reactor is of about 2.13 MG, therefore an additional reactor volume of about 1 MG will be required.

The basis of the reactor sizing is using wastewater temperature of 20 deg C. The required aeration volume at 20 deg C is higher than 30 deg C. A swing zone is created from the aeration zone which can be operated as anoxic zone at (without air) at 30 deg C and as aeration zone at 20 deg C. This will incorporate process operational flexibility and energy savings by reducing the amount of air incorporated into the system.

Table 13 presents the secondary effluent quality at 20 deg C and 30 deg C.

**Table 13. Model Predicted Secondary Effluent Quality - 4 stage Bardenpho Process**

| Process Parameters | 20 deg C | 30 deg C |
|---|---|---|
| Influent Flow per train (mgd) | 6.25 | 6.25 |
| MLSS (mg/L) | 3,006 | 2,984 |
| IR (mgd) | 25 | 25 |
| SRT (days) | 10 | 10.24 |
| RAS (mgd) | 5 | 5 |
| WAS (mgd) | 0.37 | 0.36 |
| VSS/TSS | 0.72 | 0.71 |
| Yield (lb TSS/lb BOD) | 0.80 | 0.77 |
| Anoxic Volume (MG) | 0.77 | 0.77 |
| Aeration Volume (MG) | 1.48 | 1.48* |
| Post Anoxic Volume (MG) | 0.77 | 0.77 |
| Re-aeration Volume (MG) | 0.12 | 0.12 |
| Effluent $NH_3$ (mg N/L) | 0.39 | 0.17 |
| Effluent $NO_3$ (mg N/L) | 1.18 | 0.99 |
| Effluent $NO_2$ (mg N/L) | 0.21 | 0.08 |
| Effluent TKN (mg N/L) | 1.75 | 1.52 |
| Effluent TN (mg N/L) | 3.55 | 2.99 |
| Effluent TP (mg P/L) | 4.86 | 4.61 |
| Effluent BOD, TSS (mg/L) | <5 | <5 |

** Out of 1.48 MG of aeration volume, 0.24 MG is operated as an anoxic zone.*

Note that the effluent total nitrogen is slightly higher at 20 deg C, in order to drive this to below 3 mg/L supplemental carbon is required as the influent BOD is insufficient to perform additional denitrification at the given temperature. The influent BOD/TKN ratio is lower than the typical value observed in municipal wastewater. Consideration need to be given to add supplemental carbon to the post anoxic zone after evaluating the total number of days the ambient temperature will be around 20 deg C. Addition of alum (9.09% pure) of about 833 lb/d (850 gpd) is required to achieve a secondary effluent of 1 mg/L TP.

The existing primary clarifiers are currently not being used and reusing them to provide additional reactor volume was evaluated. The additional reactor volume is estimated at about 130 ft long anoxic reactor before the existing reactors and about 44 ft long oxic reactor are required. The existing primary clarifiers are shallow (depth varies between 8-ft and 10-ft) compared to the existing reactor and top of the tanks is lower, therefore, additional pumping will required to and from the existing primaries which will result in significant operational costs and they do not provide total additional reactor volumes required for the process . Therefore, the reuse of the existing primary clarifiers for additional reactor volume is not a viable option.

### 1.4.3.2. 5-stage Bardenpho Process - Without any Additional Reactor Volume

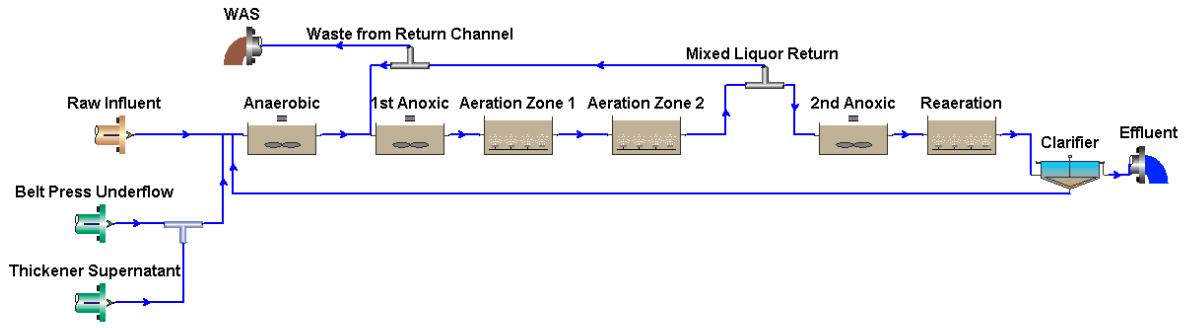
The five-stage Bardenpho process is a single sludge process with a five-stage sequence for nitrogen and phosphorus removal. The process includes anaerobic zone, and dual anoxic and aerobic zones. The existing anoxic tank will be configured into one anaerobic zone and first anoxic zone, the second set of anoxic zones would be located in Nitrification Tank using baffles.

The function of each zone is as follows:

- Anaerobic Zone
  - Organ carbon is consumed with release of soluble phosphorus
- First Anoxic Zone
  - Internal recycle returns activated sludge and nitrates/nitrites for denitrification
  - Organic carbon consumed by bacteria converting nitrates and nitrites to nitrogenous gas
- First Aerobic Zone
  - Oxidation of influent organic carbon
  - Nitrification of influent ammonia
  - Phosphorus removed by phosphorus accumulating organisms.
- Second Anoxic Zone
  - Endogenous respiration to remove remaining nitrates/nitrites
- Second Aerobic Zone
  - Re-aeration of wastewater prior to discharge to secondary clarifiers

The 5-stage Bardenpho system would require reconfiguration of the Anoxic and Nitrification tanks, and the existing aeration system in Nitrification Tank. The configuration of the aeration basins for the 5-stage Bardenpho alternative is shown on Figure 18.

**Figure 18. Schematic of 5-stage Bardenpho Process Configuration**




As observed from the schematic, the existing Anoxic tank is to be modified to incorporate a new anaerobic zone. The internal recirculation has to be discharged upstream of the new anoxic zone. The Nitrification tank modifications include incorporation of an anoxic zone with revised aeration zones.

Table 14 summarizes the preliminary runs with 5-stage Bardenpho Process configuration at 20 and 30 deg C.

**Table 14. Model Predicted Secondary Effluent Quality - 5 stage Bardenpho Process**

| Process Parameters | 20 deg C | 30 deg C |
|---|---|---|
| Influent Flow per train (mgd) | 4 | 4 |
| MLSS (mg/L) | 3,088 | 3,261 |
| IR (mgd) | 18 | 18 |
| SRT (days) | 11.21 | 11.22 |
| RAS (mgd) | 2.40 | 2.40 |
| WAS (mgd) | 0.26 | 0.23 |
| VSS/TSS | 0.67 | 0.66 |
| Yield (lb TSS/lb BOD) | 0.90 | 0.85 |
| Anaerobic Volume (MG) | 0.17 | 0.18 |
| Anoxic Volume (MG) | 0.53 | 0.59 |
| Aeration Volume (MG) | 0.96 | 0.90 |
| Post Anoxic Volume (MG) | 0.37 | 0.42 |
| Re-aeration Volume (MG) | 0.08 | 0.04 |
| Effluent $NH_3$ (mg N/L) | 0.43 | 0.18 |
| Effluent $NO_3$ (mg N/L) | 3.38 | 4.30 |
| Effluent $NO_2$ (mg N/L) | 1.50 | 0.12 |
| Effluent TKN (mg N/L) | 1.76 | 1.45 |
| Effluent TN (mg N/L) | 6.87 | 6.10 |
| Effluent TP (mg P/L) | 0.45 | 1.06 |
| Effluent BOD, TSS (mg/L) | <5 | <5 |

It can be observed that the total nitrogen value in the secondary effluent exceeds the 3 mg/L criteria. Based on the effluent nitrite at 20 deg C it shows that there is indication of simultaneous nitrification and denitrification and moreover that phosphorus uptake is higher. The exceptional phosphorus removal can attributed to the high volatile fatty acid fraction of the influent COD. As the influent BOD/TKN ratio is lower than normal, addition of supplemental carbon is required to achieve a secondary effluent TN to 3 mg/L. To verify this phenomenon the simulation was performed using an influent BOD concentration of 240 mg/L, there was a reduction in total nitrogen of about 1.5 mg/L. It is critical to get a good estimation of the influent BOD as a slight variation in influent BOD is affecting the effluent TN concentration significantly.

To improve the reliability of the 5-stage Bardenpho process to achieve repeatable results use of oxidation-reduction potential (ORP) sensors and ammonia (NH4) and nitrate (NO3) sensors is recommended. ORP sensors will be located at the end of the Pre-Anoxic and Aerobic Zones which control the amount of air added there by controlling the nitrification and denitrification. The set-points on the ORP will be revised based on feedback information NH4 and NO3 sensors are located at the end of the Aerobic Zone and at the end of Re-Aeration Zone.

### 1.4.3.3. 5-stage Bardenpho Process- With Additional Reactor Volume

The purpose of this model simulation is to determine the required additional reactor volume in a 5-stage Bardenpho Process configuration to treat an average flow of 12.5 mgd. Iterations were done by increasing the anaerobic, anoxic, and aerobic volume required to achieve desired effluent total nitrogen and total phosphorus. The total reactor volume for each train was determined at 3.44 MG. Each train of the existing MLE reactor is of about 2.13 MG, therefore an additional reactor volume of about 1.3 MG will be required. As the 5-stage process configuration is designed for biological nutrient removal of both nitrogen and phosphorus, larger reactor volume is required under 5-stage process compared to that of the 4-stage process.

The basis of the reactor sizing is using wastewater temperature of 20 deg C. The required aeration volume at 20 deg C is higher than 30 deg C. A swing zone is created from the aeration zone which can be operated as anoxic zone at (without air) at 30 deg C and as aeration zone at 20 deg C. This will incorporate process operational flexibility and energy savings by reducing the amount of air incorporated into the system.

Table 15 presents the secondary effluent quality at 20 deg C and 30 deg C.

**Table 15. Model Predicted Secondary Effluent Quality - 5 stage Bardenpho Process**

| Process Parameters | 20 deg C | 30 deg C |
|---|---|---|
| Influent Flow per train (mgd) | 6.25 | 6.25 |
| MLSS (mg/L) | 3,337 | 3,337 |
| IR (mgd) | 25 | 25 |
| SRT (days) | 11 | 11 |
| RAS (mgd) | 3.13 | 3.13 |
| WAS (mgd) | 0.37 | 0.37 |
| VSS/TSS | 0.67 | 0.67 |
| Yield (lb TSS/lb BOD) | 0.89 | 0.90 |
| Anaerobic Volume (MG) | 0.29 | 0.29 |
| Anoxic Volume (MG) | 0.99 | 0.99 |
| Aeration Volume (MG) | 1.3 | 1.3 * |
| Post Anoxic Volume (MG) | 0.74 | 0.74 |
| Re-aeration Volume (MG) | 0.12 | 0.12 |
| Effluent $NH_3$ (mg N/L) | 0.50 | 0.22 |
| Effluent $NO_3$ (mg N/L) | 0.16 | 0.16 |
| Effluent $NO_2$ (mg N/L) | 1.29 | 0.44 |
| Effluent TKN (mg N/L) | 1.86 | 1.60 |
| Effluent TN (mg N/L) | 3.71 | 2.59 |
| Effluent TP (mg P/L) | 0.49 | 0.70 |
| Effluent BOD, TSS (mg/L) | <5 | <5 |

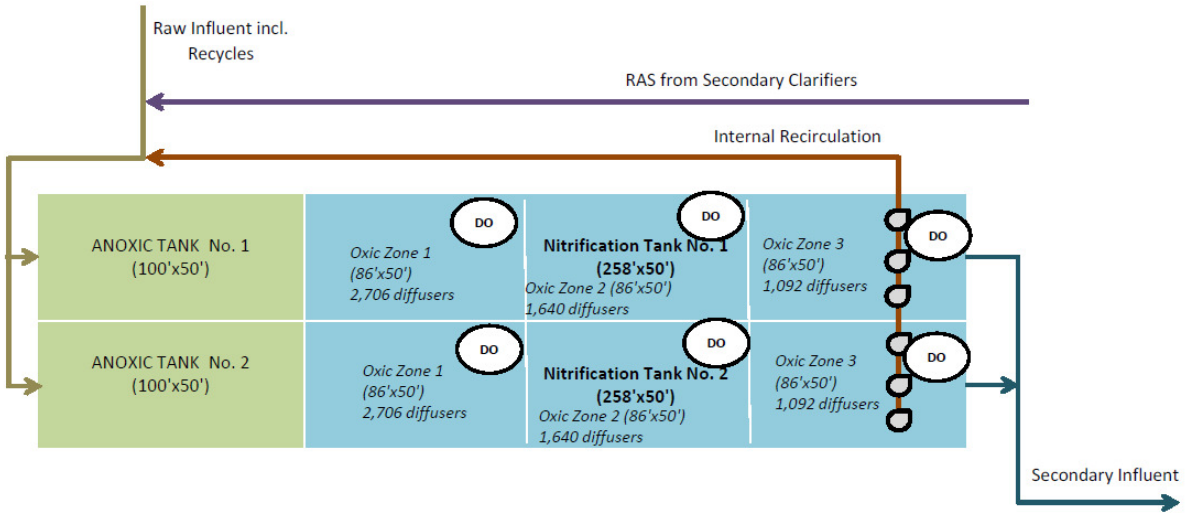
** Out of 1.3 MG of aeration volume, 0.51 MG is operated as an anoxic zone.*

The reactor volume Note that the effluent total nitrogen is slightly higher at 20 deg C, in order to drive this to below 3 mg/L supplemental carbon is required as the influent BOD is insufficient to perform additional denitrification at the given temperature. The influent BOD/TKN ratio is lower than the typical value observed in municipal wastewater. Consideration need to be given to add supplemental carbon to the post anoxic zone after evaluating the total number of days the ambient temperature will be around 20 deg C.

## 1.5. Layouts

Figure 19 shows the plan view of the existing MLE configuration including two trains with anoxic and nitrification tanks and internal recirculation pumps.

**Figure 19. Existing MLE Layout**

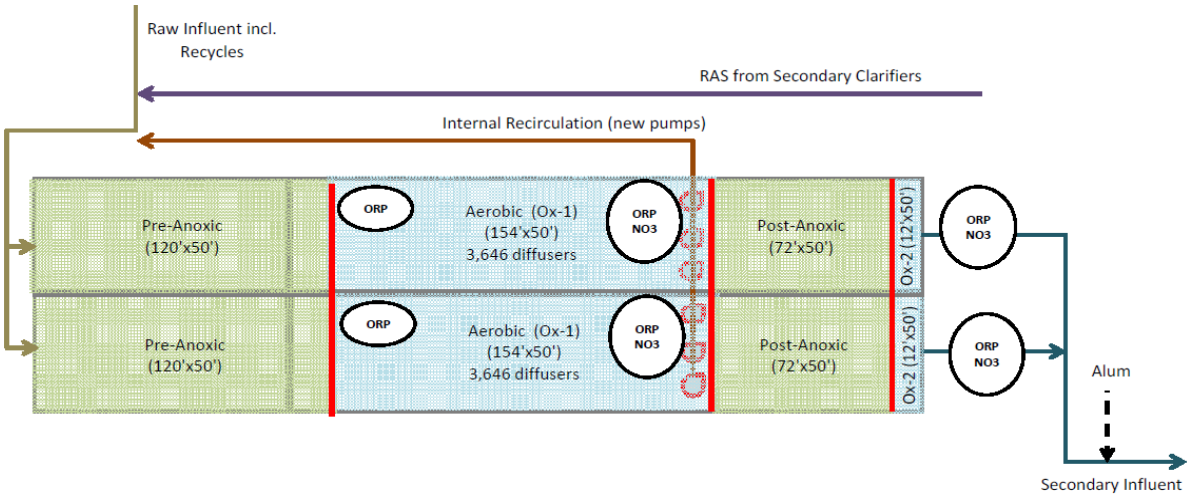



### 1.5.1. Layouts - No Additional Reactor Volume

#### 1.5.1.1. 4- Stage Bardenpho Configuration

Based on the model results for the 4-stage Bardenpho process configuration, modifications to the existing MLE Layout will be required. The major change to the existing configuration will include modification of the nitrification tank into three zones separated by baffles and relocation of the internal recirculation collection point with new pumps. The modifications to the diffuser grids installed as part of the RWRF Aeration System Blower Replacement Project is very minimal. Effectively about 2,000 diffusers in Oxic Zone-1 and all the diffusers in Oxic Zone-2 will provide the required oxygen, about 80% the Oxic Zone-3 will be converted to post anoxic zone. The influent flow each train is reduced from 6 mgd to 4 mgd which is a 33% reduction. The new aeration system will effectively provide the same amount of oxygen as the modified basin aeration volume is about 60% of the existing thereby is capable of maintaining sufficient aerobic solids retention time. Figure 20 shows layout for the proposed 4-stage Bardenpho tank modifications, with different zones and there dimensions.

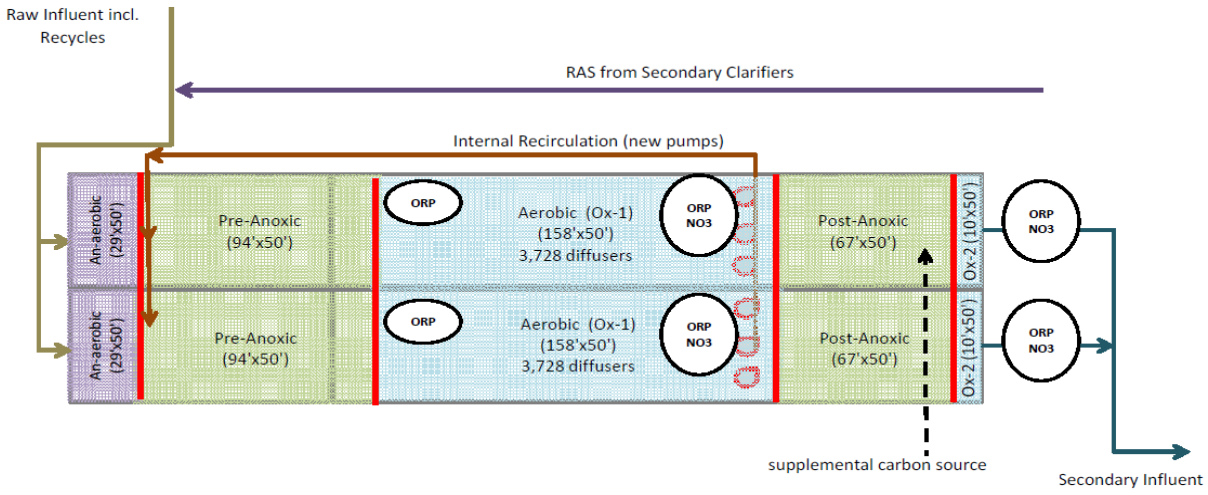
**Figure 20. 4-stage Bardenpho Process Configuration Layout**




### 1.5.1.2. 5-Stage Bardenpho Configuration

Based on the model results for the 5-stage Bardenpho process configuration, modifications to the existing MLE Layout will be required. The major change to the exiting configuration will include modification of the anoxic tank to include an anaerobic zone and Pre-Anoxic zone separated by baffle, modification of nitrification tank into three zones separated by baffles and relocation of the internal recirculation collection point with new pumps. The internal recirculation discharge point needs to be changed to downstream of the anaerobic zone to avoid reduction in phosphorus removal efficiency. The modifications to the diffuser grids installed as part of the RWRF Aeration System Blower Replacement Project is very minimal. Effectively about 2,088 diffusers in Oxic Zone-1 and all the diffusers in Oxic Zone-2 will provide the required oxygen, about 80% the Oxic Zone-3 will be converted to post anoxic zone. The influent flow each train is reduced from 6 mgd to 4 mgd which is a 33% reduction. The new aeration system will effectively provide the same amount of oxygen as the modified basin aeration volume is about 61% of the existing thereby is capable of maintaining sufficient aerobic solids retention time. Figure 21 shows layout for the proposed 5-stage Bardenpho tank modifications, with different zones and there dimensions.

**Figure 21. 5-stage Bardenpho Process Configuration Layout**

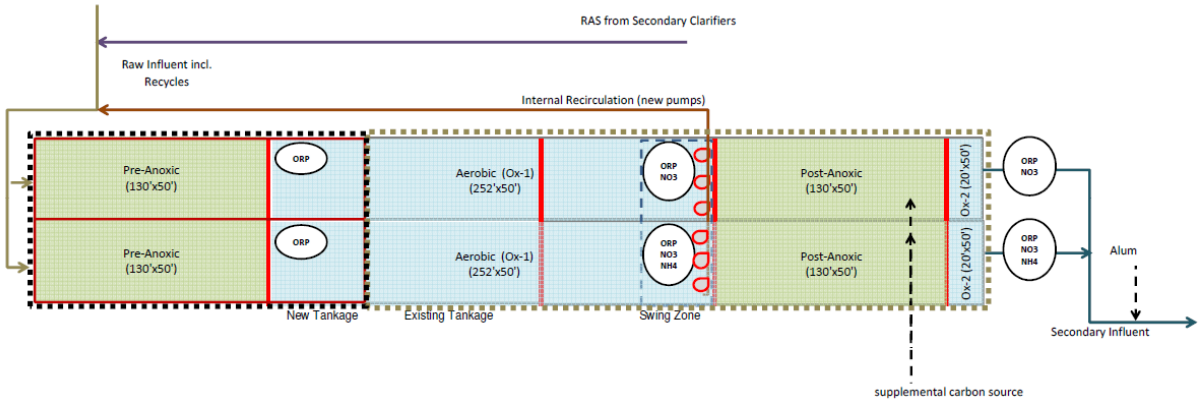


## 1.5.2. Layouts - Additional Reactor Volume

### 1.5.2.1. 4-Stage Bardenpho Configuration

Based on the model simulation for a 4-stage Bardenpho process configuration to treat an average flow of 12.5 mgd, an addition reactor volume of 1 MG is required. The new tankage (174'x50') for each train will consist of pre-anoxic reactor (130' X 50') and portion of the aerobic zone (44'x50'). The existing anoxic tank will be modified to an aerobic zone and portions of the existing nitrification tank will be modified to post-anoxic and post-aeration zones. A swing zone of 40-ft-width will be created in the aerobic zone which will be operated as anoxic zone at higher temperatures (30 deg C). Figure 22 shows layout for the proposed 4-stage Bardenpho tank modifications, with different zones and there dimensions.

**Figure 22. 4-stage Bardenpho Process Configuration Layout - Including Additional Volume**

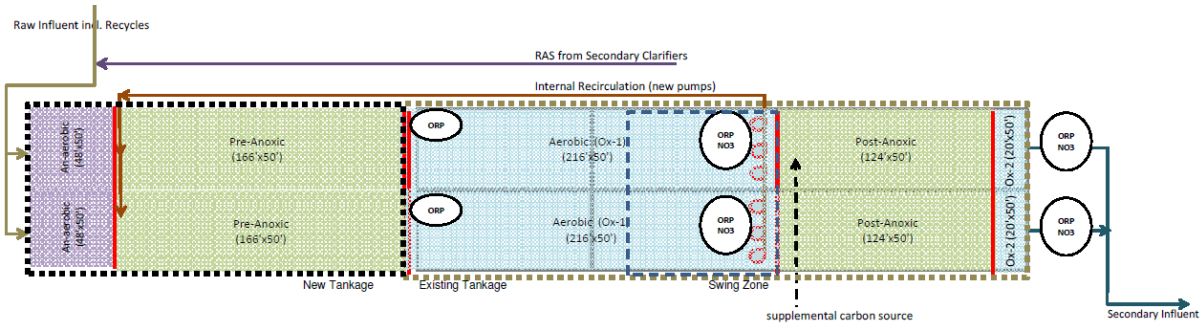



### 1.5.2.2. 5-Stage Bardenpho Configuration

Based on the model simulation for a 5-stage Bardenpho process configuration to treat an average flow of 12.5 mgd, an addition reactor volume of 1.3 MG is required. The new tankage (214'x50') for each train will consist of anaerobic reactor (48'X50') and a pre-anoxic reactor (166' X 50'). The existing anoxic tank will be modified to an aerobic zone and portions of the existing nitrification tank will be modified to post-anoxic and post-aeration zones. A swing zone of 86-ft-width will be created in the aerobic zone which will be operated as anoxic zone at higher temperatures (30 deg C).

Figure 23 shows layout for the proposed 4-stage Bardenpho tank modifications, with different zones and there dimensions.

**Figure 23. 5-stage Bardenpho Process Configuration Layout - Including Additional Volume**




## 1.6. Conclusions

- The 4-stage Bardenpho Process configuration is an viable alternative to meet the desired effluent criteria at an average flow of 8 mgd (two trains in operation) as this alternative does not include supplemental carbon source feed system. Alum feed systems are relatively cheaper and alum is

easier to handle compared to methanol. The 4-stage Bardenpho configuration does not require any modification to the internal recirculation discharge point; the existing mixed liquor channel can be reused with a new set of pumps at the proposed location. Additional reactor volume of 1 MG needs to be provided to treat an average flow of 12.5 mgd (two trains in operation).

- Reuse of existing primary clarifier for anoxic volume is not a viable option.
- The current blower upgrade and diffused aeration system project will provide three oxic zones (Ox-1 through Ox-3) each of 86 ft long. Modifying these three oxic zones into six smaller zones will better control the air to the nitrification tank and will minimize the reactor modifications for treating 8 mgd and 12.5 mgd average daily flow.
- The influent BOD concentration is lower in comparison with the TKN and TP values resulting in a substrate limitation condition as observed in the post anoxic zones which limit the denitrification and phosphorus release, therefore chemical addition in the form of coagulant needs to be added.
- The proposed configuration can reliably meet the effluent quality with a smaller post anoxic volume if supplemental carbon addition is considered. Methanol is by far a good supplemental carbon source as far as assimilation of denitrification bacteria is concerned; however the methanol handling requires additional safety requirements.
- The model predictions show very good biological phosphorus removal, the reason for such a good performance is that the influent volatile fatty acid fraction is high; confirmation of the raw influent fractionation is required.
- As there are several instances where the COD is less than the VSS, and VSS/TSS ratio is greater than 1, in the recent testing performed, therefore additional testing on the influent total COD, floc/filtered and glass fiber filtered CODs is required to get a better handle of the influent characterization.
- Assuming no significant change in the influent characterization, based on the preliminary process evaluation, it is observed that de-rating the existing plant from 12.5 mgd to 8 mgd can achieve the goal of an effluent limit of 5 mg/l (BOD); 5 mg/l (TSS); 3 mg/l (N); 1 mg/l (P) without any additional reactor volume.

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