JEA Water & Wastewater Standards Manual

VOLUME VI: Water Reclamation Facility Specifications

2024 – Edition

"Foundation for the Future - Water & Wastewater Standards"

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I. INTRODUCTION

I.1. PURPOSE OF THE MANUAL

I.1.1. As part of JEA's overall *Water and Wastewater Standards Manual*, these Design Standards focus on wastewater treatment and provide guidance for designing and constructing the following assets:

I.1.1.1. New water reclamation facilities (WRFs)

I.1.1.2. Additions to existing WRFs

I.1.1.3. Modifications to existing WRFs

I.1.2. Incorporation of these Design Standards will help improve the quality of future JEA WRF projects, improve the standardization of design, and provide guidance for designers working on these projects to reduce JEA staff review time on future projects.

I.1.3. JEA's current Water and Wastewater Design Standards consist of the following:

I.1.4. JEA's *Water and Wastewater Standards Manual* (Volumes I through V):

I.1.4.1. Volume I: Distribution and Collection Specifications

I.1.4.2. Volume II: Distribution and Collection Details

I.1.4.3. Volume III: Water and Wastewater Approved Materials Manual

I.1.4.4. Volume IV: Water and Wastewater Master Material Catalog

I.1.4.5. Volumes V and VA: Water Treatment Plant Specifications and Details

I.1.5. JEA desires to improve the overall quality, reliability, and efficiency of its WRFs and related projects without an overreliance or commitment to specific manufacturers' technologies. This will be accomplished with design criteria and technical specifications prepared to ensure performance and reliability without limiting competition or innovation. Furthermore, JEA intends to pair the design criteria and technical specifications in these Design Standards with project-specific evaluations or graded Requests for Proposal (RFPs). The Design Standards will provide minimum requirements for equipment vendors related to sizing, materials, and performance. The graded RFP will build on these minimum requirements and further evaluate the equipment for project-specific criteria, such as supporting infrastructure requirements, energy or chemical usage, maintenance requirements, and experience/performance in similar installations. Therefore, these Design Standards will allow JEA and the design engineer to include project-specific graded RFPs as necessary.

I.2. LIMITATIONS

I.2.1. The Design Standards in this volume include design criteria and technical specifications related to all key areas of JEA's WRFs. The scope is expected to cover nearly all topics relevant to the design of new WRFs and specify new equipment. However, some limitations have been identified that may require modification of the standards in the future or for project-specific evaluations.

I.2.2. Regulations that define effluent quality and solids reuse and disposal are expected to change over time. Changes to these regulations may require new treatment processes not covered in these Design Standards.

I.2.3. JEA's current WRFs have a wide range of existing conditions, such as capacity, age, effluent disposal options, treatment processes, and area within the site. Certain criteria within the Design Standards may not be applicable to all WRFs, and the existing facilities may limit the scope for modification.

I.2.4. A majority of JEA's WRFs receive a raw wastewater that is typical of residential/commercial municipal systems. However, some variation exists, particularly at JEA's largest facility, Buckman WRF, which receives wastewater from industrial sources as well as waste solid streams from several other JEA WRFs. In addition, the quantity and quality of influent data varies significantly, which can impact the recommended method for data analysis.

I.2.5. As noted previously, JEA intends to use graded RFPs for evaluation of large process and hydraulic equipment. The Design Standards do not include these evaluations but have been developed to work with these evaluations.

I.2.6. New technology may also provide JEA with advantages in the future, such as space, energy, or chemical reduction. These Design Standards will need to be updated as new technology is implemented at JEA's WRFs.

I.3. REGULATIONS

In addition to the guidelines presented in this document, the designer should be aware of, and use, the most recent edition of JEA's *Water and Sewer Standards Manual*. At a minimum, all designs for JEA WRFs must meet the requirements of the following regulatory agencies, where applicable:

I.3.1. The U.S. Army Corps of Engineers and Florida Department of Environmental Protection (FDEP) have approval authority for wetlands management.

I.3.2. The City of Jacksonville Development Management Group provides plan review approval, which is required before a building permit can be obtained.

I.3.3. FDEP issues permits related to WRF modification and design based on the Florida Administrative Code (F.A.C.). Key sections include:

I.3.3.1. Chapter 62-600, Domestic Wastewater Facilities

I.3.3.2. Chapter 62-610, Reuse of Reclaimed Water and Land Application

I.3.3.3. Chapter 62-620, Wastewater Facility and Activities Permitting

I.3.3.4. Chapter 62-640, Domestic Wastewater Residuals

I.3.4. The Nassau County Building Department reviews and inspects building plans and construction before a building permit can be obtained.

I.3.5. The St. Johns County Development Review Committee provides plan reviews and inspections for land development within St. Johns County.

I.3.6. Clay County's Development Review Management Group provides development review services for Land Development Code compliance.

I.4. ORGANIZATION OF THE MANUAL

I.4.1. As noted previously, this constitutes Volume VI of JEA's overall *Water and Wastewater Standards Manual* specific to wastewater treatment and WRFs. Volume VI includes the six sections listed as follows, which will be printed/combined into two separate files for consistent formatting and page sizing: Volume VI for text and Volume VIA for drawings and details.

I.4.1.1. Introduction (Volume VI)

I.4.1.2. General WRF Standards (Volume VI)

I.4.1.3. Unit Process Standards (Volume VI)

I.4.1.4. Technical Specifications (Volume VI)

I.4.1.5. Standard Details (Volume VIA)

I.4.1.6. Drawing Standards (Volume VIA)

II. GENERAL WATER RECLAMATION FACILITY STANDARDS

II.1. JEA POLICY DRIVERS – VISION STATEMENT

II.1.1. As a community-owned utility, JEA strives to provide reliable services at the best value to customers while ensuring the area's precious natural resources are protected. JEA has and will continue to meet or exceed all effluent requirements regardless of the discharge. This has been shown in JEA's commitment to improving the water quality in the St. Johns River, maximizing the availability of high-quality reclaimed water for irrigation, and meeting stringent advanced wastewater treatment standards for surface water discharges.

II.1.2. JEA is also committed to evaluating and implementing alternative discharge options, such as indirect potable reuse or underground injection, when such options can provide additional value and further improve natural resources.

II.1.3. The treatment standards in this manual help JEA standardize the operation and maintenance of its treatment facilities to reliably meet all treatment standards at the best value for its customers.

II.2. TREATMENT STANDARDS

II.2.1. EFFLUENT

II.2.1.1. JEA's WRFs shall meet wastewater effluent criteria as required by FDEP and as defined in the Clean Water Act (Title 40 *Code of Federal Regulations* Part 125 [40 CFR 125]). The minimum water quality criteria for domestic wastewater secondary treatment are defined in F.A.C. 62-600.420.

II.2.1.2. Carbonaceous 5-day Biochemical Oxygen Demand ($CBOD_5$):

II.2.1.2.1. Annual average shall not exceed 20.0 milligrams per liter (mg/L).

II.2.1.2.2. Monthly average shall not exceed 25.0 mg/L.

II.2.1.2.3. Weekly average shall not exceed 40.0 mg/L.

II.2.1.2.4. Maximum-permissible concentration in any single sample shall not exceed 60.0 mg/L.

II.2.1.2.5. Monthly average percent removal shall not be less than 85 percent.

II.2.1.3. Total Suspended Solids (TSS):

II.2.1.3.1. Annual average shall not exceed 20.0 mg/L.

II.2.1.3.2. Monthly average shall not exceed 30.0 mg/L.

II.2.1.3.3. Weekly average shall not exceed 45.0 mg/L.

II.2.1.3.4. Maximum-permissible concentration in any single sample shall not exceed 60.0 mg/L.

II.2.1.3.5. Monthly average percent removal shall not be less than 85 percent.

II.2.1.4. Disinfection and pH control shall be provided per F.A.C. 62-600.440 and 62-600.445. There are no nutrient limitations under the defined minimum treatment requirements. However, there are general provisions that discharge will comply with water quality criteria found in F.A.C. 62-302.

II.2.1.5. Effluent from JEA WRFs that discharge to the St. Johns River must meet Class III surface water criteria, found in F.A.C. 62-302.531, for lakes and streams. When there are stricter than secondary limitations, post-secondary or tertiary treatment is required.

II.2.1.6. Effluent from JEA WRFs that are permitted for backup discharge is regulated under the *A Prototype Realistic Innovative Community of Today* (APRICOT) Act. This discharge must be limited to 30 percent of the permitted reuse capacity annually, and the utility must provide advanced wastewater treatment (AWT) and high-level disinfection (HLD) treatment.

II.2.1.7. AWT is defined in Chapter 403, Section 086 of the Florida Statute (F.S. 403.086) as containing not more than the following concentrations:

II.2.1.7.1. $CBOD_5$ annual average shall not exceed 5 mg/L.

II.2.1.7.2. TSS annual average shall not exceed 5 mg/L.

II.2.1.7.3. Total Nitrogen (TN) annual average shall not exceed 3 mg/L.

II.2.1.7.4. Total Phosphorus (TP) annual average shall not exceed 1 mg/L.

II.2.1.8. HLD is provided, which meets the following performance standards:

II.2.1.8.1. Over a 30-day period (monthly), 75 percent of the fecal coliform values shall be below the detection limits.

II.2.1.8.2. No sample shall exceed 25 fecal coliform values per 100 milliliters (mL) of sample.

II.2.1.8.3. No sample shall exceed 5.0 mg/L of TSS before application of the disinfectant.

II.2.1.9. To ensure less than 5 mg/L of TSS, filtration is required. However, the rules allow slightly relaxed bacteria limits during backup discharge, called intermediate disinfection criteria, as provided in F.A.C. 62-600.440(7). In application, the design basis will be the HLD criteria; the intermediate criteria are only for compliance monitoring. AWT limits are summarized in Table II-1.

Table II-1. Advanced Wastewater Treatment Limitations and Select Monitoring Requirements

Surface Water Effluent Characteristic		Discharge Limitations			Monitoring Requirements	
		Annual Average	Monthly/Weekly Average	Single Sample	Monitoring Frequency	Sample Type
Flow	(mgd)	TBD	Report	NA	Daily	Calculation
$CBOD_5$	(mg/L)	5.0	6.25/7.25	10.0	Weekly	24-hour comp.
TSS	(mg/L)	5.0	6.25/7.25	10.0	Weekly	24-hour comp.
TN	(mg/L)	3.0	3.75/4.50	6.0	Weekly	24-hour comp.
NH_3-N	(mg/L)	NA	2.0/NA	Report	Weekly	24-hour comp.
TP	(mg/L)	1.0	1.25/1.50	2.0	Weekly	24-hour comp.
Fecal Coliform	75% of samples must measure below detection limits over a 30-day period.			25 #/100 mL	Weekly	Grab
pH	(SU)			$6 \le pH \le 8.5$	Continuous	Meter

Notes:

Weekly limits only apply when more than one sample is taken in a week; otherwise, the single and monthly limits apply.

Actual permits will be decided by FDEP.

= number of colonies

comp. = flow-adjusted composite

mgd = million gallons per day

NA = not applicable

NH_3-N = ammonia nitrogen

SU = standard unit(s)

TBD = to be determined

II.2.1.10. Effluent from JEA WRFs that enters the public access reuse system (South Grid Reclaimed Service System) is to be reclaimed water that is treated beyond secondary limits. To meet public access reuse quality standards, the following criteria must be met:

II.2.1.10.1. WRF must be designed to meet Class I reliability.

II.2.1.10.2. HLD shall be required and is defined under F.A.C. 62-610.460 and 62-600.440(5).

II.2.1.10.3. Filtration is required for low detection levels for fecal coliform.

II.2.1.10.4. TSS concentrations shall not exceed 5 mg/L for every sample.

II.2.2. SOLIDS

JEA's WRFs shall incorporate solids holding tanks and sludge dewatering. All future WRFs shall transport biosolids to Buckman WRF to be treated to Class A criteria. For a more detailed description of these requirements, refer to 40 CFR 503. Solids holding tanks and WRFs shall be aerobic digestors capable of treating solids to meet Class B criteria, as defined by 40 CFR 503, as a backup in case of disruption of Buckman WRF solids treatment.

II.2.3. ODOR CONTROL

JEA's WRFs shall incorporate biological trickling filters for odor control treatment. A carbon polisher may be included if deemed necessary. At a minimum, influent pump stations, headworks facilities, and splitter boxes prior to biological treatment shall treat odorous air. **Table II-2** presents the minimum requirements for odor treatment:

Table II-2. Odor Treatment Minimum Requirements

Parameter	Units	Min	Avg	Max	Comments
Temperature	°F	30	NA	110	
H_2S Removal	%	Minimum 99% removal over any 24-hour period or an outlet concentration less than 0.1 ppmv, whichever is greater			
Min EBRT @ Max Air Flow	sec	20	NA	NA	vessel diameter less than 12 feet
Pressure Loss Across Vessel	inches	NA	NA	NA	<3.0-inch water column

°F = degree(s) Fahrenheit
avg = average
EBRT = empty bed residence time
H_2S = hydrogen sulfide
min = minimum
max = maximum
ppmv = parts per million by volume
sec = second(s)

II.3. FLOWS AND LOADS DEVELOPMENT

II.3.1. TERMS USED

II.3.1.1. AAD = annual average day

II.3.1.2. AADF = annual average daily flow

II.3.1.3. $CBOD_5$ = carbonaceous 5-day biochemical oxygen demand

II.3.1.4. DMR = Discharge Monitoring Report

II.3.1.5. lb/d = pound(s) per day

II.3.1.6. MD = maximum day

II.3.1.7. MDF = maximum daily flow

II.3.1.8. mg/L = milligrams per liter

II.3.1.9. mgd = million gallons per day

II.3.1.10. M3MADF = maximum 3-month average daily flow

II.3.1.11. MinDF = minimum daily flow

II.3.1.12. MM = maximum month

II.3.1.13. MMADF = maximum month average daily flow

II.3.1.14. MW = maximum week

II.3.1.15. NH_3-N = ammonia nitrogen

II.3.1.16. PHF = peak hour flow

II.3.1.17. PIF = peak instantaneous flow

II.3.1.18. TKN = total Kjeldahl nitrogen

II.3.1.19. TP = total phosphorus

II.3.1.20. TSS = total suspended solids

II.3.1.21. VSS = volatile suspended solids

II.3.1.22. WRF = water reclamation facility

II.3.2. POPULATION/FLOW PROJECTION

Flow projections shall reflect the existing or initial service area as well as the assumed future service area. If a service area is experiencing rapid growth, phased construction is advised. Flow projection data should be supplied by JEA. Consultants should expect to work with JEA to develop the design flows and loads based on the supplied population and flow projection data.

II.3.3. PLANNING PERIOD

WRFs shall be designed assuming a 20-year planning period.

II.3.4. FLOWS BASIS

All WRF design capacities shall be based on a permitted AAD basis. Historic flow data are to be provided by JEA prior to design to determine initial and future flows. If sufficient data are not available, additional sampling may be required. The AADF, MMADF, M3MADF, MDF, MinDF, PHF, and PIF shall be calculated according to the associated peaking factors and considered in the design. These peaking factors are MMADF:AADF, M3MADF:AADF, MDF:AADF, MinDF:AADF, PHF:AADF, and PIF:AADF.

II.3.5. LOADS BASIS

All WRF design loads are to be calculated using the AADF and the AAD influent concentrations of $CBOD_5$, TSS, TKN, NH_3-N, VSS, and TP in mg/L units where data are available. Load peaking factors are to be computed from influent data and shall be applied to the AAD load to determine the design loads for the plant. Data are to be based on at least 3 years of influent data provided by JEA prior to the design. If sufficient data are not available, additional sampling may be required. Data points outside of three standard deviations should be considered for removal as they are typically outliers and can unnecessarily impact the design.

II.4. RELIABILITY AND REDUNDANCY

JEA's WRFs are to be designed to meet a minimum of Class I reliability as defined by the U.S. Environmental Protection Agency (EPA 1973). These criteria are summarized in Table II-3. Additional redundancy requirements are to be incorporated as requested by JEA.

Table II-3. Reliability Criteria Summary for Class I Reliability

Unit Process/Operation	Reliability Criteria
Screens	Required; provide manually cleaned backup bar screen for mechanically cleaned screen.
Grit Removal	Required.
Provisions for Removal of Settled Solids	Required for all components, channels, pump wells, and piping before degritting.
Headworks and Primary Splitter Box Bypass	Provide fittings and valves to allow for temporary piping during full headworks and/or primary splitter box bypass events. Permanent bypass piping can be evaluated as needed on specific projects.
Unit Operation Bypass	Not needed where two or more units are provided, and operating unit can handle peak flow.
Pumps	Provide a backup pump that performs the same function for each set of pumps. With the largest pump out of service, remaining pumps must have the capacity to handle peak flow.
Aeration Basins	Minimum of two of equal volume.
Aeration Blowers	Multiple units. with largest unit out of service, the remaining units must be able to maintain design oxygen transfer. A backup unit may be uninstalled.
Air Diffusers	Multiple sections. with the largest section out of service, oxygen transfer capability will not be measurably impaired.
Final Sedimentation Basins (Secondary Clarifiers)	Multiple basins. With largest unit out of service, remaining units have capacity for at least 75 percent of design flow.
Filters	Multiple units. Provide minimum design capacity of at least 75 percent of design flow with one unit out of service.

Table II-3. Reliability Criteria Summary for Class I Reliability

Unit Process/Operation	Reliability Criteria
Disinfectant Contact Basins	Multiple basins. With largest unit out of service, the remaining units must have the capacity for at least 50 percent of design flow.
Aerobic Sludge Digestion	Backup basin is not required. At least two blowers must be provided (may be uninstalled).
Centrifuge Dewatering	Firm capacity shall be provided (may be uninstalled).
Power Source	Provide two separate and independent power sources from either two separate utility substations or from one substation and one standby generator, with the backup power source sufficient to operate all vital components, including critical lighting and ventilation, during peak flow conditions. Grit removal and sludge processing components are optional for backup power.

II.5. RESILIENCY

The object of resiliency shall be to plan for future conditions instead of basing designs on past conditions. Service lives for most mechanical equipment shall be at least 20 years, and building service lives shall aim to be approximately 50 years, though more specific service life estimations may be made depending on the facility. There are many aspects to a resilient design, some of these aspects and mitigation strategies are discussed in the following sections.

II.5.1. FLOOD-RELATED HAZARDS

II.5.1.1. A resiliency study was completed by Jacobs for JEA. This study evaluated ways to reduce flood-related hazards to increase resiliency. Results of this study are summarized in the following sections and shall be applied to future WRFs to ensure proper flood mitigation. For more detail, refer to the *Flood Exposure Review and Resilience Guide Technical Memorandum* (Jacobs 2019).

II.5.1.1.1. Ground and access roads shall be raised to an elevation above the future flood elevations to minimize frequency and severity of potential flood impacts to access road or operations today and over the service life of the facility.

II.5.1.1.2. According to American Society of Civil Engineers (ASCE) 24-14, freeboard considerations shall be made with regard to either above the base flood elevation or above the 500-year flood elevation, whichever is higher.

II.5.1.1.3. The minimum design elevations for various points across the site shall vary based on the facility.

II.5.1.1.3.1. WRF sensitive and critical facilities: 2-foot freeboard above flood-stage elevation

II.5.1.1.3.2. Less sensitive/critical facilities: 1-foot freeboard above flood-stage elevation

II.5.1.1.3.3. Access road: 0.5 foot above flood-stage elevation

II.5.1.1.4. If elevation of facilities is unable to take place, other flood mitigation strategies, such as equipment and facility hardening, shall be implemented.

II.5.2. HIGH WIND AND FLYING DEBRIS

Adoption of Miami-Dade County Building Code design wind speed of 165 miles per hour (mph) as a minimum is best recommended for resiliency.

II.5.2.1. Maintain vegetation and large trees away from critical facilities and key access routes.

II.5.2.2. Use underground power distribution and service lines.

II.5.2.3. Secure lightweight materials, fencing, and other objects that could become flying debris.

II.5.2.4. Design buildings, equipment, communications, tanks, pipes, and so on, to 165-mph wind rating.

II.5.3. LIGHTNING

II.5.3.1. Provide lightning protection for all buildings.

II.5.3.2. Provide canopy or roof over elevated equipment to limit exposure to operators.

II.5.3.3. Provide surge protectors for all sensitive equipment.

II.5.4. EXTREME HEAT

II.5.4.1. Provide shade and cooling fans for staff and heat-producing equipment.

II.5.4.2. Provide backup power for cooling fans and heating, ventilation, and air conditioning (HVAC) units for critical equipment.

II.5.4.3. Keep chemicals in shaded or covered storage areas.

II.5.5. WILDFIRE AND BUILDING FIRE

II.5.5.1. Maintain adequate clear space around all facilities that is free from debris and vegetation.

II.5.5.2. Use barrier walls, where necessary, adjacent to areas of elevated fire risk or for critical equipment.

II.5.5.3. Maintain fire suppression equipment for all habitable and combustible buildings.

II.5.5.4. Maintain safe separation and storage for volatile and flammable chemicals.

II.5.6. DROUGHT

II.5.6.1. Awareness of impacts from drought are evaluated in the water masterplan, with plans for enhancing system reliability to avoid service impacts to JEA customers.

II.5.6.2. No further mitigation activities are anticipated at this time.

II.6. PROCESS MODELING

II.6.1. JEA has standardized on the commercially available BioWin software by Envirosim Associates Ltd. The following guidelines shall be used by design engineers when developing, modifying, and updating a BioWin model of a JEA facility.

II.6.2. The process flow diagram in model shall include all liquid and solids processes as well as all influent flows and loads to the WRF.

II.6.3. A thorough review of background information shall be conducted, including but not limited to record drawings, equipment shop drawings, operating data, and interviews with JEA staff. Existing models from previous projects shall be updated if more than 1 year has passed since the simulations were performed.

II.6.4. A calibration and validation step shall be performed when simulating existing WRF processes and sufficient influent and operating data are available. The level of validation or calibration shall be defined in the project scope but at a minimum shall include calibration using three distinct operating conditions (for example, temperature, units in service, and seasonal loading) and then validated with two additional, distinct operating conditions. Successful calibration/validation shall be defined as model results within 10 percent of operating data.

II.6.5. Flow and loading scenarios shall be developed for simulation using the process model that represents the entire range of projected conditions over the expected life of the facility. At a minimum, these scenarios shall include minimum day, AAD, MMAD, MD, and PHF. Other scenarios, such as maximum 3-month average day and MW average day, may be appropriate depending on the process and solids retention times employed. Scenarios shall also include the aforementioned loading conditions at minimum and maximum temperatures where appropriate to ensure aeration systems have the capacity and variability to respond to the full range of expected flow conditions.

II.6.6. The process model used to develop the base for any design and construction project shall be updated at every milestone deliverable and prior to facility startup.

II.6.7. Process simulations shall be performed by a qualified process engineer and reviewed by an independent senior process engineer.

II.7. HYDRAULIC PROFILE

II.7.1. Hydraulic modeling software may be used to model piping, launders, weirs, and processes. An initial yard piping plan shall be developed for the gravity process flow through the WRF, which is used to develop the hydraulic calculations. The hydraulic analysis shall also ensure that a minimum 2-foot freeboard will be provided in channels, wet wells, and other water-holding structures at the worst-case flow conditions. The following assumptions are used to create the hydraulic profile.

II.7.2. The hydraulic basis of design for wastewater handling facilities shall be the following flows for the design year:

II.7.2.1. AADF: The average of the daily volumes to be received for a continuous 12-month period, expressed as mgd. For facilities expecting to have seasonal, high hydraulic loading periods, such as recreational areas, campuses, and industrial areas, the design average flow shall be based on the average of daily volumes during the seasonal period.

II.7.2.2. Design PHF: The largest volume of flow received in a 1-hour period, expressed as mgd. For resiliency and expansion purposes, a future PHF scenario may be developed.

II.7.2.3. Design PIF: The instantaneous maximum flow rate to be received.

II.7.2.4. Where applicable, the PIF is modeled from the headworks to the process bioreactors, and the PHF is used for all piping and facilities downstream of the process bioreactor.

II.7.2.5. A preliminary land survey showing the site elevations shall be used to establish existing and expected field conditions. Distances are estimated from the initial site plan layout.

II.7.3. VERIFICATION OF EXISTING HYDRAULIC CONDITIONS

II.7.3.1. The hydraulic capacity for wastewater facilities to serve existing collection systems shall have projections made from actual flow data as much as possible. Existing data and projections for all critical design flow conditions should be evaluated for the probable degree of accuracy. This should include but is not limited to evaluations of the following:

II.7.3.1.1. The accuracy of existing data

II.7.3.1.2. Estimates for reduction in flow due to infiltration/inflow (I/I)

II.7.3.1.3. Estimates for flow increases from bypasses, backups, or hydraulic restrictions

II.7.3.2. The hydraulic capacity for wastewater facilities serving new collection systems shall be based on an average daily flow as determined by JEA Planning.

II.7.4. CONTROL POINTS

II.7.4.1. Hydraulic modeling shall evaluate low-flow conditions and peak-flow instances as described in the design flow conditions. The low-flow conditions from initial startup shall be evaluated to minimize operation issues with septicity, flow measurements, and solids dropout in early treatment stages. Peak-flow instances and conditions shall be used to evaluate their impacts on unit processes, pumping, piping, settling tanks, and other components of the treatment process.

II.7.4.2. The selected design flows shall meet the appropriate effluent and water quality standards as established in the discharge permit. Treatment units not subject to PHF requirements shall be designed for an appropriate alternate flow condition that represents the maximum flow it is expected to experience. For facilities subject to high wet-weather flows or overflow detention pump-back flows, the design MD flows to be treated on a sustained basis are to be specified.

II.7.4.3. All piping and channels shall be designed to carry the maximum expected flows, with the incoming sewer designed for unrestricted flow. Channels shall feature filleted bottom corners, excluding final effluent channels, and conduits shall avoid pockets and corners to minimize solids accumulation.

II.7.4.4. Process head losses may be estimated or provided by manufacturers listed in Volume III: Water and Wastewater Approved Materials Manual of the JEA *Water and Wastewater Standards Manual*.

II.7.5. INSTRUMENTATION AND CONTROLS REQUIREMENTS

II.7.5.1. This section addresses the philosophy driving the criteria for the instrumentation and controls (I&C) system design for all facilities. The format and content described herein is based on discussions with JEA staff and includes a description of the design criteria for the control system architecture and device control. Format and content of piping and instrumentation diagrams (P&IDs), tag numbering, naming, and abbreviations shall comply with JEA's most current Wastewater Systems P&ID Standard Guidelines.

II.7.5.2. Process Control System Philosophy

II.7.5.2.1. Interlocking that protects humans will be implemented in a manner that ensures it is functional in all equipment operational modes. For example, this type of interlock will be in the motor starter circuit for motor-driven equipment. Some equipment protection interlocks will be implemented according to the same criteria; for example, an interlock that stops a pump when a high temperature is detected in the pump's motor. The criteria will not necessarily be applied to indirect equipment protection interlocks, for example, a low level in a wet well that may lead to a high temperature in a motor winding if the associated submersible pump operates for too long a period below the interlock level.

II.7.5.2.2. The level of automation to be designed will be comparable to typical automation levels provided at plants of comparable size and unit processes. Some criteria for level of automation follow, along with additional notes on control design.

II.7.5.2.3. In general, it will be assumed that an operator will put a pump or blower hand switch (for example, ON/OFF/AUTO switch) into the OFF position whenever any valve that would prevent flow is closed. This eliminates the need to provide flow instruments solely to support pump or blower protection interlocking. For example, flow switches on pumps will not be provided for pump protection if not needed for other reasons. However, it must be understood that this increases the risk of equipment damage.

II.7.5.2.4. Neither pumps nor blowers will be provided with flow sensors solely for the purpose of proving operation. Feedback from drives or contactors will be used.

II.7.5.2.5. Valves and gates with motorized or pneumatic actuators operated by the control system will have position feedback signals wired or networked to the control system. By default, manually operated valves will not be provided with position sensors or associated signals tied to the control system. The supervisory control and data acquisition (SCADA) human-machine interface (HMI) will allow operator input of equipment that could be offline due to any number of reasons, including closure of manual valves.

II.7.5.2.6. Instruments provided for reasons other than interlocking will be used to provide equipment protection interlocking, if possible.

II.7.5.2.7. By default, pumping of wastewater will be automated and interlocked to maintain level in the associated basin or wet well. Exceptions will be made where frequent start/stop or speed adjustment is not required.

II.7.5.2.8. Measurement or automatic manipulation of flow splits will not be provided where process mechanical designers indicated that an acceptable flow split will occur over the anticipated operating regime due to a balanced hydraulic design.

II.7.5.2.9. No instrumentation, control elements, or control logic will be added to compensate for short-term or low-magnitude disturbances that will occur to process flow measurements, unless lack of compensation is deemed a serious issue. For example, in some piping configurations, return activated sludge (RAS) flow rate measurements are the sum of waste activated sludge (WAS) and RAS flow and technically in error when WAS is flowing. However, WAS may only flow for a short duration, and it is not necessary to have precise RAS flow control over short intervals.

II.7.5.2.10. Control strategies for chemical metering pumps will assume that a chemical solution's rate of flow is proportional to speed command and, where applicable, stroke length. Stroke length would be manually entered. Metering pumps will not be controlled in a closed-loop fashion using a flowmeter on the chemical solution line.

II.7.5.3. Process Control System Architecture

II.7.5.3.1. The plant's control system shall include a distributed network of programmable logic controllers (PLCs). The PLCs shall adhere to JEA's *Water and Wastewater Standards Manual*. Refer to "Electrical-Electronics-Instrumentation" in Section WT-503, Electronic Equipment, in Volume III: Water and Wastewater Approved Materials Manual of the *Water and Wastewater Standards Manual*.

II.7.5.3.2. The HMI system shall use HMI software listed in this same Section WT-503, Electronic Equipment, of the JEA Standards to interface with the PLCs. Approved graphical user interfaces are also listed in this section of the JEA Standards and shall be provided to display the status and allow control of the unit operations from the HMI. The HMI software shall be configured per JEA HMI configuration standards. A redundant pair of servers shall be located at the WRF to ensure maximum uptime for process visualization and operator control. Two or more client workstations shall be in the control room. Other client workstations shall be mounted on the front of control panels in electrical rooms. Mobile workstations shall be used elsewhere in the WRF.

II.7.5.3.3. The HMI system shall include a local historian to support trending; this shall be configured by the contractor. JEA staff will configure the existing central historian and reporting system (OSIsoft PI) as required to incorporate the new plant. The local HMI may buffer data to be sent to the central historian.

II.7.5.3.4. The distributed PLCs and HMI servers will be interconnected with a Profinet network. That network will provide fault tolerance. Fiber optic cabling will be used for segments that travel outside of protective buildings.

II.7.5.3.5. Profinet networks will be the default connection of actuators and motor controls to the plant control system.

II.7.5.3.6. All PLC processors, HMI servers, non-mobile HMI clients, and network switches shall have 10 minutes of backup power provided by an uninterruptable power supply (UPS). UPS power will not be provided to field instruments or gate/valve actuators.

II.7.5.4. Field Instrument Selection

II.7.5.4.1. Profinet networking of instruments will be used when supported by instrument vendors. If not available, Profibus DP networking will be used. If instrument vendors do not support Profinet or Profibus DP, 4- to 20-milliampere current loops will be used. Contact closures on 120-volt-alternating-current (VAC) circuits will be the default for discretely wired binary signals.

II.7.5.4.2. Refer to “Instrumentation” in Volume III: Water and Wastewater Approved Materials Manual of the *Water and Wastewater Standards Manual* for acceptable manufacturers.

II.7.6. CONTROL MODES

II.7.6.1. HMI Workstation/PLC Control Modes

Any automatic or HMI control requires the equipment to be placed in Remote mode at the local station or motor starter. Remote control indicates that control is from the SCADA system, and the operation of the piece of equipment may be based on responses to programmed actions or in response to manual commands from operators through the control system. Specific unit operation control narratives shall be included in a narrative description for the individual pieces of equipment and unit operations.

II.7.6.2. PLC-Automation Mode

This mode of operation is for processes that only require one or two entries at the HMI and automatically adjust to the changing conditions without operator intervention. Once the PLC receives the message from the HMI that the Automatic mode is selected and the setpoints are accepted, the PLC runs the Automatic mode. The equipment must be placed in the Remote mode at the local control station or motor starter.

II.7.6.3. PLC-Manual Mode

Equipment can be controlled from the HMI automatically or manually. The operator can select the manual mode of operation at the HMI and manually start and stop a piece of equipment by clicking a button on the screen. For variable-speed devices, the operator can enter the desired speed as a percentage, and the device will move to that speed setting. The equipment must be placed in the Remote mode at the local control station or motor starter.

II.7.6.4. Local-Automatic Mode

Local-Automatic only applies to a select group of equipment that usually falls under the design term "package systems." This equipment contains all the devices and controls necessary to run with no intervention from the WRF SCADA system. These systems can run standalone but offer some monitoring interfaces. Typically in this mode, the equipment must be placed in Automatic mode at the local control station.

II.7.6.5. Local-Manual Mode

This mode of operation applies to equipment that has a local control station or panel that provides enough of an interface for the operator to stand near the equipment and operate it. This term also applies to devices with drives or starters that provide the same interface. When the local switch is at ON, LOCAL, or HAND, the device is energized to start. Local control indicates that control is from the local field panel, and the SCADA system will not have the ability to start or stop the target equipment.

II.7.6.6. Local Field Device Control

II.7.6.6.1. Local field device controls are a set of controls located at the device in the field. These controls will allow operations personnel to remove control of the device from the SCADA system and use locally mounted interfaces to control the device.

II.7.6.6.2. A LOCAL/OFF/REMOTE switch, lockable in the OFF position, will be located at these devices and allow the operations personnel to make the selection. The LOCAL/OFF/REMOTE switch will be linked to the SCADA system. Using this input, the control system will indicate the current state of each device on the HMI and allow the programming control code to react properly if a device is placed in local control or is turned OFF.

II.7.6.7. Remote Field Device Control

II.7.6.7.1. The SCADA system will be programmed to allow selection of automatic operation of many of the functions, including the following:

II.7.6.7.1.1. Flow pacing of chemical injection with analyzer trim when an analyzer is available

II.7.6.7.1.2. Automatic rotation of equipment where in-line spare equipment is available

II.7.6.7.1.3. Automatic adjustment of pump speed to maintain pressure or flow, as required

II.7.6.7.1.4. Automatic start and stop of unit operations as required to maintain plant operation (for example, correct number and speed of raw water pumps based on operation demand)

II.7.7. Final Control Elements

II.7.7.1. Valve and Gate Actuators

II.7.7.1.1. Powered actuators, where required, will be motorized on larger valves and gates and solenoids on small valves.

II.7.7.1.2. Motorized actuators for both modulating and shutoff service will include integral reversing motor starters. Actuator control stations will be provided with control stations that include OPEN/STOP/CLOSE pushbuttons with momentary contact outputs. The control station will be integral to the actuator when the actuator is accessible by operators; it will be mounted nearby in an accessible location otherwise. The control station will include a maintained LOCAL/REMOTE mode selector switch when remote control is possible. The control station will also include a contact output indicating current mode. Actuators on valves in shutoff service will be provided with limit switches in the OPEN and CLOSED positions. Actuators on valves in modulating service with remote control will include positioners and position transmitters. The default power failure mode for motorized actuators will be to “fail” in last position. The default mode for modulating actuator failure reaction to loss-of-command signal will be to “fail” in last position.

II.7.7.1.3. The failure position of solenoid-operated valves, open or closed, will be chosen based on process needs.

II.7.7.2. Motor-driven Equipment

II.7.7.2.1. Unless specifically required by the equipment application, motor control circuits shall use maintained contact controls. Therefore, motors will restart automatically on loss of power.

II.7.7.2.2. Devices associated with solids dewatering may use motor control circuits based on momentary contact controls or other means to prevent restart on return of power. These devices are part of a sequenced operation that requires coordinated startup and are not required to operate continuously.

II.7.7.2.3. Interlocks for human safety and equipment protection shall be provided by discretely wired components (that is, not PLCs) and operate in both automatic and manual modes. Interlocks shall be latched and require a manual reset. The default design for process interlocks shall have an automatic reset, with the interlock operational only in Automatic mode.

II.7.7.2.4. Interlocks that are preventing manual operation of a motor-driven equipment item, along with overload relay trips, shall be combined into a single “fail” signal that will be transmitted to a central alarm panel.

II.7.7.2.5. The default location for motor control circuits shall be at the location of the motor starter. For most motors, this will be at the motor control center (MCC) or a vendor-supplied control panel. Indicating lights and operator hand switches will be at the same location in most instances. Where warranted, a custom field control panel with operator devices will be designed for a location near the equipment.

II.7.7.2.6. Variable frequency drive (VFD) shall be provided with local operator speed adjustment. The drive shall be designed to receive a speed command where remote control is required, and a speed feedback signal shall be provided.

II.7.7.3. Network and Wi-Fi

II.7.7.3.1. JEA will provide equipment associated with some of the plant networks. This equipment will be installed in one or more electronic racks. JEA will mount the equipment in the racks and make all internal connections on the rack. The racks will include an UPS for the installed equipment and fiber optic and copper network patch panels for direct connection. The construction contractor will mount the racks and make all external power and network connections to the racks.

II.7.7.3.2. Networks to be connected will include SCADA, Reuse, Business, Electronic Access Control, and Video Surveillance.

II.7.7.3.3. The portion of each network that is not on the JEA-provided network racks will be physically segregated from other networks. SCADA and Reuse networks may use separate fibers on the same cable; no other networks will use fibers in these cables. Fiber interconnect enclosures will be provided in buildings with fiber. Cables supporting other networks (that is, not SCADA or Reuse) can use the same fiber interconnect enclosures as SCADA and Reuse. JEA, through its configuration of equipment mounted in the rack that they provide, will be responsible for maintaining that segregation and any cybersecurity measures required for interconnection. Additional networks may be added as each design progresses, for example, fire alarm systems or telephony. These same segregation criteria will be used for those additional networks.

II.7.7.3.4. The business network will provide wall plates for wired connectivity in various rooms in the Operations Building and Maintenance Building. The control room in the Operations Building will include at least one of these wall plates. Business network access for the balance of the plant will be provided via strategically located wall plates. Wall plates will be deployed for wired access within other buildings (for example, Electrical Building).

II.8. POWER REQUIREMENTS

II.8.1. The electrical distribution system shall be designed to provide Class I reliability, as described in EPA Bulletin 420-99-74-001, achieved by providing normal utility power and onsite standby generator(s). The onsite standby generator(s) shall be sized to supply all vital (also called “critical”) plant loads as defined by EPA Bulletin 430-99-74-001:

II.8.1.1. *Vital component*: *A component whose operation or function is required to prevent a controlled diversion, is required to meet effluent limitation, or is required to protect other vital components from damage*.

II.8.2. The facility's internal distribution system must also provide sufficient redundancy such that no single fault or loss of power will disrupt more than one MCC or switchgear buses that service loads common to a critical unit or process by using double-ended MCCs/buses with critical load spilt evenly between the MCCs/buses.

II.8.3. The distribution voltage at existing facilities will be determined on a case-by-case basis. At new, greenfield sites, the distribution voltage will be 480 volts, three-phase.

II.8.4. Equipment will be selected with adequate momentary and interrupting capacity for the point in the system where it is used. Series-rated criteria will not be used, except for self-contained equipment. Phase and ground-fault protective devices and device settings will be selected that will function selectively to disconnect that portion of the system that is malfunctioning with as little disturbance to the rest of the system as possible. A preliminary analysis of the fault duty and device coordination will be made to produce a design that can be bid accurately by the contractor. Maximum fault duty will be analyzed with sufficient accuracy to establish the required interrupting ratings of circuit-protection devices specified. Final short-circuit, coordination, and arc-flash studies based on actual equipment purchased will be performed by the contractor to establish the range of protective device settings that will result in reasonable selectivity of device operations for both three-phase and ground faults.

II.8.5. NFPA 70 and 820 shall be used to determine if areas should be classified as “explosive hazards.” The process engineer will determine the types and quantities of vapor/gas present in the air in each space, and the electrical engineer will determine the “hazardous” classification, if applicable.

II.8.6. Electrical equipment used shall be in accordance with JEA Water and Wastewater Approved Material Manual Volume III.

II.9. ESSENTIAL FACILITIES

II.9.1. SERVICE ENTRANCE RATED MAIN BREAKERS

II.9.1.1. All service entrance rated main breakers shall be draw-out type power circuit breakers with LSIG solid-state trip units that communicate with the plant SCADA system over Profinet.

II.9.2. MAIN SWITCHGEAR

II.9.2.1. The main switchgear for the facility shall be configured in a main/tie/tie/main arrangement, with a load bus on each end and generator bus in the middle. The utility incoming service will terminate at bus A and bus B on each end of the switchgear through two main breakers. The generator bus (bus C) will be connected between bus A and bus B through two tie breakers. The generator incoming feeder(s) will terminate at the generator bus (bus C) through generator breakers.

II.9.2.2. The main, tie, and generator breakers will be electrically interlocked and controlled by PLC-based automatic throw-over (ATO) system. The ATO will follow a break-before-make scheme to prevent accidental paralleling of the utility transformers and generator(s). Under normal operation, the tie breakers will be open, and main breakers will be closed. In the event of a utility power failure on bus A while utility power remains on bus B, the ATO will automatically open the main breaker on bus A and then close both tie breakers so utility power on bus B can be provided to bus A. When normal utility power is restored to bus A, the ATO will open tie breakers and then close the main breaker on bus A so normal utility power can again be provided on bus A.

II.9.2.3. For a utility power failure on bus B, the ATO will automatically open the bus B main breaker and then close both tie breakers so bus A provides power to bus B. When utility power to bus B is restored, the ATO will open both tie breakers and then close the bus B main breaker so normal utility power can again be provided on bus B.

II.9.2.4. For a utility power failure on both bus A and bus B, the ATO will automatically open both the bus A and bus B main breakers, send a start signal to the generator, close the generator breaker(s), and then close both tie breakers so standby generator power is provided to both bus A and bus B. When utility power is restored, the ATO will open both tie breakers, close both main breakers, and open the generator breaker(s).

II.9.2.5. In the event of a failure of bus A, the main breaker for bus A and the associated tie breaker can be opened to isolate the faulted bus for repairs while keeping the loads on bus B online. Additionally, the same can be done to isolate bus B in the event of a failure.

II.9.2.6. Main switchgear for medium-voltage, three-phase systems shall be double-high metal-clad construction, with vacuum circuit breakers meeting the requirements of ANSI/IEE C37.20.2.

II.9.2.7. Main switchgear for 480-volt, three-phase systems shall be of metal-enclosed draw-out construction with maximum bus rating to 3,000 amps. If the load on the switchgear exceeds 3,000 amps, additional switchgear shall be provided. The switchgear shall be sized, at a minimum, to handle the peak demand load of both bus A and bus B. The switchgear lineup shall be sized with 20 percent spare space for future expansion. Breakers are to be power circuit breakers with solid-state trip units that provide adjustable long-time, short-time, and instantaneous settings. Main breakers also are to have an adjustable ground-fault setting. Switchgear buses shall be tin-plated copper.

II.9.3. STANDBY GENERATORS

II.9.3.1. Generator sets will be standby rated and provided with a walk-in, sound-attenuated enclosure, with attenuation to a maximum of 75 decibels at 20 feet from the generator enclosure, unless a low attenuation is required to meet local sound ordinance. Separate, double-walled, aboveground fuel tanks will be provided with enough capacity for 72 hours of operation at rated load. Refer to JEA Facilities Standards Manual for additional requirements.

II.9.3.2. A pad-mounted generator docking station shall be provided next to each generator. The docking station shall include a manual transfer switch with separate Camlok connections for a temporary generator and a load bank. Refer to JEA Facilities Standards Manual for additional requirements.

II.9.4. SWITCHBOARDS

The use of switchboards shall be limited and approved by JEA on a case-by-case basis.

II.9.5. MOTOR CONTROL CENTERS

II.9.5.1. Intelligent/smart MCCs with Profinet communications shall be used for communication with the facility SCADA system.

II.9.5.2. MCCs shall be double-ended, with a main/tie/main configuration when provided in a single lineup and with a main/tie/tie/main configuration when provided in two separate lineups. One end of the MCC shall be powered from bus A of the main switchgear and the other end powered from bus B of the main switchgear, with key interlock main and tie breakers to prevent paralleling the bus A source and the bus B source. When the MCC is located within the same electrical room or building with the main switchgear that feeds it, the MCC main breakers may be replaced with main lugs only. MCC buses shall be tin-plated copper.

II.9.5.3. When power panels and lighting panels are powered from MCCs, two feeders shall be provided, one feeder from the bus A MCC and the other from the bus B MCC, with the feeder breakers key interlocked to prevent the power panel or lighting panel from being powered from both MCCs at the same time.

II.9.5.4. The MCC shall be sized, at a minimum, to handle the peak demand load on both the bus A and bus B loads plus 20 percent spare capacity.

II.9.5.5. MCCs will include feeder circuit breakers, motor starters, and VFDs. Motor starters for constant-speed motors through 50 horsepower (hp) will be the full voltage, non-reversing, combination type with magnetic-only circuit breaker and solid-state motor overloads. Motor starters for constant-speed motors larger than 50 hp will use VFDs, in lieu of solid-state, reduced-voltage starters, with solid-state, adjustable-trip circuit breaker. VFDs for variable-speed motors smaller than 100 hp will be installed as part of the MCC lineup. VFDs for variable-speed motors 100 hp and larger will be standalone and powered from feeder breakers in the MCC.

II.9.5.6. Motor control circuits will be designed at 120 volts, and an individual control power transformer with 120-volt control voltage will be provided in each motor starter.

II.9.5.7. Main breakers, tie breakers, and feeder breakers 100 amps and larger are to have solid-state trip units with adjustable long-time, short-time, and instantaneous trip settings. Feeder breakers smaller than 100 amps shall have thermomagnetic trips.

II.9.5.8. MCC lineups shall be sized with 20 percent spare space for future expansion.

II.9.6. VARIABLE-FREQUENCY DRIVES

II.9.6.1. All VFDs shall be on the JEA Water/Wastewater Approved Manufacturer List. Refer to the JEA Facilities Standards Manual for additional requirements.

II.9.6.2. All VFDs shall be installed in electrical rooms or electrical buildings.

II.9.7. PANELBOARDS

Panelboards shall have tin-plated copper buses. Main breakers and feeder breakers 100 amps and larger are to have solid-state trip units with adjustable long-time, short-time, and instantaneous trip settings. Feeder breakers smaller than 100 amps shall have thermomagnetic trips. Panelboards shall be provided with 20 percent spare space for future expansion.

II.9.8. SURGE PROTECTIVE DEVICES

Surge protective devices are to be specified for all switchgear, MCCs, panelboards, and process instruments.

II.9.9. MOTORS

II.9.9.1. Motors 40 hp and above shall be invertor duty rated and be controlled by either a VFD or reduced voltage solid-state starter.

II.9.9.2. Alternating current (AC) induction motors will be specified to minimize energy consumption where possible. To accomplish this, premium efficiency motors shall be specified for motors smaller than 50 hp. A minimum 0.92 power factor and minimum 0.95 efficiency is to be specified for motors 50 hp and larger.

II.9.9.3. Motors (non-submersible applications) 25 hp and larger are to be provided with integral space heaters to prevent condensation when the motor is not in use. For winding thermal protection, thermostats will be provided on motors from 10 to 100 hp in variable-speed applications and 25 to 100 hp in constant-speed applications. Thermistors will be provided on motors larger than 100 hp and smaller than 250 hp. 100-ohm platinum resistance temperature detectors will be embedded in stator windings and on motor bearings for motors 250 hp and larger.

II.9.9.4. Bearings shall be grease-lubricated, with grease addition and relief fittings. Motor windings shall be copper only. Insulation systems shall be Class B with Class B temperature rise. All motors driven by VFDs shall be inverter duty rated with isolated bearing and derated to 1.0 service factor.

II.9.9.5. Motor enclosures will be provided suitable for the environment in which they will operate:

II.9.9.5.1. Explosion-Proof (EXP) – Suitable for installation in Class I, Division I or Class I, Division II hazardous areas

II.9.9.5.2. Dust Ignition-Proof (DIP) – Suitable for installation in a Class II, Division I hazardous area

II.9.9.5.3. Totally Enclosed Fan-Cooled (TEFC) – Suitable for most indoor and outdoor applications in which the environment is not corrosive or hazardous.

II.9.9.5.4. Chemical Industry, Severe Duty (CISD-TEFC) – Suitable for installation indoors and outdoors in high-humidity, corrosive, dirty, or salty atmosphere

II.9.9.5.5. Submersible – Suitable in installations where the entire motor assembly is submerged during normal operation

II.9.10. LIGHTING

II.9.10.1. Standard JEA area light poles and luminaires will be used to provide exterior area lighting. All luminaires will be specified to be LED. Emergency lighting shall be provided by standalone, emergency luminaires. Luminaires for normal lighting with emergency battery packs shall not be used.

II.9.10.2. Minimum foot-candle levels are provided in Table II-4.

Table II-4. Minimum foot-candle levels

Area	Foot-candle
Office	70
Electrical Room	50
Process area, inside Process area, outside	30 5
Walkways	5
General Site	1

II.9.11. ELECTRICAL ROOMS AND BUILDINGS

Electrical rooms and buildings shall be provided with redundant HVAC units and include a minimum of 20 percent free wall space that does not include the future electrical equipment space.

II.9.12. LIGHTNING PROTECTION

A lightning protection (LP) system shall be provided to comply with all applicable provisions of LPI 175, UL 96, UL 96A, and NFPA 780. LP will be provided on all buildings, aboveground structures, and pole-mounted luminaires. The LP system shall bear the UL 96 Master Label C.

II.9.13. BASIC ELECTRICAL MATERIALS

Selection of the basic electrical materials will be influenced by the physical characteristics of the environment and location, as well as the costs of the various options. The objective is to design the most robust electrical system possible while minimizing costs.

II.9.13.1. Raceways:

II.9.13.1.1. Direct buried: Polyvinyl chloride (PVC) Schedule 80.

II.9.13.1.2. Exterior exposed: Rigid aluminum.

II.9.13.1.3. Underground, concrete-encased: PVC Schedule 40.

II.9.13.1.4. Interior concealed: Rigid aluminum.

II.9.13.1.5. Administrative areas: Electrical metallic tubing (EMT).

II.9.13.1.6. Exterior, exposed, corrosive areas: PVC Schedule 80.

II.9.13.1.7. Interior exposed: Rigid aluminum.

II.9.13.1.8. 90-degree elbows in underground conduit shall be rigid aluminum. Elbows in transition from underground or embedded applications to exposed shall be rigid aluminum.

II.9.13.1.9. Separate conduits for discrete signal cables from conduits for power conductors and cables in parallel runs over 50 feet by a minimum of 6 inches.

II.9.13.1.10. Separate conduits for analog signal and data communications cables from conduits for power conductors and cables in parallel runs by a minimum of 12 inches.

II.9.13.1.11. Separate conduits for VFD cables from other conduits in parallel runs by a minimum of 12 inches.

II.9.13.1.12. Conduits for fiber optic cables, telephone cables, and Category 5 data cables shall be installed in strict conformance with the requirements of EIA/TIA 596-A.

II.9.13.2. Raceway Tags:

II.9.13.2.1. Identify origin, destination, voltage, and circuit number.

II.9.13.2.2. Install at each exposed terminus (switchgear, MCC, panelboard, control panel, junction box, pull-box, disconnect switch, control stations, motors, receptacles, light switches, instruments, and so forth) near midpoint and at minimum intervals of every 50 feet of exposed raceways, whether in ceiling spaces or surface-mounted.

II.9.13.2.3. Attach with nylon straps.

II.9.13.3. Enclosures:

II.9.13.3.1. Corrosive Areas: NEMA 4X, Type 316 stainless steel

II.9.13.3.2. Exterior exposed: NEMA 4X, Type 316 stainless steel

II.9.13.3.3. Interior controlled: NEMA 1, gasketed

II.9.14. STANDARDS AND CODES

II.9.14.1. The electrical design will conform to the latest applicable editions of the following standards and codes:

II.9.14.1.1. National Electrical Code (NEC)

II.9.14.1.2. National Fire Protection Association (NFPA)

II.9.14.1.3. National Electric Safety Code (NESC)

II.9.14.2. Standards and codes of the following shall govern where applicable:

II.9.14.2.1. American National Standards Institute (ANSI)

II.9.14.2.2. National Electrical Manufacturers Association (NEMA)

II.9.14.2.3. Institute of Electrical and Electronic Engineers (IEEE)

II.9.14.2.4. Insulated Cable Engineers Association (ICEA)

II.9.14.2.5. Occupational Safety and Health Act (OSHA)

II.9.14.2.6. American Society for Testing and Materials (ASTM)

II.9.14.3. Where the requirements of more than one code or standard are applicable, the more restrictive shall govern.

II.9.15. POWER SUPPLY

II.9.15.1. The following distribution voltage shall be used:

II.9.15.1.1. Main Switchgear: 480 volts, three-phase for new greenfield sites; existing facilities to be approved by JEA on a case-by-case basis

II.9.15.1.2. Motor Control Centers: 480 Volts, three-phase

II.9.15.1.3. Panelboards: 480 volts, three-phase and 208/120 volts, three-phase

II.9.15.1.4. Motors: 115-volts, single-phase for motors less than 0.5 hp; 460 volts, three-phase for motors 0.5 hp though 500 hp; 4,160 volts for motors larger than 500 hp

II.9.16. WATER SUPPLY

Potable water to serve facility support buildings, such as maintenance/operations and administration buildings, shall be supplied to the WRF site. The potable water line shall be provided with service connections to buildings and facilities with potable water needs (for example, eye wash). All potable water lines shall be sized appropriately to accommodate the number of employees the facility may have after future WRF expansions.

II.9.17. FLOW MEASUREMENT

II.9.17.1. Readings from flow measurement devices will provide JEA with information to meet regulatory requirements and maintain consistency in operations. Refer to Volume III: JEA Water and Wastewater Approved Materials Manual of the JEA *Water and Wastewater Standards Manual* for acceptable flow measurement technologies. Coordinate with approved flowmeter manufacturer for specific design requirements.

II.9.17.2. Recommended flow metering locations are listed in **Table II-5**.

Table II-5. Recommended Flow Metering Locations

Flow Stream	Location
Raw sewage	Headworks
Recycle flows (that is, combined plant drain)	Headworks
RAS	RAS pump discharge
WAS	WAS pump discharge
Process air	Diffused-air applications
Digested sludge – solids dewatering feed	Solids dewatering feed pump discharge
Disinfection influent	Upstream of disinfection equipment
Reject water	Effluent transfer pump discharge
Reject water return	Reject water return pump discharge
Plant effluent – effluent transfer/reuse storage	Effluent transfer pump discharge (upstream of reuse storage)
Plant effluent – reclaimed distribution	Reclaimed water distribution pump discharge
Plant effluent – plant water system	Reclaimed water distribution pump discharge

II.9.18. SAMPLING

II.9.18.1. Sampling requirements and locations shall be determined during the permitting phase with FDEP. However, at a minimum, the following conditions shall be incorporated:

II.9.18.1.1. A flow-proportioned composite sample of the raw influent wastewater shall be collected prior to any recycle streams.

II.9.18.1.2. A flow-proportioned composite sample of the plant effluent shall be collected following disinfection.

II.9.18.1.3. Continuous turbidity or TSS measurement of filter effluent with automated reject shall be incorporated.

II.9.18.1.4. Continuous pH measurement of plant effluent shall be incorporated.

II.9.18.1.5. Any additional sampling required by the vendor for process performance or chemical dosing shall be evaluated during the design phase.

II.9.19. FIBER OPTIC SYSTEM

II.9.19.1. JEA will provide network racks for the WRF that will be connected to some external JEA networks via fiber optic cables. JEA will supply fiber optic cable to the WRF up to a point of demarcation as specified by JEA. From the demarcation point, fiber will be routed to the network racks housed at the WRF. This fiber run shall be the contractor scope of supply, except in the event that enough fiber optic cable length be provided up to the demarcation point such that the contractor may pull the JEA-supplied cable to the end destination in the WRF server room. Otherwise, the contractor shall provide and install both the fiber optic cable required to connect from the demarcation point to the local network racks and a fiber optic patch panel to be located at the demarcation point for connecting the external JEA fiber to the contractor-provided fiber.

II.9.19.2. JEA will specify the requisite number and type of fiber optic cables that the contractor shall supply. The contractor shall also supply and install cable connectors as specified by JEA. The construction contractor shall test the fiber optic cable between the point of demarcation and the WRF network racks. The contractor shall also supply a fiber optic patch panel at the WRF server room for fiber termination. JEA will be responsible for terminating the fiber at each patch panel and connecting the cables. See Section IV.6.8 of this manual, Fiber Optic Communication Systems, for details about the fiber optic cables and accessories.

II.10. NOISE (INCLUDING NOISE ABATEMENT)

II.10.1. Noises are to be mitigated during the progression of design. OSHA requires that when noise exposure is above 85 decibels averaged over eight working hours, a hearing conservation program must be implemented. General OSHA standards that relate to occupational noise exposure can be found in Section 1910 Subpart G of OSHA. Facilities shall also be in compliance with all local noise ordinances.

II.10.2. Sound-attenuating enclosures are to be provided for necessary equipment to ensure compliance with all pertinent noise ordinances. In areas where there are high of excessive noise levels, appropriate signage shall be provided to ensure that personnel wears the appropriate personal protective equipment.

II.11. MATERIALS OF CONSTRUCTION

II.11.1. The proper selection of materials and techniques to control corrosion will be essential to limit the impacts of the following:

II.11.1.1. Elevated levels of H_2S

II.11.1.2. Aggressive chemicals such as sodium hypochlorite

II.11.1.3. Aggressive soils

II.11.1.4. Presence of galvanic conditions that allow the degradation of the anode relative to the cathode

II.11.2. All buried metallic pipe, fittings, sleeves, saddles, and restraining devices will be encased in polyethylene bags per JEA standards.

II.11.3. The methods selected to limit the impact of corrosion will be a selection of materials that are resistant to attack and the use of protective coatings and liners. Table II-6 lists the corrosive areas anticipated at the WRF and methods to limit corrosion. JEA's standard for concrete coating is Spectrashield.

Table II-6. Methods of Corrosion Control

Facility	Potential Corrosion Source	Methods to Limit Corrosion
Influent Pump Station Headworks Grit Removal Preliminary Treatment Splitter Box Primary Clarifiers	H_2S Attack and Galvanic Corrosion	**Concrete** – Interior concrete walls and underside of slab, Spectrashield coating to create corrosion barrier **Equipment** – Specify corrosion-resistant materials such as 316 stainless steel (SST) and fiberglass-reinforced plastic (FRP) **Pipe** – Odor-control duct fabricated from FRP; coat exterior of ductile-iron pipe with multilayer system (such as high-build epoxy + polyurethane enamel) **Handrail** – Aluminum **Checkerplate** – Aluminum **Hatches** – Aluminum
Anoxic and Aerobic Process Bioreactor Zones Clarifier Splitter Box Clarifiers Filters Ultraviolet (UV) Disinfection Effluent Transfer Pumps	Galvanic Corrosion	**Concrete** – No special corrosion barrier or coating **Equipment** – Coat iron body equipment with multilayer system (such as high-build epoxy + polyurethane enamel). **Pipe** – Coat ductile-iron pipe with multilayer system (such as high-build epoxy + polyurethane enamel) Air piping fabricated from 316 SST **Steel Filter Tanks** – Manufacturer standard interior and exterior epoxy coating **Handrail** – Aluminum **Checkerplate** – Aluminum **Hatches** – Aluminum
Plant Drain, Decant, and Centrate Return Pump Station	H_2S Attack and Galvanic Corrosion	**Concrete** – Interior concrete walls, coat with Spectrashield coal-tar epoxy to create corrosion barrier **Equipment** – Specify corrosion-resistant materials such as aluminum, 316 SST, and FRP **Pipe** – Coat ductile-iron pipe with multilayer system (such as high-build epoxy + polyurethane enamel). **Handrail** – Aluminum **Checkerplate** – Aluminum **Hatches** – Aluminum
Chemical Storage and Feed (that is, Sodium Hypochlorite, Alum, and Supplemental Carbon)	Chemical Corrosion	**Concrete**– Interior concrete containment walls, coat with reinforced Novolac epoxy suitable for corrosion resistance to specific chemicals **Equipment** – Specify corrosion-resistant materials compatible with specific chemicals **Pipe** – PVC
Dissimilar Metals	Galvanic Corrosion	**Pipe** – Separate any steel pipe flanges from ductile iron with an insulating flange kit **Aluminum to other Metals** – Separate aluminum from other metals with one coat of bitumastic coating at 10-mil dry-film thickness (DFT) **Anchor Bolts to Rebar** – Coat anchor bolts with fusion-bonded epoxy, one coat at 7-mil DFT

II.12. PIPING TYPES AND APPLICATION

II.12.1. The following piping design requirements shall be followed. Piping standards are summarized in Table II-7.

II.12.1.1. Piping shall be located so that it is not a tripping hazard, head-banger, or barrier to equipment access.

II.12.1.2. In general, piping shall be located close to walls to facilitate support and access where practical.

II.12.1.3. If piping must be run close to a wall but not supported from it, at least 2 feet of clearance between the outermost flange and the wall shall be provided.

II.12.1.4. To permit purging of air from the pipeline while it is being filled with water, a manual vent shall be located at all high points in the pipeline.

II.12.1.5. To permit water drainage, a manual drain valve shall be located at the lowest point on the pipeline.

II.12.1.6. Flexible connections to permit easy assembly and disassembly of piping and connections to equipment shall be provided.

II.12.1.7. Wall penetrations shall be perpendicular to the wall.

II.12.1.8. For any valve located 8 feet off the operating floor, a chain wheel shall be provided.

II.12.1.9. Ample space and support shall be provided for all valves and actuators.

II.12.1.10. Sufficient straight runs shall be provided for flowmeters and other I&C elements.

II.12.1.11. If piping reducers are required on the suction side of pumps, eccentric reducers that are flat on top shall be provided.

II.12.1.12. Swing check valves shall not be located in vertical piping runs.

II.12.1.13. Thrust restraint shall be provided for sleeves and other couplings that are not capable of internal thrust restraint.

II.12.1.14. Adequate space shall be provided for valves and gate actuators, particularly for rising stem valves and gates.

Table II-7. Piping Standards

Pipe Material	Standard	Pipe Selection Comments
PVC Pressure Pipe	ANSI/AWWA C900-16	Use on buried pressurized water piping, such as potable water and raw sewage lines along access roads. Minimum pressure rating shall be 235 psi, DR18.
PVC	Schedule 80, Type I, Grade I or Class 12454-B conforming to ASTM D1784 with ASTM D1785	Use on services where PVC is suitable and less than 4-inch diameter, such as liquid polymer, sodium hypochlorite, alum, supplemental carbon, and process drains.
CPVC	Schedule 80, Type IV, Grade I or Class 23447-B conforming to ASTM D1784 with ASTM F441	Use on hot water services.
Mechanical Joint Ductile-Iron Fittings	ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53	Minimum pressure rating 250 psi. Ductile-iron fittings shall be used at all ANSI/AWWA C900-97/905-97 PVC pipe joints. All pipe fittings shall be ductile iron, mechanical joint; restrain per JEA standards.

Table II-7. Piping Standards

Pipe Material	Standard	Pipe Selection Comments
		All ductile-iron fittings shall be fusion-bonded epoxy coated on interior and exterior. Ductile-iron fittings for raw sewage piping shall be interior coated with ceramic epoxy, 40-mil total DFT.
Ductile-Iron Flanged Pipe	ANSI/AWWA C115/A21.15 and ANSI/AWWA C110/A21.10, 125-lb flat face	Minimum pressure rating 250 psi and thickness Class 53. Ductile-iron flanged pipe shall be used for abovegrade process pipe. Transition between PVC and ductile iron can be made with flanged connections or transition couplings, ductile-iron couplings coated with fusion-bonded epoxy coating, 304 SST bolts and nuts, and ethylene propylene diene monomer (EPDM) gaskets. All ductile-iron flanged pipe shall be exterior coated with a bituminous coating. Flanged ductile-iron pipe and fittings for process piping downstream of secondary clarification, such as secondary effluent, plant effluent, and reclaimed water, shall be cement lined. Flanged ductile-iron pipe and fittings for process piping upstream of secondary clarification, such as raw sewage, mixed liquor, secondary scum, and RAS and WAS, shall be interior coated with ceramic epoxy, 40-mil total DFT.
Ductile-Iron Buried Pipe	AWWA C111/A21.11 and AWWA C151/A21.51	Minimum pressure Class 250 psi, except where shown otherwise in the plans, Type 4 trench, and 3-foot cover. Use on buried pipe greater than or equal to 4-inch diameter and all concrete-encased pipes below the foundations of structures or buildings. Proprietary restrained joints. All ductile-iron pipes shall be exterior coated with a bituminous coating. Buried ductile-iron pipe and fittings for process piping downstream of secondary clarification shall be cement lined. Buried ductile-iron pipe and fittings for process piping upstream of secondary clarification shall be interior coated with ceramic epoxy, 40-mil total DFT.
SST Pipe and Fittings	2 inches and smaller: Schedule 40S, ASTM A312M, Type 316 seamless. 2.5 inches to 6 inches: Schedule 10S, ASTM A778, "as-welded" grade Type 316L. 8 inches and Larger: Schedule 5S, ASTM A778, "as-welded" grade, Type 316L.	Use on exposed and submerged low-pressure air. Piping subjected to heat from welding shall be 316L. All SST pipe and fittings shall be pickled and passivated.

Table II-7. Piping Standards

Pipe Material	Standard	Pipe Selection Comments
Carbon Steel Pipe	Black carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B seamless or ERW.	Use on abovegrade fire sprinkler systems.

AWWA = American Water Works Association
CPVC = chlorinated polyvinyl chloride
ERW = electric resistance welded
lb = pound(s)
psi = pound(s) per square inch

II.12.2. The pipe design criteria beyond those described in Table II-7 are as follows:

II.12.2.1. All 316-SST construction for submersible pumping station piping shall be per Volume 1: Distribution and Collection Specifications of the JEA *Water and Wastewater Standards Manual*. The requirement for SST piping supersedes equipment manufacturer's standard materials.

II.12.2.2. Flanges shall be provided as necessary to remove valves and equipment.

II.12.2.3. The minimum depth of cover shall be 3 feet. Exceptions will be allowed on a case-by-case basis.

II.12.2.4. A 6- to 10-foot horizontal separation and a 12-inch positive vertical separation between potable water and all other pipelines shall be maintained throughout (unless the potable water pipe is concrete-encased). Water pipelines shall be installed at a higher elevation than wastewater pipelines.

II.12.2.5. Potable water piping shall conform with requirements set forth in Volume 1: Distribution and Collection Specifications of the JEA *Water and Wastewater Standards Manual*. Disinfect and test potable water lines in accordance with AWWA standards.

II.12.2.6. The minimum design velocities for sludges shall be 2 feet per second (fps) at average flow rates where practical. Design velocities will be in the range of 2 to 5 fps for gravity pipelines. Design velocities for scum piping shall be 4 to 6 fps. Maximum velocities for control valves shall be less than 15 fps.

II.12.2.7. Support piping shall be connected to equipment with a pipe support and not the equipment. Pipe supports shall withstand the dead loads imposed by the weight of the pipes filled with water and shall have a minimum safety factor of 5.

II.12.2.8. In general, test pressures shall be 1.5 times the maximum possible operating pressure for the pipe, such as pump shutoff head or peak surge pressure.

II.12.2.9. Refer to JEA *Water and Wastewater Standards Manual*, Volume I: Distribution and Collection Specifications, for specific pipe materials and construction standards.

II.12.2.10. Pipe shall be labeled using Brady snap-on labels or equal. Process pipes shall be color coded per federal standards and JEA color-coding standards.

II.12.2.11. At point of burial on yard pipes, a protective concrete collar shall be provided to prevent damage from mowers and string trimmers.

II.12.2.12. Pipe sizes and friction losses for Newtonian liquids shall be calculated with Darcy-Weisbach equations.

II.12.3. Valve Types and Application: The following valve design requirements shall be followed:

II.12.3.1. All valves shall comply with applicable AWWA standards and be constructed of the appropriate materials for the particular application. For wastewater valves and appurtenances, refer to Volume I: Distribution and Collection Specifications and Volume III: Water and Wastewater Approved Materials Manual of the JEA *Water and Wastewater Standards Manual*.

II.12.3.2. Valve operators shall be accessible from the ground or from adequate platforms.

II.12.3.3. For quarter-turn valves greater than 8 inches in diameter, a handwheel with gear shall be provided.

II.12.3.4. One valve shall be provided for isolation of equipment or tanks. Multiple valves or provisions to remove spool pipe sections shall not be provided to access equipment or tanks.

II.12.3.5. Check valves shall be provided on all pumped discharge lines. Check valves and butterfly valves shall be installed with upstream and downstream separating spool pieces to achieve manufacturer-recommended separation distances and to avoid mechanical interference.

II.12.3.6. Swing check valves with rugged, repeatable visual position indicators and NEMA 4X double-pole, double-throw (DPDT) valve CLOSED position switches capable of switching 5 amps at 120 VAC shall be designed. Valve CLOSED position switches shall be connected to the appropriate PLC for use in process monitoring and control.

II.12.3.7. Valve boxes for buried valves shall be cast-iron, screw-type adjustable per Volume I: Distribution and Collection Specifications and Volume III: Water and Wastewater Approved Materials Manual of the JEA *Water and Wastewater Standards Manual*.

II.12.3.8. For selected buried valves that shall be actuated on a regular basis, an extension bonnet that extends a handwheel abovegrade shall be provided.

II.12.3.9. Plug valves shall be selected for sludge, scum, raw sewage, or mixed liquor services. Plug valves shall be per Volume I: Distribution and Collection Specifications and Volume III: Approved Materials Manual of the JEA *Water and Wastewater Standards Manual*.

II.12.3.10. Butterfly valves shall be provided on air lines and dampers on odor control lines, and may be used on process piping beyond secondary effluent where appropriate.

II.12.3.11. Resilient seat gate valves for use in water and wastewater services shall conform to Volume I: Distribution and Collection Specifications and Volume III: Approved Materials Manual of the JEA *Water and Wastewater Standards Manual*.

II.12.3.12. Backflow prevention assemblies shall be reduced-pressure principal backflow preventers.

II.12.3.13. Self-contained valves with resettable setpoints that are in the mid-range of the valve's operating capability shall be used.

II.12.3.14. All valves in lines 1 inch or greater requiring automatic actuators shall be electrically or pneumatically operated unless the service demands otherwise. Solenoid valves shall be used for service in lines 1 inch and smaller.

II.12.4. The selection criteria for valve types are summarized in **Table II-8**.

Table II-8. Valve Selection Criteria

Service	Size	Isolation	Throttling	Check
Water (Potable Water and Reclaimed Water)	3 inches and smaller	Ball, Globe	Globe	Ball Check
	4 to 12 inches	Gate	NA	Swing Check
Raw Sewage, Plant Drain	All	Plug	NA	Swing Check
Mixed Liquor, RAS, WAS, Scum	All	Plug	Pinch	Swing Check
Air	All	Butterfly	High-performance Butterfly	Double Disc Swing Check
Odorous Air	All	PVC Wafer Body Style Butterfly Valve	PVC Wafer Body Style Butterfly Valve	Swing Check
Secondary Effluent, Filter Effluent, Plant Effluent	All	Plug, Knifegate, or Butterfly	Plug, or Butterfly	Swing Check
Chemical Service	All	Ball (with pressure relief hole for sodium hypochlorite service)	Diaphragm	Ball Check
Polymer	All	Ball	NA	Ball Check
Thickened Sludge	All	Plug	NA	Ball or Swing Check
Scum	All	Plug	NA	Swing Check

II.13. PAINTING AND PROTECTIVE COATINGS

II.13.1. CONCRETE

II.13.1.1. All exposed, exterior concrete surfaces shall be painted with a latex primer sealer and acrylic latex topcoat.

II.13.1.2. Chemical containment areas shall have a nonvolac epoxy applied to the exposed concrete surfaces.

II.13.1.3. All exposed interior surfaces of water-bearing structures exposed to sulfates, H_2S, or other deleterious materials or gases shall have a multi-component, stress-skin panel liner such as Spectrashield applied. These include headworks facilities, pump stations prior to secondary treatment, plant drain pump stations, and manholes receiving low pH materials. Provide materials in accordance with Volume I: Distribution and Collection Specifications of the JEA *Water and Wastewater Standards Manual*.

II.13.1.4. All other exposed interior surfaces of water-bearing structures shall be water cured.

II.13.1.5. All other pump stations and manholes shall be coated in accordance with JEA's collection system standards.

II.13.2. MASONRY

II.13.2.1. Exterior surfaces shall have an acrylic sealer applied.

II.13.2.2. Interior surfaces shall have a block filler coat and acrylic latex (semigloss) applied.

II.13.3. METAL

II.13.3.1. Galvanized and SST surfaces do not require painting, except for hollow metal doors and frames.

II.13.3.2. All exposed metal surfaces (pipe, fittings, valve, motors, and pumps) shall be factory-primed coated and ready for a topcoat in the field.

II.13.3.3. Submerged metals shall be primed in accordance with the manufacturer's recommendations and have a topcoat of coal-tar epoxy or high-build epoxy.

II.13.3.4. Awning structures shall have a coated aluminum roof.

II.13.3.5. All metal surfaces embedded or in contact with concrete shall have a bituminous paint coating.

II.13.3.6. Structural steel and metal trim shall have a rust-inhibitive primer and Alkyd Enamel topcoat.

II.13.4. PVC, CPVC, FRP

II.13.4.1. All exposed-to-view PVC and CPVC surfaces and FRP surfaces without integral UV-resistant gel coat shall have an acrylic latex semigloss coating.

II.13.5. PROTECTIVE COATINGS

II.13.5.1. Provide protective coatings in accordance with Volume I: Distribution and Collection Specifications of the JEA *Water and Wastewater Standards Manual*.

II.14. PIPING SERVICE COLOR CODES

II.14.1. All color references made herein shall meet AMS-STD-595 color standards. Where a particular gloss is not shown in AMS-STD-595, the color shall be selected to represent that gloss of the specified color as if it were shown in AMS-STD-595. Where a specific piping service is not identified in **Table II-9**, the identification of hazardous materials conveyed through piping systems shall follow ANSI A13.1.

II.14.2. Paint nonsubmerged portions of equipment the same color as the piping it serves, except as follows:

II.14.2.1. Dangerous Parts of Equipment and Machinery: OSHA Orange.

II.14.2.2. Fire Protection Equipment and Apparatus: OSHA Red.

II.14.2.3. Radiation Hazards: OSHA Purple.

II.14.2.4. Physical hazards in normal operating area and energy lockout devices, including but not limited to electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.

Table II-9. Piping Service Color Codes

Piping Service	Basic Color	Arrows, Letters, and Bands
Aeration Air	Dark Green	Black
Aeration Effluent	Silver/Gray	Black
Aeration Influent	Dark Gray	Black
Aeration Recycle	Light Brown	Black
Air – Ambient	Dark Green	Black
Air – Compressed	Dark Green	Red
Air – Instrumentation	Dark Green	White
Air – Intake, Ambient	Dark Green	Yellow
Air – Low Pressure	AMS-STD Green	White
Alum	Dark Green	White
Ammonia	AMS-STD Yellow	Black
Backwash Drain	Black	White
Bypass	Match Process Flow	Match Process Flow
Caustic Liquid	AMS-STD Yellow	Black
Centrate	Black	White
Chlorine (Gas or Solution)	AMS-STD Yellow	Black
Cooling Water	Blue	Red
Decant Sludge	Light Brown	
Digested Sludge	Dark Brown	
Drain	Black	White
Filtered Effluent	Silver/Gray	
Fire Protection Equipment	AMS-STD Red	White
Fuel Oil Return	AMS-STD Orange	
Fuel Oil Supply	AMS-STD Orange	
Headworks Scum	Light Brown	

Table II-9. Piping Service Color Codes

Piping Service	Basic Color	Arrows, Letters, and Bands
Hot Water	Green (with White Letters)	White
Internal Plant Return	Black	White
Liquid Polymer	Buff	Black
Mixed Liquor	Silver/Gray	
Natural Gas	AMS-STD Yellow	
Odor Control Drain	Black	White
Odorous Air	Natural or White	Black
Overflow	Match Process Flow	
Plant Effluent	Silver/Gray	
Polymer Solution	Buff	Black
Potable Water	Light Blue	
Primary Clarifier Influent/Effluent	Dark Gray	
Raw Sewage	Dark Gray	
Reclaimed Water	Purple	
Reject Water	Dark Gray	
Return Activated Sludge	Light Brown	
Sample	Medium Green	
Screened Raw Sewage	Dark Gray	
Secondary Effluent	Silver/Gray	
Secondary Scum	Light Brown	
Sodium Hypochlorite	AMS-STD Yellow	Black
Sulfur Dioxide	AMS-STD Orange	Black
Supplemental Carbon	Black	White
Vent	Match Process Flow	Match Process Flow
Waste Activated Sludge	Dark Brown	

II.15. REFERENCES

II.15.1. OTHER JEA STANDARDS

II.15.1.1. Water, reclaimed water, and wastewater treatment, distribution, and collection systems shall be designed and constructed according to the latest editions of the JEA *Water and Wastewater Standards Manual*, which are available in the JEA website.

II.15.1.1.1. Volume I: Distribution and Collection Specifications

II.15.1.1.2. Volume II: Distribution and Collection Details

II.15.1.1.3. Volume III: Water and Wastewater Approved Materials Manual

II.15.1.1.4. Volume IV: Water and Wastewater Master Material Catalog

II.15.1.1.5. Volume V: Water Treatment Plant Specifications and Details

II.15.1.1.6. Volume VA: Water Treatment Plant Specifications and Details

II.15.2. MINIMUM INDUSTRY STANDARDS

II.15.2.1. Industry standards and design references include:

II.15.2.1.1. Recommended Standards for Wastewater Facilities (Ten State Standards)

II.15.2.1.2. FDEP and other applicable federal, state, and local requirements

II.15.2.1.3. Chapter 62-600 F.A.C., Domestic Wastewater Facilities

II.15.2.2. Requirements for standards or specifications that are not adequately addressed in the previously referenced documents shall be evaluated by the JEA and Consultant project teams for specific use on each project. Applicable industry and government standards are referenced in the JEA standards noted in this section.

III. UNIT PROCESS STANDARDS

III.1. INTRODUCTION

III.1.1. LIQUID-PHASE TREATMENT

III.1.1.1. JEA owns and operates 11 WRFs that vary widely in size, age, and treatment; therefore, specific standards for all liquid treatment is not feasible or beneficial here. However, some guidelines can be useful as part of these standards.

III.1.1.2. Preliminary treatment including robust screening shall be included at all facilities; however, grit removal shall be included as needed depending on specific factors such as the age of the collection system, space available onsite, and the ability to clean downstream basins.

III.1.1.3. Primary treatment is employed at many existing JEA facilities; however, the benefits of primary treatment at new and existing WRFs must be considered, particularly when advanced nutrient removal is required and primary treatment may reduce the organic load to secondary treatment, thus inhibiting biological nutrient removal. Primary treatment remains a viable option at Buckman WRF due to the high influent and recycle loading as well as onsite anaerobic digestion.

III.1.1.4. A variety of secondary treatment options shall be evaluated for new and upgraded facilities, with an emphasis on reliability, operability, and flexibility to adjust to changing conditions.

III.1.1.5. HLD shall be considered a basis for any new facility.

III.1.1.6. Multiple effluent disposal options beyond the required reclaimed and reject storage shall be evaluated and implemented at WRFs wherever feasible. Storage alone is not a preferred wet-weather management option.

III.1.2. SOLIDS TREATMENT

The purpose of solids treatment at individual plants is to provide easier transportation of biosolids to the JEA Buckman WRF, unless otherwise stated for JEA master planning. For this purpose, JEA WRFs shall incorporate solids holding and dewatering processes. All future WRFs shall transport biosolids to JEA Buckman WRF unless otherwise designed. Solids holding tanks at JEA WRFs will be aerobic digestors with the capacity to treat to Class B criteria defined by 40 CFR 503 in case of solids treatment disruption at Buckman but will otherwise serve only as solids holding tanks. Sludge flows from other JEA WRFs will join the Buckman solids in the Raw Sludge Holding Tank before being thickened by gravity belt thickeners (GBTs). Thickened and dewatered solids from other plants are collected in cake bins prior to being pumped into dilution tanks and joining the Buckman thickened sludge in the aerobic digesters. The digested solids are dewatered in centrifuges and then dried in thermal drum driers. The dried pellets are stored in a silo prior to being trucked offsite for final disposal.

III.2. INFLUENT PUMPING STATION

III.2.1. GENERAL DESCRIPTION

If required based on hydraulic conditions, influent pumping stations shall be placed at the very beginning of process flow and should pump to the headworks structure. Pumping stations provide for more flexibility in pumping to facilities that require additional gravity head. Influent pumping stations are also important for increasing the capacity of received wastewater. Generally, pumping stations are to be provided if the hydraulic profile of a plant needs to be raised.

III.2.2. DESIGN REQUIREMENTS

III.2.2.1. Influent pump station shall be capable of delivering PHF.

III.2.2.2. Pump stations shall include a wet well to allow for isolation. Consider providing two wet wells for redundancy in cases when one wet well needs to be taken out of service.

III.2.2.3. Submersible-type pumps shall be used for influent pumping. Refer to JEA *Water and Wastewater Standards Manual,* Volume I, Section 433, Submersible Wastewater Pumping Stations, for detailed design requirements. The number of pumps shall be determined based on hydraulic needs of the plant. Other pump types may be considered if equalization or other means of influent storage are available.

III.2.2.4. Odor control shall be provided.

III.2.2.5. Influent pump station shall be constructed of concrete and must have protective coatings applied to surfaces.

III.2.3. PROCESS CONTROL

III.2.3.1. Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. The Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects.

III.2.3.2. Pumps in influent pumping stations are typically to be controlled on level by automatic, variable-speed drivers.

III.3. SCREENING (INCLUDING CONVEYORS AND COMPACTORS)

III.3.1. GENERAL DESCRIPTION

III.3.1.1. Screening of wastewater is intended to remove the large solids that may interfere with downstream unit operations and processes and equipment, accumulate in digesters, and cause other problems. Conventional raw wastewater coarse screens have screen openings of approximately 0.5 to 2.0 inches (12 to 50 millimeters [mm]). Fine screens, which have openings of 0.5 inch (12 mm) or less, are usually automatically cleaned. Sizing considerations shall be given to downstream process requirements, multiple screen technologies, and layouts for future conditions.

III.3.1.2. Screenings collected from coarse and fine screens are washed and compacted to remove any collected organics prior to discharging for offsite disposal. The washer/compactor is typically located directly under the screen discharge chute but may be located elsewhere nearby. Conveyors (preferably shaftless spiral conveyors) or sluices may be used to convey the screenings to the washer/compactor. An independent conveyor or sluice is preferred to convey the screenings.

III.3.1.3. The screens and washer/compactor should be provided by the same manufacturer.

III.3.2. DESIGN REQUIREMENTS

All WRFs shall have mechanically cleaned fine screens with a minimum opening of 6 mm. Depending on upstream and downstream processes, additional screening may be necessary. For example, an influent pump station may require coarse screening upstream, and a membrane bioreactor process requires a second-stage fine screening with an opening of 2 mm or less. Generally design/size any screening facility (includes the washer/compactor) to include, at minimum, one duty and one standby. A manual bar screen can serve as a standby screen for coarse screening or first-stage fine screening. Screens shall be placed in channels that can be isolated for screen maintenance as required by the manufacturer. Coordinate with the manufacturer to determine the maximum velocity through the screen opening to maximize the volume of screening capture and minimize the amount of breakthrough screenings.

III.3.3. PROCESS CONTROL

Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. The Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects. If equipment and control system will be provided as part of a package system, the Consultant shall coordinate with system supplier to ensure compatibility among different components.

III.4. GRIT REMOVAL (INCLUDING CONVEYORS)

III.4.1. GENERAL DESCRIPTION

Grit removal is a common component of the preliminary treatment train that usually follows screening. Grit systems remove settleable, non-putrescible material from the wastewater, such as sand, and include washing to remove organic material before depositing it in a container for ultimate disposal.

III.4.2. DESIGN REQUIREMENTS

The inclusion of grit removal at JEA WRFs is not a standard and should be evaluated based on specific system conditions such as historical grit accumulation; age, condition, and materials in the collection system; presence of downstream processes such as primary clarification; and the ability to clean basins either in situ or by taking out of service. If grit removal is included, there are several technologies available for evaluation, including gravity channels, vortex basins, and plate settling. In addition to grit removal performance, effective and reliable grit handling shall be considered a priority. Grit handling equipment and grit conveyance shall be conservatively sized and use gravity wherever feasible (for example, sloped sluices or flooded suction pumps). Grit removal equipment design varies per manufacturer and is often proprietary. Coordinate with equipment supplier for specific design requirements.

III.4.3. PROCESS CONTROL

Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. The Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects. If equipment and control system will be provided as part of a package system, the Consultant shall coordinate with system supplier to ensure compatibility among different components.

III.5. FLOW-SPLITTING STRUCTURES

III.5.1. GENERAL DESCRIPTION

Flow-splitting structures may be required throughout the facility. A flow-splitting structure is located prior to any unit process where the flow stream is split from a single stream to multiple streams. Typical locations are prior to clarifiers if there are multiple, biological treatment, filtration, and/or disinfection.

III.5.2. DESIGN REQUIREMENTS

Weirs shall be the primary means of splitting flow. Provide downward-acting weir gates to split the flow, and isolate the flow streams as needed for downstream process maintenance.

III.5.3. PROCESS CONTROL

Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. The Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects.

III.6. PRIMARY CLARIFICATION

III.6.1. GENERAL DESCRIPTION

Primary clarification is typically provided between preliminary and secondary treatment when load reduction is required prior to an activated sludge system or to remove colloidal matter and phosphorus when metal salts are added to the feed during primary treatment. Primary clarification is not required in every treatment plant and will be dependent on wastewater characteristics and the selected secondary treatment process.

III.6.2. DESIGN REQUIREMENTS

Primary clarifiers are typically of circular type and shall be composed of either carbon or SST. Primary clarifiers shall be sized based on hydraulic loading or surface overflow rate (SOR) in the units of gallons per day per square foot (gpd/ft^2) or meters per day (m/d). The SOR shall be calculated for both design average and for design PHF conditions, with the larger value being used. Maximum SORs for primary clarifiers are summarized in Table III-1.

Table III-1. Maximum Primary Clarifier SOR

Type of Primary Clarifier	Maximum Surface Overflow Rates in gpd/ft^2	
	Design Average Flow	Design Peak Hourly Flow
Tanks not receiving WAS	1,000	1,500 to 2,000
Tanks receiving WAS	700	1,200

Source: *Recommended Standards for Wastewater Facilities* (Ten State Standards 2014)

III.6.2.1. Basin depth shall be a function of diameter and should ensure sufficient depth for solids storage without a detention time long enough to cause solids to go septic. The typical depths based on diameter are provided in Table III-2.

Table III-2. Typical Primary Clarifier Depths Based on Diameter

Clarifier Diameter (feet)	Minimum Clarifier Depth (feet)
Less than 80	10
80 to 120	12
120 and greater	14

III.6.2.2. The effluent requirements of primary clarification are to meet the criteria summarized in Table III-3.

Table III-3. Typical Primary Clarification Design Criteria

Criteria	Range	Typical Design Value
Standard TSS Removal	50% to 70%	60%
Standard BOD Removal	25% to 40%	30%
CEPT TSS Removal	Maximum 80%	NA
Primary Solids Concentration	Maximum 4% to 6% TSS	3.5%
Primary Scum Production	0.1 to 15 mg/L	8 mg/L

CEPT = chemically enhanced primary treatment
BOD = biochemical oxygen demand

III.6.2.3. Internal Mechanism Types

III.6.2.3.1. Clarifiers are to be outfitted with center drive platforms with half or full bridge and perimeter walkways.

III.6.2.3.2. Internal mechanisms shall be composed of steel with protective coating or SST.

III.6.2.3.3. Influent feed is to be located in the center of the clarifier and shall have an associated stilling well for short-circuiting prevention. The typical diameter of the stilling well shall be approximately 15 to 20 percent of the tank diameter and shall extend to approximately 50 percent of the side wall depth (SWD). The top of the stilling well should be approximately 6 inches above the water surface and shall have slots that allow scum to escape the main clarifier area. Spray water shall be supplied in the center well to aid in scum removal.

III.6.2.3.4. Effluent control is to be done by a continuous "V"-notched weir that is placed at the perimeter of the clarifier. Weirs shall allow for 6 inches of freeboard to avoid submergence. Weirs shall be composed of corrosion-resistant material such as FRP, aluminum, or SST. Effluent is to overflow to smooth concrete effluent inboard or outboard collection launders.

III.6.2.3.5. Sludge collection is to be done by steel with protective coating or SST spiral scrapers and shall be designed to carry 1 to 2 feet of solids at maximum flow.

III.6.2.3.6. Clarifiers shall be outfitted with two full-radius steel SST scum skimmers.

III.6.2.3.7. Scum baffles shall be provided to divert scum away from the effluent launder. Coordinate scum baffle design with clarifier mechanism manufacturer to ensure compatibility with scum skimmers. Scum baffles shall be FRP.

III.6.2.4. Primary Sludge Pumping

III.6.2.4.1. Primary sludge pumps will deliver sludge collected from the primary clarifiers to sludge holding tanks or directly to solids-handling unit operations such as anaerobic digestion and/or dewatering. There are two different types of pumps that are suitable for primary sludge depending on the primary sludge composition, these are discussed in the following.

III.6.2.4.2. Recessed-impeller pumps are centrifugal pumps with an open-faced impeller that is recessed into the pump casing. These pumps shall be used when the sludge composition is 2 percent solids or less.

III.6.2.4.3. Air-operated diaphragm pumps are positive-displacement pumps that deliver a volume equal to the displacement of the driving diaphragm. These pumps require air delivered through a 1.25- to 1.5-inch minimum supply tap that is between 80 and 124 psi and is at approximately 40°F dew point. The inlet and outlet piping diameter is to be a minimum of 4 inches. These pumps shall be used when the sludge composition is 2 percent solids or more.

III.6.2.5. Primary Scum Pumping

III.6.2.5.1. Scum that is skimmed off the surface of the clarifier is to overflow into a scum collection box or holding tank. The scum box/tank top of wall shall not be located below the hydraulic grade line of the clarifiers. Scum holding tanks are to be sized to hold approximately 3 days of scum, but this shall only be the case in emergencies or in case of maintenance as leaving scum for longer than a day can lead to hardening and odor problems. Scum holding tanks are to be outfitted with a mixing mechanism. After being mixed, scum is to go through a grinder, if necessary. Scum is then to be pumped to a solids-handling unit process such as gravity thickening or anaerobic or aerobic digestion.

III.6.2.5.2. Submersible sewage pumps shall be installed in the scum collection box and shall be used to pump scum to sludge holding tanks or solids processing facilities, such as aerobic/anaerobic digestion or gravity thickening.

III.6.3. PROCESS CONTROL

Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects.

III.7. BIOLOGICAL TREATMENT

III.7.1. ACTIVATED SLUDGE PROCESS

III.7.2. GENERAL DESCRIPTION

The activated sludge process is a form of biological treatment where a biological mass of organisms is used to stabilize the waste aerobically, and the solids are separated from the wastewater and returned to the aeration basin. The process basins may also include anoxic and/or anaerobic zones for biological nutrient removal (BNR). This process produces suspended solids that are to be settled out in a secondary clarifier. This process will require consistent testing and monitoring.

III.7.3. DESIGN REQUIREMENTS

III.7.3.1. Conventional

A conventional activated sludge process takes place in a plug-flow reactor, where influent enters at the tank head and flows to the point of discharge at a constant rate.

III.7.3.2. Oxidation Ditch

Oxidation ditch or continuous loop reactors operate with mixed liquor constantly looped around the racetrack or carousel by low-speed surface aerators to keep the mixed liquor in suspension. An oxidation ditch typically operates in an extended aeration mode.

III.7.3.3. Biological Nutrient Removal

Secondary treatment processes can be designed to target nutrients in the wastewater, specifically, TN and TP. A BNR process is the primary means of removing TN; biological and chemical treatment methods are available for TP removal. Nutrient removal is required at nearly all existing JEA WRFs. The level of nutrient removal required dictates the treatment process options. Examples of BNR processes in place at JEA facilities include Modified Ludzak-Ettienger (MLE), a four- or five-stage Bardenpho, and multi-stage step-feed.

III.7.3.4. Process Basins

III.7.3.4.1. Aerated Zones

III.7.3.4.1.1. Aerated Zones are present to ensure sufficient nitrification (conversion of ammonia nitrogen to nitrate-nitrogen) of the wastewater by autotrophic nitrifying bacteria. Reaeration zones are aerated zones that are at the end of the bioreactors, typically after an anoxic zone, and serve the purpose of releasing nitrogen gas that has bound to the mixed liquor suspended solids (MLSS) in the post-anoxic zone.

III.7.3.4.1.2. Liquid depths in aerated tanks shall be between 15 and 20 feet deep if using diffused air as the form of aeration and shall be between 12 and 15 feet deep if in an oxidation ditch configuration. All aeration tanks must have a freeboard of at least 2 feet unless using a mechanical surface aerator, then the freeboard must be over 3 feet. Aeration equipment shall all be capable of maintaining a minimum of 2.0 mg/L of dissolved oxygen in the mixed liquor at all times.

III.7.3.4.1.3. A typical air requirement for all activated sludge processes shall be based upon predetermined influent characteristics.

III.7.3.4.2. Diffused Air (including types of diffusers)

If using a conventional activated sludge process, there are to be 9-inch-diameter-disk, fine-bubble membrane diffusers in the aeration zones of the bioreactors. Diffuser systems shall be designed to provide 200 percent of the design average day oxygen demand at a minimum.

III.7.3.4.3. Surface Mechanical Aeration

If using an oxidation ditch configuration, there are to be 304 SST, low-speed mechanical aerators with VFDs in the aeration zones of the bioreactors. The VFDs must adjust aerators to maintain a minimum of 2.0 mg/L of dissolved oxygen (DO) in the mixed liquor at all times (monitored by DO probes). The surface mechanical aerators are to provide 3.0 lb of O_2 per hp per hour at standard conditions. Between all present basins, there shall be enough aerators to service firm capacity at MD loads.

Unaerated zones in a four-stage Bardenpho process are anoxic. In the anoxic zones, nitrate-nitrogen is denitrified into nitrogen gas by heterotrophic, denitrifying bacteria. A supplemental carbon source may be needed for this process to meet effluent TN requirements depending on the composition of the influent. By converting nitrate to nitrogen gas, nitrogen is removed from the wastewater.

III.7.3.4.3.1. Mixing

Mixing is to be provided in the unaerated zones of the bioreactors with the purpose of providing proper blending and suspension of solids. Mixers must be designed in such a way that excess oxygen transfer is minimized to maintain proper denitrification. There are multiple options for mixers. An evaluation of mixer type should be made prior to selection. Examples include:

- Submersible, geared, low-speed blade

- Platform-mounted, blade type
- Platform-mounted, hyperboloid type

III.7.3.4.3.2. Internal Recycle Pumping

Recycle streams are required for most BNR process configurations. In conventional process basins (not oxidation ditches) pumps and piping are required for these recycle streams. These recycle streams typically require high-flow, low-head conditions. Examples of pumps include:

- Submersible
- Axial flow
- Flooded suction, horizontal

III.7.3.4.4. Secondary treatment process design standards are summarized in **Table III-4**.

Table III-4. Secondary Treatment Process Design Standards

Parameter	Conventional	Oxidation Ditch	Note
Solids Retention Time (SRT)	7 to 10 days	10 to 15 days	AAD conditions
Aerobic SRT	4 to 7 days	7 to 10 days	AAD conditions
Safety Factor on Nitrification	2	3	Minimum
MLSS	2,500 to 3,500 mg/L	2,500 to 3,500 mg/L	
Anaerobic	10% to 15%	10% to 15%	If needed for biological TP removal
Pre-anoxic	10% to 25%	10% to 25%	Higher end for single-stage anoxic processes
Post-anoxic	10% to 15%	10% to 15%	
Reaeration	<5%	<5%	
RAS	50% to 100%	50% to 100%	
Internal Recycle	200% to 400%	400% to 800%	
Internal Recycle	Pump	Gate	

III.7.4. PROCESS CONTROL

III.7.4.1. Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects. If equipment and control system will be provided as part of a package system, Consultant shall coordinate with system supplier to ensure compatibility among different components.

III.7.4.2. Instrumentation and analyzers for process bioreactors are typically provided for DO, ammonia, nitrate, phosphate, and TSS. Instrumentation shall be designed to provide continuous plant operations information regarding the process and nutrient removal and will typically be used for automatic dosing of supplemental chemical feed, as needed.

III.7.5. SECONDARY CLARIFIERS

III.7.5.1. General Description

Secondary clarifiers are provided after the bioreactors to settle out suspended biosolids from the biological treatment process. Secondary effluent will overflow to the peripheral effluent launder and will be collected in the secondary effluent collection box. From the collection box, secondary effluent will flow by gravity to the next unit process, typically effluent filters. Clarifier surface scum will be collected and will be pumped to solids-handling facilities. From the bottom of the clarifiers, RAS will be pumped upstream of the bioreactors and WAS to solids-handling facilities.

III.7.5.2. Design Requirements

Secondary clarifiers are typically circular, and sizing shall be based on hydraulic and mass loadings. Hydraulic loading must remain less than the settling velocity of the MLSS particles. Secondary clarifiers must be designed to meet the effluent criteria provided in Table III-5.

Table III-5. Secondary Clarifier Effluent Criteria

Effluent Parameter	Criteria
Removal of settleable material	Greater than 99%
Effluent TSS	Less than 10 mg/L without filtration
Underflow solids concentrations for RAS	8,000 to 10,000 mg/L

III.7.5.2.1. Internal Mechanism Types

III.7.5.2.1.1. Internal mechanisms shall be composed of carbon steel with protective coating or SST and shall use a truss design to attach spiral scrapers.

III.7.5.2.1.2. The perimeter of each clarifier is to be outfitted with continuous V-notch weirs. V-notched weirs are to be spaced at 6 inches and run 2.5 to 3 inches deep. There shall be at least 6 inches of freeboard between the V-notch weir and the downstream water surface at peak flow. These shall be composed of either FRP, aluminum, or SST.

III.7.5.2.1.3. A single effluent launder shall be present and is to be at least 2 feet wide. The launder shall be inboard and shall be composed of smooth concrete. It shall be designed to slope toward the effluent box to allow for frequent wash-downs to avoid algae buildup.

III.7.5.2.1.4. Steel with protective coating or SST spiral scrapers are to be used for sludge collection. Scrapers will transfer sludge to the center sludge hopper or sludge ring. If provided, the minimum slope of sludge hopper walls shall be 1.7 vertical to 1 horizontal. Hopper walls shall be smooth with rounded corners, and hopper bottoms should have a maximum depth of 2 feet.

III.7.5.2.2. Baffles (Stamford and scum baffles)

III.7.5.2.2.1. Stamford baffles or density current baffles shall be placed below the effluent V-notched weir and are designed to intercept the eddy current of solids. Stamford baffles shall be FRP.

III.7.5.2.2.2. Scum baffles shall be provided to divert scum away from the effluent launder. Coordinate scum baffle design with clarifier mechanism manufacturer to ensure compatibility with scum skimmers. Scum baffles shall be FRP.

III.7.5.2.3. Center Feedwell

III.7.5.2.3.1. Center feedwells shall have radial ports, with at least the same cross-sectional area as the feed column, that are sized to limit the exit velocity to less than 1.5 fps at peak flow. These must extend high enough for scum to escape.

III.7.5.2.3.2. An energy-dissipating inlet (EDI) shall be located immediately at the outlet of the center column. This shall function to prevent short-circuiting of the clarifier by intercepting radial flow and redirecting it to a tangential direction.

III.7.5.2.3.3. A flocculating center well shall be present to promote reflocculation of the biomass after mixing. These shall be designed to maintain a nominal detention time of 20 to 30 minutes and shall be sized from 25 to 33 percent of the clarifier diameter and to approximately one-half the SWD.

III.7.5.2.4. Scum Collection

III.7.5.2.4.1. Two full-radius scum skimmers shall be present in each clarifier. Flushing water is to be provided to sluice scum from large trough area. Clarifier surface scum will flow to a scum collection box, typically attached to each clarifier.

III.7.5.2.5. Return Activated Sludge/Waste Activated Sludge Pumping

III.7.5.2.5.1. To optimize the number of installed equipment, a single pump may be designed to deliver both RAS and WAS from the bottom of the clarifier to upstream of the bioreactors and solids-handling facilities, respectively. A minimum of one dedicated pump per clarifier with a common spare pump shall be provided for redundancy; however, it is recommended that two RAS/WAS pumps be provided per clarifier. RAS/WAS pumps shall be provided with variable-speed motors. RAS pumps should be dedicated to a clarifier such that there is not a common suction header. A screw-induced centrifugal pump is an acceptable pump type for RAS/WAS pumping.

III.7.5.2.5.2. RAS pumping rate is typically 50 to 100 percent of the AADF. WAS pumping rate will depend on plant operational requirements.

III.7.5.2.6. Scum Pumping

III.7.5.2.6.1. Submersible sewage pumps shall be installed in the scum collection box and shall be used to pump scum to sludge holding tanks or solids processing facilities such as aerobic/ anaerobic digestion or gravity thickening.

III.7.5.3. Process Control

III.7.5.3.1. Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects.

III.7.5.3.2. As a minimum, the clarifier mechanism will be started and stopped by a local ON/OFF/REMOTE hand switch. Flushing water will be typically controlled by solenoid valves that are initiated by a switch that is actuated by the skimmer arm. The following alarms are recommended: an alarm on HIGH clarifier mechanism torque, with the clarifier mechanism stopped on HIGH-HIGH torque, and a general FAIL alarm on the drive.

III.7.5.3.3. Typically, the scum pump located in the scum collection box of each clarifier will automatically turn ON at HIGH sump level and will automatically turn OFF at LOW sump level. A HIGH-level alarm in the receiving tank (that is, aerobic digester) is recommended to send an alarm to the SCADA.

III.7.5.3.4. RAS/WAS shall be provided with VFDs; pump speeds typically will be automatically controlled by maintaining a programmed flow ratio of the RAS flow rate for its associated clarifier to the plant influent flow rate or the manually set flow rate. WAS flows will be started and stopped by cycle timers based on operator input. Dedicated flowmeters shall be provided to separately measure RAS and WAS flows.

III.7.6. BLOWERS

III.7.6.1. General Description

During biological treatment in the aerated zones that use diffused air, blowers shall be present to supply oxygen that is required by the activated sludge process. Blower sizing and selection is to be based on the characteristics of the influent and load peaking factors specific to each plant.

III.7.6.1.1. Multi-stage: Multi-stage blowers are a type of centrifugal blower that are able to increase pressure by means of centrifugal force created using several impellers in series. These blowers typically require bearing lubrication.

III.7.6.1.2. Gear-driven: Gear-driven blowers are a type of centrifugal blower that create pressure through centrifugal force by using one high-speed impeller and gears. These require attention to an all-over lubrication system.

III.7.6.1.3. Positive-displacement: Positive-displacement blowers are a type of blower that operates by trapping a specific volume of air, then discharging the air against the system pressure.

III.7.6.2. Design Requirements

III.7.6.2.1. For smaller unit capacities, positive-displacement blowers are an option. These blowers shall be used in the aerated zone of the process bioreactors.

III.7.6.2.2. For larger unit capacities, centrifugal blowers are an option. These shall be used in the aerated zones of the process bioreactors.

III.7.6.2.3. It shall be assumed that air intake temperatures may reach 100°F or higher and may require the motor to be oversized to prevent overheating.

III.7.6.3. Process Control

III.7.6.3.1. Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects.

III.7.6.3.2. Backup blower unit(s) shall have installed capacity for MD load and reduced DO with one unit out of service. Airflow rate typically will be automatically controlled based on DO. Each blower shall have a variable-speed motor to provide the necessary airflow to meet the DO setpoint.

III.7.7. SUPPLEMENTAL CHEMICAL FEED SYSTEMS

III.7.7.1. General Description

To meet effluent nutrient standards, supplemental chemical feed systems may be required during biological treatment. The need for supplemental chemicals shall be assessed prior to design.

III.7.7.2. Design Requirements

III.7.7.2.1. Carbon

III.7.7.2.1.1. Supplemental carbon is to be provided as necessary to meet nitrogen effluent limits. Carbon is to be dosed to anoxic zones of the bioreactors to provide a readily biodegradable carbon source needed for denitrification.

III.7.7.2.1.2. The supplemental carbon source shall be MicroC 2000. The chemical oxygen demand of MicroC 2000 is 1,016,000 mg/L. The AADF nitrite nitrogen (NO_2-N) concentration limit to be met is 1 mg/L.

III.7.7.2.1.3. Supplemental carbon storage tanks are to be sized for a minimum of a 30-day storage capacity at AADF and for minimum truck delivery requirements. The tank is typically double-walled, cross-linked, high-density polyethylene (XLHDPE). If single-walled tanks are installed, design for means of secondary chemical containment as dictated by federal, state, or local regulations (whichever is most stringent).

III.7.7.2.1.4. Supplemental carbon feed pumps shall be provided in a pre-assembled, self-contained skid package. The pump type to be used shall be diaphragm positive-displacement with a variable-speed drive.

III.7.7.2.2. Metal Salt

Metal salt is to be provided as necessary to meet phosphorous effluent limits. Preferred dosing location for metal salts is at bioreactor point of discharge to allow for phosphorous removal during secondary clarification. Additional or alternative locations, such as in upstream aerobic zones or downstream prior to filtration, can be evaluated and pilot tested during schematic design.

III.7.7.2.3. Aluminum Sulfate (alum)

III.7.7.2.3.1. The AADF TP concentration limit to be met is 0.8 mg/L.

III.7.7.2.3.2. Alum storage tanks are to be sized for a minimum of a 30-day storage capacity at AAD and for minimum truck delivery requirements. The tank is typically double-walled XLHDPE. If single-walled tanks are installed, design for means of secondary chemical containment as dictated by federal, state, or local regulations (whichever is most stringent).

III.7.7.2.3.3. Alum feed pumps are typically provided in a pre-assembled, self-contained skid package. The pump type to be used is typically a positive-displacement, hydraulically-actuated diaphragm pump with a variable-speed drive.

III.7.7.2.4. Ferric Chloride/Ferric Sulfate

III.7.7.2.4.1. If using ferric chloride or ferric sulfate as the metal salt, it is to be added with a molar ratio of at least 3:1 (three metal ions to one phosphorous ion). The AADF TP concentration limit to be met is 0.8 mg/L

III.7.7.2.4.2. Ferric chloride or sulfate storage tanks are to be sized for a minimum of a 30-day storage capacity at AAD and for minimum truck delivery requirements. The tank is typically double-walled XLHDPE. If single-walled tanks are installed, design for means of secondary chemical containment as dictated by federal, state, or local regulations (whichever is most stringent).

III.7.7.2.4.3. Ferric chloride or sulfate feed pumps are typically provided in a pre-assembled, self-contained skid package. The pump type to be used typically is a positive-displacement, hydraulically-actuated diaphragm pump with a variable-speed drive.

III.7.7.2.4.4. Some filter manufacturers recommend the use of ferric chloride over alum. It is important to note that the use of ferric chloride could lower water pH more than alum; therefore, if ferric chloride is used as the coagulant, pH monitoring shall be diligent. Ferric chloride has also been proven to cause staining, which shall also be considered when selecting this chemical.

III.7.7.2.5. Polymer

III.7.7.2.5.1. Polymer feeds may be provided to secondary clarifiers as needed to aid in flocculation to achieve TSS removal goals. A permanent storage and feed system is not required; however, at a minimum, space shall be provided to locate a polymer tote with a power supply so a temporary feed system can be located adjacent to the secondary clarifier effluent. Polymer feed design is later discussed in Section III.15.

III.7.7.3. Process Control

III.7.7.3.1. Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects. If equipment and control system will be provided as part of a package system, Consultant shall coordinate with system supplier to ensure compatibility among different components.

III.7.7.3.2. Supplemental carbon feed pumps will operate as needed to achieve the nitrogen discharge limit and shall be controlled by a feedback loop based on plant influent flow rate and nitrate concentration leaving the bioreactors.

III.7.7.3.3. Coagulant (alum and ferric chloride/ferric sulfate) feed pumps will operate as needed to achieve the phosphorus discharge limit and shall be controlled by a feedback loop based on plant influent flow rate and phosphate concentration leaving the bioreactors.

III.7.7.3.4. Polymer blending skids typically include an integral, vendor-furnished local control panel, which will allow for manual or automatic control.

III.8. FILTRATION

III.8.1. GENERAL DESCRIPTION

Filtration is necessary after secondary clarification for removal of residual suspended solids prior to disinfection. Filters shall have convenient access to media for frequent inspection and cleaning.

III.8.2. DESIGN REQUIREMENTS

Filtration rates shall be based on the design PHF and should not exceed 5 gpm/ft^2. Filters are necessary where effluent concentrations of less than 20 mg/L of suspended solids or 1 mg/L of phosphorus must be achieved. Two types of filters are presented in the following sections—cloth-media filters and sand filters. Due to its compact footprint and ease of maintenance, cloth-media filter is preferred.

III.8.2.1. Cloth-Media Filters

III.8.2.1.1. Cloth-media filter design varies per manufacturer and is often proprietary. Coordinate with equipment supplier for specific design requirements.

III.8.2.1.2. Cloth-media filter cartridges shall be housed in a Type 304 SST tank. Tanks shall be placed underneath a canopy cover.

III.8.2.1.3. A bridge crane shall be considered for filter cartridge/disk removal and replacement. As a minimum, bridge crane lifting capacity shall include the weight of a fully saturated, dirty filter cartridge.

III.8.2.1.4. For redundancy, two backwash pumps per filter is recommended. Self-priming centrifugal pump is an acceptable pump type for filter backwashing, especially when net-positive suction head (NPSH) issues are present. Filter backwash piping and valves shall be SST.

III.8.2.2. Sand Filters

III.8.2.2.1. There are many different options for sand-type filters. These are summarized as follows:

III.8.2.2.1.1. Semicontinuous granular-medium filters are filters in which filtering and cleaning phases occur sequentially and should be designed according to the characteristics listed in **Table III-6**.

Table III-6. Physical Characteristics of Semicontinuous Granular-medium Filters

Type of Filter	Type of Filter Bed	Filtering Medium	Typical Bed Depth, inches	Backwash Operation	Flow Rate Through Filter
Conventional	Mono-medium	Sand or anthracite	30	Batch	Constant/Variable
Conventional	Dual-medium	Sand or anthracite	36	Batch	Constant/Variable
Conventional	Multimedium	Sand, anthracite, and garnet	36	Batch	Constant/Variable
Deep Bed	Mono-medium	Sand or anthracite	48 to 72	Batch	Constant/Variable
Deep Bed	Mono-medium	Sand	48 to 72	Batch	Constant
Pulsed Bed	Mono-medium	Sand	11	Batch	Constant

Source: *Wastewater Engineering Treatment Disposal and Reuse, Third Edition* (Metcalf and Eddy 2013)

III.8.2.2.2. Continuous granular-medium filters are filters in which the filtering and cleaning phases occur simultaneously and should be designed according to the characteristics listed in **Table III-7**.

Table III-7. Physical Characteristics of Continuous Granular-medium Filters

Type of Filter	Type of Filter Bed	Filtering Medium	Typical Bed Depth, inches	Backwash Operation	Flow Rate Through Filter
Deep Bed	Mono-medium	Sand	48 to 72	Continuous	Constant
Traveling Bridge	Mono-medium	Sand	11	Semicontinuous	Constant
Traveling Bridge	Dual-medium	Sand	16	Semicontinuous	Constant

Source: *Wastewater Engineering Treatment Disposal and Reuse, Third Edition* (Metcalf and Eddy 2013)

III.8.3. PROCESS CONTROL

III.8.3.1. Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. The Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects. If equipment and control system will be provided as part of a package system, Consultant shall coordinate with system supplier to ensure compatibility among different components.

III.8.3.2. Filter backwashing can be controlled manually or automatically. If controlled by a PLC, automatic sequencing of the backwash pumps and the opening and closing of the sludge valve for sludge removal may be performed. Filter backwashing is typically initiated based on elapsed time or on head loss (that is, level or pressure differential upstream and downstream of the filter media).

III.9. DISINFECTION

III.9.1. GENERAL DESCRIPTION

Disinfection of the effluent is required to meet applicable treatment standards. Disinfection should achieve bacterial standards as well as the disinfection residual limits. JEA typically employs UV disinfection with sodium hypochlorite injection to maintain residual disinfection in the reclaimed water (RCW) distribution system.

III.9.2. DESIGN REQUIREMENTS

III.9.2.1. Chlorination

Chlorine is the most common type of disinfectant used in wastewater applications. Chlorine disinfection usually takes place at the end of the wastewater treatment process, prior to effluent discharge. Table III-8 should serve as a guide when determining chlorine dosage.

Table III-8. Typical Chlorine Dosage Depending on Treatment

Type of Treatment	Dosage (mg/L)
Activated sludge plant effluent	8
Tertiary filtration effluent	6
Nitrified effluent	6

Source: *Recommended Standards for Wastewater Facilities* (Ten State Standards 2014)

III.9.2.1.1. Contact Tanks

III.9.2.1.1.1. After thorough mixing at design PHF or at a maximum rate of pumpage, a minimum contact period of 15 minutes is required.

III.9.2.1.1.2. Disinfectant shall be mixed positively and as rapidly as possible, reaching a complete mix in 3 seconds.

III.9.2.1.1.3. Contact tanks shall be designed to ensure short-circuiting is minimized.

III.9.2.1.1.4. Tanks without continuous mixing shall be outfitted with "over-and-under" or "end-around" baffling.

III.9.2.1.1.5. Contact tanks shall be designed to facilitate maintenance and cleaning while still prioritizing disinfection effectiveness.

III.9.2.1.2. Sodium Hypochlorite Feed Systems

III.9.2.1.2.1. Sodium hypochlorite is to be continuously dosed at the RCW pump station and intermittently to the effluent transfer pump station.

III.9.2.1.2.2. Sodium hypochlorite is to be stored in double-walled XLHDPE storage tanks. If single-walled tanks are installed, design for means of secondary chemical containment as dictated by federal, state, or local regulations (whichever is most stringent). Tanks are to be designed to meet a 30-day storage requirement at AADF.

III.9.2.1.2.3. Hypochlorite feed pumps are typically provided in a pre-assembled, self-contained skid package and are to be housed under a canopy for sunlight protection.

III.9.2.1.2.4. Hypochlorite feed pumps are typically to be of diaphragm positive-displacement type with variable-speed drivers. These pumps shall be programmed to maintain a set chlorine level.

III.9.2.1.2.5. Sodium hypochlorite is to have a concentration of approximately 12.5 percent.

III.9.2.2. Dechlorination

If effluent is discharged to surface water, dechlorination shall be provided to minimize potential concerns of toxicity related to chlorine residuals. Dosage depends on the chemical used, and criteria are summarized in Table III-9.

Table III-9. Dechlorination System Effluent Criteria

Dechlorination Chemical	Theoretical mg/L Required to Neutralize 1 mg/L Cl_2
Sodium thiosulfate (solution)	0.56
Sodium sulfite (tablet)	1.78
Sulfur dioxide (gas)	0.9
Sulfur meta bisulfite (solution)	1.34
Sodium bisulfite (solution)	1.46

Source: *Recommended Standards for Wastewater Facilities* (Ten State Standards 2014)
Cl_2 = chlorine

III.9.2.3. Ultraviolet

III.9.2.3.1. UV disinfection system design varies per manufacturer and is often proprietary. Coordinate with equipment supplier for specific design requirements. Significant advancement in UV disinfection technology in recent years has quickly made equipment models obsolete. The latest available technology shall be considered in the design to ensure availability of spare parts and product support.

III.9.2.3.2. Recent UV technology employs the use of energy-efficient, low-pressure, high-output amalgam bulbs. The UV bulbs are enclosed in quartz sleeves, so no portion of the bulbs will be directly in contact with the wastewater. The UV bulbs are arranged in a bank or module and can be installed either in horizontal, vertical, or inclined position. Depending on the manufacturer, in-channel chemical and mechanical cleaning systems and an automatic lifting mechanism for raising the UV bank out of the channel for equipment or channel inspection and maintenance may be available. All metal components in contact with wastewater flow shall be Type 316 SST, with welds pickled and passivated.

III.9.2.3.3. UV channels shall be located underneath a canopy cover. A bridge crane shall be considered for equipment removal and replacement.

III.9.3. PROCESS CONTROL

III.9.3.1. Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. The Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects. If equipment and control system will be provided as part of a package system, the Consultant shall coordinate with system supplier to ensure compatibility among different components.

III.9.3.2. Latest UV disinfection technology allows for a fully automated system that automatically adjusts the UV dosage required for proper disinfection at different flow rates by varying the number of bulbs in service. A flowmeter shall be provided immediately upstream of the UV facility for UV dosing. Instrumentation includes UV-intensity sensors, liquid-level sensors, and UV-transmittance monitoring. Water level in UV channels is controlled using either flow-control weirs or weir gates.

III.10. SLUDGE THICKENING

III.10.1. GENERAL DESCRIPTION

III.10.1.1. Sludge thickeners are to be provided for the reduction of sludge volume. The technology selection should consider the type and concentration of sludge, the stabilization process being used, the storage requirements for the facility, the desired ultimate sludge disposal method, and the chemical needs and other costs of operation.

III.10.1.2. Gravity thickening vessels with unstabilized sludges are not recommended due to septicity problems. Special attention should be given to the pumping and piping of concentrated sludges for possible anaerobic conditions.

III.10.1.3. Sludge thickener selections and unit process design parameters not described herein should be prepared based on prototype and case studies. Such studies will be required where the sizing of other plant units is dependent on the thickener performance.

III.10.2. DESIGN REQUIREMENTS

III.10.3. GRAVITY BELT THICKENERS

III.10.3.1. GBTs remove free water from conditioned sludge by passing sludge across a porous belt. While commonly used in thickening WAS, GBTs are also effective at thickening digested solids, primary solids, and blended solids. GBTs typically are designed to process 0.4 to 8 percent total solids (TS) sludges into thickened sludges ranging from 4 to 9 percent TS. While there are selections capable of higher solids concentrations, most GBTs are intentionally kept in this range to allow pumping from the unit to storage facilities or for further onsite treatments. GBTs are mostly provided in an open-to-the-air arrangement, but to aid with minimizing odorous air, they can be provided in an enclosed form.

III.10.3.2. The capacity of GBTs is predominantly determined by the width of the belt, the type of sludge and initial solids concentration, polymer type and dosage, and belt speed. The capacity of a GBT is described and designed for the volume of sludge thickened per meter of the belt width, generally in liters per second per meter, but gallons per minute per meter (gpm/m) is not uncommon. Table III-10 shows the hydraulic loading rates for the typical belt widths in meters treating 1.0 percent solids concentration sludge.

Table III-10. Hydraulic Loading Rate for GBTs per Meter Width

Belt Width (meters)	Hydraulic Loading Range (gpm)	Hydraulic Loading Range (L/sec)
1.0	100 to 250	6.7 to 16
1.5	150 to 375	9.5 to 24
2.0	200 to 500	12.7 to 32
3.0	300 to 750	18 to 47

Source: Adapted from Metcalf & Eddy (2013); EPA (1979); WEF et al. (2018)
L/sec = liters per second

III.10.3.3. Operating up to approximately 85 percent of maximum rated unit hydraulic capacity can maintain desired performance and provide solids capture rates of 95 percent or higher. Polymer is typically used for all sludges on GBTs and ranges in doses from 3 pounds per dry ton (lb/dry ton) (raw primary sludge [PS]) up to 12 lb/dry ton (anaerobically digested sludge). Typical design criteria for various sludge flow streams are shown in Table III-11.

Table III-11. Typical GBT Design Criteria and Performance

Parameter	PS	WAS	Co-thickened PS and WAS
Typical Feed Concentration	1% to 4% TS	0.5% to1% TS	1.5% to 3% TS
Typical Thickened Sludge Concentration	5% to 10% TS	4% to 6% TS	5% to 8% TS
Typical Polymer Dose	4 to 8 lb active/dry ton	5 to 12 lb active/dry ton	5 to 10 lb active/dry ton
Typical Percent Capture	95% to 99%	95% to 99%	95% to 99%

Source: Adapted from Metcalf & Eddy (2013); EPA (1979); WEF et al. (2018)

III.10.3.4. Solids loadings are calculated based on feed solids per hour per meter of belt width or kg/m·h (lb/hr/m). Typical solids loading rates (SLRs) for various types of feed sludge are shown in Table III-12.

Table III-12. Typical Solids Loading Rates for GBTs

Type of Feed Solids	Solids Loading Rate (lb/m/hour)	Solids Loading Rate (kg/m/hour)
Raw PS	2,000 to 3,000	910 to 1,360
50% primary, 50% WAS	1,500 to 2,000	680 to 910
Anaerobically digested (100% primary)	1,300 to 1,750	590 to 795
Anaerobically digested blend (50% primary, 50% WAS)	1,300 to 1,750	590 to 795
Aerobically Digested	1,100 to 1,500	500 to 680
WAS	660 to 1,200	300 to 545

Source: WEF (2017)

III.10.4. ROTARY DRUM THICKENERS

III.10.4.1. Rotary drum thickeners (RDTs) are simple thickening devices used at WRFs to thicken sludge for further processing or prior to ultimate disposal. Normally, RDTs are selected for small- to medium-sized WRFs. They are similar to GBTs in that they have a lower capital cost and lower operation and maintenance requirements than other thickening devices. Unlike GBTs, RDTs are always enclosed for containment of odor and aerosols that reduce housekeeping issues and odor control. RDTs typically use less wash water than GBTs.

III.10.4.2. RDTs also have relatively low power consumption when compared to other thickening units. They are typically used to thicken WAS, but they can be successful at thickening most wastewater sludges and can achieve between 5 and 12 percent TS. They also typically are used as standalone thickening devices but can be used ahead of belt presses to aid in gravity dewatering before pressing of the sludge.

III.10.4.3. Conditioned sludge enters the drum on one end and is moved along the length of the drum by an internal screw conveyor or paddles (flights). Sludge moves up the side of the drum and then falls back to the bottom. Free water drains through the perforations in the drum and is captured in a trough that is underneath the drum.

III.10.4.4. RDTs and all mechanical thickening equipment achieve the best and most consistent performance when feed characteristics are consistent. For this reason, a feed tank is normally provided to buffer changes in the inlet feed flows and loads. Sizing of the feed tank is dependent upon the upstream sludge pumping strategies, but typically 2 to 6 hours of storage capacity is sufficient.

III.10.4.5. As sludge characteristics change, adjustments are typically made to the sludge feed rate or polymer feed rate first. A variable-speed drive unit rotates the drum at approximately 5 to 20 revolutions per minute (rpm). The drum speed is changed to improve the drum filtrate quality by holding the sludge in the drum slightly longer. Changing the drum speed will also change the thickened sludge concentration.

Increasing the drum speed reduces the thickened sludge concentration; reducing the drum speed increases the thickened sludge concentration.

III.10.4.6. RDTs typically are designed with up to a maximum feed rate based on a 1 percent WAS concentration of 400 gpm (90 cubic meters per day [m^3/d]), but some manufacturers more recently have designed units with maximum feed rates of up to 800 gpm (180 m^3/d). Often, these larger capacity units will house two drums in parallel. It is recommended to operate only up to approximately 85 percent of maximum rated unit hydraulic capacity to maintain desired performance. Solids loading capacities range from 250 to 2,250 lb/hour. Process performance of the RDT is often evaluated by the thickened sludge concentration that is achievable, polymer consumption, power consumption, and percent capture (solids recovery). The typical design criteria and performance ranges for RDTs when thickening various types of sludge are shown in Table III-13.

Table III-13. Typical RDT Design Criteria

Type of Solids	Feed Solids (%)	Thickened Solids Concentration (%)	Polymer Dose (Active lb/dry ton)	Solids Capture (%)
Primary	1.0 to 4.0	4.5 to 10.0	6.0 to 18.0	95 to 98
WAS	0.5 to 1.0	4.0 to 6.0	6.0 to 18.0	95 to 98
Co-thickening (PS and WAS)	1.5 to 3.0	0.5 to 8.0	6.0 to 18.0	95 to 98
Aerobically Digested	0.8 to 2.0	4.0 to 6.0	8.0 to 18.0	90 to 98
Anaerobically Digested	2.5 to 5.0	6.0 to 9.0	8.0 to 18.0	90 to 98

Source: Adapted from WEF et al. (2018) and Metcalf & Eddy/AECOM (2014)

III.10.4.7. The polymer dose typically ranges from 4 lb/dry ton (2 grams per kilogram [g/kg]) for raw PS up to 14 lb/dry ton (7 g/kg) for anaerobically digested sludges. Some RDTs can improve the thickened solids concentrations by adjusting the screen size openings or by increasing the angle of the drum. Some manufacturers have stationary drums, while others allow for the drum angle to be adjusted to no more than 6 percent above horizontal.

III.10.5. PROCESS CONTROL

Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects. If equipment and control system will be provided as part of a package system, Consultant shall coordinate with system supplier to ensure compatibility among different components.

III.11. AEROBIC DIGESTION

III.11.1. GENERAL DESCRIPTION

An aerobic sludge digestion system shall include provisions for digestion, supernatant separation, sludge concentration, and any necessary sludge storage. These provisions may be accomplished by separate tanks or processes or in the digestion tanks. Multiple digestion units capable of independent operation are desirable and shall be provided in all plants where the design average flow exceeds 100,000 gallons per day (380 m³/d). Digesters are preferred to be operated in series to provide increased efficiency. All plants not having multiple units shall provide alternate sludge handling and disposal methods. The digesters will be periodically decanted to increase the solids concentration in the digester. Decanting of a digester will be achieved via gravity flow and operator initiated by opening motorized, modulating, telescoping valves to discharge to a decant pump station. Decant pumping will be controlled via level monitoring, with remote monitoring to alert operations of status and faults.

III.11.2. DESIGN REQUIREMENTS

III.11.2.1. Aerobic digesters in series include prestressed concrete circular tanks. The digesters shall be designed to operate in series and provide a combined SRT of at least 28 days at MMADF condition (14 days per digester) to produce Class B biosolids. Digested sludge shall be stored onsite in sludge storage tanks prior to dewatering, as described in Section III.13.2.

III.11.2.2. Digestion tank capacities shall be identified based on process modeling. The volume of sludge produced will depend on the wastewater characteristics, activated sludge processes, and other site specific values.

III.11.2.3. For calculating design sludge handling and disposal needs, sludge production values from aerobic digesters shall be based on a maximum solids concentration of 2 percent without additional thickening. The solids production values on a dry-weight basis shall be based on the process modeling.

III.11.3. MIXING

Aerobic digesters shall be provided with mixing equipment that can maintain solids in suspension and ensure complete mixing of the digester contents. Refer to Section III.11.4 for aeration system requirements.

III.11.4. AERATION

III.11.4.1. Sufficient air shall be provided to keep the solids in suspension and maintain DO levels between 1 and 2 mg/L. For minimum mixing and oxygen requirements, an air supply of 30 cubic feet per minute per 1,000 cubic feet (0.5 liter per cubic meter per second) of tank volume shall be provided with the largest blower out of service.

III.11.4.2. Each digester includes a non-clog, coarse-bubble diffuser system that delivers air to the waste sludge for digestion and mixing. Air is supplied to each digester via dedicated blowers. A common discharge header may be used to allow the use of a common spare blower but must be valved to provide dedicated blowers.

III.11.4.3. Blowers

Blowers for the aerobic digesters will operate continuously, except during decanting and as necessary to denitrify the sludge, to supply the required airflow rate to meet the process air requirements for oxygen demand (actual oxygen rate [AOR]) and mixing for aerobic digesters. The sludge blowers may be variable-speed, positive-displacement (rotary-lobe) blowers. Instrumentation is included to give operations continuous information regarding the process inlet and effluent air parameters.

III.11.4.4. Diffusers

Coarse-bubble diffusers will be supplied air by the aerobic digester blowers, providing the primary mixing and oxygen supply.

III.11.4.5. Piping

The digesters will provide effective separation or decanting of supernatant through multiple levels of the withdrawal zone. An unvalved, high-level overflow and any necessary piping should be provided to feed excess flow back to the head of the plant. Design considerations related to the digester overflow shall include waste sludge rate and duration during the period the plant is unattended, potential effects on plant process units, discharge location of the emergency overflow, and potential discharge of suspended solids in the plant effluent.

All piping for the sludge digesters will be supplied to handle the corrosive and high-solids nature of the sludge flow stream. Special consideration shall be given to the corrosion resistance and permanence of supporting systems for piping located inside the digestion tank.

III.11.5. PROCESS CONTROL

III.11.5.1. Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects. If equipment and control system will be provided as part of a package system, Consultant shall coordinate with system supplier to ensure compatibility among different components.

III.12. SLUDGE DEWATERING

III.12.1. GENERAL DESCRIPTION

III.12.1.1. Dewatering is used to reduce the volume of sludge or biosolids for further processing or reuse/ultimate disposal. Dewatering differs from thickening in that while sludge thickening produces TS in the range of 2 to 10 percent, dewatering typically produces solids in the range of 10 to 45 percent. Sludge dewatering systems convey and process thickened liquid sludge, stabilized biosolids, or scum streams to reduce the amount of excess water in those streams. Reducing the amount of water in those streams also reduces the amount of sludge or biosolids to be further treated or disposed. Dewatering units can also be used for “pre-dewatering” prior to the thermal hydrolysis process that typically requires between 16 and 20 percent solids concentration.

III.12.1.2. The dewatering process generates two products: a solids cake that is concentrated solids and a liquid stream that consists primarily of water with a small amount of residual solids. The liquid stream can have various names depending on the type of dewatering equipment (centrate, underdrainage, evaporated moisture, pressate, and filtrate) and is recycled back to a designated location in the liquid stream of the WRF. The performance of dewatering equipment is measured by optimizing the cake solids content and the solids capture rate.

III.12.2. DESIGN REQUIREMENTS

III.12.2.1. Centrifuges can be used to thicken and dewater sludges. Depending on the operating parameters of the centrifuge, the characteristics of the feed sludge, and the polymer dosing, centrifuges can achieve discharge solids concentrations from 3 to 30 percent TS.

III.12.2.2. Centrifuges are designed to maintain both an SLR and an hydraulic loading rate (HLR); however, the SLR determines the HLR.

III.12.2.3. Dewatering centrifuges are sized based on hydraulic or solids loading rate and are designed to meet process goals that have been specified by the engineer and operations staff for the WRF. These process goals include cake dryness, solids capture or centrate quality, polymer use, and power consumption. Typically, centrifuges are sized or rated based on kilograms (pounds) of solids per hour. The TS of the feed sludge will, therefore, determine the hydraulic flow rate.

III.12.2.4. Table III-14 shows the performance characteristics of dewatering centrifuges for various feed sludges.

Table III-14. Performance of Dewatering Centrifuges for Feed Solids Relevant to JEA

Type of Feed Solids	Feed Solids (%)	Cake Solids (%)	Polymer (lb active/dry ton)
Raw 50% primary, 50% WAS	2 to 4	25	20 to 25
Raw 100% WAS	0.5 to 2	20	25 to 35
Aerobically digested WAS	0.5 to 1	16 to 18	20 to 30

III.12.2.5. Centrifuges are commonly composed of the following major components: base, bowl, conveyor or scroll, feed or inlet pipe, main bearings, gear drive, back drive assembly, and main motor. The centrifuge case rests on the base, and there are vibration isolators in between that reduce the transference of vibration from the machine to the base. The scroll fits inside of the bowl, which rests inside of a case on the main bearings. The case encloses the entire rotating assembly of the unit for safety and sound attenuation reasons.

III.12.2.6. In most cases, polymer can also be added to several feed points on the centrifuge to enhance the dewatering process. In addition, progressive cavity pumps with variable-speed drives are typically used to both deliver sludge to the machine and move the dewatered sludge on to other processes. In some cases, dewatered sludge can also be conveyed from the machine using screw conveyors if the desired discharge percent TS is higher or if the solids are being directly loaded to a truck for beneficial reuse.

III.12.3. PROCESS CONTROL

Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. The Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects. If equipment and control system will be provided as part of a package system, the Consultant shall coordinate with system supplier to ensure compatibility among different components.

III.13. SLUDGE STORAGE

III.13.1. GENERAL DESCRIPTION

Sludge storage shall be provided to accommodate daily sludge production volumes and as an operational buffer for unit outage and adverse weather conditions.

III.13.2. DESIGN REQUIREMENTS

III.13.2.1. Designs shall not use increased sludge age in the activated sludge system as a means of storage. Liquid sludge storage facilities shall be developed based on process modeling to provide 28 days of storage at design MMAD conditions.

III.13.2.2. Additional sludge storage beyond digestion and before dewatering shall be provided at all plants. Separate storage tank(s) are preferred, but additional volume in the digesters is acceptable for liquid sludge.

III.13.2.3. Liquid sludge storage tanks receive digested sludge from the primary and/or secondary digester via gravity flow. Modulating, telescoping valves are used for periodic decanting of the tanks to a decant pump station. DO level is monitored within the tank, which will be transmitted to the plant SCADA to alert operations of status and faults.

III.13.2.4. Aerated sludge holding provides odor mitigation in sludge storage tanks by maintaining aerobic conditions in the tank, preferably through diffused aeration. Other appropriate means may be considered during design. Blowers for the digested sludge storage tanks will operate continuously, except during decanting and as necessary to denitrify the sludge, to supply the required airflow rate to meet the process air requirements for oxygen demand (AOR) and mixing for sludge storage tanks. The blowers may be variable-speed, positive-displacement (rotary-lobe) blowers. Instrumentation is included to give operations continuous information regarding the process inlet and effluent air parameters.

III.13.2.5. Rational calculations justifying the number of days of storage to be provided shall be submitted and shall be based on the total sludge handling and disposal system. Sludge production values for other stabilization processes should be justified in the basis of design.

III.13.3. PROCESS CONTROL

Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects.

III.14. SLUDGE PUMPING

III.14.1. GENERAL DESCRIPTION

The sludge pumping station will include variable-speed, progressing-cavity pumps that will transfer digested sludge from the sludge storage tank to the sludge dewatering system. The sludge pumps will transfer digested sludge from the tank and discharge it to the inlet of the dewatering system.

III.14.2. DESIGN REQUIREMENTS

A minimum positive head of 24 inches (610 mm) shall be provided at the suction side for all types of sludge pumps. Pump capacities shall be adequate but not excessive. Provisions for varying pump capacity should be made if different dewatering technologies are selected. A rational basis of design shall be provided with the plan documents.

III.14.3. PROCESS CONTROL

III.14.3.1. Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. The Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects. If equipment and control system will be provided as part of a package system, the Consultant shall coordinate with system supplier to ensure compatibility among different components.

III.14.3.2. Sludge pumps shall be provided with stator thermal monitoring for interlocking motor operation by the MCC equipment at the recommended high temperature setting. A discharge pressure switch is recommended for pump and pipe fitting protection.

III.15. POLYMER FEED SYSTEMS

III.15.1. GENERAL DESCRIPTION

Polymer feed systems shall provide mixing and dosing for emulsion-type polymers consistent with those used at existing JEA WRFs. Polymer feed systems shall adhere to the industry standards for the selected dewatering and sludge thickening technologies.

III.15.2. DESIGN REQUIREMENTS

III.15.2.1. Polymer feed systems for sludge dewatering are to supply a dosage of 15 to 30 lb/dry ton, with an activity of 40 percent.

III.15.2.2. Polymer feed systems for sludge thickening are to supply a dosage of 2 to 12 lb/dry ton, with an activity of 40 percent.

III.15.2.3. Polymer skids are to be of hydro-mechanical-mixing type.

III.15.2.4. Polymer feed systems are to use plant water for dilution water. Polymer feed systems shall include filtration equipment as necessary to accommodate variations in plant water quality.

III.15.2.5. Polymer storage shall provide a minimum 30 days capacity at AAD design conditions. Tote storage is acceptable if required volume is three or fewer totes. Storage tanks shall be XLHDPE tanks with a dome top.

III.15.2.6. Polymer recirculation pumps are to be of rotary-lobe type that operate at a constant speed.

III.15.2.7. Polymer blending skids are to include an integral, vendor-furnished, local control panel. Manual and automatic control will be available via the SCADA system.

III.15.3. PROCESS CONTROL

Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects. If equipment and control system will be provided as part of a package system, Consultant shall coordinate with system supplier to ensure compatibility among different components.

III.16. REUSE STORAGE AND PUMPING

III.16.1. GENERAL DESCRIPTION

Reclaimed water produced as a result of treatment shall be stored and pumped for reuse onsite (plant water system) or to the RCW distribution system. Effluent must meet RCW standards prior to distribution.

III.16.2. DESIGN REQUIREMENTS

III.16.2.1. Storage Tanks

III.16.2.1.1. Reuse water storage tanks shall be circular, prestressed concrete tanks with dome cover. Tank framing shall include steel shell diaphragm shotcrete wall with linear and circumferential prestressing strands. Prestressed concrete tanks for reuse water storage shall comply with applicable design requirements specified in Section IV, Ground Storage Tanks, of Volume V of the JEA *Water and Wastewater Standards Manual*.

III.16.2.1.2. Sodium hypochlorite addition points shall be provided upstream and downstream of the reuse water storage tank.

III.16.2.2. Pumping Stations

III.16.2.2.1. RCW distribution pump stations shall distribute chlorinated plant effluent from the storage tanks for onsite and offsite use.

III.16.2.2.2. Pumps are typically horizontal, split-case, centrifugal-type and shall have variable-speed motors.

III.16.3. PROCESS CONTROL

III.16.3.1. Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. The Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects.

III.16.3.2. Reuse water distribution pumps will normally operate automatically to maintain a set pressure to the reuse system. Pumps will be sequenced ON and OFF to maintain a pressure setpoint and lead pumps will alternate to distribute run time. Process control shall be coordinated with other JEA RCW distribution system facilities.

III.17. ODOR CONTROL

III.17.1. GENERAL DESCRIPTION

The purpose of odor control is to remove odors, including H_2S and volatile organic compounds (VOCs) from the odorous air.

III.17.2. DESIGN REQUIREMENTS

III.17.2.1. Establishing Odor Goals

III.17.2.1.1. For established WRF's, obtain odorous-air sample data for the area to be treated to establish the baseline H_2S and VOCs to be removed.

III.17.2.1.2. Typically new (greenfield) WRF's shall assume the average baseline H_2S concentration at the inlet of the biotrickling filter shall be 300 ppmv and the maximum shall be 500 ppmv. However, coordinate with JEA to determine the correct H_2S concentration to be used in design.

III.17.2.1.3. **Table III-15** presents the minimum odor control design criteria.

Table III-15. Minimum Odor Control Design Criteria

Parameter	Units	Min	Avg	Max	Comments
Temperature	°F	30	NA	110	
H_2S Removal	%	Minimum 99% removal over any 24-hour period or an outlet concentration less than 0.1 ppmv, whichever is greater			
Min EBRT @ Max Air Flow	sec	20	NA	NA	vessel diameter less than 12 feet
Pressure Loss Across Vessel	inch	NA	NA	NA	<3.0-inch water column

III.17.2.2. Unit Processes Requiring Odor Control

III.17.2.2.1. The following is a list of unit processes that will require odor control at a minimum:

III.17.2.2.1.1. Headworks facilities (including screens, washer/compactors, and dumpsters)

III.17.2.2.1.2. Grit removal facilities

III.17.2.2.1.3. Preliminary flow-splitting structures

III.17.2.2.1.4. Primary clarifiers

III.17.2.2.1.5. Additional unit processes may be considered for odor control, such as enclosed solids processing areas, vacuum truck unloading facilities, and so forth.

III.17.2.3. Allowable Types of Treatment Systems

JEA has standardized on biotrickling filters (bioscrubbers) followed by a carbon polishing unit if required. The biotrickling filter odor control system shall use a high-surface synthetic/inert media to provide an optimal site for growth of microorganisms (biomass). The biotrickling filter vessel shall be made of FRP.

III.17.2.4. Ventilation Rates

The ventilation rates used shall be evaluated for each space to be treated. Key rates to be evaluated include but are not limited to the number of air changes per hour, capture velocity, and sweep velocity. Table III.16 presents the minimum ventilation rates to be considered.

Table III-16. Minimum Odor Control Design Criteria

Ventilation Rate Parameter	Minimum Criteria
Air Changes per Hour[a] (unoccupied spaces)	3
Capture Velocity	100 fpm
Sweep Velocity	40 fpm

[a] Follow OSHA requirements for all spaces when using air changes per hour.

fpm = foot (feet) per minute

III.17.2.5. Pipe and Ductwork

FRP duct shall be provided to convey the odorous air from the process unit to the biotrickling filter.

III.17.2.6. Blower Types

Provide centrifugal fan blowers with VFDs.

III.17.2.7. Sampling

Provide influent and effluent air sampling ports.

III.17.3. PROCESS CONTROL

III.17.3.1. Process control will vary per WRF and will depend on existing and new equipment, infrastructure, and site conditions. Consultant shall closely coordinate with plant personnel to incorporate user preferences and lessons learned from past projects. If equipment and control system will be provided as part of a package system, Consultant shall coordinate with system supplier to ensure compatibility among different components.

III.17.3.2. The process control skid shall be pre-piped and pre-wired and delivered as a single unit. The skid shall be designed for a highly corrosive environment and shall be suitable for direct sunlight.