City of Baltimore
Department of Public Works

BACK RIVER WWTP

Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland, License No. 34269, Expiration Date: May 14, 2023.

THIRD-PARTY ENGINEERING REPORT

June 6, 2021

GREELEY AND HANSEN

TABLE OF CONTENTS

SECTION 1 INTRODUCTION ... 1-1

1.1 Background and Purpose ... 1-1
1.2 Methodology ... 1-2
1.2.1 Evaluation Criteria ... 1-2
1.2.1.1 Permit Compliance ... 1-2
1.2.1.2 Reliability and Redundancy ... 1-3
1.2.2 Schedule Categorization ... 1-3
1.3 Facility Overview ... 1-3

SECTION 2 EQUIPMENT AND OPERATIONS EVALUATION ... 2-7

2.1 Equipment Evaluation ... 2-7
2.1.1 Headworks ... 2-7
2.1.1.1 Challenges ... 2-8
2.1.1.2 Solutions ... 2-8
2.1.2 Primary Settling Tanks ... 2-8
2.1.2.1 Challenges ... 2-9
2.1.2.2 Solutions ... 2-9
2.1.3 Activated Sludge ... 2-9
2.1.3.1 Challenges ... 2-11
2.1.3.2 Solutions ... 2-11
2.1.4 Final Clarifiers ... 2-11
2.1.4.1 Challenges ... 2-12
2.1.4.2 Solutions ... 2-13
2.1.5 Denitrification Filters ... 2-13
2.1.5.1 Challenges ... 2-13
2.1.5.2 Solutions ... 2-14
2.1.6 Sand Filters ... 2-14
2.1.6.1 Challenges ... 2-14
2.1.6.2 Solution ... 2-15
2.1.7 Chlorine Contact Tanks ... 2-15
2.1.7.1 Challenges ... 2-15

TABLE OF CONTENTS

2.1.7.2 Solutions 2-15
2.1.8 Plant Flushing Water 2-15
2.1.8.1 Challenges 2-15
2.1.8.2 Solutions 2-16
2.1.9 Gravity Sludge Thickeners 2-16
2.1.9.1 Challenges 2-16
2.1.9.2 Solutions 2-17
2.1.10 Gravity Belt Thickener 2-17
2.1.10.1 Challenges 2-17
2.1.10.2 Solutions 2-18
2.1.11 Dissolved Air Floatation Tanks 2-18
2.1.11.1 Challenges 2-18
2.1.11.2 Solutions 2-18
2.1.12 Anaerobic Digestion 2-19
2.1.12.1 Challenges 2-19
2.1.12.2 Solutions 2-20
2.1.13 Dewatering 2-20
2.1.13.1 Challenges 2-21
2.1.13.2 Solutions 2-21
2.1.14 Summary 2-21
2.2 Operations Evaluation 2-24
2.2.1 Operation and Maintenance Staff Shortages 2-25
2.2.2 Procurement Challenges 2-25
2.2.2.1 Solutions 2-25
2.2.3 Operations and Maintenance Challenges 2-25
2.2.3.1 Solutions 2-25
2.2.4 Staff Retention Challenge 2-25
2.2.4.1 Solutions 2-26
2.2.5 Wages 2-26
2.2.5.1 Solutions 2-26
2.2.6 Morale 2-26
2.2.6.1 Solutions 2-26

TABLE OF CONTENTS

	2.2.7	Planning	2-26
	2.2.7.1	Solutions	2-26
SECTION 3	**SOLUTIONS**		**3-1**
	3.1	Record of Ongoing Actions	3-1
	3.2	Short Term Equipment Evaluation Improvements	3-1
	3.3	Long Term Improvements	3-1
	3.3.1	Equipment Evaluation	3-1
	3.3.2	Operations Evaluation	3-1
SECTION 4	**KEY RECOMMENDATIONS**		**4-1**

List of Tables

Table 2-1:	Headworks Facility Evaluation	2-7
Table 2-2:	Primary Settling Tank Facility Evaluation	2-8
Table 2-3: Primary Settling Tank - Status and Planned Action		2-9
Table 2-4:	Activated Sludge Facility Evaluation	2-10
Table 2-5:	Final Clarifier Facility Evaluation	2-11
Table 2-6:	Denitrification Filter Facility Evaluation	2-13
Table 2-7:	Sand Filter Facility Evaluation	2-14
Table 2-8:	Chlorine Contact Tank Facility Evaluation	2-15
Table 2-9:	Gravity Sludge Thickener Design Criteria	2-16
Table 2-10:	Gravity Belt Thickener Facility Evaluation	2-17
Table 2-11:	DAF Facility Evaluation	2-18
Table 2-12:	Anaerobic Digester Facility Evaluation	2-19
Table 2-13:	Dewatering Facilities Evaluation	2-20
Table 2-14:	Equipment Evaluation Summary	2-21
Table 3-1:	Record of Ongoing Actions (as of May 20, 2022)	3-2
Table 3-2:	Short-Term Equipment Evaluation Improvements	3-3
Table 3-3:	Long-term Equipment Evaluation Improvements	3-5
Table 3-4:	Long-term Operations Evaluation Improvements	3-6

List of Figures

Figure 1-1:	Aerial Site Plan	1-5
Figure 1-2:	Process Flow Diagram	1-6
Figure 2-1:	Back River WWTP Sludge Processing	2-24

TABLE OF CONTENTS

List of Attachments

Appendix A	MDE Letter
Appendix B	Facility Overview
Appendix C	Vacancy Analysis

SECTION 1 INTRODUCTION

The City of Baltimore ("City") owns and operates the Back River Wastewater Treatment Plant ("BRWWTP") which is located on a 466-acre lot in Dundalk, Maryland. Wastewater from an approximately 140 square mile service area is treated at the plant with an advanced treatment processes to achieve enhanced nutrient removal (ENR), chlorination, and de-chlorination. The BRWWTP is rated to treat an average daily flow of up to 180 million gallons per day (MGD). The annual average daily flow (AADF) was 130 MGD for the January 2021- April 2022 operating period.

The City operates the BRWWTP subject to a discharge permit (State No. 15-DP-0581, NPDES No. MD0021555) issued by the Maryland Department of the Environment (MDE). Over the last twenty years, the City has implemented a number of major facility improvements, valued over $1.0 Billion, to improve the processes for accommodating flow, treating various pollutants of concern, providing enhanced nutrient removal (ENR), and complying with the permit. Two of these key improvements that demonstrate the City's environmental stewardship and leadership in protecting public health and the environment are the new Headworks Facility and the Nitrification and Denitrification Facilities. Of note, the BRWWTP was complying with the permit as recently as 2019. In recognition of this achievement, MDE provided funds for chemicals to the City for use in the treatment process. However, over the past several years the City has faced significant challenges with operation and maintenance of the BRWWTP due to the May 2019 ransomware attack, the COVID-19 pandemic beginning in 2020, supply chain crisis further aggravated by the pandemic, staffing shortages, historic inflation, and the retirement of many of its senior wastewater staff. As a result, the BRWWTP has faced operational challenges that have led to occasions of permit excursions. On March 24, 2022, MDE issued an administrative order to the City to take necessary steps to return to permit compliance and directed Maryland Environmental Services (MES) to provide supplemental staffing, management, and technical guidance to assist the City in returning the BRWWTP to compliance as expeditiously as possible.

1.1 BACKGROUND AND PURPOSE

During a facility inspection conducted by MDE in June 2021, the MDE inspector noted violations per Back River WWTP's NPDES No. MD0021555. The Back River WWTP was failing to consistently meet the total suspended solids (TSS), biological oxygen demand (BOD), Total Nitrogen (TN), and Total Phosphorous (TP) final effluent standards.

On March 3, 2022, the MDE issued a letter (Appendix A) to the City regarding additional investigation and information requested related to permit non-compliance. The MDE directed the City to submit information regarding the following:

a) Staffing
b) Primary Settling Tank Cleaning, Maintenance & Repair
c) Fats, Oils, & Grease Sources & Processes
d) Total Suspended Solids Processes
e) Nitrogen, Phosphorus, & Biochemical Oxygen Demand Processes

f) Capital Project List
g) Third-Party Certified Engineering Evaluation & Report
h) Industrial Stormwater Discharge Permit
i) Plant Tour & Meeting

In reference to Item (g), the City engaged a national wastewater treatment consultant firm, Greeley and Hansen, to conduct the engineering evaluation and generate the Report. This Report is the culmination of the evaluation and fulfills MDE's requirement as set forth in the March 3, 2022 letter. The rest of this document provides a third-party evaluation of the Back River WWTP operations and equipment completed to identify improvements required to bring the BRWWTP back into compliance as soon as possible. The recommended improvements are categorized as short-term and long-term.

1.2 METHODOLOGY

A purpose driven approach was implemented to identify the critical elements for permit compliance and these elements were prioritized based on their impact. Information was obtained through the following activities:

1. Review, analysis and validation of prior engineering evaluations
2. Site visits to review existing conditions and review ongoing plant improvements
3. Interviews/discussions with management, engineering, operations, and maintenance staff
4. Data analysis (influent, effluent, plant performance data)
5. Review of BRWWTP contract documents from historical improvements.

The required improvements identified were further subjected to a quantitative scoring system. The following subsections describe the quantitative scoring system implemented to rank and prioritize the improvements.

The evaluation and the recommendations presented in this Report is based on extensive collaboration efforts between Greeley and Hansen and officials from MES, City, and other stakeholders through weekly meetings, task specific calls, and review of draft versions of the Report. The City and MES played an integral role in providing information and status regarding the ongoing improvements.

1.2.1 Evaluation Criteria

Improvements were rated based upon two evaluation criteria: Permit Compliance, and Redundancy and Reliability.

1.2.1.1 Permit Compliance

This criterion will convey the importance of focusing on projects which not only expand or enhance current processes, but instead restore the plant to a fully functioning state. Permit compliance is weighted **60 percent** and scored based on the criticality of the improvement for achieving compliance with the NPDES Permit.

1.2.1.2 Reliability and Redundancy

Reliability is defined as the ability of the BRWWTP unit processes to perform functions consistently and continuously to meet permit compliance under all operating conditions. Redundancy is defined as standby (backup) capacity that is available in case of unforeseen circumstances related to equipment/process failure. The reliability/redundancy category is applicable for an improvement that is required to achieve state of good repair and enhance the reliability and redundancy of the BRWWTP in accordance with industry best management practice. The redundancy and reliability criterion is weighted at **40 percent**.

1.2.2 Schedule Categorization

Following the evaluation and prioritization of improvements as per the Evaluation Criteria discussed above, the improvements were further categorized chronologically as follows:

- **Ongoing Improvements** - Critical improvements that are currently underway as this Report is being developed. The ongoing improvements can be categorized as operational modifications and emergency maintenance repairs to failed or critical process/equipment.
- **Short Term Improvements** - Critical improvements which can be completed within six (6) months following the date of this Report submission to the MDE are considered short-term projects. Short-term projects require planning and design prior to construction or implementation of the improvement.
- **Long-Term Improvements** - Projects that require greater than six (6) months to implement. These projects are capital intensive rehabilitation or expansion projects and align with efficient implementation of the Capital Improvements Plan (CIP).

1.3 FACILITY OVERVIEW

The rated design capacity of the Back River WWTP is 180 MGD. The annual average daily flow (AADF) and the maximum month flow (MMF) for the January 2021- March 2022 operating period is 130 MGD and 170 MGD respectively. The Facility is an advanced WWTP consisting of preliminary treatment (headworks screening), primary treatment (primary settling tanks), secondary treatment (biological nutrient removal activated sludge process), tertiary treatment (denitrification filters for enhanced nutrient removal), disinfection (chlorination), de-chlorination and reaeration (cascade) to meet the final effluent criteria as per the NPDES Permit. Treated effluent is discharged to the Back River and High Head Lake at Sparrows Point, which ultimately discharges to the Patapsco River.

At the beginning of calendar year 2021, a new Headworks facility along with two wet-weather/Equalization (EQ) Tanks, with a combined volume of 36 MG, were brought online. These improvements have enhanced preliminary treatment of plant influent and significantly reduce fine and coarse screenings and grit loading on downstream processes. Furthermore, the new Headworks facility has helped reduce wear and tear and downtime of downstream equipment and reduced the probability of excessive solids build-up in pipes and primary settling tanks. Furthermore, the EQ tanks have been effective in mitigating wet-weather flows, reducing peak hydraulic and pollutant loading on downstream processes and to maintaining effective treatment during storm events. Another key benefit of these tanks is the significant reduction in wet weather sanitary sewer overflows (SSOs) which have decreased by 69 percent, by volume, as compared to the year prior to the Headworks completion.

Primary sludge (PS) and waste activated sludge (WAS) produced by the primary treatment and secondary treatment process is thickened by a process that consists of gravity sludge thickeners (GST), dissolved air flotation (DAF) tanks and gravity belt thickeners (GBT). Once thickened, sludge is stabilized through a two-step process consisting of a two-step anaerobic digestion process (acid-gas phase), yielding Class B biosolids, in accordance with the 40 CFR Part 503 regulations. Class B biosolids (digested sludge) are further dewatered through centrifuges, after which stabilized dewatered 'cake' is conveyed to an off-site composting facility for beneficial reuse. A portion of the digested sludge is conveyed to a dryer facility that dewaters and dries the biosolids further for beneficial reuse such as agricultural land application. The Dryer Facility has been owned, operated, and maintained by a Third-Party firm under a public private partnership (PPP) arrangement with the City since the early 1990s.

Figure 1-1 is an aerial site plan of the Back River WWTP. Figure 1-2 is a process flow diagram (PFD) of the Back River WWTP process. The PFD identifies different liquid streams (treated water, mixed liquor, untreated water, and centrate (recycle stream)) and solids streams. Refer to **Appendix B** for additional description of the Back River WWTP facilities and process.

Figure 1-1: Aerial Site Plan

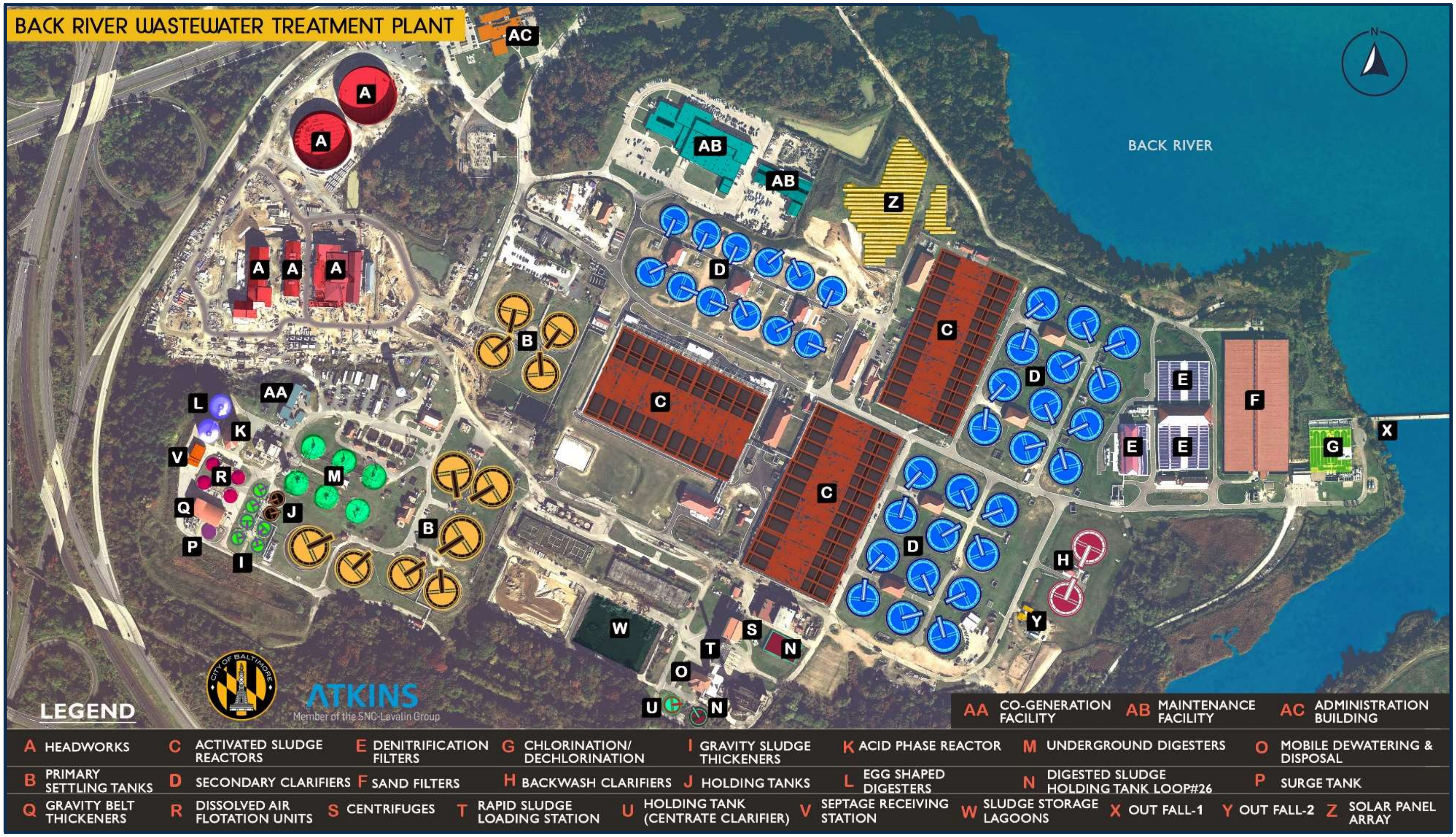
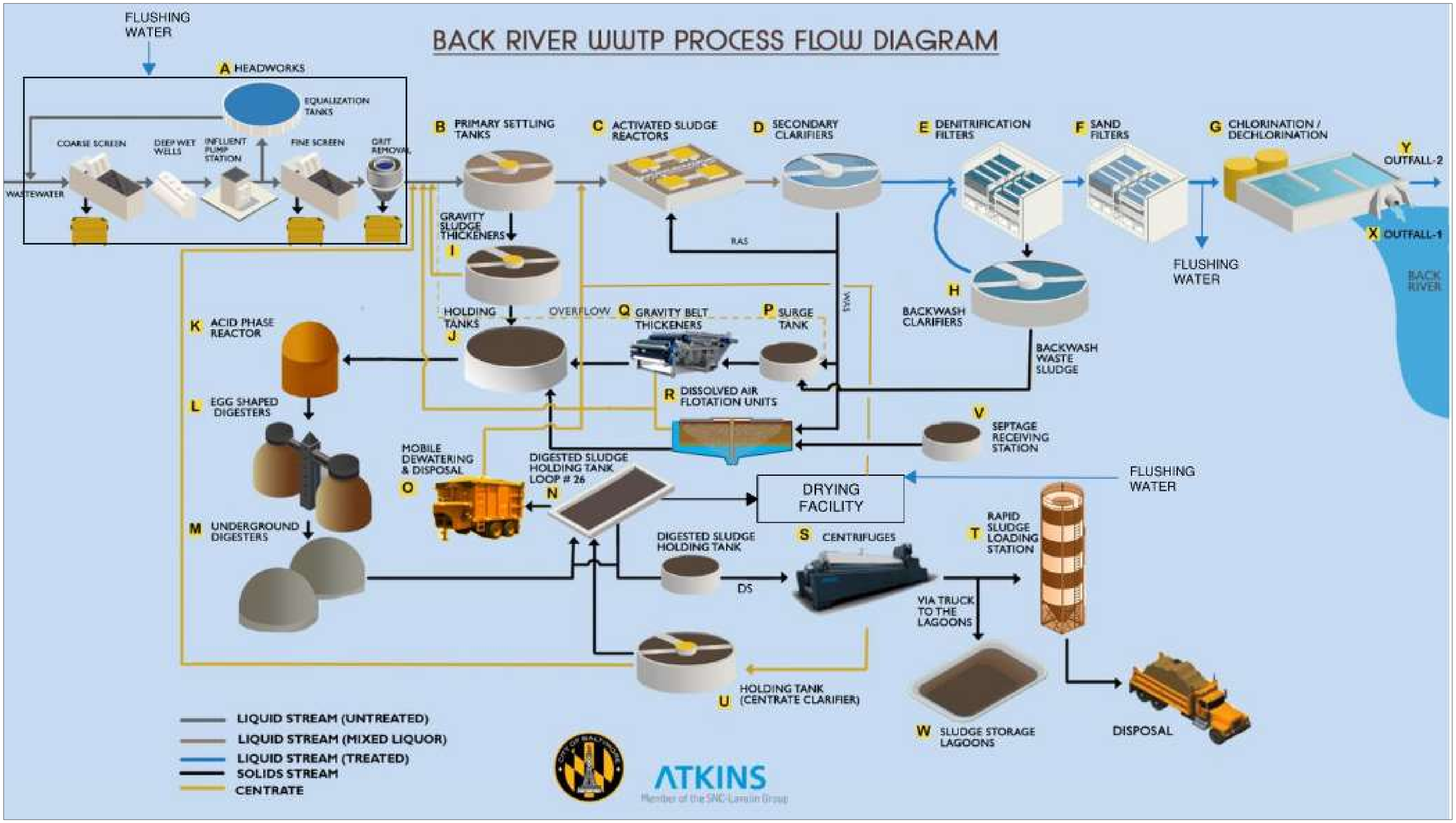


Figure 1-2: Process Flow Diagram



SECTION 2 EQUIPMENT AND OPERATIONS EVALUATION

2.1 EQUIPMENT EVALUATION

The purpose of the equipment evaluation was to gain a high-level understanding of:

- Equipment design criteria
- Number of units required to achieve permit compliance (average daily flow basis)
- Challenges in meeting the permitted limits

The capacity analysis was limited to the determination of a baseline for permit compliance. The number of units at an observed average daily flow is estimated to identify the minimum requirements. It is noted that more units may be needed to process higher flows and loads.

As part of this evaluation, possible solutions and recommendations are described for the identified challenges. The following sections are organized based on the process flow diagram (Figure 1-2) for liquid side and solids side unit processes.

2.1.1 Headworks

The new headworks facilities are designed to treat an average daily flow of 180 MGD and a peak flow of 750 MGD. The new Headworks Facility has adequate capacity to treat the current average daily flow of 130 MGD. As mentioned in Section 1.3, these facilities have had a positive impact on overall plant operations since going online in January of 2021. Table 2-1 shows the Headworks Facility Evaluation.

Table 2-1: Headworks Facility Evaluation

Headworks Facility Evaluation		
Item	**Quantity**	**Units**
Average Daily Flow	180	MGD
No. of Coarse Screens at ADF	1	
No. of Influent Pumps at ADF	2	
No. of Fine Screens at ADF	2	
No. of Grit Tanks at ADF	4	
No. of Grit Blowers at ADF	2	
Peak Flow	752	MGD
No. of Coarse Screens at Peak Flow	4	
No. of Influent Pumps at Peak Flow	4	
No. of Fine Screens at Peak Flow	4	
No. of Grit Tanks at Peak Flow	8	
No. of Grit Blowers at Peak Flow	4	
No. of Equalization Pumps at Peak Flow	4	
Influent Pumps	8	
Max Flow per pump	100	MGD

Headworks Facility Evaluation		
Item	**Quantity**	**Units**
Coarse Screens	4	
Capacity	80 – 200	MGD
Screen Opening Size	1.25	in
Fine Screens	6	
Min Design Flow	100	MGD
Screen Opening Size	6	mm
Equalization Pumps	4	
Max Flow per pump	88	MGD
Hydrogen Sulfide Odor Control Scrubbers	4	

2.1.1.1 Challenges

- All equipment associated with the headworks building is fully functional.
- The plant effluent is used as flushing water for the fine screens and influent pumps as well as process water for the hydrogen sulfide scrubbers. The presence of total suspended solids in the plant effluent may be clogging the piping. The scrubbers are not fully functional as only the fans are in operation without the process water.
- Currently two Grit Blowers are out of service for maintenance.

2.1.1.2 Solutions

- Make temporary provisions for the use of City water for the flushing water system until the plant effluent quality improves. Evaluate the performance of the system and plan for developing a permanent city water backup solution for the use of plant effluent flushing water system at the headworks building.

2.1.2 Primary Settling Tanks

There are eleven (11) center feed type circular primary settling tanks (PST) with rotating truss arm sludge scraping. They were constructed in three phases with Nos. 3, 4, 5, 6, and 7 first, followed by Nos. 1 and 2, and finally by No. 8, 9, 10, and 11. Table 2-2 shows the facility evaluation for the PSTs.

Table 2-2: Primary Settling Tank Facility Evaluation

Primary Settling Tank Facility Evaluation		
Item	**Quantity**	**Units**
No. of PSTs	11	
Diameter of PST No. 1 and 2	200	ft
Diameter of PST Nos. 3-11	170	ft

Primary Settling Tank Facility Evaluation		
Item	**Quantity**	**Units**
Currently Operational Units	2 (PST No. 8 and PST No. 11)	
No. of units required for current ADF at 1,200 gpd/sf (2 units 200 ft diameter and 2 units at 170 ft diameter)	4	
Units required for design ADF	7	

2.1.2.1 Challenges

- The two operating PSTs are subject to very high loading rate (3,000 gpd/sf) at current average daily flow of 130 MGD, reducing the effectiveness of the clarifier and resulting in greater solids carry through to the activated sludge process.
- Five (5) of the eleven (11) PSTs are filled with grit/sludge. Three (3) were recently cleaned for rehabilitation and one (1) is currently being cleaned for rehabilitation. The associated drives, raking mechanisms and the primary sludge pumps for these PST's are in disrepair /non-functional and are currently in various stages of planned repair. A summary of PST status and planned actions is included in Table 2-3.

Table 2-3: Primary Settling Tank - Status and Planned Action

PST #	Status	Planned Action
8 & 11	Fully Operational	
3 & 4	Clean, Rehab needed	To be rehabilitated under Sanitary Contract (SC) 954
9 & 10	Clean, Rehab needed	To be rehabilitated under SC 954 as added scope
7	Clean, Rehab needed	To be rehabilitated by MES
1	Debris filled	To be cleaned and rehabilitated under SC 954 as added scope
5	Debris filled	To be cleaned under SC 954
2	Debris filled	To be cleaned under SC 954 and rehabilitated by MES
6	Debris filled	To be cleaned by Third-party Dryer Facility Operator

2.1.2.2 Solutions

- Continue monitoring progress for PST rehabilitation as part of SC 954.
- Identify means to accelerate the PST rehabilitation.
- Prioritize these improvements to ensure procurement and contracting time frames are reasonable and not delayed.

2.1.3 Activated Sludge

The BRWWTP has three activated sludge (AS) plants. AS No. 1 was decommissioned and is not one of the three existing plants. AS No. 2 and AS No. 3 have various operational challenges (see below) but have been online for some time. AS No. 4 is a new facility and has been fully operational while completing the Phase 3 30-day performance testing. AS No. 4 was designed with an air piping cross-connection to AS No.

3 to provide redundancy. The activated sludge process is configured as Modified Ludtzack-Ettinger (MLE) process which includes anoxic, swing, and oxic zones with internal recycle to achieve BOD removal, nitrification, and partial denitrification. Table 2-4 shows the facility evaluation for the activated sludge process.

Table 2-4: Activated Sludge Facility Evaluation

Activated Sludge Facility Evaluation		
Item	**Quantity**	**Units**
Activated Sludge Plant No. 2		
Basin Nos. 5-10	6	
Total Basin Nos. 5-10 Volume	30	MG
Each Basin Capacity	12.5	MGD at ADF
Blowers in Blower Building No. 2	5	
Blower Capacity	33,000	scfm
Blower Horsepower	1500	HP
No. of Mixers per basin	9	
Total No. of Mixers	54	
No. Mixers online	36	
Activated Sludge Plant No. 3		
Basin Nos. 11-16	6	
Total Basin Nos. 11-16 Volume	39	MG
Each Basin Capacity	16.3	MGD at ADF
Blowers in Blower Building No. 3	5	
Blower Capacity	33,000	scfm
Blower Horsepower	1500	HP
No. of Mixers per basin	9	
Total No. of Mixers	54	
No. Mixers online	38	
Activated Sludge Plant No. 4		
Basin Nos. 17-22	6	
Total Basin Nos. 17-22 Volume	36	MG
Each Basin Capacity	11.3	MGD at ADF
Number of Blowers	12	
Blower Capacity	57,000	scfm
No. Of Mixers per basin	4	
Total No. of Mixers	24	
No. Mixers online	24	
Total capacity of AS No. 2, 3, and 4 (all 18 units in service)	212	MGD
No. of Reactors required for current ADF 130 MGD	4 reactors from AS 4 3 reactors from AS 3 3 reactors from AS 2	

2.1.3.1 Challenges

- Several mixers (34 out of 108 mixers) in the AS No. 2 & 3 plants are non-functional. This impacts the nutrient removal capability of the process.
- There are Plant Control System (PCS) programming issues. This requires manual oversight and control of the process.
- There are inoperable dissolved oxygen (DO) meters. This prevents the activated sludge process from running in fully "Auto" mode; and manual operation requires operations attention.
- For AS No. 3, two (2) of the five (5) aeration blowers are out of service resulting in no air supply redundancy.
  - In addition, there is no cross-connection between AS No. 2 and AS No. 3 air supply system, thereby resulting in limited oxygen availability and increased treatment process risks for AS No. 3 in case of another blower failure.

2.1.3.2 Solutions

- With AS No. 4 being online several challenges associated with redundancy and reliability of AS No. 2 and 3 can be addressed.
- The mixers and instrumentation in AS No.2 and AS No.3 need to be repaired or replaced.

2.1.4 Final Clarifiers

There are a total of thirty-six (36) final clarifiers: twelve (12) associated with each AS plant. Table 2-5 shows the facility evaluation for the final clarifiers.

Table 2-5: Final Clarifier Facility Evaluation

Final Clarifier Facility Evaluation		
Item	**Quantity**	**Units**
Activated Sludge Plant No. 2		
Final Clarifier (FC) Nos. 5A - 10A & 5B-10B	12	
FC Diameter	155	ft
Average design flow per FC including RAS	11.3	MGD
No. of Final Clarifiers online in AS No. 2	11	
No. of FCs needed	6	
Return Activated Sludge Pumps	18	
Return Activated Sludge Pump Capacity	10	MGD
No. of RAS pumps online	9	
Waste Activated Sludge Pumps	8	
Waste Activated Sludge Pump Capacity	600	gpm
No. of WAS pumps online	5	

Final Clarifier Design Criteria		
Item	**Quantity**	**Units**
Activated Sludge Plant No. 3		
Final Clarifiers Nos. 11A - 16A & 11B - 16B	12	
FC Diameter	160	ft
Average design flow per FC including RAS	12.3	MGD
No. of FCs needed	6	
No. of Final Clarifiers online in AS No. 3	11	
Return Activated Sludge Pumps	18	
Return Activated Sludge Pump Capacity	8.2	MGD
No. of RAS pumps online	10	
Waste Activated Sludge Pumps	12	
Waste Activated Sludge Pump Capacity	400	gpm
No. of WAS pumps online	4	
Activated Sludge Plant No. 4		
Final Clarifiers Nos. 17A - 22A & 17B-22B	12	
FC Diameter	120	ft
Average design flow per FC including RAS	12.3	MGD
No. of FCs needed	8	
Return Activated Sludge Pumps (all online)	18	
Return Activated Sludge Pump Capacity	7.5	MGD
Waste Activated Sludge Pumps (all online)	12	
Waste Activated Sludge Pump Capacity	260	gpm
Total capacity of the Final Clarifiers (including 50% RAS)	318	MGD
No. of clarifiers required at 195 MGD (current ADF of 130 MGD and RAS of 65 MGD) (split amongst AS 2, 3, 4)	20	

2.1.4.1 Challenges

- Several final clarifiers need rehabilitation and equipment replacement, as well as removal of vegetation growing within the effluent launders and center columns.
- The sludge blanket depth in the final clarifiers is too high. Observed average sludge blanket depth in May 2022 was 9 ft.
  - Normal operating depth is 2-4 ft
- The RAS/WAS pumps need replacement.
  - Pump failure or loss of pumping capacity for RAS will result in:
    - Inability to recirculate the mixed liquor and poor activated sludge treatment performance.
  - Pump failure or loss of pumping capacity for WAS will result in:

  - Inability to waste sludge from the process reactors and accumulation of solids in the secondary treatment process.
- Programmable Logic Controllers (PLC) in the Sludge Pumping Stations are outdated.
- The RAS and WAS flow meters are at the end of their useful life. They are not properly monitoring and recording flows rates.

2.1.4.2 Solutions

- Remove vegetation from the clarifiers.
- Manage sludge blankets to 2-4 feet. Increase sludge wasting.
- Repair/replace RAS/WAS pumps to increase reliability and redundancy for AS No. 2 and 3.
- Perform manual operations until the PLCs are updated and set up for automatic operation.

2.1.5 Denitrification Filters

The denitrification (DNF) facility contains 52 gravity filters and support systems such as backwash pumps and blowers. Table 2-6 shows the facility evaluation for the denitrification filters.

Table 2-6: Denitrification Filter Facility Evaluation

Denitrification Filter Facility Evaluation		
Item	**Quantity**	**Unit**
Number of Cells	52	
Currently Operational Units	39	
Hydraulic loading rate (ADF)	3	gpm/sf
No. of units operating in AUTO mode	13	
Units required for current ADF	39	
Units required for design ADF	50	
Filter Operation Parameter	**Influent (mg/L)**	**Effluent (mg/L)**
TSS	15	5
BOD_5	10	10
Nitrate	6	0.5
NH_3-N	0.5	0.5
Orthophosphate	0.1	<0.1
Alkalinity (as $CaCO_3$)	60	85

2.1.5.1 Challenges

- Observations made during the site visits are as follows:
  - One quadrant (13) of the filters was operational, with the other three quads having an assortment of service and maintenance needs.
  - DNFs were observed to be submerged and clogged with solids with an accumulated later of scum.

- Nitrogen removal is not optimized due to:
  - Sensors which determine methanol dosing are not reporting data to the control panel due to poor maintenance and miscalibration.
  - Existing challenges with the automatic backwash operation
    - Local control panels are not fully integrated into SCADA system
    - Media is clogged with solids received from the final clarifiers
    - Significant amount of backwashing is required to restore the media to desired condition and improve performance.
- DNF filter effluent quality impacts all the unit processes using the plant effluent.

2.1.5.2 Solutions

- Continue backwashing filters to clean the media and restore filter performance.
- Procure and install the instruments required for filter operation.
- Use the filter backwash clarifier to avoid solids carryover from the filter back wash to the head of the plant.

2.1.6 Sand Filters

There are forty-eight sand filters, each consisting of an automatic backwashing system comprised of a travelling bridge, backwash pump, and control station. Table 2-7 lists the facility evaluation for sand filters.

Table 2-7: Sand Filter Facility Evaluation

Sand Filter Facility Evaluation		
Item	**Quantity**	**Unit**
Number of Cells	48	
Currently Operational Units	12	
Hydraulic loading rate (ADF)	1.5	gpm/sf
No. of units operating in AUTO mode	13	
Units required for current ADF	33	
Units required for design ADF	46	
Filter Operation Parameter	**Influent (mg/L)**	**Effluent (mg/L)**
TSS	30	5
TP	0.5	0.2

2.1.6.1 Challenges

- Observations from our site visits indicate:
  - Fifteen (15) of the forty-eight (48) sand filters were functioning.
  - The other filters were not functional due to insufficient sand which was lost during the backwashing process and non-functioning mechanical equipment.

- Sand filters are not operating as designed and require sand media replenishment and the replacement of the majority of mechanical equipment.
- The support grids, media (sand), and travelling bridges needs replacement.

2.1.6.2 Solution

- It is not clear if the sand filters are currently required to achieve permit compliance if the DNFs are properly working. It is recommended that the sand filters are not prioritized for repair until an evaluation can be performed to determine if they are necessary.

2.1.7 Chlorine Contact Tanks

There are four chlorine contact tanks with mixers for diffusion of sodium hypochlorite. The chlorine contact tanks are in good condition. Chlorination is achieved through sodium hypochlorite feed pumps. Dechlorination is performed prior to the discharge of the plant effluent to the outfall. Table 2-8 lists the facility evaluation for the chlorine contact tanks.

Table 2-8: Chlorine Contact Tank Facility Evaluation

Chlorine Contact Tank Facility Evaluation		
Item	Quantity	Unit
Number of Tanks	4	
Number of Units online	4	
Units required for current ADF	3	
Units required for design ADF	4	
Detention time at 150 MGD ADF w/ 4 tanks	30	minutes
Detention time at 180 MGD ADF w/ 4 tanks	25	minutes

2.1.7.1 Challenges

- Observations of floating sludge in the CCTs are a result of poor performance of the upstream processes such as filters. No issues are currently identified regarding the chlorination and dechlorination system.

2.1.7.2 Solutions

None proposed.

2.1.8 Plant Flushing Water

The non-potable plant effluent water after disinfection is used as plant flushing water (FW).

2.1.8.1 Challenges

- The presence of high solids in the plant FW system due to excessive TSS in the plant effluent has resulted in the clogging of process equipment (small pipes and valves) that use FW.

- The FW is used as spray water for equipment in the new Headworks facilities, and there have been clogging issues reported.
- The FW is also used by the Drying facility for fire suppression and as scrubbing fluid in the air stripper for air pollution control. The presence of high TSS has resulted in higher maintenance on the pumping and piping system.

2.1.8.2 Solutions

- Portions of the FW piping system may need "clean-water" flushing to restore functionality.
- Provide temporary potable water (City Water) for the Dryer facility and the headworks building. Consider converting the temporary system to a permanent installation based on a performance evaluation of City Water versus typical plant effluent.

2.1.9 Gravity Sludge Thickeners

There are six (6) 65-ft diameter gravity sludge thickeners (GSTs). Previously there were eight (8) GSTs; two of these were converted to Thickened Sludge Holding Tanks (TSHT). At the current design average flow of 130 MGD and raw influent TSS of 170 mg/L and assuming a 25% TSS removal in the PSTs, primary sludge production is estimated to be 46,000 dry pounds per day. Only 1 GST is required at typical design loading for GSTs of pounds per day per square fee (lbs/day*sf) The facility evaluation for the Gravity Sludge Thickeners is shown in Table 2-9.

Table 2-9: Gravity Sludge Thickener Design Criteria

Gravity Sludge Thickeners		
Item	**Quantity**	**Unit**
Total GSTs	6	
Diameter	65	ft
Solids Loading Rate	15	lb/d/sf
Units required for current ADF	1	at 15 lb/d/sf
Units required for Design ADF	2	
Units online	2	

2.1.9.1 Challenges

- The GSTs routinely get clogged with rags, which creates frequent maintenance problems. Vegetation growth is observed on the GSTs.
- Current primary sludge production is limited due to only two PSTs online. Only two GSTs are fully operational. The remainder can feed flow and draw solids, but the gravity thickening mechanism is not functional.
- Several pumps have leaking seals, and the floor drains in this area are clogged, making cleanup very difficult. The piping is also old with reports of several non-functioning valves.

2.1.9.2 Solutions

- Removal of the vegetation from the GSTs and cleaning is underway. The thickened sludge pump rehabilitation needs to be performed in conjunction with the GSTs rehabilitation.
- Achieve reliability and redundancy on GST operation in conjunction with the primary settling tanks brought online.
- Perform preventive maintenance on the GST equipment (pumping and piping).

2.1.10 Gravity Belt Thickener

There are total of eight (8) Gravity Belt Thickeners (GBTs). Five of the GBTs are from the original 1995 installation. The other three GBTs were installed in 2013. Thickened sludge from each GBT is discharged to a hopper that feeds the GBT Thickened Sludge Pumps in the basement. Thickened sludge from the GBTs is sent to the sludge holding tanks prior to anaerobic digestion. The facility evaluation for Gravity Belt Thickeners is shown in Table 2-10 below.

Table 2-10: Gravity Belt Thickener Facility Evaluation

Gravity Belt Thickener Facility Evaluation		
Treatment Unit	**Quantity**	**Units**
Gravity Belt Thickeners	8	
Gravity Belt Width	3	meters
Hydraulic Loading Rate	140	gpm/meter
Solids Loading Rate	WAS: 596 WAS and GST Sludge: 1058	lbs/hr/meter lbs/hr/meter
No. GBTs required for current ADF	6	
No. GBTs required for design ADF	7	
No. GBTs in working condition	4	
Thickener Feed Pumps	10	
Thickener Feed Pump Capacity	660	gpm
Thickened Sludge Pumps	8	
Thickened Sludge Pump Capacity	100	gpm
WAS Surge Tank	1	
WAS Surge Tank Diameter	65	ft
WAS Surge Tank SWD	20	ft
WAS Surge Tank Capacity	500,000	gal

2.1.10.1 Challenges

- At current average daily flow condition of 130 MGD, 6 GBTs are required.
- Currently only four GBTs are in working condition, the remaining four GBTs have missing parts, instrumentation issue, and motor issue.

- The GBT performance offers the ability to thicken sludge to 5-8 % TS. However, the %TS of the facility is limited by the ability of the thickened sludge pumps. Thickened sludge must be diluted before pumping if the %TS is too high.

2.1.10.2 Solutions

- The original five (5) GBTs are over 20 years old and need evaluation for rehabilitation.

2.1.11 Dissolved Air Floatation Tanks

There are total of four (4) Dissolved Air Floatation Thickeners (DAFs), which are used to thicken a combination of WAS and septage. DAFs #1 and #2 are 50-ft diameter and were refurbished in 2015. DAFs #3 and #4 are 60-ft diameter and were installed in 1990. Thickened sludge from the DAFs is sent to the sludge holding tanks prior to anaerobic digestion. Table 2-11 shows the DAF facility evaluation.

Table 2-11: DAF Facility Evaluation

Dissolved Air Floatation Thickener Facility Evaluation		
Treatment Unit	**Quantity**	**Units**
Number of Units	4	
Hydraulic Loading Rate	DAF Nos. 1 and 2: 644 DAF Nos. 3 and 4: 711	gpd/sq. ft gpd/sq.ft.
Flow Rate w/ all in service	1-5	MGD
Solids Loading Rate	28.8	lb/sq.ft./day
Solid Loading	275,960	lbs/day
Number of Units required at current ADF	1	
Number of Units required at Design ADF	2	
Number of active units	1	

2.1.11.1 Challenges

- DAF No. 2 is out of service and requires rehabilitation. DAF No. 1 is currently in manual operation.
- The mechanism in DAF No. 3 is broken and needs to be repaired before it can be put back into service.
- DAF No. 4 is missing the sludge screw auger, but the unit is operated nonetheless, and the trough get clogged frequently as a result.

2.1.11.2 Solutions

- Work towards getting one of the three non-operational DAFs and thickened sludge pumps back online to provide redundancy and reliability.

2.1.12 Anaerobic Digestion

The BRWWTP has three different types of reactors to anaerobically digest thickened sludge from the Thickened Sludge Holding Tanks. The three sets of digesters are designed to operate in series under normal operation. The three sets are as follows:

- Acid Phase Reactor (APR)
- Egg-Shaped Digesters (ESD)
- High-Rate Underground Digesters (HRD).

Table 2-12 shows the facility evaluation for the anaerobic digesters.

Table 2-12: Anaerobic Digester Facility Evaluation

Anaerobic Digestion Facility Evaluation		
Treatment Unit	**Quantity**	**Units**
Acid Phase Reactor	1	
Acid Phase Reactor Capacity	2	MG
Egg Shaped Digesters	2	
Capacity Per Digester	3	MG
Design VSS Loading	139,200	lbs/day
Operating Temperature	95	F
HRT (days)	11.10	days
Egg Shaped Digesters Online	2	
High-Rate Anaerobic Digesters	6	
High-Rate Anaerobic Digester Diameter	100	ft
High-Rate Anaerobic Digester Depth	25	ft
Dry Solids Loading	282,000	lbs/day
Dry Solids Loading Rate	0.2	lbs/cf/day
Volatile Solids	70%	
Operating Temperature	98	F
High-Rate Anaerobic Digesters Online	4	
Digested Sludge Pumps	2	
Digested Sludge Pump Capacity	440	gpm

2.1.12.1 Challenges

- Total volume for methanogenesis is 12.24 MG (2 ESDs + 6 HRUDs) or 1,640 kilo cubic feet (KCF). This can cater to a VS loading of 262,000 lb/d at a typical design VS loading rate of single-stage mesophilic digestion (160 lb VS/KCF/day)
- Currently the recirculation pumps and the gas compressors (for mixing) on the Acid Phase Reactor (APR) are not working, This results in inability to send sludge to APR and

digesters downstream of APR. Bypass of the APR is currently in place to enable conveyance of sludge to the ESD.

- The Egg-Shaped Digesters (ESDs) were installed in 1991 and are over 30 years old. The draft tube mixer for ESD 8 has been replaced once, but the mixer for ESD 7 is original.
- Only 2 out of 6 sludge recirculation pumps on the ESDs are functional.
- The High-Rate Underground Digesters (HRDs), installed in 1970, are the oldest digesters at BRWWTP. Currently two of these digesters (1 & 4) are clogged. Cleaning is underway.

2.1.12.2 Solutions

- Capital improvements projects are underway for ESDs and HRDs rehabilitation.
- Gas compressors on the APR are out of service.
- Mechanical seals need to be replaced on the sludge recirculation pumps for the APR and ESDs.
- VFDs needs to be replaced on the sludge holding tank pumps.

2.1.13 Dewatering

Digested sludge from the digestion facilities (APR, ESD, and HRD) is pumped into the Loop Line and Tank 26, where the sludge continuously circulates until it is withdrawn by the Dryer Facility or by the City for dewatering. The centrate from both the City Dewatering and Third-Party Drying Facilities is pumped to a Centrate Tank located by the Vacuum Filter Building. Table 2-13 shows the evaluation for the dewatering facilities.

Table 2-13: Dewatering Facilities Evaluation

Dewatering Facilities Evaluation		
Treatment Unit	**Quantity**	**Units**
Vacuum Filter Building		
Digested Sludge Pump & Grinder	8	
Centrate Tank Effluent Pumps	3	
Centrate Tank Effluent Pump Capacity	2500	gpm
City Dewatering Facility		
Number of Centrifuges	4	
Number of Centrifuges Online	2	
Firm Capacity @4000 lb/hr/unit	144	DT/d
Total Capacity @4000 lb/hr/unit	192	DT/d
Centrate Pump	3	
Screw Conveyor	1	
Belt Conveyor, Diverter Gate, Plow	2	
Cake Hauled to Compost		
Wet Tons (Avg. per day)	83	
% Dry Solids (Avg)	23	

Dewatering Facilities Evaluation		
Treatment Unit	**Quantity**	**Units**
TS Load, DT/d (Avg)	19	
Sludge (Rapid) Storage Room		
Rotary Discharger Drive on the Silos	9	
Third-Party Drying Facility		
Centrifuges	3	
Feed solids concentration	2-3	%
Centrifuge Capacity	200	gpm

2.1.13.1 Challenges

- Two (2) of four (4) centrifuges in the City Dewatering Facility are currently operational. One centrifuge is out of for rehabilitation and the other centrifuge is being scavenged for parts (to keep the two centrifuges in operation).
- A minimum of 2 centrifuges are required to meet the current average conditions. Reliability and redundancy of centrifuges are major challenges for performing dewatering operations.
- Several ancillary equipment systems, such as the centrifuge feed pumps, flushing water booster system, and Centrate pumps have operational problems that need to be addressed.
- The polymer system in the dewatering building is at the end of its useful life.

2.1.13.2 Solutions

- One additional centrifuge needs to be brought online to achieve required redundancy and reliability.
- Ongoing efforts for fixing the centrifuges and evaluation to rehabilitate feed pumps are underway.

2.1.14 Summary

Following is a summary of the number of units required for design average daily flow (180 MGD) and current average daily flow (130 MGD for compliance), along with major challenges identified as part of facilities evaluation.

Table 2-14: Equipment Evaluation Summary

Item	Units Required at Design ADF	Units Required for Permit Compliance at Current ADF	No of Units Online Out of Total Units	Challenges
Coarse Screens	2	2	4/4	No challenges observed other than the impact of plant
Influent Pumps	2	2	4/4	
Fine Screens	2	2	4/4	

Item	Units Required at Design ADF	Units Required for Permit Compliance at Current ADF	No of Units Online Out of Total Units	Challenges
Grit Tanks	4	4	8/8	effluent on the flushing water quality
Grit Blowers	2	2	2/4	
Primary Settling Tanks	7	4	2/11	Only 2 in operation, impacts the solids loading to the AS, Final Clarifiers and Denitrification Filters
Activated Sludge No.2 Reactors	4	3	6/6	Not all DO instruments are functional
Activated Sludge No.2 Mixers	54	27	36/54	No reactor has all mixers functional. Lack of mixing impacts the nutrient removal capacity
Activated Sludge No.2 Final Clarifiers	8	6	11/12	Vegetation growth
Activated Sludge No.2 RAS Pumps	12	9	9/18	Need redundancy and reliability
Activated Sludge No. 2 WAS Pumps	6	4	5/8	
Activated Sludge No.3 Reactors	4	3	6/6	
Activated Sludge No.3 Mixers	36	27	38/54	Only reactor 15 has all mixers functional. Lack of mixing impacts the nutrient removal capacity
Activated Sludge No.3 Final Clarifiers	8	6	11/12	Vegetation growth
Activated Sludge No. 3 RAS Pumps	16	12	10/18	Need redundancy and reliability
Activated Sludge No. 3 WAS Pumps	8	6	4/12	Need redundancy and reliability
Activated Sludge No. 4 Reactors	6	4	6/6	Recently brought online no challenges
Activated Sludge No. 4 Mixers	24	16	24/24	
Activated Sludge No. 4 Final Clarifiers	12	8	12/12	
Activated Sludge No. 4 RAS Pumps	18	12	18/18	
Activated Sludge No. 4 WAS Pumps	12	8	12/12	

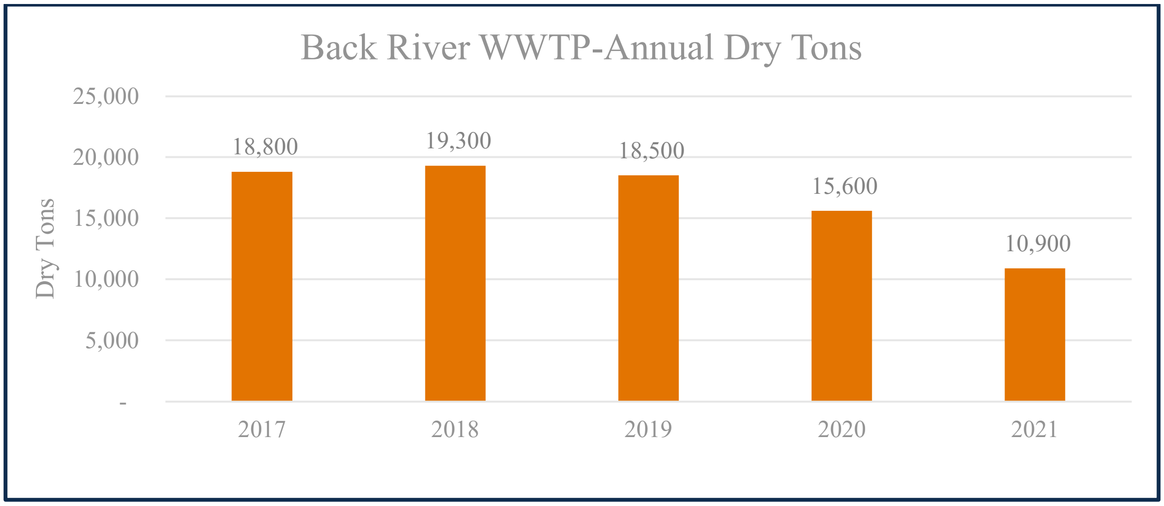
Item	Units Required at Design ADF	Units Required for Permit Compliance at Current ADF	No of Units Online Out of Total Units	Challenges
Denitrification Filters	50	39	39/52	Instrumentation issues, only 13 filters operate in AUTO mode
Sand Filters	46	33	12/48	Media loss
Chlorine Contact Tanks	4	3	4/4	No challenges identified
Gravity Sludge Thickeners	2	1	2/6	Vegetation growth
Gravity Belt Thickeners	7	6	4/8	Reliability and redundancy issues. Challenges with process mechanical equipment and piping system to reliably process sludge through the solids treatment process.
Dissolved Air Flotation Thickener	2	1	1/4	
Acid Phase Digester	1	1	1/1	
Egg Shape Digesters	2	2	2/2	
High-Rate Anaerobic Digesters	6	4	4/6	
City Dewatering Centrifuges	3	2	2/4	

Based on the facilities evaluation, the following objectives are derived to be used as a road map to achieve permit compliance:

- Maximize the biosolids processing to provide plant operations the ability to waste from the AS reactors to minimize solids accumulation in the reactors. This will result in reducing the solids inventory in the reactors and final clarifiers.
- Increase primary clarification capacity to reliably meet the WWTP operating needs.
- Improve the denitrification filter performance
- Manage sludge blankets in the final clarifiers
- Optimize the process of thickening, digestion, and dewatering.

A review of solids removed from the Back River WWTP during the 2017 to 2021 was completed and results are presented in Figure 2-1. Solids produced by the BRWWTP are managed via drying, composting and landfilling.. The annual solids produced by the BRWWTP in 2019 was 18,500 dry tons per year (annual average of 51 dry tons per day (DTPD)). In 2020, solids produced by the BRWWTP reduced by 16 percent to 15,600 dry tons (annual average of 43 DTPD), and further reduced by 30 percent in 2021 to 10,900 dry tons (annual average of 30 DTPD).

Figure 2-1: Back River WWTP Sludge Processing



Currently, the City is taking necessary steps to maximize the solids removal from the BRWWTP and to reduce the solids inventory built-up. As of the last two weeks of May, 2022 the following is the daily average quantity of solids processed by the various biosolids management options discussed above and removed from the BRWWTP:

- 40 DTPD to Dryer
- 20 DTPD to Composting
- 15-20 DTPD to Landfills

At a daily processing capacity of 75 to 80 DTPD, operations is able to process the average daily solids production (50 to 55 DTPD) and reduce the built-up solids inventory at a rate of 20 to 25 DTPD. The historical solids buildup in the BRWWTP is estimated to be between 1,500 to 2,000 dry tons. This quantity does not include solids accumulated in the primary clarifier. At this rate it is estimated to take approximately 4-6 months (+/-) to reduce the built-up solids inventory and reach normal operating levels.

The reduction in sludge inventory improves the treatment effectiveness of every step of the treatment process. The solids loading rate on PSTs, AS, final clarifiers, DNFs plays a significant impact on effluent quality. Returning the sludge inventory to a normal operating level is paramount for achieving permit compliance. The City should coordinate with the Dryer Facility Operator and the Compositng Facility Operator to accelerate and maximize solids removal and processing. It is recommended that the City also investigates additional biosolids management contracts to diversify biosolids management otpions and reduce permit compliance risks in the future.

2.2 OPERATIONS EVALUATION

The purpose of the operations evaluation is to understand the root cause for equipment failure and permit compliance challenges. During Greeley and Hansen site visits, discussions with key operation and maintenance staff indicated several factors. The challenges identified associated with these factors and their impact along with possible solutions are outlined below:

2.2.1 Operation and Maintenance Staff Shortages

- Total staff vacancy percentage: 29.3 (61 of the total 208 positions are vacant)
  - Operations staff vacancy: 26 percent
  - Maintenance staff vacancy: 36 percent
  - Industry median: 9 percent (range of 3-18 percent)
  - Goal is to achieve industry median value.

Refer to the vacancy analysis included in **Appendix C.**

2.2.2 Procurement Challenges

- Preventative maintenance involves a lengthy paperwork process
- Wait time of ordering parts for repair and maintenance is exceptionally long
- Staff resorting to cannibalizing parts from equipment meant for redundancy to maintain treatment process capacity to the degree possible with available resources. This approach is not sustainable and results in gradual treatment capacity erosion.

2.2.2.1 Solutions

- Provide a procurement person and buyer for the BRWWTP to assist the plant operations and maintenance staff with items specific to the BRWWTP.
- Plan for ordering parts for equipment associated with critical infrastructure in advance, taking into consideration typical process duration and lead time for equipment supply.

2.2.3 Operations and Maintenance Challenges

- Limited staffing results in overloading remaining staff with additional responsibilities
- Steep learning curve for new employees due to an inactive training program and institutional knowledge not being retained
- Burden on staff is high, this is exacerbated by labor-intensive processes throughout the plant.

2.2.3.1 Solutions

- Consider staff augmentation through contract operations to reduce the burden on the staff.
- Restart the operator training program with a training company instead of in-house staff.
- Fix the existing Computerized Maintenance Management System (CMMS) to establish the work order system.

2.2.4 Staff Retention Challenge

Retention of new staff is a challenge. New operations staff onboard as apprentices at the City facilities and procure jobs elsewhere after they obtain their operations license.

2.2.4.1 Solutions

Identify means of incorporating minimum service required to be provided to the City after the candidate receives the license.

2.2.5 Wages

The wage rates for the City Wastewater Treatment Plant operators are lower than the utilities in the DMV (DC, Maryland, and VA) region. This is resulting in lowering the chances of finding candidates for several key positions.

- For comparison wages for typical wastewater treatment plant operator at the City is 15-20 percent lower than wages offered by DC Water at same level of qualification and responsibilities.

2.2.5.1 Solutions

Perform a study of the wages within the City and compare this to the other utilities in the region. Consider pay revisions based on service, commitment, and performance metrics.

2.2.6 Morale

- Staff tasked with multiple assignments and roles and routinely required to work double shifts
- Limited incentives are currently in place to motivate the staff

2.2.6.1 Solutions

Identify means of encouraging staff with exceptional commitment. Develop performance evaluation to encourage frequent interaction of the staff with their Supervisor. Staff augmentation can possibly reduce the amount of work to be addressed by the current staff.

2.2.7 Planning

Management staff is unable to perform adequate planning due to staffing shortages/challenges and drawing management staff into day-to-day operations. Upper-level operations staff are unable to address the supervisor-level activities such as:

- Staffing plans
- Operations training
- Operations succession planning
- Preventive maintenance plans

2.2.7.1 Solutions

- Perform condition assessment and inventory of existing assets to develop an asset management program.
- CMMS system upgrade can incorporate the decision making derived from the analysis performed by the asset management.

SECTION 3 SOLUTIONS

Current issues identified for the Back River WWTP as a part of this evaluation are categorized into three different categories as listed below:

3.1 RECORD OF ONGOING ACTIONS

These include the ongoing efforts the City and stakeholders are currently performing as regular operations protocol. The challenges and action taken are organized by process area as shown in Table 3-1.

3.2 SHORT TERM EQUIPMENT EVALUATION IMPROVEMENTS

These include the challenges and the recommended solutions prioritized based on the weighted average scoring as shown in Table 3-2. Short term schedule of 2-6 months is applicable for this category.

3.3 LONG TERM IMPROVEMENTS

3.3.1 Equipment Evaluation

These include the long-term challenges and the recommended solutions associated with equipment, prioritized based on the weighted average scoring as shown in Table 3-3. These require more than 6 months to be executed.

3.3.2 Operations Evaluation

These include the long-term challenges and the recommended solutions associated with operations, prioritized based on the weighted average scoring as shown in Table 3-4 . Similar to equipment improvements, these require more than 6 months to be executed.

Table 3-1: Record of Ongoing Actions (as of May 20, 2022)

Process Area	Challenge	Action
Achieve optimum solids inventory in the treatment process	Dryer facility startup	Coordination with Dryer facility staff
	Resolve Flushing Water Issue at facility	Temporary solution of providing City Water to Dryer facility
	Centrifuges repair	Equipment repair efforts ongoing
	Centrifuge feed pumps	
	Polymer feed for thickening	
	GBTs repair	
	Haul the dewatered cake located across several locations on the plant	MES coordination with Veolia
	No sludge being sent to Acid Phase Reactor	Fix the recirculation pumps
Improve biological treatment process for TSS, TN, and TP removal	Denitrification Filter Backwash Pumps	Ongoing efforts with filter manufacturer
	Denitrification Filters (control panel issues)	
	Backwash Clarifiers Grit Accumulation	Solids are removed, facility back online
Improve TSS removal from Final Clarifiers	RAS/WAS Pumps	Currently minimum number of pumps are in operation. Work on achieving redundancy
	Sludge blankets in final clarifiers	Monitoring
Get Primary Clarifiers into service	Rehab PST #1, #3, #4, #9, and #10 (SC 954)	Work progressing as per plan
	Clean PST #1, #2, and #5 (SC 954)	
	Rehab PST #2 & #7 (MES)	
	Clean PST #6 (Third-Party Dry Facility Operator)	
Improve volatile solids reduction during anaerobic digestion	Cleaning High-Rate Digesters 1&4	In procurement by MES
	Confirm if the sludge meets Class B	Completed
	TCLPs data analysis	Completed
	Compressors at High Rate Digesters 1 & 4	In procurement by MES
Floatables (floating sludge) in reactors/tanks	FOG separation	Ongoing effort by City

Table 3-2: Short-Term Equipment Evaluation Improvements

Process Area	Challenge	Recommendation/Possible Solution	Permit Compliance Scoring	Reliability & Redundancy Scoring	Weighted Total Score
Dryer	Dryer facility startup	Continue operation of the dryer facilities. Continuous communication with Dryer facility operations staff to accelerate solids removal and processing	10	8	9.2
Dryer	Plant effluent water used for fire suppression system (flushing water) is a challenge to start the Dryer	Monitor the temporary solution provided, which is providing City potable water to the Dryer facility	10	7	8.8
Solids Handling	Maximize the available biosolids handling avenues	Maximize the amount of solids which can be sent to composting facility and identify alternative means of disposal.	10	7	8.8
Overall	Condition and age of unit processes and equipment is not well-organized and regularly tracked.	Develop, expand, and update asset inventory and incorporate rapid deployment of CityWorks (computerized maintenance management system) to get work order system (repair, maintenance) in working condition.	8	8	8
Denitrification Filters	Historical solids overloading on Denitrification Filters may have negative impact on filter performance	Continue ongoing efforts of extra backwashing cycles to flush media and fix the instrumentation issues.	9	4	7
Final Clarifiers	Sludge blankets in the final clarifiers	Continue monitoring sludge blankets, take advantage of AS No. 4 brought online to manage solids inventory	8	5	6.8
Final Clarifiers	Floating sludge in reactors	Continue ongoing skimming efforts. FOG separation efforts.	8	5	6.8

Process Area	Challenge	Recommendation/Possible Solution	Permit Compliance Scoring	Reliability & Redundancy Scoring	Weighted Total Score
Centrifuges	Not all centrifuges and centrifuge feed pumps in service	Continue tracking the repair progress	5	8	6.2
Primary Clarifiers	Primary Clarifier Operation	Investigate sludge blankets to make sure thickened primary sludge is being sent to GSTs	7	4	5.8
GBTs	Not all GBTs in service	Continue tracking the repair progress	4	8	5.6
Digesters	Cleaning High-Rate Digesters 1&4 and rehabilitation of the compressors	Work towards cleaning the High Rate Digesters 1&4 (ongoing effort)	4	7	5.2
Final Clarifiers	RAS/WAS Pumps	Repair or rehabilitate pumps	3	8	5
Primary Clarifiers	Primary Clarifiers rehabilitation	Continue ongoing efforts of PST rehabilitation.	3	8	5
Digesters	Cleaning of Egg-Shaped Digesters	Upcoming CIP project	3	8	5
Activated sludge	Activated Sludge 2 and 3 mixers rehab.	Repair or rehabilitate mixers	2	6	3.6
Digesters	Maintaining clogged tanks associated with solids storage	Upcoming CIP projects associated with digester rehabilitation and sludge storage	2	6	3.6
Activated sludge	Instrumentation at Activated Sludge 2, 3	Contract to remove debris	3	3	3
Digesters	Sludge cleaners (strain presses) are not in operation for many years.	Further evaluation required on need for sludge cleaners.	1	1	1

Table 3-3: Long-term Equipment Evaluation Improvements

Challenge	Recommendation/Possible Solution	Permit Compliance Scoring	Reliability & Redundancy Scoring	Total Score
Sludge processing to manage daily sludge production	Develop alternative means of solids disposal	10	10	10
Challenge with sludge storage, DAF performance	SC-996 Renovations to the sludge storage and dissolved air flotation No. 3 and 4 at the Back River Wastewater Treatment Plant.	7	7	7
Mixers at AS 2 & 3 not working	Upcoming CIP project for Activated Plant 3 repair at Back River WWTP. Evaluate rehabilitation of Activated Plant 2.	7	7	7
Preventive maintenance is lacking and not actively managed	Develop CMMS (Cityworks) which at a minimum tracks preventative maintenance, and ideally incorporates predictive maintenance components	6	8	6.8
Inventory of spare parts is lacking and not cataloged, leading to insufficient look ahead for ordering spare parts and accounting for lead times.	Develop CMMS (Cityworks) which at a minimum tracks preventative maintenance, and ideally incorporates predictive maintenance components	6	8	6.8
Maintaining clogged tanks associated with solids storage	Upcoming CIP project	6	6	6
High-Rate Digesters not being able to be used	Upcoming CIP project to rehabilitate the existing High-Rate Digesters.	6	6	6
Egg shaped digesters not being cleaned for a while impacting capacity	Upcoming CIP project for rehabilitation of ESDs.	6	6	6
Future use of sand filters	Perform an evaluation and consider including them as part of the wet weather operation. Upcoming CIP project.	5	4	4.6
Instrumentation at Activated Sludge 2, 3	Contract to remove debris	3	3	3

Table 3-4: Long-term Operations Evaluation Improvements

Challenge	Recommendation/Possible Solution	Permit Compliance Scoring	Reliability & Redundancy Scoring	Total Score
Lack of current operation, maintenance, and procurement staff hiring	Utilize third party hiring firms. Consider utilizing a business advisory consultant to review human resources organization and process for potential improvements. Utilize staff augmentation and service contracts with outside vendors in the interim.	5	5	5
Procurement, planning, authorization delays affecting the repair and rehab. activities	Designate staff (procurement and buyer) at BRWWTPs. Increase internal coordination and develop long term vision for procurement process.	5	3	4.2
Failure to retain institutional knowledge through staff departures	Devise organization for saving institutional knowledge and a plan for succession of senior operations staff. Institutional knowledge should be documented in plant-wide O&M manual if developed.	4	4	4
Steep learning curve for staff new to the plant and lack of cross-area knowledge and operability	Restart training program which was stopped during COVID. Hire a professional operations training staff.	4	4	4
Low morale and work ethic from certain plant staff	Leverage, appreciate, and encourage existing highly motivated staff. Establish frequent and short meetings for recognitions and lessons learned to boost overall morale. Provide incentives to staff exhibiting environmental stewardship.	3	2	2.6
Difficulty hiring and retaining staff	Revise compensation and benefits to compete with nearby utilities. Allocate additional budget to operations and maintenance to support this effort. Consider doing a market analysis (hiring a consultant to do so if necessary) in order to justify additional funding. Consider providing onboarding incentives to draw in new staff.	6	6	6

SECTION 4 KEY RECOMMENDATIONS

The most critical improvements based upon the scoring evaluation in section 3 are discussed further below:

- Returning the solids stream to normal operation and establishing a reasonable solids inventory is critical.
- The effectiveness of treatment process cannot be properly and fully assessed until sludge removal returns to nominal conditions. For this reason, it is recommended that the City coordinate with the third-party Dryer Facility Operator to process the existing sludge and also maximize the available solids processing alternatives (composting/landfill) and seek additional and redundant means of sludge removal.
- Prioritize reinstatement of GBTs, centrifuge feed pumps, centrifuges, recirculation pumps on digesters, to fully functional condition.
- Continue backwash of the denitrification filters and expedite the rehabilitation of the PST's.
- The current ongoing comprehensive inventory of plant asset condition is the first step to achieve long term goal of asset management program which will help to optimize decision making in operations, maintenance, and planning.
- Rapid deployment of CMMS will assist in maintaining the work order system in the interim, Once the asset condition assessment is completed and the asset management program is established, an upgraded CMMS can be utilized to further assist in maintenance tracking and spare parts procurement in the long term.

GREELEY AND HANSEN

8403 Colesville Road, Suite 11
Silver Spring, MD 20910