FINAL

PRELIMINARY ENGINEERING REPORT

Broad River Wastewater Treatment Plant

B&V PROJECT NO. 410381
B&V FILE NO. 40.0510

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CERTIFICATE OF AUTHORIZATION

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BLACK & VEATCH

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Executive Summary

The Broad River Wastewater Treatment Plant (BRWWTP) is located in Gaffney, SC, at 100 Marietta Street. The existing plant was constructed in 1981 with a permitted capacity of 4.0 million gallons per day (MGD).

The purpose of this preliminary engineering report (PER) is to assess and ensure that the BRWWTP can reliably process wastewater to its permitted capacity. A finding of this this evaluation is that the BRWWTP has sufficient capacity to process at 4.0 MGD of wastewater based on existing permit requirements. While capacity exists, there will need to be upgrades or replacements projects at the BRWWTP to maintain this capacity over the next several years.

This PER 1) assesses the capacity of each unit treatment process and 2) provides recommendations for BRWWTP improvements to maintain the calculated capacity.

The existing liquid process train consists of a headworks, a lagoon aeration basin, a secondary clarification system, and chlorine disinfection. The existing solids process train consists of two sludge thickening tanks and a biosolids holding tank.

The following projects have been identified to maintain the permitted capacity:

- Replace influent pumps and add AFDs at the Providence Creek pump station
- Install differential head controls at the headworks screening system
- Implement Hydraulic control improvements
- Conduct a survey and then adjustment of final clarifier weirs
- Conversion of sludge wet well to piping gallery
- Selective wasting improvements
- An additional sludge storage tank of 1-million-gallon capacity
- Electrical and Instrumentation upgrades

This PER discusses each of these improvements and provides an opinion of probable cost to install these facilities at the BRWWTP.

1.0 Introduction

1.1 Background

This Preliminary Engineering Report (PER) presents a facility assessment of the Broad River Wastewater Treatment Plant (BRWWTP) prepared by Black & Veatch (BV) under contract with the Gaffney Board of Public Works (GBPW).

Gaffney is the county seat of Cherokee County, South Carolina. The GBPW owns and operates two wastewater treatment plants (WWTP) which include the Clary WWTP and the Broad River WWTP (BRWWTP). Both plants are extended aeration wastewater treatment plants. The influent flow at each plant is a combination of industrial and domestic wastewater. The BRWWTP has a permitted flow of 4.0 MGD and an average existing flow of approximately 2.0 MGD of treated wastewater.

1.2 Purpose and Scope

This PER provides an evaluation of the existing facilities, flows, and loads, and recommends capital improvements for the BRWWTP. The improvements are recommended to maintain a reliable operation, to accommodate projected flows from current city limits and prospect industries, and to meet discharge permit limits. An opinion of probable cost estimate for the recommended improvements has been provided to allow the City to prioritize the implementation schedule.

1.3 Contact Information

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2.0 Study Area and Wastewater Characteristics

2.1 Introduction

This section provides an overview of the BRWWTP based on

1) A summary of the existing and future sewer service area
2) Estimate of population projections for future conditions
3) Review of historical and projected wastewater characteristics (flow and loads)
4) Assessment of impacts from the flood information
5) Review of flood information impact

2.2 Site Location

The BRWWTP is located at 100 Marietta Street, Gaffney, SC 29340, which is in Cherokee County and on the eastern side of Gaffney as shown in Figure 2-1.

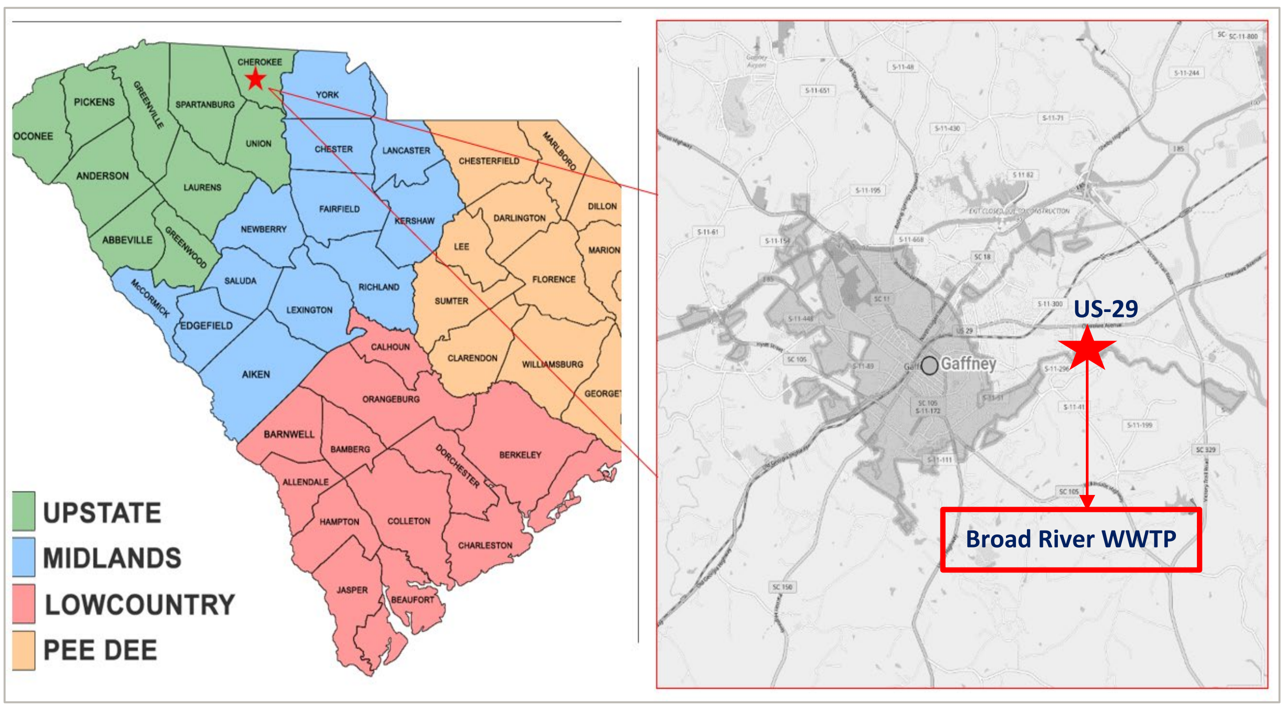

Figure 2-1 Site Location Map

2.3 Sewer Service Area

The GBPW provides wastewater treatment services to customers in the greater Gaffney area of Cherokee County, South Carolina. Flows from the sewer service area as shown in Figure 2-2, are conveyed throughout Gaffney to both the BRWWTP and the Clary WWTP using 12 wastewater pump stations.

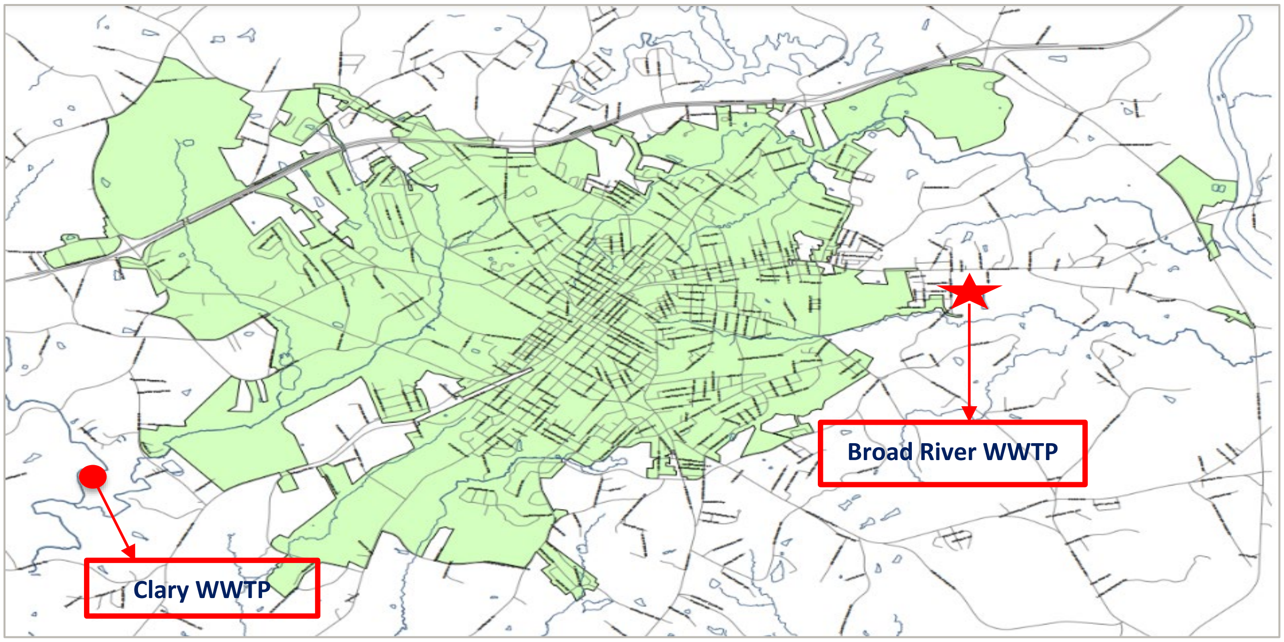

Figure 2-2 Sewer Service Area

2.4 Populations Projections

The 2010 Census (last official U.S. Census) established the population of the City at 12,414 which represents a four (4) percent decline over a decade, 2000. Gaffney's population has declined steadily since 1980, following a two (2) percent increase between 1970 and 1980. Between 1980 and 2010, the city's population declined by 1039 persons which accounts for 8.37 percent. Refer to Table 2-1.

Population projections by the South Carolina Revenue and Fiscal Affairs Office, the official census agency in the South Carolina, projected the Cherokee County population to increase through 2020, but remain consistent between 2020 and 2025, as shown in Table 2-2.

Vismor & Associates previously projected the population growth for the City using low, median, and high growth estimates shown in Table 2-2. In 2021-2022, the population of the City was approximately 12,700 people based on internal estimates. The calculated 2021-2022 population corresponds closest with the low growth estimate by Vismor & Associates. For the purposes of this assessment, the low growth approach was used to project the population trends. It is anticipated that insignificant growth changes will occur over the planning period.

Table 2-1 U.S. Census Estimates – City of Gaffney

Year	Population	Actual Growth	Annual Growth Rate
2022	12,780	57	+0.45%
2021	12,723	57	+0.45%
2020	12,666	57	+0.45%
2019	12,609	102	+0.45%
2018	12,507	-275	-2.20%

Year	Population	Actual Growth	Annual Growth Rate
2017	12,782	-138	-1.08%
2016	12,920	354	+2.74%
2015	12,566	-31	-0.247%
2014	12,597	-60	-0.476%
2013	12,657	208	+1.64%
2012	12,449	18	+0.145%
2011	12,431	17	+0.137%
2010[(1)]	12,414	-540	-4.35%
2000	12,954	-191	-1.47%
1990	13,145	-308	-2.34%
1980	13,453	322	+2.39%
1970	13,131		

1. Last official U.S. Census.

Table 2-2 Population Forecasts, Cherokee County and City of Gaffney

	2013	2015	2020	2025
Cherokee County	55,885[(1)]	56,100[(2)]	56,800[(2)]	56,700[(2)]
City of Gaffney	12,657[(1)]			
Low Growth[(3)]		12,600	12,540	11,980
Median Growth[(4)]		12,850	13,035	13,345
High Growth[(5)]		N/A	13,300	13,600

1. U.S. census estimates.
2. Projections for county by South Carolina Revenue and Fiscal Affairs Office.
3. Projection for the City by Vismor & Associates (V&A) based on assumption that City will continue to lose population at the same rate as from 2000 to 2010.
4. Projection for the city by V&A based on assumption that the city will grow at the same projected rate as the county (4 % over a 10-yr period), with limited annexation.
5. Projection for the city by V&A based on moderately aggressive annexation program, and internal growth equal to 2 % rate of projected county growth.

2.5 Wastewater Characteristics

The main components of the BRWWTP influent flows are residential and industrial. This section presents the current wastewater flows based on the evaluation of historical data. Recorded data provided by the BRWWTP staff include influent flow and daily rainfall from calendar years 2018 through 2021.

2.5.1 Influent Flows

The BRWWTP has a permitted capacity of 4.0 MGD while existing annual average (AA) flows are 2.0 MGD. The maximum monthly (MM) average influent flows and the peak day (PD) flows were analyzed and calculated based on actual daily wastewater flow data recorded from 2018 through 2021. During this 4-year period, the highest PD flow of 5.65 MGD occurring in 2020 compared to the corresponding AA flow of 1.92 MGD yields a peak day factor (PDF) of approximately 3.0 as shown in Table 2-3.

Table 2-3 Flow Data, 2018-2021

Influent Parameters	Units	2018	2019	2020	2021	4-Yr Avg
Annual Average Flow	MGD	2.00	2.03	1.92	1.68	1.91
Maximum Month Flow	MGD	2.78	2.49	2.39	2.46	2.53
Peak Day Flow	MGD	5.19	5.22	5.65	3.95	5.00
MM: AA Peaking Factor	-	1.39	1.23	1.25	1.47	1.33
PD: AA Peaking Factor	-	2.60	2.57	2.94	2.35	2.52

The instantaneous flow data at the BRWWTP is recorded on a circular chart that has a 24-hr duration (from 7AM to 7AM). The maximum instantaneous wet-weather flow that can be recorded on the circle chart is 5 MGD.

Daily total flow is recorded on Supervisory Control and Data Acquisition (SCADA), however, digital hourly flow data was not available. Therefore, the peak hour factor (PHF) was determined by analyzing selected circle chart data during wet-weather storm events over a 5-year period (2018-2022). Only flow data during storm events where flows could be continuously recorded on the circular charts (5 MGD or less) were evaluated.

The following Tables 2-4 and 2-5 present a range of flow data corresponding to the selected storm events and summarize the peaking factors for the selected storm events.

Table 2-4 Flow Data Range of Selected Storm Events, 2018-2022

Parameters	Units	2018	2019	2020	2021	2022
Selected Events	-	17	7	14	11	6
24-hr Average Flow	MGD	1.9 – 2.7	2.2 – 3.1	1.9 – 3.0	1.6 – 2.8	1.9 – 2.5

Parameters	Units	2018	2019	2020	2021	2022
Storm Average Flow	MGD	2.2 – 3.5	2.4 – 3.3	1.6 – 3.3	1.7 – 3.5	2.3 – 3.0
Storm Maximum Hourly Flow	MGD	2.4 – 4.4	2.7 – 3.5	2.3 – 3.8	2.1 – 4.6	2.8 – 3.7
Peaking Factor	-	1.1 – 1.4	1.0 – 1.3	1.1 – 1.6	1.1 – 1.5	1.1 – 1.5
Note: Flows and factors are represented by range based on the selected events.						

Table 2-5 Flow Data for Peak Hour Factor, 2018-2022

Influent Parameters	Units	2018	2019	2020	2021	2022
24-hr Average Flow	MGD	2.0	2.5	2.0	2.2	2.2
Storm Average Flow	MGD	2.2	2.9	2.1	2.8	2.7
Peak Hourly Flow	MGD	2.6	3.5	2.5	3.5	3.2
Peak Hourly/Storm Average Factor	-	1.18	1.21	1.19	1.25	1.19

The average of the peak hourly/storm average ratio was used to approximate the relationship to the extended wet weather event on the peak day. Flow data for peak day flow events correlate to extended wet-weather events of 24 hours or longer. The projection of the future flow rates was estimated using the relationship between the peak day to the annual average factor (PD:AA) and the peak hour to the storm average factor (PH:SA).

The PD:AA and PH:SA factors are 3.0 and 1.2, respectively. Therefore, a factor of 3.0 is used to estimate the peak day flow from the annual flow and a factor of 3.6 is used to estimate the peak hour flow during a storm event. The peak flow rates are shown in Table 2-6.

Refer to section 4.0 – Plant Hydraulics for impact of flow rates on each unit process.

Table 2-6 Permitted Flow Rate with Peaking Factors

Annual Average	PD:AA Factor	Peak Day	PH:AA Factor	Peak Hour
Permitted flow, 4.0 MGD	3.0	12 MGD	3.6	14.4 MGD

2.5.2 Influent Loads

Influent waste load characteristics were determined on a mass basis using historical data. Mass loads were analyzed for biochemical oxygen demand (BOD) and total suspended solids (TSS) from 2018-2011.

The annual average (AA), maximum month (MM), and peak daily (PD) mass loads were calculated to determine the plant capabilities to meet the current permit limits under all conditions.

Daily BOD_5 and TSS concentrations for the period of January 2018 through November 2021 is presented in Tables 2-7 and 2-8, respectively.

Table 2-7 Historical BOD_5 Loading Data, 2018-2021

Influent Parameters	Units	2018	2019	2020	2021	4-Yr Avg
Annual Average Concentration	mg/L	126	130	146	170	143
Annual Average Load	ppd	2,130	2,195	2,599	2,356	2,320
Maximum Month Load	ppd	3,121	3,490	3,892	3,211	3,428
Peak Daily Load	ppd	5,964	4,531	6,012	5,026	5,383
MM: AA Peaking Factor	-	1.47	1.59	1.50	1.36	1.48
PD: AA Peaking Factor	-	2.8	2.06	2.31	2.13	2.32

Table 2-8 Historical TSS Loading Data, 2018-2021

Influent Parameters	Units	2018	2019	2020	2021	4-Yr Avg
Annual Average Concentration	mg/L	120	136	139	142	134
Annual Average Load	ppd	2,049	2,327	2,517	1,981	2,218
Maximum Month Load	ppd	4,000	3,728	5,529	2,963	4,055
Peak Daily Load	ppd	11,394	5,563	10,707	5,248	8,228
MM: AA Peaking Factor	-	1.95	1.60	2.20	1.50	1.81
PD: AA Peaking Factor	-	2.85	1.49	1.94	1.77	2.01

2.6 Receiving Waters

Effluent from the Broad River WWTP is discharged into the Broad River via an existing diffuser to aid in mixing.

2.7 Flood Information

According to the Department of Health and Environmental Control (DHEC) Standards for Wastewater Facility Construction – Regulation 61-67 Section 67.300.F.4, all new wastewater treatment facilities shall be designed to be fully operational during flooding from a twenty-five (25) year flood and shall be designed to be protected from physical damage from flooding from a one hundred (100) year flood.

Through the project development review process, Cherokee County will review the proposed plan and confirm compliance with both federal and local floodplain regulations.

The BRWWTP site is located on FEMA flood insurance rate map (FIRM) panel 45021C0180D, dated September 16, 2011. The map shows special flood hazard areas including the regulatory floodway and the areas subject to inundation by 1% annual chance (100-yr flood), and the areas subject to inundation by 0.2% annual chance (500-yr flood). Figure 2-3 shows floodplain information from the FEMA FIRM panel along with the current site plan layout of BRWWTP. On this figure, the 100-year floodplain is identified by areas in blue and pink, including the hatch pattern, which represents the regulatory floodway boundary.

The 500-year floodplain is identified by the orange areas and includes the 100-year floodplain areas. These floodplain boundaries are designated as floodway, Zone AE, and Zone X, each carrying different floodplain regulations. The floodway is the most restrictive zone, as this area is intended to remain free from obstruction to convey flood water.

The BRWWTP site is adjacent to the floodplain limits, with the south side encroaching into the 100-year and the 500-yr floodplain boundaries. FEMA's Flood Insurance Studies and the Cherokee County's flood map provide water surface elevation (WSEL) for each flood frequency. The 100-year and 500-year flood WSEL is recorded as 633.2 feet and 635 feet, respectively. All elevations reference the North American Vertical Datum of 1988. Therefore, water level rise during the 100-yr flood event will only impact the disinfection process.

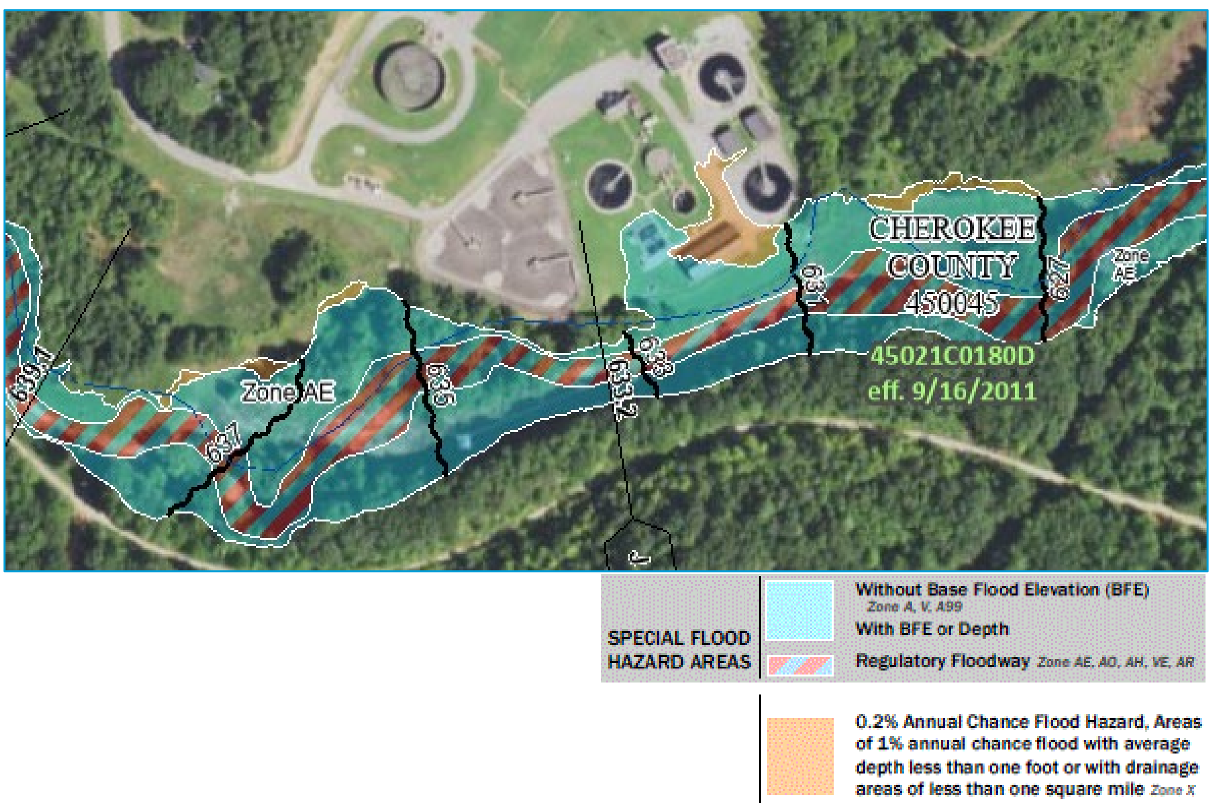

Figure 2-3 Flood Areas from FEMA Flood Map

3.0 Existing Facilities

This section outlines the design data for existing treatment units and major equipment.

3.1 NPDES Discharge Permit

The BRWWTP operates under NPDES discharge permit # SC0047091, issued on April 20th, 2015, and effective June 1st, 2015 through May 31st, 2020. Although expired, the permit will continue to be in effect beyond the expiration date due to re-application by Gaffney Board of Public Works pursuant to Regulation 61-9.122.6 and Regulation 61-9.122.22.

The discharge limits for conventional pollutants through the Broad River outfall are shown in Table 3-1.

Table 3-1 NPDES Discharge Limits at the Broad River Outfall

Permit Parameters	Units	Monthly Average	Weekly Average	Daily Maximum
Flow	MGD	MR	MR	-
BOD_5	mg/L	30	45	-
TSS	mg/L	30	45	-
NH3-N	mg/L	MR	MR	-
TRC	mg/L	0.5	-	1.0
Dissolved Oxygen	mg/L	1.0 Minimum at all times		
pH	-	6.0 – 8.5 Standard Units		
BOD_5 Percent Removal	%	85	-	-
TSS, Percent Removal	%	85	-	-
Total Phosphorus	ml/L	MR	MR	-
Total Nitrogen	mg/L	MR	MR	-

3.2 History and Upgrades

The BRWWTP was initially constructed in 1950 and has undergone improvements and upgrades in 1969, 1981, 1994, 1997, and 1998. The BRWWTP is an activated sludge system consisting of a screening influent structure, a concrete lined aeration basin followed by secondary clarification, a chlorine contact basin, an effluent pumping station, a sludge thickening structure, and a sludge holding tank.

The most recent upgrade completed in 1998 included improvements to the aeration basin effluent structure, secondary clarifiers, sludge holding and transfer system, and chlorine contact basin.

A general process flow schematic is shown in Figure 3-1, and an aerial of the site layout is presented in Figure 3-2.

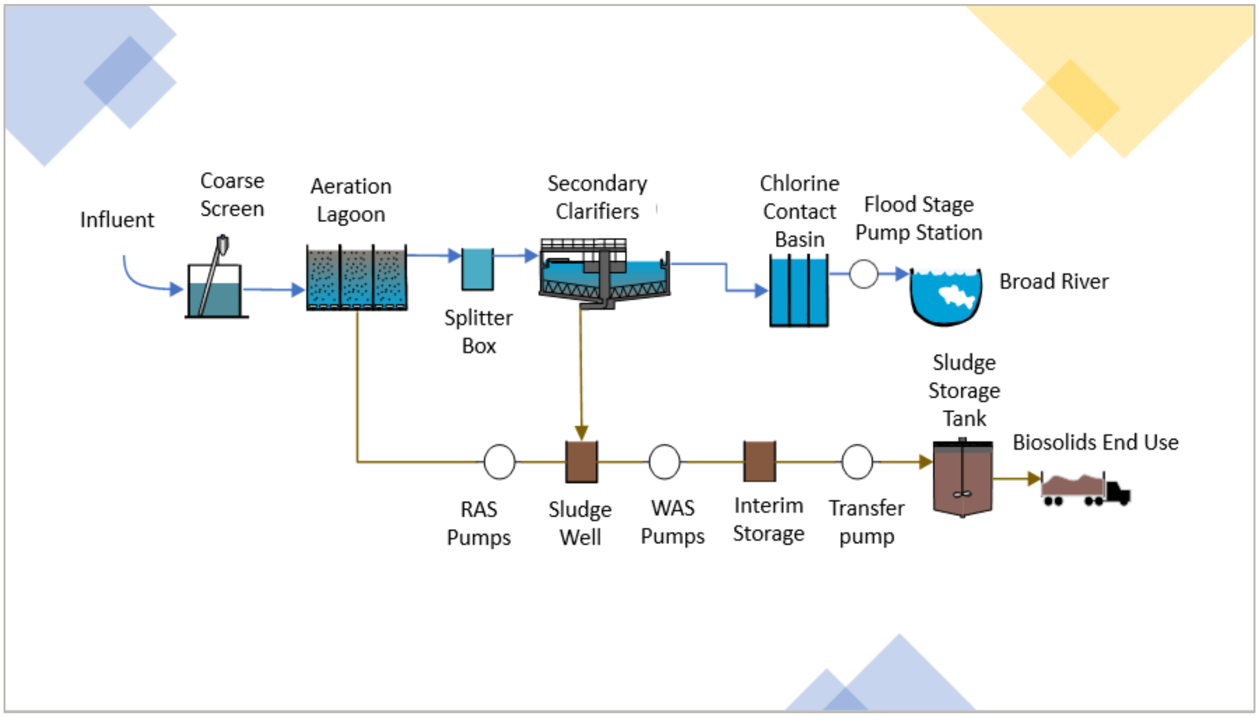

Figure 3-1 Existing Process Flow Schematic

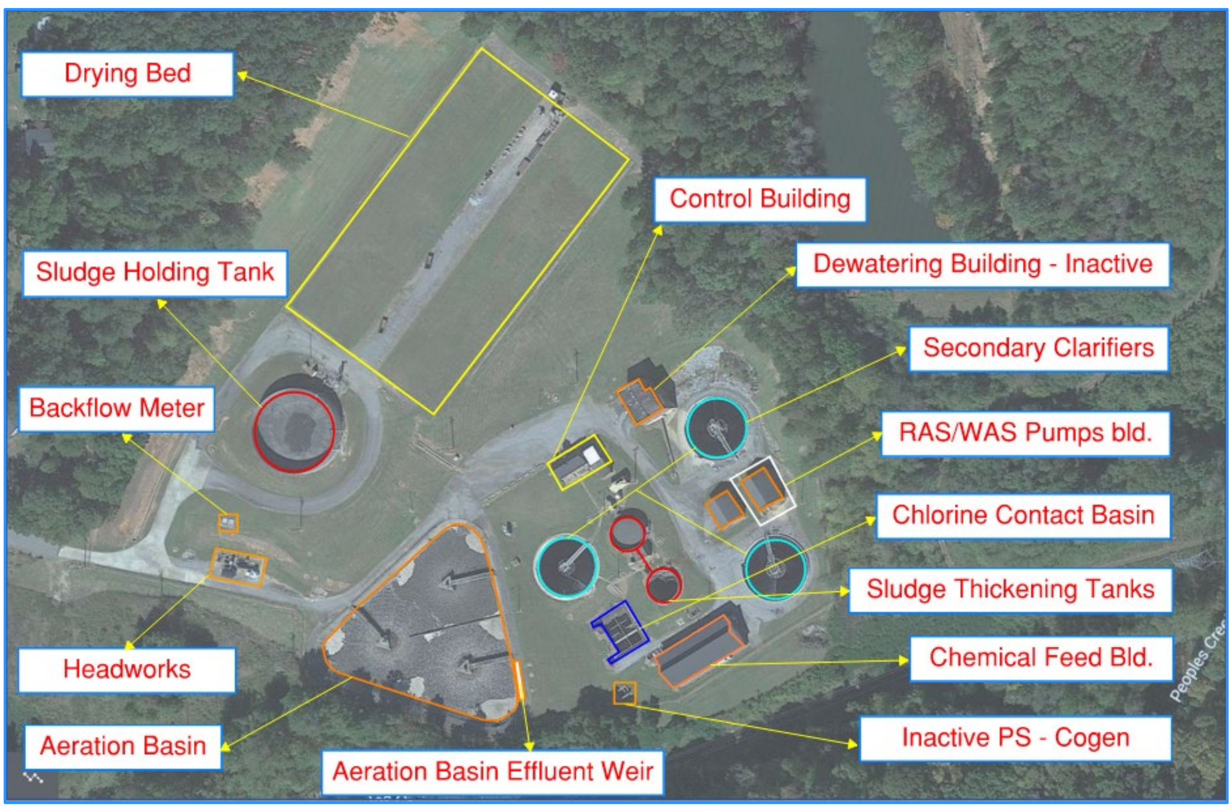

Figure 3-2 Existing Aerial Layout

3.3 Providence Creek Pump Station

The Providence Creek pump station constructed in 1998 consists of three (3) constant speed Fairbanks Morse submersible non-clog sewage pumps controlled by a triplex control panel as described in the table below.

Table 3-2 Existing Pumps – Providence Creek Pump Station

Parameter	Description
Manufacturer	Fairbanks Morse
Model	5434MV
Type	Submersible
Capacity/each, gpm	1285 @ 210' TDH
Quantity	3
Maximum Operating Speed, rpm	1800
Rated Power /each, hp	150

When the wet well is drawn down to the cutoff level, the Providence Creek pump station stops discharging and flow to the BRWWTP drops off a corresponding amount. Such flow variations at the treatment facility create process issues for flow pacing disinfection and other flow-based controls.

The Gaffney Board of Public Works has requested an upgrade to the Providence Creek pump station by replacing existing pumps and adding variable frequency drives (VFDs) to regulate flows into the BRWWTP. This work is further described in Section 5 – Wastewater Treatment Plant Improvements.

3.4 Headworks Structure

The Headworks structure was built in 1998 and consists of mechanical and static bypass screening and flow monitoring through a Parshall flume. The raw influent enters the headworks through a 36-inch pipe. Debris collected by the mechanical screen is compacted and discharged into a dumpster.

3.4.1 Screening

Broad River WWTP is equipped with an Aqua Guard Screen Model AG-MN-A with compactor and spray header. The screen operates as an endless moving belt that collects, conveys, and ultimately discharges the solids that are removed from the wastewater.

The screen was originally installed in 1998 with float and timer capabilities, but currently operates continuously. The design basis of the mechanical bar screen is as follows:

Table 3-3 Existing Mechanical Screen

Parameter	Description
Number of Screens	1
Filtration Opening, mm	6

Parameter	Description
Manufacturer	Parkson Corporation
Capacity, MGD	15

3.4.2 Parshall Flume

The headworks structure consists of a 24-inch throat Parshall Flume which has an approximate hydraulic capacity of 21 MGD. The overall condition of the Parshall Flume is good and does not require any improvements or upgrades.

3.5 Aerated Lagoon

3.5.1 Aerated Lagoon Basin

The aeration basin was constructed in 1969 and consists of a triangular shape with a total volume of 3.2 MG and a side water depth of 12 feet. The raw influent and return mixed liquor from the headwork enters the aeration basin at the upstream end of the basin.

The aeration basin is equipped with three (3) 100 hp surface aerators that mechanically transfer oxygen to the mixed liquor.

The flow leaves the aeration basin through a splitter box at the downstream end of the basin and continues to the secondary clarifiers through a 24-inch pipe.

Table 3-4 Existing Aeration Basin

Parameters	Description
Number of Basins	1
Volume in Service, MG	3.2
Aerator Type	Mechanical
Mixers, Qty	3
Mixers Rated Power (each), hp	100

The plant staff indicated that when one of the three (3) surface aerators is out of service it impacts the ability of the plant to maintain the desired dissolved oxygen (DO) level.

GBPW staff have indicated that repair and maintenance of aeration equipment will be an internal project.

3.5.2 Aerated Lagoon Splitter Box

The function of the aerated lagoon splitter box is to divide the wastewater flow equally between the three secondary clarifiers. Gates are located in the splitter box to control and isolate flow to the secondary clarifiers. However, the gates are not fully operational, and improvements will be required to allow plant operations to fully control flow at the structure.

3.6 Secondary Clarifiers

The system consists of three (3) secondary clarifiers. Secondary Clarifier No. 1 was constructed in 1998 and Secondary Clarifier No. 2 and No. 3 were constructed in 1981. Each clarifier is a center feed unit with a sludge scraper mechanism.

Settled activated sludge is returned from the clarifiers to the aeration basin to maintain the mixed liquor suspended solids (MLSS). All excess settled sludge is wasted to the solids storage tank for the residuals contract operator to collect and arrange for final disposal.

The secondary clarifiers have weir elevation discrepancies which impact process performance during low flow scenarios. This is discussed further in Section 5.0 Wastewater Treatment Plant Improvements.

Table 3-5 Existing Secondary Clarifiers

Parameters	Description
Number of Clarifiers	3
Geometry, Type	Circular
Diameter, ft	75
Side Water Depth, ft	14
Manufacturer	Envirex /US Filter
Overflow Rate (all clarifiers in Operation):	
Avg. @ 2.0 MGD, gal/day/ft^2	226
Peak day @12 MGD, gal/day/ft^2	905
Peak hour @ 14.4 MGD, gal/day/ft^2	1,649
Detention Time @ 2.0 MGD, hours	5.5
Volume, gal	462,440
Drive, hp	1

Typical overflow rates at 700 gpd/ft^2 for average conditions and 1,400 gpd/ft^2 for peak day events. Clarifies appear to have sufficient capacity form a process evaluation standpoint.

3.7 RAS/WAS Pump Station

The system consists of a pump and piping system for return activated sludge (RAS) and waste activated sludge (WAS). Once the wastewater has been settled in the secondary clarifiers, the RAS is recirculated back to the aeration basin to maintain the desired mixed liquor suspended solids (MLSS) concentration. WAS is gradually pumped to the sludge thickening tanks before being transferred to the sludge storage tank.

3.7.1 Return Activated Sludge Pumps

Return activated sludge (RAS) pumps return solids from the clarifiers to the aeration basin. RAS flow from each of the clarifiers is controlled by weir gate. The RAS flow rate is set by the operators. The system includes three pumps, valves, and flow meters.

The wet well is a separate fully enclosed underground chamber located beneath the RAS/WAS pump room structure into which sewage is collected prior to pumping.

The existing configuration of the system including one (1) RAS pump directly connected to Secondary Clarifier No. 1 and two (2) other Pumps (one duty and one standby) that are connected to Secondary Clarifiers No. 2 and No. 3 via a common wet well.

GBPW indicated they would prefer to see the sludge piping configured to allow pumping RAS/WAS from the individual clarifiers rather than the existing common wet well. Refer to Section 5 for recommended improvements.

Table 3-6 Existing RAS Pumps

Parameter	Pump 1	Pump 2	Pump 3
Manufacturer	Gorman-Rupp	Gorman-Rupp	Gorman-Rupp
Type	Self-Priming Centrifugal	Self-Priming Centrifugal	Self-Priming Centrifugal
Model	T6A-B-3	T8A-B-3	T8A-B-3
Rated Power, hp	25	40	40
Capacity, gpm	1,150	1,670	1,670

3.7.2 Waste Activated Sludge Pumps

Waste activated sludge (WAS) pumping capacity is adequate with all units in service and is evaluated as a proportion of design average flow. WAS pumping basis criteria is as follows:

Table 3-7 Existing WAS Pumps

Parameter	Description
Manufacturer	Gorman-Rupp
Number of Pumps	2
Rated Power (each), hp	75
Capacity per Pump, gpm	200 @ 37.5’ TDH

3.8 Solids Handling

3.8.1 Sludge Thickening Tanks

There are two sludge thickening tanks between the administration/control and chemical feed buildings. Sludge thickening is accomplished by gravity settling. Refer to Table 3-8 and Table 3-9 for blower and pump information associated with these two sludge tanks.

One of the two sludge thickening tanks was initially used as an anaerobic digester before being converted in 1981. Both tanks have a similar configuration, the same air piping system, and the same design criteria for the blowers with an arrangement of inner and outer rings.

The tanks receive the sludge produced by the secondary clarifiers, where it is settled, and decanted before being pumped to the new sludge holding tank uphill.

Table 3-8 Existing Sludge Thickening Tanks

Parameter	Description
Type	Cast-in-Place Concrete Tanks
Number of Tanks	2
Inner Ring Diffusers, qty.	23
Outer Ring Diffusers, qty.	64

Table 3-9 Existing Sludge Thickening Tank Blowers

Parameter	Description
Manufacturer	Jim Myers & Sons Inc.
Type	Positive Displacement Rotary
Number of Blowers	2
Flow, scfm	1,250
Pressure, psig	11
Rated Power (each), hp	100
Speed, rpm	1,725

Table 3-10 Existing Sludge Transfer Pumps

Parameter	Description
Manufacturer	Gorman-Rupp
Model	T6A3-B

Parameter	Description
Type	Self- priming Centrifugal
Number of Pumps	2
Rated Power (each), hp	40
Speed, rpm	1,530
Capacity per Pump, gpm	500 @ 102' TDH

3.8.2 Sludge Storage Tank

The sludge storage tank has a volume of 1 million gallons and provides sufficient sludge storage for anticipated maximum month sludge generation rates.

Table 3-11 Existing Sludge Storage Tank

Parameter	Description
Manufacturer	Liquid Tech. Tank Systems Inc.
Type	Bolted Stainless Steel
Number of Storage Tanks	1
Inner Ring Diffusers, qty.	39
Outer Ring Diffusers, qty.	79
Diameter, ft	101
Side Water Depth, ft	17
Storage Volume, MG	1

The capacity of the sludge storage tank is sufficient for the maximum daily sludge production rates. However, the capacity of this tank can be exhausted if offsite hauling and disposal are delayed due to weather or transportation delays. A discussion of additional sludge storage tanks is presented in Chapter 4.0

Table 3-12 Existing Sludge Storage Tank Blower

Parameter	Description
Manufacturer	United Blower Inc.
Type	Rotary Lobe
Number of Blowers	1
Rated Power, hp	125

Parameter	Description
Flow, scfm	1,250
Speed, rpm	1,765

3.9 Chlorine Contact Basin

Disinfection is achieved in the chlorine contact basin where chlorine is added to kill remaining bacteria. There is one basin that is divided into two trains, baffled to promote plug flow through the basin. At the effluent end of the basin, sulfur dioxide is added for dechlorination.

Table 3-13 Existing Chlorine Contact Basin

Parameter	Description
Number of Basins	1
Number of Channels	2
Both Channels in Operation:	
Total Volume	88,000 gallons
Detention Time at Average Flow of 2.0 MGD	63.4 minutes
Detention time at Peak Day flow of 12.0 MGD	10.6 minutes
Detention Time at Peak Hour Flow of 14.4 MGD	8.8 minutes

Therefore, the detention time at the peak day flow conditions is a bit less than the 15 minutes at peak flow conditions established by literature and 10 State Standards. To achieve effective disinfection the chlorine dose will need to be increased due to the shorter contact times during peak flow events.

3.9.1 Chemical Feed System

The chemical feed system consists of low-pressure, vacuum-type gaseous feed units for chlorine disinfection, and sulfur dioxide for dechlorination fed from 2-ton cylinders.

Table 3-14 Existing Chemical Feed System

Parameter	Description	Description
Type	Chlorinators	Sulfonators
Number of Feeders	2	2
Capacity (each)	500 lbs./day	200 lbs./day

3.10 Effluent Flow Monitoring

Effluent from the chlorine contact basin flows into an effluent monitoring channel. At this point, effluent flow proportioned composite samples are taken, and the pH and dissolved oxygen are monitored. Flow then enters the effluent Parshall flume (18-inch throat width) for flow measurement.

3.11 Effluent Pump Station and Outfall

The effluent pump station downstream of the Broad River Wastewater Treatment Plant (BRWWTP) consists of two Flygt submersible pumps capable of pumping treated effluent from the BRWWTP to the Broad River when flooding conditions in the river do not permit a gravity flow. The treated effluent is pumped through a 12-inch force main and discharged into the river through a diffuser.

The diffusion system includes multiple orifices evenly spaced along the length of the outfall pipe. The diffuser helps distribute and maximize the velocity of the effluent discharge to increase the mixing speed with the river and allow for more gradual integration.

The effluent pump station includes site piping, electrical and control equipment, and an emergency generator system.

Table 3-15 Existing Effluent Pumps

Parameters	Description
Manufacturer	Flygt
Type	Submersible
Model	FLS 3300
Qty	2
Capacity (each), MGD	8.6
Operating Speed, rpm	875
Rated Power (each), hp	60

The BRWWTP effluent pump station has sufficient capacity to avoid backflows during critical 100-yr storm events.

3.12 Existing Electrical Conditions

The electrical distribution system consists of a single utility pad mounted transformer which feeds the normal side of an automatic transfer switch. The emergency side of the transfer switch is fed by a 545kVA standby diesel generator. The load side of the automatic transfer switch feeds a 1000A, 480V outdoor switchboard. The switchboard distributes power to each motor control center (MCC) via feeder breakers. Each MCC then distributes power to various process loads adjacent to it. With exception of the RAS Building MCC, all 480V electrical distribution equipment (MCC-1, MCC-2, Main Switchboard) are located outdoors. The outdoor equipment shows visible rust forming on the outside of the enclosure, each with locations of paint peeling. The table below is provided to provide reference for each piece of major electrical equipment and key factors of the equipment.

Table 3-16 Existing Major Electrical Equipment

Equipment	Location	Manufacturer / Model	Year Installed	Condition
Main Switchboard	Outdoors	Square D / I-Line	1980	Exterior paint peeling, presence of insects within enclosure, minimal rust on interior, some breaker labels missing, main breaker tripping upon return to utility from generator (coordination issue)
MCC-1	Outdoors	GE / Model 7700	1970	Exterior paint peeling, presence of insects within enclosure
MCC-2	Outdoors	Square D / Model 4	1980	Exterior paint peeling, cover for a wireway unattached, moderate rust on interior, presence of insects within enclosure
RAS MCC	RAS Building	Square D / Model 4	1980*	Minor dust and dirt accumulation
Automatic Transfer Switch	Outdoors	ASCO	1992*	Minor rust accumulation on bottom of enclosure, minor paint peeling
Engine-generator	Outdoors	CAT	1992	Moderate exterior rust
*approximate year				

Outside of the electrical distribution equipment, it was noted that the site had security issues with unauthorized access to the plant and equipment being tampered with. Therefore, the electrical switchboard and MCC will need to be replaced as part of this PER.

3.13 Existing Instrumentation and Controls Conditions

There are no SCADA workstations onsite, all monitoring is done by water plant personnel. All equipment is operated manually with exception of chlorination, which is based on effluent flow measurement. Current instrumentation exists for effluent flow, sludge return pumped flow and influent flow. There are some instances where existing instrumentation has been installed and is no longer operating. Currently the bar screen runs continuously due to lack of level sensing upstream of the bar screen. The plant also lacks influent flow pH monitoring. Currently the sludge tanks have no level sensing and operators are required to manually check tank level. Therefore additional instrument and control improvements will need to be made under this project.

3.13.1 Instrumentation and Controls Upgrades

To keep the bar screen at the headworks facility from continuously operating and to increase screen efficiency, level control should be added. A pH instrument is recommended to be added at the headworks to better monitoring influent flow into the plant. It is recommended to install ultrasonic level transducers on the sludge storage tanks to reduce the chance of an overflow and allow plant operations to view tank level without manually checking tank level. The influent flow monitoring is currently scaled to 5 MGD, however the flows have surpassed 5 MGD during wet weather events. The scale of the flow monitoring device should be rescaled to better capture influent flow to the plant.

4.0 Plant Hydraulics

4.1 Plant Hydraulic Capacity Analysis

Previous studies, record drawings, and Black & Veatch (BV) engineering tools were used to assess the hydraulic capacity of the Broad River Wastewater Treatment Plant (BRWWTP). The BRWWTP hydraulic profile was developed to evaluate water surface elevations and unit process capacities throughout the facility.

BV has performed a detailed review of the hydraulic model and the assumptions; and the outputs appear to be reasonable when compared with record plans.

BV took measurements of the water surface elevation from the known elevations of the top of the concrete wall at the plant to compare them with the values indicated in the calculations of the hydraulic profile and the record drawings to verify existing conditions. The values were reconciled with the calculated values. The following flows were evaluated:

Table 4-1 Design Flow Capacity

Parameters	Value
Existing Average, MGD	1.9
Design Annual Average (AA), MGD	4.0
Design Peak Day (PD), MGD	12
Design Peak Hour (PH), MGD	14.4

The goal of this evaluation was to a) identify which unit process(es) become limiting as flows and loads increase over time, b) to identify flow bottlenecks that were identified during the preliminary analysis, and c) to identify any flow management strategies that could be used to improve operations. The following conclusions were made:

- No system hydraulic bottlenecks were identified during modeling runs using the existing average daily flow of 1.9 MGD.
- No future system hydraulic bottlenecks were identified for peak day flows of 12 MGD.
- Future bottlenecks were identified for the peak hour wet weather flow of 14.4 MGD. Two-thirds of the total plant flow + RAS flow flows through a single 24" pipe between aeration and Secondary Clarifier Nos. 2 and 3 resulting in significant backups at the aeration basin effluent structure.

The annual average and peak flow capacity of each unit process is identified in Figure 4.3. Each unit process is hydraulically capable of handling or conveying flows up 12 mgd without major modifications or upgrades.

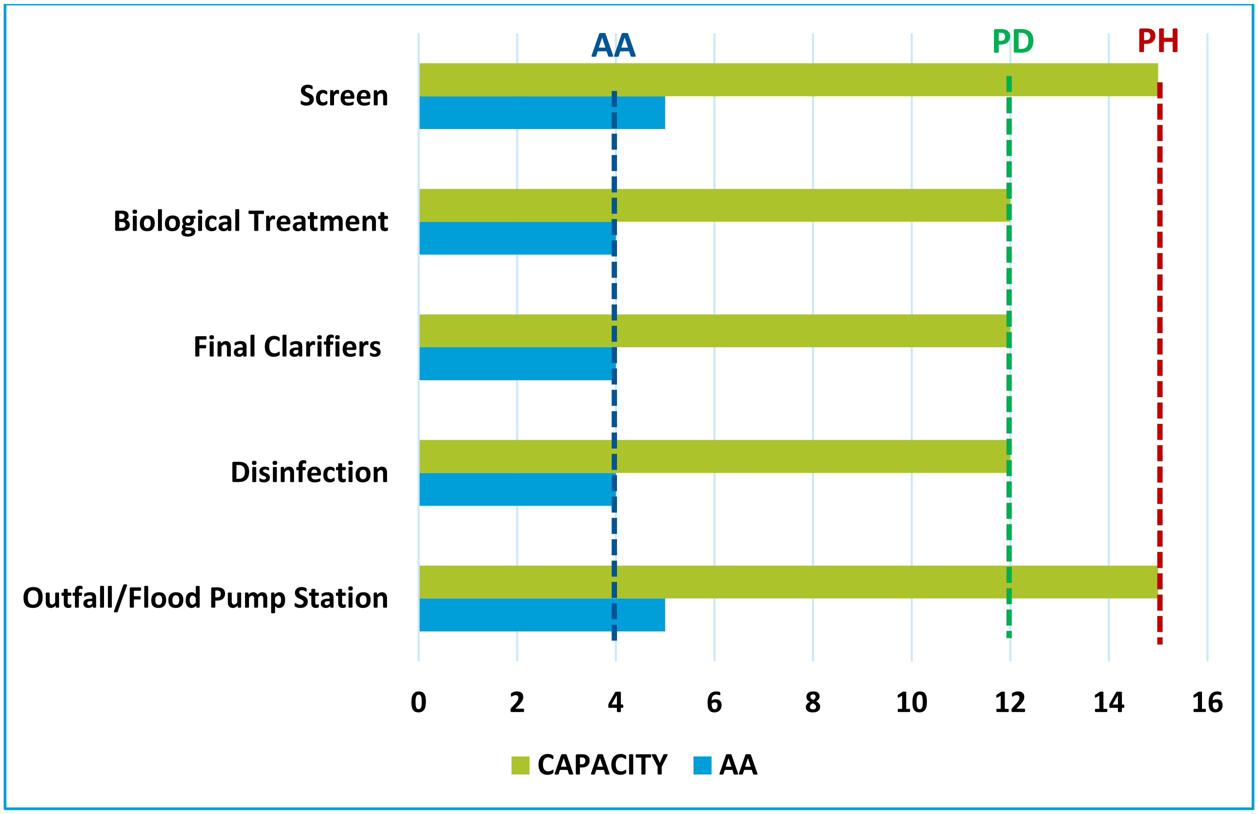

Figure 4-1 Existing Unit Process Hydraulic Capacity

When the annual average flow rate at the facility approaches 80% of design capacity, or 3.2 MGD, SCDHEC requires facility planning for upgrade and expansion. Long range planning for this facility indicates that the hydraulic profile and flow routing will eliminate the bottlenecks described above. When the PD/AA and PH/AA peaking factors are applied to an annual average of 3.2 MGD, they result in flows of a peak day of 9.6 MGD and a peak hour of 11.5 MGD, which are within the hydraulic capacity of the plant. Black & Veatch recommends addressing future hydraulic bottlenecks with process improvements being considered in long range planning. If required, interim pipeline upgrades could be considered when or if actual peak flows approach 12 MGD.

5.0 Wastewater Treatment Plant Improvements

The evaluation of the BRWWTP facility to reliably meet the current permitted capacity has been conducted and the following improvements are recommended for an interim upgrade to the facility:

- Replace pumps and add AFDs at the Providence Creek pump station
- Headworks screening controls-differential head
- Hydraulic control improvements
- Survey and adjustment of clarifier weirs
- Conversion of sludge wet well to piping gallery
- Selective wasting improvements
- An additional sludge storage tank of 1-million-gallon capacity
- Electrical and Instrumentation upgrades

A summary of the recommended improvements to the main unit processes is as follows:

5.1 Providence Pump Station

The Gaffney Board of Public Works requested the replacement of all three (3) pumps with the addition of adjustable frequency drives (AFDs) in order to standardize operations for their current collection system, and to avoid large process flow changes at the BRWWTP.

Recommended design criteria for the upgrade of the Providence Creek pump station are as follows:

Table 5-1 Providence Creek Pump Station

Parameters	Description
Name	Xylem/Flygt
Model	3315-096
Type	Submersible
QTY	3
Maximum Operating Speed, rpm	1750
Capacity, gpm	1410 @ 232' TDH
Rated Power, hp	130
Frequency, Hz	60
Rated Voltage, volt	460

In addition to the installation of AFDs, it is recommended to replace the existing Siemens distribution panelboard PP-1 due to the installation age of the equipment. This panelboard distributes power to the entire pump station, including the submersible pumps. The panelboard is nearing the end of its useful life, and although in good visual condition, replacement parts for the power panel will continue to get challenging with age and is therefore recommended for replacement.

5.2 Headworks

5.2.1 Screening Controls

The existing headworks structure has one mechanical screen as described in Section 3.4 above. The screen itself is in good condition and has adequate capacity with a manual static screen as backup.

The automatic controls originally installed with the equipment are no longer operable. As a result, the screen runs continuously. Normal efficient operation for a mechanical screen is to allow material to build up on the surface of the screen until a preset amount of head loss has developed across the equipment. The benefit of the debris across the screen is that it reduces the projected area within the channel, allowing for the capture of smaller material. Recommended upgrades include additional instrumentation as follows:

- Ultrasonic differential head loss indication (upstream/downstream) control for normal operation
- High Level Float for backup operation and alarm
- Optional timer-based operation.

5.2.2 Influent Flow Monitoring

The existing 24-inch Parshall flume has adequate capacity for monitoring flows in excess of the rated capacity and expected peak flows at this facility. However, the existing circle charts are limited to 5 MGD. Instrumentation upgrades are recommended so that instantaneous flows can be recorded throughout the flow ranges anticipated at permitted flows.

5.3 Biological Treatment

The aeration basin is equipped with three (3) mechanical mixers (surface aerators) operating at 100 hp each. One of the mixers has reduced capacity and is affecting the oxygen transfer rate at the biological treatment tank. Maintenance of the aerator is scheduled to be performed by GBPW.

5.4 Hydraulic Control Improvements

Replace and upgrade gates at the aeration basin and distribution structure upstream of Secondary Clarifier No. 2 and No. 3.

5.5 Secondary Clarifiers

The weirs of Secondary Clarifier No. 2 and No. 3 were replaced from metal to fiberglass during the latest system upgrades. Initial assessments determined the weirs of Clarifier No. 2 are approximately two (2) inches higher than those of Clarifier No. 3. This results in zero effluent flow from Clarifier No. 2 during extreme low flow periods.

BV recommends that the elevations for all weirs throughout the plant be verified by a licensed surveyor, and that any discrepancies be corrected.

5.6 RAS/WAS Pump Station

The new RAS/WAS pumping configuration has been proposed after discussion with the Gaffney Board of Public Works and plant operations personnel about exploring options for a more efficient RAS/WAS operating system.

The proposed modification to the existing common wet well is shown in the schematic Figure 5-1 below, where a new common suction header and separate RAS/WAS discharge headers will be installed in the pump station in a 3-duty, 1-standby pumping arrangement.

- Temporarily pipe Clarifier Nos. 2 & 3 to the existing pumps.
- Dewater and clean the existing wet well.
- Add duplex sump pumping system to wet well to accommodate pump station floor drains.
- Install discharge header for wasting direct from each clarifier.
- Maintain space in the building for the circulation of personnel and the maintenance of equipment.
- Add monitoring at sludge transfer and additional storage.

From a design perspective, the objective is to allow plant operations staff to pump sludge independently from each secondary clarifier.

Return Activated Sludge (RAS) from all three clarifiers will pump back to the aeration basin via the RAS common discharge header. Waste activated sludge will be transferred from selected secondary clarifier to sludge thickening tanks via the existing WAS force main.

Table 5-2 New RAS Pumping

Parameters	Description
Manufacturer	Gorman-Rupp
Number of Pumps	3 new +1 existing
Horsepower (each), hp	25
Capacity, gpm	1,150

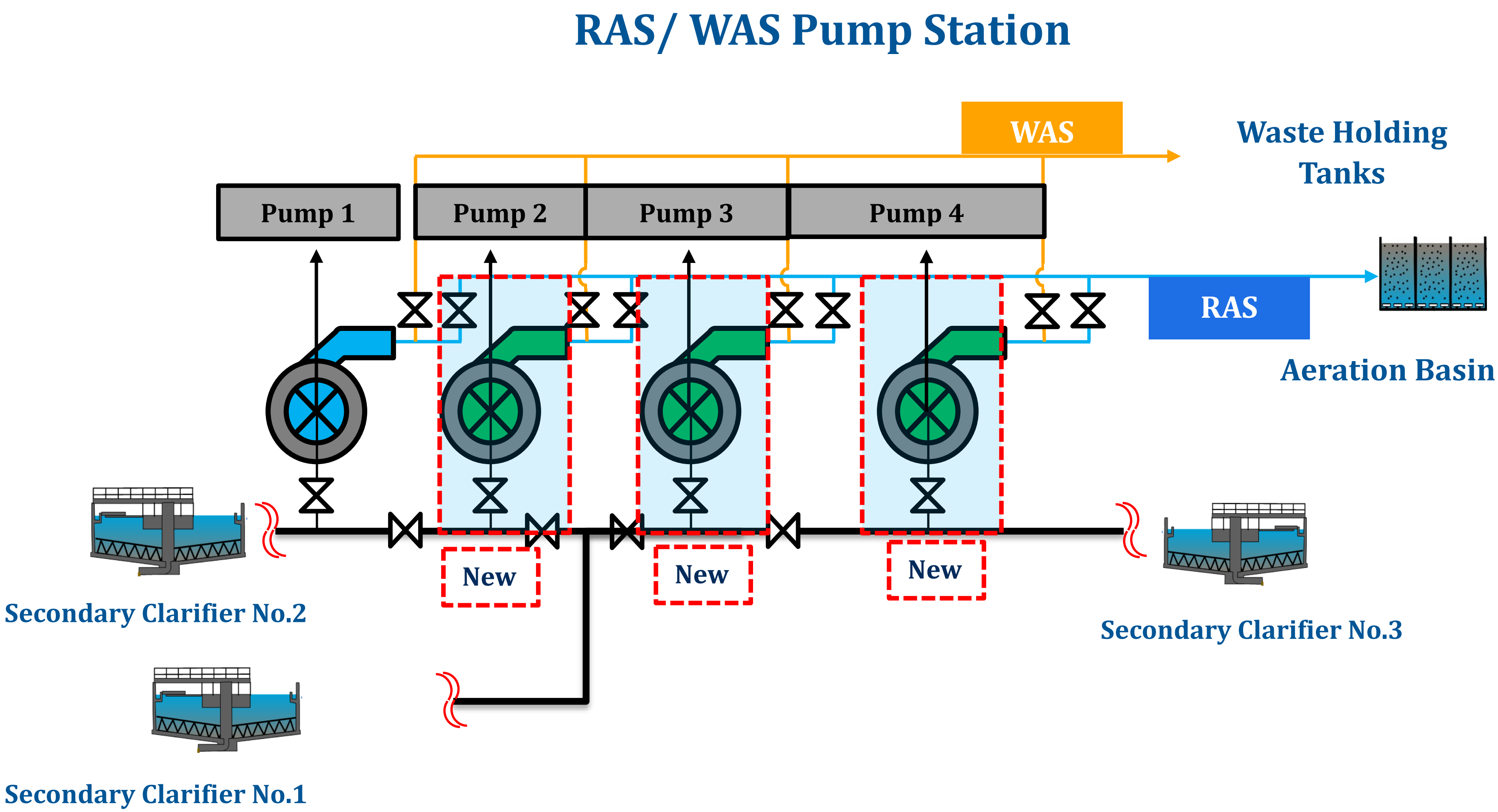

Figure 5-1 **RAS/WAS New Concept Proposal**

5.7 Sludge Storage Tank

The Broad River Wastewater Treatment Plant currently operates with a single bolted steel sludge holding tank erected from ground surface level with a working capacity of 1 million gallons and is 101 feet in diameter.

Operations staff noted that the capacity of this tank can become exhausted if offsite sludge hauling and disposal becomes backed up due to wet-weather or driver availability. BV recommends a similar, additional 1-million-gallon storage tank to maintain an adequate volume of storage. The additional tank will add redundancy, provide sufficient storage capacity, and provide for additional thickening prior to disposal.

Table 5-3 New Sludge Storage Tank

Parameters	Description
Type	Bolted Stainless Steel Tank, Concrete Base
Inner Ring Diffusers, qty.	39
Outer Ring Diffusers, qty.	79
Diameter, ft	101
Capacity, MGD	1
Side Water Depth, ft	17

Table 5-4 New Sludge Storage Tank Blower

Parameter	Description
Manufacturer	United Blower Inc.
Type	Rotary Lobe
Inlet Piping, inches	12
Discharge Piping, inches	10
Number of Blowers	1
Rated Power, hp	125
Flow, scfm	1,250
Speed, rpm	2,600

5.8 Electrical

Given the rust accumulation identified and, most importantly, age of the equipment, failure of the equipment is imminent. Typical useful life of electrical equipment is between 20-30 years, and each of these distribution centers are well beyond that timeframe. When the electrical equipment is used beyond its useful life, it should be expected that none of the electrical protective devices would operate properly under an overload or fault condition, causing a safety risk for all personnel working on any equipment. Given the lack of redundancy in the distribution scheme, failure of the equipment would pose a significant risk to plant operation. For those reasons, all MCC's and the main switchboard are recommended to be replaced immediately, with replacement of the Automatic Transfer Switch and Engine Generator following the replacement of the other distribution gear.

To resolve the issue of physical security at the plant, an automatic security gate with cameras is recommended so that plant operations can better control access into the plant.

5.9 Instrumentation and Controls

To keep the bar screen at the headworks facility from continuously operating and to increase screen efficiency, level control should be added. A pH instrument is recommended at the headworks to better monitoring influent flow to the plant. It is recommended to install ultrasonic level transducers on the sludge storage tanks to reduce the chance of an overflow and allow plant operations to view tank level without manually checking tank level. Influent flow monitoring is currently scaled to 5 MGD and should be rescaled to better capture influent flow to the plant during wet weather events.

Table 5-5 Electrical Upgrade Summary

Parameter	Description
Main SWBD	Outdoor location, Square-D, I-Line SWBD Model, 480V, 3PH, 4W, 1000A, D-42-71420-11 Catalog Number *Replacement in kind, using existing wire and conduit runs.*
Motor Control Centers (MCC-1)	Outdoor location, GE, Model 7700 MCC, 480V, 3PH, 4W, 600A, 305X0297M01 Catalog Number *Replacement in kind, using existing wire and conduit runs.*
Motor Control Centers (MCC-2)	Outdoor location, Square-D, Model 4 MCC, 3PH, 4W, 600A, 25kA A-579987 F.O. 12-64842-2 Catalog Number *Replacement in kind, using existing wire and conduit runs.*
Return Activated Sludge (RAS) MCC	Indoor location, Square-D, Model 4 MCC, 3PH, 4W, 600A, 25kA A-579987 F.O. 12-64842-1 Catalog Number *Replacement in kind, using existing wire and conduit runs*
Automatic Transfer Control (ATS)	Outdoor location, ASCO, 480V, 3PH, 4W, 800A, 17188-05 Catalog Number *Replacement in kind, using existing wire and conduit runs. Incl. in Generator cost.*
Generator	Outdoor location, CAT, 480V, 3PH, 545kW, 3412 Catalog Number *Replacement in kind, using existing wire and conduit runs.*

6.0 Conceptual Budget Cost Estimation

This section of the Preliminary Engineering Report presents the conceptual budget cost estimation for BRWWTP interim improvement projects.

Harper Corporation has provided budgetary cost information to assist with an understanding of the current volatile market conditions for equipment and construction costs in the Carolinas. Budget costs include contingency, escalation to 2025, and engineering costs for design and construction.

The estimate in Table 6-1 includes quantities and costs required to complete Broad River WWTP interim improvements.

Table 6-1 Conceptual Budgetary Cost Estimate

UNIT PROCESS LOCATION	COST ELEMENTS OR EQUIPMENTS	DESCRIPTION	COSTS	SUBTOTAL
Headworks	Ultrasonic Differential head control (2ea)	Teledyne ISCO Ultrasonic Flow Meter	$40,000.00	**$50,000.00**
	pH-Meter	N/A	$10,000.00	
Aeration Basin	24" Gates / 3ea	Stainless steel slide gates	$180,000.00	**$180,000.00**
Secondary Clarifiers	36"x42" weir gates (2ea)	Aluminum, manual gates	$110,000.00	**$160,000.00**
	Survey	N/A	$20,000.00	
	Weirs Adjustment on Secondary Clarifier No.3	N/A	$30,000.00	
RAS/WAS Pump Station	RAS/WAS pump station piping modifications	6" Influent from tie-in to existing clarifier effluents (assumed 5' outside building), 6" influent header with isolation plug valves, 8" RAS discharge header with check valves and isolation plug valves, 8" WAS discharge header with check valves and isolation plug valves, discharge piping to tie-in locations (assumed 5' outside existing building; Piping arrangement based on Clary WWTP setup	$400,000.00	**$1,250,000.00**
	Modify RAS discharge header for 4th pump	Included in above piping modifications	-	
	Add WAS discharge header and valves	Included in above piping modifications	-	
	Add RAS suction header	Included in above piping modifications	-	
	WAS flow meter (if necessary)	Rosemount 4" mag meter and precast vault	$90,000.00	
	WAS electric valve (if necessary)	Electric, modulating valve	$20,000.00	
	Pump, clean, and dispose of solids in wet well	N/A	$90,000.00	
	Add grout fill to slope bottom and create sump in wet well	N/A	$20,000.00	
	Add duplex sump pump to drain wet well (floor drains above)	Basic sump pumps with floats	$10,000.00	
	Remove existing Gorman-Rupp pumps	Demo	$20,000.00	
	Provide and install 3ea 25 hp Gorman-Rupp self-priming pumps	1ea existing pump to be reused; Includes VFDs for 3ea (reuse 1ea existing)	$600,000.00	
Sludge Holding Tank	1MG Sludge Storage Tank	Bolted stainless steel tank with concrete base	$1,930,000.00	**$2,590,000.00**
	1MG Sludge Storage Tank	***Prestressed concrete tank (alternative cost, not incl. in subtotal)***	***$1,480,500.00***	
	Rotary Lobe Blower	2600 rpm, 12" inlet, 10" discharge	$210,000.00	

UNIT PROCESS LOCATION	COST ELEMENTS OR EQUIPMENTS	DESCRIPTION	COSTS	SUBTOTAL
	10" DIP air piping	~60 LF of flanged piping, 5ea 90s, 1ea BFV	$55,000.00	
	Ultrasonic level indicator for sludge transfer tank (2ea)	N/A	$10,000.00	
	New tank piping to tie into existing truck loading station	Assumed ~200 LF of 6" DIP (below grade)	$25,000.00	
	Tank Influent Piping	Assumed ~200 LF of 6" DIP (below grade), 1ea 6" buried plug valve	$40,000.00	
	Tank Draw off Piping	6" Header, 4" valves to match existing tank draw off	$150,000.00	
	Aeration Grid	Fine bubble diffuser grid (7,854 sqft tank floor)	$170,000.00	
Providence Creek Pump Station	Xylem/Flygt model 3315 submersible pumps (3ea)	130 hp	$1,160,000.00	**$1,180,000.00**
	Variable Frequency Drive (VFD's)/3ea	Included in above pump price	-	
	HVAC	Standard wall-mount mini split unit	$20,000.00	
Electrical Equipment Replacement -in-kind	Main SWBD	Outdoor location, Square-D, I-Line SWBD Model, 480V, 3PH, 4W, 1000A, D-42-71420-11 Catalog Number *Replacement in kind, using existing wire and conduit runs.*	$510,000.00	**$2,690,000.00**
	Motor Control Centers (MCC-1)	Outdoor location, GE, Model 7700 MCC, 480V, 3PH, 4W, 600A, 305X0297M01 Catalog Number *Replacement in kind, using existing wire and conduit runs.*	$365,000.00	
	MCC-2	Outdoor location, Square-D, Model 4 MCC, 3PH, 4W, 600A, 25kA A-579987 F.O. 12-64842-2 Catalog Number *Replacement in kind, using existing wire and conduit runs.*	$365,000.00	
	Return Activated Sludge (RAS) MCC	Indoor location, Square-D, Model 4 MCC, 3PH, 4W, 600A, 25kA A-579987 F.O. 12-64842-1 Catalog Number *Replacement in kind, using existing wire and conduit runs.*	$365,000.00	
	Automatic Transfer Control (ATS)	Outdoor location, ASCO, 480V, 3PH, 4W, 800A, 17188-05 Catalog Number Replacement in kind, using existing wire and conduit runs. Incl. in Generator cost.	-	
	Generator	Outdoor location, CAT, 480V, 3PH, 545kW, 3412 Catalog Number *Replacement in kind, using existing wire and conduit runs.*	$1,085,000.00	
			Total Estimated Budget Cost	**$8,100,000.00**