KC Water
Blue River Wastewater Treatment Plant Biosolids Facility

BASIS OF DESIGN REPORT

FINAL | January 2020

This document is released to the City of Kansas City, Missouri and Shortlisted Respondents as part of the Request for Proposals Package issued January 24, 2020, Project No. 81000821 – Contract Number 1595.

This report does not incorporate any modifications made by subsequent addenda since this report was initially issued to Shortlisted Respondents.

KC Water
Blue River Wastewater Treatment Plant
Biosolids Facility

BASIS OF DESIGN REPORT

FINAL | January 2020

CITY OF FOUNTAINS
HEART OF THE NATION

KANSAS CITY
MISSOURI

CERTIFICATION PAGE

Project/Contract Number 081000821/1595

Project Title Blue River Biosolids Facility Project

I am responsible for the following sections of the Basis of Design Report:

Introduction

Performance Requirements

Project Siting and Existing Facilities

Sludge Screening

East Holding Tank

Pre-THP Dewatering and Cake Storage

Digester Improvements

West Holding Tank Improvements

Post-THP Dewatering and Cake Storage

Sidestream Treatment

Polymer Storage and Feed Facilities

Odor Control Systems

STATE OF MISSOURI
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NUMBER PE-027318
PROFESSIONAL ENGINEER

1/22/2020

(SEAL)

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HEART OF THE NATION
KANSAS CITY
MISSOURI

CERTIFICATION PAGE

Project/Contract Number __081000821/1595______

Project Title _Blue River Biosolids Facility Project_______

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Project/Contract Number 081000821/1595

Project Title Blue River Biosolids Facility Project

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Project/Contract Number 081000821/1595

Project Title Blue River Biosolids Facility Project

I am responsible for the following sections of the Basis of Design Report:

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Project/Contract Number 081000821/1595

Project Title Blue River Biosolids Facility Project

I am responsible for the following sections of the Basis of Design Report:

Chapter 5

Section 5.3 Architectural

- 5.3.1 Basis of Design
- 5.3.2 Facilities Requirements
- 5.3.3 Codes and Standards
- 5.3.4 Materials and Specifications

STATE OF MISSOURI
JULIE BLACK WELLNER
NUMBER
A-5006
REGISTERED ARCHITECT

Julie Wellner 1/22/18 (SEAL)

:

CERTIFICATION PAGE

Project/Contract Number: [illegible]

Project Title: Blue Plains Biosolids Facility Project

I am responsible for the following sections of the Basis of Design Report

SCADA, Instrumentation & Controls

Thermal Hydrolysis Process and Steam Generation

Biogas Processing

1/10/2020

Date

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Abbreviations

3D	three-dimensional
A	amperes
AA	annual average or Aluminum Association
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AC	asphalt concrete
ACH	air changes per hour
ACI	American Concrete Institute
ACSM	American Congress on Surveying and Mapping
AD	anaerobic digester
ADA	American Disabilities Act
AHRI	Air Conditioning, Heating, and Refrigeration Institute
AHU	air handling units
AISC	American Institute of Steel Construction
AMCA	Air Movement and Control Association
ANAMMOX®	anaerobic ammonium oxidation
ANSI	American National Standards Institute
AOB	ammonia oxidizing bacteria
AOR	allowable operating range
API	American Petroleum Institute
APWA	American Public Works Association
ARC	Aluminum Rigid Conduit
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Association
ASL	Above Sea Level
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASTM	American Society for Testing and Materials
ATS	Automatic Transfer Switch
AVAR	air vacuum/air-release valves
AWG	American Wire Gauge
AWS	American Welding Society
AWWA	American Water Works Association
BDF	blended digester feed
BFP	belt filter press
BIM	building information model
BH	Birmingham

BMP	best management practice
BNR	Biological Nutrient Removal
BOD_5	biochemical oxygen demand five day
BODR	Basis of Design Report
BODu	ultimate biochemical oxygen demand
BR	Blue River
BSP	black steel pipe or British Standard Pipe
BTU	British thermal unit
BTU/hr	British thermal unit per hour
C	Celsius or coefficient
Carollo	Carollo Engineers, Inc.
CEQA	California Environmental Quality Act
cf	cubic feet
CFD	computational fluid dynamics
cfh	cubic feet per hour
cfm	cubic feet per minute
CH_4	methane
CHP	combined heat power
City or Owner	City of Kansas City, Missouri
CL	Cement Lined
cm	centimeters
CMU	concrete masonry unit
CNG	compressed natural gas
CO	carbon monoxide
CO_2	carbon dioxide
COD	chemical oxygen demand
COD/day	chemical oxygen demand per day
CPVC	chlorinated polyvinyl chloride
CRSI	Concrete Reinforcing Steel Institute
CSA	Canadian Standards Association
CU	condensing units
cy	cubic yard
d	Day
D	diameter
DAF	dissolved air flotation
DB	design build
deg.	degrees
Dig	Digester
DIP	ductile iron pipe

DIPRA	Ductile Iron Pipe Research Association
DLR	Device Level Ring
DO	dissolved oxygen
DT	Dry Tons
D/T	dilutions to threshold
DT/day	Dry Tons Per Day
DTM	digital terrain model
dtpd	Dry Tons Per Day
ea	each
EBRT	empty-bed residence time
EF	exhaust fan
EPA	Environmental Protection Agency
EQ	Equalization
EWSS	Emergency Eyewash and Safety Showers
F	Fahrenheit
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
F/M	Food to Microorganism
FM	Flow Meter
FOG	fats, oils, and grease
FPDB	Fixed Price Design-Build
fpm	feet per minute
FRP	fiberglass reinforced plastic
ft	feet
ft^3	cubic feet
ft/s	feet per second
FW	fresh water
g	grams
gal	gallon
GFCI	ground-fault circuit interrupter
GIS	geographic information system
gpd	gallons per day
gph	gallons per hour
gpm	gallons per minute
H	height
HCP	HVAC Control Panel
HDPE	high-density polyethylene
HMI	human machine interface

hp	horsepower
HP	Hewlitt Packard
hr	hours
hr/day	hours per day
HRT	hydraulic retention time
H_2S	hydrogen sulfide
H_2SO_3	sulfurous
H_2SO_4	sulfuric acid
HSS	hollow structural sections
HVAC	heating, ventilation, and air conditioning
Hz	hertz
IBC	International Building Code
I&C	instrumentation and control
ICC-ES	International Code Council Evaluation Service
ICE	internal combustion engine
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IFAS	integrated fixed-film activated sludge
IFC	International Fire Code
IMC	International Mechanical Code
in.	inches
I/O	input/output
IPC	International Plumbing Code
ISA	International Society of Automation
ISO	International Organization for Standardization
Jacobs	Jacobs Engineering Group, Inc.
JW	jacket water
KCMO	City of Kansas City, Missouri
KCP&L	Kansas City Power and Light
KC Water or WSD	City of Kansas City, Missouri Water Services Department
kPa	kilopascals
ksi	kilopounds per square inch
kV	kilovolt
kW	kilowatt
L	length
lb	pounds
lb/cf	pounds per cubic foot
lb/day	pounds per day
lbf	pound-force

lb/gal	pounds per gallon
lb/hr	pounds per hour
LCP	local control panels
LED	light emitting diode
LEL	lower explosive limit
LIDAR	Light Detection and Ranging
L/s	liters per second
m^3	Cubic Meters
mA	milliampere
MAU	makeup air units
Max	maximum
MBBR	moving bed biofilm reactor
MCC	motor control center
MDNR	Missouri Department of Natural Resources
mg	milligrams
MG	million gallons
mg/L	milligrams per liter
mgd	million gallons per day
mg-TSS/L	milligrams of total suspended solids per liter
min	minute or minimum
MM	maximum month
mm	millimeter
mmBTU/hr	million British thermal units per hour
mm/sec	millimeters per second
MMAD	Maximum Month Average Day
MOPO	Maintenance of Plant Operations
MOR	Monthly Operational Report
mph	miles per hour
MW	maximum week or megawatt
N or N_2	Nitrogen or Nitrogen gas
NACE	National Association of Corrosion Engineers
NAD	North American Datum
NaOCl	Sodium hypochlorite
NaOH	Sodium Hydroxide
$NaSHO_3$	sodium bisulfite
NAVD	North American Vertical Datum
nbVSS	non-biodegradable volatile suspended solids
ND	no data
NEC	National Electrical Code

NEID	Northeast Industrial District
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NFRC	National Fenestration Rating Council
NH_3	ammonia
NH_3-N	ammonia nitrogen
NIST	National Institute of Standards and Technology
No.	number
NOx	nitrogen dioxide
NPDES	National Pollutant Discharge Elimination System
NPSH	net positive suction head
NSF	National Sanitation Foundation
NTP	notice to proceed
O_2	oxygen
OA	Owner's Advisor
OC	Odor Connection
OIT	Operator Interface Terminal
O&M	operations and maintenance
OOS	out of service
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety and Health Administration
P	Phosphorus
Pa	pascals
PBU	Polymer Blending Units
PC	progressing cavity
PCC	Portland cement concrete
PF	peaking factor
PFD	process flow diagram
Ph	phase
P&ID	Process and Instrumentation Drawings
PLC	programmable logic controller
PO_4-P	Orthophosphate as Phosphorus
ppm	parts per million
ppmv	parts per million by volume
PRO2D2	Jacobs' Professional Process Design and Dynamics
Project	Blue River Biosolids Facility Project
PS	pump station
psf	pounds per sqare foot

psi	pounds per square inch
psig	pounds per square inch gauge
PTOF	Pulse Time of Flight
PVC	polyvinyl choloride
PVDF	polyvinylidene fluoride
PWC	plant water chlorinated
QBL	quadruple bottom line
Qty	quantity
RAS	return activated sludge
RCP	reinforced concrete pipe
RFI	Request for Information
RFP	Request for Proposals
RGRC	rubber gasketed reinforced concrete
RIN	Renewable Identification Number
RMS	root mean square
rpm	revolutions per minute
s	seconds
SAE	Society of Automotive Engineers
SCADA	supervisory control and data acquisition
scfh	standard cubic feet per hour
scfm	standard cubic feet per minute
SCH	Schedule
SCR	selective catalytic reduction
SDR	Standard Dimension Ratio
sf	square feet
SF	safety factor
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SO_2	sulfur dioxide
SO_3	trioxide
SPF	Small Form-Factor Pluggable
sq. cm	square centimeter
sq. ft	square foot
sq. in.	square inch
sq. m	square meters
SRT	solids retention time
SS	stainless steel
SWD	side water depth
SWPPP	Storm Water Pollution Prevention Plan

TAN	Total Ammonia Nitrogen
TBD	to be determined
TDH	total dynamic head
TF	trickling filter
THP	thermal hydrolysis process
THS	Thermally Hydrolyzed Sludge
TIN	triangular irregular networks
TKN	total Kjeldahl nitrogen
TP	Total Phosphorus
TPO	Thermoplastic Polyolefin
TRS	total reduced sulfur compounds
TS	total solids
TS/day	total solids per day
TSS	total suspended solids
UG/KCK	Unified Government of Wyandotte County/Kansas City, Kansas
UK	United Kingdom
UL	Underwriters Laboratories
UPC	Uniform Plumbing Code
UPS	Uninterruptible Power Supply
USACE	United States Army Corps of Engineers
UV	ultraviolet
V	volts
VCP	vendor control panel or vitrified clay pipe
VFA	volatile fatty acid
VFD	variable frequency drive
VNC	Virtual Network Computing
VOC	volatile organic compound
VS	volatile solids
VSS	volatile suspended solids
W	width
WAS	waste activated sludge
WBS	Work Breakdown Structure
w.c.	water column
WEF	Water Environment Federation
WS	Westside
WWTP	wastewater treatment plant

Chapter 1

INTRODUCTION

1.1 Purpose of Design Criteria Documents

The City of Kansas City, Missouri (City or Owner) Water Services Department has embarked on the Blue River Biosolids Facility Project (Project) for the Blue River Wastewater Treatment Plant (WWTP) that will be delivered under the Fixed Price Design-Build (FPDB) method. As the Owner's Advisor (OA) the Carollo/Jacobs team completed process and site evaluations, developed design criteria, and the preliminary design as part of the overall procurement documents for the shortlisted Respondents.

This Basis of Design Report (BODR), in conjunction with the other Project Technical Requirements, is provided as Attachment E to the Request for Proposals (RFP) and is intended to communicate to shortlisted Respondents the scope, design criteria and the Owner's technical requirements for the new and modified facilities that comprise the Project. The intent of these requirements is to provide guidelines for design and construction of the Project facilities. Also included in Attachment E are the Preliminary Drawings (as PDF), Building Information Model (BIM, native files), Technical Specifications, and the Best and Final proposal to the City for Cambi Thermal Hydrolysis Process (THP) equipment. Provided drawings represent the reference design feasibility and layout and are not intended for construction. It is the responsibility of the Design-Builder to verify, modify, and complete any and all concepts illustrated in these design and supporting technical documents to advance the reference design sufficiently to provide the required Fixed Price.

This BODR is intended to complement and explain the Preliminary Design Drawings, however the Design-Builder shall refer to the Drawings for any apparent conflicts between BODR and drawings.

1.1.1 Basis of Design Report Organization

This BODR is organized by chapter and sections as follows:

- Chapter 1 Introduction – Describes the purpose of this BODR and design requirements.
- Chapter 2 Performance Requirements – Describes influent flow and load analysis and process modeling results.
- Chapter 3 Project Siting and Existing Facilities – Describes existing site conditions as well as requirements for the project site in general, such as laydown areas and future considerations.
- Chapter 4 Treatment Process Design Criteria – Organized by process area and provides a summary of criteria, brief process and controls narratives, as well as other design considerations for each process.
- Chapter 5 Discipline Design Criteria – Organized by discipline and provides a summary of criteria applicable to the entire Project or identified areas.
- Chapter 6 Permitting Responsibility – Identifies the responsibilities of the City and the Design-Builder for permitting.

1.2 Design Criteria for the Representative Project

The Owner's design requirements for the Representative Project are described in this BODR by process area and discipline. Criteria have been identified in each section and categorized as follows: Fixed, Indicative, and Indicative Preferred. Design requirements are provided through the combination of complete or partial technical specifications, tables within this BODR, and narrative within this BODR.

The design criteria in this BODR and in Attachment E Project Technical Requirements describe the Representative Project.

1.2.1 Fixed Design Criteria

Fixed Design Criteria must be adhered to and followed. Variants from Fixed Design Criteria are not acceptable. If, during the procurement phase, a shortlisted Respondent wishes to modify a fixed design criteria, they may bring it up with the City through the Proposal Request for Information (RFI) process. Fixed Design Criteria will only be changed via an RFP addendum.

1.2.2 Indicative Design Criteria

Indicative Design Criteria are the City's design intent and can be deviated pending City approval. Proposed variants must be introduced in shortlisted Respondent's Interim Deliverable and justified during Confidential Meeting #2. Approval must be granted by the City for inclusion in shortlisted Respondent's technical and cost proposal. Proposed and approved variants will be considered by the City as confidential. Shortlisted Respondents are referred to Section 3 of the RFP for more information.

1.2.3 Indicative-Preferred Design Criteria

Indicative-Preferred Design Criteria are the same as Indicative Design Criteria with an emphasis of strong Owner preference. Deviation from these criteria will follow the same approval process as Indicative Design Criteria.

1.3 Project Overview

The Blue River WWTP is a 120 million gallons per day (mgd) municipal wastewater treatment facility that discharges treated effluent into the Missouri River. It receives combined sludge from two other facilities to generate 94 dry tons per day of biosolids. The Project will enable the WWTP to produce Class A Biosolids and increase biogas production by incorporating a new THP system and replacement and rehabilitation of aging infrastructure, including the existing incinerator system from 1965. This project will incorporate improvements to address the region's future capacity needs while providing the flexibility needed to meet future regulatory requirements through 2035.

The Project includes screening combined raw sludge before it is sent to dewatering centrifuges (Pre-THP Centrifuges). Cake will then be processed by the THP system to produce thermally hydrolyzed sludge (THS). THS will be cooled prior to anaerobic digestion. Digested sludge will be processed through dewatering centrifuges (Post-THP Centrifuges) to reduce the volume of digested sludge. Concentrated cake will be conveyed to the truck loadout station and centrate returned to the plant's sidestream treatment process. Biogas from the anaerobic digesters will be conditioned and flared.

Chapter 2

PERFORMANCE REQUIREMENTS

2.1 Introduction

This chapter presents the basis for the preliminary design of the recommended facilities as part of this improvement project. It includes the results of the influent flow and load analysis for Blue River WWTP, Birmingham WWTP, and Westside WWTP, as well as the results from the process modeling for the improved Blue River WWTP conducted during the development of the preliminary reference design of this project, including:

- Primary, secondary and digested sludge production.
- Anaerobic digestion (biogas and digested sludge production).
- Dewatering sidestream production.

2.2 Influent Flows and Loads

This section presents the flows and loads projections that served as the basis for the process modelling efforts conducted during the Conceptual Design stage of this project. Projections were developed for the following three treatment facilities for current and future (year 2025 and 2035) conditions:

1. Blue River WWTP.
2. Birmingham WWTP.
3. Westside WWTP.

Table 2.1 Blue River WWTP Forecasted Population and TSS and BOD_5 Loadings

Parameter		Loadings, lb/day			
		2015(2)	2025(3)	2035(3)	2035 MP(4)
Population(3)	Projected	481,590	347,620	327,100	
TSS	Average	112,400	81,100	76,300	81,200
	MM	146,200	105,500	99,200	121,800
	MM PF	1.30	1.30	1.30	1.50
BOD_5	Average	78,300	56,500	53,200	51,700
	MM	101,200	73,000	68,700	77,600
	MM PF	1.29	1.29	1.29	1.50
Flow	Average	63.5	45.8	43.1	57.1
	MM	92.5	66.8	62.9	75.0
	MM PF	1.46	1.46	1.46	1.31

Notes:
(1) Abbreviations: BOD_5 = biochemical oxygen demand five day; lb/day = pounds per day; MM = maximum month; MP = Master Plan; PF = peaking factor; TSS = total suspended solids.
(2) Updated loadings using plant data from 2014-2018.
(3) Reflects wastewater contribution from Johnson County service area discontinuing by 2020 per Wastewater Master Plan.
(4) Source: Wastewater Master Plan 2017.

Table 2.2 Birmingham WWTP Forecasted Population and TSS and BOD_5 Loadings

Parameter		Loadings, lb/day			
		2015(1)	2025	2035	2035 MP(2)
Population(2)	Projected	89,000	67,300	82,500	
TSS	Average	17,100	12,900	15,900	13,900
	MM	21,700	16,400	20,200	20,900
	MM PF	1.27	1.27	1.27	1.50
BOD_5	Average	14,600	11,000	13,500	15,100
	MM	18,900	14,200	17,400	22,700
	MM PF	1.29	1.29	1.29	1.50
Flow	Average	10.8	8.2	10.0	10.9
	MM	17.3	13.1	16.1	17.9
	MM PF	1.60	1.60	1.60	1.64

Notes:
(1) Updated loadings using plant data from 2014-2018.
(2) Source: Wastewater Master Plan 2017.

Table 2.3 Westside WWTP Forecasted Population and TSS and BOD_5 Loadings

Parameter		Loadings, lb/day			
		2015(1)	2025	2035	2035 MP(2)
Population(2)	Projected	66,980	68,140	69,540	
TSS	Average	38,900	39,600	40,400	38,300
	MM	50,600	51,500	52,500	57,500
	MM PF	1.30	1.30	1.30	1.50
BOD_5	Average	29,100	29,600	30,200	26,900
	MM	33,500	34,100	34,800	39,300
	MM PF	1.15	1.15	1.15	1.46
Flow	Average	16.4	16.7	17.1	15.9
	MM	24.0	24.4	24.9	24.5
	MM PF	1.46	1.46	1.46	1.54

Notes:
(1) Updated loadings using plant data from 2014-2018.
(2) Source: Wastewater Master Plan 2017.

Nutrients Influent Loads. The loads projections and assumptions made for their estimation are presented in Table 2.4.

Table 2.4 Forecasted Nutrient Load for Blue River WWTP, Birmingham WWTP and Westside WWTP

Service Area	Plant Influent, lb/day					
	2015		2025(6)		2035(6)	
	AA	MM	AA	MM	AA	MM
Blue River						
TAN(2)	7,400	9,600	5,350	6,900	5,000	6,500
TP(3)	3,200	4,100	2,300	3,000	2,200	2,800
Birmingham(4)						
TAN	1,262	1,600	950	1,250	1,200	1,500
TP	540	700	400	500	500	650
Westside(5)						
TAN	2,200	2,500	2,200	2,600	2,300	2,600
TP	620	700	630	720	640	740

Notes:
(1) Abbreviations: AA = annual average; TAN = Total Ammonia Nitrogen; TP = Total Phosphorus.
(2) Updated loadings using plant data from 2014-2018.
(3) Total Phosphorus based on Wastewater Master Plan Design Conditions for Unit Processes.
(4) Based on Blue River concentrations and ratios (total Kjeldahl nitrogen (TKN)/ammonia (NH_3), BOD_5/TP, BOD_5/TKN).
(5) Data quality from the Monthly Operational Reports (2014-2018) allowed for the estimation of current loads.
(6) Considers population projections presented in the Wastewater Master Plan 2017.

2.3 Process Modeling Conditions and Results

A whole-plant process model was set up for different loading conditions and operational scenarios for Blue River WWTP. Simulations using this model accounted for current and future (year 2025 and 2035) conditions. Current conditions and year 2025 considered that secondary treatment is performed using the existing trickling filters while the model projecting year 2035 conditions considered a conversion to biological nutrient removal (BNR) using a 5-Stage Bardenpho process configuration as a reference. Two main scenarios were modeled: 1) Blue River WWTP receives sludge from Birmingham WWTP and from Westside WWTP; and 2) Blue River WWTP receives sludge from Birmingham WWTP only and not from Westside WWTP. As such, separate process models were set up for Birmingham and Westside WWTPs to determine the quantity and characteristics of the sludge produced at current and future conditions (year 2025 and 2035). In addition, a scenario for co-digestion using fats, oils, and grease (FOG) was added to each of the mentioned conditions and scenarios to support the evaluation of this alternative.

The following conditions and operational scenarios serve as the basis for the preliminary design of the improvements for Blue River WWTP considered under this project:

- Blue River WWTP in year 2025- Retains existing trickling filters as secondary treatment and assumes new sidestream ammonia removal.
  - Annual Average:
    - Receiving FOG for co-digestion:
      - Receiving sludge from Birmingham and Westside WWTPs.

      - Receiving sludge from Birmingham WWTP only, and not from Westside WWTP.
    - Without receiving FOG for co-digestion:
      - Receiving sludge from Birmingham and Westside WWTPs.
      - Receiving sludge from Birmingham WWTP only, and not from Westside WWTP.
  - Maximum Month:
    - Receiving FOG for co-digestion:
      - Receiving sludge from Birmingham and Westside WWTPs.
      - Receiving sludge from Birmingham WWTP only, and not from Westside WWTP.
    - Without receiving FOG for co-digestion:
      - Receiving sludge from Birmingham and Westside WWTPs.
      - Receiving sludge from Birmingham WWTP only, and not from Westside WWTP.
- Blue River WWTP in year 2035- assumes new BNR as secondary treatment, new sidestream nutrient recovery (P-recovery) and continuation of sidestream ammonia removal.
  - Annual Average:
    - Receiving FOG for co-digestion:
      - Receiving sludge from Birmingham and Westside WWTPs.
      - Receiving sludge from Birmingham WWTP only, and not from Westside WWTP.
    - Without receiving FOG for co-digestion:
      - Receiving sludge from Birmingham and Westside WWTPs.
      - Receiving sludge from Birmingham WWTP only, and not from Westside WWTP.
  - Maximum Month:
    - Receiving FOG for co-digestion:
      - Receiving sludge from Birmingham and Westside WWTPs.
      - Receiving sludge from Birmingham WWTP only, and not from Westside WWTP.
    - Without receiving FOG for co-digestion:
      - Receiving sludge from Birmingham and Westside WWTPs.
      - Receiving sludge from Birmingham WWTP only, and not from Westside WWTP.

The following tables presents the results of the simulations performed according to the conditions and scenarios described above. These results serve as the basis of this preliminary design of the recommended improvements for Blue River WWTP. Raw sludge production under the different conditions and scenarios are presented in Table 2.5. Simulation results for digestion parameters and performance are presented in Table 2.6, and sidestream loads resulting from the different simulations are presented in Table 2.7.

Table 2.5 Raw Sludge Production

Parameter	BR with Trickling Filter		BR with Trickling Filter+FOG		BR with 5 Stage-Bardenpho+NutrRecovery		BR with 5 Stage-Bardenpho+NutrRecovery+FOG	
	2025				2035			
	AA	MM	AA	MM	AA	MM	AA	MM
Scenario 1: Processing Sludge Produced in Blue River, Birmingham and Westside								
BR+BH+WS Total Sludge Production (thickened+BR PS) (tons TS/day)	68.2	87.7	70.1	90.1	73.5	95.6	73.6	95.7
BR+BH+WS Total Primary Sludge (tons TS/day)	45.5	59.0	45.5	59.0	45.2	58.6	45.2	58.6
BR+BH+WS Total Secondary Sludge (tons TS/day)	22.8	28.7	22.8	28.7	28.3	37.1	28.3	37.1
Solids to THP, ton/day	66.9	85.9	66.6	85.6	72.0	93.7	72.1	93.8
Solids to THP, %	16.50%	16.50%	16.50%	16.50%	16.50%	16.80%	16.50%	16.50%
FOG to Digestion, gpd	-	-	8,838	8,838	-	-	8,838	8,838
FOG to Digestion, %Solids	-	-	5.20%	5.20%	-	-	5.20%	5.20%
FOG to Digestion, %VS	-	-	89%	89%	-	-	89%	89%
FOG to Digestion, ton COD/day	-	-	6.38	6.38	-	-	6.4	6.4
%FOG-COD (FOG/Total)	-	-	8%	7%	-	-	8%	6%
Scenario 2: Processing Sludge Produced in Blue River and Birmingham (no Westside sludge)								
BR+BH+WS Total Sludge Production (thickened+BR PS) (tons TS/day)	44.8	58.4	46.0	59.9	49.4	65.4	49.1	65.0
BR+BH+WS Total Primary Sludge (tons TS/day)	30.4	39.4	30.4	39.4	30.0	38.9	30.0	38.9
BR+BH+WS Total Secondary Sludge (tons TS/day)	14.4	18.9	14.4	18.9	19.4	26.5	19.4	26.5
Solids to THP, ton/day	43.9	57.2	43.7	56.9	48.4	64.1	48.1	63.7
Solids to THP, %	16.50%	16.50%	16.50%	16.50%	16.50%	16.50%	16.50%	16.50%
FOG to Digestion, gpd	-	-	8,838	8,838	-	-	8,838	8,838
FOG to Digestion, %Solids	-	-	5.20%	5.20%	-	-	5.20%	5.20%
FOG to Digestion, %VS	-	-	89%	89%	-	-	89%	89%
FOG to Digestion, ton COD/day	-	-	6.38	6.38	-	-	6.4	6.4
%FOG-COD (FOG/Total)	-	-	12%	9%	-	-	12%	9%

Notes:
(1) Abbreviations: BR = Blue River; BH = Birmingham; COD/day = chemical oxygen demand per day; gpd = gallons per day; PS = pump station; TS/day = total solids per day; VS = volatile solids; WS = Westside.

Table 2.6 Anaerobic Digestion

Parameter	BR with Trickling Filter 2025 AA	BR with Trickling Filter 2025 MM	BR with Trickling Filter+FOG 2025 AA	BR with Trickling Filter+FOG 2025 MM	BR with 5 Stage-Bardenpho+NutrRecovery 2035 AA	BR with 5 Stage-Bardenpho+NutrRecovery 2035 MM	BR with 5 Stage-Bardenpho+NutrRecovery+FOG 2035 AA	BR with 5 Stage-Bardenpho+NutrRecovery+FOG 2035 MM
Scenario 1: Processing Sludge Produced in Blue River, Birmingham and Westside								
Sludge to Digestion								
BR+BH+WS Total Sludge Load (tons TS/day)	61.20	79.21	62.87	80.84	63.97	84.02	65.88	85.69
BR+BH+WS Total Sludge Load (tons COD/day)	69.89	90.84	91.84	92.84	70.84	93.54	77.24	99.60
BR+BH+WS Total Sludge Flow (mgd)	0.15	0.19	0.15	0.20	0.15	0.20	0.16	0.21
BR+BH+WS Total sludge TSS content (%)	10.0	10.0	9.7	9.8	10.0	10.0	9.7	9.8
BR+BH+WS Total sludge VSS content (% of TS)	74%	74%	74%	75%	74%	74%	74%	74%
Digestion HRT, d	21.9	16.9	20.7	16.2	21.0	16.0	19.8	15.3
Digestion HRT, d (1 OOS)	11.0	8.5	10.4	8.1	10.5	8.0	9.9	7.7
Digester volume, MG	3.57	3.57	3.57	3.57	3.57	3.57	3.57	3.57
Percent of Volume that is Active, %	90%	90%	90%	90%	90%	90%	90%	90%
Volatile Solids Loading - kg/m3-day	3.4	4.4	3.5	4.5	3.5	4.6	3.6	4.8
Dig VS, lb	780,532	902,926	756,397	879,788	847,462	951,952	820,119	935,037
F/M, lb COD/lb Dig VS/day	0.18	0.20	0.20	0.22	0.17	0.19	0.19	0.21
Sludge after digestion, ton/day	32.3	45.4	32.9	46.0	34.0	48.4	34.7	49.0
Sludge concentration after digestion, %	5.3	5.7	5.1	5.6	5.3	5.8	5.1	5.6
Methane production, cfm	370	442	411	482	364	437	407	480
Biogas production, cfm	585	700	659	773	577	691	654	771
Scenario 2: Processing Sludge Produced in Blue River and Birmingham (no Westside sludge)								
Sludge to Digestion								
BR+BH+WS Total Sludge Load (tons TS/day)	40.13	52.81	41.88	54.47	42.43	56.91	44.40	58.71
BR+BH+WS Total Sludge Load (tons COD/day)	44.96	61.50	89.84	90.84	45.64	63.92	52.03	69.97
BR+BH+WS Total Sludge Flow (mgd)	0.10	0.13	0.10	0.13	0.10	0.14	0.11	0.14
BR+BH+WS Total sludge TSS content (%)	10.0	10.0	9.6	9.7	10.0	10.0	9.6	9.7
BR+BH+WS Total sludge VSS content (% of TS)	72%	73%	73%	73%	72%	72%	73%	73%
Digestion HRT, d	33.4	25.4	30.7	23.8	31.6	23.6	29.0	22.2
Digestion HRT, d (1 OOS)	16.7	12.7	15.4	11.9	15.8	11.8	14.5	11.1
Digester volume, MG	3.57	3.57	3.57	3.57	3.57	3.57	3.57	3.57
Percent of Volume that is Active, %	90%	90%	90%	90%	90%	90%	90%	90%
Volatile Solids Loading - kg/m3-day	2.2	2.9	2.3	3.0	2.3	3.1	2.4	3.2
Dig VS, lb	685,702	858,701	654,405	824,323	781,275	925,717	743,291	899,541
F/M, lb COD/lb Dig VS-d	0.13	0.14	0.16	0.16	0.12	0.14	0.14	0.16
Sludge after digestion, ton/day	20.5	30.3	20.5	30.3	22.3	33.1	23.0	33.8
Sludge concentration after digestion, %	5.1	5.7	4.7	5.4	5.2	5.8	5.0	5.6
Methane production, cfm	251.3	308.5	251.3	308.5	244.7	305.3	288.7	350.5
Biogas production, cfm	395.2	487.4	395.2	487.4	385.5	482.4	464.5	564.3

Notes:
(1) Abbreviations: cfm = cubic feet per minute; d = day; Dig = digester; F/M = food to microorganism; HRT = hydraulic retention time; MG = million gallons; OOS = out of service; VSS = volatile suspended solids.

Table 2.7 Dewatering Sidestream

	BR with Trickling Filter		BR with Trickling Filter+FOG		BR with 5 Stage-Bardenpho+ NutrRecovery		BR with 5 Stage-Bardenpho+ NutrRecovery+ FOG	
	2025				2035			
Scenario 1: Processing Sludge Produced in Blue River, Birmingham and Westside								
Centrate flow	0.12	0.15	0.12	0.15	0.13	0.16	0.14	0.17
Sidestream NH_3-N Load, lb/day (Before Treatment)	2,202	2,498	2,202	2,498	2,292	2,682	2,239	2,620
Sidestream NH_3-N, mg/L (Before Treatment)	2,173	1,940	2,173	1,940	2,171	1,967	1,985	1,830
Sidestream PO_4-P Load, lb/day (Before Treatment)	771	859	771	859	2,394	2,811	2,442	2,984
Sidestream PO_4-P, mg/L (Before Treatment)	760	667	760	667	2,268	2,061	2,165	2,084
Scenario 2: Processing Sludge Produced in Blue River and Birmingham (no Westside sludge)								
Centrate flow	0.08	0.27	0.08	0.27	0.08	0.11	0.09	0.12
Sidestream NH_3-N Load, lb/day (Before Treatment)	1,512	1,734	1,512	1,734	1,562	1,874	1,515	1,818
Sidestream NH_3-N, mg/L (Before Treatment)	2,263	783	2,263	783	2,224	2,034	1,955	1,836
Sidestream PO_4-P Load, lb/day (Before Treatment)	557	611	557	611	2,001	2,343	1,810	2,228
Sidestream PO_4-P, mg/L (Before Treatment)	833	276	833	276	2,850	2,544	2,337	2,249

Notes:
(1) Abbreviations: mg/L = milligrams per Liter; NH_3-N = ammonia nitrogen; PO_4-P = Orthophosphate as Phosphorus.
(2) Sidestream flows do not include polymer & wash water from final dewatering.
(3) For Alternatives with Nutrient Recovery, modeling assumes a waste activated sludge (WAS) P-release tank is used to minimize struvite production potential in anaerobic digestion.
(4) For Alternatives with FOG, the results do not consider any significant N and P contribution from received FOG.

Chapter 3

PROJECT SITING & EXISTING FACILITIES

3.1 Existing Site Conditions

This section provides the Design-Builder with information regarding the existing site facilities at the Blue River WWTP. The City performed investigations including as-built document review, potholing, surveying, and geotechnical investigation.

This preliminary information is to be reviewed and modified by the Design-Builder as part of the development their proposal.

Scans of the as-built drawings are provided in Attachment D of the RFP.

3.1.1 Site Survey & Potholing Data

Exploratory potholing was performed by the City to identify the location of existing utilities.

Potholing program was performed to identify the location of the existing utilities such as pipelines and duct banks.

A topographic survey was performed based on a fixed horizontal and vertical datum. The surveys depict 1-foot topographic contour relief and spot elevations to 0.1 foot accuracy per American Congress on Surveying and Mapping (ACSM) standards.

Field survey of center line control or other control monuments were used to locate the following:

- Street right-of-ways and centerlines.
- Right-of-ways for flood control channel.
- Property/parcel boundary lines.
- Easements.

Additional potholing and surveying to locate potential subsurface facilities are to be undertaken, as required, by the Design-Builder prior to finalizing design and commencing site work.

The topographic site survey and potholing data are provided in Attachment D Project Background Documents of the RFP.

3.1.2 LIDAR Information

The Building Information Model (BIM) is based on Light Detection and Ranging (LIDAR) scans conducted in September 2018. Design-Builder shall refer to Section 1.2.1 Project Technical Requirements of the RFP for more information about LIDAR scans and the application and intended use of the BIM. The LIDAR data are provided in Attachment D (Project Background Documents) of the RFP.

The Owner provided the BIM in RFP Attachment E (Project Technical Requirements).

3.1.3 Geotechnical Report

A geotechnical investigation of the site was performed in 2018. Borings were drilled as part of the investigation.

Design-Builder is to retain the services of a licensed geotechnical engineer and undertake the appropriate additional investigation, testing, and analysis suitable for design of the facilities.

The Final Geotechnical Report is provided in Attachment D of the RFP.

Chapter 4

TREATMENT PROCESS DESIGN CRITERIA

4.1 Introduction

This chapter is organized by process area and provides a process description, the basis of design, design criteria and requirements, and control narratives, as well as other design considerations for the process area. Design criteria and requirements are provided through the combination of complete or partial technical specifications, tables within this BODR, and narrative within this BODR.

This chapter is organized by process area as follows:

- Sludge Screening (Screens, Pumps, support equipment).
- East Holding Tank including Pre-THP Sludge Supply Loop.
- Pre-THP Dewatering and Cake Storage (Pumps, Centrifuges, Conveyance, Cake Silos).
- Thermal Hydrolysis Process including Steam Generation.
- Digester Improvements including Biogas Collection.
- West Holding Tank Improvements including Biogas Storage and West Holding Tank Supply Loop.
- Post-THP Dewatering and Cake Storage (Pumps, Centrifuges, Conveyance, Cake Silo)
- Biogas Processing.
- Sidestream Treatment.
- Pre-THP and Post-THP Polymer Storage and Feed.
- Odor Control.

An additional section called "Deductive Work Items" is provided to describe the requirements of specific scope items that are 1) not addressed in the Preliminary Drawings and 2) require line-item cost identification per the RFP.

The Representative Project Design is Preliminary, and is developed to approximately 20 percent. It is not intended to, nor does it represent a complete or near complete design. It is intended to convey a reference design as a starting point for Design Build respondents. The Representative Project is not limited to the equipment identified in this chapter. Shortlisted respondents must consider all necessary ancillary and support equipment to make systems described in this BODR complete for the Representative Project.

4.2 Drawings and Informational Design Documents

4.2.1 Drawings

Drawings represent conceptual feasibility and layout and are not intended for construction. It is the responsibility of the Design-Builder to verify, modify, and complete any and all concepts illustrated in these design and supporting technical documents.

CAD files for the drawings are provided external to this BODR to aid the respondents in creating a design sufficiently developed to allow the Design Builder to produce its Fixed Fee estimate, and that are suitable to take to a level to support construction.as part of Attachment E (Project Technical Requirements) to the RFP.

4.2.2 Informational Only (BIM and Sketchup)

The native BIM files are provided external to this BODR as part of Attachment E (Project Technical Requirements) to the RFP. The BIM files are to be considered for informational only, intended to illustrate the design concepts. Shortlisted Respondents may develop their design based on the BIM but must rely on this BODR and the Drawings to dictate Owner's design requirements.

4.3 General Treatment Equipment Procurement Requirements

Design-Builder is to consider the following requirements as indicative design criteria:

- Equipment must be procured through the local manufacturer's representative who will be performing the service on such equipment.
- All equipment of the same type, for example Chopper-Type Centrifugal pumps, shall be of the same manufacturer.

4.4 Sludge Screening

4.4.1 Process Description

Sludge from the Blue River WWTP/Birmingham WWTP and Westside WWTP will enter the Sludge Screening Building into the new wet wells located along the north side of the western half of the building. Sludge will be able to flow between the two wet wells or be isolated by a gate between them. Sludge will be pumped from the wet wells to the Sludge Screens located on the second floor in the east half of the Sludge Screening Building. Recirculation piping will allow the sludge pumps to be used for mixing the wet wells and a bypass line will allow the sludge pumps to bypass the screens and go directly to the East Holding Tank.

Sludge will be screened through pressurized in-line sludge screens. Screened sludge will be sent to the east holding tank, while any screenings will drop out of the sludge screens and onto conveyors beneath the screens. The telescoping belt conveyors will distribute sludge evenly along the length of the dumpsters located beneath the sludge screens. Dumpsters will be provided for collection and removal.

4.4.2 Basis of Design

The new Sludge Screening Building will be designed to treat combined sludge flows and loads from the Blue River WWTP/Birmingham WWTP as well as the Westside WWTP. Sludge screening will occur on a continuous basis, 24 hours per day, 7 days per week. Total solids are assumed to be approximately 2.5 percent. A summary of the design criteria for the sludge flows and loads is provided in Table 4.1.

Table 4.1 Sludge Screening Flows and Loading Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Flow	640	gpm	Fixed
Total Solids	2.5	%	Fixed
Operating days	7	days/week	Fixed
Operating Hours	24	hours/day	Fixed

Notes:
(1) Abbreviations: gpm = gallons per minute.

4.4.3 Sludge Screens

The Sludge Screens installed in the new Sludge Screening Building will be pressurized, in-line sludge screens. The indicative basis of design is two units, 600 gpm capacity each. Screen opening shall be a maximum of 3 millimeters (mm) and maximum power is 5 horsepower (hp). The drawing layouts are based on the Huber Strainpress. A list of fixed and indicative design criteria is provided in Table 4.2.

Table 4.2 Sludge Screen Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Screen Type	Pressurized, In-line	-	Fixed
Number of Screens	2	-	Indicative
Unit Capacity	600	gpm	Indicative
Maximum Inlet Pressure	17.4	psig	Fixed
Average Pressure Drop	0-6	psig	Fixed
Screen Opening	3	mm	Fixed
Power	5	hp	Indicative
Minimum Screenings Dryness	35	%	Fixed
Equipment Weight	4,600	lb	Indicative

Notes:
(1) Abbreviations: psig = pounds per square inch gauge.

4.4.4 Sludge Pumps

The Sludge Pumps installed in the new Sludge Screening Building will be progressing cavity sludge pumps. The indicative basis of design is two units, 640 gpm capacity each. The drawing layouts are based on the Seepex BN 130-6LS. A summary of the fixed and indicative design criteria is provided in Table 4.3.

Table 4.3 Sludge Pump Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Type	Progressing Cavity	-	Fixed
Number of Units	2	-	Indicative
Unit Capacity	640	gpm	Indicative
Pressure	25	psig	Indicative
Maximum Motor hp	40	hp	Indicative
Equipment Weight	1,500	lb	Indicative

4.4.5 Support Equipment

Additional equipment will be required within the Sludge Screening Building to support the Sludge Screens and Sludge Feed Pumps, including dumpsters to capture sludge screenings for disposal, winches to position the dumpsters within the Sludge Screening Building, and conveyors to evenly distribute the sludge screenings across the length of the dumpsters.

Two dumpsters are required, located below the Sludge Screening Room. The number of conveyors will need to match the number of sludge screens depositing sludge screenings into the dumpsters. Winches must have adequate capacity to pull empty 30-cubic yard (cy) dumpsters into place. A summary of the fixed and indicative design criteria is provided in Table 4.4.

Table 4.4 Sludge Screening Support Equipment Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Conveyor Type	Telescoping Belt Conveyor	-	Indicative
Number of Units	2	-	Indicative
Dumpster Type	Roll-off	-	Indicative
Number of Units	2	-	Indicative
Dumpster Capacity	30	cy	Fixed
Winch Capacity	6500	lb	Indicative

4.4.6 Sludge Screening Building

The Sludge Screening Building will be a new construction, two-story 2,100-square foot (sf) minimum building located south of the East Sludge Storage Tank. The building will contain two 2,600-cubic foot (cf) wet wells adjacent to the Sludge Pump Room on the lower level. East of the Sludge Pump Room will be a Dumpster Room that captures falling sludge screenings from the Sludge Screening Room above. The Dumpster Room will have two rollup doors so dumpsters may be removed from the building in order to haul away screenings. A summary of the fixed and indicative design criteria is provided in Table 4.5.

Table 4.5 Sludge Screening Building Design Criteria

Parameter	*Value*	Unit	Fixed/ Indicative
Footprint (1st floor)	2,100	sf	Indicative
Configuration	2-story	-	Indicative
Number of Rooms	3	-	Indicative
Number of Man Doors	5	-	Indicative
Screen Location	2nd Floor	-	Indicative
Dumpster Location	1st Floor below Screens	-	Indicative
Pump Location	1st Floor	-	Indicative
Number of Wet Wells	2	-	Indicative
Wet well capacity (ea)	2,600	cf	Indicative
Number of Rollup Doors	2	-	Indicative
Drain Locations	All Rooms	-	Indicative
Drain Type	18-in. Trench Drain	-	Indicative
Roof Safety	Parapets	-	Indicative
Roof Access	Stairs	-	Indicative

Notes:
(1) ea = each; in. = inch.

Drainage will be provided by 18-in. trench drains in each room for hosing down any sludge splatter. Hose bibs will be located in each room of the Sludge Screening Building. Drains will tie into the existing plant drain system near the new Sludge Screening Building. Roof access will be required, and a safety parapet will be located around the edge of each roof.

Design Builder to provide adequate access to all utility systems. Design Builder will be responsible for relocating any existing utilities necessary for construction of any new facilities.

4.4.7 Control Narrative

The Sludge Pumps in the Sludge Screening Building will automatically run based on level sensors in the wet wells. Once the wet wells reach a HIGH level, a sludge pump will start and run until the level drops to the LOW level. If the HIGH level is exceeded, the second Sludge Pump will run when a HIGH-HIGH level is reached. The Sludge Screens will run while the Sludge Pumps run. Motor actuated valves will be used to isolate individual screens and pumps. Manual override will allow operators to select a specific screen and/or pump for duty operation. Conveyors will also run while the screens and pumps are running. Each conveyor will be dedicated to a Sludge Screen. Adjustment to the conveyor length will be manual. For example, if sludge screenings begin piling unevenly within the dumpsters, the telescoping conveyor length may be adjusted to evenly distribute the screenings.

4.5 East Holding Tank

4.5.1 Process Description

The Transfer Pump Building located between the East and West Holding Tanks currently houses the Sludge Transfer and Mixing Pumps associated with each tank. This area will be repurposed to house the East Holding Tank Mixing Pumps and Pre-THP Sludge Supply Loop Pumps, as well as the West Holding Tank mixing pumps and West Holding Tank Supply Loop Pumps discussed in this document.

The Transfer Pump Building shares a common wall with each of the Sludge Holding Tanks and is therefore classified as a Class I Division II space. In order to provide a safe working space for the new pumps, new walls will need to be constructed so the Digesters and Transfer Pump Building no longer share common walls, changing the classification to Unclassified.

4.5.2 Basis of Design

The existing East Holding Tank is a circular concrete tank originally constructed in 1964. The tank parameters are shown in Table 4.6.

Table 4.6 Existing East Holding Tank Parameters

Parameter	Unit	Quantity
Inside Diameter	ft	80
Inside Top Elevation	ft	767.33
Inside Bottom of Wall Elevation	ft	736.00
Bottom Floor Slope (rise:run)		1:6
Bottom Center Sump Diameter	ft	8
Volume (each)	MG	1.26

Notes:
(1) Abbreviations: ft = feet.

4.5.3 Tank Mixing Improvements

A new tank mixing system will be installed in the East Holding Tank. The new mixing system will be designed to provide a minimum of six (6) tank turnovers per day, which will break up the surface scum layer and minimize grit deposition at the bottom of the tank. This will require one new chopper pump to be installed. The pump motor will run on a variable frequency drive (VFD) to allow plant staff to fine tune the mixing system. Table 4.7 presents the design criteria for the tank mixing pumps as determined by Vaughan Company, Inc. Refer to Specification Section 11233 –Holding Tank Mixing System for additional requirements and information.

Table 4.7 East Holding Tank Mixing Pumps Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Tank Turnovers (minimum)	6	per day	Indicative
No. of Units	1 (+1 shelf pump)	-	Fixed
Type	Chopper-type centrifugal	-	Fixed
Drive	VFD		Fixed
Capacity	5,250	gpm	Indicative
Pressure	32	ft	Indicative
Motor (maximum)	75	hp	Fixed

The final design criteria of the tank mixing system pump shall be adjusted and coordinated with the mixing system manufacturer once the operating sludge surface levels in the tank have been finalized. Refer to the instrumentation and controls narrative for additional information pertaining to instrumentation and controls.

Due to the new design conditions, as well as the new walls in the Transfer Pump Building, the mixing system will require all new piping as well as new in-tank mixing nozzles. The new mixing pump will be located in the newly declassified area along with the other pumps associated with the East and West Holding Tanks pumping systems. Because of the layout constraints of the existing building, all pumps will need to be in a horizontal arrangement, i.e. the drive shaft of the pump will be parallel to ground surface. A process flow diagram (PFD) for the East Holding Tank is provided in the drawings. Additionally, the new suction piping shall be furnished with drain taps equipped with quick connects so that the line can be drained and flushed.

4.5.4 Pre-THP Sludge Supply Loop

The Pre-THP Sludge Supply Loop will prevent sludge buildup between the East Holding Tank and the Pre-THP Centrifuges by continuously conveying sludge to the Solids Processing Building (current Incinerator Building) and back to the East Holding Tank. Sludge to be dewatered will be pulled off the supply loop by the Pre-THP Centrifuge Feed Pumps for conveyance to the Pre-THP Centrifuges.

The Pre-THP Sludge Supply Loop will employ two duty chopper-type centrifugal pumps that will operate in parallel, equipped with dedicated VFDs, and be located in the existing Sludge Transfer Area adjacent to the East Holding Tank. The Pre-THP Sludge Supply Loop Pumps were analyzed for three operational scenarios and with the assumption that pump speed will be controlled by recirculation flow back to the tank. For more information pertaining to instrumentation and controls, refer to the instrumentation and controls narrative.

Scenario 1: One centrifuge online at minimum demand with recirculation.

Scenario 2: Two centrifuges online at maximum demand with recirculation.

Scenario 3: Recirculation through the sludge supply line only.

Table 4.8 below illustrates the assumed flow criteria for each of the scenarios.

Table 4.8 Design Criteria for Pre-THP Sludge Supply Loop Pumps

Scenario	Centrifuge Feed (2)	Sludge Recirculation back to East Holding Tank
1	250 gpm	620 gpm
2	1000 gpm	310 gpm
3	0 gpm	620 gpm

Notes:
(1) Centrifuge feed can vary from 250 to 500 gpm.
(2) Recirculation flow is targeted to maintain velocities in the force main back to the tank between 3.5 to 7.0 feet per second (ft/s). Recirculation flows assumed are indicative and subject to change.

Table 4.9 below displays the pump head conditions required to be met for each of the scenarios described above. The piping system modeled reflects what is shown on the drawings.

Table 4.9 Pre-THP Sludge Supply Loop Pumps Operational Points

Scenario	Pump Flow (2)	TDH (3)
1	435 gpm	32.50 ft
2	655 gpm	24.50 ft
3	310 gpm	22.75 ft

Notes:
(1) Abbreviations: TDH = total dynamic head.
(2) Two pumps operating in parallel to achieve the assumed full system flow.
(3) All head conditions provided are indicative and subject to change.

Table 4.10 below depicts the pump and motor requirements.

Table 4.10 Pre-THP Sludge Supply Loop Pumps Design Criteria

Parameter	Value	Unit	Fixed/Indicative
Pump Type	Chopper-type Centrifugal		Fixed
No. of Units	2 duty (+1 standby pump) (2)		Indicative
Motor Size	15	hp	Indicative
Motor Power Requirements,	460/3/60	V/Ph/Hz	Indicative
Drive	VFD		Fixed

Notes:
(1) Abbreviations: Hz = hertz; Ph = phase; V = volts.
(2) Standby will be a shelf unit.

Similar to the Tank Mixing Pumps, the Sludge Supply Loop Pumps will be in a horizontal arrangement. The discharge piping will be routed down the existing east-west pipe corridor to the Solids Processing Building where the Pre-THP Centrifuge Feed Pumps will be located and will follow the same route back for recirculation back to the tank.

Suction piping shall be furnished with drain taps and flushing connections equipped with quick connects so that the line can be drained and flushed.

4.5.5 Structural Modifications

Per the recommendations of the City's recent condition assessment, the existing pre-cast concrete roof on the East Holding Tank needs to be replaced. A new, aluminum geodesic cover, similar to those on the existing dissolved air flotation (DAF) tanks will replace the existing cover on the East Holding Tank. Additionally, the existing Pump Transfer Building will be repurposed to house the new pumping equipment associated with the East and West Holding Tanks. Due to the existing electrical classification of this space, a new wall will be constructed in the existing Transfer Pump Building to separate the adjacent sludge tanks.

4.5.6 Control Narrative

The operation of unit processes upstream and downstream of the East Sludge Holding Tank are dependent upon the volume of sludge within the Tank. The East Holding Tank will be equipped with a minimum of two level sensor devices (radar and ultrasonic) that provide simultaneous output at the human machine interface (HMI). The level sensing readout will be used as a process control input within the programmable logic controller (PLC) to determine whether upstream and downstream processes should be in operation. The plant operator shall be able to select what device provides the process control input to the PLC. Although both instruments should report similar readings in the absence of foam or froth, the ultrasonic level sensor will detect the top of the foam or froth layer while the Pulse Time of Flight radar level sensor will detect the sludge surface.

In general, sludge conveyance in and out of the East Holding Tank should be proportional to the influent sludge demand of the THP train(s).

HMI Operator Selectable Set Points and PLC Inputs from Level Sensing Equipment

1. High-high level:
   a. Set as a failsafe to automatically trigger the shutdown of upstream sludge screening equipment, including Sludge Screen Feed Pumps.
2. High level:
   a. Results in an alarm to alert plant staff that the volume of sludge within the tank is outside of typical operating range. If this alarm occurs, plant staff may elect to increase the flow to Pre-THP Dewatering Centrifuges to lower the volume of sludge within the tank.
3. Low level:
   a. Results in an alarm to alert plant staff that the volume of sludge within the tank is outside of typical operating range. If this alarm occurs, plant staff may elect to decrease flow to Pre-THP Dewatering Centrifuges to increase the volume of sludge within the tank.
4. Low-low level:
   a. Set as a failsafe to automatically trigger the shutdown of downstream equipment.

Upstream Treatment Processes

1. Sludge Screening:
   a. If high-high level within the tank is observed, the upstream sludge screening equipment, including Sludge Screen Feed Pumps, shall be shut down immediately to prevent process spillage.

Downstream Treatment Processes

1. Pre-THP Sludge Dewatering:
    a. If low-low level within the tank is observed, the Pre-THP Dewatering Centrifuges shall be shut down immediately to protect the equipment.
    b. If the East Holding Tank Sludge Supply Loop pumps are shut down, all Pre-THP dewatering equipment including, but not limited to, centrifuge feed pumps, centrifuges, and polymer feed equipment shall be shut down immediately.

East Holding Tank Mixing System

1. If low-low level within the tank is observed, the East Holding Tank mixing system shall be shut down immediately to protect the East Holding Tank Mixing Pump.
2. The rate of mixing provided by this system shall be adjusted according to the volume of sludge within the Tank. Furthermore, due to the anticipated variance in sludge volume, a timing control strategy for the mixing system should be considered.

Pre-THP Sludge Supply Loop

1. If low-low level within the tank is observed, the East Holding Tank sludge supply system shall be shut down immediately to protect the East Holding Tank Sludge Supply pumps.
2. The rate of recirculation provided by this system shall be adjusted according to downstream demands and desired flow back to the tank. Return flow to the Tank will be measured with a magnetic flow element.

4.6 Pre-THP Dewatering and Cake Storage

4.6.1 Process Description

Prior to processing by the THP system screened sludge will be dewatered by centrifuges. This treatment area includes the Pre-THP Centrifuge Feed pumps which pull directly off the East Holding Tank Sludge Supply Loop, polymer system, Pre-THP Dewatering Centrifuges, conveyors and storage for the cake prior to conveyance to the THP system (Pre-THP Cake Silos), and Pre-THP cake pumping to the THP System. A reversible screw conveyor will collect dewatered cake from centrifuge No. 2 and distribute the sludge between one of the two pre-THP cake silos. Centrifuge No. 1 and No. 2 will drop cake directly into a Pre-THP Cake Silo.

4.6.2 Basis of Design

The sludge loading condition including solids transferred from Westside WWTP was evaluated for pre-THP dewatering.

Table 4.11 Basis of Design for Pre-THP Dewatering and Cake Storage

Parameter	Value	Unit	Fixed/ Indicative
Flow (1)	637	gpm	Fixed
TS load	191,200	lb/day	Fixed
TS	2.5	%	Fixed
Dewatering days	7	days/week	Fixed
Dewatering hours(2)	24	hr/day	Fixed

Notes:
(1) Abbreviations: hr/day = hours per day.
(2) Based on 2035 max month flowrates.

4.6.3 Pre-THP Centrifuge Feed Pumping

The Pre-THP centrifuge feed pumping system will pull off the East Holding Tank Sludge Supply Loop and consist of inline sludge grinders and centrifuge feed pumps. The centrifuge feed pumps will be located in the Solids Processing Building on the first floor and piped above to the elevated centrifuges.

Progressing cavity pumps were selected for centrifuge feed service to provide steadier flow rate to the centrifuges because the flow rate does not vary with discharge pressure. A dedicated progressing cavity pump for each centrifuge will be provided. A grinder will be provided on the suction side of each pump to protect the pump and downstream equipment from being damaged with rogue debris passing through the screening facility. The pumps will discharge to a common header to provide flexibility in case a feed pump or centrifuge goes out of service. A progressing cavity pump will only operate when a centrifuge is in service.

Table 4.12 presents the design criteria for the inline grinders and Table 4.13 contains design criteria for the Pre-THP Centrifuge Feed Pumps.

Table 4.12 Design Criteria for Pre-THP Inline Grinders

Parameter	Value	Unit	Fixed/ Indicative
Type	In-line	--	Fixed
Duty units	3	--	Fixed
Standby units	1	--	Indicative
Diameter	6	in.	Indicative
Motor size	5	hp	Indicative
Manufacturer	• JWC Environmental, Model No. 30004T-1208 In-line Muffin Monster. • Moyno, EZSTRIP TR Muncher. • Vogelsang Xripper XRS 186-130Q.		Fixed

Table 4.13 Design Criteria for Pre-THP Centrifuge Feed Pumps

Parameter	Value	Unit	Fixed/ Indicative
Type	Progressing cavity	--	Fixed
Duty units	3	--	Fixed
Standby units	1	--	Fixed
Minimum flow	200	gpm	Indicative
Maximum flow	500	gpm	Indicative
Discharge pressure	15/40	psi	Indicative
Motor size	25	hp	Indicative
Manufacturer	• Seepex, BN-SCT Series. • Moyno Industrial Products Division of Robbins & Meyers, Inc., Model Series EZ Strip.		Indicative

Notes:
(1) Abbreviations: psi = pounds per square inch.

Attachment E contains Progressing Cavity Pump data sheet that shows the design criteria for the grinders and centrifuge feed pumps.

4.6.4 Pre-THP Dewatering Centrifuges

Each pre-THP dewatering centrifuge will be provided with a diverter gate to send slop to the plant drain.

A bridge crane above the centrifuges will be provided to allow operators to move the centrifuges and components for routine maintenance. The centrifuge components can be picked up by the bridge crane and carried outside of the building to a truck loading area.

Table 4.14 presents the design criteria for the Pre-THP Centrifuges.

Table 4.14 Design Criteria for Pre-THP Centrifuges

Parameter	Value	Unit	Fixed/ Indicative
Pre-THP Centrifuges			
Hydraulic capacity	450	gpm	Indicative
Solids capacity (dry)	5,000	lb/hr	Indicative
Duty units	2		Indicative
Standby units	1		Indicative
Bowl diameter	29	in.	Indicative
Length	23	ft	Indicative
Empty decanter weight	32,000	lb	Indicative
Rotating assembly weight	11,000	lb	Indicative
Vibration limits	4.5	mm/sec	Fixed
Static vertical load	38,000	lb	Indicative
Total vertical load	41,000	lb	Indicative
Main drive power	200	hp	Indicative
Secondary Motor	40	hp	Indicative
Water to drain	553	gpm	Fixed
Pre-THP Bridge Crane			
Length	210	ft	Indicative
Capacity	15	Tons	Indicative
Hoist Motor	20	hp	Indicative
Trolley Motor	1	hp	Indicative

Notes:
(1) Abbreviations: lb/hr = pounds per hour; mm/sec = millimeters per second.

4.6.5 Pre-THP Cake Conveyance

A reversible screw conveyor will divert cake from Pre-THP Centrifuge No. 2 and each Pre-THP Cake Silo will have a dedicated reversible screw conveyor to send cake to the THP unit process.

Table 4.15 presents the design criteria for the reversible screw conveyors.

Table 4.15 Design Criteria for Reversible Screw Conveyors

Parameter	Value	Unit	Fixed/ Indicative
Centrifuge No. 2 Conveyor			
Length	30	ft	Indicative
No.	1		

4.6.6 Pre-THP Cake Silos

To utilize the existing incinerator foundation pads, the diameter of the Pre-THP Cake Silos must fit within the diameter of the pads. Two Pre-THP Cake Silos will be provided to avoid single point of failure. Sliding frame silos will be provided to maximize the effective storage capacity while meeting the height restrictions imposed by the existing building. Each silo will be equipped with leveling mechanisms to maximize the effective storage capacity.

Table 4.16 shows the design criteria for the Pre-THP Cake Storage Silos.

Table 4.16 Design Criteria for Pre-THP Cake Silos

Parameter	Value	Unit	Fixed/ Indicative
Centrifuge feed solids	95.6	dry tons/day	Indicative
Solids retention efficiency	98	%	Indicative
Cake produced	93.7	dry tons/day	Fixed
Target total solids	18	%	Indicative
Cake Produced	520	wet tons/day	Indicative
Bulk density	55	lb/cf	Indicative
Cake volume	701	cy	Indicative
Silo type	Cylindrical with sliding frame		Indicative
No. silos	2		Fixed
Silo diameter (each)	22	ft	Indicative
Silo height	16	ft	Indicative
Tank volume available	394	cy	Indicative
Available storage time	13	hr	Indicative
Ventilation requirements	6,100	cfm	Indicative
Power requirement	10	hp	Indicative
Manufacturers	• Spirac. • Schwing.		Fixed

Notes:
(1) Abbreviations: lb/cf = pounds per cubic foot.

Attachment E of the RFP contains the data sheet for the Pre-THP Cake Silos.

4.6.7 Pre-THP Cake Pumping

Two progressing cavity pumps will serve as Pre-THP Cake Pumps, one dedicated to each silo. Pumps will be located underneath the screw conveyors and send dewatered cake (~18 percent TS) to the THP system or a truck loading area for offsite disposal. Dilution water will be added to to obtain the THP manufacturer's recommended concentration of 16.5 percent TS.

Table 4.17 presents the design criteria for the Pre-THP Cake Pumps.

Table 4.17 Design Criteria for Pre-THP Cake Pumps

Parameter	Value	Unit	Fixed/ Indicative
Type	Progressing cavity	--	Fixed
Duty units	2	--	Indicative
Standby units (Uninstalled)	1	--	Indicative
Minimum flow	70	gpm	Fixed
Maximum flow	100	gpm	Fixed
Discharge pressure	150/275	psi	Indicative
Motor size	60	hp	Indicative

Attachment E of the RFP contains the abbreviated pre-THP cake pumping specification.

4.6.8 Control Narrative

Pre-THP Centrifuge Feed Pumps

Flow rate of the pumped sludge will be recorded with meters installed on the influent pipeline to each centrifuge upstream of the polymer injection locations. A TSS monitor upstream of the centrifuge will determine the polymer dosage.

Pre-THP Dewatering Centrifuges

Each centrifuge will be equipped with a centrifuge motor start panel and control panel. The centrifuge motor start panel will house the VFD, motor control equipment, and motor starter equipment. The centrifuge control panel will house the centrifuge's PLC. Both motor start panel and control panel will be located in the control room next to the post-THP centrifuge dewatering equipment.

Sludge pumped to each centrifuge will be mixed with polymer before being fed to the centrifuge with at least 3 polymer feed points. The polymer and sludge flow rate will be controlled through the centrifuge control panel. Motor speed of the centrifuge equipment will be controlled by the centrifuge motor start panel. Both the centrifuge control panel and motor start panel will adjust as needed to provide an optimum solids concentration for dewatered cake.

Pre-THP Cake Silos

Dewatering cake will be contained in one of the two pre-THP cake silos. Cake drops from above and directly into a pre-THP cake silo. A non-contact level instrument at each pre-THP cake silo will record the level of cake within the tank and stop a centrifuge from dewatering when a high level is triggered. A sliding frame, built into each pre-THP cake silo, will discharge contained cake into a bottom loading screw conveyor when a cake pump is turned on. Cake from the screw conveyor will be conveyed to cake pump discussed in the next section.

Pre-THP Cake Pumps

Based on operating THP plant's personnel experience and manufacturer input, the cake pumps will be provided with torque measurements to approximate the percent TS and identify the amount of dilution water needed to obtain the target TS concentration. Lubrication rings will be provided at the discharge of each pump to provide the ability of injecting water and/or polymer to facilitate cake pumping. A valve on the discharge cake pipeline will control flow to either the THP system or to the truck loading area located south of the Solids Building.

4.7 Thermal Hydrolysis Process and Steam Generation

4.7.1 Process Description

The THP system will consist of a series of pressure vessels that process dewatered sludge at elevated temperatures, in series and in parallel to allow continuous flow into and out of the system, while providing batch processing internally. The system will be located outdoors on prefabricated modules bolted together as a skid on an awning-covered concrete slab. The system includes reactor feed/pulper circulation pumps and digester feed pumps. The package system will be provided by Cambi. A process gas skid that condenses vapors from the THP and separate non-condensable gases will be located adjacent to or on the THP skid.

The THP system will include a spare pulper tank and a spare flash tank to allow continuous operation during maintenance and inspection of the pulper and flash tanks. The spare pulper will be equipped with reactor feed/ pulper circulation pumps.

Support systems for the THP that are addressed in this section include:

- Thermally hydrolyzed cooling and cooling water system.
- Steam system, including steam boilers and water conditioning.

Pre-dewatered solids will be pumped by one of the THP feed pumps (Pre-THP Cake Pumps) to the first THP tank, called a pulper tank at an average dry solids concentration of 16.5 percent. Solids will be heated and mixed in the duty pulper tank, using flash steam vented from the downstream tanks. One of two reactor feed/pulper recirculation pumps will feed each reactor sequentially or circulate solids back to the duty. The other reactor/pulper circulation pump will circulate sludge to the duty pulper tank. Process gases will be vented from the duty pulper tank through a gas cooler and then to the process gas skid.

During each reactor filling cycle, steam will be added through lances located in the reactor to heat the solids to about 330 degrees Fahrenheit (deg. F). Once a reactor is filled (about 85 percent of available volume) and reaches the set-point temperature, filling and heating will stop and the reactor will be held at this temperature for a minimum of 20 minutes to satisfy the time/temperature Class A pathogen reduction requirements of the Environmental Protection Agency (EPA) 503 Rule. The pressure within the reactor will be 87 psig to keep the contents liquid. Steam may be added intermittently during the hold cycle if the temperature drops due to thermal losses. When the cycle is completed, the solids will be discharged to the duty flash tank.

The duty flash tank will be operated at close to atmospheric pressure and the vapor vented to the duty pulper tank. Solids from the reactor will experience a sudden drop in pressure, cooling the solids to about 220 deg. F and liquid will be flashed to steam. The flash steam will be vented to the duty pulper tank. The THS will be pumped from the bottom of the duty flash tank by one of the digester feed pumps to the cooling system. The THS will be approximately 12 percent - 14 percent dry solids concentration. An automatic post-dilution system using non-potable water will dilute the THS to approximately 8 percent - 10 percent dry solids concentration, which is required before feeding to the digesters. The addition of dilution water will also cool THS to below 190 deg. F, which will protect the stator and rotor of the Digester Feed Pump.

The Digester Feed Pump will modulate speed to maintain operator flow rate set-point, as well as duty flash tank level. The continuous flow of THS will be mixed with recirculated digested sludge to maintain a constant total flow of blended digester feed (BDF) of 900 gpm to THS cooling. The BDF will be sent to two tube-in-tube sludge coolers, where the BDF will be cooled to approximately 100 deg. F. The re-combined BDF will be piped to the two anaerobic digesters.

Process gases from the duty pulper tank, following cooling will be condensed and separated from the non-condensable gases in the condensate tank on the process gas skid. Condensate will be returned to the duty pulper tank. Non-condensable gases are injected into the BDF piping downstream of cooling.

Each sludge cooler will be located outdoors and sized for 60 percent of the total design cooling load for THS. Each sludge cooler will use a closed-loop cooling water system that includes cooling towers and circulation pumps. The cooling towers, also located outdoors, will consist of two cells, each having a cooling capacity to cool the total THS design cooling load and to cool the water from 89 deg. F to 79 deg. F at design flow rates. The flow of cooling water to each cooler will be modulated by control valves to maintain the BDF set point temperature.

Saturated steam at 175 psig will be generated by one of two firetube steam boilers located in the new Boiler Room. Existing boilers will remain in service to maintain digester temperatures during THP outages and provide heat for the Administration Building. Non-potable water will be treated by triplex water softeners to remove hardness, then by a duty/standby deaerator to remove oxygen before being pumped to the operating boiler. The feedwater pump (duty/standby) will be mounted below one of the deaerators. Chemicals will be pumped from three chemical tanks to the deaerator and boiler to further condition water. Continuous and intermittent blowdown from each boiler will be collected in a blowdown tank and cooled before discharge to drain. Each boiler will be equipped with natural gas and biogas fuel trains to supply the selected fuel to the burner. Each boiler will have a blower for its burner and exhaust gases vented through flues and stacks to the atmosphere.

4.7.2 Basis of Design

The basis of design criteria for the THP system and its support systems are presented in Table 4.18. The design criteria are based on maximum month solids loads at design year 2035.

Table 4.18 THP System Design Criteria

Parameter	Value	Unit	Manufacturer	Fixed/ Indicative
Sludge Feed Load	94	DT/day		Fixed
Total Solids	16.5	%		Indicative
Operating days	7	days/week		Fixed
Operating Hours	24	hours/day		Fixed
Steam Feed	7,970	lb/hr		Indicative
Steam Conditions - Saturated	175	psig		Fixed
Thermally Hydrolyzed Sludge	217	gpm		Indicative
THS Total Solids	8	%		Indicative
Dilution Water - 8%	85	gpm		Indicative
THP Train (Skid) [Specification Sections 11355 and 11312I]				
Manufacturer			Cambi	Fixed
Model	B6-4, 2P2			Fixed
Pulper Tanks	2			Fixed
Flash Tanks	2			Fixed
Quantity	1			Fixed
Number of Reactors	4			Fixed
Reactor Hold Time	20	minutes		Fixed
Reactor Operating Temperature	320 - 330	deg. F		Indicative
Discharge Temperature	221 - 230	deg. F		Indicative
Process Gas Skid	1			Indicative
Reactor Feed/Pulper Circulation Pumps - Type	Progressing Cavity			Fixed
Reactor Feed/Pulper Circulation Pumps - Quantity	4			Fixed
Reactor Feed/Pulper Circulation Pumps - Capacity	By Vendor			Indicative
Digester Feed Pumps - Type	Progressing Cavity			Fixed

Parameter	Value	Unit	Manufacturer	Fixed/ Indicative
Digester Feed Pumps - Quantity	2			Fixed
Digester Feed Pumps - Capacity	By Vendor			Indicative
Skid Weight	250,000	lb		Indicative
Sludge Cooling [Datasheet 11403]				
THS Flow	217	gpm		Indicative
Recirculated Digestate	670	gpm		Indicative
Total Flow to Sludge Cooling	900	gpm		Indicative
Combined Temperature - Inlet	120	deg. F		Indicative
Cooled Temperature	104	deg. F		Indicative
CW Flow	1660	gpm		Indicative
CW Inlet Temperature	79	deg. F		Indicative
CW Outlet Temperature	89	deg. F		Indicative
Sludge Cooler				
Manufacturer			OTI	Indicative
Type	Tube-in-tube			Fixed
Quantity	1+1			Fixed
Sludge Flow (60% of design)	540	gpm		Indicative
CW Flow (60% of design)	996	gpm		Indicative
Cooler Weight (each)	50,000	lb		Indicative
Cooling Tower [Data Sheet 15680]				
Manufacturer			Marley/SPX	Indicative
Type	Induced Draft, Crossflow			Indicative
Number of Cells	2			Fixed
Fan hp (per cell)	30	hp		Indicative
Weight (per Cell)	26,000	lb		Indicative

Parameter	Value	Unit	Manufacturer	Fixed/ Indicative
CW Circulating Pumps				
Manufacturer			Bell & Gossett	Indicative
Type	Centrifugal			Fixed
Quantity	2			Fixed
Motor	50	hp		Indicative
Weight	2,000	lb		Indicative
Cooling Tower Auxiliaries				
Solids Separation System - Model, Make	CSS 400 - HH		GWS	Indicative
Solids Separation System - Quantity	2			Fixed
Chemical Tank Systems - Type	Tank, Mixer, Duplex Pump			Indicative
Chemical Tank Systems - Quantity	2			Fixed
Steam System [Data Sheet 15582-A, -B]				
Steam Load to THP	7,970	lb		Indicative
Steam Load to Deaerator	1,680	lb		Indicative
Total Steam Load	9,650	lb		Indicative
Steam Conditions - Saturated	175	psig		Indicative
Treated Boiler Feedwater	25	gpm		Indicative
Boiler Blowdown	2.5	gpm		Indicative
Steam Boiler				
Manufacturer			Cleaver Brooks	Indicative
Type	Firetube			Indicative
Boiler Horsepower	300	hp		Indicative
Quantity	1+1			Fixed
Biogas Input	340	cfm		Indicative
Pilot Fuel	Natural Gas			Indicative

Parameter	Value	Unit	Manufacturer	Fixed/ Indicative
Blower Motor	20	hp		Indicative
Weight	43,500	lb		Indicative
Boiler Auxiliaries				
Manufacturer			Cleaver Brooks	Indicative
Deaerator - Type	Spray Valve & Storage			Indicative
Deaerator - Quantity	2			Indicative
Operating Pressure	5	psig		Indicative
Weight (including pumps)	6,000	lb		Indicative
Boiler Feedwater Pump - Type	Centrifugal			Indicative
Boiler Feedwater Pump - Quantity	2			Fixed
Boiler Feedwater Pump - Flow	25	gpm		Indicative
Boiler Feedwater Pump - Motor	7.5	hp		Indicative
Manufacturer			Culligan	Indicative
Water Softener - Type	Zeolite - Triplex			Indicative
Water Softener - Quantity	1			Fixed
Water Softener - Weight	6,500	lb		Indicative
Blowdown Tank - Quantity	1			Fixed
Blowdown Tank - Weight	3,500	lb		Indicative
Chemical Tank Systems	Tank, Mixer, Duplex Pump			Indicative
Chemical Tank Systems - Quantity	3			Indicative

Notes:
(1) Abbreviations: CW = cooling water; DT/day = dry tons per day.

4.7.3 Control Narrative

The THP system, including sludge cooling and the steam system will be provided with vendor packaged control systems, and interfaced with the plant supervisory control and data acquisition (SCADA), or directly controlled by the plant SCADA. The following summarizes the process control description of each of the processes in the THP system.

THP

The THP will be controlled by a vendor provided packaged control system, which will be PLC based. The packaged control system will monitor and control the THP Feed Pumps, the Reactor Feed/Pulper Circulation Pumps, the Digester Feed Pumps, pulper tank level, the reactor fill/hold/discharge sequence, steam injection to the reactors, flash tank level and process gas skid operation. Local control stations will be provided for the equipment/valves and a PLC monitors and controls the system. A summary of the operation follows.

The control system will operate on a "pull through" principle. The Cambi THP system throughput will be controlled by operations staff setting the sludge flow at the Digester Feed Pump (downstream of the flash tank). As the feed flow to the digesters is increased, the THP system will automatically increase the batch processing frequency through the reactors, which in turn will automatically increase the rate at which the solids are pumped into the pulper tank. Inversely, if the digester feed flow rate is reduced, then THP controls will automatically compensate to reduce THP throughput.

The dilution downstream of the THP will be controlled by setting the desired dilution rate (most commonly derived based on the %TS target in the digester influent). If the influent to the THP increases or decreases, the dilution flow will be automatically adjusted by the THP control system.

The steam supply will be controlled by providing a constant set pressure in the steam supply header. If the steam pressure is insufficient for the THP operation, the THP system will automatically slow down or put itself "on hold" until the pressure is restored.

Sludge Cooling

The sludge cooling system will include the sludge cooling heat exchangers, the cooling towers and the cooling water circulating pumps. Local controls stations will be provided for the cooling water pumps, the cooling towers and all control valves. The cooling tower fan motors will have VFD drives.

The following summarizes the operation of each of the components.

Digested sludge will be circulated by pumps, located at the West Sludge Holding Tank and mixed with THS. The flow rates of the digested sludge and THS will be measured and the control valve at the circulation pumps will modulate to maintain a total flow of BDF sludge at 900 gpm when both heat exchangers are operating. If only one digester is operating, the flow will be maintained at 540 gpm.

BDF will flow through two heat exchangers, where the sludge will be cooled. Flow split to each heat exchanger will not be controlled. Cooling water from the cooling towers will flow through each heat exchanger, with the flow controlled by modulating valves to maintain the setpoint BDF temperature. If one of the heat exchangers is out of service, cooling water will flow through the operating heat exchanger and the modulating valve will control the flow.

There will be two cooling towers, with one normally operating. The cooling tower fan will modulate to maintain the setpoint outlet cooling water temperature. The cooling tower auxiliaries will include solids separation and chemical addition. These will be operated as necessary.

There will be two cooling water circulating pumps, with one normally operating. The pump will start when the cooling system is turned on by the SCADA.

Steam System

The steam system will include steam boilers, feedwater pumps, deaerators, water softeners, chemical feed system systems and blowdown tank. The steam boilers will have local control panels, with PLC based controls that control combustion, emissions and water level, with status, alarms and start/stop controls integrated into SCADA. The deaerators will have local control panels, with PLC based controls that will control steam addition, deaerator level/temperature and boiler feedwater pumps, with status, alarms and start/stop controls integrated into SCADA. Water softeners, chemical feed systems and blowdown tank will have local control panels and will be operated locally.

The following summarizes the operation of each components.

The controls for the operating steam boiler will be set locally, including, selection of fuel (biogas or natural gas), set point pressure and all valving will be set locally. The selected boiler can be started from SCADA, once operator has selected remote operation and all interlocks such as water level between low- and high-level cut-out and boiler feedwater pump operating are satisfied, boiler can start. The boiler will start, go through a burner/boiler purge cycle, followed by burner startup at low fire and heat up. Once heated to operating temperature, the burner will modulate through high fire, producing steam at the desired pressure. Under normal operation, the burner system will modulate to maintain steam pressure at setpoint. As steam is used, steam pressure will drop and burner will modulate to increase firing rate to increase steam production and the steam pressure will stabilize. The level control valve will modulate to increase or decrease feedwater flow in response to steam production.

The boiler will be equipped with several safeties, including water level cut-offs for high and low level, safety valves if boiler or steam pressure exceed pressure relief set point and burner safeties, including loss of flame, loss of fuel.

There will be two deaerators, with one normally operating. Each will be equipped with boiler feedwater pumps arranged in lead/lag configuration. The operating deaerator will be selected locally. Once the operator has selected remote operation and all interlocks are satisfied, the deaerator can start. Feedwater flow from the water softeners will begin, controlled by the level control valve. Steam flow will be modulated to maintain deaerator temperature. If steam is not available on initial startup, deaerator will fill with cold water. During initial startup, operator will add hydrazine through the chemical injection system to scavenge oxygen from the water. Once deaerator temperature is reached, operator will reduce hydrazine dosing. When the deaerator level has been reached, the lead feedwater pump will start and transfer water to the boiler and its operating pressure. The pump system will be equipped with a circulation system to respond to changes in boiler load.

The deaerator will be equipped with several safeties, including water level cut-offs and safety valves.

The water softener system will be a triplex system, equipped with a local control panel to control regeneration frequency cycles. The triplex system will allow regeneration of one of the tanks without reducing softening operation. The skid will be equipped with a brine tank, which will be part of the regeneration system. Once operating, the softener will regenerate automatically. The operator will monitor the salt levels in the brine tank and will add salt as necessary.

There will be three chemical injection systems, which can supply chemicals to the operating deaerator and operating boiler. Each system will include a storage tank a mixed and duplex pumps. Different chemicals be used in each system. The operator will monitor level in each of the chemical tanks and will replenish chemical as necessary. The operator will also set the injection rate, based on deaerator and boiler water chemistry.

The blowdown tank will receive continuous and intermittent blowdown from the operating steam boiler. The tank has a non-potable water connection. The flow of non-potable water is controlled by a self-contained modulating valve which control the drain temperature to below 160 deg. F. once the operator has opened the non-potable water shut-off valve, non-potable water will flow in response to drain temperature.

4.8 Digester Improvements

4.8.1 Process Description

Anaerobic digestion will take place downstream of the THP process. The THS will be diluted and pumped, by Cambi-provided progressing cavity pumps, from the THP skid to the sludge coolers. Recirculated digested sludge flow from the West Holding Tank will also be pumped, by progressing cavity pumps (digester recirculation pumps), to the THS lines, for blending, downstream of the Digester Feed Pumps, prior to the sludge cooler. The Digester Recirculation Pumps will be required to pump the blended digester feed through the sludge coolers to digestion. Influent blended digester feed to the digesters will be controlled as described in this document.

4.8.2 Basis of Design

Table 4.19 contains the design criteria for the influent flow rates to the Anaerobic Digesters.

Table 4.19 Design Criteria for Thermally Hydrolyzed Sludge to Digestion

	Parameter	Unit	With Westside
10% Solids Leaving THP	THS Flowrate at 10.0% Solids (1)(2)	gpm	156
	THS Dilution Water Flowrate (3)	gpm	46
	Digested Sludge Recirculation from West Holding Tank(8)	gpm	734 (4)
	Blended Sludge Flowrate into Digesters (9)	gpm	900 (10)
8% Solids Leaving THP	THS Flowrate at 8.0% Solids (1)(2)	gpm	217
	THS Dilution Water Flowrate (3)	gpm	85
	Digested Sludge Recirculation from West Holding Tank(8)	gpm	673 (5)
	Blended Sludge Flowrate into Digesters (9)	gpm	900 (10)

Notes:
(1) Flowrate listed is total flow leaving the THP skid.
(2) Flowrate includes dilution water.
(3) Dilution to limit digester ammonia concentration to < 2500 mg/L to prevent inhibition.
(4) Flowrate varies from 734-900 gpm.
(5) Flowrate varies from 673-900 gpm.
(6) Flowrate varies from 442-600 gpm.
(7) Flowrate varies from 483-600 gpm.
(8) Digested sludge will be approximately 5.6 percent solids per the process model.
(9) Blended THS and digested sludge flow entering digesters. Percent solids of the blended sludge varies with recirculation flow rate.
(10) Sludge cooler design flow rate. Includes residual capacity for 10 gpm of FOG addition.

The existing digesters are circular concrete tanks originally constructed in 1981. The tank parameters are shown below in Table 4.20.

Table 4.20 Existing Digester Tank Parameters

Parameter	Unit	Quantity
Inside Diameter	ft	85
Inside Top Elevation	ft	772.50
Inside Bottom of Wall Elevation	ft	729.00
Bottom Floor Slope (rise:run)		1:61
Bottom Center Sump Diameter	ft	20
Volume (each)	MG	1.78

Currently, the digesters are operated with a sludge surface elevation of 771.00, which corresponds to a side water depth of 42-feet. Undigested sludge is conveyed to each digester from the East Holding Tank through an 8-inch sludge inlet line, and the inlet line discharges into the center of the digester from above the operating level. The existing digesters are completely mixed via jet mixing, accomplished by (recently replaced) chopper pumps. Digested sludge from both digesters is transferred into the West Holding Tank, through a common 8-inch diameter pipe, by the resulting pressure head between the digester and West Holding Tank sludge surface elevations. Biogas produced during anaerobic digestion is collected in a 36-inch diameter sludge gas dome, tapped and threaded for a 10-inch pipe connection, and then routed through the 10-inch piping to a gas flare where it is burned. Each digester is equipped with its own sludge gas dome and all biogas produced is currently burned off at the flare.

Improvements are required to the existing digester systems so that it is adequate to handle the characteristics of the THS.

4.8.3 Sludge Stabilization

The existing digesters have been determined to possess enough capacity for digestion of the THS and therefore are suitable for reuse. It should be noted that the anaerobic digesters have sufficient capacity to accept up to 90,000 gpd of FOG. However, FOG receiving must be kept below 15,000 gpd or the feed concentration of the THS will need to be increased to exceed 10 percent solids. The future operational parameters of the anaerobic digesters are outlined in Table 4.21 below.

Table 4.21 Future Operational Parameters of Blue River WWTP Anaerobic Digesters

Parameter	Unit	Blue River WWTP Digesters (1)	
		with Westside	without Westside
Volume	MG	3.57 (2)	3.57 (2)
HRT	Day	15.3 (3)	22.2 (4)
Influent Sludge Flow, THS	gpm	156-217 (5)	107-148 (5)
Solids Loading Rate	lb VSS/10^3 ft^3-d	300	200
Blended THS Influent TSS	%	6.4% (6)	6.2% (6)
Influent VSS/TSS	%	74% (7)	73% (7)
Digested Sludge TSS	%	5.6%	5.6%
Digested Sludge VSS/TSS	%	60%	60%
Temperature	deg. F	95-105	95-105

Notes:
(1) All design criteria listed is for MM at the design year 2035 with 10 gpm FOG addition.
(2) Total volume available for digestion; each digester is approximately 1.78 MG.
(3) HRT becomes 7.7 days with one digester out of service.
(4) HRT becomes 11.1 days with one digester out of service.
(5) Influent THS flow from THP; does not include recirculation. Flow of THS with 10 percent solids leaving the THP skid is listed first, 8 percent solids is listed second.
(6) Blended THS Influent TS; includes recirculated digested sludge.
(7) VSS/TSS ratio for THS sludge only; does not include recirculated digested sludge.

Rapid rise and rapid drop in sludge and foam elevation have been observed in the past by Blue River WWTP staff. These phenomena occur due to variances in digester feeding rates coupled within variances in mixing energy input. For example, during high feeding rates and low mixing energy input, biogas production increases and the biogas bubbles become entrained within the sludge, which causes volume expansion or rapid rise. During low feeding rates and high mixing energy input, biogas production increases, but the biogas bubbles are released, which causes volume reduction or rapid drop. These phenomena can be mitigated in a multitude of ways:

1. Mixing pumps employ VFDs so that mixing energy input can be proportionate to solids loading.
2. Mixing pumps are cycled on and off; implement a timing control strategy.
3. Providing standby/emergency power to the mixing pumps, in case of power failure.

4. Providing redundant mixing pumps.
5. Adjusting the digester feed so that it is constant and low flow.

Several of the options listed above can be used in conjunction with one another. Option 5, listed above, is achievable with the Cambi™ THP system. Cambi's THP systems allows the operators to adjust the outflow of the last THP module, which feeds the digesters.

4.8.4 Digester Mixing

As previously mentioned, the Blue River WWTP digesters are currently mixed via jet mixing, accomplished by chopper pumps. Each chopper pump is equipped with its own dedicated VFD and each digester employs its own mixing system. The mixing systems are comprised of two single nozzle assemblies, four double nozzle assemblies, and one wall-mounted foambuster assembly for a total of 11 mixing nozzles per tank. According to Blue River WWTP staff, the existing digester mixing systems were replaced only two years ago. Table 4.22 below presents the design criteria for the existing (centrifugal) chopper pump mixing system as manufactured by Vaughan.

Table 4.22 Design Criteria for the Existing Digester Mixing System

Parameter	Unit	Value
Capacity	gpm	6,800, 7,100, 7,480 (2)
TDH	ft	36, 34, 31.4 (2)
Motor	hp	100
Motor speed	rpm	885
Motor power requirements	V/Ph/Hz	460/3/60

Notes:
(1) Abbreviations: revolutions per minute (rpm).
(2) Three design points were provided for this system. The flow rates and pressures are listed in respective order.

Per Vaughan, the rated design point for these pumps is 6,800 gpm at 36 ft, but the expected performance is 7,100 gpm at 34 ft with 10 nozzles in service (omits foambuster assembly) and 7480 gpm at 31.4 ft with all 11 nozzles in service.

In order to achieve the required digester turnover rate of four (4) hours, each pump must be able to pump 7,417 gpm. As illustrated in Table 4.22 above, the existing chopper pumps are capable of meeting this demand and appear suitable for reuse. Additionally, Vaughan has indicated these existing pumps are capable of handling the anticipated maximum influent solids concentration of 6.4 percent for the blended THS.

The Design-Builder will need to provide a standby pump that can be installed in the event one of the existing chopper pumps requires maintenance. The standby pump will be a shelf unit. Additionally, City staff has indicated problems with clogging of pump suction piping and mixing nozzles in the past. The existing suction piping shall be modified to include drain taps equipped with quick connects so that the line can be drained and flushed.

4.8.5 Sludge Heating and Cooling

Currently, digester heating is accomplished through a sludge recirculation system. The sludge recirculation system is comprised of recirculation pumps, heat exchangers, and natural gas boilers, all of which are located in the Digester Control Building. The recirculation pumps draw sludge from the digesters, and pump it through the heat exchangers, back into the digesters. The heat exchangers use a hot water supply, heated by the natural gas boilers, as the source of heat for transfer into the sludge. Overall, the sludge recirculation system is used to keep the temperature of the digesters in mesophilic temperature range for sludge digestion and biogas production.

The existing sludge recirculation system should be retained for digester startup during the conversion to THP. During the conversion to THP, it is paramount that the digesters remain heated, especially during seeding. The seed populations of anaerobic microorganisms will need a mesophilic environment to remain alive for future digestion of the THS. Once there has been sufficient digester turnover with THS, the existing recirculation/heating system can be taken offline as the sludge coolers, located downstream of the last THP module, will be used to regulate digester temperature. Refer to THP System narrative for additional information pertaining to sludge cooling. Additionally, the existing sludge recirculation system should be retained for usage during annual THP equipment maintenance.

4.8.6 Sludge Inlet Piping and Digested Sludge Transfer

Currently, undigested sludge enters the center of each digester above the sludge operating level though an 8-inch diameter sludge inlet line. Blended digester feed during future plant operation will vary between 600 gpm to 1,000 gpm, which corresponds to velocities of 3.8 to 6.4 ft/s within an 8-inch inlet line. Although these velocities are within acceptable design range, the condition of the existing piping is unknown. The existing piping is assumed to be 38 years old and has experienced some internal pipe erosion. The existing piping shall be replaced due to the age and unknown condition. The inlet piping of each digester will be modified to include an actuated isolation valve and flow totalizer. Replacement piping will be 10 inches in diameter to limit blended sludge velocities to a range of 2.5 to 4.1 ft/s during future operation.

At each digester, digested sludge is collected in a sludge outlet box located adjacent to the digester roof. The sludge outlet box has five pipe connections, all 8 inches in diameter; three sludge draw-off lines from the digesters located at centerline elevations 754.50, 762.00, and 767.50, one sludge transfer line to the West (Digested) Holding Tank; and one sludge overflow that sends sludge to the head of the plant. The outlet elevations of the transfer and overflow lines, within the sludge outlet box, are 770.50. There is a 12-inch high weir separating the transfer line from the overflow. Digested sludge is conveyed from the digesters into the sludge outlet box through one of three sludge draw-off lines, from the resulting pressure head difference between the sludge surface in the digester and the 770.50 outlet elevation. Typically, one draw-off line is in service at a time and it is the draw-off located at centerline elevation 762.00. Collected digested sludge is routed through the 8-inch transfer pipe to the West Holding Tank, by the resulting pressure head between the digester and West Holding Tank sludge surface elevations. Prior to the sludge inlet connection to the West Holding Tank, the two 8-inch transfer pipes, one serving each digester, converge into a common 8-inch diameter pipe. A process flow diagram illustrating sludge transfer and biogas conveyance from the anaerobic digesters to the West Holding Tank is presented in the drawings.

The existing sludge transfer infrastructure was modeled to assess its capacity and determine whether it is suitable for reuse with digested THS. Table 4.23 below provides the sludge surface elevations assumed for the analysis of digested sludge conveyance from digestion to the West Holding Tank.

Table 4.23 Sludge Surface Elevations

Parameter	Digesters	West Holding Tank
Sludge Surface Elevation	771.00 ft (1)	765.00 ft (2)

Notes:
(1) Assuming existing operational sludge surface elevation to remain.
(2) Assumed high level within the West Holding Tank

Table 4.24 below lists the assumed design criteria for sludge transfer. The design criteria selected provides an opportunity to maintain a constant level within the West Holding Tank, which is critical to plant operations. Refer to West Holding Tank narrative for additional information.

Table 4.24 Sludge Transfer Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Sludge Flowrate Per Digester	617 (1)	gpm	Fixed

Notes:
(1) 1,234 gpm total is the worst case scenario of all design conditions considered; 734 gpm of recirculated digested sludge for blending and 500 gpm for Post-THP dewatering centrifuges.

In order to be deemed suitable for reuse, each of the current 8-inch diameter sludge transfer pipes must be capable of conveying 617 gpm of digested THS from the digesters to the West Holding Tank; thus, the combined flowrate must be at least 1,234 gpm. Refer to Post-THP dewatering narrative for additional information.

The existing 8-inch diameter sludge transfer piping was evaluated for three scenarios:

1. Current configuration with no modifications and both digesters in service.
2. Current configuration with one digester out of service.
3. Alternative configuration where both digesters are in service, but one sludge transfer pipe is offline for maintenance and sludge transfer from both digesters is conveyed through one transfer pipe.

Scenario 1: The capacity of each sludge transfer pipe, with the current piping configuration, was determined to be approximately 768 gpm (4.5 ft/s). Thus, the total conveyance in the common 8-inch inlet pipe to the West Holding Tank is 1,536 gpm (7.1 ft/s), which meets the required flow rate of 1,234 gpm.

Scenario 2: The capacity of one sludge transfer pipe, with the current piping configuration and one digester out of service, was determined to be approximately 1,010 gpm (5.95 ft/s), which does not meet the required flow rate of 1,234 gpm.

Scenario 3: The capacity of one sludge transfer pipe, with both digesters in service, was determined to be approximately 1,013 gpm (6.0 ft/s), which does not meet the required flow rate of 1,234 gpm.

As indicated above, the existing 8-inch diameter sludge transfer piping is under sized for two of the three scenarios considered. The same configurations and scenarios were modeled with 10-inch diameter piping and the results are outlined below.

Scenario 1: The capacity of each 10-inch sludge transfer pipe, with the current piping configuration, was determined to be approximately 1,395 gpm (5.2 ft/s). Thus, the total conveyance in the common 10-inch inlet pipe to the West Holding Tank is 2,790 gpm (10.1 ft/s), which meets the required flow rate of 1,234 gpm.

Scenario 2: The capacity of one sludge transfer pipe, with the current piping configuration and one digester out of service, was determined to be approximately 1,894 gpm (7.1 ft/s), which meets the required flow rate of 1,234 gpm.

Scenario 3: The capacity of one sludge transfer pipe, with both digesters in service, was determined to be approximately 1,920 gpm (7.2 ft/s), which meets the required flow rate of 1,234 gpm.

By increasing the size of all sludge transfer piping to 10-inches in diameter, all three evaluated scenarios meet the assumed design criteria requirement. Therefore, all existing 8-inch diameter sludge transfer piping shall be replaced with 10-inch diameter piping.

City staff has indicated that there are approximately 15, 90-degree bends located on the existing sludge transfer lines, some of which can be removed. The existing sludge transfer piping appears to be welded steel, which offers no opportunity for transfer piping cleanout. Consideration and routing to the new 10-inch diameter sludge transfer lines should eliminate pipe fittings where sludge deposit can occur and to add cleanout locations for routine maintenance. City staff has also indicated that the interiors of the existing sludge outlet boxes are in poor condition.

A cross connection shall be provided between the two sludge transfer lines with isolation valves to aid with maintenance.

Glass lined ductile iron pipe (DIP) is to be provided. Struvite may become an issue if there is no phosphorus recovery facility associated with the planned improvements.

4.8.7 Digester Biogas Collection

Currently, digester biogas is collected on top of each digester that has been tapped and threaded for a 10-inch pipe connection. The collected biogas is then routed through a common 10-inch diameter pipe to a flare where it is burned.

However, Biogas produced from the anaerobic digestion process will be re-routed to a dual membrane cover affixed to the top of the West Holding Tank. Biogas storage is discussed in West Holding Tank narrative.

Table 4.25 below displays digester biogas production rates. Biogas production rates were assessed for the condition of sludge digestion with Westside plus the future addition of FOG for design of a biogas system that will accommodate maximum gas production.

Table 4.25 Digester Gas Production

Parameter	Unit	With Westside + FOG
Gas Production - AA	cfm	654
Gas Production - MM	cfm	771(1)

Notes:
(1) Gas production value used to assess existing collection system infrastructure.

As part of the modifications to accommodate the new biogas collection system, gas piping, combined from existing Digesters Nos. 1 and 2, currently routed to the existing gas flare will be intercepted with a tee, with one branch being routed to a new opening in the sidewall of the West Holding Tank (located above the maximum operating level in the tank) for discharge and collection of the digester gas into the new dual membrane cover to be installed on the West Holding Tank. The second branch of the gas line will go to a new waste gas flare, discussed in this document. This new piping shall be stainless steel (Type 316L) to prevent corrosion from the digester gas and hydrogen sulfide (H_2S) attacks. A manual isolation valve, as well as several taps to allow for purging of the gas along the line, shall be included on the piping from the Digesters to the West Holding Tank.

The gas piping from the Digesters to the West Holding Tank shall be sloped a minimum of 2 percent in the direction of flow, and include condensation traps at all low points for collection of condensate. The gas piping from each digester shall be equipped with a gas flow meter to measure gas production from each tank, as well as a pressure sensor, on both the individual digester lines as well as the header piping, to monitor gas pressure in the line. Once gas is released within the West Holding Tank, it will be collected within the gas membrane until the membrane is inflated to the operator-selected operating pressure. From there, gas will either be conveyed to the Gas Conditioning System or burned off at the new waste gas flare.

The gas discharge off of the membrane cover system will be routed, above-grade, across the top of the solids piping corridor, over to the new biogas conditioning facility, or burned off at the new enclosed waste gas flare. This piping shall be sloped a minimum of 2 percent in the direction of flow, and should include condensate traps at every low point, and at least every 100 feet.

To assess the capacity of the existing gas piping from each digester, the existing collection piping and appurtenances on the roof of each digester were modeled using AFT Arrow for biogas production at the following MM conditions for the design year 2035 with Westside WWTP sludge and FOG addition:

- Both digesters in service: 771 cfm total, 386 cfm per digester.
- One digester in service: 550 cfm total.

Modeling assumptions made were as follows:

- Biogas is 61 percent methane and 39 percent carbon dioxide by mass, which corresponds to a specific gravity of 0.85.
- Biogas temperature of 95 deg. F.
- Adiabatic piping system (no heat loss).
- All plug valves are fully open (no sonic choking).
- All piping is DIP, 10-inches in diameter.
- Anaerobic digester maximum pressure is 12 inches water column above ambient pressure.

Inlet pressure required to the biogas conditioning facility at the H_2S scrubber varies from 8 to 10 inches water column (w.c.) above ambient pressure.

Table 4.26 below displays the system capacity during the assumed pressure conditions.

Table 4.26 Digester Biogas Collection System Capacity

Anaerobic Digester Pressure	Biogas Condition Facility Inlet Pressure	System Capacity
12 inches w.c.	8 inches w.c.	9,296$^{(1)}$ – 16,800$^{(2)}$ cfm
12 inches w.c.	10 inches w.c.	5,800$^{(1)}$ – 6,180$^{(2)}$ cfm

Notes:
(1) Maximum biogas flow for one digester through one pipe.
(2) Maximum biogas flow for two digesters through one common header.

As indicated in Table 4.26 above, the existing infrastructure appears to be sufficiently sized for anticipated gas production at the assumed design pressures. However, further evaluation of gas piping sizes, as well as the condition of the existing gas piping and appurtenance, is required of the Design Builder during design development for optimization of pipe size based on the timing of FOG addition to the system.

Redundant biogas collection points are desired for future operation.

Stainless steel pipe shall be used for above ground installation and high-density polyethylene (HDPE) for below ground installation. All exposed piping must be insulated.

4.8.8 Additional Considerations

Design-Builder shall confirm the set pressure of air/vacuum relief valves on all gas outlets in digester roofs to determine whether or not the design conditions assumed are adequate. Furthermore, when batch feeding a digester acidic sludge, gas production spikes in seconds and, consequently, internal pressure on the fixed digester roof increases within seconds. Additionally, the 900 gpm of influent sludge flow will also increase the internal pressure of the digesters. The existing biogas collection system and the digester structure itself warrant additional evaluation, although the initial calculations indicate the existing collection system is adequate.

Rehabilitate the existing sludge outlet box for each digester as they have been damaged due to the corrosive nature of their environment, especially since the existing sludge transfer piping is recommended to be replaced. The new sludge transfer piping should be routed to minimize bends and other locations where solids deposition may occur. Also, the new sludge transfer piping should be installed with cleanouts at operator accessible locations for routing maintenance.

The existing chopper-type centrifugal pumps used for the mixing system run on the far right-hand side of the curve. Have Vaughan evaluate whether or not these pumps should be modified to improve performance and longevity; i.e. are there impeller, motor, VFD modifications that can lead to pump operation further within the allowable operating range (AOR) and/or improve motor efficiency. Additionally, as previously mentioned, chopper pump mixing systems can create foaming problems. The existing pump controls systems should be examined to see what improvements, such as pump cycle/timing strategies, can be implemented to help mitigate the rapid rise/rapid drop phenomena. Furthermore, the existing sludge and foam surface measurement instruments, if there are any, should be evaluated to ensure they are operating as intended. Lastly, as previously stated, City staff have indicated problems with the clogging of pump suction piping and nozzles in the past. The existing suction piping may need to be modified to include cleanouts and/or flushing assemblies.

4.8.9 Control Narrative

The influent flow rate of blended sludge fed to each digester will be controlled by the number of sludge coolers in service at the upstream THP skid. During normal operation, when both sludge coolers are operating in parallel, the total influent flow rate will be approximately 900 gpm. If one of the sludge coolers is out of service, the total influent flow rate will be approximately 600 gpm. The digesters cannot be fed simultaneously, and thus digester feed will be controlled by a combination of magnetic flow elements (totalizers) and actuated isolation feed valves. The actuated isolation valves will open and close based on an operator selected set point at the HMI for total flow to a digester. The selected total flow set point will be used as a process control input within the PLC. When digester feed is to be switched between digesters upon reaching the operator selected total flow, the currently closed isolation valve will be required to be fully open prior to the currently open valve beginning to close; only one actuated valve may be in operation at a time.

Outflow of digested sludge from the digesters to the West Holding Tank is controlled by the pressure head differential between the tanks. Total digested sludge outflow (volume) will be directly limited to the difference between the inlet elevation of the sludge transfer pipe leaving sludge outlet box and the operating level of the digester, if that digester is not being fed.

As mentioned, mixing pump cycle/timing strategies should be explored if rapid rise and rapid drop phenomena are still encountered during startup and facility functional testing. Additionally, existing pump instrumentation should be tested for defects and Owner input gathered for potential improvements.

HMI Operator Selectable Set Points and PLC Inputs from Flow Totalizer

1. Total Flow to Digester:
    a. Set to control digester feed cycle.

Upstream Treatment Processes

1. THP:
    a. If THP is shut down and the sludge coolers are offline, the existing digester recirculation system shall be immediately called to service to maintain digester temperature. Refer to the THP discussion for other factors and considerations associated with this process's controls.

Downstream Treatment Processes

1. West Holding Tank:
    a. If the West Holding Tank is out of service, more than likely THP is also shut down. Refer to THP above for digester controls requirements during a THP outage. Refer to the West Holding Tank narrative for other factors and considerations associated with this tank's controls.

4.9 West Holding Tank Improvements

4.9.1 Process Description

The existing West Holding Tank currently serves as a storage vessel for digested sludge. The stored digested sludge is then pumped from the West Holding Tank to the Birmingham Land Farm for lagoon storage and land application. The existing West Holding Tank is a circular concrete tank originally constructed in 1964.

Similar to its existing service, the West Holding Tank will store digested sludge and serve as a wet well for the new Post-THP Sludge Supply Loop pumps. A new chopper-type centrifugal pump mixing system will be added to the West Holding Tank to prevent sludge stratification, which will aid the operation of the West Holding Tank Supply Loop pumps. Also, the West Holding Tank roof will be removed and replaced with a biogas storage membrane. West Holding Tank volume and the existing structure were evaluated to determine whether the existing tank is of adequate size to serve as the storage vessel/wet well and to assess if the walls are able to handle loadings associated with the gas storage membrane.

4.9.2 Basis of Design

Table 4.27 below lists the West Holding Tank geometry.

Table 4.27 West Holding Tank Geometry

Parameter	Unit	Value	Fixed/ Indicative
Inside Diameter	ft	80	Fixed
Inside Top Elevation	ft	768.00	Fixed
Inside Bottom of Wall Elevation	ft	736.00	Fixed
Bottom Floor Slope (rise:run)	ft:ft	1:6	Fixed
Bottom Center Sump Diameter	ft	8	Fixed
Volume	MG	1.26	Fixed

4.9.3 Tank Mixing Improvements

The West Sludge Storage Tank will be equipped with a new tank mixing system. The new mixing system will be designed to provide a recommended minimum tank turnover of six per day, which will help minimize solids deposition at the bottom of the tank. Additionally, the mixing system will aid in producing a homogeneous sludge, which is desirable for both the West Holding Tank Supply Loop pumps and Post-THP dewatering equipment. The new mixing system will require one new chopper pump to be installed. The pump motor will run on a VFD to allow plant staff to fine tune the mixing system. Table 4.28 below presents the design criteria for the proposed chopper-type centrifugal pump mixing system at determined by Vaughan. Refer to specification Section 11233 – Holding Tank Mixing System for additional requirements and information.

Table 4.28 Design Criteria for West Holding Tank Mixing System

Parameter	Value	Unit	Fixed/ Indicative
Type	Chopper-type Centrifugal		Fixed
No. of Units	1 duty (+1 standby pump)(1)		Fixed
Capacity	5,250	gpm	Indicative
TDH	32	ft	Indicative
Drive	VFD		Fixed
Motor Size (maximum)	75	hp	Indicative
Motor Power Requirements	460/3/60	V/Ph/Hz	Fixed
Tank Turnovers (minimum)	6	per day	Indicative

Notes:
(1) Standby will be a shelf unit. The shelf unit will serve as a spare for both the East and West Holding Tank Mixing Systems and thus only 1 shelf unit is to be provided.

It should be noted that the current design criteria assumes the full tank will required 6 tank turnovers per day. However, the final design criteria for the mixing system pump shall be adjusted and coordinated with the mixing system manufacturer once the operating sludge surface levels in the tank have been finalized.

The new mixing pump will be located in the newly declassified area along with the other pumps associated with the Pre and Post-THP Sludge Supply Loop pumping systems. Due to the layout constraints of the existing building, the pumps will need to be installed in a horizontal configuration, i.e. the drive shaft of the pump will be parallel to ground surface.

The new mixing system serving the East Holding Tank will be of the same design. Therefore, the shelf pump will serve as a spare for both the East and West Holding Tanks. In addition, the new suction piping shall be furnished with drain taps equipped with quick connects so that the line can be drained and flushed.

4.9.4 Digester Biogas Storage

As discussed in this document biogas produced from anaerobic digestion will be collected and routed to a biogas storage membrane fixed to the top of the West Holding Tank.

The Design-Builder must evaluate the existing tank walls to determine if they are adequately sized to handle the additional load associated with the biogas storage membrane. If the walls are not adequate, the biogas storage membrane volume may need to be reduced or the storage membrane removed from the project.

The biogas storage membrane will be designed to store a minimum of three hours of gas production at AA conditions. Design criteria for the dual membrane cover is listed below in Table 4.29.

Table 4.29 Digester Biogas Storage Membrane Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
3 Hour Storage Volume for AA	118,000 (1)	cf	Indicative
Operating Pressure	12	inches of w.c.	Indicative
Manufacturer	Dystor		Indicative Preferred

The biogas storage system shall be a dual membrane air pressurized gas holder cover system and include the following:

- An outer, cable-restrained, air supported sealing membrane.
- An inner floating gas membrane.
- Inner membrane collector system.
- Air supply system.
- Air pressure control system.
- All necessary safety devices.
- Electrical controls.
- All other equipment, devices, supports, anchors, and control for a complete functioning system.

Performance Requirements

The membrane cover shall have a minimum usable gas storage volume of 134,000 cubic feet at the maximum sludge level in the tank with three feet minimum freeboard; and shall perform in accordance with the following requirements:

- Permit digester gas to be stored and maintained automatically at a preset constant operating pressure, as the stored gas volume varies on demand.
- Provide cover with an adjustable operating pressure from a minimum of 5 inches w.c. to a maximum of 9 inches w.c. without requiring the addition or removal of ballast material. Any adjustments shall be made by setting the pressure control valve relief pressure only.
- Maximum Gas Fill Rate: 700 standard cubic feet per minute (scfm).
- Average Gas Fill Rate: 550 scfm.
- Minimum Gas Fill Rate: 0 scfm.
- Maximum Gas Withdrawal Rate: 700 scfm.
- Maximum Rate of Change of Fill Rate: Minimum to Maximum fill rate in two seconds.
- Maximum Rate of Change of Withdrawal Rate: Minimum to Maximum withdrawal rate in two seconds.

The gas holder cover system to allow a pressure increase of up to 2-inch w.c. above the selected operating pressure and a vacuum of 2-inch w.c. of negative pressure relative to atmospheric pressure to allow proper operation of waste gas and emergency relief systems.

Product/Material Requirements

Air Membrane: The air/sealing membrane shall consist of high strength vinyl coated polyester fabric, with thermoplastic vinyl coating. The membrane material shall have a minimum tongue tear strength of 214 pounds, and a minimum strip tensile strength of 646 lb/inch; must be non-blocking, and non-sticking at an elevated temperature of 180 deg. F; and shall remain flexible at temperatures as low as minus 30 deg. F, and shall not crack at minus 40 deg. F.

All seams in the fabric in contact with the air chamber shall be heat or radio frequency welded.

Gas Membrane: The gas membrane, shall be fabricated of a material that is highly resistant to the normal constituents of digester gas. The material shall consist of a base fabric of tire cord strength polyester yarns, with a polyolefin coating containing a non-migrating plasticizer.

Membrane Appurtenances and Accessories: Additional components associated with the dual membrane cover system shall include:

- Membrane Seals at the tank wall; with aluminum clamping bars and 304 SS hardware.
- Cable Restraining System, radially extending from the center tension ring to the tank walls.
- Cable Tension and Gas Takeoff Ring, located at the center of the membrane for attaching the restraining cables.
- Inner Membrane Collector System for protection of the membranes from damage from the inner components of the tank.
- Stored Gas Volume Detection, to provide an approximate reading of stored gas volume to operating personnel.
- Tank Mounting Brackets.
- All associated air piping; instrument taps; flexible gas lines; pressure control tubing; valves; and supports as necessary for a complete and operable system.

Air System Components: A complete air supply system shall be provided as an integral part of the dual membrane system, including:

1. Air blowers to provide system pressure.
    a. Quantity: 2, minimum; for duty/standby operation.
    b. Design Rating: 70 cfm at 14 in. w.c., based on standard inlet conditions.
    c. Motor:
        i. TEFC.
        ii. 5 hp, max.
        iii. 3500 rpm.
        iv. 460/3/60.
2. Blower Inlet Filter: washable, interchangeable, polyurethane prefilter and polyester element having a nominal removal efficiency of 99 percent for 10-micron particles.
3. Air Pressure Control Valve: weighted diaphragm type for setting system operating pressure.
4. Flame Traps: on inlet and discharge ducting with thermal shutoff valve assemblies.
5. Air Purge Valve: butterfly valve to serve as a pressure/gas purge valve on the air discharge piping; provided with motorized operator. Install by-pass line around the valve system to allow small amounts of air to continually vent from the air chamber so that it may be monitored for the presence of methane.
6. Air Piping and Appurtenances: including all air system piping, ducting, valves, and flexible tubing; check valve on the blower discharge piping; pressure gauges at the discharge of each blower and at the air pressure control valve; pipe supports, flexible expansion joints; and couplings.

7. Air System Controls: Provide pressure transmitters, and methane sensor and transmitter, and all other sensors and control wiring necessary for a complete and operating system.
8. Air System Control Panel: Provide PLC based local control panel for gas holder cover equipment for control and monitoring of the air blowers, motorized valves, differential pressure transmitter, air solenoid valve, and gas detector.

4.9.5 West Holding Tank Supply Loop

The West Holding Tank will store digested sludge and serve as a wet well for the West Holding Tank Supply Loop pumps. The sludge recirculation loop will convey digested THS from the current Sludge Transfer Area, located between the East and West Holding Tanks, to the Post THP Dewatering Centrifuge Feed Pumps and the Digested Sludge Recirculation Pumps located in the Solids Building.

The new West Holding Tank Supply Loop will employ one duty and one stand-by chopper-type centrifugal pumps, equipped with a VFD, and the pumps will be located in the existing Sludge Transfer Area adjacent to the West Holding Tank. The West Holding Tank Supply Loop Pumps were analyzed for three operational scenarios and with the assumption that pump speed will be controlled by recirculation flow back to the tank.

Scenario 1: 2 centrifuges online at maximum demand, max demand for sludge blending at THP with THS at 10 percent solids, and recirculation.

Scenario 2: 1 centrifuge online at minimum demand, max demand for sludge blending at THP with THS at 8 percent solids, and recirculation.

Scenario 3: Recirculation only.

Table 4.30 below illustrates the assumed flow criteria for each of the scenarios.

Table 4.30 Design Criteria for West Holding Tank Supply Loop Pumps

Scenario	Digested Sludge Recirculation Pump Demand for Sludge Blending at THP (1)	Centrifuge Feed (2)	Digested Sludge Recirculation back to West Holding Tank
1	734 gpm	500 gpm	400 gpm
2	673 gpm	75 gpm	400 gpm
3	0 gpm	0 gpm	600 gpm

Notes:
(1) Sludge cooler is designed for a constant flow rate of 900 gpm; Digester Feed Pump Demand + THS flow cannot exceed 900 gpm. Digested Sludge Recirculation Demand in Scenario 1 corresponds to THS flow at 10 percent solids leaving THP. Digested Sludge Recirculation Demand in Scenario 2 corresponds to THS flow at 8 percent solids leaving THP.
(2) Centrifuge feed pumps are sized for a maximum demand of 250 gpm and a minimum demand of 75 gpm.

Table 4.31 below displays the pump head conditions required to be met for each of the scenarios described above. The piping system modeled reflects what is shown on the drawings.

Table 4.31 West Holding Tank Supply Loop Pump Operational Points

Scenario	Pump Flow (1)	TDH (2)
1	1634 gpm	12.0 ft
2	1148 gpm	9.5 ft
3	600 gpm	14.5 ft

Notes:
(1) One duty pump operating to achieve the assumed full system flow.
(2) All head conditions provided are indicative and subject to change.

Table 4.32 below depicts the pump and motor requirements for the proposed chopper-type centrifugal recirculation pumping system.

Table 4.32 Design Criteria for West Holding Tank Supply Loop Pump

Parameter	Value	Unit	Fixed/ Indicative
Type	Chopper-type Centrifugal		Fixed
No. of Units	1 duty +1 standby pump		Indicative
Motor Size	20	hp	Indicative
Motor Power Requirements	460/3/60	V/Ph/Hz	Fixed
Drive	VFD		Fixed

The West Holding Tank Sludge Supply Loop pumps shall be installed in a horizontal configuration within the existing Sludge Transfer Area due to height restraints within the existing facility. All new mixing and sludge supply pumps located within this area shall be installed in a horizontal configuration.

The new suction piping shall be furnished with drain taps equipped with quick connects so that the line can be drained and flushed. Also, bypass piping around the magnetic flow element shall be provided in case the flow element requires maintenance. A redundant magnetic flow element shall be installed on the bypass piping configuration.

4.9.6 Digester Sludge Recirculation Pumps

The West Holding Tank Recirculation Loop will convey digested sludge from storage in the West Sludge Holding Tank to the Dewatering Centrifuge Feed Pumps as well as the Digested Sludge Recirculation Pumps. The Digested Sludge Recirculation Pumps will draw digested sludge from the recirculation line and pump it to the THP skid for blending with the THS prior to the sludge cooler. The Digested Sludge Recirculation Pumps will be required to convey the blended digested sludge through the sludge cooler and into the digesters.

The Digested Sludge Recirculation Pumps will be progressing cavity pumps and operate in a 1 duty + 1 standby configuration. Each of the Digested Sludge Recirculation Pumps will be equipped with a dedicated VFD and located in the Solids Building. The Digested Sludge Recirculation Pumps were analyzed for two operational scenarios and with the assumption that the THP train will utilize two sludge coolers that operate in parallel, and the number of sludge coolers in service will dictate digested sludge conveyance to THP.

Scenario 1: Both sludge coolers are in service.

Scenario 2: One sludge cooler is in service.

Table 4.33 below illustrates the assumed flow criteria for each of the scenarios.

Table 4.33 Design Criteria for Digester Feed Pumps

Scenario	Digested Sludge to THP Skid	Blended Digested Feed Through Sludge Coolers (3)
1	734 gpm (1)	900 gpm
2	490 gpm (2)	600 gpm

Notes:
(1) Digested sludge flow required for blending when THS is 10 percent solids.
(2) Assumed digested sludge flow required for blending when THS is 10 percent solids and one sludge cooler is out of service. The assumed flow maintains the same ratio of digested sludge to THS in Scenario 1.
(3) Sludge cooler maximum capacity is 600 gpm. However, during the MM scenario in the design year 2035, each sludge cooler will responsible for cooling 450 gpm of blended digester feed.

Table 4.34 below displays the pump head conditions required to be met for each of the scenarios described above. The piping system modeled reflects what is shown on the drawings.

Table 4.34 Digester Recirculation Pump Operational Points

Scenario	Pump Flow (1)	TDH (2)
1	900 gpm	115.0 ft
2	600 gpm	131.0 ft

Notes:
(1) One duty pump responsible for the assumed full system flow.
(2) All head conditions provided are indicative and subject to change.

Table 4.35 below depicts the pump and motor requirements.

Table 4.35 Digester Sludge Recirculation Pumps Design Criteria

Parameter	Value	Unit	Fixed/Indicative
Pump Type	Progressing Cavity		Indicative
No. of Units	1 duty (+1 standby pump) (1)		Indicative
Motor Size	150	hp	Indicative
Motor Power Requirements	460/3/60	V/Ph/Hz	Indicative
Drive	VFD		Indicative

Notes:
(1) Standby to be installed in the field adjacent to the duty pump.

4.9.7 Additional Considerations

As the design progresses, computational fluid dynamics (CFD) modeling may be a beneficial tool to use in order locate pump suction inlets within the tank. If both the mixing pump and sludge recirculation pump have suction inlets in close proximity to one another, some undesirable inlet conditions may be created, e.g. vortices, that negatively impacts pump performance.

Additional evaluation and coordination with the pump mixing system manufacturer should be considered once the final operating levels of the tank have been determined. The low and low-low levels discussed in this document should be set after the final pump selections have been made and the net positive suction head (NPSH) requirements determined.

The biogas storage membrane is designed for a fixed volume.

4.9.8 Structural Modifications

The Design-Builder is responsible for field verifying the conditions of all existing structures impacted by their proposed work and making the necessary structural modifications. See Structural narrative for additional information.

4.9.9 Control Narrative

The operation of treatment processes upstream and downstream of the West Holding Tank are directly reliant upon the volume of sludge within the tank. The West Holding Tank will be equipped with two level sensing technologies, at minimum, that provide readouts simultaneously at the HMI. The level sensing readout will be used as a process control input within the PLC to determine whether upstream and downstream processes should be in operation. The plant operator shall be able to select what device provides the process control input to the PLC.

Per the Process and Instrumentation Drawings (P&ID), the suggested level sensing technologies are Pulse Time of Flight (PTOF) Radar and Ultrasonic. These technologies should both be in service at the same time as they complement each other. While both instruments should report similar readings in the absence of foam or froth, the Ultrasonic level sensor will detect the top of the foam or froth layer while the PTOF level sensor will detect the sludge surface.

In general, sludge conveyance into the West Holding Tank should be proportional to the influent Blended Digester Feed to Anaerobic Digestion.

HMI Operator Selectable Set Points and PLC Inputs from Level Sensing Equipment

1. High-high level:
   a. Set as a failsafe to automatically trigger the shutdown of upstream equipment.
2. High level:
   a. Results in an alarm to alert plant staff that the volume of sludge within the tank is outside of typical operating range. If this alarm occurs, plant staff may elect to increase the flow to Post-THP dewatering to lower the volume of sludge within the tank.
3. Low level:
   a. Results in an alarm to alert plant staff that the volume of sludge within the tank is outside of typical operating range. If this alarm occurs, plant staff should be aware that the volume of digested sludge within the tank is reaching critically low volume and shutdown of THP may be imminent.
4. Low-low level:
   a. Set as a failsafe to automatically trigger the shutdown of upstream and downstream equipment/processes.

Upstream Treatment Processes

1. THP:
   a. If high-high level within the holding tank is observed, the upstream THP train(s) shall be shut down immediately to prevent process spillage. Additionally, if the THP train(s) are shut down, the digested sludge recirculation pumps shall also shut down.
   b. If low-low level within the holding tank is observed, the upstream THP train(s) shall be shut down immediately to protect equipment. This occurs due to the absence of

digested sludge for blending. If the west holding tank supply loop is offline, the digested sludge recirculation pumps are offline.

c. Refer to the THP discussion for other factors and considerations associated with this process's controls.

2. Anaerobic Digestion:
   a. If high-high level within the holding tank is observed, the digested sludge recirculation pumps shall be shut down immediately to prevent process spillage. After the digested sludge recirculation pumps have shut down, the digester feed isolation valves shall close. Additionally, the retained existing sludge recirculation system currently used to regulate digester temperature, located in the Digester Control building, shall be called to service after the digested sludge recirculation pumps have been shut down.
      i. Whenever the digested sludge recirculation pumps are offline, the existing sludge recirculation system, located in the Digester Control building, shall be called to service.
   b. If low-low level within the holding tank is observed, Anaerobic Digestion will no longer receive influent blended digested sludge from THP as the THP train(s) will be shut down as well as the digested sludge recirculation pumps. If this event occurs, the retained existing sludge recirculation system used to regulate digester temperature shall be called to service.

Downstream Treatment Processes

1. Digested Sludge Tank Mixing System:
   a. If low-low level within the tank is observed, the holding tank mixing system shall be shut down immediately to protect the pump.
   b. The rate of mixing provided by this system shall be adjusted according to the volume of sludge within the tank. Furthermore, due to the anticipated variance in sludge volume, a timing control strategy for the mixing system should be considered.
   c. The mixing system pump will be fitted with its own instrumentation and protection accessories that may be used to control pump operation.
      i. Pump protection accessories and their relation to pump operation shall be discussed with the Owner. Accessories identified include, but are not limited to, the following:
         1) Motor winding heater.
         2) Motor winding temperature detection.
         3) Motor bearing temperature detection.
         4) Motor moisture detection.
         5) Pump bearing temperature detection.
      ii. Instrumentation for the mixing pump and its relation to pump operation shall be discussed with the Owner. Instrumentation identified includes, but is not limited to, the following (also illustrated on the P&IDs):
         1) Pressure Switch (Low) on the pump suction piping. If this switch is triggered, the pump should be shut down immediately.
         2) Pressure Switch (High) on the pump discharge piping. If this switch is triggered, the pump should be shut down immediately.

3) Position Switch on the check valve located on the pump discharge.

2. West Holding Tank Supply Loop.
   a. If low-low level within the tank is observed, the West Holding Tank supply loop shall be shut down immediately to protect the pumps.
   b. The rate of recirculation provided by this system shall be adjusted according to downstream demands and desired flow back to the tank. The processes downstream of the supply loop are Post-THP Dewatering and the digested sludge recirculation Pumps. Flow back to the tank will be measured with a magnetic flow element.
      i. Per the aforementioned design criteria, a recirculation flow of 400 gpm was assumed when downstream equipment and processes are in service.
   c. The West Holding Tank supply loop pumps will be fitted with their own instrumentation and protection accessories that may be used to control pump operation.
      i. Pump protection accessories and their relation to pump operation shall be discussed with the Owner. Accessories identified include, but are not limited to, the following:
         1) Motor winding heater.
         2) Motor winding temperature detection.
         3) Motor bearing temperature detection.
         4) Motor moisture detection.
         5) Pump bearing temperature detection.
      ii. Instrumentation for the West Holding Tank supply loop pumps and their relation to pump operation shall be discussed with the Owner. Instrumentation identified includes, but is not limited to, the following (also illustrated on the P&IDs):
         1) Pressure Switch (Low) on the pump suction piping. If this switch is triggered, the pump should be shut down immediately.
         2) Pressure Switch (High) on the pump discharge piping. If this switch is triggered, the pump should be shut down immediately.
         3) Position Switch on the check valve located on the pump discharge.
3. Digested sludge recirculation Pumps: It should be noted that although this equipment draws from the West Holding Tank supply loop, its operation is governed by THP.
   a. If high-high level within the tank is observed, the digester feed pumps shall be shut down immediately since THP will be shut down.
   b. If low-low level within the tank is observed, the digested sludge recirculation pumps shall be shut down immediately to protect the equipment since the West Holding Tank Supply Loop will be offline.
   c. The rate of digested sludge conveyed to the THP train(s) will be controlled by the operation and status of equipment on the THP skid, e.g. blended digester feed is directly related to the number of sludge coolers in service.

d. The digested sludge recirculation pumps will be fitted with their own instrumentation and protection accessories that may be used to control pump operation.
    i. Pump protection accessories and their relation to pump operation shall be discussed with the Owner. Accessories identified include, but are not limited to, the following:
        1) Stator run dry protection.
        2) Stator temperature detection.
        3) Motor winding temperature detection.
        4) Motor bearing temperature detection.
        5) Motor moisture detection.
    ii. Instrumentation for the digested sludge recirculation pumps and their relation to pump operation shall be discussed with the Owner. Instrumentation identified includes, but is not limited to, the following (also illustrated on the P&IDs):
        1) Pressure Switch (Low) on the pump suction piping. If this switch is triggered, the pump should be shut down immediately.
        2) Pressure Switch (High) on the pump discharge piping. If this switch is triggered, the pump should be shut down immediately.
        3) Position Switch on the check valve located on the pump discharge.

4. Post-THP Sludge Dewatering:
    a. If low level within the tank is observed, the Post-THP Sludge Dewatering equipment shall be shut down immediately.
    b. If the West Holding Tank Sludge Supply Loop Pumps are shut down, all Post-THP dewatering equipment including, but not limited to, centrifuge feed pumps, centrifuges, and polymer feed equipment shall be shut down immediately.
    c. Refer to the Post-THP Sludge Dewatering discussion for other factors and considerations associated with process controls.
5. Biogas Storage:
    a. Process Control - Biogas Collection and Storage:
        i. In automatic mode, the selected lead blower for the gas holder cover system shall operate and the purge valve shall be closed. The selected standby blower shall remain idle unless the lead blower overload is tripped. The air chamber shall be inflated to the operating pressure set by the pressure control valve, pressurizing the gas chamber to the same pressure. The purge valve by pass line solenoid valve shall be open when either blower is running.
        ii. During normal operation, gas pressure will be slightly higher than air pressure due to the added distributed weight of the gas membrane. As gas storage reaches depletion, gas pressure will begin to drop until it is below the air chamber pressure. When gas pressure drops to the same level as air pressure, the "COVER EMPTY" alarm shall be activated at the panel. When gas pressure reaches a level of 0.5 in. w.c. below the air chamber pressure, the "COVER EMPTY" signal shall cause the indicator and alarm horn to be on continuously. The signal shall also stop the blower and open the purge valve to relieve air chamber pressure.

iii. Once the air chamber pressure has been relieved to a level of 0.35 in. w.c. above gas pressure, the purge valve shall close and a blower restart delay timer, adjustable from 0 to 9 minutes, shall be energized. After the restart delay timer has timed out, the blower shall restart, again pressurizing the air and gas chambers.

iv. Should gas pressure drop to 0.75 in. w.c. below the air chamber pressure, a "DIFFERENTIAL PRESSURE ALARM" signal shall be activated at the panel and energize a remote alarm horn. The alarm shall be provided with a manual reset.

v. When the air chamber has been depleted (maximum gas storage), gas pressure will rise above the air chamber pressure. When gas pressure reaches a point approximately 0.75 in. w.c. above the air chamber pressure, a "COVER FULL" signal shall be activated at the control panel.

vi. If at any time the concentration of methane in the air discharge line of the gas holder reaches a preset point of approximately 35 percent of the lower explosive limit (LEL), the purge valve shall be opened without stopping the blower. A timer shall keep the purge valve open for a period, adjustable up to 99 minutes, allowing the blower to purge the air chamber. If, after this period, the methane concentration has not dropped below the set point, the alarm shall be sounded. If, at any time, the methane concentration reaches 60 percent of the LEL, the alarm shall also be sounded.

4.10 Post-THP Dewatering and Cake Storage

4.10.1 Process Description

The Post-THP Dewatering Process will reduce the volume of digested sludge. Digested sludge will be pumped from the West Holding Tank to the Post-THP Dewatering Centrifuges where water will be removed from the sludge. The concentrated cake product will be discharged on to a dedicated cake collection train while the removed centrate will be sent to the plant's sidestream treatment process. The dewatered cake can be sent to the cake storage silo via one of two conveyor trains, or can be sent directly to a truck discharge chute via the 3rd bypass conveyor train. The Post-THP Cake Silo will provide up to two days of storage the ability to load trucks in a controlled manner. Underneath the silo will be a truck weighing station that will weigh trucks as they are loaded.

4.10.2 Basis of Design

The Post-THP Dewatering Process will include Post-THP Centrifuge Feed Pumps, Post-THP Dewatering Centrifuges, cake conveyors, and a Post-THP Cake Silo. Anaerobically digested sludge will be pumped from the West Holding Tank to the Post-THP Dewatering Centrifuges. Table 4.36 shows the basis of design for post-THP dewatering and cake storage.

Table 4.36 Basis of Design for Post-THP Dewatering and Cake Storage

Parameter	Unit	With Westside	Fixed/Indicative
TS load from digestion(1)	ton/day	48.7	Fixed
Flow from digestion(2)	gpd	295,800	Indicative
Digested sludge total solids	%	3.9	Indicative
Dewatering days	days/week	7	Indicative
Dewatering hours	hr/day	24	Indicative
Dewatered cake total solids	%	35	Indicative

Notes:
(1) Includes 0.25 tons per day of residual solid from pasteurized FOG digestion.
(2) Includes 15,000 gpd of FOG.

4.10.3 Post-THP Centrifuge Feed Pumping

The Post-THP Centrifuge Feed Pumps will send Post THP sludge from the West Holding Tank sludge supply loop to the Post-THP Dewatering Centrifuges. Table 4.37 presents the design criteria for the centrifuge feed pumps, and a data sheet outlining the pump specifications is provided in Attachment E of the RFP.

Table 4.37 Design Criteria for Post-THP Centrifuge Feed Pumps

Parameter	Value	Unit	Fixed/ Indicative
Type	Progressing cavity		Fixed
Duty units	1		Fixed
Standby units	1		Indicative
Minimum flow	75	gpm	Indicative
Maximum flow	250	gpm	Indicative
Discharge pressure	30	psi	Indicative
Motor size	40	hp	Indicative

4.10.4 Post-THP Dewatering Centrifuges

The Post THP Dewatering Centrifuges receive sludge from the West Holding Tank sludge supply loop. The centrifuges can be removed via a bridge crane that is located within the building. For more information on the bridge crane reference the Pre-THP Dewatering section. A centrifuge equipment specification is provided in Attachment E of the RFP. Table 4.38 contains the design criteria for the Post-THP Dewatering Centrifuges.

Table 4.38 Design Criteria for Post-THP Dewatering Centrifuges

Parameter	Value	Unit	Fixed/ Indicative
Hydraulic capacity	250	gpm	Fixed
Solids capacity	5,000	lb/hr	Fixed
Duty units	1		Fixed
Standby units	1		Indicative
Bowl diameter	29	in.	Fixed
Length	23	ft	Fixed
Empty decanter weight	32,000	lb	Fixed
Rotating assembly weight	11,000	lb	Fixed
Vibration limits	4.5	mm/sec	Fixed
Static vertical load	38,000	lb	Fixed
Total vertical load	41,000	lb	Fixed
Main drive power	200	hp	Fixed
Water to drain	378/553	gpm	Fixed

4.10.5 Post-THP Cake Conveyance

One inclined shaftless screw conveyor will be provided for each Post-THP Dewatering Centrifuge. The inclined conveyors will transfer cake from the centrifuges to one of three conveyor trains. The first two trains are duty and standby belt conveyor trains that will transfer cake to the Post-THP Cake Silo loading conveyor, which will distribute cake evenly into the Silo. The third train will be a bypass shaftless screw conveyor that transfers cake to a bypass loading chute located outside of the building.

Shaftless screw conveyors will be located in the following locations: on the discharge side of each centrifuge, on top of the cake storage silo, and the bypass train. Table 4.39 presents the design criteria for the shaftless screw conveyors, and a data sheet outlining the conveyor specifications is provided in Attachment E of the RFP.

Table 4.39 Design Criteria for Shaftless Screw Conveyors

Parameter	Value	Unit	Fixed/ Indicative
Classifying Screw Conveyors			
Length	40	ft	Indicative
Angle	10.5	degrees	Indicative
No.	2		Indicative
Distribution Screw Conveyor			
Length			Indicative
No.	1		Indicative
Bypass Screw Conveyor			
Length	85	ft	Indicative
No.	1		Indicative

Belt conveyors are used to transfer cake from the centrifuge discharge conveyors up to the silo loading conveyor. There are two parallel belt conveyor trains (one duty one standby), each containing one continuous cake conveyor. On each train the horizontal section of the belt conveyor accepts cake from the centrifuge discharge conveyors. The cake continues along the inclined section of the belt conveyor before transitioning the cake to the second horizontal section of the conveyor, which then transfers the cake to the silo distribution conveyor. Table 4.40 presents the design criteria for the belt conveyors, and a data sheet outlining the conveyor specifications is provided in Attachment E of the RFP.

Table 4.40 Design Criteria for Belt Conveyors

Parameter	Value	Unit	Fixed/ Indicative
Belt Conveyors			
Length	125	ft	Indicative
No.	2		Indicative

A live bottom conveyor with three shafted screws will be located at the bottom of the Post-THP Cake Silo to aid in the transfer of cake from the Silo to the distribution gates. The conveyor is initiated when the discharge gates are opened, and they help control the amount of sludge that is being released to the trucks. Table 4.41 presents the design criteria for the live bottom conveyors, and a data sheet outlining the conveyor specifications is provided in Attachment E of the RFP.

Table 4.41 Design Criteria for Live Bottom Conveyors

Parameter	Value	Unit	Fixed/ Indicative
Length	28	ft	Indicative
No.	3		Indicative

4.10.6 Post-THP Cake Silo

The Post-THP Cake Silo will temporarily store dewatered cake before it is hauled away by truck. A live bottom conveyor and discharge gates will help control the amount of cake released to the trucks. Table 4.42 presents the design criteria for the Post-THP Cake Silo, and a data sheet outlining the silo specifications is provided in Attachment E of the RFP.

Table 4.42 Design Criteria for Post-THP Cake Silo

Parameter	Value	Unit	Fixed/ Indicative
Centrifuge feed solids	48.4	DT/day	Indicative
Solids retention	95	%	Fixed
Cake produced (dry)	46.0	ton/day	Indicative
Target total solids	35	%	Indicative
Cake Produced (wet)	131	ton/day	Indicative
Bulk density	50	lb/cf	Indicative
Cake volume	195	cy	Indicative
Silo type	Rectangular		Indicative
No. silos	1		Indicative
Volume per silo	389	cy	Indicative

Parameter	Value	Unit	Fixed/ Indicative
Available storage time	2	days	Indicative
Ventilation requirements	5,250	cfm	Indicative
Power requirement	40	hp	Indicative

4.10.7 Cake Loadout

A truck weighing station will be located underneath the Post-THP Cake Silo to measure the amount of cake loaded into a truck for hauling. The scale will provide signals to the silo discharge gates when the truck moves from the scale or when the truck reaches a set weight.

4.10.8 Control Narrative

Post-THP Centrifuge Feed Pumps

The Post-THP Centrifuge Feed Pumps will be tied to the West Holding Tank Sludge Supply Loop Pumps, and the Post-THP Dewatering Centrifuges. The pumps will shutdown if their dedicated centrifuge shuts down, if both of the West Holding Tank sludge supply loop pumps are not in operation, or upon triggering of internal alarms (such as high pressure, etc.).

Post-THP Dewatering Centrifuges

The Post-THP Dewatering Centrifuges will be controlled by the plant PLC. The centrifuges will be tied to the Post-THP Centrifuge Feed Pumps, Post-THP Cake Conveyors, polymer blending units, and Post-THP Cake Silo.

The centrifuge will start when the associated Centrifuge Feed Pump is running. The centrifuge will shut down if one of the following occurs: polymer system failure, associated Centrifuge Feed Pump failure, Cake Conveyor failure, high cake storage silo failure, or any internal equipment failure.

Post-THP Cake Conveyors

The conveyors located on the discharge side of the centrifuges will only run if their associated centrifuge is running. During centrifuge startup, a diverter will send the startup solids to the drain. Once the centrifuge target torque is reached, the conveyors will begin running in the forward direction.

Conveyors will transfer sludge to one of three discharge chutes. The discharge chute that is open will depend on which conveyance train(s) is selected by the operator. The first two trains (discharge gates A and B) are belt conveyor trains that will transfer cake up to the silo loading conveyor. The third train (discharge gate C) will be a shaftless screw conveyor that transfers cake to a bypass chute located outside of the building. The two belt conveyor trains will operate based on operator selection. If any conveyor train goes down, then all conveyors in that train will automatically shut down. If both of the centrifuges are shut down, then the conveyor trains will turn off after an adjustable time delay. The conveyors trains will also stop running if a maximum level is reached within the Post-THP Cake Silo.

Post-THP Cake Loadout

The Post-THP Cake Silo discharge gates will not open unless the scale recognizes a truck is on top of it and receives operator input. Once a truck is on top of the scale, the operator can begin to open the gates. The discharge gates will close if they detect that the truck is moving off of the scale, or once a predetermined weight limit is reach.

4.11 Biogas Processing

4.11.1 Process Description

Located at the Anaerobic Digesters, the Biogas Processing System will receive biogas at 12 inches w.c. from the anaerobic digester. The biogas processing system will include H_2S removal, flaring of excess biogas and boosting of biogas and conveyance to the steam boilers at the Solids Building.

The H_2S removal system consists of three vertical processing tanks, each filled with media. The system will be piped so that the tanks can be operated in series or parallel, with individual tanks taken out of service to replace media. Biogas routing within the system will be controlled through a control panel that operates actuated valves to maintain operator selected routing. The system will be located outdoors on a concrete pad.

The discharge header will convey biogas to two locations: to the waste biogas flare and to a biogas booster which will supply biogas to the steam boilers.

The waste biogas flare will be located north of the digesters and Solids Building on a concrete slab. The location of the flare will provide sufficient clearance required by regulations between the digesters, Solids Building, north parking lot, internal access roads, railroad lines, and plant boundary. The enclosed flare will include a biogas booster to boost the biogas pressure to operating pressure required by the flare combustion system, a main burner and pilot burner system and control dampers in the base of the flare. The local control panel will control the biogas booster, the burner and combustion system and the operating temperature.

The biogas blowers for the steam boilers will be located in an enclosure adjacent to the H_2S removal system, with one duty, the other standby. Each blower will boost the biogas pressure to 8 psig. The inlet piping to the blower will be equipped with a sediment trap to remove moisture and other impurities, which will be drained by an automatic drip trap. There will be a water-cooled aftercooler on the discharge piping to cool the biogas to 80 deg F. Condensate from the shell of the aftercooler will be drained by a high-pressure automatic drip trap. A recirculation pipe with a modulating control valve will return biogas to the suction of the blower to prevent surge conditions. Each blower will be a rotary lobe type unit, driven by a TEFC electric motor (Class I Div I Group D), mounted on a steel base with a discharge silencer located below the steel deck.

4.11.2 Basis of Design

The basis of design criteria for the Biogas Processing system and its support systems are presented in Table 4.43. The flare is sized for biogas production at maximum week (MW) solids loads at design year 2035.

Table 4.43 Digester Gas Processing Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Biogas Flow - Maximum Month	691	cfm	Fixed
Biogas Flow - Maximum Week	905	cfm	Fixed
H_2S Treatment			

Parameter	Value	Unit	Fixed/ Indicative
Manufacturer	Varec		Indicative
Type	Iron Sponge - Triplex		Indicative
Quantity	1		Fixed
Maximum Effluent Concentration	50	ppmv	Fixed
Removal Efficiency	98	%	Fixed
Weight - Total	204,000	lb	Indicative
Biogas Booster (Steam Boiler)			
Manufacturer	Roots		Indicative
Type	Rotary PD		Indicative
Quantity	2		Fixed
Flow	340	cfm	Fixed
Motor	25	hp	Indicative
Aftercooler - Type	Shell and Tube		Indicative
Aftercooler - Cooling	Water		Indicative
Weight	2,500	lb	Indicative
Flare			
Manufacturer	John Zink		Indicative
Type	Enclosed		Fixed
Quantity	2		Fixed
Flow	905	cfm	Fixed
Pilot Fuel	Natural Gas		Indicative
Booster - Motor	10	hp	Indicative
Weight	15,000	lb	Indicative

4.11.3 Control Narrative

The Biogas Processing system will be provided with vendor packaged control systems which will be interfaced with the plant SCADA or directly controlled by the plant SCADA. The following summarizes the process control description of each of the processes in the Biogas Processing system.

H2S Treatment

The H_2S treatment system will comprise a three-tank system with interconnecting, valved piping and a local control panel for valve sequencing. The system will have a continuous regeneration system which uses compressed air.

The operator will set the flow configuration and initiate the continuous regeneration. The treatment system will be a passive system, so once the valve configuration is set, biogas purification will begin with biogas flow. The operator will sample the biogas periodically to have H2S concentrations analyzed. When the media is spent, it needs to be removed and replaced. During that time, two tanks will operate.

Biogas Boosting

Two biogas booster blowers, duty/standby, will boost the biogas pressure to about 8 psig for use in the operating boiler. The blowers will be equipped with local panels that will be interfaced with SCADA. Once in remote, SCADA control can be initiated. Each booster will have safeties required by Code, including high gas pressure, and low suction pressure and relief valves. The biogas will be cooled by an aftercooler. A biogas bypass system will circulate cooled biogas to the blower suction, if there is no or a low demand. The aftercooler cooling water flow will be controlled by a self-contained temperature-controlled valve.

Flare

The two flares, which will include a biogas booster, a purge blower and a burner system, all controlled through a vendor packaged PLC, which will be interfaced with SCADA.

The flare operation will be initiated by low digester headspace pressure. A completed purge cycle will initiate the biogas booster starting and the burner pilot lighting, followed by the main flame. The flames will be monitored and the stack temperature and air dampers will modulate to maintain stack temperature setpoint.

4.12 Sidestream Treatment

4.12.1 Process Description

The ammonia-laden post-THP centrate will be treated with sidestream treatment before being returned to the mainstream liquids process. The concentrated ammonia will be converted to nitrite and then into nitrogen gas during deammonification. Sidestream deammonification utilizes anaerobic ammonium oxidizing (ANAMMOX®) and ammonia oxidizing bacteria (AOB) to reduce nitrogen loads in the return stream. Design Builder may recommend an alternative technology for Owner review during the confidential meetings that will allow the owner to meet its ammonia and pH effluent limits.

4.12.2 Basis of Design

Only post-THP centrifuge dewatering centrate with Westside sludge will be treated. Table 4.44 shows the unit process design criteria relevant to sidestream treatment.

Table 4.44 Sidestream Design Criteria

Parameter	Unit	Design Criteria Based on Liquid/Solids Model	Fixed/Indicative
		With Westside(3)	
Deammonification System MM Flow	gpm	180[2]	Indicative
BOD_5 Particulate	lb/day	345[1]	Fixed
BOD_5 Soluble	lb/day	221[1]	Fixed
COD Particulate	lb/day	2,268[1]	Fixed
COD Soluble	lb/day	4,880[1]	Fixed
COD Particulate, bio	lb/day	524[1]	Fixed
COD Soluble, bio	lb/day	28[1]	Fixed
COD Colloidal, bio	lb/day	176[1]	Fixed

Parameter	Unit	Design Criteria Based on Liquid/Solids Model With Westside(3)	Fixed/Indicative
TSS	lb/day	1,752[1]	Fixed
NH_3-N (MM) (4)	lb/day	2,685[1]	Fixed
PO_4-P (MM)(4)	lb/day	2,924[1]	Fixed
Alkalinity	mg/L	1,500[2]	Fixed
Temperature	deg. F	85-105[2]	Fixed
Nitrogen Removal	%	80	Indicative
Manufacturer	-	At least one installation treating THP centrate/filtrate. Anita-Mox (Preferred) DEMON	Indicative

Notes:
(1) Direct value from Liquid/Solids Modeling Results Summary dated November 30, 2018 and revised February 8, 2019.
(2) Values based on modeling results.
(3) Average flows and loads are 30 percent less than maximum month.

Two sidestream deammonification technologies are being considered. These technologies include:

- ANITA™ Mox.
- DEMON®.

The ANITA™ Mox system will be used as the basis of design, however, the Design-Builder may select the DEMON® system for sidestream treatment provided they meet all of the performance requirements with the design criteria provided herein.

4.12.3 ANITA™ Mox

The traditional ANITA™ Mox process is a single-stage nitrogen removal process based on the moving bed biofilm reactor (MBBR) platform. The system will include several pieces of equipment to operate the reactor. Blowers and coarse bubble diffusers will be required for mixing and to supply the dissolved oxygen required by the AOB to convert ammonia to nitrite. ANITA™ Mox also will include mechanical mixers to increase contact time between the biofilms and the influent wastewater, as well as perforated screens to retain media while allowing effluent to leave the reactor.

Because a post-THP application contains higher strength sidestream compared to that of standard anaerobic digestion, Kruger has proposed an ANITA™ Mox/integrated fixed-film activated sludge (IFAS) process, which is a two-sludge system that requires the addition of a clarifier. See Figure 4.1 below. The two-sludge system will help the annamox bacteria thrive in the higher strength sidestream, and the addition of a clarifier helps manage solids inventory. Beyond the addition of a clarifier downstream, Kruger does not require further enhancements to the treatment process to address a post-THP sidestream.

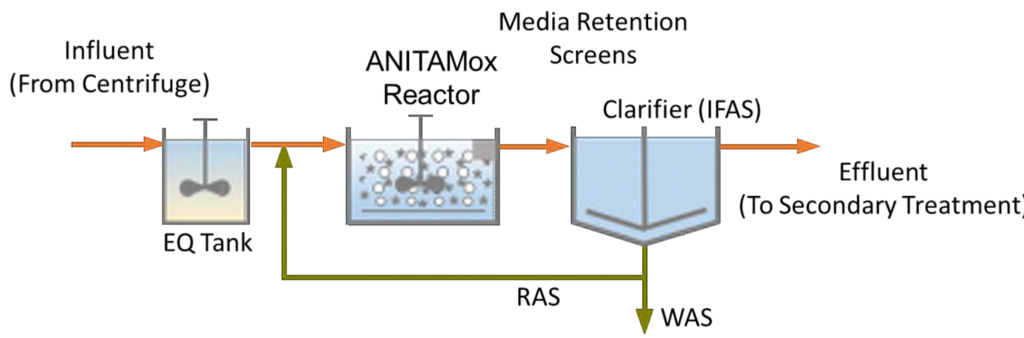

Figure 4.1 ANITA™ Mox/IFAS Process Proposed for Blue River

Kruger's minimum scope of supply will include the AnoxKaldness media, screen assemblies, medium bubble aeration grids, mixers, blowers, clarifier mechanism, and instrumentation and control (I&C). The system will also require alkalinity addition to bring the alkalinity to 3,500 mg/L, and dilution water (2:1 ratio). Kruger expects 80-85 percent ammonia removal.

Table 4.45 includes proposed reactor dimensions and process design summary.

Table 4.45 Design Summary

Parameter	Scenario 1 (Retrofit)
Number of Process Trains	2
ANITA™ Mox Reactor Dimensions (each), cf	60 ft D x 10 ft SWD
Reactor Volume – Each, cf	28,270
Total Volume – All reactors, all trains, cf	56,540
Number of Clarifiers	1
Clarifier Dimension	23 ft D x 10 ft SWD
Clarifier Volume, cf	4,155
Media Type	K5
Fill Percentage	35
Residual DO, mg/L	1.0
Total Process Air Requirement – All reactors, all trains, scfm	4,020
Mixed Liquor Solids Concentration, mg/L	3,500
RAS Flow, %	100

Notes:
(1) Abbreviations: D = diameter; DO = dissolved oxygen; RAS = return activated sludge; SWD = side water depth.

Table 4.46 lists the included equipment.

Table 4.46 Anita™ Mox Equipment

Equipment	Quantity	Description
AnoxKaldness K5 Media, cf	19,930	Carrier elements made of HDPE. Includes ~5% seeded media.
Cylindrical Screen Assemblies	4	Two (2) per reactor. 23-in. diameter x 5 ft long.
Cylindrical Screen Assembly for Drain	1	One (1) per reactor.

Equipment	Quantity	Description
Medium Bubble Aeration System	12	Six (6) air grids per reactor.
Mechanical Mixers	6	Three per reactor. Includes VFD.
Airlift Pump	8	Four (4) per reactor.
Blowers	2 + 1	2,010 scfm at 5.5 psig per blower. Includes VFD.
Check and Isolation Valves	15	6 isolation and 3 check valves for the blower inlet and discharge piping, and 4 isolation and 2 check valves for the RAS inlet and discharge piping.
RAS Pump	1 + 1	One duty pump + one standby.
Clarifier Mechanism	1	25-ft diameter, helical style.
Influent Control Valves	3	1 per reactor and 1 on dilution line.
WAS Control Valve	1	1 valve to be installed on the RAS discharge line for WAS.
PLC Control Panel	1	NEMA 12 Allen-Bradley ControlLogix 1756-L8x series.
High Level Float Switch	2	1 per zones.
DO probe (LDO®)	2	1 per aerobic zone.
pH meter	2	1 per reactor.
Thermal Mass FM	2	1 per reactor.
Magnetic FM	3	1 per reactor and 1 on dilution line.
Influent Ammonia Nitrogen Probe	1	1 total for both trains.
Ammonia/Nitrate/Nitrogen Probes	2	1 per reactor.

Notes:
(1) Abbreviations: FM = flow meter; NEMA = National Electrical Manufacturers Association.

The following modifications will be made to the existing DAF tanks to retrofit them for the ANITA™ Mox system:

- Fill bottom of tank with concrete to allow for flat surface for diffuser mounting (but raise and leave opening for existing drain line).
- New 8-inch feed piping into tank (12-inch before split to each tank), one per tank. Piping will enter tank above the water surface. Exterior lines shall be insulated to prevent temperature loss.
- New 8-inch effluent piping leave the tank, two per tank. Piping will leave tank via 23-in. diameter x 5 ft long screens placed side by side about 5 ft apart. Screen centerlines will be 3 ft below the water surface.
- New tank covers that will allow for personnel entry.
- New mixer bridges (1 per tanks) that allows personnel to walk across the full tank diameter and mixer access.

The existing DAF tanks are not large enough to accommodate new effluent drop boxes with weirs for level control, therefore, a new box will be built on the outside of each tank downstream of the effluent screens to collect the effluent and will contain a weir to control the water surface elevation. An 8-inch diameter pipe will leave each box and combine at a tee to a 12-inch diameter pipe that will take flow to the clarifier.

All of the existing equipment associated with the DAF units located in the existing DAF building will be demolished. Existing boiler will remain in service.

The following new equipment associated with the ANITA™ Mox system will be installed in the building:

- Blowers and associated valves/piping.
- RAS Pumps and associated valves/piping.
- PLC control panels.

4.12.4 Additional Considerations

Post-THP centrate contains BOD, COD, TSS and ammonia at levels higher than typical anaerobic digester sidestream (up to two to three times higher). Because of this, some precautions have been used to avoid inhibiting the deammonification process.

Dilution Water

All the manufacturer's proposals require some level of dilution water to reduce the post-THP characteristics to more treatable levels. Potable water will be used for this application as plant water is not available.

Dissolved Air Flotation

Some installations following THP have installed Dissolved Air Flotation units prior to deammonification reactors; however, this was primarily for TSS control related to the dewatering process. All the deammonification manufacturers consulted (ANITA Mox and DEMON) did not require any settling equipment prior to their process for this application.

Temperature

Testing of treatment of some post-THP sidestream showed that the high temperatures in the post-THP sidestream might inhibit some of the treatment efficiency. This was resolved by lowering the THP temperature 10 deg. Celsius (C) during start-up and then raising back to normal temperatures during full operation.

Alkalinity

Alkalinity provided in the Basis of Design table is an estimated value. If the manufacturer requires alkalinity higher than this to meet the required treatment performance, the manufacturer will provide an associated chemical feed skid for alkalinity addition.

Manufacturer Guaranteed Performance

Both ANITA™ Mox and DEMON® were consulted about guaranteeing their performance for this post-THP application. While both are aware of some issues treating post-THP centrate, both have installations under similar conditions and understand the design modifications required in order to be successful and meet process guarantees. Therefore, both manufacturers still provided process guarantees of at least 80 percent removal of ammonia.

According to the design team's knowledge, ANAMMOX® does not have an installation treating post-THP centrate, therefore, they were not consulted with further and accordingly were not consulted regarding a performance guarantee for this application.

4.12.5 HVAC/Odor Control Requirements

The existing DAF storage treatment building space can remain unclassified so long as the building is continuously ventilated at 6 air changes per hour (ACH) or more. Because the entire area above the DAF tanks will be covered, the entire space will be classified as Class I, Division 2 so long as the interior of the tank is maintained at a negative pressure. No further odor control is planned for this area.

4.13 Polymer Storage and Feed Facilities

4.13.1 Process Description

The new polymer system will include storage and feed facilities to supplement Pre- and Post-THP dewatering. Process flow diagrams for both the pre- and post-THP makedown and aging systems are presented in the drawings. Each system is designed in parallel to allow for duty/standby operation of each system to avoid shutdown of the dewatering operation in the event of failure of one of the dewatering Polymer Blending Units (PBU).

Piping, flowmeters, and valves will be provided for manual addition of post-dilution water to allow the polymer solution concentration to be further thinned, if necessary, for more effective injection and mixing at the polymer injection points in the sludge feed lines. Post-dilution will not impact the dose of polymer provided but will increase the hydraulic flow rate of polymer solution added to the centrifuges.

4.13.2 Basis of Design

The basis of design for these systems is based on the solids production established by the process modeling, discussed earlier in this report.

Based on the sludge production rates established earlier in the report, at a min/max polymer does of 15-25 lb active polymer per dry ton, that has 40 percent active content, and a specific weight of 8.6 pounds per gallon (lb/gal), the maximum month neat polymer consumption would be 18 - 30 gallons per hour (gph). Table 4.47 lists the basis of design criteria for the Pre-THP Polymer System.

Table 4.47 Pre-THP Polymer System Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Polymer Type	Emulsion		Fixed
Minimum	15	lb active/DT	Indicative
Maximum	25	lb active/DT	Indicative
Polymer % Active	40	%	Indicative
Polymer Density	8.6	lb/gal	Indicative
Operating Days	7	days/week	Fixed
Operating Hours	24	hr/day	Fixed

4.13.3 Pre-THP Polymer Storage Tank and Polymer Recirculation Pumps

Polymer solution will be pumped into each feed line of the Pre-THP Dewatering Centrifuges for conditioning sludge to enhance the dewatering process. The polymer make-down system, for inversion of the emulsion polymer, will consist of neat polymer storage, mixing, and blending. Two 5,000 gallon fiberglass reinforced plastic (FRP) storage tanks, to accommodate a full truck load of polymer, will be provided for the pre-THP dewatering system.

Each Pre-THP Polymer Storage Tank will be equipped with a progressing cavity Polymer Recirculation Pump. The polymer recirculation pumps have the capacity to turn the tank over a minimum of three times every 24 hours. To prevent localized mixing, the polymer recirculation pump return pipe will be located near the top of the tank, 180 degrees from the pump suction inlet nozzle located near the tank bottom.

There will also be a transfer line between the two tanks to allow for transfer of polymer as necessary.

The fill lines for each of the storage tanks will be located outside of the Solids Building on the west end of the south wall. A duplex basket strainer is recommended on the line to each PBU to remove large particles that could clog the downstream polymer blending equipment. Upstream of each PBU, a calibration column will be provided. The calibration column will allow for field calibrations and measurements for each polymer transfer pump to provide precise chemical metering of the emulsion polymer.

Table 4.48 lists the design criteria for the Pre-THP Neat Polymer Storage Tanks.

Table 4.48 Pre-THP Neat Polymer Storage Tanks Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Tank Material	FRP		Indicative
Quantity	1+1		Indicative
Total Neat Polymer Consumption	430, min/ 715, max	gpd	Indicative
Storage Volume, per tank	5,000	gal	Indicative
No. of Storage Days	12 at min dose/ 7 at max dose	days	Indicative
Tank Dimensions	8 x 14	ft x ft (D x H)	Indicative

Notes:
(1) Abbreviations: gal = gallons; H = Height.

4.13.4 Pre-THP Polymer Blending Units

One duty and one standby PBU will be provided for the pre-THP Dewatering Centrifuge system. Each PBU will be sized to provide sufficient polymer for two centrifuges, each operating at the maximum solids loading rates. Each PBU will include a progressing cavity polymer transfer pump sized to supply neat polymer from the associated Pre-THP Polymer Storage Tank to a dedicated PBU.

The emulsion neat polymer will be mixed, diluted, and activated with water in the skid-mounted mixing chamber. Each PBU dilution water system will have a solenoid valve, inline flowmeters, and modulating valves to allow the controller-based vendor control panel to provide and maintain the desired final diluted polymer solution concentration. Each PBU will also modulate the polymer solution flow rate to maintain level in the downstream aging tanks. The dilution water solenoid valve will open upon startup of the blender and close after the blender completes its shutdown cycle.

A consistent polymer solution concentration is required in the aging tanks to allow each centrifuge polymer solution feed pump to flow pace the polymer solution based on the corresponding centrifuge feed sludge flow and input feed sludge concentration.

Flushing and drain connections will be provided upstream and downstream of each PBU. Each PBU will be place on grating to facilitate housekeeping. The connections will allow periodic flushing and draining of both the emulsion neat polymer and diluted polymer solution pipes. A polymer connection point upstream of the PBUs will also be installed to allow for flushing or temporary polymer tote connections if alternative polymers are considered or evaluated. This would allow evaluation of different polymers through full-scale sludge processing trials without the need to purchase a full tank load of polymer.

Table 4.49 lists the design criteria for the Pre-THP Polymer Blending Units.

Table 4.49 Pre-THP Polymer Blending Units Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Manufacturer	Velodyne VM-60P-36000		Indicative Preferred
Blending Unit Mixing Method	Mechanical		Indicative
Pump Type	Progressing Cavity		Indicative
Quantity	1+1		Indicative
Pump Flow Rate, each	3.0 - 60	gph	Indicative
Neat Polymer Flow Rate	18, min/ 30, max	gph	Indicative
Power - Pump	0.5	hp	Indicative
Power - Mixer	2	hp	Indicative
Skid Dimensions	48 x 36 x 72	in.	Indicative
Diluted Polymer Flow Rate	7145, min/ 11905, max	gph	Indicative
Diluted Polymer Solution Concentration Range	0.25 - 0.50	%	Indicative
Dilution Water Booster Pump	Centrifugal, Skid-Mounted		Indicative

4.13.5 Pre-THP Polymer Aging Tanks

Once mixed and activated in the skid-mounted PBU mixing chamber, the diluted polymer solution flows are conveyed to the Pre-THP Polymer Aging Tanks. No additional pumps will be required to pump the diluted polymer solution from the PBUs to the aging tanks.

The aging tanks will maximize activation of the dewatering polymer solution. Both tanks will be used in normal operation to provide a minimum of 60 minutes retention or aging time under average operating conditions. Each tank will provide sufficient volume for a minimum of 30 minutes retention or aging time for a 0.5 percent polymer solution concentration at a maximum dewatering polymer dose of 25 pounds active polymer per dry ton of solids required by the two active pre-THP centrifuges loaded at 5,000 lb/hr.

Table 4.50 lists the design criteria for the Pre-THP Polymer Aging Tanks.

Table 4.50 Pre-THP Polymer Aging Tanks Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Tank Material	FRP		Indicative
Hydraulic Retention Time Needed	30	min	Indicative
Number of Aging Tanks	1+1		Indicative
Aging Volume Needed	3570, min/ 5950, max	gal	Indicative
Aging Tank Dimensions	8 x 14	ft x ft (D x H)	Indicative

4.13.6 Pre-THP Centrifuge Polymer Solution Feed Pumps

One Pre-THP Centrifuge Polymer Solution Feed Pump will be dedicated to each pre-THP Dewatering Centrifuge with one common standby Pre-THP Centrifuge Polymer Solution feed pump that will be able to supply polymer to any Pre-THP Dewatering Centrifuge. The Pre-THP Centrifuge Polymer Solution Feed Pumps will be progressing cavity pumps, each sized to provide sufficient polymer solution for one pre-THP dewatering centrifuge operating at the maximum rated solids loading of 5,000 lb/hr at 450 gpm of feed sludge.

Each dewatering centrifuge polymer solution feed pump will be provided with pressure gauges, a pressure switch, and a stator temperature switch for monitoring and pump protection. A flowmeter will be installed on the polymer solution feed line prior to being injected into the corresponding dewatering centrifuge.

Table 4.51 lists the design criteria for the Pre-THP Centrifuge Polymer Solution Feed Pumps.

Table 4.51 Pre-THP Centrifuge Polymer Solution Feed Pumps Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Manufacturer	Seepex		Indicative
Pump Type	Progressing Cavity		Indicative
Number of Pumps	2+1		Indicative
Pump Flow Rate, each	30 - 180	gpm	Indicative
Total Dynamic Head, each	100	psi	Indicative
Maximum Pump Speed	360	rpm	Indicative
Power, each	20	hp	Indicative

4.13.7 Polymer Slip Injection Pumps

Two additional progressing cavity pumps will also be installed downstream of the Pre-THP Polymer Aging Tanks. These pumps will be designed to feed polymer solution into several, strategically located, slip-injection rings along the THP feed lines. This system is designed to aid in lubricating the THP sludge feed lines to reduce friction losses, and, thus, the discharge pressure and power consumption of the THP feed pumps. The Polymer Slip Injection Pumps will be connected to a common discharge line off of the Pre-THP Polymer Aging Tanks.

4.13.8 Post-THP Polymer

The polymer system for Post-THP sludge will be stored and handled similarly as the Pre-THP Polymer System. Emulsion polymer will initially be stored in bulk storage tanks, fed to polymer blending units, aged and fed to an in-line mixer on the post-THP centrifuge feed lines. Following the make-down of the bulk polymer, the polymer solution will be aged for a minimum of 30 minutes before being pumped to the post-THP centrifuge feed lines.

As with the pre-THP polymer system, a parallel make-down system is recommended for full redundancy of the system. The post-THP polymer bulk storage tanks are also sized to accommodate a full truck load of polymer. The post-THP bulk storage and mixing system is to be housed adjacent and similarly to the pre-THP system. There will also be a dedicated transfer line between the two post-THP storage tanks to allow for transfer of polymer between the two tanks as necessary.

Table 4.52 below shows the design flows and criteria relevant to the unit processes for the post-THP polymer system.

Table 4.52 Post-THP Polymer System Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Sludge Flow to be fed by Polymer(1)	33 - 48	DT/day	Indicative
Polymer Type	Emulsion		Fixed
Minimum Polymer Dosage	25	lb active/DT	Indicative
Maximum Polymer Dosage	35	lb active/DT	Indicative
Polymer % Active	40	%	Indicative
Polymer Density	8.60	lb/gal	Indicative
Operating Days	7	days/week	Fixed
Operating Hours	24	hr/day	Fixed

Notes:
(1) Flows shown reflect 2035 MM conditions.

4.13.9 Control Narrative

Pre-THP and Post-THP Polymer Storage Tanks and Polymer Recirculation Pumps

The ultrasonic level transmitter installed on top of the Pre-THP Polymer Storage Tanks will provide local and remote level signals for monitoring and alarming. The level transmitter will provide high-high and low-low level alarms. A software interlock will be provided to shut down the dewatering polymer blender units and polymer recirculation pump upon a low-low level alarm.

The storage tank will be provided with a level-indicating transmitter to monitor polymer level. A mechanical level-indication device, utilizing floats with double pulleys, will also be supplied to allow visual monitoring of the tank level from within the polymer area.

The dewatering polymer recirculation pump will operate under local or remote control. Under remote control, operations staff will manually start the duty polymer recirculation pump from SCADA, the pump will operate continuously or intermittently based on a setpoint mixing time per hour. Each polymer recirculation pump will be provided with a stator temperature switch hardwired to stop the pump upon high stator temperature. A low-low polymer storage tank level software interlock will also be provided to stop the duty pump and inhibit the pump from operating.

Pre-THP and Post-THP Polymer Blender Units

Each of the PBUs will be provided with a Vendor Control Panel (VCP) for local and remote operation. The VCP will allow local manual control and optimization of each PBU. Remote start and stop of each PBU will be controlled via the SCADA system. The respective centrifuge control panels will also be integrated with the SCADA system to monitor and indicate the status of the PBUs. During remote operation, operations staff can manually input the polymer dose, pre- or post-THP sludge concentration, diluted polymer solution concentration, polymer specific weight, and percent of active polymer at SCADA or at the centrifuge control panels. The inputs will be relayed between SCADA and the centrifuge control panels.

Under normal automatic operation, the SCADA system will start the duty, respective PBU at startup of the respective centrifuge. Upon startup, the PBU will automatically mix, dilute, and activate the neat-emulsion polymer. An automatic flow-control valve will be included with the polymer blender to allow the PBU to modulate dilution water flow to maintain the desired polymer solution concentration, - typically 0.5 percent. The respective, duty PBUs VCP will modulate the speed of the polymer transfer pump and flow rate of the dilution water to maintain the level setpoint in the respective polymer solution aging tanks and required diluted polymer solution concentration. The blender unit will continue to operate until a setpoint stop time each day or until breach of an interlock. A high-high polymer solution aging tank level software interlock will be provided to stop the respective PBU. A flowmeter will be provided on the common dilution water feed line to monitor flow locally and at SCADA.

The standby polymer blender unit will have the ability to start automatically upon failure of the duty unit. As part of the standby polymer blender unit start-up sequence, a time delay will be provided to allow the standby unit to begin operation before a failed signal is relayed to the centrifuge control panel as long as the aging tank is above the setpoint.

Pre-THP and Post-THP Aging Tanks

Each aging tank will be provided with an ultrasonic level sensor to provide local and remote level signals for monitoring, control, and alarming. The level signals will be used to control the respective PBUs. Operations staff will manually input the desired tank level setpoint at SCADA. The aging tank levels will be relayed from SCADA to the respective, dewatering HMI for monitoring and indication. A low-level alarm will be provided to indicate a low polymer supply alarm at SCADA. As stated above, a high-high level will cause shutdown of the respective dewatering PBUs. Low-low levels in the aging tanks will cause shutdown of the centrifuge polymer solution feed pumps through a software interlock.

The diluted polymer solution is carried and transferred into the aging tanks using the dilution water system pressure. Each of the polymer solution aging tanks will be provided with a level-indicating transmitter to monitor the tank level. The tanks will be connected to allow operation in parallel or series. The tanks will normally be in parallel and will both be used to allow the level between the two tanks to equalize to a single level. The equalized level will be used to modulate the output of the polymer blending unit.

Pre-THP and Post-THP Centrifuge Polymer Solution Feed Pumps

Each dewatering centrifuge will be provided with a dedicated centrifuge polymer solution pump. Local control panels (LCP) will be provided for the centrifuge polymer solution pumps for local and remote operation. Remote control of the pumps will be through SCADA based on signals from the centrifuge control panels.

As noted above, under remote control, operations staff will manually input the polymer dose, respective sludge concentration, sludge flow to each centrifuge, diluted polymer solution concentration, polymer specific weight, and percent active polymer at SCADA or the centrifuge control panels. The inputs will be relayed between SCADA and the centrifuge control panels. The SCADA system will calculate the solids loading for each centrifuge based on the input sludge concentration and the flow signals from flowmeters installed ahead of each centrifuge. The SCADA system will determine the required flow of diluted polymer solution to maintain the setpoint polymer dose for each centrifuge. The SCADA system will then modulate speed for the centrifuge polymer solution pumps to maintain the calculated flow rates as measured by flowmeters installed at each centrifuge polymer solution pump discharge.

Under normal automatic operation, once the respective dewatering systems are initiated for start-up, the centrifuges will undergo a sequenced start-up process. Once the centrifuge is ready to receive polymer, a signal will be relayed from the control panel to SCADA and the corresponding centrifuge polymer solution feed pump will be started. The centrifuge polymer solution pumps will then be controlled by SCADA to maintain the calculated flow of polymer solution. Flowmeters will be provided to monitor the diluted polymer solution flow prior to injection into the centrifuge feed tubes or piping.

Each centrifuge polymer solution pump and its corresponding centrifuge will be provided with interlocks for shutdown upon low-low level in the aging tanks. Each centrifuge polymer solution pump will also be provided with a stator temperature and high discharge pressure switch hardwired interlock to stop the pump. The centrifuge polymer solution pumps will be configured to allow automatic switchover to the standby pump upon failure of any duty pump. Once a failed signal is sensed for a duty pump, the motorized valve on the discharge line connecting the standby pump to the failed pump will open. SCADA will then control the standby pump based on signals for the failed pump. A time delay will be provided to prevent immediate shutdown of the centrifuge associated with the failed pump. The time delay will allow the automatic switchover to occur before a failed signal is relayed to the centrifuge control panel.

Pre-THP Polymer Solution Slip Injection Pumps

One duty and one standby slip injection pump will be provided downstream of the pre-THP aging tanks to supply polymer solution to multiple slip injection rings on each THP sludge feed line. Operations Staff will select one pump for duty operation, and that pump will be initiated for start-up based on a permissive interlock with the THP sludge feed pumps. When had THP feed pump is called to start, the respective, duty slip injection pump is also called to start, and will inject polymer solution into each connected slip ring. The slip injection pumps will include VFDs to allow Operations Staff to manually adjust the amount of polymer solution feed into the feed lines as needed.

4.14 Odor Control Systems

4.14.1 Process Description

The Screening and Solids Buildings and equipment will require odor control. The following areas below will be connected to the odor control system. The main odorant to be treated is H_2S which is a rotten egg smell that has a very low detection threshold. The secondary odorant is ammonia which is a pungent odor. Although there are many other odorants, they are hard to quantify until after the new processes are in place. Therefore, this BODR focuses on H_2S and ammonia for this preliminary design of the odor control system.

Table 4.53 lists the areas requiring odor control and the numbers of ACH.

Table 4.53 Odor Control Areas

Area	ACH	Building/ Location	Scrubber System	Criteria
East Holding Tank	6	Sludge Screening	Existing Bio-Scrubber	Fixed
Screen Dumpsters	12	Sludge Screening	Existing Bio-Scrubber	Fixed
Sludge Screens 1, 2, & 3	OC	Sludge Screening	Existing Bio-Scrubber	Fixed
Wet Well	OC	Sludge Screening	Existing Bio-Scrubber	Fixed
Pre-THP Tank 1 & 2	30	Solids Processing	New Bio-Scrubber	Fixed
Pre-THP Centrifuges 1, 2, & 3	OC	Solids Processing	New Bio-Scrubber	Fixed
Cake Storage Bins 1 & 2	6	Solids Processing	New Chemical Scrubber	Fixed
Belt Press Room (2)	24	Solids Processing	New Chemical Scrubber	Fixed
Dewatering Centrifuges 1 & 2	OC	Solids Processing	New Chemical Scrubber	Fixed
Belt Conveyors 1& 2	6	Solids Processing/ Truck Unloading	New Chemical Scrubber	Fixed
Cake Silos 1 & 2	6	Truck Unloading	New Chemical Scrubber	Fixed

Notes:
(1) Abbreviations: Odor Connection (OC).
(2) Belt Press is an option.

The site currently uses several bio trickling scrubbers with great success. The existing Evoqua BTF-1346 biotrickling scrubber was investigated for re-use at the Screening Building. The available capacity will meet the needs for the sludge screening area.

4.14.2 Basis of Design

Each area being served has a different associated odor profile, requiring individual consideration of treatment technology.

The existing biotrickling filter or bioscrubber can be re-used for the Sludge Screening Area. The capacity of the unit is 12,700 cfm, large enough to meet the estimated demand for the sludge area.

At the Solids Building the odor control system will be split into two areas.

4.14.3 Pre-THP Area Odor Control

The first area will treat pre-THP tanks, pre-TP centrifuges, and pre-THP conveyors. The centrifuges will require 200 cfm of exhaust air to maintain a negative pressure and control odors from escaping the centrifuges. The pre-THP tanks will be ventilated at 30 ACH to keep the tank at a negative pressure. The main odorant issue will be H_2S and the biotrickling filter or bioscrubber is best suited to handle the varying load cost effectively.

The scope of the Bioscrubber System Supplier responsibilities includes the following components and systems: Any other equipment not provided by the Odor Control Supplier shall be provided by the Design-Builder for a complete operable system.

- FRP bioscrubber vessels and associated internals.
- Nozzles.
- Media.
- Moisture irrigation and nutrient delivery system.
- Recirculation pumps. (1 duty, 1 standby).
- FRP Bioscrubber Fans and VFDs. (1 duty, 1 standby).
- Instruments, including pressure gauges, pressure transmitters, pH, and flowmeters associated with the Bioscrubbers and the Bioscrubber Fans.
- Interconnecting FRP ductwork from the inlet dampers at the Bioscrubber Fans and including the bioscrubbers exhaust stacks, all dampers and pipe supports.
- All interconnecting piping external to the bioscrubber including the piping, valves, supports, and instruments associated with the recirculation pumps and bioscrubber.
- One Master VCP and 1 water control panel that will house the controls related to the Bioscrubber fans, VFDs, Bioscrubbers, and Bioscrubber recirculation pumps, nutrient systems, and irrigation system.
- All other associated and required accessories.
- The system is located outdoors. All components are to be insulated and heat traced.
- All FRP is to be provided with ultraviolet (UV) inhibiters.

Table 4.54 is a list of the Design Critiera for the Bioscrubber.

Table 4.54 Pre-THP Bioscrubber Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Manufacturers	• Daniel Mechanical, BioDan 14000. • Evoqua, similar model. • PureAir, similar model.		Indicative
Number of vessels	1		Indicative
Vessel Size (D x H)	(Per Manufacturer)		Indicative
Number of water control panels	1		Indicative
Number of master electrical control panels, also referred to as VCP	1		Indicative
Total design air flow rate	14,100	cfm	Indicative
Maximum pressure drop across vessel at startup	3.0	in. w.c.	Indicative

Parameter	Value	Unit	Fixed/ Indicative
Minimum media depth	20 ft-6 in.	ft - in.	Indicative
Minimum EBRT per vessel	15	seconds	Indicative
Average inlet hydrogen sulfide concentration	10 (variable)	ppm	Indicative
Peak inlet hydrogen sulfide concentration	100 (variable)	ppm	Indicative
Required hydrogen sulfide removal efficiency	≥ 99% or ≤ 0.5 ppmv in discharge, whichever is higher.		Indicative

Notes:
(1) Abbreviations: EBRT = empty-bed residence time; ppm = parts per million; ppmv = parts per million by volume.

4.14.4 Post-THP Area Odor Control

The second area of concern is the odors generated from post-THP process which includes the Post-THP Dewatering Centrifuges, conveyors, and Post THP Cake Silo, and are suspected to contain a higher amount of ammonia. A chemical scrubber is the best suited odor technology to handle ammonia and H_2S.

The centrifuges will require 200 cfm of exhaust air to maintain a negative pressure and control odors from escaping the centrifuges. The belt conveyor area will require 6 ACH to maintain negative pressure in the conveyor tunnel. The cake storage bins will be ventilated with 6 ACH to maintain the negative pressure. The scrubber will use sodium hypochlorite (NaOCl), caustic (NaOH), and sulfuric acid (H_2SO_4) to remove the H_2S and ammonia from the foul air. The process flow diagram is shown in the drawings.

This chemical scrubber system may be procured as a package odor scrubber system. The package scrubber system shall consist of at least 2 stages of counter current flow, vertical, packed bed scrubbers, and appurtenant equipment:

- Vessel (FRP, insulated and heat traced).
- FRP Fans (1 duty, 1 standby).
- Dampers.
- Piping.
- Instruments, including pressure gauges, pressure transmitters, pH, and flowmeters associated with the scrubber and the fans.
- Interconnecting FRP ductwork from the inlet dampers and including the exhaust stacks, all dampers and pipe supports.
- All interconnecting piping external to the scrubber including the piping, valves, supports, and instruments associated with the recirculation and chemical pumps.
- Recirculation pumps. (1 duty, 1 standby.)
- Metering pumps per chemicals listed below. (1 duty, 1 standby.)
- Chemical tanks listed below.
- Junction boxes and panels for wiring and controls.
- Connections to ductwork, piping, power and instrumentation.
- The unit will be located outdoors and all components are to be insulated and heat traced.

- All FRP is to be provided with UV inhibiters.

Table 4.55 is a list of the Design Criteria for the Chemical Scrubber.

Table 4.55 Chemical Scrubber Design Criteria

Parameter	Value	Unit	Fixed/ Indicative
Manufacturers	• Daniel Mechanical. • Evoqua. • Davis Water and Waste Industries, Division of US Filter. • R. J. Environmental. • Poly-Stage Scrubber Systems.		Indicative
Number of vessels	1		Indicative
Vessel Size (D x H)	(Per Manufacturer)		Indicative
Number of master electrical control panels, also referred to as VCP	1		Indicative
Total design air flow rate	28,700	cfm	Indicative
Maximum pressure drop across vessel at startup	3.0	in. w.c.	Indicative
Minimum media depth	(Per Manufacturer)		
Minimum EBRT per vessel	1.5	seconds	Indicative
Average inlet hydrogen sulfide concentration	2.5 (variable)	ppmv	Fixed
Peak inlet hydrogen sulfide concentration	7.5 (variable)	ppmv	Fixed
Required hydrogen sulfide removal efficiency	≥ 99% or ≤ 0.5 ppmv in discharge, whichever is higher.		Fixed
Average inlet NH_3 concentration	5 (variable)	ppmv	Fixed
Average Odor	3,000	D/T	Indicative
Required NH_3 removal efficiency	≥ 99% or ≤ 0.5 ppmv in discharge, whichever is higher.		Fixed

Notes:
(1) Abbreviations: D/T = dilutions to threshold.

The bulk chemical tanks for the Chemical Scrubber system will be located outdoors and will need to be insulated and heat traced. Table 4.56 is a summary of the associated chemical tanks for the Chemical Scrubber System.

Table 4.56 Scrubber Chemical Tanks

Parameter	Unit	Sodium Hypochlorite	Caustic	Sulfuric Acid	Criteria
Usage Rate	gph	4	1.3	0.3	Indicative
Tank Size	gal	6000	4000	500	Indicative
Number of Days of Storage	days	62.5	125	62.5	Indicative
Tank Material		FRP	FRP	FRP	Fixed
Tank Dimensions	diameter, height (ft)	10 ft-0 in., 12 ft-0 in.	9 ft-0 in., 10 ft-0 in.	4 ft-0 in., 7 ft-0 in.	Indicative
Number of Feed Pumps		2 (1+1)	2 (1+1)	2 (1+1)	Indicative

4.14.5 Additional Considerations

1. All ductwork is to be FRP.
2. Ducting for odor control systems:
   a. Minimum internal pressure: 15.0 inches water column.
   b. Minimum internal vacuum: 15.0 inches water column.
3. Support spacing: As needed to comply with wall thicknesses calculations but not greater than the following:
   a. Contact-molded ductwork: Not greater than 5 foot centers.
   b. Filament-wound ducts: In accordance with Sheet Metal and Air Conditioning Contractors National Association (SMACNA) standards below:

Table 4.57 Ductwork Support

Duct Inside Diameter (Inches)	Maximum Span (Feet)	Criteria
3 to 19	10	Fixed
20 to 29	15	Fixed
30 to 35	20	Fixed

4. Minimum flooding: Design ductwork for water accumulation as follows:
   a. Rectangular ductwork: 1-inch deep across bottom of duct.
   b. Round ductwork: 2 inches deep across bottom of duct.
5. Physical and mechanical properties: Duct shall meet the following standards for physical and mechanical properties:

Table 4.58 Ductwork Material

Pipe Property	Standard	Design Properties		Criteria
		Hoop (psi)	Axial (psi)	
Ultimate Flexural Stress	ASTM D2412	50,000	18,000	Fixed
Flexural Modulus		3.05×10^6	1.0×10^6	Fixed
Ultimate Tensile Stress	ASTM D2105	52,000	7,485	Fixed
Tensile Modulus		1.5×10^6	1.56×10^6	Fixed
Ultimate Shear Strength		Approximate Typical Values (psi)		Fixed
Inter-laminar	ASTM D2344	2130-2730		Fixed
Cross		15,000		Fixed
Density	ASTM D792	0.065-0.072 lb/In^3		Fixed

Notes:
(1) Abbreviations: ASTM = American Society for Testing and Materials.

6. Design tensile stress:
   a. Calculations for design of wall thickness assume a laminate ultimate tensile stress of 9,000 pounds per square inch maximum.
   b. Decrease ultimate tensile stress as appropriate to the laminate design.
      i. Round ducting: The maximum allowable design tensile stress shall be the ultimate tensile stress divided by 5.
      ii. Rectangular ducting: The maximum allowable design tensile stress shall be the ultimate tensile stress divided by 10.
7. Manufactures of Fiberglass reinforced plastic ductwork:
   a. One of the following or equal:
      i. Bondstrand.
      ii. NOV Fiber Glass Systems.
      iii. Spunstrand.
      iv. Belco Manufacturing.
      v. Daniel Mechanical.
      vi. Perry Fiberglass.

4.15 Trickling Filter Snails Removal

The design requirements for this Deductive Work Item will be provided in a forthcoming addendum to the RFP.

4.16 Deductive Work Items

4.16.1 Replacement of Solids Building Elevator (Deductive Work Item No. 1)

Existing elevator shall be replaced in-kind with new elevator of equal capacity, functionality, and size as the existing.

4.16.2 Exhaust Stack Demolition (Deductive Work Item No. 2)

Design-Builder shall install new radio tower at location to be determined by Owner and associated power cables to control room. Design-Builder shall remove all existing antennae and antennae/radio combination equipment currently installed on Exhaust Stack. Exhaust Stack shall be demolished to top of pilings.

4.16.3 Radio Relocation or Replacement (Deductive Work Item No. 3)

Design-Builder shall install new radio tower at location to be determined by Owner and associated power cables to control room. Design-Builder shall remove all existing antennae and antennae/radio combination equipment currently installed on Exhaust Stack. Exhaust Stack shall be demolished to top of pilings. Owner will indicate which existing antennae and combination equipment will be relocated to new radio tower. Replacement radios, if used, shall be provided by Owner. Owner will provide City-Owned land and utilities to newly relocated radio tower. Shortlisted Respondent shall reference Attachment D Project Background Documents for information on radios and antennae/radio equipment.

4.16.4 Trickling Filter Snail Removal System (Deductive Work Item No. 4)

Design-Builder shall design and construct a system for removing snails in trickling filter. System shall be located at the trickling filters in the Blue River WWTP "Secondary" site located at 7500 E. Front Street, Kansas City, MO 64120. The design requirements for this Deductive Work Item are in Section 4.15 Trickling Filter Snails Removal.

4.16.5 Second Flare (Deductive Work Item No. 5)

Design-Builder shall design and construct an additional enclosed waste biogas flare as shown in Drawings 80I01, 80I02, and 80M01 so that biogas treatment system has full redundancy and operates with one duty and one standby flare.

Chapter 5

DISCIPLINE DESIGN CRITERIA

5.1 Civil

The site preparation will include the demolition and/or retrofit of existing facilities on the site proposed for treatment facilities, as well as initial site preparations (excavation, backfill, rough grading, paving, and facility construction, etc.). Existing plant roads will be modified to allow semi-truck turning movements within the site (assumed 53 feet trailer length). Design work will commence upon receipt of the engineering phase Notice to Proceed (NTP). The major activities are:

- ***Design:*** The development of contract documents for site preparation. These documents will be largely based upon existing "as-built" drawings of the original system. Conceptual design documents generated to date by the City may be provided to the Design-Builder as reference documents.
- ***Preliminary Site Investigation:*** It includes potholing, surveying, and geotechnical investigation. Exploratory potholing will be performed to identify the location of existing utilities. Required surveying and geotechnical investigations to occur.
- ***Construction:*** Initial site preparation including demolition of existing systems and site restoration consistent with planned new facilities.

The civil guidelines provided here pertain to the Blue River WWTP site, associated yard piping and conduits, and retrofitted process equipment for the solids handling.

5.1.1 Codes and Standards

The following codes, specifications, and standards shall apply to the related civil design. Unless specifically stated otherwise, the latest edition of all codes shall apply.

- International Building Code (IBC).
- Uniform Plumbing Code (UPC).
- International Fire Code (IFC), 2012 Edition.
- Missouri Department of Natural Resources (MDNR).
- Occupational Safety and Health Administration (OSHA) Title 29, Part 1910, General Industry Occupational Safety and Health Standards.
- National Fire Protection Association (NFPA) Standards.
- American Water Works Association (AWWA) Standards and Manuals of Water Supply Practices.
- ASTM Standards.
- Missouri Concrete Industry Board.
- KC Water Department and Public Works Department's standard specification and design criteria Kansas City Metro Chapter American Public Works Association, Standard Specifications and Design Criteria as revised, adopted by the City.
- KC Water Department Standards will supersede any other City specification.

- All sewer lines, piping, excavation and backfill shall be in accordance with KC Water Department Standards and Inspections.
- Manual of Uniform Traffic Control Devices.
- American Disabilities Act requirements (ADA).

5.1.1.1 Civil Design References

Procedures and standards described in the latest edition of the following design publications are to be used in the design:

- American Association of State Highway and Transportation Officials (AASHTO) Green Book.
- Best management practices to be identified in a project specific Storm Water Pollution Prevention Plan (SWPPP).

5.1.1.2 General Design Requirements

Site Layout: The site and process facility layout are to incorporate the following criteria:

- Walkable paved perimeter areas will be provided around process tanks and structures. Handrails will be required in conformance with OSHA and ADA standards.
- Containment areas with emergency eyewash stations around all chemical storage and feed facilities.
- Protective guardrails between structures and roadway where roadway is closer than three feet to structures. Guardrails around all equipment that is adjacent to roads or parking areas.
- Protective bollards around all equipment or above-grade utilities that are exposed to potential collision (other than described for guardrails above).
- Maintain minimum structure setbacks and clearance as follows:
  - From edge of plant road: 4.0 feet.
  - From edge of property: 3.0 feet.
  - From adjacent structures: 10.0 feet.
- Sidewalks, Ramps, Stairways:
  - Sidewalks will be used in high foot traffic areas as noted on preliminary layouts provided. The longitudinal slope will not exceed 10 percent. The cross slope will not exceed 4 percent. The accessible route will have slope not to exceed 5 percent or a cross slope of 2 percent.
  - The maximum slope of accessible ramps will be 1:12 (vertical: horizontal) with a maximum rise of 30 inches for any run. Landings will have a minimum length of 5 feet and sufficient width per ADA requirements.
  - Stairs will be provided where pedestrian access is required, and grade exceeds 10 percent.
  - Sidewalks and ramps will shall be concrete per City standard.

Roadways and Parking Lot. With the construction of the new facilities, parking lot and roadway will be needed to serve these improvements. The proposed parking lot will be north of the administration building in the grass area. This area is outside of the existing security perimeter fence, and is proposed as asphalt with curb and gutter. The proposed lot provides slightly less parking than the existing site and will be configured with back-to-back stalls with a 25 foot aisle between per City code. Site roadway restoration includes a combination of full depth pavement replacement and mill and overlay. Existing curb and gutter will be removed and replaced at intersections and along the access road around the current sludge thickener basins no. 1 and 2 to accommodate truck turning movements based on a WB-67 design vehicle. The plan for truck route is to have the empty semi-trucks circle the site in a clockwise manner on the loop road adjacent to the admin/solids processing building and tanks. The road south and east of the buildings will be milled and overlay with some full depth asphalt replacement. The road to the west and north of buildings will be full depth asphalt replacement and road widening. North of the facility and to the west and east of the proposed cake loadout building will be concrete to accommodate the weight of loaded semi-trucks. Furthermore the existing parking lot south of the admin building will be removed for construction of the THP area. Concrete pavement will be constructed under the THP Equipment. Pavement design criteria is summarized in the City's standard specifications, and will be a combination of concrete and asphalt.

Grading. Grading design will conform to the Building Code, American Public Works Association (APWA) criteria, and the recommendations included in the geotechnical report supplied to the Design-Builder. The minimum drainage slopes on paved and unpaved areas are one percent and two percent, respectively. Concrete gutters have a minimum drainage slope of 0.4 percent. Sheet flow will not be permitted to drain across cut or fill slopes from adjacent areas. Finished first floor elevations of buildings will be set a minimum 6 inches above adjacent outdoor grade.

The design of cut and fill slopes, including requirements for benches, keyed foundations, and allowable inclinations (horizontal and vertical) will conform to the recommendations in the geotechnical report commissioned by the Design-Builder.

Drainage. The existing storm drain system consisting of reinforced concrete, corrugated metal, or high-density polyethylene pipes, and open channels to collect and transport storm water runoff to the plant headworks. Reconfiguration and reconstruction of roadways will require modifications of storm water for collection and conveyance.

No new drainage and/or flood protection improvements are anticipated for these improvements as this site is within Zone X according to the Federal Emergency Management Agency (FEMA) Map. The area is protected by the levee and the lowest base flood elevation adjacent to the site of 739 feet.

Striping and Marking: Striping, signage, and markings conform to City specifications.

Pavement Design: Areas receiving pavement will be designed in accordance to the geotechnical recommendations for pavement sections and include the following:

- Roadways will be asphalt concrete (AC).
- Chemical unloading areas will be Portland cement concrete (PCC).

Landscaping and Irrigation: No landscaping design work is anticipated in this project.

Yard Piping: Yard piping design will incorporate the following criteria:

- Minimum cover for pressure pipes will be four feet.
- Large-diameter process pipe (sizes larger than 18 inches in diameter) will have a five foot minimum cover.

- Where entering a structure, pipe larger than 12 inches in diameter will be installed with harnessed sleeve-type couplings to accommodate differential settlement. Special ball joints will be provided for seismic or extreme differential settlement consideration, where required.
- Pipe profiles will be prepared for large-diameter process pipe sizes larger than 18 inches in diameter and for all gravity flow pipe systems.
- Buried valves 30 inches in diameter and larger, will be installed in underground vaults or as deemed appropriate by the City. Vaults located in traffic area shall be H-20 rated, including frame and cover.
- Yard chemical piping will be a single containment pipe, installed in cast-in-place reinforced concrete trenches, properly sloped at 0.24 percent minimum, with a metal or concrete cover in common corridors. Trench systems shall be H-20 traffic rated where required. Double containment piping will be installed where required.
- Product water distribution system will have isolation valves, air vacuum/air-release valves (AVAR) at high points and blow-offs at low points and piped to drain. All AVARs will be installed with an air-gap separation in an aboveground enclosure.
- Corrosion control design, and high groundwater and dewatering considerations will be based on geotechnical investigations and recommendations.
- Piping materials will be as summarized in Table 5.1. Materials are to be consistent with the service and environment anticipated.

Table 5.1 Piping Materials

Service	Pipe Material	Pipe Lining	Criteria
Gravity Sewer	PVC (SDR-26)	None	Indicative
Pressurized Sewer (Buried)	DIP (CL 150)	Ceramic coated	Indicative
Pressurized Sewer (Exposed)	DIP (CL 53)	Ceramic coated	Indicative
Water (1-3 in.) (3)	PVC (SCH 80)	None	Indicative
Water (above 3 in.) (3)	DIP (CL 150)	Cement-mortar	Indicative
Storm Sewer	HDPE	None	Indicative
Natural Gas Piping	BSP (SCH 40)	None	Indicative
PW (3)	Match Existing	Match Existing	Indicative
Chemicals (4)	Provide A Ranked Corrosion Resistance	None	Indicative

Notes:
(1) Abbreviations: BSP = British Standard Pipe; CL = Cement Lined; PVDF = polyvinlyidene fluoride; RCP = reinforced concrete pipe; SCH = Schedule; SDR = Standard Dimension Ratio.
(2) Materials are ductile iron, PVC Schedule 80, galvanized steel, stainless steel, brass, and copper.
(3) Materials are ductile iron, stainless steel, brass, and copper.
(4) Materials include PVC Schedule 80, chlorinated polyvinyl chloride (CPVC) Schedule 80, PVDF, alloy 20, stainless steel, and black steel.

Potable Water Service: The existing water service (potable water) will be extended to the new facilities as required per KC Water criteria. Potable water lines will be sized to accommodate demand. Proper separation will be maintained between potable water lines and sanitary sewers in accordance with the requirements of the MDNR and the City.

Storm Drain System: Runoff from new facilities will be directed to existing storm drain systems that drain to the head of the Blue River WWTP. Storm drain design will conform to KC Water guidelines.

5.1.2 Survey

Potholing and surveying to locate potential subsurface facilities are to be undertaken by the Design-Builder prior to finalizing design and commencing site work. Access to all junction boxes and manholes is to be maintained. Construction over conduits requires review and approval by the City as part of the design review process. The relocation of any existing conduits requires review and approval by the City as part of the design review process and production of as-built drawings.

5.1.2.1 Horizontal and Vertical Control

- Control survey will be set to North American Datum 1983 (NAD 83) for horizontal control, and North American Vertical Datum of 1988 (NAVD 88) for vertical control. All coordinates and elevations are provided in feet.
- Field survey of center line control or other control monuments used to locate the following:
  - Street right-of-ways and centerlines.
  - Right-of-ways for flood control channel.
  - Property/parcel boundary lines.
  - Easements.
- Spot check each survey control point and provide horizontal and vertical information as well as a brief description of the control monument. A minimum of three (3) control monuments will be provided to be used for the construction staking of the project and plotted in CAD in 3D.

5.1.2.2 Topographic Survey

- Mapping survey to depict one-foot topographic contour relief and spot elevations to 0.1 foot accuracy per ACSM standards. The drawing scale is one-inch is equal to 20 feet.
- Random spot checks per ACSM standards.
- Minimum topographic survey boundary for project area covers 50 feet minimum beyond each side of the work area. Mapping area includes the full width of the road and nearby intersection.
- All planimetric features to be plotted.
- Research of existing record utility drawings and plot all found utilities of record on a utility base sheet as a separate CAD file than the topographic mapping file. Tie-in and map all visible surface features.
- Hard copy of control surveys and level control surveys with cover letter, signed and stamped by a Missouri Professional Land Surveyor.
- CAD mapping is composed of several master files such as control, topographic and utility files, all correctly referenced in proper 3D space that exactly fit together. AutoCAD 2018 or Civil 3D are the platforms.
- A complete digital terrain model (DTM) or triangular irregular networks (TIN) in 3D as a separate file compatible with AutoCAD 2018.

5.1.3 Geotechnical Requirements

Design-Builder is to retain the services of a licensed geotechnical engineer and undertake the appropriate investigation, testing, and analysis suitable for design of the facilities.

5.1.4 Environmental Requirements

5.1.4.1 SWPPP/Stormwater Management

Since the area impacted by the construction will be greater than one acre a National Pollutant Discharge Elimination System (NPDES) Permit is required for Storm Water Discharges for this construction activity. It will be the responsibility of the Design-Builder to prepare, submit, and then implement a SWPPP. The SWPPP will identify best management practices (BMP) designed to remove silt, hydrocarbons, and other chemicals of concern.

5.1.4.2 Dust and Erosion Control

The Design-Builder shall control dust and erosion during construction as needed to minimize adverse consequences to neighboring property and to comply with environmental regulations including National Environmental Policy Act (NEPA)/California Environmental Quality Act (CEQA) mitigation requirements. The Design-Builder shall continuously monitor and control dust and erosion during construction and operation phases. The Design-Builder shall apply the following guidelines:

- Water active grading sites twice daily as a minimum and when dust is observed migrating from the site.
- Suspend all grading and excavation operations when wind speeds exceed 25 miles per hour (mph).
- Apply non-toxic chemical soil stabilizers in accordance with manufacturer specifications to the affected areas. Sweep access roads in accordance with State and local requirements.

5.1.4.3 Air Emission Monitoring and Control

The contractor shall maintain and operate construction equipment as to minimize exhaust emissions. The contractor shall phase and schedule activities to avoid emissions peaks and discontinue activities during second-phase stage smog alerts. Trucks and vehicles in loading and unloading queues shall be kept with their engines off, when not operational.

5.1.4.4 Noise Control

Specific mitigation measures are to be considered for all emitting sources in excess of local regulations at the source. It is understood that the City may require greater than minimum attenuation of noise/vibration emissions. The following codes, standards, and ordinances shall be considered as part of the design criteria. Whenever a difference exists between documents issued and any referenced publications, the more stringent requirement shall govern.

- City of Kansas City noise ordinance.
- Recognized State and Federal codes and standards.

5.1.5 Demolition

Design-Build team will prepare demolition work plans to be reviewed and approved by the owner's representatives and regulatory bodies prior to the start of the work. Demolished materials will be removed from project site and disposed in accordance with local regulations. Any hazardous materials encountered during demolition will be reported to the owner's representatives prior to handling and mitigation. The Contractor shall be responsible for identification, removal, and proper disposal of lead, asbestos, mercury and any other hazardous materials in accordance with recognized City, State and Federal codes and standards.

Demolition of the existing structures include:

- Smoke Stack (East of Solids Building): complete removal.
- Solids Building; complete roof removal; interior concrete masonry unit (CMU) or concrete walls; partial concrete floor removal; partial exterior wall removal; and miscellaneous structural steel framing removal to accommodate removing the old equipment and installation of the new equipment.
- East and West Holding Tanks: complete double-T roof removal.

5.2 Structural

The structural design guidelines are primarily related to the design of structural systems and elements comprised of concrete, masonry, steel, and aluminum. These include buildings, process tankage, platforms, utility structures, and equipment supports and pads. Major structures are not located within 500 feet of levee (Levee Critical Zone).

5.2.1 Basis of Design

5.2.1.1 Loads and Serviceability

Structures shall be designed to support and resist actions due to all applicable loads and load combinations that are estimated in accordance with the applicable building codes, design standards, and the prevailing engineering practice for the type of facility that is being designed. The structure and its components shall be proportioned as required to limit material stresses and deformations within the limits established by the applicable building code or relevant design standard.

5.2.1.2 Dead Loads

Structures shall be designed to resist the effects of all dead loads. Dead loads shall include the following as a minimum:

- Weight of the structural members.
- Weight of all fixed construction, equipment, and fixtures, such as, platforms, walls, partitions, finishes, ceilings, mechanical and electrical equipment, equipment bases, and all permanent non-removable construction. Mechanical and electrical equipment that is mounted to a floor or slab may be considered as live load provided the equipment precludes any additional vertical floor loading within the footprint of the equipment. However, for the purposes of seismic design permanent fixtures should be considered dead load.
- Weight of valves, pipes, pipe contents, and pipe supports.

- Weight of cable tray, conduit, cables, bus ducts, and other similar conduit routing systems.
- Weight of heating, ventilation, and air conditioning (HVAC) ducts.

All building roofs shall be designed for the additional dead load of solar panels and their associated equipment, if applicable.

5.2.1.3 Live Loads

Live loads shall meet all the applicable code requirements set forth in the referenced codes and standards listed herein. Live loads provided in Table 5.2 shall be considered as minimum live loads for design.

Structures shall be designed to resist the effects of dynamic piping loads that include thrust due to internal pressure, thermal expansion and contraction, and the change in velocity of the pipe contents. Live loads due operating equipment shall also be considered in the design of the supporting and/or affected structural members. Live load due to equipment operation is anticipated to include the following:

- Thrust forces (vertical, lateral, and torque) due to rotating equipment.
- Lateral impact forces due to operation of bridge cranes and monorails.
- Temporary placement of equipment due to maintenance activities or replacement.

Structures shall be designed to resist the effects of loads from jib cranes, fall prevention systems, and hoists. The live load shall be considered the rated capacity of the lifting or fall protection equipment. Load effects due to vertical, transverse, and longitudinal impact loading shall be considered in the structural design.

Table 5.2 Design Criteria Summary – Live Loads

Description	Value
Office Areas (office use)	50 psf + 2,000 lb concentrated load
Office Areas (record area and computer use)	125 psf + 2,000 lb concentrated load
Catwalks	100 psf
Egress Corridors/Stairs	100 psf
Storage Areas (light)	125 psf+ 2,000 lb concentrated load
Storage Areas (heavy)	250 psf+ 3,000 lb concentrated load
Electrical/Control Rooms	300 psf
Process Areas and Pump Stations(2)	250 psf+ 2,000 lb concentrated load
Vehicle Loads (Unrestricted Vehicular Access)	AASHTO HS-20
Gratings, Tread Plates, and Hatches	Minimum of 100 psf + 1,000 lb concentrated load(3)
Roof (non-work area)	20 psf + equipment load + 300 lb concentrated load

Notes:
(1) Abbreviations: psf = pounds per sqare foot.
(2) Includes all gratings, tread plates, hatches, and floor coverings.
(3) But not less than loading for adjacent floor or grade. Deflection shall be limited to L/240 with ¼/4-inch maximum.

5.2.1.4 Wind Load

Wind loads shall be based on the following parameters:

- Risk Category: III.
- Basic Wind Speed: 120 mph.
- Exposure Category: C.

5.2.1.5 Seismic Load

The seismic loads shall be determined based on the following parameters and updated based on the findings from the geotechnical investigation:

- Risk Category: III.
- Soil Site Class: D.
- S_s: 0.096g.
- S_1: 0.069g.
- F_a: 1.6.
- F_v: 2.4.
- S_{DS}: 0.102g.
- S_{D1}: 0.11g.
- T_L: 12 sec.
- Seismic Design Category: B.
- Importance Factor: 1.25.

5.2.1.6 Process Liquid Loads

Structures that are meant to retain fluid, whether temporarily or during service conditions, shall be designed assuming the liquid level is at the maximum operating level using applicable load factors and combinations. Also, structures should be checked to ensure that temporary surcharge or overflow conditions can be accommodated by the structure without excessive stresses or deformations to the structure and its members. The water level associated with a surcharge or overflow condition should be assumed to be at the maximum level that the structure can retain.

Structural members shall be designed to resist fluid pressures without counter-acting loads, such as soil backfill or fluid pressures from adjacent compartments.

Structures that are covered and can become pressurized by fluid and/or air pressure shall be designed for the maximum head pressure and any additional transient pressures generated by dynamic hydraulic conditions, which may include pressurization or vacuum pressures.

Hydrodynamic loads shall be determined in accordance with referenced design standards. Where tanks are open or where covers can be damaged, the freeboard used in the design shall be provided to prevent damage and overtopping of the tank where such an event can cause unacceptable damage to facilities and/or pose a safety risk to plant personnel. Where liquid is completely confined, as within a fully pressurized conduit, the full mass of the liquid will need to be considered and the hydrodynamic load will be completely impulsive (no convective component). Where liquid is partially confined by a rigid roof or concrete slab, the impulsive component will need to be increased and the convective component decreased in proportion to the amount of confinement.

5.2.1.7 Soil Loads

Soil loads shall be determined by a geotechnical engineer. Soil loads may include the following:

- Active and at-rest earth pressure.
- Groundwater pressure.
- Seismic soil pressure acting on buried walls.
- Lateral surcharge due to surface loading.
- Passive reaction.
- Buoyant uplift due to high groundwater conditions.
- Increased soil pressures due to liquefaction, should it occur.

Where high groundwater can occur in conjunction with buried structures and pipes that do not contain liquid or sufficient liquid to offset uplift forces, the structure shall be designed to withstand the effects of groundwater uplift according to the latest US Army Corps of Engineers (USACE) guidelines and requirements. Additionally, structural members that are subject to groundwater uplift forces shall be designed to resist the effects using appropriate load factors in accordance with the applicable code or standard.

5.2.1.8 Serviceability

Basic deflection criteria shall be as listed as follows. These limits shall be used in design, unless higher or lower limits are appropriate for a particular structure.

- Monorail Beam and Supporting Structure – L/450 (¼/4-inch maximum). A stiffer system is usually preferred to prevent bouncy operation. A maximum deflection of L/600 or L/800 is preferred. This is of particular concern for monorails moving chlorine cylinders, if applicable. For multi span monorails, check for uplift and deflection on the back spans.
- Bridge Crane Girder – L/1,000 (not including impact).
- Grating - L/240 (¼/4-inch maximum).
- Steel Floor Plate – L/240 (¼/4-inch maximum).
- Beams, Lintels, or Slabs Supporting Masonry - L/720 (3/8-inch maximum for lintels above windows).
- Roof Live Load without Ceiling - L/240.
- Roof Live Load without Ceiling at roof framing comprised of open-web steel bar joists/trusses - L/360.
- Roof Live Load with Ceiling – L/360 (Check roofs for ponding or increased load due to plugged drains; provide emergency overflow. Slope roof ¼/4-inch per foot minimum after dead load deflection has taken place).
- For Metal Roof Decks without Built Up Roofing or Ceiling – L/180.
- Steel Floor Beam - L/360.
- Steel Floor Beam Supporting Plaster Ceiling below - L/480.
- Steel Floor Beam Supporting Masonry Wall - 1/8-inch for L<90 inches or L/720 for L>90 inches.
- Concrete - Refer to American Concrete Institute (ACI) 318, Table 24.2.2.

Cambers may be considered for roof members to control deflection.

5.2.1.9 Vibration

Vibration due to reciprocating or rotating machinery shall be addressed as required to prevent transmission of vibration to structural elements where such vibration has the potential to damage the structure, affect the operation of sensitive equipment and instrumentation, or where it is considered to be a nuisance to plant personnel. Vibration shall be mitigated as required by passive and/or mechanical means. Passive means of vibration mitigation may include the provision of additional equipment base mass as required to offset the range of operating frequencies from the natural frequency of the supporting structure/foundation by margins recommended in ACI 350.4. Mechanical means of vibration mitigation may include, but may not be limited to vibration isolation and energy dampening systems.

Consideration of equipment frequencies during the start-up phase of operation shall be considered as required to prevent resonance with the structure/foundation.

5.2.2 Facilities Requirements

5.2.2.1 Sludge Screening Building

The Sludge Screening Building will be a new building located south of the existing East Sludge Holding Tank. The building will consist of below grade reinforced concrete wetwells, structural concrete framing, non-load-bearing masonry walls, and precast double-T concrete beam roof assemblies. Considering the weight of the building and soil properties in the area, it is expected that auger cast piles or similar deep foundation system will be required for this building structure.

Due to the corrosive environment inside the building, coated reinforced concrete or other corrosion resistant material should be used in the building. This includes primary and secondary building elements such as roof system, walls, stairs, elevated walkways, HVAC equipment, rails, etc.

It is required to provide such façade and appearance to match the rest of the buildings in the area, as indicated in the Architectural section.

5.2.2.2 Existing Solids Building

The existing Solids Building was built in the 1960s. The structural steel framing of the building sits on concrete piles and foundation. This building has masonry and metal exterior walls and is connected to the Administration Building on the east side. The lower level, located in the east side of the building, is surrounded by reinforced concrete walls. Most of the existing interior walls are built with CMU. Stairs, walkways, grates, and rails are mostly galvanized steel. Regardless the age of the building and the abundant equipment inside, the building structure appears to be in sound condition.

Updating the existing facility inside the building would require: removing existing equipment as identified by demolition and process-mechanical plans; removal and replacement of the roof structure to transfer equipment and tanks; partial removal and replacement of the exterior walls to transfer equipment and tanks; potential removal and replacing of the structural steel framing where needed; rehabilitation and strengthening of the structural steel framing including columns, beams and connections; removing and relocating interior CMU walls; modifying and adding new walkways, stairs and grates in different floors and different areas; partial removal of existing concrete floors; forming and pouring new lightweight concrete floors; and a new exterior staircase adjacent to the building. Lightweight concrete should be used for any new concrete work inside the Solids Building to limit the building dead load.

A bridge link structure will attach the Solids Building to the new Cake Loading Building to the north. The bridge link will be 16ft width (W) x 20ft height (H) x 45ft length (L) in dimensions (or as shown in the Revit model) and consist of steel framing with full-height steel trusses at each side. The metal structure will be attached to the Solids Building at one end and the Cake Loading Building at the other, eliminating the need for piers and separate footings. Structural isolation techniques such as installing neoprene bearing pads where the bridge attaches to the Solids Building, may be used to reduce lateral and/or temperature load effects on both structures.

The new staircase will be an open steel structure on top of a shallow foundation. The existing roof shall be replaced where needed. New openings or infilling existing openings may be required to fulfill the design intent.

5.2.2.3 THP Area

THP equipment will be located east of the Solids Building in the existing parking lot area. Equipment will be mounted on an 18in. to 24in. concrete pad. Due to a recent ground washout and poor soil condition, a deep foundation system will be required to support the concrete pad. A separated cooling tower will also be placed on a 12in. concrete pad.

A metal roof shall be provided above the THP equipment. The shelter system shall be structural steel frames with braces in some of the spans where it does not conflict with THP operation and maintenance.

5.2.2.4 Cake Storage and Truck Loading Building

Cake Storage and Truck Loading Building will be a single loading structure, approximately 60ft high, and located north of the existing Solids Building to contain one loading silo. The building will consist of auger cast piles or similar deep foundation system with an 18in. to 30in. thick concrete pile cap, structural steel framing, brick veneer and metal wall panels to match adjacent buildings, and a metal roof system. A new open steel staircase will provide access to the floors from the northeast corner of the building.

5.2.2.5 East and West Sludge Holding Tanks

The existing East and West Sludge Holding Tanks are approximately 86ft diameter cast-in-place concrete tanks with brick veneer built in 1964. The original steel roof of each tank was replaced by double-T precast concrete beams and approximately 3.5in. concrete topping in 1998. Based on a 2017 inspection of the East Sludge Holding Tank structure sulfuric acid in the tanks has damaged the upper portion of the tank walls and most of the precast roof and surrounding cast-in-place roof elements.

The Project includes removal of both concrete roof structures and replacement with a prefabricated aluminum dome for the East Sludge Holding Tank and a gas storage membrane for the West Sludge Holding tank. Tank walls must be repaired before installing the new roof systems. Modifications to the top of tank walls may be required to attach the new aluminum dome and gas storage membrane. Chapter 4 has more detail about the replacement roof systems.

5.2.2.6 Biogas Process

Biogas processing equipment located at the Anaerobic Digesters will be placed on concrete pads inside a new pre-engineered metal building on a spread footing.

5.2.2.7 Electrical Substation Building

Electrical Substation Buildings will be a new masonry building on top of a concrete vault and spread footings. Walls can be load-bearing CMU all around. The roof system shall consist of open web steel joists and metal deck.

5.2.3 Codes and Standards

The following codes, specifications and standards shall apply to the related structural design. Unless specifically stated otherwise, the latest edition of all codes and standards shall apply.

- General Design Criteria:
  - American Society of Civil Engineers (ASCE) 7-16, Minimum Design Loads for Buildings and Other Structures.
  - IBC.
  - OSHA and all applicable state and local codes.
- Concrete:
  - ACI 301-16, Specifications for Structural Concrete.
  - ACI 318-14, Building Code Requirements and Commentary for Reinforced Concrete.
  - ACI 350-06, Environmental Engineering Concrete Structures.
  - ACI 350.5-12, Specifications for Environmental Concrete Structures.
  - ACI 350.3-06, Seismic Design of Liquid-Containing Concrete Structures.
- Masonry:
  - ACI 530-13, Building Code Requirements and Commentary for Masonry Structures.
  - ACI 530.1-13, Specifications for Masonry Structures.
- Steel:
  - American Institute of Steel Construction (AISC) 360-16, Specifications for Structural Steel Buildings.
  - AISC 341-16, Seismic Provisions for Structural Steel Buildings.
  - American Welding Society (AWS) D1.1-15, Structural Welding Code – Steel.
- Aluminum:
  - Aluminum Association Design Manual 2015.
  - AWS D1.2-14, Structural Welding Code – Aluminum.
- American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels.

5.2.4 Structural Design References

The following references and professional organizations/institutions have published industry design guidelines that are to be used in the design as applicable.

- ASTM.
- American National Standards Institute (ANSI).
- ACI:
  - ACI 543R-12, Guide to Design, Manufacture, and Installation of Concrete Piles.
- Concrete Reinforcing Steel Institute (CRSI) Handbook.

- AISC, 15th Edition.
- AWS:
  - ANSI/AWS D1.1, Structural Welding Code, (AWS).
- National Association of Corrosion Engineers (NACE).
- American Petroleum Institute (API).
  - API 650-13, Welded Tanks for Oil Storage.
- AWWA:
  - ANSI/AWWA D100, Welded Steel Tanks for Water Storage, and NACE Standard PRO 178-89, Item No. 53041.

5.2.5 Structural Materials and Specifications

The following criteria for materials include minimum strength and types deemed necessary for the construction of the facilities:

5.2.5.1 Concrete

Performance Requirement

1. Design-Builder shall secure for every part of the Work concrete with homogeneous mixture, which when hardened will have required strength, watertightness, and durability:
   a. Specify construction, contraction, and expansion joints and position in structures as required, for purpose of minimizing number and size of cracks, due to normal expansion and contraction expected from concrete mixes.
   b. Repair cracks which develop in walls or slabs and repair cracks which show any signs of leakage until all leakage is stopped.
   c. Pressure inject visible cracks, other than hairline cracks and crazing, in following areas with epoxy:
      i. Floors and walls of water bearing structures.
      ii. Walls and overhead slabs of passageways or occupied spaces, outsides of which are exposed to weather or may be washed down and are not specified to receive separate waterproof membrane.
      iii. Other items not specified to receive separate waterproof membrane: Slabs over water channels, wet wells, reservoirs, and other similar surfaces.
   d. Walls or slabs, as specified above, that leak or sweat because of porosity or cracks too small for successful pressure injection with epoxy: Seal on water or weather side by coatings of surface sealant system.
   e. Pressure injection and sealing: Continue as specified above until structure is watertight and remains watertight for not less than 3 year after final acceptance or date of final repair, or date of final warranty whichever occurs later in time.
2. Workmanship and methods: Provide concrete work, including detailing of reinforcing, conforming with best standard practices and as set forth in ACI 318, ACI 350, Manual of Concrete Practices, and recommended practices.

Materials

1. Admixtures:
   a. General:
      i. Admixtures shall be compatible with concrete and other admixtures. Admixtures other than pozzolans shall be the products of a single manufacturer to ensure compatibility.
      ii. Fly ash will only be allowed in an admixture with City approval.
      iii. Do not use admixtures containing chlorides calculated as chloride ion in excess of 0.5 percent by weight of cement.
      iv. Use in accordance with manufacturer's recommendations. Add each admixture to concrete mix separately.
   b. Air entraining admixture:
      i. Provide concrete with 5 percent, within 1 percent, entrained air of evenly dispersed air bubbles at time of placement, and in accordance with ASTM C260.
   c. Water reducing admixture:
      i. May be used at the Contractor's option.
      ii. In accordance with ASTM C494, Type A or Type D.
      iii. Not contain air-entraining agents.
      iv. Liquid form before adding to the concrete mix.
      v. No decrease in cement is permitted as result of use of water reducing admixture.
   d. Super-plasticizers: Are not to be used without acceptance by Engineer.
2. Aggregate:
   a. General:
      i. Provide concrete aggregates that are sound, uniformly graded, and free of deleterious material in excess of allowable amounts.
      ii. Grade aggregate in accordance with ASTM C136 and D75.
      iii. Provide unit weight of fine and coarse aggregate that produces in place concrete with weight of not less than 140 pounds per cubic foot for normal weight concrete.
      iv. Do not use aggregate made from recycled materials such as crushed and screened hydraulic-cement concrete, brick, and other construction materials.
   b. Fine aggregate:
      i. Provide fine aggregate for concrete or mortar consisting of clean, natural sand or of sand prepared from crushed stone or crushed gravel.
      ii. Do not provide aggregate having deleterious substances in excess of following percentages by weight of contaminating substances. In no case shall total exceed percent listed.

Table 5.3 Allowable Limit of Deleterious Substances in Fine Aggregate

Item	Test Method	Percent
Removed by decantation (dirt, silt, etc.)	ASTM C117	3
Shale or Chert	ASTM C123 ASTM C295(1)	1 1
Clay Lumps	ASTM C142	1

Notes:
(1) Test Method C123 is used to identify particles in the sample lighter than 2.40 Specific Gravity. Test Method C295 is used to identify which of the lightweight particles are shale or chert. If the results of Test Method C123 are less than 1 percent, Test Method C295 is not required.

iii. Grade fine aggregate from coarse to fine in accordance with ASTM C33.

c. Coarse aggregate (In accordance with National Sanitation Foundation (NSF) 61):

i. Provide coarse aggregate consisting of gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter, or other foreign substances.

ii. Not exceeding 15 percent by weight, of thin or elongated pieces having length greater than 5 times average thickness.

iii. Deleterious substances: Not in excess of following percentages by weight, and in no case having total of all deleterious substances exceeding 2 percent.

Table 5.4 Allowable Limit of Deleterious Substances in Coarse Aggregate

Item	Test Method	Percent
Shale or chert	ASTM C123 ASTM C295(1)	1.25 1
Coal and lignite	ASTM C123	1/4
Clay lumps and friable particles	ASTM C142	1/4
Materials finer than Number 200 sieve	ASTM C117	1/2(2)

Notes:
(1) Test Method C123 is used to identify particles in the sample lighter than 2.40 Specific Gravity. Test Method C295 is used to identify which of the lightweight particles are shale, chert, coal, or lignite. If the results of Test Method C123 are less than 1.25 percent (the minimum combined percentage of shale, chert, coal and lignite), Test Method C295 is not required.
(2) Except when material finer than Number 200 sieve consists of crusher dust, maximum amount shall be 1 percent.

iv. Grading:

1) Aggregate for Class A, B, C, and D concrete: In accordance with ASTM C33, Size Number 57.

2) Aggregate for Class CE concrete for encasement of electrical conduits:

a) Graded in accordance with ASTM C33, Size Number 8.

3. Concrete sealer:

a. Manufacturers: One of the following or equal:

i. Euclid Chemical Co., Diamond Hard.

ii. L&M Construction Chemicals, SealHard.

4. Conduit encasement coloring agent:

a. Color: Red color concrete used for encasement of electrical ducts, conduits, and similar type items.

b. Manufacturers: One of the following or equal:

i. Davis Co., #100 Utility Red.

ii. Reiss Co., Inc., equivalent product.

        iii. Euclid Chemical Co., Increte Division, "Colorcrete Brick Red."
    c. Conduit encasement concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.
5. Evaporation retardant:
    a. Manufacturers: One of the following or equal:
        i. BASF, Confilm.
        ii. Euclid Chemical Co., Eucobar.
6. Fly ash:
    a. No fly ash is permitted to be used in this project.
7. Keyway material: Steel, plastic, or lumber.
8. Nonslip abrasive:
    a. Aluminum oxide abrasive size 8/16, having structure of hard aggregate that is, homogenous, nonglazing, rustproof, and unaffected by freezing, moisture, or cleaning compounds (used on stairs and ramps).
    b. Manufacturers: One of the following or equal:
        i. Exolon Co.
        ii. Abrasive Materials, Inc.
        iii. Euclid Chemical Co., "Non-Slip Aggregate".
9. Portland cement:
    a. Conform to specifications and tests in accordance with ASTM C150, Types II or III, low alkali.
    b. Have total alkali containing not more than 0.60 percent.
    c. Exposed concrete in any individual structure: Use only one brand of portland cement.
    d. Cement for finishes or repairs: Provide cement from same source and of same type as concrete to be finished or repaired.
    e. In accordance with NSF 61.
10. Sheet membrane for curing:
    a. Polyethylene film:
        i. In accordance with ASTM C171.
        ii. Color: White.
        iii. Thickness: Nominal thickness of polyethylene film shall not be less than 0.0040 inches when measured in accordance with ASTM D2103. Thickness of polyethylene film at any point shall not be less than 0.0030 inches.
        iv. Loss of moisture: Not exceed 0.055 grams per square centimeter of surface when tested in accordance with ASTM C156.
11. Sprayed membrane curing compound: Clear type with fugitive dye in accordance with ASTM C309, Type 1D.
12. Surface sealant system:
    a. In accordance with NSF-61.
    b. Manufacturers: One of the following or equal:
        i. Euclid Chemical Co., Vandex Super.
        ii. Kryton International, Inc., Krystol T1.
        iii. Xypex Chemical Corp., Xypex Concentrate.

13. Water:
    a. Water for concrete, washing aggregate, and curing concrete: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.
    b. Chlorides and sulfate ions:
        i. Water for conventional reinforced concrete: Use water containing not more than 1,000 milligrams per liter of chlorides calculated as chloride ion, nor more than 1,000 milligrams per liter of sulfates calculated as sulfate ion.
        ii. Water for prestressed or post-tensioned concrete: Use water containing not more than 650 milligrams per liter of chlorides calculated as chloride ion, or more than 800 milligrams per liter of sulfates calculated as sulfate ion.

Concrete Mixes

Minimum required concrete compressive strength shall be:

- f'c = 4,000 psi – all structural applications.
- f'c = 3,000 psi – curb and gutter and drainage structures.
- f'c = 2,000 psi – reinforced thrust blocks, pipe encasements, and concrete fill for structural foundations.
- f'c = 5,000 psi – Precast concrete.
- f'c = 1,500 psi – Electrical duct encasement.

All new concrete structures exposed to wastewater shall be sealed with chemical resistant sealer throughout.

Field Quality Control

1. Testing of concrete:
    a. During progress of construction, the Owner will have tests made to determine whether the concrete, as being produced, complies with requirements specified.
    b. Tests will be performed in accordance with ASTM C31, ASTM C39, and ASTM C172.
    c. Make provisions for and furnish concrete for test specimens, and provide manual assistance to the Owner's representative in preparing said specimens.
    d. Assume responsibility for care of and providing of curing conditions for test specimens in accordance with ASTM C31.
    e. Sampling frequency:
        i. 1 set of test cylinders for each 50 cubic yards of each class of concrete.
        ii. Minimum of 1 set of test cylinders for each class of concrete placed.
        iii. Not less than 1 set of test cylinders for each half-day's placement.
        iv. At least 2 sets of test cylinders for each structure.
2. Compressive strength tests:
    a. Set of 5 cylinder specimens, 6-inch diameter by 12 inch long.
    b. Information: Test 2 cylinders at 7 days.
    c. Acceptance: Test 2 cylinders at 28 days.
    d. One Hold.
3. Slump tests:
    a. Test slump of concrete using slump cone in accordance with ASTM C143.
    b. Do not use concrete that does not meet specification requirements in regards to slump:
        i. Remove such concrete from project site.

ii. Test slump at the beginning of each placement, as often as necessary to keep slump within the specified range, and when requested to do so by the Owner's representative.

4. Air entrainment tests:
   a. Test percent of entrained air in concrete at beginning of each placement, as often as necessary to keep entrained air within specified range, and when requested to do so by the Owner's representative.
   b. Do not use concrete that does not meet Specification requirements for air entrainment:
      i. Remove such concrete from project site.
   c. Test air entrainment in concrete in accordance with ASTM C173.
   d. The Engineer may at any time test percent of entrained air in concrete received on project site.
5. Enforcement of strength requirement:
   a. Concrete is expected to reach a compressive strength (f'_c) equal to or greater than the specified minimum values.
   b. Strength level of concrete will be considered acceptable if following conditions are satisfied:
      i. Averages of all sets of 3 consecutive strength test results is greater or equal to specified compressive strength (f'_c).
      ii. No individual strength test (average of 2 cylinders) falls below specified compressive strength (f'_c) by more than 500 psi.
   c. Non-compliant strength tests:
      i. Mark non-compliant strength test reports to highlight that they contain non-complying results and immediately forward copies of test reports to all parties on the test report distribution list.
      ii. Provide treatment of non-compliant concrete at no additional cost to Owner and with no additional time added to project schedule:
      iii. Initial treatment may consist of additional curing and testing of the affected concrete.
         1) Provide additional curing of concrete using means and duration acceptable to the Owner's representative.
         2) Upon completion of the additional curing, provide additional testing designated by the Owner's representative.
            a) Obtain and test core samples for compression strength in accordance with ASTM C42, ACI 318, and ACI 350.
            b) Provide not less than 3 cores for each affected area. Obtain Owner's acceptance of proposed coring locations before proceeding with that work.
            c) Submit report of compression strength testing for Owner's review.
            d) If required by the Owner, provide additional cores and obtain petrographic examination in accordance with ASTM C856. Submit report of petrographic analysis for Owner's review.
         3) If additional curing does not bring average of 3 cores taken in affected area to at least the minimum specified compressive strength (f'_c), designate such concrete in affected area as defective.

5.2.5.2 Grouting

Non-Shrink Epoxy Grout

1. Manufacturers: One of the following or equal:
   a. Five Star Products, Inc., Five Star Epoxy Grout.
   b. BASF Construction Chemicals, Masterflow 648 CP Plus.
   c. L&M Construction Chemicals, Inc., EPOGROUT.
2. Non-shrink epoxy grout shall be 100 percent solid, premeasured, prepackaged system containing 2-component thermosetting epoxy resin and inert aggregate.
3. Maintain flowable consistency for at least 45 minutes at 70 deg. F.
4. Shrinkage or expansion: Less than 0.0006 inches per inch when tested in accordance with ASTM C531.
5. Minimum compressive strength: 10,000 psi at 24 hours and 14,000 psi at 7 days when tested in accordance with ASTM C579, Method B.
6. Compressive creep: Not exceed 0.0027 inches/per inch when tested under 400 psi constant load at 140 deg. F in accordance with ASTM C1181.
7. Coefficient of thermal expansion: Not exceed 0.000018 inches per inch per degree Fahrenheit when tested in accordance with ASTM C531, Method B.

Non-Shrink Grout

1. Manufacturers: One of the following or equal:
   a. Five Star Products, Inc., Five Star Grout.
   b. BASF Construction Chemicals, Masterflow 928.
   c. L&M Construction Chemicals, Inc., CRYSTEX.
2. In accordance with ASTM C1107.
3. Preportioned and prepackaged cement-based mixture.
4. Contain no metallic particles such as aluminum powder and no metallic aggregate such as iron filings.
5. Require only addition of potable water.
6. Water for pre-soaking, mixing, and curing: Potable water.
7. Free from emergence of mixing water from within or presence of water on its surface.
8. Remain at minimum flowable consistency for at least 45 minutes after mixing at 45 deg. F to 90 deg. F when tested in accordance with ASTM C230.
   a. If at fluid consistency, verify consistency in accordance with ASTM C939.
9. Dimensional stability (height change):
   a. In accordance with ASTM C1107, volume-adjusting Grade B or C at 45 deg. F to 90 deg. F.
   b. Have 90 percent or greater bearing area under bases.
10. Have minimum compressive strengths at 45 deg. F to 90 deg. F in accordance with ASTM C1107 for various periods from time of placement, including 5,000 psi at 28 days when tested in accordance with ASTM C109 as modified by ASTM C1107.

5.2.5.3 Epoxy Adhesive

1. Materials:
   a. Meeting the physical requirements of ASTM C881, Type IV, Grade 3, Class B or C depending on site conditions.
   b. 2-component, 100 percent solids, insensitive to moisture.

c. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.

2. Manufacturers: One of the following or equal:
   a. Hilti, Inc., HIT-RE 500-V3.
   b. Powers Fasteners, Inc., Powers Pure110+.
   c. Simpson Strong-Tie Co., Inc., SET-XP.

5.2.5.4 Acrylic and Hybrid Adhesive

1. Materials:
   a. 2-component, high-solids, acrylic-based or hybrid acrylic and epoxy-based adhesive.
   b. Approved by the manufacturer for installation at substrate temperatures of 0 deg. F and above.
2. Manufacturers: One of the following or equal:
   a. Hilti, Inc., HIT-HY-200.
   b. Simpson Strong-Tie Co., Inc., AT-XP.

5.2.5.5 Epoxy Resin/Portland Cement Bonding Agent

1. Materials:
   a. Epoxy resin/portland cement adhesive:
      i. Component "A" shall be an epoxy resin/water emulsion containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.
      ii. Component "B" shall be primarily a water solution of a polyamine.
      iii. Component "C" shall be a blend of selected portland cements and sands.
      iv. The material shall not contain asbestos.
2. Manufacturers:
   a. Sika Corp., Sika Armatec 110 or approved equal.
3. Performance Criteria:
   a. Properties of the mixed epoxy resin/portland cement adhesive:
      i. Pot life: 75 to 105 minutes.
      ii. Contact time: 24 hours.
      iii. Color: Dark gray.
   b. Properties of the cured epoxy resin/portland cement adhesive:
      i. Compressive strength in accordance with ASTM C109:
         1) 3 day: 4,500 pounds per square-inch minimum.
         2) 7 days: 6,500 pounds per square-inch minimum.
         3) 28 days: 8,500 pounds per square-inch minimum.
      ii. Splitting tensile strength in accordance with ASTM C496:
         1) 28 days: 600 pounds per square-inch minimum.
      iii. Flexural strength:
         1) 1,100 pounds per square-inch minimum in accordance with ASTM C348.
      iv. Bond strength in accordance with ASTM C882 modified at 14 days:
         1) 0 hours open time: 2,800 pounds per square-inch minimum.
         2) 24 hours open time: 2,600 pounds per square-inch minimum.
      v. The epoxy resin/portland cement adhesive shall not produce a vapor barrier.

vi. Material must be proven to prevent corrosion of reinforcing steel when tested under the procedures as set forth by the Federal Highway Administration (FHWA) Program Report Number FHWA-RD-86-193. Proof shall be in the form of an independent testing laboratory corrosion report showing prevention of corrosion of the reinforcing steel.

5.2.5.6 Waterstops

1. Waterstops - PVC:
   a. Manufactured from prime virgin polyvinyl chloride plastic compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements as specified in this Section.
   b. Manufacturers: One of the following or equal:
      i. Vinylex Corp.
      ii. Greenstreak Plastic Products Co., Inc.
   c. Type: Ribbed waterstop:
      i. Construction joints: minimum 6-inch wide ribbed type.
      ii. Contraction joints: minimum 6-inch wide ribbed type.
      iii. Expansion joint for wall penetrations for concrete encased electrical duct banks: minimum 6-inch ribbed type with hollow center bulb.
      iv. Expansion joints: minimum 9-inch wide ribbed type with hollow center bulb.
      v. Dumbbell-type waterstop are not allowed.
      vi. No scrap or reclaimed material shall be used.
   d. Properties as indicated in the following table:

Table 5.5 Minimum Requirements for Waterstop Characteristics

Physical Characteristics	Test Method	Required Results
Specific Gravity	ASTM D792	Not less than 1.3.
Hardness	ASTM D2240	70 to 90 Type A15 Shore durometer.
Tensile Strength	ASTM D638	Not less than 2,000 psi.
Ultimate Elongation	ASTM D638	Not less than 300 percent.
Alkali Extraction	CRD-C-572	Change in weight after 7 days: Between minus 0.1 percent and plus 0.25 percent. Change in hardness after 7 days: Not more than plus 5 points.
Low Temperature Brittle Point	ASTM D746	No sign of cracking or chipping at -35 deg. F.
Water Absorption	ASTM D570	Not more than 0.15 percent after 24 hours.
Accelerated Extraction Test	CRD-C-572	Tensile strength: Not less than 1,600 psi. Elongation: Not less than 280 percent.
Stiffness in Flexure	ASTM D747	Not less than 600 psi.
Tear Resistance	ASTM D624	Not less than 225 pounds per inch.
Thickness	-	3/8 inch.

Physical Characteristics	Test Method	Required Results
Center Bulb		
6-inch Waterstops	-	7/8 inch or 1-inch nominal outside diameter.
9-inch Waterstops	-	For expansion joints 1 inch and narrower: 1-inch nominal outside diameter. For expansion joints wider than 1 inch: 2-inch nominal outside diameter.
Allowable Tolerances		
Width	-	Plus or minus 3/16 inch.
Thickness	-	Plus or minus 1/32 inch.

5.2.5.7 Reinforcement

- Reinforcing steel bars:
  - General structural use: ASTM A615 Grade 60 with f_y = 60 kilopounds per square inch (ksi).
  - Welded reinforcing steel: ASTM A706 Grade 60 with f_y = 70 ksi.

5.2.5.8 Masonry

- f'_m = 1,900 psi.
- ASTM C90-N concrete masonry units with typical compressive unit strength of 2,350 psi or greater.
- Grout, ASTM C476, f'_g= 2,500 psi.
- Mortar, ASTM C270, type S, f'_c = 1,800 psi.

5.2.5.9 Structural Steel and Stainless Steel

Steel fabricators and erectors shall be AISC certified.

1. Material:
   a. Wide-flange shapes: ASTM A992 with fy = 50,000 psi.
   b. Other Shapes, Bars & Plates: ASTM A36 with fy = 36,000 psi.
   c. Pipe: ASTM A53, Grade B with fy = 35,000 psi.
   d. Hollow structural sections (HSS): ASTM A500, Grade B with fy = 42,000 psi.
   e. Stainless Steel Bars and Shapes: ASTM A276 with fy = 35,000 psi.
2. Galvanized carbon steel:
   a. Where galvanizing is required, hot-dip structural steel after fabrication in accordance with ASTM A123:
   b. Do not electro-galvanize or mechanically galvanize.
   c. Field repair cut or otherwise damaged galvanized surfaces to equivalent original condition using a galvanized surface repair.
3. Welding: Carbon steel:
   a. General: In accordance with AWS D1.1: Weld ASTM A36 and A992 structural steel, ASTM A500 and A501 structural tubing, and ASTM A53 pipe with electrodes in accordance with AWS A5.1, using E70XX electrodes; AWS A5.17, using F7X-EXXX electrodes; or AWS A5.20, using E7XT-X electrodes.

5.2.5.10 Aluminum

1. Material:
   a. Structural sheet aluminum: ASTM B209, Alloy 6061-T6.
   b. Structural aluminum: ASTM B308, Alloy 6061-T6.
   c. Extruded aluminum: ASTM B221, Alloy 6063-T42.
2. Required coating for dissimilar metals:
   a. Alkali resistant bitumastic:
      i. Manufacturers: One of the following or equal:
         1) Carboline, Bitumastic Super Service Black.
         2) Tnemec, 46-465.
         3) Wasser, MC-Tar.

5.2.5.11 Structural Bolts

- Structural bolts for structural steel shall conform to ASTM A325 Type 3 bolts with threads included in the shear plane. Anchor bolts in normally dry environments shall be ASTM A307 and shall be designed in accordance with ACI 318-14, Chapter 17, "Anchoring to Concrete". Anchor bolts immersed in water, intermittently or continuously, or in a moist environment shall be stainless steel Type 316.
- Structural bolts for structural stainless steel or aluminum structures shall be Type 316 and conform to ASTM A193.

5.2.5.12 Structural Anchors

- Anchorage of equipment shall be based on IBC criteria using the site-specific seismic factors specified in this report plus vertical forces equal to two thirds of the calculated horizontal force acting in either direction.
- Both the horizontal and vertical forces shall be applied concurrently. Expansion anchors shall not be used to resist seismic forces.
- Post-installed anchors shall be designed in accordance with the provisions set forth in ACI 318-14, Chapter 17, "Anchoring to Concrete."
- Anchorage of equipment installed with vibration isolators shall be designed to resist concurrent seismic forces equal to 2.5 times the governing acceleration of the IBC lateral force criteria.
- Cast-in-place anchor bolts shall be used whenever possible. Chemical anchor bolts, only if approved by Owner, shall be in accordance with the requirements under Structural Bolts. No cinch anchor, expansion anchor, or chemical anchor shall be used on rotating equipment greater than 2.0 horsepower.
- Concrete anchors for anchorage to concrete:
  - Acceptance criteria:
    - Concrete anchors shall have a current International Code Council Evaluation Service (ICC-ES) Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and with ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).

        - Concrete anchor performance in the current ICC-ES Report shall be "Category 1" as defined in ACI 355.2.
    - Manufacturers: One of the following or equal:
        - Hilti, Kwik Bolt TZ Expansion Anchor.
        - Powers Fasteners, PowerStud+ SD2.
        - Simpson Strong-Tie, Strong Bolt 2 Wedge Anchor.
    - Materials: Integrally threaded stud, wedge, washer, and nut:
        - Stainless steel: Type 316.
- Concrete anchors for anchorage to concrete masonry (fully grouted cells):
    - Acceptance criteria: Concrete anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified in accordance with ICC-ES AC01, including all mandatory tests and optional seismic tests.
    - Manufacturers: One of the following or equal:
        - Hilti, Kwik Bolt 3 Expansion Anchor.
        - Powers Fasteners, Power-Stud+ SD1.
        - Simpson Strong-Tie, Wedge-All Anchor.
    - Materials. Integrally threaded stud, wedge, washer, and nut:
        - Stainless steel: Type 316.

5.2.5.13 Open Web Steel Joists

1. Design requirements:
    a. Design joists and bridging in accordance with current Steel Joist Institute (SJI) Standard Specifications and load tables to support loads indicated based on the depth, spacing, and deflections, indicated.
        i. Maximum deflection under live load:
            1) Roof joists: Span divided by 240 (L/240).
            2) Floor joists: Span divided by 360 (L/360).
        ii. Minimum design loads as required:
            1) Dead load.
            2) Live load.
            3) Rain load (ponding).
            4) Snow load.
            5) Wind load (net uplift).
            6) Axial tension and compression forces applied to the truss at end connections.
        iii. Camber: Provide standard camber based on SJI Standard Specifications.
            1) In no case shall joists be manufactured with negative (downward) camber.
            2) Where a joist will be installed parallel to and within 6 feet of a wall, decrease camber in that joist nearest the wall to one-half of the standard camber.
    b. Joist chord extensions:
        i. Top chord extensions. Capable of withstanding the loads indicated for the joist plus any concentrated loads indicated. Brace to prevent lateral torsional buckling of the extension under loads.
        ii. Bottom chord extensions. Capable of supporting weight of ceilings or other items indicated. Extending to within 1 inch of interior finished wall surface.

c. Bridging: Provide horizontal and diagonal bridging as required by the SJI Standard Specifications, and as required to maintain stability under gravity, uplift, erection, and construction loadings.
d. End anchorage: Provide end anchorage details to secure and/or stabilize joists at supports, and to transfer any loads.
e. Header units: Provide header units to support joists at openings in floor or roof framing not framed with structural steel shapes.
f. Accessories:
    i. Provide miscellaneous items including splice plates, reinforcing angles, and bolts required to complete the installation.
    ii. Provide supplemental steel framing to support steel deck where normal deck bearing is precluded by other framing members and minor openings.

2. Steel joists:
    a. Provide joist type, chord configuration, depth, and bearing.
    b. Comply with SJI Standard Specifications for joist series.
    c. Details: Provide the following.
        i. Chord members: Rolled double angle sections only. Rod or bar members are not permitted.
        ii. Chord extensions - Joists.
            1) Bottom chord ("ceiling") extensions: Where required.
3. Bridging:
    a. In accordance with SJI Standard Specifications for type of joist, chord size, spacings, spans and uplift loads.
    b. Anchored to walls, girders, and roof deck as required.
4. Coatings:
    a. Shop primer: Clean and prime joists and accessories in accordance with SSPC Paint 15.
    b. Shop paint. In accordance with SSPC Paint 15.
5. Fasteners:
    a. Anchor bolts and anchor rods to concrete and masonry: As specified in this document.
    b. Bolts: pre-tensioned bolted connections.
        i. Provide high-strength bolt assembly with hardened flat washers and nuts. Provide uncoated components unless galvanized coating is indicated on the Drawings.
        ii. Uncoated:
            1) Bolts: Plain, heavy hex structural bolts conforming to ASTM A325 Type 1.
            2) Nuts: Heavy hex nuts conforming to ASTM A563, Grade C.
            3) Washers: Circular flat washers conforming to ASTM F436.
    c. Galvanized:
        i. Bolts, nuts, and washers: As specified for uncoated assemblies, and with the following provisions:
            1) Hot dip galvanized in accordance with ASTM A153, Class C or ASTM F2329.
            2) Nuts: In accordance with ASTM A563, Grade DH, galvanized as specified and lubricated in accordance with ASTM A563 Supplementary Requirement S1 to minimize galling.

5.2.5.14 Steel Decking

1. Manufacturers shall be one of the following or equal:
   a. Vulcraft.
   b. ASC Profiles (Formerly IMSA Building Products).
   c. Verco Manufacturing Co.
2. Materials:
   a. Sheet steel: ASTM A653, G 90 minimum coating designation.
   b. Minimum required gauges: 20 gauge

5.3 Architectural

5.3.1 Basis of Design

This section establishes the design criteria, space needs, and architectural preferences for the Project. It is intended to be used as a starting point in determining the special requirements and layout of the facilities. The Design-Builder shall evaluate alternatives to achieve an economical and functional layout. The following information is provided as a guideline for the Design-Builder in preparation of their design.

Design Builder may elect to pursue a fire suppression exemption.

5.3.2 Facilities Requirements

5.3.2.1 Sludge Screening Building

The new Sludge Screening Building will house two (2) sludge screens on the second floor. Screened materials will be transferred to 20-cubic yard roll-off dumpsters in the room directly below the Sludge Screening Room. Each dumpster will have a dedicated coiling overhead door for dumpster removal. Adjacent to the sludge screening portion of the building will be a pump room and exterior wet wells covered with FRP grating. Although the building will not be used to store hazardous materials, the storage of waste materials within a building in containers or dumpsters in excess of 1.5 cubic yards requires an automatic sprinkler system per IBC 304.3.3, exception 1.

Required floor areas (in square feet):

Pump Room:	600
Dumpster Room:	1200
Screening Room:	1200
Total:	**3000**

Due to the corrosive nature of the environment around and within this building, corrosion resistant construction is recommended. Concrete load bearing frame with CMU infill exterior walls with brick façade and insulated cavity matching the adjacent plant buildings is recommended. Precast concrete should be used for the second floor and roof structure. Metals used for flashings and door hardware should include aluminum and stainless steel, while FRP is recommended for personnel door panels and frames, stairs and railings.

The occupancy classification of this building will be IBC - 306.2 Moderate Hazard Factory Industrial, Group F-1. Factory industrial uses which are not classified as Factory Industrial F-2 Low Hazard shall be classified as F-1 Moderate Hazard.

5.3.2.2 Solids Building

Solids dewatering will occur within the existing Solids Building; nearly all current functions of this building will be removed. The renovated building will house a pre-THP pump station, polymer rooms, pre-THP dewatering room with centrifuges, sludge cake storage silos, post-THP pump station, post-THP dewatering room with centrifuges, conveyor room, digested sludge pumps, centrifuge control room and adjacent restroom, laboratory with adjacent restroom, and support spaces including two electrical rooms, mechanical room, and boiler room. The conveyor room will include two conveyors to transfer dewatered sludge to two post-THP dewatered sludge cake storage hoppers and truck loading building. The centrifuge room will require adequate head room for a 10-ton bridge crane running the length of the building. Sludge cake storage silos and scrubbers will make use of the existing incinerator and scrubber space which extends from the basement floor to the bottom of the roof. No hazardous material storage is anticipated for this building unless chemical scrubbers are utilized. The building currently has only one means of egress. Due to the size of the building footprint and travel distances, at least one additional means of egress will be required for Level 2.

Required Floor Areas (in square feet):

Basement Level:	
Sludge Cake Silos and Odor Control:	4,500
Level 1:	
Pre-THP Pump Station:	1,060
Pre-THP Polymer Room:	2,200
Post-THP Pump Station:	1,060
Post-THP Polymer Room:	1,850
Boiler Room:	1,880
Electrical Room 1:	1,470
Electrical Room 2:	1,270
Laboratory:	650
Restroom:	70
Level 2:	
Mechanical Room:	4,600
Centrifuge Room:	5,700
Centrifuge Control Room:	1,400
Conveyor Room:	2,700
Restroom:	70
Total:	**24,100**

Mezzanine Areas:

Level 2 Mezzanine:

Centrifuge Equipment Platform: 3,800

Existing exterior walls will remain. CMU partitions will be utilized in the interior. Aluminum or FRP grating is recommended where grated floors are required. Metals used for flashings and door hardware should include aluminum and stainless steel, while FRP is recommended for personnel door panels and frames.

The entirety of the interior walls, floors, ceilings, and structural steel should be repainted. Depending on the substrate and substrate contaminants, surfaces may require either power washing, pressure washing, or abrasive blast preparation, as appropriate for the coatings to be utilized. An epoxy paint with a urethane topcoat is recommended for the walls. Recommended floor coatings include sealed concrete (for basement, mechanical room, electrical rooms, boiler room, pump rooms, and general circulation areas) and epoxy resin with non-slip texture and integral cove base (for polymer rooms, conveyor room, centrifuge rooms, laboratory, and centrifuge control room). At rooms where containment is required, epoxy resin flooring systems should extend up walls to the required containment height.

At numerous locations throughout the exterior brick façade mortar is cracking and brick faces are popping out and spalling. Selective tuck pointing is recommended to maintain the integrity of the façade for the life of the building. Broken bricks should be replaced.

The concave metal panel siding on the upper portion of the building has slipped at a few locations. These should be repaired. The new layout of the process will result in existing penetrations being abandoned and new ones being required. Care should be taken in demolition of panel system for new opening to salvage panel system for repair at existing abandoned openings. Patching of smaller openings is allowed when the openings are within one panel width. Infill of existing openings with new non-matching panels should be a last resort solution.

The Solids Building and the Administrative Building will be treated as Mixed Use, Separated Occupancies per IBC Section 508.4.

- **508.4 Separated occupancies.** Buildings or portions of buildings that comply with the provisions of this section shall be considered as separated occupancies.
- **508.4.1 Occupancy classification.** Separated occupancies shall be individually classified in accordance with Section 302.1. Each separate space shall comply with this code based on the occupancy classification of that portion of the building.
- **508.4.2 Allowable building area.** In each story, the building area shall be such that the sum of the ratios of the actual building area of each separated occupancy divided by the allowable area of each separated occupancy divided by the allowable building area of each separated occupancy shall not exceed one.
- **508.4.3 Allowable height.** Each separated occupancy shall comply with the building height limitations based on the type of construction of the building in accordance with Section 503.1.
- **508.4.4 Separation.** Individual occupancies shall be separated from adjacent occupancies in accordance with Table 508.4.

From Table 508.4: No separation of occupancies is required between Occupancy Types F-1, B, and S-1.

The Solids Processing Building will be categorized as IBC - 306.2 Moderate Hazard Factory Industrial, Group F-1. Factory industrial uses which are not classified as Factory Industrial F-2 Low Hazard shall be classified as F-1 Moderate Hazard.

The Administration Building will be categorized as IBC - 304.1 Business, Group B. Includes the use of a building or portion thereof, for office, professional, or service-type transactions, including storage of records and accounts.

Additional Building Improvements

Egress

Because travel distances to the existing stair tower, level two requires an additional means of egress; an additional stairway, enclosed with fire resistance rated construction, will be added to the west wall of the solids building. This stairway will serve Level 2. An exterior metal egress stair may be required from Level 2, near the freight elevator on the south side of the building. On the ground level, all existing points of egress will be maintained. Additionally, a stairway from the basement to the ground level will be required near the existing freight elevator.

Automatic Sprinkler System

Due to the size of the existing building, floor areas exceed those permitted by the building code for the Group F-1 Occupancy Classification; therefore, an automatic sprinkler system for the solids building and adjacent administration building will be required to utilize the existing building for the intended purpose. Additionally, because the combined fire areas of the Group F-1 occupancy exceed 24,000 square feet, and the building exceeds two stories in height, an automatic sprinkler system is required by the building code.

Separation between Administration Building and Solids Processing Building

The City has requested a physical separation between the Administration Building and Solids Building to improve indoor air quality within the Administration Building. Currently, the two buildings share a stair tower and elevator. The elevator opens on the east side to the Administration Building at the basement, ground level and Level 2, and on the west side to the Solids Building at the ground level, ground level mezzanine (currently identified as Level 2), Level 2 (currently identified as Level 3), and Level 2 mezzanine (currently identified as Level 4). The proposed means of separation is to seal off the elevator openings on the Solids Building side with construction matching the existing adjacent walls; closing the stairwell access from Level 2 of the Administration Building; modifying the ground level discharge of the stairwell so that the stair exits directly to the exterior, as required by code; and adding a wall and door in the basement between the Administration Building and the stairway. The south entrance to the Administration Building will require modification to accommodate changes to the stairwell discharge.

Roof Replacement

The existing ballasted modified bitumen roofing system is greatly deteriorated. Asphalt flashing at equipment curbs is brittle with evident holes. Metal flashings are corroded. The entire roofing system and roof edge flashing system, including wood nailers, must be replaced. Insulation should be replaced with an R21 rigid insulation. A Thermoplastic Polyolefin (TPO) of PVC roofing system is recommended. Stainless steel and/or aluminum flashings are recommended due to the corrosive atmosphere of the facility.

Roof drainage appears to be in serviceable condition, however, overflow drains should be added; additionally, roof drainage piping may require reconfiguration due to potential conflicts with new process, HVAC, and electrical equipment, piping, and conduit.

There is currently no parapet or other means of fall protection around the roof edge. A roof edge guardrail system is required around the perimeter if equipment is installed within 10ft of the perimeter.

5.3.2.3 Electrical Substation One Building

The Electrical Substation One Building will be located in the west portion of the site, adjacent to the existing sludge thickener basin. The building will require one room to house electrical gear. The building will have a vault beneath the ground floor for the full extent on the building. The vault room will have a clear head height of 6ft below the deepest structural member. Access to the vault will be by two access hatches. Both hatches will be situated to not be in the common path of travel for installation of major equipment.

Required Floor Areas (in square feet):

Electrical Substation One: 850

A CMU building with an insulated brick veneer facade. The interior concrete floor will be sealed. With a metal bar joist and metal deck roof structure and TPO roofing system.

This building will be classified as IBC - 312.1 Utility and Miscellaneous Group U. Building and structures of an accessory character and miscellaneous structures not classified in any specific occupancy shall be constructed, equipped and maintained to conform to the requirements of this code commensurate with the fire and life hazard incidentals to their occupancy.

5.3.2.4 Cake Storage and Truck Loading Building

The Cake Storage and Truck Loading Building will consist of truck loading bays situated below a cake storage hopper. The building footprint will be sized to accommodate tractor and trailer. The building will be connected to the Solids Building with a bridge for post-THP dewatered sludge conveyors, maintenance platforms, and stairs. An egress stair will be required from the top of the equipment platform to the ground.

Required Floor Areas (in square feet):

Truck Loading Bay: 1,800

Equipment platforms: 400

An insulated, pre-engineered steel building with prefinished steel or aluminum wall panels and TPO roof will be used. The interior concrete floor will be sealed. Grating is recommended for use as equipment platforms and catwalks around and above the cake storage hoppers. The bridge connecting this building to the Solids Building will also be of similar prefinished steel or aluminum construction. Due to its height, the egress stairway at the north side of the building should be 7in. max risers with 12in. maximum treads. Guardrails should be 42in. in height and should not allow a 4in. sphere to pass between the rails.

This building will be classified as IBC – 311.3 Low Hazard Storage, Group S-2. Includes, among others, buildings used for the storage of noncombustible materials.

Depending on the use of automatic sprinkler systems, a 1-hour or 2-hour occupancy separation between the Cake Storage and Truck Loading Building and the Solids Building will be required.

5.3.2.5 Digester Gas Processing

An iron sponge / H_2S removal system will be used for processing digester gas (see Chapter 4 for more information) and will need a structural pad to support the equipment. The biogas booster pumps, sediment trap with electric drip trap, and aftercooler will need to be arranged to be contained in an enclosed pre-engineered metal building. The structure is to have the minimum following requirements:

Provide a complete, integrated set of mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior. Rigid Clear Span: Solid-member, structural-framing system without interior columns with a clear head height of 8ft-0in. at perimeter and a minimum clearance of 12in. form all equipment. Provide metal panel systems capable of withstanding the effects of loads based on testing according to ASTM E1592. Metal roof and wall panels to have no water penetration when tested according to ASTM E1646 or ASTM E331 at the test-pressure difference of 2.86 pound-force per square foot (lbf/sq. ft). Exposed Coil-Coated Finish to be Three-Coat Fluoropolymer per AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions. Provide personal doors and frames to access and service all equipment safely.

Table 5.6 Sprinkler System Requirements by Process Area

Building	Occupancy Classification	Construction Type	Allowable Building Height, Table 503	Tabular Building Area, Table 503	Automatic Sprinkler System Building Height Increase, 504.2	Automatic Sprinkler System Building Area Increase, 506.3	Allowable Building Area with Building Area Modifications	Fire-resistance Rating for Exterior Walls based on Separation Distance	Automatic Sprinkler System Required
Sludge Screening Building	Moderate-hazard factory industrial, Group F-1	II-B, noncombustible - no fire resistance rating required for all building elements	2 stories, 55 feet	15,500 sf per story	1 story, 20 feet	200%	46,500 sf per story	< 5ft = 2 hr < 10ft = 1 hr < 30ft = 0 hr > 30ft = 0 hr	Yes, Per IFC 304.3.3, buildings containing dumpsters in excess of 1.5 cubic yards.
Solids Processing Building & Admin Building	Separated Occupancies per 508.4 Administration Building is not in the scope of this project.								
Solids Processing Building	Solids Processing Building - Moderate-hazard factory industrial, Group F-1	II-B	2 stories, 55 feet	15,500 sf per story	1 story, 20 feet	200%	46,500 sf per story	< 5ft = 2 hr < 10ft = 1 hr < 30ft = 0 hr > 30ft = 0 hr	Yes, per IBC 903.2.4, 1 & 3, a Group F-1 fire area exceeds 12,000 sf & combined area of all Group F-1 fire areas exceeds 24,000. And to increase the allowable area of the existing building to meet actual building area.

Building	Occupancy Classification	Construction Type	Allowable Building Height, Table 503	Tabular Building Area, Table 503	Automatic Sprinkler System Building Height Increase, 504.2	Automatic Sprinkler System Building Area Increase, 506.3	Allowable Building Area with Building Area Modifications	Fire-resistance Rating for Exterior Walls based on Separation Distance	Automatic Sprinkler System Required
Administration Building	Business Group B	II-B	3 stories, 55 feet	23,000 sf per story	1 story, 20 feet	200%	69,000 sf per story	< 5ft = 2 hr < 10ft = 1 hr < 30ft = 0 hr > 30ft = 0 hr	No
Electrical Substation One Building	Utility and Misc Group U	II-B	2 stories, 55 feet	8,500 sf per story				< 5ft = 2 hr < 10ft = 1 hr < 30ft = 0 hr > 30ft = 0 hr	No
Cake Storage & Truck Loading Building	Low Hazard Storage, Group S-2	II-B	3 stories, 55 feet	26,000 sf per story	1 story, 20 feet	200%	78,000 sf per story	< 5ft = 1 hr < 10ft = 1 hr < 30ft = 0 hr > 30ft = 0 hr	No. If post THP sludge cake is determined: classified as combustible waste material, an automatic sprinkler system is required.

5.3.3 Codes and Standards

- The following codes, specifications and standards shall apply to the related structural design. Unless specifically stated otherwise, the latest edition of all codes and standards shall apply:
- International Building Code.
- 2012 IFC.
- 2012 International Mechanical Code (IMC).
- 2012 UPC.
- 2011 National Electrical Code (NEC).
- NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
- Metal Fabrications:
  - Aluminum Association (AA): DAF-45: Designations from Start to Finish, M12-C22-A41.
  - ASTM International (ASTM):
    - B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
    - B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
    - B308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
    - B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
- Structural sheet aluminum- ASTM B209- Alloy 6061-T6.
- Structural aluminum- ASTM B209, B308 - Alloy 6061-T6.
- FRP handrail and guardrail:
  - ASTM International: F1092 - Standard Specification for Fiberglass (GRP) Pultruded Open-Weather Storm and Guard, Square Railing Systems and OSHA.
- FRP Doors and Frames:
  - ASTM.
  - Society of Automotive Engineers (SAE).
  - International Building Code, Plastics (Chapter 26).
  - Underwriters Laboratories (UL) 10b and UL 10c, NFPA 252 and UBC7-2.
- Translucent Skylight System:
  - American Architectural Manufacturers Association (AAMA):
  - 2604 - Voluntary Specification Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
  - ASTM International (ASTM):
    - C297 - Standard Test Method for Flatwise Tensile Strength of Sandwich Construction.
    - D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
    - D1002 - Standard Test Method for Apparent Shear Strength of Single-Lap-Joints Adhesively Bonded Metal Specimens by Tension Loading (Metal to Metal).

    - D1037 - Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials.
    - D1183 - Standard Practices for Resistance of Adhesives to Cyclic Laboratory Aging Conditions.
    - D2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
    - E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
    - E108 - Standard Test Methods for Fire Tests of Roof Coverings.
  - National Fenestration Rating Council (NFRC):
    - 100 - Procedure for Determining Fenestration Product U-Factors.
  - UL:
    - 790 - Standard Tests Methods for Fire Tests of Roof Covering.

5.3.4 Materials and Specifications

5.3.4.1 Brick Veneer

Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

Facing brick complying with ASTM C216, grade SW, Type FBX FBS FBA. Provide brick that has been tested according to ASTM C67 and is rated "not effloresced." Size (Actual Dimensions): 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long. Color and texture to match existing.

Mortar Materials to be Portland Cement ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated. Alkali content shall not be more than 0.1 percent when tested according to ASTM C114. Hydrated Lime to be ASTM C207, Type S. Portland Cement-Lime Mix to be Packaged blend of portland cement and hydrated lime containing no other ingredients. Masonry Cement to be ASTM C91/C91M. Mortar Cement to be ASTM C1329/C1329M. Mortar Pigments to be Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar. Colored Cement Products to be Packaged blend made from portland cement and hydrated lime masonry cement or mortar cement and mortar pigments, all complying with specified requirements, and containing no other ingredients. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors. Pigments shall not exceed 10 percent of portland cement by weight. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight. Aggregate for Mortar to be ASTM C144. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve. Colored-Mortar Aggregates to be

Natural sand or crushed stone of color necessary to produce required mortar color. Cold-Weather Admixture to be Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated. Water-Repellent Admixture to be Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer. Water to be potable. Ties and anchors shall extend at least 1-1/2 inches into veneer but with at least a 5/8-inch cover on outside face. Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated. Hot-Dip Galvanized, Carbon-Steel Wire to be ASTM A82/A82M, with ASTM A153/A153M, Class B-2 coating. Stainless Steel Wire to be ASTM A580/A580M, Type 316. Steel Sheet to be galvanized after Fabrication to ASTM A1008/A1008M. Commercial Steel to be finished to ASTM A153/A153M, Class B coating. Stainless Steel Sheet to be ASTM A240/A240M or ASTM A666, Type 316.

5.3.4.2 Embedded Flashing Materials

Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows. Stainless Steel to be ASTM A240/A240M or ASTM A666, Type 304, 0.016 inch thick. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed. Fabricate through-wall flashing with sealant stop unless otherwise indicated. Fabricate by bending metal back on itself 3/4 inch at exterior face of wall and down into joint 1/4 inch to form a stop for retaining sealant backer rod. Fabricate metal drip edges and sealant stops for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water. Fabricate metal drip edges from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod. Fabricate metal expansion-joint strips from stainless steel to shapes indicated. Solder metal items at corners.

Unless otherwise indicated, use the following. Where flashing is indicated to receive counterflashing, use metal flashing. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge or flexible flashing with a metal drip flashing with a drip edge. Where flashing is fully concealed, use metal flashing. Solder for Stainless Steel to be ASTM B32, Grade Sn96, with acid flux of type recommended by stainless steel sheet manufacturer.

Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work. Proceed with installation only after unsatisfactory conditions have been corrected.

Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed. Matching Existing Masonry, Match coursing, bonding, color, and texture of existing masonry. Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C67. Allow units to absorb water so they are damp but not wet at time of laying.

Dimensions and Locations of Elements for dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4-inch in a story height or 1/2-inch total.

Lines and Levels bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations. Bond Pattern for Exposed Masonry unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs. Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry. Built-in Work as construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

Lay masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints. Lay with face shells fully bedded in mortar and with head joints of depth equal to bed joints. At starting course, fully bed entire units, including area under cells. At anchors and ties, fully bed units and fill cells with mortar as needed to fully embed anchors and ties in mortar. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated. For glazed masonry units, use a nonmetallic jointer 3/4 inch or more in width.

5.3.4.3 Metal Fabrications

Design and fabricate assemblies' handrails and guardrails to conform to current local, State, and OSHA standards and requirements. Coordinate layout of assemblies and post spacings to avoid conflicts with equipment and equipment operators. Highlight locations where railings cannot be made continuous and obtain Engineer's directions on how to proceed before fabricating or installing railings.

5.3.4.4 Aluminum Handrails and Guardrails (Nonwelded Pipe)

Rails, posts, and fitting-assembly spacers in accordance with ASTM B429, 6005, 6063 or 6105, minimum Schedule 40, extruded aluminum pipe of minimum 1.89-inch outside diameter and 0.14-inch wall thickness. Kick plates to be 6061 or 6105 aluminum alloy. Fastenings and fasteners are as recommended or furnished by the manufacturer. Other parts to be 6063 extruded aluminum, or F214 or F514.0 aluminum castings in accordance with ASTM B209 or ASTM B221. Extruded bars Bases to be 6061 or 6063 extruded aluminum alloy. Plug screws or blind rivets to be type 305 stainless steel. Type 300 series stainless steel. Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting. Aluminum Association Specification M12-C22-A41, mechanical finish non specular as fabricated, chemical finish-medium matte, anodic coating-clear Class I Architectural. Pretreat aluminum for cleaning and removing markings before anodizing. Fabricate posts in single, unspliced pipe length. Perform without welding. Do not epoxy bond the parts. Maximum clear opening between assembled railing components as indicated on the Drawings.

Manufacturers to be one of the following or equal:

- Moultrie Manufacturing Co., Wesrail.
- Golden Railings, Riveted System.
- Craneveyor Corp. Enerco Metals, C-V Rail.

Aluminum ladders and cages to be safety type conforming to local, State, and OSHA standards as minimum. Furnish guards for ladder wells.

Manufacturers to be subject to compliance with requirements, provide products by one of the following or equal:

- UPNOVR, Inc. (ACL Industries, Inc.)
- Precision Ladders, LLC.
- O'Keefe's Inc.

Aluminum ladders to be Basis of Design Model Number to be U-300 by ACL Industries. Materials to be ASTM B221, Alloy 6063, Temper T-6, non-spark extruded aluminum and ASTM B209, Alloy 6063 Temper T-6 sheet aluminum with Mill finish. Side Rails to be 1-3/4 inches (45 mm) wide by 3 inch (76 mm) tubes with 1/8 inch (3 mm) wall thickness. Extend rails 42 inches above roof line. Extension to be at the top of side rails provide 19 inches extension, 28 inches high, Rungs to be 1-1/4 inches wide by 1-1/4 inches (32 mm) tube with serrated surfaces and capable of 1,000 pound load. Space 12 inches (310 mm) on center. Attach rungs in centerline of side rails by welding. Rung Length to be 24 inches (610 mm). Wall Brackets to be 2 inches by 1/4 inch minimum flat bar aluminum wall brackets. Floor Brackets to be Anchor side rails to floor with 2 by 1/4 inch minimum flat bar aluminum floor brackets. Allow 7 inches minimum clearance from wall to center line of rungs.

Security Door to be Hinged security door to cover bottom rungs and prevent unauthorized roof access. Fabricate from 11 gage flat aluminum sheet covering front of ladder. Provide side flanges extending toward wall and meeting aluminum flange mounted to wall. Equip door with continuous hinge and padlock hasp.

Safety Post Extension to be Post extension for fixed ladders constructed of tubular aluminum sections with adjustable mounting brackets for attachment to top of ladder. Permanently mount operating instructions on safety post to be plainly visible to ladder users.

Equip ladders with safety cages where required to meet local codes. Fabricate from 2 inches (50 mm) wide by 1/4 inch (6 mm) thick aluminum vertical strips and horizontal loops welded for form a cage around the ladder. Bottom Loop Radius to be 17-1/2 inches (445 mm). Radius of Other Loops to be 13-1/2 inches (343 mm). Vertical Strips to be 7 vertical strips equally spaced around perimeter of cage. Horizontal Loops to be 48 inches (1220 mm) maximum spacing. Minimum clearance from ladder to back of cage shall be 27 inches (686 mm).

Cage Start Above Grade or Floor Level to be 8 feet. At roof over rail extension ladders, extend safety cage 42 inches minimum above top rung and attach to side rails as detailed on Drawings and reviewed shop drawings.

Fall prevention system to be Include but not limit to railing, brackets, clamps, 2 sleeves, and 2 belts, satisfying OSHA safe climbing requirements:

- Manufacturers: One of the following or equal:
- North Consumer Products, Saf-T-Climb.
- Swager Communications, Climbers Buddy System.

Security Door to be Hinged security door to cover bottom rungs and prevent unauthorized roof access. Fabricate from 11 gage flat aluminum sheet covering front of ladder. Provide side flanges extending toward wall and meeting aluminum flange mounted to wall. Equip door with continuous hinge and padlock hasp.

Safety Post Extension to be Post extension for fixed ladders constructed of tubular aluminum sections with adjustable mounting brackets for attachment to top of ladder. Permanently mount operating instructions on safety post to be plainly visible to ladder users.

5.3.4.5 Fiberglass Reinforced Plastic Products

The material covered by these specifications shall be furnished by an International Organization for Standardization (ISO) ISO-90012000 certified manufacturer of proven ability who has regularly engaged in the manufacture and installation of FRP systems. Fabricator Qualifications Firm experienced in successfully producing FRP fabrications similar to that indicated for this project, with sufficient production capacity to produce required units without causing delay in the work. The design of FRP products including connections shall be in accordance with governing building codes and standards as applicable. Design live loads of FRP gratings and floor panels shall not be less than 100 psf uniformly distributed unless specifically stated otherwise in drawings and/or supplementary conditions. Grating and floor panel deflection at the center of a simple span not to exceed 0.25in. Structural members shall be designed to support all applied loads. Deflection in any direction shall not be more than L/180 of span for structural members. Connections shall be designed to transfer the loads.

Materials used in the manufacture of the FRP products shall be raw materials in conformance with the specification. All materials shall be of the kind and quality specified. With the exception of molded gratings and treads, all FRP products noted in 1.02 shall be manufactured using a pultruded process utilizing polyester resin with flame retardant and UV inhibitor additives. A synthetic surface veil shall be the outermost layer covering the exterior surface. The flame retardant FRP shapes shall achieve a flame spread rating of 25 or less in accordance with ASTM test method E-84. (Polyester resin is available without flame retardant and UV inhibitor additives.) If required, after fabrication, all cut ends, holes and abrasions of FRP shapes shall be sealed with a compatible resin coating. FRP products exposed to weather shall contain an ultraviolet inhibitor. Should additional ultraviolet protection be required, a one mil minimum UV coating can be applied. All exposed surfaces shall be smooth and true to form.

Manufacturers to be subject to compliance with requirements, provide products by one of the following or equal:

- Strongwell Corporation.
- Fibergrate Composite Structures Inc.
- Or Equal approved by the City.

Stair Treads shall be shipped from the manufacturer, palletized and banded with exposed edges protected to prevent damage in shipment. Each piece shall be clearly marked showing manufacturer's applicable drawing number. The panels shall be 11 inches deep and sustain a deflection of no more than 0.25in. under a uniform distributed load of 100 psf for the span lengths shown on the plans. The bearing bars shall be joined into panels by passing continuous length fiberglass pultruded cross rods through the web of each bearing bar. A continuous fiberglass pultruded bar shaped section shall be wedged between the two cross rod spacers mechanically locking the notches in the cross rod spacers to the web of the bearing bars. Continuous chemical bonding shall be achieved between the cross rod spacers and the bearing web and between the bar shaped wedge and the two cross rod spacers locking the entire panel together to give a panel that resists twist and prevents internal movement of the bearing bars. Stair treads shall be capable of withstanding a uniform load of 100 psf or a concentrated load of 300 lb. on an area of 4 sq. inches located in the center of the tread, whichever produces greater stress. The top surface of all panels shall have a non-skid grit affixed to the surface by an epoxy resin followed by a top coat of epoxy resin. Hold down clamps shall be type 316L stainless steel saddle clips. Use 2 at each support with a minimum of 4 per panel. All bearing bars that are to be exposed to UV shall be coated with polyurethane coating of a minimum thickness of 1 mil.

The FRP stair treads shall be fabricated from bearing bars and cross rods manufactured by the pultrusion process. The glass fiber reinforcement for the bearing bars shall be a core of continuous glass strand rovings wrapped with continuous strand glass mat. A synthetic surface veil shall be the outermost layer covering the exterior surfaces. Fiberglass grating and stair treads shall be made from a chemical resistant, fire retardant polyester resin system with antimony trioxide added to meet the flame spread rating of 25 or less in accordance with ASTM E-84 testing and meet the self-extinguishing requirements of ASTM D-635. UV inhibitors are added to the resin. If required, all cut and machined edges, holes and abrasions shall be sealed with a resin compatible with the resin matrix used in the bearing bars and cross rods. All panels shall be fabricated to the sizes shown on the approved shop drawings.

Structural shapes and plate shall be made from isophthalic polyester resin with fire retardant additives to meet a flame spread rating of less than 25 per ASTM E-84 and meet the self-extinguishing requirements of ASTM D-635. All structural shapes shall contain a UV inhibitor ans manufactured by the pultrusion process. Structural FRP members' composition shall consist of a glass fiber reinforced polyester or vinyl ester resin matrix, approximately 50 percent glass by weight. A synthetic surface veil shall be the outermost layer covering the exterior surfaces. Glass strand rovings shall be used internally for longitudinal strength. Continuous strand glass mats or stitched reinforcements shall be used internally for transverse strength.

The FRP standard railing system shall be designed to meet the configuration and loading requirements of OSHA, IBCO, or any required local codes, with a minimum factor of safety on loading of 2.0. The rails and posts material shall be 1.90in.Ø o.d. x 1.51in.Ø i.d.tube manufactured by the pultrusion process. The pultruded parts shall be made with a fire retardant resin that meets the ASTM E-84 test for a flame spread rating of 25 or less. The resin matrix shall be polyester or and shall contain a UV inhibitor. The parts shall be coated with an industrial grade polyurethane coating for additional UV protection and wear resistance. The color shall be chosen by the city from manufacturer's standard colors. The fiberglass standard railing system shall be fabricated into finished sections by fabricating and joining together the pultruded square tube using molded or pultruded components; epoxy bonded and connected as shown in the fabrication details. Railing sections shall be fabricated to the size shown on the approved fabrication drawings and shall be piece marked with a water proof tag. For side mount post shall be constructed with a square pultruded bottom plug. Length shall be sufficient to extend a minimum of 1in. beyond the uppermost bolt hole to prevent crushing of post tubing. Bolt holes shall provide clearance of 1/16in. for 1/2in. diameter bolts/studs. On square tubes, holes shall be on longitudinal center line of post, 1in. from bottom of post (minimum) and not less than 3in. apart on center. Posts shall be fastened with stainless steel anchor bolts or studs, 1/2in. diameter extending no less than 2-1/4in. into the concrete, or into minimum thickness of 1/4in. structural steel or pultruded fiberglass. Post locations shall be no greater than 18in., nor less than 9in. from horizontal or vertical change in handrail direction. For square tubes, post centers shall be no greater than 72in. apart on any straight run or rail, or 48in. apart on any inclined rail section. Basemount, embedded and removable are also types of mounting procedures for railing pending design and approval by the Engineer. The fabricated railing sections shall be supplied complete with fittings by the FRP manufacturer. The components used to join fabricated sections together may be shipped loose, to be epoxied and riveted, if required, together, if required in the field by the contractor. The fabricated handrail sections shall be installed as shown on the approved shop drawings. The handrail sections shall be accurately located, erected plumb and level. The sections shall be fastened to the structure as shown on the approved shop drawings.

The FRP molded grating and treads shall be manufactured by the open mold process. Molded stairtreads shall be 1-1/2in. thick in a 1-1/2in. x 6in. rectangular mesh pattern. The resin system will be polyester, isophthalic or orthophthalic. The stairtread shall come complete with anti-slip nosing. Hold down clamps shall be type M clips for attaching grating to supports. If required, all cut and machined edges, holes and abrasions shall be sealed with a compatible resin. All panels shall be fabricated to the sizes shown on the approved shop drawing.

All field cut and drilled edges, holes and abrasions shall be sealed with a catalyzed resin compatible with the original resin as recommended by the manufacturer.

5.3.4.6 Fiberglass Reinforced Plastic Handrail and Guardrail

Design and fabricate assemblies to conform to current local, State, and OSHA standards requirements. Capable of withstanding concentrated vertical or horizontal load of 200 pounds at any point within 6-foot span. Maximum 5/8-inch deflection when subjected to 200-pound concentrated vertical load at mid-point of 5.0-foot span. Use of fiberglass handrails must be approved in each instance by the City.

Manufacturers are subject to compliance with requirements, provide products by one of the following or equal:

- Fibergrate Corp.
- Strongwell.
- Approved Equal by City.

Fiberglass reinforced plastic to be Pultruded premium flame retardant vinyl ester resins containing ultraviolet absorbers, resistant to corrosion by hydrochloric acid, ferric chloride, sodium hydroxide, sodium hypochlorite, and chlorinated water at temperatures up to 120 deg. F; safety yellow, unless directed otherwise by the Engineer. Materials shall meet Class I flame spread rating of ASTM E84 and self-extinguishing requirements of ASTM D635. Touch-up resin to be compatible with handrail resin matrix. Anchor bolts and brackets to be type 316 stainless steel. Fabricate handrail and guardrail in accordance with ASTM F1092. Seal machined edges and holes with touch up resin. Posts to be minimum 2 inch square by 1/4-inch wall tubes. Rails to be minimum 1-3/4 inch square by 1/8-inch wall tubes. Kick or toe plates to be corrugated 1/8 inch by 4 inch or 1/4 inch by 4 inches with stiffening ridges.

Guardrail to be 3 rail, nominal 42 inches high with middle rail nominal 29-1/2 inches above grade, and bottom rail 17 inches above grade. Inclined handrail height to be 34 inches from top of top rail to work line. Post spacing to be equally spaced for each section, but no greater than 5 foot center to center. For Side Mount Post they shall be constructed with a pultruded bottom plug. Length shall be sufficient to extend a minimum of 1 inch beyond the uppermost bolt hole to prevent crushing of post tubing. Bolt holes shall provide clearance of 0.0625 inches for 0.5 inch diameter bolts/studs. On square tubes, holes shall be on longitudinal center line of post, 1 inch from bottom of post (minimum) and not less than 3 inches apart on center. Posts shall be fastened with stainless steel anchor bolts or studs as required to meet structural performance criteria, but not less than 0.5 inch diameter extending no less than 2.25 inches into the concrete, or into minimum thickness of 0.25 inch structural steel or pultruded fiberglass. Post locations shall be no greater than 18 inches, nor less than 9 inches from horizontal or vertical change in handrail direction. For square tubes, post centers shall be no greater than 60 inches apart on any straight run or rail, or 48 inches apart on any inclined rail section.

5.3.4.7 Insulated Metal Wall Panel

Provide modular metal wall panel system meeting performance requirements as determined by comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated. Design modular metal wall panel system fabricated to withstand the effects of wind loads under conditions indicated below. Determine loads based on uniform pressure, building category, exposure category, and basic wind speed indicated on drawings. Allow for thermal movements from variations in both ambient and internal temperatures. Accommodate movement of support structure caused by thermal expansion and contraction. Wall systems that incorporate foam plastic insulation must be tested by the foam plastic supplier in accordance with NFPA 285. Air leakage of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) when tested according to ASTM E283 at the following test-pressure difference to be test-Pressure Difference: 1.57 lbf/sq. ft. (75 Pa). Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference: test-Pressure Difference to be 2.86 lbf/sq. ft. (137 Pa). Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss. Temperature Change (Range) to be 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces. Provide metal wall panels and system components with the following fire-test-response characteristics, as determined by testing identical panels and system components per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency. Provide materials and construction tested for fire resistance per ASTM E119. Intermediate-Scale Multistory Fire Test to be Tested mockup, representative of completed multistory wall assembly of which wall panel is a part, complies with NFPA 285 for test method and required fire-test-response characteristics of exterior non-load-bearing wall panel assemblies. No ignition when tested according to NFPA 268. Acceptable level when tested according to NFPA 259. Provide wall panels with a flame-spread index of 25 or less and a smoke-developed index of 450 or less, per ASTM E84

5.3.4.8 Thermoplastic Polyolefin Roofing

A qualified manufacturer that is UL listed, listed in FM Approvals' RoofNav for roofing system identical to that used for this Project. Installer Qualifications to be a qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty. Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period for 20 years from date of Substantial Completion. Special warranty includes roof membrane, base flashings, roof insulation, fasteners, cover boards, vapor retarder, substrate board, and other components of roofing system.

Installed roofing system and flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings shall remain watertight. Roof membrane shall withstand 2000 hours of exposure when tested according to

ASTM G152, ASTM G154, or ASTM G155. Roof membrane shall resist impact damage when tested according to ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470. Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience. Roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897 to be corner Uplift Pressure to be as established by ASCE/SEI 7. Perimeter Uplift Pressure to be as established by ASCE/SEI 7. Field-of-Roof Uplift Pressure to be as established by ASCE/SEI 7. Roof membrane, base flashings, and component materials shall comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and shall be listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings. Fire/Windstorm Classification to be Class 1A-90. Hail-Resistance Rating to be SH. Roofing system shall be listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products. Roofing system shall have an initial solar reflectance of not less than 0.70 and an emissivity of not less than 0.75 when tested according to CRRC-1. Exterior Fire-Test Exposure to be ASTM E108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency. Fire-Resistance Ratings to comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

TPO Roofing sheet to be ASTM D6878/D6878M, internally fabric- or scrim-reinforced, TPO sheet.

Manufacturers are subject to compliance with requirements, provide products by one of the following:

- Carlisle SynTec Incorporated.
- Firestone Building Products.
- Johns Manville; a Berkshire Hathaway company.

Obtain components for roofing system from roof membrane manufacturer or manufacturers approved by roof membrane manufacturer. Thickness to be 60 mils, nominal. Exposed Face Color to be White.

Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components. Substrate Board to be ASTM C1396/C1396M, Type X gypsum board. Thickness to be 5/8 inch (16 mm). Substrate Board to be ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M, fiber-reinforced gypsum board.

Manufacturers are subject to compliance with requirements, provide products by one of the following:

- CertainTeed Corporation.
- Georgia-Pacific Gypsum LLC.
- National Gypsum Company.

Thickness to be type X, 5/8 inch (16 mm) thick. Surface Finish to be Factory primed. Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck. Preformed roof insulation boards manufactured or approved by TPO roof membrane manufacturer, approved for use in FM Approvals' RoofNav-listed roof assemblies. Polyisocyanurate Board Insulation to be ASTM C1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces. Compressive Strength to be 20 psi (138 kPa). Roof Field to be 1/4 inch per foot (1 to be 48) minimum. Saddles and Crickets to be 1/2 inch per foot (1 to be 24) unless otherwise indicated on Drawings. Flexible Walkways to be Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer. Size to be approximately 36 by 60 inches install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning Work on adjoining roofing. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

5.3.4.9 FRP Doors and Frames

Company specializing in the manufacture of FRP doors and frames with a minimum of five years documented experience. Where labeled fire doors are required, Fiberglass Doors and frames shall be UL listed and shall be tested successfully to UL10B / UL10C, UBC 7-2 standards. Certify that FRP doors are manufactured via press-molding technology. Provide written limited guarantee for FRP doors and frames as follows for fire labeled doors to be guaranteed for 10 years against delamination due to corrosion from the specific chemical environment named at the time of purchase. Furthermore, all products are inspected prior to shipment and guaranteed against defective workmanship for a period of ten (10) calendar years after the date of purchase. Fiberglass frames and windows, welded corners and chemically bonded hinge reinforcements are guaranteed for the life of the product against failure due to corrosion from the specific chemical environment named at the time of purchase. Furthermore, all products are inspected prior to shipment and guaranteed against defective workmanship for a period of ten (10) calendar years after the date of purchase.

Manufacturers are subject to compliance with requirements, provide products by one of the following:

- Corrim Company.
- Metropolitan Door Industries.
- Tiger Door, LLC.

Fire rated FRP doors shall be of seamless press-molded construction. Laminated FRP face sheets shall be applied while wet and uncured to an internal door subframe/core assembly and then press-molded under heat and pressure. The composite door panel must be integrally fused over its entire surface area. Doors shall remain under pressure during curing for flat, warp-free surfaces. For maximum rigidity and compressive strength, a fire resistant mineral core shall be used. Molding pressure and resin gel time shall be sufficient to allow for penetration of resin into the cellular structure of the core to maximize shear and peel strengths at the skin/core interface and reduce the possibility of delamination. The mineral core is to be completely enclosed within the intumescent and FRP laminated edge perimeter. Only Category A type door construction is permitted. All intumescents shall be molded into the door structure with a minimum of 1/8-in. thick perimeter FRP edge banding (prior to machining). Category B type door construction, with post applied and/or exposed edge intumescent components or products are not acceptable. Door facings shall utilize a chemical resistant proprietary class I flame spread thermosetting polyester resin formulation with glass fiber reinforcing layers. Chopped strand mat layers shall be used to provide bond integrity between gelcoat, laminated facings and the internal door structure. Structural reinforcement shall be in the form of a knitted multi-layer material with layers of uni-directional glass fiber oriented in both the vertical and horizontal directions for high stiffness, impact resistance and resistance to warping. The exposed FRP door faces must have either an integrally molded 25/30 mils thick (wet) ultraviolet light stabilized marine grade NPG-isophthalic polyester gelcoat or a industrial urethane chemical coating color topcoat. Gelcoated facings shall have a slightly textured semi-gloss finish to minimize the visual effects of wear and tear. Door face color shall be selected from the manufacturer's available colors. Gelcoat shall not be sprayed onto the door face as a secondary coating. Provide a heavy pultruded FRP angle astragal on the meeting stile edge of each inactive leaf of double door pairs. Provision for door lights shall be performed during manufacture and shall not be attempted in the field. Cutouts are to be totally enclosed by internal high density fire resistant mineral core composite blocks incorporated into door subframe prior to press-molding and machining, the opening is completely fused to both door skins. Vision frames shall be a commercially available UL fire rated kit. Maximum glass size shall not exceed 1296 in2 for up to a 90 minute application. Louvers to be Provision for door louvers shall be performed during manufacture and shall not be attempted in the field. Cutouts are to be totally enclosed by internal high density fire resistant mineral core composite blocks incorporated into door subframe prior to press-molding and machining, the opening is completely fused to both door skins. Door louvers shall be a commercially available UL fire rated kit. Maximum louver size shall not exceed 24 in. x 24 in. for up to a 90 minute application. The maximum double door jamb opening size shall not exceed nominal 8 ft – 0 in. x 8 ft – 0 in.

Heavy Duty non-fire rated FRP Doors. FRP doors shall be of seamless press-molded construction. Laminated FRP face sheets shall be applied while wet and uncured to an internal door stile and rail subframe/core assembly and then press-molded under heat and pressure. The composite door panel must be integrally fused over its entire surface area, not just adhesive-bonded at perimeter stiles and rails. Doors shall remain under pressure during curing for flat, warpfree surfaces. A high-modulus pultruded FRP square or rectangular tube subframe is to be provided within the door. Tubes are to be mitered and joined internally at the corners with solid polymer blocks to yield a one-piece unit that does not require any secondary external sealing. Provide a tubular midrail across width of door at lock height, and additional horizontal rails where specific design conditions dictate. Doors shall incorporate molded in FRP edge strips, chemically bonded to the subframe stiles, for machining of hardware mortises so as not to cut or otherwise compromise the integrity of the pultruded stiles, nor allow moisture to penetrate into the core of the door. All connections shall be chemically welded. No mechanical fasteners will be allowed. The use or inclusion of aluminum, steel, gypsum or wood into stile and rail construction is not permitted. For maximum rigidity and compressive strength either a triangular shaped 3/8in. cell phenolic resin impregnated kraft paper honeycomb or a plastic honeycomb with face scrim core shall be used. Molding pressure and resin gel time shall be sufficient to allow for penetration of resin into the cellular structure of the core to maximize shear and peel strengths at the skin/core interface and eliminate the possibility of delamination. The honeycomb is to be completely enclosed within the stile and rail subframe. Use of foam or balsa wood is not permitted. High-modulous pultruded tubular FRP, high-density polymer compression blocks, or plastic compression blocking at all hardware locations, and corner locations. No wood blocking, steel or aluminum reinforcing plates, ribs or fittings shall be used. A minimum of 900 lb of pullout strength is required for each factory supplied hinge screw. Door facings shall utilize a chemical resistant thermosetting polyester resin system with fiber reinforcing layers. Supplier shall furnish door faces as shown on the drawings and in the door elevations. Chopped strand mat layers shall be used to provide bond integrity between gelcoat, laminated facings and the internal door structure. Structural reinforcement shall be in the form of a knitted multi-layer material with layers of uni-directional glass fiber oriented in both the vertical and horizontal directions for high stiffness, impact resistance and resistance to warping. The exposed FRP door faces must have an integrally molded 25/30 mils thick (wet) UV light stabilized marine grade NPG-isophthalic polyester gelcoat or an industrial urethane chemical coating color topcoat. Facings shall have a slightly textured semi-gloss finish to minimize the visual effects of wear and tear. Door face color shall be selected from the manufacturer's available colors. Gelcoat may not be sprayed onto the door face as a secondary coating. All pairs of doors shall be furnished with an astragal from door manufacturer made of same pultruded FRP material as door stile, rail and edge as required. Astragal shall be located on the meeting stile edge of each inactive leaf of double door pairs. Architect shall advise active leaf of door, and astragal shall be installed to cover meeting stile gap to effect seal and security. Glass per job specification shall be factory furnished, glazed and installed. Standard glass thickness is 1/4-in. Centered glazing shall be installed between 45 degree pultruded FRP glazing stops and vinyl foam tape with concealed compression retainers for 1/4-in. glazing. No exposed fasteners or exposed silicone will be allowed for securing 1/4-in. glazing. Stainless steel screws may be allowed for other glazing thicknesses. Offset glazing shall be installed against a molded-in 5/8-in. wide exterior face flange with a bed of tape caulk, square 5/8-in. pultruded glazing stops with stainless steel screws shall complete the installation to secure the glazing in place and cover all unsightly caulking. Double flush 1/4-in. glazing shall be installed with vinyl foam tape and silicone sealant at all edges to complete flush appearance. All glazing stop material shall be pultruded FRP with a minimum fiberglass content of 50 percent. Metal, pvc, or vinyl "Glass Kit" type lights are not acceptable for non-fire rated openings. Fiberglass inverted V blade privacy or flat blade lovers shall be factory furnished and installed. All louvers and louver trim shall be manufactured exclusively from pultruded FRP profiles with a minimum fiberglass content of 50 percent. All louvers shall be coated to match door in color and sheen. Inverted V blade minimum thickness shall be 3/32-in. thick, flat blade louver minimum thickness shall be 3/16-in. thick. Metal, PVC, vinyl or other non-fiberglass louvers are not acceptable for non-fire rated openings. All doors shown in elevation to have raised panels or plants shall be equipped with plants in configuration as shown on plans and in door schedule. Plants shall be applied by the door manufacturer as an integral part of the door face. Plants shall be bonded to the door skin; no mechanical fasters shall be permitted. All applied moldings shall be of resin material and shall be installed by the manufacturer to resemble a raised panel door.

Field applied plants or moldings shall not be acceptable. Provisions for lights and louvers shall be performed during manufacture and shall not be attempted in the field. Cutouts are to be totally enclosed by pultruded FRP stiles and rails incorporated into the door structure. Light and louver cutouts that expose core material are not acceptable.

Heavy duty non-fire rated FRP Doors. FRP doors shall be of seamless press-molded construction. Laminated FRP face sheets shall be applied while wet and uncured to an internal door stile and rail subframe/core assembly and then press-molded under heat and pressure. The composite door panel must be integrally fused over its entire surface area, not just adhesive-bonded at perimeter stiles and rails. Doors shall remain under pressure during curing for flat, warp-free surfaces. A high-modulus pultruded FRP square or rectangular tube subframe is to be provided within the door. Tubes are to be mitered and joined internally at the corners with solid polymer blocks to yield a one-piece unit that does not require any secondary external sealing. Provide a tubular midrail across width of door at lock height, and additional horizontal rails where specific design conditions dictate. Doors shall incorporate molded in FRP edge strips, chemically bonded to the subframe stiles, for machining of hardware mortises so as not to cut or otherwise compromise the integrity of the pultruded stiles, nor allow moisture to penetrate into the core of the door. All connections shall be chemically welded. No mechanical fasteners will be allowed. The use or inclusion of aluminum, steel, gypsum or wood into stile and rail construction is not permitted. For maximum rigidity and compressive strength either a triangular shaped 3/8-in. cell phenolic resin impregnated kraft paper honeycomb or a plastic honeycomb with face scrim core shall be used. Molding pressure and resin gel time shall be sufficient to allow for penetration of resin into the cellular structure of the core to maximize shear and peel strengths at the skin/core interface and eliminate the possibility of delamination. The honeycomb is to be completely enclosed within the stile and rail subframe. Use of foam or balsa wood is not permitted. High-modulous pultruded tubular FRP, high-density polymer compression blocks, or plastic compression blocking at all hardware locations, and corner locations. No wood blocking, steel or aluminum reinforcing plates, ribs or fittings shall be used. A minimum of 900 lb of pullout strength is required for each factory supplied hinge screw. Door facings shall utilize a chemical resistant thermosetting polyester resin system with fiber reinforcing layers. Supplier shall furnish door faces as shown on the drawings and in the door elevations. Chopped strand mat layers shall be used to provide bond integrity between gelcoat, laminated facings and the internal door structure. Structural reinforcement shall be in the form of a knitted multi-layer material with layers of uni-directional glass fiber oriented in both the vertical and horizontal directions for high stiffness, impact resistance and resistance to warping. The exposed FRP door faces must have an integrally molded 25/30 mils thick (wet) UV light stabilized marine grade NPG-isophthalic polyester gelcoat or an industrial urethane chemical coating color topcoat. Facings shall have a slightly textured semi-gloss finish to minimize the visual effects of wear and tear. Door face color shall be selected from the manufacturer's available colors. Gelcoat may not be sprayed onto the door face as a secondary coating. All pairs of doors shall be furnished with an astragal from door manufacturer made of same pultruded FRP material as door stile, rail and edge as required. Astragal shall be located on the meeting stile edge of each inactive leaf of double door pairs. Architect shall advise active leaf of door, and astragal shall be installed to cover meeting stile gap to effect seal and security. Glass per job specification shall be factory furnished, glazed and installed. Standard glass thickness is 1/4in. Centered glazing shall be installed between 45 degree pultruded FRP glazing stops and vinyl foam tape with concealed compression retainers for 1/4-in. glazing. No exposed fasteners or exposed silicone will be allowed for securing 1/4-in. glazing. Stainless steel screws may be allowed for other glazing thicknesses. Offset glazing shall be installed against a molded-in 5/8-in. wide exterior face flange with a bed of tape caulk, square 5/8-in. pultruded glazing stops with stainless steel screws shall complete the installation to secure the glazing in place and cover all unsightly caulking. Double flush 1/4-in. glazing shall be installed with vinyl foam tape and silicone sealant at all edges to complete flush appearance. All glazing stop material shall be pultruded FRP with a minimum fiberglass content of 50 percent. Metal, PVC, or vinyl "Glass Kit" type lights are not acceptable for non-fire rated openings. Fiberglass inverted V blade privacy or flat blade lovers shall be factory furnished and installed. All louvers and louver trim shall be manufactured exclusively from pultruded FRP profiles with a minimum fiberglass content of 50 percent. All louvers shall be coated to match door in color and sheen. Inverted V blade minimum thickness shall be 3/32-in. thick, flat blade louver minimum thickness shall be 3/16-in. thick. Adhesives for louver assembly shall meet or exceed all requirements set forth in section 2.05.1 Mechanical Properties and test performance. Metal, PVC, vinyl or other non-fiberglass louvers are not acceptable for non-fire rated openings. All doors shown in elevation to have raised panels or plants shall be equipped with plants in configuration as shown on plans and in door schedule. Plants shall be applied by the door manufacturer as an integral part of the door face. Plants shall be bonded to the door skin; no mechanical fasters shall be permitted. All applied moldings shall be of resin material and shall be installed by the manufacturer to resemble a raised panel door. Field applied plants or moldings shall not be acceptable. Provisions for lights and louvers shall be performed during manufacture and shall not be attempted in the field. Cutouts are to be totally enclosed by pultruded FRP stiles and rails incorporated into the door structure. Light and louver cutouts that expose core material are not acceptable.

Fire rated FRP Door frames furnished under this specification shall utilize a high-modulus pultruded structural FRP shape. Standard frame profile is a double rabbeted 5 3/4 in. depth x 2 in. face, 3/16 in. thick, with integral 5/8in. doorstop. The minimum frame section shall be limited to a 4-in. jamb depth, 1-in. face. Four inch header and expanded profiles are acceptable. Frame cavities shall be filled with a proprietary fire resistant composite formulation with a minimum density of 25 lb/ft^3. Hollow metal or Stainless Steel frames are not acceptable. All intumescent material shall be internal to the door structure. Post applied or exposed intumescent components or products are not acceptable jambs and header shall be joined at corners via miter connections with hidden stainless steel flat head screws. Corner screws shall not be visible on interior or exterior frame faces. Provide 3/8 in. diameter x 5 in. expanding sleeve type for masonry walls per jamb side at bolt in anchors. Frames shall have a factory applied industrial urethane chemical coating color topcoat, to match the color and sheen of the doors, for superior weatherability. Gelcoat may be sprayed onto the frame as a secondary coating if required.

Non-fire rated FRP Frames furnished under this specification shall utilize a high-modulus pultruded structural FRP shape. The frame section shall be standard double rabbeted 5-3/4 in. deep x 2 in. face, 3/16-in. thick, with integral 5/8-in. doorstop with 1 15/16 in. soffits, to match typical hollow metal configurations. Corner Joints to be KD jambs and header shall be joined at corners via miter connections. Post and beam corners will not be acceptable. Exposed fasteners for miter connections will not be acceptable except for wrap wall applications. One piece frames shall be factory joined at corners via miter connections then chemically welded with FRP material and ground visibly smooth at frame face. Mechanical joints will not be accepted in lieu of welded frames if specified. Hardware Reinforcements to be FRP reinforcing shall be chemically welded to door frame material at required locations. Minimum screw pullout strength of 1100 lb per #12 x 1-in. sheet metal screw is required. Mechanically fastened reinforcements are not permitted. Provide manufacturer's required number of 3/8 in. diameter x 4 in. long flat head stainless steel sleeve anchors for masonry openings, 3/8 in. diameter x 4 in. machine screw with nut and washers for structural steel openings, #14 x 4 in. stainless steel flat head sheet metal screws for wood or steel stud openings. Include extra anchors for additional frame height in two foot increments above 8 ft-0 in. Provide single bolt anchor at center of all headers over four feet in nominal width. Stainless Steel bolts shall be furnished by the factory. Frames shall have a factory applied industrial urethane chemical coating color topcoat, to match the color and sheen of the doors, for superior weatherability. Gelcoat may not be sprayed onto the frame as a secondary coating. Electrical Components, Devices, and Accessories to be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

Pultruded structural shapes for stiles; rails, frames, and astragals shall exhibit the following minimum longitudinal coupon properties (per ASTM):

- Tensile strength (D638) 30,000 psi.
- Comprehensive strength (D695) 30,000 psi.
- Flexural strength (D790) 30,000 psi.
- Flexural modulus (D790) 1,600,000 psi.
- Shear strength (D2846) 4,500 psi.
- Impact, notched (D256) 25 ft-lb/in.
- Barcol hardness (D2853) 50.
- Fire Resistance (E-84) Class I.

Core material shall exhibit the following minimum coupon properties (per ASTM):

- Core material must comply with the International Building Code (IBC) chapter 26 requirements for use with a plastic skin.
  - Shear strength, longitudinal direction (C273) 68.2 psi.
  - Shear strength, transverse direction (C273) 25.8 psi.
  - Shear modulus, longitudinal direction (C273) 6940 psi.
  - Shear modulus, transverse direction (C273) 1878 psi.
  - Shear elongation, longitudinal direction (C393 short beam) 1.79 percent.
  - Shear elongation, transverse direction (C393 short beam) 2.72 percent.
  - Maximum facing stress, longitudinal direction (C393 short beam) 735 psi.
  - Maximum facing stress, transverse direction (C393 short beam) 289 psi.
  - Maximum core shear stress, longitudinal direction (C393 short beam) 63.8 psi.
  - Maximum core shear stress, transverse direction (C393 short beam) 24.9 psi.
  - Modulus of elasticity (EI) per 1-in. width, longitudinal direction (C393 short beam) 4.92E+04 psi.
  - Modulus of elasticity (EI) per 1-in. width, transverse direction (C393 short beam) 1.97E+04 psi.
  - Maximum facing stress, longitudinal direction (C393 long beam) 9011 psi.
  - Maximum facing stress, transverse direction (C393 long beam) 4727 psi.
  - Maximum core shear stress, longitudinal direction (C393 long beam) 48.3 psi.
  - Maximum core shear stress, transverse direction (C393 long beam) 23.5psi.

- Modulus of elasticity (EI) per 1in. width, longitudinal direction (C393 long beam) 1.14E+05 psi.
- Modulus of elasticity (EI) per 1in. width, transverse direction (C393 long beam) 7.23E+05 psi.
- Stiffness "D", longitudinal direction (C393 long beam) 379,270 psi.
- Stiffness "D", longitudinal direction (C393 long beam) 260,608 psi.
- Compressive strength (C365) 53 psi.
- Compressive modulus (C365) 2110 psi.
- Density (C271) 2.42 lb/ft^3.

Adhesive shall exhibit the following minimum coupon properties (per SAE):

- Tensile Strength (D882-83A modified) minimum 2000 psi.
- 8 day 25º C at 100 percent humidity Cross Peel (SAE J1553) minimum 330 psi.
- 7 day immersion in seawater Cross Peel (SAE J1553) minimum 330 psi.
- 30 day immersion in saltwater Cross Peel (SAE J1553) minimum 330 psi.
- 72 hour immersion in gasoline Cross Peel (SAE J1553) minimum 330 psi.
- 72 hour immersion in 20 percent sulfuric acid Cross Peel (SAE J1553) minimum 300 psi.

ANSI A250.4 1,000,000 cycle test 1. 4 ft x 8 ft door (up to a full light) and frame successfully tested in excess of 1,000,000 cycles with no failure of any of the design features of the door or frame. All fasteners for all hardware shall be type 304 CRSS (18-8 series corrosion resistant stainless steel). No carbon steel or aluminum components shall be used. Doors shall be factory mortised and drilled for mortise template butt hinges, with #12x2 in. long stainless steel screws pre-installed for hinge attachment. Provide and Install hardware as listed in other section(s). If manufacturer's standard screws do not comply, supplier shall furnish suggested screw size and type in 301 CRSS (18-8 SS).

Frames shall be factory machined and drilled for all hardware requiring mortises, with #12x1 in. long stainless steel screws pre-installed for hinge attachment. Hardware shall be furnished as listed in this document or as so designated in appropriate section and shall be coordinated by GC and installed by experienced mechanics. Supplier shall furnish manufacturer's standard templates, installation instructions, or full size approved door and frame preparation instructions as approved by the architect and as required by door and frame manufacturer prior to door and frame factory initiated manufacture. Standard factory lead-time for production of FRP doors and frames shall commence only and when all distributor.

5.3.4.10 Overhead Coiling Doors

Doors and equipment items provided shall be compatible with space limitations. Make modifications to doors and equipment items necessary to conform with space limitations or with utility services specified for rough-in. Provide items complete including all necessary ancillary equipment as may be required for complete and trouble-free operation. Door components and operators capable of operating for not less than 100,000. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position. Include tamperproof cycle counter. Air Infiltration to be Maximum rate of 1.0 cfm/sq. ft. (5.1 L/s per sq. m) at 15 and 25 mph (24.1 and 40.2 km/h) when tested according to ASTM E 283 or DASMA 105. STC Rating to be 21 minimum. Curtain R-Value to be 7.5 minimum. Door Curtain Material to be Aluminum. Door Curtain Slats to be Flat profile slats. For ease of maintenance, provide overhead coiling doors complying with following requirements: Provide each door assembly as complete unit produced or supplied by a single manufacturer, including frames, sections, brackets, operating mechanisms, hardware, except hardware items specified in this document, and all necessary accessories for installation of complete in openings indicated. Unless otherwise specified, all doors of particular type throughout the entire project shall be as manufactured or supplied by a single manufacturer.

Manufacturers are subject to compliance with requirements, provide products from one of the following or equal:

- Cornell Iron Works, Inc.
- Overhead Door Corp.
- Wayne-Dalton Corp.
- The Cookson Co., Inc.

Door mounting to be to face of wall. Motor operator with emergency manual operation. Exterior Slats to be ASTM B 209 sheet or ASTM B 221 extrusions, alloy and temper standard with manufacturer for type of use and finish indicated; minimum thickness of 0.040 inch; and as required; interlocking flat-faced slats with ends of alternate slats fitted with metal end locks to hold curtain in alignment. Manufacturer's standard continuous gasket between slats. Bottom bar to be fitted with 2 equal-sized aluminum angles, not less than 1-1/2 by 1-1/2 inch, minimum 1/8-inch thick, with lift handle and slide bolt at either end. Manufacturer's standard to provide a flexible PVC bulb type astragal to ensure a consistent seal along the floor. Extrusion designed to interlock with door curtain. Manufacturer's standard, wool or nylon pile, vinyl extrusion seals. Manufacturer's standard neoprene baffle. Steel galvanized in accordance with ASTM A123, formed of roll formed steel channels and angles or structural angles of sufficient depth to provide a groove of adequate depth on each jamb to hold curtain firmly in guides under design wind pressure. Steel galvanized in accordance with ASTM A123, steel plate with permanently sealed ball bearings designed to enclose ends of coil and provide support for counterbalance pipe at each end. Barrel and counterbalance mechanism to be Steel pipe of sufficient size to carry door load with maximum deflection of 0.03 inch per foot of opening width and counterbalanced by helical springs, oil tempered torsion type designed with minimum safety factor of 1.25, and having cast iron barrel plugs that anchor springs to tension shaft and pipe.

Hood to be fabricated minimum 0.050-inch thick aluminum, designed to enclose curtain coil and counterbalance mechanism. Interior slats insulation to be material to match exterior slats as specified in previous article, interlocking flat-faced slats, manufacturer's standard size with ends of alternate slats fitted with metal end locks to hold curtain in alignment. Minimum aluminum thickness 0.032 inch. Insulation to be CFC-free Polyurethane foam yielding a minimum R-value of 7.5. Maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84 or UL 723. Enclose insulation completely within slat faces. Chain operator to provide a continuous hand chain and gearing on coil side of door for emergency manual operation. Provide a heavy-duty type motor operator. High starting torque type motor having sufficient power to operate the load at an average speed of 1 foot per second. Totally enclosed, fan cooled, continuous-duty motor, sized to suit door size (1 horsepower minimum), with Class B insulation. Controlled by momentary contact 3-button station marked OPEN, CLOSE, and STOP. Provide automatic screw-type limit switch to break circuit at termination of travel. Provide gear reducer consisting of high efficiency worm gearing running in an oil bath and a spring set, solenoid-operated brake designed to hold the load when power is off. Provide emergency hand chain operator which does not affect the time of the limit switch, to operate the load in case of power failure. Operator to have reversing NEMA Size 1 starter having mechanical and electrical interlocks, properly sized 24-volt control transformer, and other controls necessary for proper operation, completely assembled and wired to a terminal strip to facilitate field wiring of the power source, pushbutton stations, and/or other remote devices. Unless otherwise indicated on the Drawings, all electrical material supplied shall be in NEMA Type 12 enclosures for interior locations and in NEMA Type 4X enclosure or NEMA Type 4 enclosures for exterior or wet locations. Provide electronic safety edge to reverse direction of door if obstruction is encountered. Where no safety edge is specified, 2-button constant pressure type pushbutton stations marked OPEN and CLOSE shall be provided in lieu of 3-button station previously indicated.

5.3.4.11 Door Hardware

Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Design-Builder and Owner about door hardware and keying. Key all new doors per City's standards. Obtain each type of door hardware from a single manufacturer. Means of Egress Doors latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation. Accessibility Requirements for door hardware on doors in an accessible route, comply with ICC/ANSI A117.1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22.2 N). Comply with the following maximum opening-force requirements for interior Non-Fire-Rated Hinged Doors to have 5 lbf (22.2 N) applied perpendicular to door. Fire Doors to have a minimum opening force allowable by authorities having jurisdiction. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door. Fasteners to concrete, marble, or masonry to be Machine screws and flush shells. On gypsum board or plaster screws of sufficient length to provide solid connection to framing or backing behind gypsum board or plaster. To mineral and hollow core doors provide Hex bolts. Exit devices to doors are to be Thru-bolts, unless otherwise specified. Screws to be exposed to be Phillips-head type, full-threaded screws, not combination type. Sizes to be suitable for heavy use. Finish in Stainless steel, unless otherwise required to match material and hardware finish.

Hinges to be Stainless Steel BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

- Hager Companies.
- IVES Hardware; an Ingersoll-Rand company.
- McKinney Products Company; an ASSA ABLOY Group company.
- Stanley Commercial Hardware; Div. of The Stanley Works.

Continuous Hinges to be BHMA A156.26; minimum 0.120-inch- (3.0-mm-) thick, hinge leaves with minimum overall width of 4 inches (102 mm); fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete. Continuous, Gear-Type Hinges to be Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.

Basis-of-Design Product subject to compliance with requirements or comparable product by one of the following:

- Hager Companies.
- IVES Hardware; an Ingersoll-Rand company.
- McKinney Products Company; an ASSA ABLOY Group company.
- Stanley Commercial Hardware; Div. of The Stanley Works.

Lock Throws to comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

- Mortise Locks: Minimum 3/4-inch latchbolt throw.
- Lock Backset: 2-3/4 inches, unless otherwise indicated.
- Lock Trim:
  - Levers: Cast.
  - Schlage L06.
  - Escutcheons (Roses): Forged.
  - Schlage L Full Face.
  - Operating Device: Lever with escutcheons.

Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch. Flat-Lip Strikes for locks with three-piece antifriction latchbolts, as recommended by manufacturer. Mortise Locks to be BHMA A156.13; Security Grade 1; having only stainless steel or brass parts; Series 1000. Basis-of-Design Product subject to compliance with requirements, provide product by:

- Schlage Commercial Lock Division; an Ingersoll-Rand company.

Materials for latchbolts, strikes, and trim to be stainless steel. Lock Cylinders to be tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Manufacturer to be same manufacturer as for locking devices. High-Security Lock Cylinders to be BHMA A156.30; Grade 1; Type M, mechanical; permanent cores that are removable; face finished to match lockset. Construction Cores to be provide construction cores that are replaceable by permanent cores.

Surface Closers to be BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

Basis-of-Design Product subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

- LCN Closers; an Ingersoll-Rand company.
- SARGENT Manufacturing Company; an ASSA ABLOY Group company.
- Exit Devices and Auxiliary Items: BHMA A156.3.

Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

- Precision Hardware, Inc.; Division of Stanley Security Solutions, Inc.
- SARGENT Manufacturing Company; an ASSA ABLOY Group company.
- Von Duprin; an Ingersoll-Rand company.

Corrosive environment provisions to b zinc dichromate coated internal parts.

Wall- and Floor-Mounted Stops to be BHMA A156.16; polished cast brass, bronze, or aluminum base metal.

Basis-of-Design Product are subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

- IVES Hardware; an Ingersoll-Rand company.
- Rockwood Manufacturing Company.
- Stanley Commercial Hardware; Div. of The Stanley Works.

Door Gasketing to be BHMA A156.22; air leakage not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

Basis-of-Design Product are subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

- Hager Companies.
- National Guard Products.
- Pemko Manufacturing Co.; an ASSA ABLOY Group company.
- Sealeze; a unit of Jason Incorporated.

Thresholds to be BHMA A156.21; fabricated to full width of opening indicated.

Basis-of-Design Products are subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

- Hager Companies.
- National Guard Products.
- Pemko Manufacturing Co.; an ASSA ABLOY Group company.
- Sealeze; a unit of Jason Incorporated.

5.3.4.12 Metal Protective Trim Units

Metal Protective Trim Units to be BHMA A156.6; fabricated from 0.050-inch- (1.3-mm-) thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.

Basis-of-Design Product are subject to compliance with requirements, provide product indicated on schedule or comparable product by one of the following:

- IVES Hardware; an Ingersoll-Rand company.
- Rockwood Manufacturing Company.
- Trimco.

Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect. Manufacturer's identification is permitted on rim of lock cylinders only. Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated. For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt. Spacers or Sex Bolts are for use at through bolting of hollow-metal doors. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

Keying System to be Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock. Set up with owner keying conference and Incorporate decisions made in keying conference. Master key or grand master key locks to Owner's existing system. Coordinate with owner. Keys to be Nickel silver. Permanently inscribe each key with a visual key control number and include notation to be furnished by Owner.

Steel Doors and Frames for surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6. Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations in Standard Doors and Frames to be ANSI/SDI A250.8.

Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing. Do not install surface-mounted items until finishes have been completed on substrates involved. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards. Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided. Install construction cores to secure building and areas during construction period. Replace construction cores with permanent cores as directed by Owner. Furnish permanent cores to Owner for installation. Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule. Set thresholds for exterior doors and other doors indicated in full bed of sealant. Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic. Apply to head and jamb, forming seal between door and frame. Apply to bottom of door, forming seal with threshold when door is closed.

5.3.4.13 Translucent Skylight System

Structural aluminum box beam superstructure with permanent lifting eye-hooks. Factory prefabricated structural insulated translucent sandwich panels. Aluminum installation system with exterior accessible anchor bolts. Absolute Clear Opening Size to be sized for equipment to be removed. Aluminum Box Beam Size as required for specified loads and dimensions. Roof Pitch minimum to manufactures requirements. Lifting eye-hooks shall be incorporated as required. Anchor bolts shall be accessed from the outside by removing the perimeter flashing.

The manufacturer shall be responsible for the configuration and fabrication of the complete skylight panel system. Design loads for wind, snow, seismic, and dead load in accordance with the building code. Fall protection to comply with OSHA 1910.23(e)(8) without the use of skylight screen. Skylight system manufacturer shall be listed by a recognized building code authority, including the International Conference of Building Officials which requires quality control inspections by an approved agency for sandwich panel construction. Panel system must be listed by an ANSI accredited Evaluation Service, which requires quality control inspections and fire, structural and water infiltration testing of sandwich panel systems by an accredited agency. Submit ICBO report indicating UL Class "A" rating. Quality control inspections and testing conducted at least once each year shall include manufacturing facilities, sandwich panel components, and production sandwich panels for conformance with AC177 "Translucent FRP Faced Panel Wall, Roof and Skylight Systems" as issued by the ICC-ES. Materials and products shall be manufactured by a company continuously and regularly engaged in the manufacture of specified materials for a period of not less than 10 consecutive years; and can show evidence of these materials being satisfactorily used on at least 6 projects of similar size, scope, and type within such a period. At least 3 of the projects shall have been in successful use for 10 years or longer. Installer shall have been in the business of erecting specified materials for at least 5 consecutive years and can show evidence of satisfactory completion of projects of similar size, scope, and type.

Subject to compliance with requirements, provide products from one of the following or equal:

- Kalwall.
- Structures Unlimited.

Translucent fiberglass faces shall be manufactured from glass fiber reinforced thermoset resins by insulated skylight system fabricator specially for architectural use. The interior face sheet shall be UL listed and have a flame spread of Class I in accordance with ASTM E84. Flame spread rating no greater than 20 and smoke developed no greater than 200 when tested in accordance with UL 723. Burn extent by ASTM D 635 shall be no greater than 1 inch. Faces shall not deform, deflect, or drip when subjected to fire or flame, or become detached when subjected to 300 deg. F for 1 hour. The full thickness of the exterior face shall not change color more than 3.0 Hunter or CIE Units (DELTA E by ASTM D2244) after 5 years outdoor South Florida weathering at 7 degrees facing south, determined by the average of at least 3 white samples without a protective film or coating to insure maximum, long term color stability. The exterior face shall have a permanent glass veil erosion barrier to provide maximum long-term resistance to reinforcing fiber exposure and shall be warranted against same for 25 years. Plastic film overlays are not acceptable. The face sheets shall be uniform in color to prevent splotchy appearance. Faces shall be completely free of ridges and wrinkles which prevent proper surface contact in bonding to the aluminum grid core. Clusters of air bubbles/pinholes which collect moisture and dirt are not acceptable. Exterior face sheets shall be smooth 0.070-inch thick and white in color. Interior face sheets shall be 0.045-inch thick and white in color. Faces shall not vary more than plus/minus 10 percent in thickness. The exterior face sheet shall be uniform in strength, impenetrable by hand held pencil and repel an impact minimum of 70 ft lb without fracture or tear when impacted by a 3-1/4-inch diameter, 5 lb. free-falling ball per UL 972. Thermally broken 6063-T6 or 6005-T5 aluminum I-beams with mechanical interlocking muntin-mullions and perimeter framing to prevent high and low intersections which do not allow full bonding surface to contact with face material. I-beam Thermal break to be minimum 1 inch, thermoset fiberglass composite. Pour and debridge is not acceptable. Width of I-beam shall be no less than 7/16 inch. Aluminum I-beam grid shall be machined to tolerances of not greater than plus/minus .002 inch. Panels shall withstand 1,200 deg. F fire for minimum 1 hour without collapse or exterior flaming. Laminate Adhesive to be heat and pressure resin type adhesive engineered for structural sandwich panel use, with minimum 25-years field use. Adhesive shall pass testing requirements specified by the International Code Council "Acceptance Criteria for Sandwich Panel Adhesives". Minimum tensile strength of 750 psi when the panel assembly is tested by ASTM C 297 after two exposures to six cycles each of the aging conditions prescribed by ASTM D 1037. Minimum shear strength of the panel adhesive by ASTM D 1002 after exposure to four separate conditions: 50 percent Relative Humidity at 68 deg. F to be 540 psi, 182 deg. F to be 100 psi, Accelerated Aging by ASTM D 1037 at room temperature to be 800 psi, Accelerated Aging by ASTM D 1037 at 182 degree Fahrenheit to be 250 psi. Full cycle soak at 715 psi, 500-hour oxygen bomb to be 1,400 psi.

Translucent panel fabrication to be the following. Panel thickness to be 4 inches. Panel U-factor by NFRC certified laboratory to be 0.08, thermally broken. Light transmission to be 5 percent. Solar heat gain coefficient to be 0.04. Skylight panels shall be a true sandwich panel of flat fiberglass sheets bonded to a thermally broken grid core of mechanically interlocking aluminum I-beams and shall be laminated under a controlled process of heat and pressure. Panel core grid to be grid pattern shall be nominal 12 inch by 24 inch and symmetrical about the horizontal centerline of each panel, for flat panel. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat, sharp edge. In order to ensure bonding strength, white spots at intersections of muntins and mullions shall not exceed 4 for each 40 square feet of panel, nor shall they be more than 3/64 inch in width. Standard panels shall deflect no more than 1.0 inch at 30 psf in 10 feet 0 inch span without a supporting frame by ASTM E 72. Standard panels shall withstand 1200 deg. F fire for minimum one hour without collapse or exterior flaming. Minimum Condensation Resistance Factor of 85 by AAMA 1503 measured on the bond line. Removable Skylight System shall pass Class A Roof Burning Brand Test by ASTM E 108. Roof system shall be UL listed as a Class A Roof by UL 790, which requires periodic unannounced factory inspections and retesting by UL. Removable skylight system shall meet the fall through requirements of OSHA 1910.23 as demonstrated by testing in accordance with ASTM E 661, thereby not requiring supplemental screens or railings. Skylight panels and aluminum perimeter frame shall be pre-assembled where practical and sealed at the factory. Panels should be shipped to the job site in rugged shipping units and shall be ready for erection.

Closure system to be thermally broken extruded aluminum 6063-T6 and 6063-T5 alloy and temper clamp-tite screw type closure system. Sealing tape to be manufacturer's standard, pre-applied to closure system at the factory under controlled conditions. Fasteners to be 300 series stainless steel screws for aluminum closures, excluding final fasteners to the building. Finish to be manufacturer's factory applied 70 percent PVDF finish, which meets, at a minimum, the performance requirements of AAMA 2604. Color to be selected from manufacturer's standards. The superstructure shall be pre-fabricated of extruded aluminum alloy 6005-T5, 6005A-T61 or 6061-T6 box beams. Ferrous metals shall not be allowed. All parts shall be pre-assembled at the factory and knocked down for shipment. System shall be a Rigid Frame design. Finish to be Manufacturer's factory applied 70 percent PVDF finish, which meets, at a minimum, the performance requirements of AAMA 2604. Color to be selected from manufacturer's standards. Aluminum structural system design and calculations must be furnished in accordance with the Aluminum Association "Specifications for Aluminum Structures" and the applicable building code. Design calculations must be prepared and stamped by a Licensed Professional Engineer. The superstructure shall incorporate permanent lifting eye-hooks that allow for the unit to be lifted by crane. Installer to test skylights according to procedures in AAMA 501.2. Repair or replace work that does not pass testing or that is damaged by testing and retest work.

5.4 Electrical

5.4.1 Basis of Design

The electrical guidelines are primarily related to the design of planned electrical facilities for the project and integration with existing electrical systems.

1. This section includes:
    a. Criteria for use in selection of electrical equipment and appurtenances specified in subsequent of this BODR or on the Drawings.
    b. Criteria for use in design of anchors for connecting mechanical (HVAC) and electrical equipment to supporting structures.
2. The criteria included in this section are general criteria that apply throughout the Work unless more restrictive or more stringent criteria are indicated on the Drawings or in the technical Specifications. See Drawings and Specifications for additional criteria relevant to specific locations, materials and equipment.

Table 5.7 summarizes recommendations for electrical design, including voltages, and requirements for raceways, wiring, and lighting materials. For more information on existing conditions see Attachment D for the load study.

Table 5.7 Electrical Design Basis of Design Summary

System	Description
System Voltages	Use 460 volts, three phase supply for motors less than 300 hp. Motors over 300 hp shall be 4160 volts, unless 460 volts is determined to be required due to special circumstances. Lighting shall be 120 Vac. Motor conrol centers (MCC) shall be 480 volts, 3 phase, 4 wire (solidly grounded wye). Panelboards shall be 480 volts, 3 phase, 4 wire (solidly grounded wye) or 120/208 volts, 3 phase, 4 wire, as applicable. Provide 120/240-volt, 1 phase, 3 wire transformers and panelboards only if necessary, to meet special equipment needs. In accordance with NEC recommendations
Panelboards	Provide panelboards with Molded-case circuit breakers with trip ratings as shown on the panel schedules. NEMA enclosure type as indicated on the Drawings. Minimum width: 20 inches. Gutter space in accordance with the NEC. Dead-front, no live parts when the panelboard is in service. Enclose entire panelboard bus assembly in a stainless steel cabinet. 4-piece front to provide ease of wiring access. Lockable, hinged door over the protective devices with a flush, cylinder tumbler-type lock with catch and door pull. Outdoor locations: Provide NEMA Type 4X enclosures with a NEMA Type 4X stainless steel outer enclosure (with a hinged door) and a NEMA Type 1 interior panelboard, unless otherwise indicated. Finish panelboards mounted in motor control centers to match the motor control center finish and color.
Ground Materials	Ground rod: Minimum: 3/4-inch diameter, 10 feet long. Uniform 10 mil covering of electrolytic copper metallically bonded to a rigid steel core: The copper-to-steel bond shall be corrosion resistant. In accordance with UL 467. Sectional type joined by threaded copper alloy couplings. Fit the top of the rod with a threaded coupling and steel-driving stud. Ground cable Requirements: Soft drawn (annealed). Concentric lay, coarse stranded in accordance with ASTM B8. Bare copper in accordance with ASTM B3. Size not less than required by the NEC.
Conductor Ampacity	In accordance with NEC requirements.
Power Factor	Correction as required to maintain an overall 95 percent power factor or better if required to avoid utility power factor penalty charges. Correction to be closely coordinated with harmonic generating loads to avoid resonant conditions.
Equipment Fault Duty Ratings (minimum)	480 V switchgear and MCC's- 65kA. Higher ratings shall be used if higher fault currents are encountered.
Cables	Low voltage - stranded copper conductors, XHHW-2, except for VFD outputs, use low capacitance, VFD-rated cables. Use 75-degree ampacity ratings, maximum. Low voltage Instrumentation – American Wire Gauge (AWG), twisted pair, individual/overall mylar shielded, PVC-jacketed, black/white 600 V (similar to Belden 8719).
	Medium voltage power - stranded copper, tape shield, EPR insulation, single conductor, type MV-105 (using 90-degree ampacities).
	Medium voltage cables rated 5,000 through 35,000 volts. Applications: Suitable for use in wet and dry locations in conduit and underground duct systems. Cables larger than AWG 1/0 suitable for CT use in cable tray. Insulation level:133 percent. Insulation screen: Extruded semiconducting thermosetting compound. Applied directly over the insulation in accordance with: ICEA S-93-639 and ICEA S-97-682.Free-striping. Provide color differentiation between semi-conducting layers and insulation.
	Fiber optic, communications, etc., - specialty cables as required. Indoor/outdoor cable construction: Flame retardant, low smoke, zero halogen, UV resistant. Waterproofing: Water blocking layer. Approvals and listings: UL 1666 and UL 1685. Design and test criteria in accordance with ICEA S-104-696. Outer jacket material: Linear low-density polyethylene. Meet all requirements of the NEC for use in all indoor/outdoor areas (excluding plenums) without being enclosed in conduit. Flame retardant OFNR riser rated conforming to UL 1666.
	Exposed conduit - Aluminum Rigid Conduit (ARC)
	Exposed conduits in wet area - ARC
Raceways	Indoor conduit - ARC
	Concrete embedded conduit - PVC Schedule 40 with FRP or PVC coated rigid steel where the conduits emerge from encasement. Use PVC coated rigid galvanized steel where emerging into hazardous areas.
	Cable tray - aluminum ladder type.
	Conduits in reinforced duct bank - PVC Schedule 40.
	Outlet boxes: Use deep threaded-hub malleable iron or aluminum boxes in hazardous areas. Use deep threaded-hub plastic coated malleable iron boxes in corrosive and NEMA Type 4X area and when the conduit system is PVC coated steel.
	Provide outlet box materials to match the conduit system
Hangers and Supports	Manufacturers: One of the following or equal: Thomas & Betts, Power-Strut, Unistrut, Cooper B-Line, Robroy. Tyco. Materials: Use materials appropriate as specified for each area. Hot dip galvanized steel: Supports: In accordance with ASTM A123 or A153. Minimum zinc coating thickness of 2.5 mils. Hardware: Electro-galvanized in accordance with ASTM A153. Stainless steel: Supports in accordance with ASTM A240. ANSI Type 316 material. Hardware: ANSI Type 316 material. PVC coated galvanized steel: Supports: Hot dip galvanized steel as specified in this Section. PVC coating thickness of 10 to 20 mils. Hardware: ANSI Type 316 material. Fiberglass: Supports: Vinyl ester. Hardware: Polypropylene. Thermal plastic elastomer. Fiberglass reinforced plastic.

Pre-fabricated Walk-In Electrical Enclosures	Pre-fabricated walk-in electrical enclosures, completely engineered and assembled. Manufactured Units: General: Metal construction; self-supporting and freestanding. Free from burrs and sharp edges. Interlocked, self-framing design, or framed design using minimum 3-inch square ASTM A500 structural grade steel tubing and welded connections. Base: All welded, seamless construction utilizing ASTM A36 structural steel members sized by structural design calculations to meet or exceed the required static and dynamic loads. Locate structural members to coordinate with the enclosed equipment, to properly support it and to allow maximum access to equipment floor openings for cable penetration. Provide lifting lugs capable of lifting the fully equipped electrical enclosure at the specified lifting points with deflection not exceeding L/240. Floor: Constructed of minimum 1/4-inch thick ASTM A36 smooth steel plate securely welded to the structural steel members of the enclosure base. Rated to withstand not less than 250 pounds per square foot distributed load, and rated to withstand the concentrated load of any equipment installed into the enclosure. Where bottom access is required for electrical equipment, provide floor cutouts with gasketed removable 12-gauge galvanized steel cover plates. Walls: Constructed with an exterior wall of minimum 18-gauge steel and an interior wall of minimum 16-gauge steel. Enclosure roof and ceiling: Enclosures shall be constructed with a roof panel of minimum 18-gauge steel and a ceiling panel of minimum 16-gauge steel. The roof shall be designed to withstand a minimum live load of 40 pounds per square foot, and shall be designed to support interior and exterior equipment loads without compromising roof load design. Where roof penetrations are required, provide flashing, adequately sealed, to maintain the weatherproof integrity of the roof. Insulation: Walls and roof insulated to the R-11 level using fiberglass batt material installed between the inner and outer steel panels. Floor insulated to the R-11 level using polyurethane foam installed on the underside of the floor. Doors: Personnel and equipment doors: Provide doors sized and located as indicated on the Drawings. Double wall steel construction with R-15 thermal insulation. Include interior panic hardware with exterior knob and cylinder lock, interior automatic closure devices and integrated hold open devices. Outwards opening with a minimum swing of 105 degrees. Provide drip shields above each door. Provide a 24-inch removable transom above each equipment door. Rear access doors: Provide equipment doors allowing rear access to equipment where indicated on the Drawings or required to meet the working clearance requirements of the NEC. Hinged and padlockable. Gasketed to maintain a weatherproof seal when closed.
Medium Voltage Cable Connections	Cable splices and terminations: Splices: Permanent in-line splice. Suitable for submersible, direct burial applications. Electrical requirements: Continuous current rating equal to cable. 5 to 8 kilovolts (kV) voltage class: Maximum voltage phase-ground. Minimum partial discharge voltage (less than 3 pC) 7 kV. AC withstand, 1 minute: 23 kV. AC withstand, 1 hour: 35 kV. AC withstand, 5 hour: 23 kV. DC withstand, 15 minutes: 45 kV. Impulse withstand, 1.2 by 50 microsecond 95 kV (crest). 15 kV voltage class: Minimum partial discharge voltage (less than 3 pC): 13 kV. AC withstand, 1 minute: 35 KV. AC withstand, 1 hour: 53 kV. AC withstand, 5 hour: 35 kV. DC withstand, 15 minutes: 70 kV. Impulse withstand, 1.2 by 50 microsecond 110 kV (crest). Power cable splices for shielded solid dielectric plastic-insulated cables shall utilize factory engineered kits containing all necessary components to maintain primary cable insulation level and metallic shielding/grounding systems. Splice insulation shall be of a uniform cross section heat shrinkable polymeric construction with a linear stress relief system, a high dielectric strength insulating material, and an integrally bonded outer conductive layer for shielding. The splice shall be covered with a heavy wall heat shrinkable sleeve overlapping the cable insulation, with a waterproof mastic seal on both ends. The splice shall accommodate a range of cable sizes and be completely independent of cable manufacturer's tolerances. When assembled on cables the splice shall be capable of passing the electrical test in accordance with: IEEE 48. IEEE 404. Manufacturers: The following or equal: Raychem. Live front terminators: Terminators for shielded solid dielectric plastic-insulated cables shall utilize factory engineered kits containing all necessary components to terminate the primary cables and shield systems. All locations exterior of buildings shall be considered outdoors and appropriate heat shrinkable skirts of a non-tracking material shall be installed. Terminators shall be of a material that will relieve the voltage stresses at the point of termination. Non-tracking. Ultra-violet, ozone, sulphur dioxide resistant. Terminator insulation shall be of a uniform cross section heat shrinkable polymeric construction with a linear stress relief system. Electrical requirements: Continuous current rating equal to cable. 5 to 8 kV voltage class: Minimum partial discharge voltage (less than 3 pC) 9 kV. AC withstand, 1 minute: 35 kV. DC withstand, 15 minutes: 65 kV. Impulse withstand, 1.2 by 50 microsecond (outdoor) 95 kV (crest). Impulse withstand, 1.2 by 50 microsecond (indoor) 80 kV (crest). Wet withstand, 10 seconds: 30 kV root mean square (RMS). Dry withstand, 6 hours: 25 kV RMS.

Medium Voltage Cable Connections (continued)	15 KV voltage class: Minimum partial discharge voltage (less than 3 pC) 13 kV. AC withstand, 1 minute: 50 kV. DC withstand, 15 minutes: 75 kV. Impulse withstand, 1.2 by 50 microsecond (outdoor) 110 kV (crest). Impulse withstand, 1.2 by 50 microsecond (indoor) 95 kV (crest). Wet withstand, 10 seconds: 45 kV RMS. Dry withstand, 6 hours: 35 kV RMS. The terminator kit shall accommodate a range of cable sizes and be completely independent of cable manufacturer's tolerances. When assembled on cables the terminator shall be capable of passing the electrical test in accordance with: Institute of Electircal and Electronics Engineers (IEEE) 48. Manufacturers: The following or equal: Raychem. Dead front terminators (600 Amperes): Terminators for shielded solid dielectric plastic-insulated cables shall be factory engineered kits containing all necessary components to terminate the primary cables and shield systems. Modular, pre-molded, fully shielded dead front system. Submersible. Capable of mating with any manufacturer's interface in accordance with IEEE 386. Crimp connector suitable for copper conductors using standard compression tools to join the conductor to the interface. To be used as an elbow or a "T". Cable stress relief adapters to connect the cable insulation to the dead front terminator. Heat shrink seal over the junction between the cable insulation and the terminator body. Conductor shield shall be grounded near the termination and connected to the conductive shield of the terminator. Terminator shall be bolted to the bushing or connector plug, with an insulating plug to cover the connection. Conductive cap covering the insulating plug. Conductive shield to provide reliable continuity between jacket of cable and connector. Conductive insert around connector to prevent corona. With a capacitive test point on the insulating plug to allow circuit testing without disturbing the connection. Electrical requirements: Voltage class: 15 kV: Maximum voltage: Phase to Ground: 8.3 KV RMS. Phase to Phase: 14.4 KV RMS. Withstand voltage: Impulse (1.2 by 50 microseconds) 95 KV Crest. AC 1 minute: 34 KV. DC 15 minutes: 53 KV. Minimum corona extinction level: 11 kV RMS. Continuous current rating: 600 amps RMS. Momentary rating: 25,000 amps RMS at .17 seconds. 10,000 amps RMS at 3.0 seconds. Manufacturers: One of the following or equal: Elastimold. 3M. Cooper. Dead front terminators (200 Amperes): Terminators for shielded solid dielectric plastic-insulated cables shall be factory engineered kits containing all necessary components to terminate the primary cables and shield systems. Modular, pre-molded, fully shielded dead front system. Loadbreak type. Submersible. Capable of mating with any manufacturer's interface in accordance with ANSI 386. Crimp connector suitable for copper conductors using standard compression tools to join the conductor to the interface. To be used as an elbow or a "T". Heat shrink seal over the junction between the cable insulation and the terminator body. Conductor shield shall be grounded near the termination and connected to the conductive shield of the terminator. Conductive shield to provide reliable continuity between jacket of cable and connector. Conductive insert around connector to prevent corona. With a capacitive test point with protective cover to allow circuit testing without disturbing the connection. With hold-down bail to hold connector to terminal or junction bushing. Electrical requirements: Voltage class 15 kV. Withstand voltage: Impulse (1.2 by 50 microsecond) 95 kV Crest. AC 1 minute: 34 kV. DC 15 minutes: 53 kV. Minimum corona extinction level: Eleven kV RMS. Continuous current rating: 200 A RMS.

Medium Voltage Cable Connections (continued)	Momentary rating: 10,000 A RMS, symmetrical at 0.17 seconds. 3,500 A RMS, symmetrical at 3.0 seconds. Manufacturers: One of the following or equal: Elastimold. 3M. Cooper. Cap all unused taps with an insulating cap approved for the application: Manufacturers: One of the following or equal: Elastimold. 3M. Cooper.
Utility Coordination	Electrical systems: Before bidding, the electrical contractor shall contact the utilities to determine the Work and materials that will be required from the Contractor, and all fees and permits that will be required, so that all utility systems furnished by the Contractor will be included in the bid. Coordinate Work with Engineer to minimize downtime of existing operating equipment and electrical distribution systems and to preclude unsafe operation: Coordinate downtime with Owner and local electric utility. Before commencing Work, coordinate electric service entrance requirements with local electric utility to ensure that the installation will be complete as specified in these Contract Documents: Ensure power transformer size, electrical characteristics, and location are consistent with the design and service voltage provided by the electric utility coordinated with other trades. Arrange for utility revenue meter. Coordinate installation of metering CTs and PTs furnished by the electric utility. During the construction of the Project, the existing electrical service must remain fully functional in order to supply uninterrupted electrical power to the facility and its ancillary buildings and structures. Telephone systems: Before commencing Work, coordinate complete telephone service: Verify compliance with telephone utility requirements. Verify exact location of each service point and type of service. Coordinate complete telephone line connections at locations indicated on the Drawings with the local telephone utility. Before commencing Site Work, coordinate underground conduit installations with other Work to eliminate conflicts and avoid interferences with other underground systems.
Vaults	Vaults shall be at least 6ft deep to provide sufficient space for the installation of cable trays and to facilitate safe maintenance activities.
Lighting System	All Areas - light emmitting diode (LED) Type. LED Luminaires: General: Pre-wired with leads of 18-AWG, minimum, for connection to building circuits. Individual LEDs connected such that a catastrophic loss or the failure of 1 LED will not result in the loss of the entire luminaire. Minimum ambient temperature range of 0 degrees Celsius to 40 degrees Celsius. Minimum rated life: Office Areas: 70,000 hours when operated at 25 degrees Celsius. Process Areas: 60,000 hours when operated at 40 degrees Celsius. Hazardous Areas: 50,000 hours when operated at 40 degrees Celsius. Minimum efficacy of 70 lumens/watt. Hazardous Areas: Minimum 60 lumens/watt. Minimum Color Rendering Index of 70. Tested according to IESNA LM-79 and LM-80. Lumen maintenance projection in accordance with IESNA TM-21. RoHS compliant. Integral driver. Suitable for dry, damp, or wet locations as indicated on the Drawings or on the Luminaire Schedule. Wet or damp locations: UL 1598 listed. Designed as a complete LED assembly. Retrofit LED lamps in luminaires not designed specifically for LED light sources shall not be used. Exterior/outdoor luminaires: Luminaires in combination with their mounting pole and bracket shall be capable of withstanding: Wind levels at the project site without damage. Seismic levels at the project site. Corrosion-resistant hardware and hinged doors or lens retainer. Luminaires furnished with integral photoelectrical control shall be of the luminaire manufacturer's standard design. Provide exterior luminaires with photocells to automatically control exterior lighting dusk to dawn to turn off or lower the lighting levels during inactive periods. Luminaires in hazardous areas: In accordance with NEC Section 500 requirements. UL labeled and identified for hazardous area. Marking on Class I and II Division 1 and 2 areas shall identify the applicable material classification group. Marking shall include the temperature class (T code). Exterior lighting shall have shields to mitigate light pollution.

Equipment and materials for the Work shall be suitable for performance in a wastewater treatment plant environment, and under conditions specified in the following paragraphs.

1. See technical specifications for each type of equipment for additional requirements.

Climate data for site:

1. Temperatures - Outdoor: As specified in Table 5.8:

Table 5.8 Design Temperatures - Outdoor

Condition	Criteria
Winter	2.4 deg. F dry-bulb at ASHRAE 99.6 percent.
Summer	110.5 deg. F dry-bulb / 76.5 deg. F mean coincident wet-bulb at ASHRAE 99.6 percent.
	Daily mean range: 20.4 deg. F.
Mean of annual extremes	Maximum: 100 deg. F dry-bulb.
	Minimum: minus 3.9 deg. F dry-bulb.

2. Temperatures - Indoor: As specified in Table 5.9:

Table 5.9 Design Temperatures - Indoor

	Summer (deg. F)	Winter (deg. F)
Process and process equipment areas:		
Electrical, Control, and Mechanical (HVAC equipment) rooms.	85	55
Non-process areas:		
Offices, conference rooms, vestibules, kitchen, restrooms. Control room, wet analysis room. PLC, instrument shop, instrument storage, electrical/com room.	75	70
Mechanical (HVAC equipment) rooms.	75	70

Seismic design criteria:

1. Mechanical and electrical equipment, including equipment supports and anchorage to structures or foundations, and including associated distribution systems such as piping, ductwork, conduits, cable trays, bus ducts, etc.:
   a. Design in accordance with the provisions of ASCE 7-10, Chapter 13, except as modified herein.
   b. Seismic design category B exemptions:
      i. Exemptions in ASCE 7, paragraph 13.1.4 for anchoring and bracing of mechanical, and electrical components in Seismic Design Category B are permitted for this Work.
   c. Component amplification factor (ap) and component response modification factor (Rp): In accordance with ASCE 7, Table 13.6-1.

d. Overstrength factor for anchorage to concrete (Ωo): In accordance with ASCE 7, Table 13.6-1.

e. Component importance factor, Ip: In accordance with the provisions of ASCE 7, Chapter 13 unless otherwise specified in Table 5.10 of this Section:

Table 5.10 Mechanical and Electrical Equipment, Component Importance Factor, Ip

Component	Description	Ip
Electrical	Equipment and appurtenances provided and installed under Division 16.	1.5
Mechanical (HVAC)	Equipment and appurtenances provided and installed under Division 15.	1.0

2. "Statement of seismic qualification" or "special seismic certification":
   a. Electrical: See Section 16050 - Common Work Results for Electrical for requirements.

Redundancy Considerations:

1. The Blue River WWTP is considered a "critical" process facility. The WWTP is fed from two separate Kansas City Power and Light (KCP&L) substations. Blue Valley circuit 5381 is south and Hawthorn circuit 9622 is north. Hence the new biosolids facility substations will be fed from this electrical power pen via two existing dual 13.2kV feeds. The existing solids handling facility has three substations (Substations 2, 3, and 4). These three substations will be consolidated into two substations located in the New Biosolids West Electrical Room called New Substation 2, and New Substation 3. Existing Substation 1 and new loads will be fed from a New Substation 1 located in the New Substation 1 building. The three existing solids handling substation service conductors will be existing to remain from the power pen to the existing splice at the solids facility. Design-Builder shall verify the capacity and condition of the existing cables before splicing or replace with new cables as required. From there, the two new feeders shall be routed via different duct banks to improve redundancy. Each of the 13.2kV substations shall be designed with an Automatic Transfer Switch (ATS). Provisions to connect an emergency generator shall be provided. The critical loads and non-critical loads shall be identified. Non-critical loads can automatically be shed when emergency generator power is necessary. Each feed shall be capable of sustaining 100 percent of the load in case of an outage.
2. The existing Substation No. 1 and all electrical equipment in the Digester Control Building and transfer areas are in classified spaces. In order to bring existing electrical systems up to code, all new electrical distribution equipment and equipment controls outside of the classified areas shall be brought into a standalone electrical facility.
3. Per the load study located in the attachments, the size of the existing electrical system shall be sufficient to accommodate all new loads proposed in the THP; however, Design-Builder shall verify system capacity to support all new loads. Table 5.11 contains the existing load summary and Table 5.12 is the new electrical load summary.

Table 5.11 Existing Electrical Load Summary

	LOAD SUMMARY				
KCP&L 1200A,13.2kV Circuit	KCP&L Bill Max Demand (kW)	SKM Analysis Max Demand (kW)	% Difference Between Demands	KCP&L Circuit Max Load (kW) at 0.8 PF	KCP&L Additional Available Load Capacity (kW) per SKM Max Demand
CKT 5381	1,538.04	3,730.6	58.7	12,672.00	8,941.40
CKT 9622	1,827.84	3,747.5	51.2	12,672.00	8,924.5

Notes:
(1) Abbreviations: kW = kilowatt; PF = peaking factor.

Table 5.12 New Electrical Load Summary

	LOAD SUMMARY				
KCP&L 1200A,13.2kV Circuit	KCP&L Bill Max Demand (kW)	SKM Analysis Max Demand (kW)	% Difference Between Demands	KCP&L Circuit Max Load (kW) at 0.8 PF	KCP&L Available Load Capacity (kW) per SKM Max
CKT 5381	1,538.04	3,881.39	60.37	12,672.00	8790.61
CKT 9622	1,827.84	4,093.66	54.75	12,672.00	8,924.5

Safety:

1. Electrical equipment ratings shall exceed the required calculated short circuit currents available to ensure the safety of plant personnel and equipment. Where transformers step down to 480 volts, short circuit currents shall be limited to allow the use of 65 kA electrical equipment wherever possible. A short circuit device coordination and arc-flash study shall be required for all equipment provided in the project using the first upstream device or the utility as a fixed reference. Arc flash labels shall be provided on electrical equipment. If an existing and relevant computer-based protective device study exists, the new equipment shall be added to the existing study, a complete updated study shall be provided. All computer model files shall be SKM and shall be turned over to the Owner at completion. Arc-flash mitigation equipment shall be provided in accordance with NEC requirements, as applicable.
2. Grounding shall use separate ground conductors routed with the non-grounded conductors and shall not rely solely on the raceway as the equipment ground conductor. Distribution systems shall be wye connected, and solidly grounded. Resistance grounding may be used to limit ground fault currents on medium voltage systems only.
3. The ground system resistance (electrode to ground) of the completed installation shall be: 5 ohms or less for industrial systems. 1 ohm or less for electrical buildings, outdoor substations.

Power Quality:

1. The plant electrical system shall be designed to meet voltage and current distortion levels as specified in IEEE 519 and to meet KCP&L requirements. Harmonic calculations shall be performed during the design and verified by field measurement when the system is commissioned. Voltage drops from source to load shall meet recommended NEC limits. Line reactors shall be provided on VFDs as required to reduce harmonics.

Energy Efficiency:

1. Transformers shall meet or exceed applicable Department of Energy efficiency standards. Motors shall be NEMA Premium Efficiency type for all applicable motors.

Equipment:

1. Design-Builder to define equipment layouts considering minimum clearances in accordance with NEC requirements to facilitate operations and maintenance, and as approved by the Owner. The tentative equipment arrangements for the following electrical rooms are provided in the drawings:
   a. New Substation-1 Electrical Room.
   b. New Biosolids West Electrical Room.
   c. New Biosolids East Electrical – MCC and Distribution Room.

Table 5.13 Biosolids Substation 2 & 3 in West Electrical Room

Substation 2:
• 600 A Main 13.2kV Automatic Transfer Switch
• 2500 kVA, 13.2kV-480/277V, Cast Coil Transformer
• 480V, 3000A Main
• 3000 A, 480V Switchboard
Substation 3:
• 600 A Main 13.2kV Switch
• 2500 kVA, 13.2kV-480/277V, Cast Coil Transformer
• 480V, 3000A Main
• 3000 A, 480V Switchboard
480/240V Transformer – T1
240/120V, 1PH Panel Board - PNL-1
120V- PLC -1

Table 5.14 New Biosolids East Electrical MCC and Distribution Room

600A, 480V, 3PH, 4W MCCs:
• Sludge Screening MCC-1
• Solids Building MCC- 2
• Solids Building MCC- 3
• Solids Building MCC- 4
• THP System & Cake Load Building MCC- 5
• THP System & Cake Load Building MCC- 6
• Biogas Processing Building MCC-7
480/240V Transformer – T2
240/120V, 1PH Panel Board - PNL-2
• Pre-THP Dewatering Centrifuge Grinders
480/240V Transformer – T3
240/120V, 1PH Panel Board - PNL-3
120V- PLC -2

Table 5.15 New Substation 1 Electrical Room

Substation 1:
• 600 A Main 13.2kV Automatic Transfer Switch
• 2000 kVA,13.2kV-480/277V, Cast Coil Transformer
• 480V, 3000A Main
• 3000 A, 480V Switchboard
600A, 480V, 3PH, 4W MCCs:
• Holding Tanks & Digesters MCC-8
• Side Stream Treatment MCC-9
• Side Stream Treatment MCC-10
480/240V Transformer – T4
240/120V, 1PH, Panel Board - PNL-4
• East Holding Tank VFPs
• West Holding Tank VFPs
120V- PLC -3

Future Expansion:

1. Floor space, reserve transformer capacity, spare raceways, spare positions in switchgear line-ups and power centers for known future loads shall be provided. MCCs and panelboards shall include 20 percent usable spare space and load capacity provisions for unknown future loads.

Supports and Anchorage for Equipment:

1. Do not use more than 60 percent of the weight of the electrical and mechanical (HVAC) equipment for designing anchors for resisting overturning due to seismic forces.

Space Requirements:

1. Dedicated electrical rooms shall be provided for switchboards, MCCs, VFDs, panelboards, general purpose transformers, etc. Rooms shall be air conditioned per HVAC requirements. Doors shall have panic hardware and shall open in the direction of egress from the electrical room. Multiple exits shall be provided at opposite ends of electrical rooms as required by code and personnel safety. Each electrical room with door(s) shall have a removable transom. Electrical rooms with floor-mounted equipment shall be provided with at least one set of double doors. Equipment access space shall meet NEC requirements as a minimum. Equipment and mountings shall meet seismic requirements for the location.
   a. Area Classifications:
      i. Area classifications shall be determined for all areas constructed and/or modified as part of the work. All outdoor and process areas that are not hazardous shall be considered wet/corrosive and shall have NEMA 4X or NEMA 3R, 316 stainless steel enclosures suitable for the expected environment. Hazardous areas shall also be considered corrosive. Electrical rooms, control rooms, administrative areas and office areas shall be considered NEMA 12 – General Purpose.
   b. Lighting Fixture Types and Receptacles:
      i. Luminaires shall be energy-saving LED type, suitable for the environment where the luminaire is installed. Consistent LED color temperature 4000K shall be provided throughout the facilities.
      ii. Lighting levels shall meet local code requirements, IBC and Illuminating Engineering Society (IES) requirements. Where IES does not apply, equivalent IES lighting levels for similar types of spaces shall be provided. Lighting shall be sufficient to perform routine operation and maintenance activities without the use of portable, supplemental or task lighting. Design shall be based on lighting level calculations (photometric study) using established computer program(s) for photometric studies such as Visual lighting software or approved equal.
      iii. Emergency luminaires shall be utilized to meet IBC and NFPA-101 emergency egress lighting requirements, including exterior emergency luminaires at building egress points as required. Emergency and exit luminaires shall include 90-minute battery packs.
      iv. Receptacles shall be located in process areas so that they may be utilized anywhere in the process area by use of a 25-foot extension cord. Weatherproof and/or ground-fault circuit interrupter (GFCI) receptacles shall be utilized in wet areas and where required by the NEC. Exterior receptacles shall be weatherproof and GFCI with plastic cover.
   c. Lighting Controls:
      i. Exterior lighting shall be controlled by controls similar to the existing exterior lighting. If none exists, photocell-controlled luminaires shall be provided.
      ii. Interior lighting controls shall utilize manual switches.

d. Distribution Equipment:

   i. Low voltage draw-out switchgear shall be used for main distribution equipment. Smaller systems (800 amperes or less) may use MCCs for distribution where appropriate. Main-tie-main arrangements shall be provided with key interlocking to prevent parallel operation for switchgear and MCCs. Electrically operated power circuit breakers shall be used for automatic transfer schemes, except where transfer switches are used. MCCs shall use NEMA-rated devices. Starters shall be NEMA Size 1 minimum. MCC enclosures shall be 20 inches deep, front access only. Panelboards shall use bolt-in circuit breakers. All busses for medium voltage equipment and 600V MCCs shall be copper. All buses for low voltage distribution panels shall be aluminum. Equipment shall not rely on series ratings to meet short circuit fault requirements. Critical panelboards shall be fed from both the A and B sides and shall include a manual transfer switch between the sources. Local disconnects for equipment shall be provided in accordance with NEC requirements. Fused disconnects shall be used where calculated fault current values exceed the ratings of non-fused equipment.

   ii. Medium voltage equipment shall utilize metal-clad, draw-out, and vacuum switchgear for power distribution. Metal enclosed starters shall utilize fused draw-out vacuum contactors and may be close-coupled to the switchgear where feasible. Metal enclosed breakers or fused switches shall not be used for distribution.

e. Fire Alarm, Telephones and Public Address System:

   i. The biosolids facility shall match existing plant systems for fire alarm, data, telephone and public address (intercom) systems. Existing systems shall be expanded as required to integrate the new facilities into the existing site.

f. VFDs:

   i. Where VFDs are used, motors shall be inverter duty and equipped with shaft grounding rings. Insulated bearings shall be utilized where recommended by the driven equipment, motor and/or VFD manufacturers, but shall not substitute for shaft grounding rings. dV/dT devices shall be installed where required by the VFD and/or motor manufacturers. VFD rated cables shall be utilized for VFD outputs. VFDs shall not be used on rewound or non-inverter duty motors. If a VFD is to be installed on an existing load, an inverter-rated motor shall be specified. KCP&L requires all soft starts on motors over 10 hp. All motors that are not VFD and over 10 hp shall be required to have soft starters.

Interfaces with Existing Facilities:

1. In general, the Blue River Biosolids Facility shall be designed to be electrically independent from the rest of the site.

Power and Vibration Monitoring:

1. Key electrical parameters are sent to plant SCADA. Historical sequence of events and power quality records are accessed at the Multilin relay when needed.

Electrical Coordination, Short Circuit, and Arc-Flash Studies:

1. The electrical contractor shall prepare power system reports for the project, including short circuit calculations, a protective device coordination study, a harmonic analysis,

and an arc flash study in accordance with City standards. The studies shall include all portions of the electrical distribution system for normal and standby power sources. The studies shall include all equipment operating at 208 V and above. The analyses shall include an evaluation of harmonic distortion and the furnishing and installation of filters and any other equipment that may be required to meet the requirements of IEEE 519 Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems. All studies and reports shall be prepared utilizing SKM software.

Fire Detection and Alarm:

1. Existing plant systems shall be matched to fire alarm, gas alarms, data, telephone and public address (intercom) systems. The existing systems shall be expanded as required to integrate the new facilities into the existing site.

5.4.2 Codes and Standards

The following codes and their latest edition are used in the design:

1. NEC – NFPA 70, latest City adopted edition.
2. NFPA 70E – Standard for Electrical Safety in the Workplace.
3. IBC, latest City adopted edition.
4. NFPA-101 for emergency lighting.

5.4.3 Electrical Design References

The following references are used in the design:

1. IEEE 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
2. IES, Lighting Handbook for Lighting Levels.

5.5 SCADA, Instrumentation & Controls

The overall SCADA system at the Blue River WWTP is being upgraded under a separate project that sets forth the control system design, commissioning, hardware, software, and networking standards for the City's wastewater facilities SCADA systems. The SCADA system designed for the Project must conform to these guidelines and standards which are provided below. All SCADA requirements shall be indicative.

5.5.1 Basis of Design

The SCADA system at Blue River WWTP utilizes Allen-Bradley Logix series PLCs. The system also includes HMI operator workstations, HMI and Historian Servers, and networking hardware. The PLCs are programmed using Rockwell's Studio 5000 software and the HMI system uses Rockwell's FactoryTalk suite of software. The network communication protocol is ODVA Ethernet IP. The system utilizes both fiber optic and copper Ethernet connections and associated hardware.

The work of this Section shall be performed by an entity that demonstrates experience in the design and commissioning of process instrumentation and control system of comparable size and complexity to the work detailed herein and other related Sections. The SCADA system provided for the Project must ensure proper process control and monitoring for the new and upgraded solids processes.

5.5.2 Codes and Standards

The I&C and SCADA system designed for the Project shall conform to the standards specific to the water and wastewater industry, as well as to nationally-recognized standards. Design shall, as a minimum, conform to the standards, and recommended practices shown below:

Table 5.16 Standards and Recommended Practices

Organization	Code/Standard Title
International Society of Automation (ISA)	The Automation, Systems, and Instrumentation Dictionary, Fourth Edition
ISA	ISA18.2 – Alarm Management
ISA	ISA 88 – Process Modeling
ISA	ISA95 – Enterprise/Control Integration (B2MML)
ISA	ISA99 – Industrial Automation and Control Systems Cybersecurity (also known as ISA/IEC 62443)
ISA	ISA100 – Wireless Systems for Automation
ISA	ISA101 – Human Machine Interfaces for Process Automation Systems
NFPA	National Electric Code (NFPA 70)
Federal Communications Commission (FCC)	FCC Part 15 – Class A (digital computing devices)
NEMA	Enclosures for Electrical Equipment (1000 Volts Maximum) (NEMA 250)
National Institute of Standards and Technology (NIST)	Cyber Security Framework 800-53, 800-82, and 800-30
UL	UL 508 – Industrial Control Equipment

5.5.3 Control System Design Requirements

5.5.3.1 Control System Hardware

The SCADA system provide for the project shall include a freestanding, Main Control Panel with an Allen-Bradley ControlLogix PLC. The panel shall be installed in the solids processing building control room. This panel shall provide direct control for all non-package solid processes equipment, and exercise supervisory control over the package control systems being furnished as part of the Project.

The package control systems shall monitor and control all process and ancillary equipment within the limits of the associated equipment package. If a package control system is equipped with a PLC, the PLC shall be installed in a local control panel and shall be Allen-Bradley ControlLogix or CompactLogix. The MicroLogix series PLCs is not permitted.

City's standard PLC hardware for ControlLogix and CompactLogix based systems is defined below and shall be utilized on the project without exception:

Table 5.17 City Standard PLC Hardware

Card Type	Description	Model Number
Processor ControlLogix	ControlLogix PLC processor	ControlLogix 5580 Processor 1756-L83E or better.
Processor CompactLogix	CompactLogix PLC processor	CompactLogix 5370 Processor 1769-L30ER or better
Analog Input - ControlLogix	Isolated, six channel 4 to 20 milliamp input card	1756-IF6I
Analog Input - CompactLogix	Isolated, four channel 4 to 20 milliamp input card	1769-IF4I
Analog Output - ControlLogix	Isolated, six channel 4 to 20 milliamp output card	1756-OF6CI
Analog Output - CompactLogix	Isolated, four channel 4 to 20 mA milliamp output card	1769-OF4CI
Discrete Input - ControlLogix	Sixteen channel 120 volts AC input card	1756-IA16
Discrete Input - CompactLogix	Isolated, eight channel 120 volts AC input card	1769-IA16
Discrete Output - ControlLogix	Sixteen channel 120 volts AC output card	1756-OA16
Discrete Output - CompactLogix	Isolated, eight channel 120 volts AC output card	1769-OA16
Ethernet/IP	Two port Ethernet/IP communications card	1756-EN2T or 1756-EN2TR
Modbus TCP	Modbus TCP protocol communication card	Prosoft MVI56E-MNET

All input/output (I/O) cards shall use screw type terminal blocks: 1756-TBCH (analog) and 1756-TBNH (discrete). All I/O signals shall be of the types stated above. No pulse frequency or pulse duration type signals shall be utilized without prior approval by the City.

Discrete inputs shall be connected to the control system through a relay in the monitored device. The relay shall be completely isolated from the control power for the equipment, otherwise known as a "dry contact". Discrete output signals shall be connected to an interposing relay with compatible coil rating at the controlled device. The output of the interposing relay shall then be a "dry contact" connected to the equipment control circuitry, regardless of the control voltage used by the equipment. All relays shall have an LED integral pilot light to indicate coil energization and a manual override.

To facilitate local control, the package control systems with PLCs shall also include an Operator Interface Terminal (OIT) mounted on the panel front. The OITs shall be Rockwell PanelView Plus 7 Graphic Terminals with 10.4 inches diagonal size or larger, and 16:9 aspect ratio.

An HMI operator workstation running FactoryTalk View thin-client application shall be furnished and installed in the solids processing building control room. This workstation shall have two wide screen monitors (16:9 aspect ratio) set to ultra-high (4K) 3840 x 2160 pixel resolution. The manufacturer shall be Hewlett Packard (HP).

Any deviations from the requirements listed above shall require City's explicit permission.

5.5.3.2 Control System Architecture

For the overall architecture of the SCADA system, refer to the control system block diagram included with the Drawings.

The main PLC, the thin-client HMI operator workstation, and all package control systems provided as part of the project shall be placed on the plant control network and fully integrated with the existing control system infrastructure.

To enable this configuration, a 22-U freestanding rack enclosure shall be provided in the solids processing building control room/lab. The rack shall house one managed Ethernet Switch with both copper and fiber ports, and one fiber optic closet connector housing equipped with four connector housing panels. This rack shall serve as the networking hub for the solid processes and shall be furnished with an appropriately sized rack mounted uninterruptable power supply (UPS) (30 minutes of backup run time at full load).

Networking Scheme

The networking scheme described below utilizes copper connection between the rack enclosure and the main and package system control panels. If the end-to-end distance between the nodes is greater than 300 ft, fiber shall be utilized as the communication media.

Package Systems Connection

Each package control system panel with PLC/OIT shall be provided with an unmanaged Ethernet switch to internally connect the package PLC and the OIT. From one of the copper ports in this switch, the package control system shall be connected to a copper port of the managed Ethernet switch in the rack enclosure.

Main Control Panel Connection

A managed Ethernet switch shall be provided and connected to the main PLC in the solids building Main Control Panel. From one of the copper ports in this switch, the main control panel shall be connected to a copper port of the managed Ethernet switch in the rack enclosure.

HMI Operator Workstation Connection

The thin client HMI operator workstation shall be equipped with a network card and shall be connected to a copper port of the managed Ethernet switch in the rack enclosure.

Plant Control Network Connection

The nearest connection point to the plant control network is in the control room of the Administration Building. A 24-pair hybrid fiber-optic cable (12 single mode pairs and 12 multimode pairs) shall be routed from the solids building rack enclosure to the Administration Building control room. All fiber pairs shall be terminated at both ends and tested per industry standards.

Electrical Systems Network Connection

The power monitors and intelligent protective devices/relays in the electrical panels that have Ethernet interface shall be connected to the copper ports of the managed Ethernet switch in the Main Control Panel.

All VFDs provided on the project that have Ethernet interface shall be connected to copper ports of the managed Ethernet switch in the Main Control Panel.

5.5.3.3 Networking Hardware

The rack enclosure shall be Hoffman, model Proline or equal with front, side, and back access as required per installation location.

The managed Ethernet switch in the rack enclosure shall be equipped with both single mode and multimode Small Form-Factor Pluggable (SPF) fiber ports to enable connection to the plant control network. The managed Ethernet switches shall be Allen-Bradley Stratix without exception. The unmanaged Ethernet switches shall be by N-Tron Corporation, or equal.

The closet connector housing shall be Corning Cable Systems, CCH-02U or equal, and the connector housing panels shall be Corning Cable Systems, CCH-CP or equal. Coordinate exact fiber type (OS/OM rating, fiber size, etc.) and connector types (ST, LC, etc.) with the City.

5.5.3.4 Server Hardware

The thin client HMI operator workstation shall communicate with the existing HMI Server. New HMI Server is not required for the project.

For reporting and trending needs, the main PLC and the package systems PLCs shall log data directly in the existing Historian Server. New Historian Server is not required for the project.

To facilitate remote monitoring and control of package systems, the package system OIT graphic screens shall be accessible at the HMI operator workstations in the control rooms, including the thin client HMI operator workstation being provided as part of the project. To enable this feature, a Virtual Network Computing (VNC) server along with all required software shall be provided. The server manufacturer shall be Stratus.

5.5.3.5 Control Panel Requirements

Materials of Construction

All panels provided for the project shall be UL certified. The material of construction for all control panels provide for the project shall be suitable for the installation environment. Indoor panels shall be NEMA 4X, 304 SST, and panels designated for outdoor installation shall be NEMA 4X, 304 or 316 SST. All panels installed in corrosive environment shall be NEMA 4X, 316 SST. All panel front mounted devices (switches, lights, etc.) shall have the same NAMA rating as the panel.

Freestanding panels shall be constructed using minimum metal thickness of 12-gauge and non-freestanding panels shall be constructed using minimum metal thickness of 14-gauge.

Panel Arrangement

Indoor panels shall be designed so that the conduits enter the panels from the top or bottom only. Outdoor panels shall be designed with bottom conduit entry only. Conduits shall not enter from the sides of the panels. A four-inch high concrete maintenance pad shall be provided under every freestanding panel.

If a control panel contains a PLC, the PLC hardware shall be located in the upper portion of the panel. Incoming power connections, power distribution, power supplies, and other devices related to panel and instrument power shall be located below the PLC. If no PLC is contained in the panel, the devices related to panel and instrument power shall be located at the top of the panel. Field terminals shall be installed in the lower portion of the panel. Analog and digital signals shall be segregated to avoid interference between the two types of signals.

The analog I/O cards shall be segregated from the digital I/O cards. Within racks, discrete input and output cards shall reside on the left-most portion of the I/O rack (to the right of the processor). Where multiple racks are provided, the upper or left-most rack shall contain the digital I/O cards. Analog input and output cards shall be on the right-most portion of the I/O rack. Where multiple racks are required, the bottom or the right-most rack shall contain the analog I/O cards. A minimum of two spare slots or 10 percent spare slots, whichever is greater, shall be provided between the digital cards and the analog cards to allow expansion of the digital I/O. Each I/O rack shall minimally contain four spare slots or 20 percent spare slots, whichever is greater, including the spare slots between the digital I/O and analog I/O modules noted above. Provide hardware for supporting spares with related wire ducts space, terminal strip locations, fusing and loop power provisions, etc. Cards required to communicate to device-level networks (HART, Ethernet, etc.) shall be located after the analog cards.

Panels with both VFD and PLC shall be furnished with a solid metal barrier, approximately 90 percent of height and 90 percent of width of the interior, to separate VFD from PLC and interior circulation fans to aid overall heat dissipation.

On the panel front, OITs shall be installed at a 5ft-0in. centerline. Switches, push buttons, or other panel-front devices shall be located within 2ft-6in. and 6ft-6in. from the base of the panel.

Panel Doors

Panel doors shall be provided with stiffeners as required to meet UL requirements. Each door shall be provided with a piano-style continuous hinge. The door handle for all panels shall be pad-lockable.

PLC control panels shall be provided with grace ports on the front door. Grace ports shall include Ethernet RJ-45 ports at a minimum. Where additional network protocols are implemented within the PLC enclosure, such as serial communication, additional respective communication grace ports shall be provided for control system monitoring, maintenance and troubleshooting without opening the control panel doors. In addition to communication ports, the grace port shall provide a 120-volts AC duplex receptacle to power laptop computers. Grace ports shall be provided with a secure lockable cover and located at a convenient elevation.

Free-standing control panels shall be provided with a cantilevered fold-down shelf for placing laptop computers. The shelf shall be permanently affixed to the interior of the panel door(s). Shelf shall be mounted at standing height.

Panel Wiring

Panel wiring shall conform to the requirements detailed below:

Wiring Size: Panel wiring sizes indicated herein are minimum size preferences. Perform all calculations as required by the current version of the NEC to verify that conductors are sized accordingly. Panel power distribution wiring on the line side of panel fuses or circuit breakers shall be minimally 12 AWG. Internal 120 Vac panel wiring shall be Type MTW stranded copper. Secondary power distribution wiring shall be a minimum wire size of 16 AWG, with circuit breakers and fuses sized accordingly. Analog circuiting in the panel shall minimally use 18 AWG twisted shielded pair (black(-)/clear(+) color-coded). For all wire types, insulation shall be 600 volts.

Unless directed otherwise by the instrument manufacturer, shields for analog circuits shall be clipped at the field end and terminated on individual Green/Yellow terminal blocks in the control panel. All instrument and electrical safety grounds in the control panel shall be tied together and the panels shall be grounded per code requirements.

Wireways: Wireways, sometimes also referred to as "Panduit", shall be provided to route all wiring within the panels. Wireway sizes shall be sufficient for all wiring provided under the project and allow for 20 percent spare capacity. Minimally one inch of clearance shall be provided between the wireway and the nearest point of termination. For wiring routed to the panel door, wiring shall be neatly bundled and wrapped with plastic spiral wrap and secured to the panel door.

Wiring Colors: Power wiring colors shall be as indicated in Table 5.18:

Table 5.18 Power Wiring Colors

Phase or Type of Conductor	240/120 Volts	208/120 Volts	240 Volts	480/277 Volts
Phase A	Black	Black	Black	Brown
Phase B	Red	Red	Orange	Orange
Phase C	N/A	Blue	Blue	Yellow
Neutral	White	White	White	Gray
Ground	Green	Green	Green	Green

Wiring colors for other types of signals shall be as indicated in Table 5.19:

Table 5.19 Other Wiring Colors

Type of Wiring	Color
L1 (hot)	Black
L2 (neutral)	White
AC control circuits	Red
DC power source	Blue
DC power common	White/Blue
24-volts AC Source	Brown
24-volts AC Common	Brown w/White
Temporary	Purple
Control Foreign Voltages	Orange
Isolated DC Ground	Green w/Yellow
Equipment ground	Green

Provisions for Fiber Optic Cabling

Where fiber optic cabling passes through a control panel, each fiber (including spares) shall be terminated and connected to a fiber patch terminal inside the control panel. Fiber patch panels shall be in the lower portion of the control panel and may be mounted on a subpanel affixed to the panel side, if required. Alternatively, a DIN-Rail mounted fiber patch panel shall be utilized. All individual fibers shall be terminated and tested.

Wire Tags

Shrink-on sleeve type wire tags shall be affixed to each end of every conductor terminated in the panel. Wire tags shall match the tags shown on the control panel supplier's drawings. The device and signal tags used on the P&ID drawings shall be used to derive wire tag identifiers. Multiple signal wires within the same signal identifier shall be appended by -1, -2, etc. for digital circuits. Analog circuits shall be appended by (+) and (-) as appropriate.

Terminals

Terminals shall be screw-down type, not spring loaded. Terminals shall be provided with a stand-off rail to allow easy access to the terminals and to the wiring. Terminals shall be equivalent to those manufactured by Phoenix Contact. Terminals shall be single-high construction with labels on each terminal. A minimum of 20 percent spare terminals shall be provided in each panel for possible future use.

Power Distribution and Power Distribution Circuit Breakers

All control panels containing PLC/HMI shall be equipped with a double conversion type UPS with Ethernet/IP communication capability. The UPS shall be sized to provide a minimum of 30-minute of backup run time at full load. The manufacturer shall be APC.

Since two wire instruments are powered out of the control panels, process-critical instrumentation shall be powered from the same UPS circuit. A separate, non-UPS power circuit shall be provided to power accessories such as lighting, ventilation, and heating circuits in the panel. Additionally, the non-UPS powered circuit shall be used to power instruments that are not critical to the process. Panels with two power feed connections shall be labeled as required by the latest version of the NEC to warn of the presence of two power feeds to the panel. For panels with two power feed connections, a separate, isolated ground shall be provided for UPS circuits.

Each incoming power circuit shall be provided with a surge suppressor, for both UPS and non-UPS circuits. All mode TVSS shall be provided in all control panels. Surge protection shall also be provided on the lighting panel/load center providing power to the control panel.

Each device powered out of the control panel's 120 volts AC sources (whether UPS or non-UPS) shall be provided with a DIN-rail mounted circuit breaker for protection and for easy isolation from other devices.

Heaters and Ventilation

Every panel installed in environmentally controlled room shall be provided with a thermostatically controlled ventilation fan. The thermostat shall be specifically designed for cooling service. Each vent in the panel shall be provided with a filter to minimize dust intrusion. Blank plates shall be provided along to slide in place of the filter to completely shut the panel, if desired. A disconnecting means shall be provided to prevent the fan from running. If natural ventilation is not adequate, the panels shall be provided with air-to-air heat exchangers or air conditioning units. The cooling equipment shall not compromise the NEMA rating of the panel.

Panels for outdoor service or for mounting in an outdoor enclosure shall be provided with a thermostatically controlled strip heater. The thermostat shall be specifically designed for heating service. Panels for outdoor service shall not have ventilation provisions and shall be sized to adequately dissipate heat. A disconnecting means shall be provided to prevent the heater from turning on. Panels for outdoor service will be provided with stainless steel or painted steel sunshades.

H_2S Mitigation

Control panels located in areas where H_2S is present shall use air purging to prevent H2S intrusion into the panel. Where possible metals not susceptible to H2S corrosion, such as aluminum wiring, shall be utilized. All electronic devices that are available conformally coated shall be utilized to extend the operating life.

Lighting

Each control panel shall be provided with LED panel light(s) as required to sufficiently illuminate the panel. A light switch inside the panel as opposed to a door switch shall control the light.

Convenience Receptacle: Each panel, regardless of size or mounting, shall be provided with a 120-volt, 20 ampere, duplex convenience receptacle. This receptacle shall be in addition to those needed for plug-in transformer type power supplies for communication or other permanently installed equipment. A separate, orange- colored, isolated ground receptacle shall be provided and connected to the UPS power feed for panels that are powered from both UPS and non-UPS circuits.

Nameplates

The outside of each panel shall be provided with a nameplate. Additionally, each permanently mounted interior or exterior panel component shall be provided with an identifying nameplate. Nameplates shall be phenolic black with white lettering. Nameplates shall be attached using self-tapping stainless-steel screws when possible.

Indicating Lights

Indicating lights shall be transformer type with LED lamps. Lights shall be push-to-test type and complete with the appropriate color lens. Color scheme shall be as indicated in Table 5.20:

Table 5.20 Color Scheme

Indication	Color
Running	Red
Stopped	Green
Valve Opened	Red
Valve Closed	Green
Control Power On	White
Alarm	Amber

Power Supplies

Power supplies for DC circuits in panels should be redundant. Additionally, regulated power supplies should be utilized. The power supply shall be equivalent to Phoenix Contact.

Tagging System

The tagging system used on the Project shall follow standards and conventions adopted by the City.

5.5.3.6 Control Hierarchy

Equipment shall be controlled at different layers (hierarchy). Control layers refer to modes (local or remote) and type (manual or automatic) which may be selected by an operator for a specific device.

Local-Manual Control

All equipment, regardless of manufacturer or who provides the equipment, shall be provided with a means of locally controlling the equipment. This shall include a "Local-Off-Remote" selector switch and Start-Stop pushbuttons for equipment that has just On or Off control. In addition, local indicating lights shall be provided to indicate "Running" and "Stopped" status.

For valves, the local control shall be via a "Local-Off-Remote" selector switch and Open-Close pushbuttons. Preferably, the controls for the valve shall be located on the actuator. If the actuator is not easily accessible, a remote-control station shall be installed in a more accessible location.

VFDs shall be provided with a "Local-Off-Remote" selector switch on the face of the drive enclosure. When in Local, the drive status and speed shall be controlled from the drive operator interface terminal.

Remote-Manual Control

All equipment controlled by a PLC shall be provided with an option to manually control the equipment from the SCADA HMI/OIT. This functionality shall be provided via a Manual-Auto selection on a control graphic screen. When the "Local-Off-Remote" selector switch at the equipment is in the "Remote" position and the equipment is selected for Manual operation at the HMI/OIT, the operator shall be presented with a Start-Stop or Open-Close selection on the same control graphic screen. For equipment having speed or position control, the speed or position control shall resort to the Manual mode of operation once the equipment has been selected for Manual operation and the operator shall be allowed to enter the speed or position.

Remote-Automatic Control

When the "Local-Off-Remote" selector switch at the equipment is in the "Remote" position and the equipment is selected for Auto operation at the HMI/OIT, the equipment shall be controlled by the PLC as detailed in the software control narratives. Automatic controls shall control the equipment based on comparison of the process variable versus operator-entered setpoints. Additionally, automatic sequences may be initiated based on process conditions or upon the operator initiating the sequence.

5.5.3.7 Standard Hardwired I/O for Equipment

The following hardwired I/O shall be provided for various equipment.

Open/Close Service Valves and Gates

Table 5.21 Open/Close Service Valves and Gates

Type of Signal	Signal Description
Discrete Input	Local-Off-Remote selector switch in "Remote"
Discrete Input	Local-Off-Remote selector switch in "Off"
Discrete Input	Valve Opened position (limit switch contact closed in opened and intermediate states)
Discrete Input	Valve Closed position (limit switch contact closed in closed and intermediate states)
Discrete Output – Momentary	Valve Open command (seal-in circuit in the actuator)
Discrete Output – Momentary	Valve Close command (seal-in circuit in the actuator)

Modulating Service Valves and Gates

Table 5.22 Modulating Service Valves and Gates

Type of Signal	Signal Description
Discrete Input	Local-Off-Remote selector switch in "Remote"
Discrete Input	Local-Off-Remote selector switch in "Off"
Discrete Input	Valve Opened position (limit switch contact closed in opened and intermediate states)
Discrete Input	Valve Closed position (limit switch contact closed in closed and intermediate states)
Analog Output	Valve position control
Analog Input	Valve position feedback

On/Off Motors

Table 5.23 On/Off Motors

Type of Signal	Signal Description
Discrete Input	Local-Off-Remote selector switch in "Remote"
Discrete Input	Local-Off-Remote selector switch in "Off"
Discrete Input	Running status
Discrete Input	Common Fail
Discrete Input	Motor overload trip
Discrete Output – Momentary	Start command (with latching done at the starter)
Discrete Output – Momentary	Stop command

VFD Driven Motors

Table 5.24 VFD Driven Motors

Type of Signal	Signal Description
Discrete Input	Local-Remote selector switch in "Remote"
Discrete Input	Local-Off-Remote selector switch in "Off"
Discrete Input	Running status
Discrete Input	Common Fail
Discrete Input	Drive alarm/fault
Analog Output	Equipment speed control
Analog Input	Equipment speed feedback
Discrete Output – Momentary	Start command
Discrete Output - Momentary	Stop command

HVAC System Hardwired Interface

The HVAC system furnished for the project will be controlled via a proprietary control system. HVAC control system ill not digitally communicate with the process SCADA system. Critical alarms from the HVAC Control Panels (HCP) shall be hardwired to the main control panel. Upon receiving an alarm, the operator will walk to the associated HCP to obtain further details and to troubleshoot.

5.5.4 Instrumentation Design Requirements

5.5.4.1 General

Every instrument providing a continuous measurement shall be the "smart" variety with digital communication capability. "Smart" instruments shall use HART protocol. Instruments shall also have a 4 to 20 milliamp output for connection to a field interface device such as a PLC. Provide two universal handheld calibrators with stored device configurations for all HART instruments used in the project. Device network shall not be utilized for instruments and valves.

All instruments that are loop-powered, otherwise referred to as two-wire, shall be powered by a 24-volt DC power supply. All four-wire instruments requiring a power supply connection external to the instrument's output signal shall be provided with a 120-volt AC, single phase power connection.

Each instrument shall be provided with a stamped stainless-steel tag. Stamping shall include the device tag number and calibrated range.

All instruments required to have a static line connection to the process shall be provided with an instrument shutoff ball valve.

Instruments mounted outdoors shall minimally be provided with a sun shade. Where required by the transmitter manufacturer, the transmitter shall be installed in a ventilated enclosure.

5.5.4.2 Sensor Material Guidelines

For instruments requiring direct connection to process, the materials of construction for the parts that are in contact with the process shall be per manufacturer recommendation. The following minimum guidelines shall be followed:

Table 5.25 Minimum Guidelines

Process Fluid/Air	Approved Material(s)
Alum	316 stainless steel
Sodium hypochlorite	Hastelloy C
Digester gas	Hastelloy C
Ferric Chloride	Tantalum or TFE & FEP
Lime	316 stainless steel
Sodium Hydroxide	316 stainless steel
Polymer	316 stainless steel

5.5.4.3 Instrument Field Wiring

For connection to instruments with a 4 to 20 milliamp output, utilize No. 16 AWG twisted, shielded, pair field cable. Except where required by the instrument manufacturer, wiring shields shall be grounded at the point of termination, rather than at the instrument itself. Shield grounds shall only be grounded at one end.

For instruments requiring a DC power connection, the DC power connection shall minimally use No. 14 AWG conductors. Voltage drop calculations should be performed as required to determine whether the conductor size shall be increased.

Instruments that are located outdoors or in an outdoor enclosure shall be provided with surge arresters. Surge arresters shall be installed at both the instrument and at the point of termination (e.g., control panel).

Provide intrinsically safe relays/barriers for all signals that originate in a hazardous area and are used in a safe area.

Instrument power shall come from power distribution panels, not lighting panels. Each instrument shall be provided with a separate breaker in the power distribution panel. Instrument power should be run in a conduit separate from the signal-wiring conduit.

5.5.4.4 Instrument Preferences

City's preferred Instrument type and manufacturers for major applications are detailed below. These are based upon matching existing installed equipment and favorable experience with the installed units. If an alternate unit is proposed, information shall be submitted for City's review and acceptance. To the extent possible, instruments used for similar types of functions and services shall be of the same brand and model line.

Level Application

Table 5.26 Level Application

Type of Measurement	Technology	Required Accessories	Approved Manufacturers
Discrete – Point Level	Float switches that do not contain mercury	None	Anchor Scientific, Roto- Float SST, Flygt
Discrete – Point Level	Flood Level switches that do not contain mercury	None	Flygt, Siemens
Discrete – Point Level	Electrode conductance relay systems	None	Warrick, Ametek, Magnetrol
Discrete – Point Level	Pressure-sensing level switch, snap action (non-mercury)	None	Ashcroft, Barksdale, Dwyer, S.O.R.
Continuous	Ultrasonic level transmitter	Transmitter separate from measuring element	Siemens, Rosemount, Magnetrol
Continuous	Radar level transmitter	None	Rosemount, Magnetrol, Vega
Continuous	Submersible pressure-sensing level transmitter	None	GE Druck, Ametek
Continuous	Flange-mount or static line pressure-sensing level transmitter	Two-valve manifold, glycerin filled, stainless steel construction	McDaniel Controls, ABB, Rosemount, Foxboro
Continuous	Laser level transmitter	None	ABB

Pressure Applications

All pressure gauges, pressure switches, and pressure transmitters shall be isolated from the process fluid with diaphragm or annular seals based on the process fluid characteristics and shall be furnished with bleed block valves.

Table 5.27 Pressure Applications

Type of Measurement	Technology	Required Accessories	Approved Manufacturers
Discrete – Single Point	Pressure switch with snap action switch (non- mercury)	None	SOR, Mercoid, Barksdale
Continuous	Pressure gauge- Bourdon tube	Pointer vibration dampening, throttling device	Ashcroft
Continuous	Gauge pressure transmitter for pressures greater than 100 inches water column (w.c.)	Two-valve manifold, glycerin filled, stainless steel construction	ABB, Rosemount, Foxboro
Continuous	Differential pressure transmitter for pressures less than or equal to 100 inches w.c. (low side vented to atmosphere)	Three-valve manifold, glycerin filled, stainless steel construction	ABB, Rosemount, Foxboro

Differential Pressure Applications

Table 5.28 Differential Pressure Applications

Type of Measurement	Technology	Required Accessories	Approved Manufacturers
Discrete – Single Point	Differential pressure switch with snap action switch (non-mercury)	Three-valve manifold	SOR, Mercoid, Barksdale
Continuous	Differential pressure transmitter	Three-valve manifold	ABB, Rosemount, Foxboro

Flow Applications

Table 5.29 Flow Applications

Type of Measurement	Technology	Required Accessories	Approved Manufacturers
Discrete – Liquid	Paddle/vane type	None	Magnetrol, McDonnell & Miller (Xylem), Sparling
Discrete – Air	Thermal dispersion	None	Magnetrol
Continuous – Liquid	Flanged-style magnetic flowmeters	Grounding rings; Teflon lining for high solids applications	ABB, Foxboro, Rosemount
Continuous – Liquid	Open channel ultrasonic flowmeter	Separate transmitter	Milltronics, Ametek, Siemens
Continuous – Air Flow	Thermal dispersion	Separate transmitter, Hastelloy probes	Magnetrol
Continuous – Digester Gas	Ultrasonic	None	Sage
Continuous – Liquid or Air Flow	Coriolis effect mass flowmeter	None	Emerson Micromotion, Krohne

Analytical Applications

Table 5.30 Analytical Applications

Type of Measurement	Technology	Required Accessories	Approved Manufacturers
Continuous	Ammonia (ISE) (Above 2 ppm)	None	Hach, WSI(Xylem)
Continuous	Electrode style pH meter	None	Electro-Chemical Devices, Foxboro, Hach/GLI, ABB, Rosemount
Continuous	Nitrate	None	Hach, WSI(Xylem)
Continuous	TSS	Hot-Tap assembly for inline applications	Hach, WSI(Xylem)
Continuous	Free or total chlorine residual (Amperometric)	RS-485 output and accompanying software	Capital Controls/De Nora, ATI, Evoqua/Wallace & Tiernan
Continuous	Gas Detector Systems	None	MSA Ultima X, Sierra
Continuous	Dechlorination	None	Evoqua/Wallace & Tiernan Products Deox/2000
Continuous	Dissolved Oxygen concentration (luminescent type)	None	Hach LDO probe with SC200 controller
Continuous	Density meter – microwave	Separate transmitter, RS-485 output and accompanying software	Toshiba, Valmet, Metso

Power Monitoring Applications

Table 5.31 Power Monitoring Applications

Type of Device	Required Accessories	Approved Manufacturers
Motor Management Relay (process-critical motors)	Motor RTD's, current and voltage transformers for each phase.	GE - 369
Power Quality Meter (for switchgear)	Current and voltage transformers for each phase. Ethernet digital communications.	GE - PQM II

Other Applications

Table 5.32 Other Applications

Type of Measurement	Technology	Required Accessories	Approved Manufacturers
Discrete – Temperature (single point)	Snap action temperature switch	None	Ashcroft, Barksdale
Continuous – Temperature	RTD (100 ohm)	Transmitter – integral or separate	ABB, Rosemount, Foxboro
Continuous – Vibration Monitor (for process critical motors)	Vibration monitor/ transmitter	None	Bentley-Nevada

5.5.5 SCADA System Application Programming Design Requirements

5.5.5.1 Package Control Systems

The application programming for each package control system shall be conducted by the equipment supplier or a package system integrator provided by the equipment supplier. The package system integrators shall also be responsible for the testing and startup of their respective equipment packages. The package system PLCs shall be programmed using Rockwell's Studio 5000 software. The OITs shall be programmed utilizing FactoryTalk View ME. Confirm the versions to be used with the Owner.

The package system integrators shall provide their own software licenses for programming. Additional software licenses need not be furnished to the Owner.

The package system application programs are not required to follow City's PlantPAX based programming standards. Manufacturer standard programming is acceptable. The package system PLCs shall be configured to allow remote monitoring and control from the plant SCADA system. The package system integrators shall provide read/write data mapping tables to facilitate this data exchange. It is anticipated that the monitoring and control features available at the plant SCADA system will be a subset of what is available at the local OIT. The details shall be developed as part of control narrative preparation.

5.5.5.2 Integration with Plant SCADA System

The integration of the solid processes control system with the plant SCADA system shall be conducted by a City approved system integrator. One of the following City approved system integrator shall be subcontracted for these services without exception:

R.E. Pedrotti Company, Inc.
5855 Beverly Ave, Suite A
Mission, KS 66202
913-677-3366

Integrated Controls, Inc.
15707 S Mahaffie St
Olathe, KS 66062
913-782-9600

Durkin, Inc.
2383 Chaffee Dr.
St. Louis, MO 63146
314-432-2040

The City approved system integrator shall perform the following services:

Main PLC and HMI Workstation Application Programming

Application program for the Main PLC and the thin client HMI operator workstation using City's programming standards and control narratives developed as part of the project. Control narrative development shall not be the responsibility of the City approved integrator. This effort shall also include:

- Programming of the hardwired HVAC system monitoring interface.
- Programming of the hardwire electrical equipment monitoring and control interface
- Programming of the Ethernet interface with the VFDs, power monitors and intelligent protective devices and control relays.
- Programming of the hardwired package control systems interface
- Programming of the Ethernet interface with the package control systems using data exchange tables.
- Modifications to the existing HMI and Historian Servers to incorporate the data from the new and upgraded solid processes
- Program the VNC server for accessing package systems OIT graphics from the SCADA system HMIs. Each package system OIT shall have a single connection (i.e., only one user can access a given OIT at any given time).

Seven hundred (700) hours shall be included in the bid for the City approved system integrator to perform the above tasks. The final scope and fee shall be developed and negotiated with the City prior to start of the programming effort.

5.6 Building Mechanical (HVAC, Plumbing and Fire Protection)

The mechanical HVAC, plumbing and fire protection design guidelines for Blue River as well as the support buildings are outlined in this section. These criteria are indicative.

5.6.1 Basis of Design

5.6.1.1 HVAC Design Basis

The following sections present the HVAC design basis for the building processes.

Outdoor Design Conditions

1. Based on climate data in Kansas City, Missouri, and as documented in ASHRAE Fundamentals Handbook latest edition:
   a. Summer (0.5 percent): 96 deg. F dry bulb, coincident 77 deg. F wet bulb. Site elevation: 740 feet ASL.

  b. Winter (99.6 percent): 2 deg. F.
2. For air-cooled condensing unit selection, the summer design dry bulb temperature of 105 deg. F will be used.
3. Process areas and mechanical rooms will not be provided with cooling. These areas will be provided with heating to minimum 60 deg F.
4. Electrical equipment rooms will be provided with mechanical cooling within the range of 75-80 deg. F and ASHRAE 90.1 Energy Code requirements will be applicable.
5. Control rooms and occupied spaces (if any) will be provided with mechanical cooling to 75 deg. F and heating to 68 deg. F and will need to comply with the ASHRAE 90.1 Energy Code requirements.

Ventilation Schedule

1. Outside air intake and exhaust air ventilation flow rate for all rooms and occupied spaces will be designed according to NFPA 820.

Table 5.33 summarizes the ventilation schedule for the different process buildings.

Table 5.33 Ventilation System Schedule Summary

Building Service	Ventilation Rate (ACH)	Ventilation type	Criteria
SOLIDS BUILDING			
Boiler Room	12	Mechanical (Supply and Exhaust)	Indicative
Polymer Room	6	Mechanical (Supply and Exhaust)	Indicative
Pre-THP Pump Room	6	Mechanical (Supply and Exhaust)	Indicative
Post-THP Pump Room	6	Mechanical (Supply and Exhaust)	Indicative
East Polymer Room	6	Mechanical (supply and Exhaust)	Indicative
Pre-THP Storage Room	6	Mechanical (Supply and Exhaust)	Indicative
Centrifuge Room	6	Mechanical (Supply and Exhaust)	Indicative
Conveyor (Cake) Rooms and Walkways	18	Mechanical Supply	Indicative
Odor Control Room	6	Mechanical supply	Indicative
Electrical and MCC Rooms	AC	Positive Pressure	Indicative
Control Room Spaces	AC	Positive Pressure	Indicative
CAKE STORAGE AND TRUCK LOADING BUILDING			
Cake Conveyor and Loading Rooms	18	Mechanical (Supply and Exhaust)	Indicative
Truck Drive	18	Mechanical (Supply and Exhaust)	Indicative

Building Service	Ventilation Rate (ACH)	Ventilation type	Criteria
SLUDGE SCREENING BUILDING	6	Mechanical supply with Exhaust Odor Control	Indicative
ELECTRICAL SUBSTATION ONE BLDG	AC	Positive Pressure	Indicative

Ventilation Systems

Ventilation heating will be natural gas. All HVAC equipment will have special construction to withstand the corrosion caused by H_2S. Special materials such as stainless steel, aluminum or chemically coated metal are acceptable. All copper piping, valves and accessories in any HVAC equipment will be coated with heresite, e-coating or approved equal.

5.6.1.2 Plumbing Design Basis

1. Plumbing fixtures or fittings intended to dispense water for human consumption will comply with ANNEX G of NSF/ANSI 61-2008.
2. All fixtures will be "water saving" type and will comply with the 2012 Uniform Plumbing Code.
3. Emergency Eyewash and Safety Showers (EWSS): Free standing all-in-one package combination shower and eye wash will be provided per code.
4. Floor drains will be provided with trap priming line to maintain trap seal per UPC.
5. Trap primer will be provided in wall box with access door located strategically to provide trap priming lines to the floor drains.
6. Hot water heaters will be provided for fixtures and for tempered water on EWSS system.

5.6.1.3 Fire Protection Design Basis

The following presents the Fire Protection design basis for the building processes.

1. Fire sprinkler system:
   a. Based on NFPA 13 and 14 latest edition.
   b. Combustible gas detection systems and portable fire extinguishers will be installed in all buildings per NFPA 820.
   c. Portable fire extinguishers will be installed, located, and maintained per NFPA 10.
   d. If required by site modifications, new fire hydrants will be installed per NFPA 24 and CFC requirements. Where feasible, the fire hydrants are recommended to be located at least 40 feet from the new structures to provide a safe separation from the structures the hydrants are protecting. Fire hydrants will be located around any new facility on the paved areas accessible by fire department apparatus. They will be readily visible and will be 5 feet from any obstruction. Fire hydrants subject to possible vehicular damage will be adequately protected with bollards. A sectional valve will be installed after every two (2) fire hydrants.

5.6.2 Facilities Requirements

5.6.2.1 General Requirements

Design-Builder will apply the following requirements when developing the design and selecting equipment and products:

- Select manufacturers whose products (i.e., air handling equipment, damper, register, valve, pump, flowmeter, duct, piping, sprinklers, control devices, alarms, etc.) have had successful operational experience and corrosion resistance in comparable service.
- Review maintenance requirements before selecting major process equipment. Provide 20-year present-worth analysis considering labor, spare part, chemical, and energy costs.
- Provide equipment in contact with potable fresh water (FW) with materials that comply with 2012 Uniform Plumbing Code.
- Equipment selection and design considerations should include the following:
  - Vibration considerations:
    - Resonant frequency:
      - For single-speed equipment, ensure there are no natural resonant frequencies within 25 percent above or below the operating rotational frequencies that may be excited by the equipment design.
      - For variable-speed equipment, ensure there are no natural resonant frequencies within 25 percent above or below the range of operating frequencies.
    - Equipment units weighing 50 pounds or more: Provide with lifting lugs or eyes to allow removal with hoist or other lifting device.
  - Power transmission systems:
    - V-belts, sheaves, shaft couplings, chains, sprockets, mechanical variable-speed drives, variable frequency drives, gear reducers, open and enclosed gearing, clutches, brakes, intermediate shafting, intermediate bearings, and U-joints are to be rated for 24 hour-a-day continuous service or frequent stops-and-starts intermittent service, whichever is most severe, and sized with a service factor of 1.5 or greater in accordance with manufacturer recommendations:
      - Apply service factor to nameplate horsepower and torque of prime source of power and not to actual equipment loading.
  - Safety guards:
    - Provide guards that protect personnel from rotating shafts or components within 7.5 feet of floors or operating platforms. Allow visual inspection of moving parts without removal. Allow access to lubrication fittings.
    - Prevent entrance of rain or dripping water for outdoor locations. Size belt and sheave guards to allow for installation of sheaves 15 percent larger and addition of 1 belt.
    - Materials:
      - Sheet metal: 12-gauge minimum thickness; stainless steel or carbon steel with hot-dip galvanized coating applied after fabrication.
      - Fasteners: Type 304 stainless steel.

- Shop drawing documentation:
  - Drawings for equipment:
    - Cut-away drawings, parts lists, material specification lists, and other information required to substantiate that proposed equipment complies with specified requirements.
  - Outline drawings showing equipment, driver, driven equipment, pumps, seal, motor(s) or other specified drivers, variable frequency drive, shafting, U-joints, couplings, drive arrangement, gears, base plate or support dimensions, anchor bolt sizes and locations, bearings, and other furnished components.
  - Installation instructions including leveling and alignment tolerances, grouting, lubrication requirements, and initial Installation Testing procedures.
  - Wiring, control schematics, control logic diagrams and ladder logic or similar for computer-based controls.
  - Recommended or normal operating parameters such as temperatures and pressures.
  - Alarm and shutdown setpoints for all controls furnished.
- Equipment Nameplates:
  - Fastened to equipment at factory in an accessible and visible location.
  - Stainless steel sheet engraved or stamped with text, holes drilled or punched for fasteners.
  - Fasteners: Oval head stainless steel screws or drive pins.
  - Text:
    - Manufacturer's name, equipment model number and serial number, motor horsepower when appropriate, and identification tag number.
- Special warranties:
  - Refrigerant compressors and closed or sealed refrigerant systems warranty duration: Provide 5-year warranty.
  - Gas fired heat exchangers warranty duration: Provide 10-year warranty.
  - Evaporator and condensing coils warranty duration: Provide 10-year warranty.

5.6.2.2 Solids Building HVAC

Ventilation System

Heating and ventilation equipment for the Solids Building will be located in the mechanical room on third floor (west). The ventilation rates per NFPA 820 are indicated in Table 5.33.

The heating/ventilation supply system will have three 50 percent direct-fired 100 percent fresh air makeup air units (MAU-1, 2 & 3. Supply air will be distributed to spaces via an aluminum distribution duct system.

The air that does not get exhausted from the odor control system will be discharge to atmosphere with three 50 percent exhaust fans (EF-1, 2 & 3) also located in the mechanical room. These units will be sized for the building to be under slightly negative pressure with the odor control system operating. The exhaust system will also require aluminum ductwork return to the fans. The air exhausted from each exhaust fan will discharge directly up thru the roof above.

Air Conditioning Systems

There are two electrical rooms and a control room located in the solids building each requiring a positive pressure air conditioning system. The two electrical rooms (Elect Room 1 and the MCC room) are located at grade level on first floor. The control room is located on the third level just below the roof on the north east side.

Each of the electrical room spaces will have two 50-75 percent DX split systems (12.5 ton each unit estimated). The air handling units (AHU) will be located either inside the room, directly above or adjacent to the room depending on space available. Each AHU will have direct access to fresh air to outside for pressurization and economizer cycle.

The condensing units (CU) will be located on the roof with refrigerant piping distributed between the systems.

As an alternate cooling source, there is a relatively new water-cooled chiller with some spare capacity located in the basement of the adjacent administration building. If there is enough capacity in this unit, chilled water could be piped to the AHUs. However, no chilled water pipe will be located in the electrical rooms, which will require the AHUs to be outside the space if chilled water can be used as the source of cooling. Once the exact loads are known for the air-conditioned spaces, a determination can be made to see if the existing chilled water system can be used for air conditioning electrical room spaces.

The control room (two 7.5 tons est.) has several options. DX split systems or chilled water systems can be used similar to the electrical rooms. Since the control room is directly below the roof, gas fired-DX roof top units could be used as an alternative to DX or chilled water systems.

Cake Storage and Truck Loading Building Ventilation

Due to the high air change rate required for the cake conveying and unloading systems, the ventilation unit (MAU-4) for this building will be located adjacent to the building at grade level outside. Due to the large size of this unit, here will be only a single 100 percent capacity direct-fired makeup unit. Exhaust fans on the roof can be used for exhaust and for backup.

The distribution ductwork for this system will be suitable for exterior routing and shall be routed into the building either thru the side or on the roof.

5.6.2.3 Sludge Screen Building HVAC

Ventilation

Ventilation shall be supplied by a roof mounted direct-fired make up air unit (MAU-5). The aluminum distribution ductwork shall be located within the space. The odor control system which is slightly larger in flow will provide negative pressure exhaust for the entire building.

5.6.2.4 Electrical Substation No. 1 Building HVAC

The Substation building located on west side of site will be air conditioned to positive pressure. This building will utilize two 50-75 percent DX wall mounted air conditioning units (10 tons est.) with an interior aluminum distribution duct system.

5.6.3 Codes and Standards

The applicable provisions of the following codes are used in the design. Unless specifically stated otherwise, the latest edition of all codes and standards shall apply.

- International Building Code.
- International Mechanical Code, 2012 edition.
- UPC, 2012 edition.
- National Fire Protection Association, latest edition.

5.6.4 Mechanical Design References

The applicable sections of the following commercial standards and publications are used in the design:

- Air Movement and Control Association (AMCA).
- Air Conditioning, Heating, and Refrigeration Institute (AHRI).
- SMACNA.
- ASTM International.
- ASHRAE.
- ANSI.
- NEMA.
- NFPA Section 820.
- NFPA Section 13 and 14.

5.6.5 Mechanical Piping and Ductwork Materials

The pipe, duct, and fitting materials are to be selected based on the type of material or fluid being conveyed and selected for longevity, durability and economy. Duct design considerations shall include the following:

- Sheet metal thicknesses:
  - The greater of that thickness required to in accordance with SMACNA for the design pressure specified and the following minimum thicknesses:

Table 5.34 Sheet Metal Duct Minimum Thickness Criteria

Diameter or Largest Dimension of Rectangular Duct (Inches)	Minimum Sheet Thickness, Inches (B&S Gauge)
Up to 12	0.025 (22)
13 to 30	0.032 (20)
Larger than 31	0.040 (18)

- Spacing of hangers and supports:
  - Provide supports as required in accordance with SMACNA stipulations but no greater than the spacing or the following requirements; whichever is less:
    - Ducts 18 inches and smaller in largest dimension: 8 feet on center.
    - Ducts over 18 inches in largest dimension: 4 feet on center.
  - Design pressure: 2 inches water column.
  - Hanger reinforcement:
    - Ducts 18 inches and smaller in largest dimension: None.

        - Ducts over 18 inches and under 30 inches in largest dimension: 1-1/2 inches by 1-1/2 inches by 1/8-inch angles, 8 feet on center.
        - Ducts 30 inches and larger in largest dimension: 1-1/2 inches by 1-1/2 inches by 1/8-inch angles, 4 feet on center.
- Access openings:
    - Size: 2 inches less than duct size.
    - Doors:
        - Gauge not less than duct sheet.
        - Provide continuous hinge and latch on outside.
    - Gasket: Along door periphery.
    - Visual panel: 1/8-inch thick, clear plexiglass.
- Turning vanes:
    - Material: Same as ductwork.
    - Type:
        - Single-blade vanes for duct widths less than 36 inches.
        - Airfoil type vanes for duct widths of 36 inches and greater:
            - No trailing edge.
    - Mounted in side rails.
    - Provide turning vanes for square-turn elbows and splitters.
    - Size: 2-inch blades for ducts up to 18 inches, 4-1/2 inch blades for larger ducts.

Insulation shall be provided on ducts carrying conditioned air that pass through outdoor or unconditioned spaces. Insulation to be either flexible or rigid duct liner with one coated surface meeting the following:

- Thickness: As required to achieve the following R-values:
    - For interior ducting on air conditioning supply, return and fresh air ducts. (FCU-1A and 1B) Provide 1-1/2 inches minimum thickness to meet an installed value of R4.2.
- Temperature range: 40 to 250 deg. F.
- Density: 1.5 pounds per cubic foot.
- Thermal conductivity: 0.25 Btu-inch per hour per square foot per degree Fahrenheit at 75 deg. F.
- Fire hazard classification in accordance with ASTM E84:
    - Flame spread: 25.
    - Smoke developed: 50.
- Service conditions: Velocities to 2,500 feet per minute.

Leading edges of insulation to be provided with galvanized metal nosing; other edges shall be sealed with manufacturer's recommended edge treatment. Insulation shall be attached with adhesive to duct and fasteners shall be spaced at not to exceed 12 inches transverse (perpendicular) to flow and 18 inches parallel (longitudinal) to flow. Fasteners also to be provided within 3 inches of transverse edges and 4 inches of longitudinal edges.

5.7 Mechanical Piping and Valves

5.7.1 Basis of Design

The piping and valve design criteria for the new facilities associated with the Project should generally be in accordance with the criteria listed in this document. While some of the proposed criteria presented herein are based on the "baseline" design definition efforts, the intent of these criteria is to provide general guidelines to the Design-Builder for the design and construction of these facilities. Good judgment will still be required by the detailed design engineers, as not all mechanical design criteria could reasonably be listed in this document.

The selection of the appropriate piping and valves will be based on performance, operating efficiency, safety, long-term durability, and Owner preferences and standard practices. Corrosion resistance, and operations and maintenance are also important considerations.

5.7.2 Codes and Standards

- The following codes and standards were used to develop the mechanical piping Unless specifically stated otherwise, the latest edition of all codes shall apply. International Building Code.
- 2018 IMC.
- 2018 International Plumbing Code (IPC).
- 2018 IFC.
- 2016 NFPA 820.
- American Society of Plumbing Engineers (ASPE) Handbooks.
- ASHRAE Handbooks and Standards.
- NFPA Recommended Practices and Manuals.
- OSHA Standards Manual.
- 2017 NEC.

In addition to the codes listed above, the following reference codes and standards shall be followed in the design of the systems involved with this project.

- **ASME Pressure Vessel Code Section VIII**. The various pressure vessels associated with this project shall be designed in accordance with this code.
- **AWWA Standards, as applicable.** Specific components of the systems, such as piping and valves, shall be specified to meet these standards.
- **ASTM, ANSI, and ASME Standards, as applicable**. Specific components of the piping and valve systems, including joints and connections, shall be specified to meet these standards.
- **Ductile Iron Pipe Research Association (DIPRA) Standards, as appropriate**. Specific components of ductile iron pipe, including thrust restraints, shall be specified to meet these standards.

5.7.3 Pipe Material Design Requirements

5.7.3.1 Piping Schedule

A list of pipe identifiers, materials, pipe color/markers, and flow stream identifiers with descriptions, are summarized and presented in Table 5.35 and Table 5.36, respectively.

Table 5.35 Preliminary Pipe Identifiers and Materials

Identifier	Material
BSP	Black Steel Pipe
CIP	Cast Iron
CISP	Cast Iron Soil Pipe
CPVC	Chlorinated Polyvinyl Chloride
CUP	Copper Pipe
DIP	Ductile Iron Pipe
FRP	Fiberglass Reinforced Plastic Pipe
GSP	Galvanized Steel Pipe
HDPE	High Density Polyethylene
PP	Polypropylene
PVC	Polyvinyl Chloride
RCP	Reinforced Concrete Pipe
SST	Stainless Steel
STL	Steel
VCP	Vitrified Clay Pipe

Table 5.36 Flow Stream Identifiers, Descriptions, and Pipe Identification Schedule

Flow Stream Identifier	Descriptions	Color of Pipe	Color of Bands/Markers	Color of Letters
AA	Aeration Air			
BDF	Blended Digester Feed			
BG	Biogas			
CE	Centrate			
CHD	Chemical Drain	Yellow	Match Chemical Service	Black
CW	Cooling Water	Blue	None	Black
CWR	Cooling Water Return	Blue	None	Black
CWS	Cooling Water Supply	Blue	None	Black
D	Drain (Sanitary)	Black	None	White
DG	Digester Gas			
DS	Digested Sludge	Brown	Dark Green	White

Flow Stream Identifier	Descriptions	Color of Pipe	Color of Bands/Markers	Color of Letters
DWS	Dewatered Sludge			
FAD	Foul Air Duct			
H2S04	Sulfuric Acid			
HWR	Hot Water Return	Blue	Red	Black
HWS	Hot Water Supply	Blue	Red	Black
IA	Instrument Air	Dark Green	None	Black
NAOH	Sodium Hydroxide (Caustic Soda)			
NG	Natural Gas	Yellow	Red	Black
NPW	Non-Potable Water	Blue	None	Red
OF	Overflow	Yellow	Match Chemical Services	Black
PD	Pump Drain	Black	None	White
PRTP	Pre-THP Polymer	Yellow	Orange with Green Stripes	Black
POTP	Post-THP Polymer	Yellow	Orange with Green Stripes	Black
PTS	Post THP Sludge			
RAS	Return Activated Sludge	Brown	None	White
RD	Roof Drain			
RS	Raw Sludge	Brown	None	White
S (G), S (P)	Sanitary Sewer (Gravity or Pumped)	Gray	None	Black
SA	Sample Line	Dark Blue	Black	White
SCR	Screenings			
SS	Storm Sewer			
SSL	Screened Sludge			
STM	Steam	Yellow	Green	White
SOX	Siloxane			
THS	Thermally Hydrolyzed Sludge	Brown	Dark Blue	White
TS	Thickened Sludge			
V	Vent			
VTR	Vent to Roof			
W	Potable Water	Blue	None	Black
WAS	Waste Activated Sludge	Brown	None	White

5.7.3.2 Sludge Piping

The general criteria for sludge piping shall include the following:

- Minimize number of fittings.
- Provide quick breakdown (Victaulic type) fittings in appropriate locations.
- Use long radius bends.
- Use flexible connections at pumps.
- Provide fittings, valves, and blind flanges for flushing of pipeline.
- Pressure gauges will be full pipe diameter sensor type (Red Valve, Onyx, or equal).
- Flowmeters (if required) will be ultrasonic or magnetic type.

5.7.3.3 Buried Pipeline Design

All design issues pertaining to buried pipeline shall adhere to civil design criteria in the Basis of Design Document. Unless otherwise specified, all buried piping shall be installed with a minimum 4-foot cover without air traps. Buried piping for pressure systems shall be restrained and glass lined.

5.7.3.4 Ductile Iron Piping

All DIP shall be installed in accordance with AWWA C600 and shall be in conformance to the following design criteria:

- External load calculations per AWWA C150.
- Thrust restraints per DIPRA methodology:
  - Design pressure: 100 psi or test pressure (whichever is higher).
  - Allow for polyethylene encasement in calculations.
- Standard laying condition:
  - Diameter < 16 inches: Type '2' per AWWA C150.
  - Diameter = 16 inches: Type '3' per AWWA C150.
  - Diameter > 16 inches: Type '5' per AWWA C150.
- Pressure class selection per DIPRA Standards (100 psi surge allowance).
- Corrosion protection:
  - Two layers of loose polyethylene wrap per AWWA C105 / A21.5-99.

Flanged Connections. Flanges shall be DIP screw-on and will comply with the diameter, thickness, drilling, and other characteristics specified in ANSI B16.1 for 150-pound flanges. Two bolt holes, aligned at both ends of the pipe, will be provided. All bolts and nuts shall be as specified in ANSI/ASME B16.1. Standard gasket materials for DIP should be as follows:

- Non-steam cleaned - neoprene, EPDM, or Viton.
- Steam cleaned, non-glass-lined - neoprene, EPDM, or Viton with non-asbestos fiber reinforcement.
- Steam cleaned, glass lined - one-piece Teflon.
- Flanged digester gas - Teflon enveloped EPDM.
- Non-metallic piping - Teflon enveloped EPDM.

Mechanical Joint Connections. Mechanical joints shall be in accordance with AWWA C111/ANSI A21.11.

Push-On Rubber Gasket Connections. Push-on rubber gasket joints shall be in accordance with AWWA C111/ANSI A21.11.

Restrained Push-On Connections. Restrained push-on joints shall be designed to have flexibility after assembly and shall be such that they are suitable for the following working pressures:

- For 4- through 24-inch pipe: 350 psig.
- For 30- through 54-inch pipe: 250 psig.

Grooved Connections. Grooved joints shall adhere to AWWA C606, as complemented and modified below:

- Couplings shall be rigid type, cast from ductile iron in accordance with ASTM A536, Grade 65-45-12 or malleable iron in accordance with ASTM A47, Grade 32510.
- Bolts and nuts shall be in accordance with ASTM A183, Grade 2.
- Gaskets shall be capable of being applied on surface of piping with cavities to provide for an improved seal with the internal piping pressure; material for the following services:
  - For liquid service: Halogenated butyl, EPDM, or Viton.
  - For air service: Fluoroelastomer.
  - For hot water service: EPDM.
- Fittings shall adhere to AWWA C606. They shall be rigid radius-cut groove with center-to-center dimensions in accordance with AWWA C110/ANSI A21.10 and wall thickness in accordance with AWWA C153.

Fittings. Fittings shall conform to AWWA C110/ANSI A21.10 or AWWA C153/ ANSI A21.53.

Asphaltic Base Coating. Asphaltic base coating shall be applied in accordance with AWWA C151/ANSI A21.51 over cement mortar linings and to outside surface of pipes that will not receive another coating.

Cement Mortar Lining. Cement-mortar lining shall be applied in accordance with AWWA C104/ANSI A21.4 on clean bare metal surfaces, extended to faces of flanges, ends of spigots, and shoulders of hubs.

Polyethylene Lining. All polyethylene lining shall be a blend of high-density and low-density polyethylene powders. It shall be compounded with an inert filler and carbon black. This lining shall be a minimum of 30-mils thick and resistant to ultraviolet light. It shall be in conformance with ASTM D1248. Polyethylene lining shall be applied uniformly to preheated pipes and fittings at a temperature that allows uniform fusing of the polyethylene powders and proper bonding to surfaces.

Glass Lining. Glass lining shall be formed of special glasses and inorganic materials suited for lining of sewage, sludge, and scum piping. It shall have the following characteristics:

- Thickness: 0.008 to 0.012 inch.
- Hardness: 5 to 6 on the Mohs Scale.
- Density: 2.5 to 3.0 grams per cubic centimeter, measured in accordance with ASTM D792.
- Thermal shock resistance: Capable of withstanding 350 deg. F change from 430 deg. F to 80 deg. F without crazing, blistering, or spalling.
- Gloss retention: Capable of retaining gloss after immersion of an 8 percent sulfuric acid solution at 148 deg. F for 10 minutes.

- Weight loss: Maximum 3 milligrams per square inch when tested in accordance with ASTM C283.

Epoxy Lining. The interior of all pipe specified as coal tar epoxy lined shall be lined with epoxy coating as specified for submerged metal.

Polyethylene Encasement. DIP to be buried with polyethylene encasement shall be wrapped in accordance with AWWA C600 and C105.

5.7.3.5 High Density Polyethylene Piping

The dimensions of all HDPE piping shall be based on controlled outside diameter in accordance with ASTM F714. All fittings and custom fabrications shall be fully rated for the same internal pressure as the mating pipe. Pressure de-rated fabricated fittings are prohibited. Piping and fitting determination and usage shall be governed as follows:

- Molded fittings: ASTM D3261.
- Outside diameter, wall thickness, and eccentricity: ASTM D2122 at a frequency of at least once/hour.
- Straightness, inside and outside surface finish, markings, and end cuts: ASTM D1505.
- Melt index: ASTM D1238 at a frequency of at least once per extrusion lot.
- Carbon content: ASTM D1603 at a frequency of at least once per day per extrusion line.
- Quick burst pressure: ASTM D1599 at a frequency of at least once per day per line.
- Ring tensile strength: ASTM D2290 at a frequency of at least once per day per line.
- Installation: ASTM F645, or as instructed by manufacturer.

5.7.3.6 Polyvinyl Chloride Piping:

- PVC schedule type piping of designation PVC 1120 shall conform to ASTM D 1785 and its appendices.
- The pipes and fittings shall be extruded from Type 1, Grade 1, Class 12454-B material, in accordance with ASTM D 1784.
- All PVC schedule type piping shall be Schedule 80 unless otherwise indicated.
- The solvent cement shall be in accordance with ASTM D 2564.
- PVC class type piping, for water and reclaimed water distribution service, shall conform to AWWA C 900, Minimum Pressure Class 150, and DR not more than 18.
- The fittings shall be cast or ductile iron, sized for the dimensions of the pipe being used.
- Joints shall be push-on or mechanical type, as identified in the Piping Schedule.
- PVC gravity sewer piping shall be in accordance with ASTM D 3034 for piping NPS 15 and smaller diameter, and ASTM F 679 for piping NPS 18 and larger diameter.
- NPS 15 and smaller diameter shall have a wall thickness SDR 26, whereas NPS 18 and larger diameter will be Class Number 12454-B as specified in ASTM D 1784 and a SDR not greater than 35.
- Neoprene gaskets conforming to ASTM D 3212 or ASTM F 477 shall be used.
- For gaskets connecting to manholes, stainless steel clamps or similar devices shall be used to seal the penetration.

5.7.3.7 Post-Chlorinated Polyvinyl Chloride Piping

- CPVC pipe shall be Schedule 80, in accordance with ASTM F 441.
- The fittings shall conform to ASTM F 438. Pressure fittings shall conform to or ASTM F 439 as appropriate to the service and pressure requirement.
- The solvent cement shall be in accordance with ASTM F 493.
- In instances when the CPVC pipe will be in sodium hypochlorite service, IPS Corp Type 724 cement or another cement certified by the manufacturer for high strength hypochlorite service shall be utilized.

5.7.3.8 Rubber Gasketed Reinforced Concrete Piping

Two types of rubber gasketed reinforced concrete (RGRC) pipe may be used in the project. The first type is for gravity flow (open channel) applications and is manufactured per ASTM C-76 Standards:

- Used for gravity influent sewers provided that it is plastic-lined to resist damage from hydrogen sulfide.
- Designed according to the specific "D-load" required to handle anticipated external loads. Load calculations will be based upon installation conditions, including trench condition, trench with superimposed load condition, or embankment condition as appropriate.
- Portland cement shall be per ASTM C-150, Type II, low alkali.
- Rubber gaskets shall be per ASTM C-361, O-Ring type, with a minimum 50 percent neoprene compound.
- Cast-in-place reinforced concrete pipe shall not be allowed.
- Existing plant pipelines constructed of RGRC (ASTM C-76) include:
  - 24-inch canal drain.
  - 48-inch influent sewer.

The second type of RGRC pipe will be low-head pressure piping per ASTM C-361:

- Suitable for low pressure, full pipe flow conditions where larger diameter buried pipelines are required between process basins.
- The design parameters shall be based on required internal pressure and depth of cover.
- Must also be plastic-lined for hydrogen sulfide resistance in all locations upstream of the aeration basins.
- This pipe material is preferred over ASTM C-76 RGRC piping where water tightness at low pressure is important.
- Cement and gasket materials are identical to the ASTM C-76 pipe.

5.7.3.9 Fabricated Steel Piping

External load calculations per AWWA Manual M11, with the following modifications:

- Wall thickness: As designed or minimum 1/4 inch for pipe from 12 inches in diameter to, and including, 72 inches in diameter or minimum 5/16 inch for pipe larger than 72 inches in diameter, whichever is thicker.
- Inside diameter of unlined pipe: Nominal.
- Inside diameter of lined pipe: As measured from face to face of liner, but not less than nominal.

- Deflection of underground pipe inside diameter: Maximum 2 percent under trench load of H-20 live load in accordance with AASHTO specifications.
- Working stress of steel: Maximum 50 percent of yield stress.

Corrosion protection:

- Exterior dielectric coating (fusion-bonded epoxy or plastic tape wrap).
- Electrically isolated from aboveground piping at both ends.

5.7.4 Valve Design Requirements

Table 5.37 summarizes the types of valves to be used in various applications as part of this project.

Table 5.37 Preliminary Valve Schedule

Flow Type	Application	Valve Type	Lining / Comment
Sludge Digested BDF Dewatered RAS Raw Screened Thickened THS WAS	Isolation	Eccentric plug	Full round port
		Pinch valve	Use where practical with unscreened sludge.
	Check valves	Swing check or Cushioned Swing Check	Must be installed horizontally Sometimes installed in pairs Upstream grinding recommended
		Motorized eccentric plug	Interlocked to pumps
Centrate	Isolation	Eccentric plug	Pinch valve
Water Plant Water Cooling Water Hot Water Potable Water	Isolation	Butterfly	
	Check valves	Cushioned Swing	
	Flow control valves	Motorized Butterfly	Capable of modulation
Aeration Air	Isolation	Butterfly	
	Check valves	Cushioned Swing	
	Flow control valves	Motorized Butterfly	Capable of modulation
Gas Natural Gas Digester Gas Biogas Steam	Isolation	Eccentric Plug	

Flow Type	Application	Valve Type	Lining / Comment
Chemical			
Sodium Hydroxide Siloxane Sulfuric Acid Pre-THP Polymer Post-THP Polymer	Isolation	Ball Valve	

Notes:
(1) Acceptable valve types for chemical systems are listed in TM-A7.

Valve handwheels and levers should be painted with matching color as pipe.

5.7.4.1 Butterfly Valves

The following is a list of pertinent butterfly valve design requirements:

- Design valves and actuators for maximum operating torque per AWWA C540 using the following values:
  - Safety factors as identified in AWWA C540.
  - Maximum water velocity: 16 feet per second with valve fully open.
  - Maximum pressure differential across closed valve: Equal to the pressure class designation.
  - Coefficient for seating and unseating torque, dynamic torque, and bearing friction in accordance with valve manufacturer's published recommendations.
  - Valve disc: Seat in an angular position of 90 degrees to the pipe axis and rotate an angle of 90 degrees between fully open and fully closed positions.

The butterfly valves shall have tight shutoff at the pressure rating of the valve with pressure applied in either direction. The valves shall be suitable for the following service conditions: throttling, frequent operation, operation after long periods of inactivity, installation in any position, and flow in either direction.

5.7.4.2 Swing Check Valves

For valves 1/4 inch through 3 inches, design should be as follows:

- Threaded joints.
- Y-pattern body with integral seat.
- Hinged disc.
- Access to valve seat for regrinding without disassembly of piping.

For valves 1/4 inch through 3 inches, materials should be as follows:

- Body, cap, hinge, and disc: Bronze.

For valves 4 inches through 24 inches, design should be as follows:

- Conform to AWWA C508.
- Constructed to permit top entry and removal of internal components without removal of valve.

- Equipped with outside lever and weight.

For valves 1/4 inch through 3 inches, materials should be as follows:

- Body: Cast-iron, ASTM A126, Class B.
- Disc: 4-inch valves - Bronze; 6 inches and larger valves - Bronze faced.
- Hinge pins: Stainless steel.

5.7.4.3 Cushioned Swing Check Valves

Valve design should be as follows:

- Counter-weighted, mounted horizontally.
- Rubber seated and drip tight.
- Pneumatic dampening chambers with adjustment for closing speed.

Valve materials should be as follows:

- Body, cover, and disc: Cast-iron, ASTM A126, Class B.
- Disc seat: EPDM.
- Shaft: Stainless steel.
- Cushion cylinder: Corrosion-resistant metal.
- Disc ring seat: Bronze.
- Seat pins and lock screws: Stainless steel.

5.7.4.4 Ball Check Valves

- Ball check valves shall be of ductile iron, ASTM A536, or of cast iron, 30,000 psi tensile strength, ASTM A126, Grade B.
- The top entry, bolted bonnet casing shall be cast with integral flanges conforming to ANSI B16.1, Class 125.
- All bolts, nuts, and washers shall be zinc- or cadmium-plated or 304 stainless steel.
- The ball shall be ductile iron, ASTM A536, Grade 65-45-12 or cast iron, ASTM A126, Grade B with rubber coating. The ball shall be of sufficient weight to sink under a non-flow condition in the sludge or wastewater for the service intended.
- The valves shall be clog-proof in design.
- The valve shall be provided with a stem seal of TFE or Viton that seals tightly from internal pipeline forces.
- All ball check valves shall be rated at a minimum working pressure of 150 psig.

5.7.4.5 Non-Lubricated Plug Valves

Valve design should be as follows:

- Type: Eccentric.
- Plug face: Resilient material, which operates satisfactorily at a temperature of 180 deg. F continuous and 215 deg. F intermittent, except for valves in compressed air or digester gas service.
  - Valves in compressed air service: Resilient material suitable for continuous duty at 250 deg. F.
  - Valves in digester gas service: Resilient material suitable for petroleum or digester gas at continuous duty at 180 deg. F.
  - Valves for use in centrate service: Glass lined full-port plug valve.

- Compression washer: Provide flat compression washer made of Teflon, or of a material having equal physical characteristics on valve stem between plug and bonnet.
- Stem seals: Provide stem seals serviceable without unbolting the valve bonnet assembly.
- Clearly mark valves to indicate their open and closed positions.

Valve materials should be as follows:

- Body and plug: ASTM A126, Class B, cast-iron with plug face composed of Neoprene, Buna N, isoprene, hycar, EPDM, or Viton.
- Body seats in valves 3 inches and larger: Provide with overlay of not less than 90 percent nickel and minimum thickness of 1/8 inch on surfaces contacting the plug face.
- Stem bearing and bottom bearing: Stainless steel Type 316.
- Internal parts, except the body and plug: Type 316 stainless steel, Monel, or nickel.
- Exposed nuts, bolts, and washers: Zinc plated.
- Exposed nuts, bolts, and washers for buried service: Type 316 stainless steel.

5.7.4.6 Lubricated Eccentric Plug Valves

Valve design should be as follows:

- Type: Semi-steel tapered plug valve.
- Plug removable through top of valve.
- Combined lubricant screw and grease gun fitting, of the type where the pressure of the grease can be used to raise the plug slightly off its seat.
- If necessary, provide plug valves with high head extension and floor stand with indicator. Provide worm gear-operated valves with worm shaft extension and floor stand, and with indicator supplied by manufacturer of plug valve.
- Equip floor stands serving plug valves with individual operating wrenches.

5.7.4.7 Multi-Port Plug Valves for Sludge Service

The design should include a non-lubricated tapered plug valve including plugs faced with neoprene, body of cast-iron, and stainless steel bearings in the upper and lower journal areas. Valves should be furnished with single, double, or transfer style plugs.

5.7.4.8 Pinch Valves

The design should include sleeve material suitable for operation requiring continuous opening and closing of the valve. Sleeves shall be Teflon reinforced with butyl nylon or other equivalent reinforcing material.

5.7.4.9 Ball Valves

Metal body ball valves shall be used on metallic pipelines and plastic body ball valves shall be used on plastic pipelines. It should be noted that metal body ball valves should <u>not</u> be used in sodium hypochlorite systems.

Metal body valves ≥ 6 inches in size:

- Shall be non-lubricated and capable of sealing in either flow direction.
- Shall conform to AWWA C507.
- The stem packing shall be manually adjustable while the valve is under pressure.
- The valves shall comply with ANSI B16.1, Class 125 flanged ends.

- The body shall be ASTM A48 cast iron and integrally cast bronze-brushed trunnions.
- The ball shall be Type 304 or Type 316 stainless steel.
- The seal shall be PTFE or Viton.

Metal body valves of < 6 inches in size:

- Shall also be non-lubricated and capable of sealing in either flow direction.
- Valves less than 3 inches in size shall have threaded or soldered end connections. Valves between 3 and 6 inches in size shall be flanged according to ANSI/ASME B16.1, Class 150 standards.
- The stem packing shall be manually adjustable while the valve is under pressure.
- The shafts shall connect rigidly to the ball by a positive means.
- The connection shall be designed to transmit torque equivalent to at least 75 percent of the torsional strength of the shaft.
- The handles shall be stainless steel latch lock with vinyl grip and stainless steel nut designed to open and close the valve under operating conditions.
- The valve shall be suitable for operation between 20 and 350 deg. F.
- The body of valves in copper lines shall be bronze; whereas for valves in steel and ductile iron piping, the bodies shall be ductile iron or cast steel.
- The ball shall be Type 304 or Type 316 stainless steel.
- The seat shall be PTFE, and the seal shall be either PTFE or Viton.
- The bearings shall be self-lubricated, corrosion resistant, constructed of material that will not contaminate potable water.

Plastic body valves of <6 inches in size:

- The end connections shall be true union; or solvent or heat welded to piping.
- The body shall be polyvinyl chloride.
- The ball shall be polyvinyl chloride.
- The seats shall be PTFE.
- Rings shall be EPDM (sodium hydroxide service) or Viton (siloxane and sulfuric acid service).

5.7.4.10 Gate Valves (Aboveground)

Aboveground gate valves less than 3 inches in size used to transport clean water and air service shall be formed of manufacturer's standard bronze and have the following: solid wedge disc, rising stem, screwed end. These valves shall be of Class 150 pounds. Valves 3 inches in size and larger shall be resilient wedge type in compliance with AWWA C509.

5.7.4.11 Gate Valves (Belowground)

Valve design should be as follows:

- Resilient wedge type in compliance with AWWA C509.
- Iron body, resilient seat, non-rising stem, double O-ring stem seal.
- Ductile or cast iron wedge encapsulated in nitrile rubber and capable of sealing in either flow direction.
- Bronze stem with double or triple O-ring or braided packing stem seals.

- Coat interior and exterior surfaces of valve body and bonnet with fusion bonded epoxy in accordance with AWWA C550.
- Valve Operator: Provide standard AWWA 2-inch operating nut, matching valve key and valve box for operating stem.

5.7.5 Pipe System Design Requirements

5.7.5.1 Pipe Velocities

- Minimum velocities in wastewater piping should generally be limited to 2 to 3 ft/s. If the minimum flow is relatively constant, the lower velocity limit will be acceptable. In order to minimize the possibility of stagnation and bacterial growth with plant water chlorinated (PWC) and potable water pipelines, the minimum velocities should be at least 1 ft/s.
- Maximum pipe velocities in wastewater and water piping should generally be limited to less than 5 ft/s, except in piping over 16 inches in diameter, where the velocity can be increased up to 6 ft/s. For short force mains, higher velocities (up to 10 ft/s) will be allowed. Head loss constraints should supersede these criteria, if critical. Note that pump discharge velocities can be greater than 10 ft/s. Maximum pipe velocities will be calculated at the appropriate peak design flow condition (normally peak hour flow).
- Minimum velocities in solids piping should be on the order of 2 to 3 ft/s to minimize deposition. Dilute sludges with grit should be maintained greater than 3 ft/s.
- Maximum velocities in solids piping should generally be on the order of 6 to 7 ft/s. Sludge pumping without grit requires sufficient velocity to maintain solids in suspension, but not as high as with grit.
- Maximum velocities in aeration air and gas piping should generally be less than 2,500 feet per minute (fpm) to reduce noise through fittings.

5.7.5.2 Pipe Supports

The following design standards should be applied to design of piping support systems:

- American National Standard Institute or Manufacturer's Standardization Society (ANSI/MSS):
  - SP-58 - Standard for Pipe Hangers and Supports - Materials, Design, and Manufacture.
  - SP-69 - Standard for Pipe Hangers and Supports - Selection and Application.

Materials of Construction. Type 304 or 316 stainless steel pipe supports shall be used at all submerged locations, where supports are located below the tops of walls of water-bearing structures, and in other wet and/or corrosive areas. At all other locations, the City may approve on a case by case basis hot-dip galvanized steel.

Installation:

- Two-inch and smaller piping shall be supported on horizontal and vertical runs at maximum 5 feet on center, unless otherwise specified.
- Piping larger than 2 inches shall be supported on horizontal and vertical runs at maximum 10 feet on center, unless otherwise specified.
- Regardless of size, PVC and other plastic pipes shall be supported at maximum 5 feet on center, unless otherwise specified.

- Tubing, copper pipe and tubing, fiber-reinforced plastic pipe or duct, and rubber hose and tubing shall be supported at intervals close enough to prevent sagging greater than 1/4 inch between supports.
- Supports shall be installed at horizontal bends, both sides of flexible pipe connections, base of risers, floor penetrations, connections to pumps, blowers and other equipment, and valves and appurtenances.
- All hanger rods, supports, clamps, anchors, brackets, and guides shall be sized in accordance with ANSI/MSS SP 58 and SP 69.

5.7.5.3 Connection of Pipes to Structures

Flexible Pipe Connections to Structures

It is necessary to provide flexibility in the connection of a pipe to a structure for a number of reasons. The two most common reasons are for soil settlement and seismic movement. A practical means of accommodating soil movement is by providing flexible pipe joints. Usually pipe joints should be used in pairs to allow the pipe to articulate between the two pipe joints. The first pipe joint should be located as close to the wall of the structure as practical. Locate the second pipe joint a distance away from the first joint as is required to accommodate the expected soil movement. Depending on the pipe materials, restrained or unrestrained pipe joints shall be required.

In general, the typical connection should provide a short section of pipe rigidly connected to the wall. A flexible coupling such as a Dresser Coupling may connect this short section of pipe to a "floating" section of pipe. Another flexible coupling may then connect the floating section of pipe to the rest of the pipe.

Wall Penetrations

Various wall penetration details shall be required based on the different pipe materials, above or below water surface elevation, and degree of fixity at the wall. The below water surface elevation wall penetration may be to use a link type seal with City approval; and when the wall is 12 inches in thickness or greater, two link type seals should be provided. The other common below water surface elevation wall penetration shall be to use a flanged spool piece with an annular ring cast in to the wall during the wall construction.

5.7.5.4 Signage

- Signage and color-coding will be provided on all piping as required by Owner standards
- Individual equipment components will be signed as required by OSHA and Owner standards.
- Chemical rooms will be signed as required by the International Fire Code (IFC) and Owner standards.

5.8 Security (Physical and System)

Fencing shall be 8 ft tall vinyl coated with 3 strands of barbed wire.

Relocate or replace the existing guard shack in kind.

Chapter 6

PERMITTING RESPONSIBILITY

Design/Builder shall consult with Owner relative to applicable project permits.

Design Builder shall create a Permitting Plan during the Preliminary Design Phase and revise throughout the project duration. Design Builder will hold most of the permits and shall develop permit applications and supporting documentation in accordance with applicable regulations. Design Builder Permitting Plan shall provide a list of necessary Design Builder-held permits that are Design Builder led, in which the Design/Builder will obtain the permit from the respective permitting agency. A summary of the anticipated Design/Builder-held permits that are Design Builder-led is provided in Table 6.1. The Design/Builder's Schedule, prepared in accordance with the requirements of the Contract Documents, shall include permitting activities occurring within both technical and construction phases, including a schedule for permit development, review of each permit, incorporating review comments, agency submittal, preparing responses to agency comments, review of responses, resubmittal to agency, and anticipated approval. The Permitting Plan shall identify submittal requirements and address roles and responsibilities, internal and external communication strategies and protocol as well as permit tracking procedures (for compliance purposes). The Design/Builder Permitting Plan shall also identify Owner-held permits and designate if the permits are Owner-led or Design/Builder led. Permits on the critical path for the delivery of the design or construction will be identified.

The Design Builder has primary responsibility for preparation, coordination, agency approval, compliance with permit requirements, renewals, transfers and/or closeout of the Design Builder-held and Design Builder-led permits identified in Table 6.1. They have responsibility for supporting Owner in compliance with permit requirements for Owner-led permits identified in Table 6.1.

If required during the Construction Phase, Design/Builder shall pay all agency permitting fees for the Design Builder-held permits identified in Table 6.1, including application, review, inspections, renewals, bonding and insurance, transfers and closeout, except for the Kansas City Building/Utility Permits for permanent structures.

Design Builder shall submit ten (10) copies of the draft updated Permitting Plan to Owner within twenty-one (21) calendar days following notice to proceed. Thereafter, Design Builder will coordinate with Owner to determine if an update to the Design Builder Permitting Plan is required for the project duration.

Design Builder shall schedule and facilitate a half-day review meeting with Owner to present the draft Permitting Plan and discuss permitting coordination between the Design/Builder and Owner. Owner will provide comments on the draft updated Permitting Plan prior to the meeting.

Design/Builder will address comments at meeting and Owner will be requested to accept draft updated Permitting Plan with the adjudication of comments reviewed at the meeting.

Design Builder shall support Owner maintenance of the permit tracking database with monthly updates of Design/Builder permit acquisition activities and manage the critical path schedule for permit acquisition. Owner to support maintenance of the critical path schedule through monthly updates of Owner permit acquisition activities. The anticipated approval dates for each permit shall be shown in the Progress Schedule provided by the Design Builder as a requirement of the Contract Documents.

Design Builder shall schedule and facilitate monthly permitting coordination meeting with Owner to discuss permit acquisition, coordination, and compliance activities. The Design Builder shall provide monthly status report to Owner.

The Design Builder shall prepare for and attend up to six (6) agency coordination and/or public meetings for the project. The Design Builder shall prepare and distribute meeting minutes.

Table 6.1 Identified Permits for Westside Facility Plan

Permit	Permit Holder	Document Lead
Air Permit	Owner	Owner
Construction permit/licenses	Contractor	Contractor
Land Disturbance permits	Contractor	Contractor
SWPP	Contractor	Contractor
All applicable licenses/permits from public or private for Subs	Contractor	Contractor
For disposal of asbestos materials.	Contractor	Contractor
Permit Required Confined Space	Contractor	Contractor
Occupancy permits	Contractor	Contractor
Demolition	Contractor	Contractor
Severance of utility services	Contractor	Contractor
Transport/Disposal of debris	Contractor	Contractor
Close/Obstruction of Roadways	Contractor	Contractor
Permit to work in MoDOT ROW	Contractor	Contractor
Permit from KC Public Works	Contractor	Contractor
Permits for temp process pumping	Contractor	Contractor
Permits for discharging testing water	Contractor	Contractor
Permit for water disposal/discharge	Contractor	Contractor
Permit for usage of temporary boilers and/or generators	Contractor	Contractor
Applicable USACE permits	Contractor	Contractor
Permits/fees for temp power and electrical service	Contractor	Contractor

Notes:
(1) This list of permits is for guidance only and may not include every permit required for successful completion of this Work. Design Builder will be responsible for obtaining, completing, submitting, and paying for all applicable permits.

If Design Builder intends to use temporary generators and/or steam boilers, the Design Builder should indicate the capacity and sizing of the units in their Technical Proposal so that it can be incorporated into the Owner's Air Permit.