Bottom Ash Transport Water - Initial Certification Statement and Development of Best Available Technology Economically Achievable Limits by Best Professional Judgment

Gallatin Fossil Plant

Report Date: October 7, 2024

Prepared for:

Tennessee Valley Authority

Prepared by:

Stantec Consulting Services Inc.

BOTTOM ASH TRANSPORT WATER - INITIAL CERTIFICATION STATEMENT

Revision	Description	Author		Quality Check		Independent Review	
0	Final	LPJ	06-21-24	ACS		WMK	
1	Update	LPJ	10-07-24	ACS		WMK	

BOTTOM ASH TRANSPORT WATER - INITIAL CERTIFICATION STATEMENT

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BOTTOM ASH TRANSPORT WATER - INITIAL CERTIFICATION STATEMENT

<u>PE Certification Statement</u>

I certify that I am a licensed Professional Engineer in the State of Tennessee with sufficient knowledge of and familiarity with the Gallatin Fossil Plant and the regulatory requirements found in EPA's 2020 and 2024 Effluent Limitations Guidelines found in 40 CFR 423.

Approved By ______________________
(signature)

Approved By Adam Carl Sutherland
(Print name)

Company Stantec Consulting Services Inc.

Date October 8, 2024

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Abbreviations

BA	Bottom ash
BAT	Best Available Technology Economically Achievable
BATW	Bottom ash transport water
BPJ	Best professional judgment
DCS	Distributed control system
EPA	United States Environmental Protection Agency
ELGs	Effluent Limitations Guidelines
FGD	Flue gas desulfurization
FMS	Flow Management System
GAF	Gallatin Fossil Plant
ICS	Initial Certification Statement
IMP	Internal monitoring point
MGD	Million gallons per day
mg/l	Milligrams per liter
ng/L	Nanograms per liter
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
rMDS	Remote mechanical drag system
RO	Reverse osmosis
SFC	Submerged flight conveyor
TDEC	Tennessee Department of Environment and Conservation
TSS	Total suspended solids
TVA	Tennessee Valley Authority
µg/L	Micrograms per liter

1.0 PURPOSE

This initial certification statement (ICS) has been prepared for the Tennessee Valley Authority (TVA) Gallatin Fossil Plant (GAF). TVA plans to submit this ICS to the Tennessee Department of Environment and Conservation (TDEC) to comply with the United States Environmental Protection Agency's (EPA) 2020 revision to the Steam Electric Power Generating Effluent Limitations Guidelines (ELGs) for bottom ash transport water (BATW). This ICS is being submitted to comply with provisions found in 40 CFR 423.19(c) for the 2020 revision (and 40 CFR 423.19(d) in the published 2024 ELGs):

> (1) Initial Certification Statement. For sources seeking to discharge bottom ash transport water pursuant to § 423.13(k)(2)(i) or 423.16(g)(2)(i), an initial certification shall be submitted to the permitting authority by the as soon as possible date determined under § 423.11(t), or the control authority by October 13, 2023, in the case of an indirect discharger.
>
> (2) Signature and certification. The certification statement must be signed and certified by a professional engineer.
>
> (3) Contents. An initial certification shall include the following:
>
> (A) A statement that the professional engineer is a licensed professional engineer.
>
> (B) A statement that the professional engineer is familiar with the regulation requirements.
>
> (C) A statement that the professional engineer is familiar with the facility.
>
> (D) The primary active wetted bottom ash system volume in § 423.11(aa).
>
> (E) Material assumptions, information, and calculations used by the certifying professional engineer to determine the primary active wetted bottom ash system volume.
>
> (F) A list of all potential discharges under § 423.13(k)(2)(i)(A)(*1*) through (4) or § 423.16(g)(2)(i)(A) through (D), the expected volume of each discharge, and the expected frequency of each discharge.
>
> (G) Material assumptions, information, and calculations used by the certifying professional engineer to determine the expected volume and frequency of each discharge including a narrative discussion of why such water cannot be managed within the system and must be discharged.
>
> (H) A list of all wastewater treatment systems at the facility currently, or otherwise required by a date certain under this section.
>
> (I) A narrative discussion of each treatment system including the system type, design capacity, and current or expected operation.

2.0 REGULATORY REQUIREMENTS

2.1 BOTTOM ASH TRANSPORT WATER EFFLUENT LIMITATIONS GUIDELINES

EPA promulgated revisions to the steam electric power generating sector ELGs in 2020 (Federal Register/Vol. 85, No. 198/Tuesday, October 13, 2020/Rules, and Regulations). The 2020 best available technology economically achievable (BAT) for sites that will continue to operate beyond December 31, 2028, and discharge BATW was determined to be a high-recycle system with a limited quantity of permitted BATW purge (i.e., blowdown or discharge). The 2024 ELGs were published on May 9, 2024 (Federal Register/Vol 89, No 91/Thursday, May 9, 2024) and also contain ELGs for bottom ash. EPA intends that facilities will come into compliance with the 2020 revision to the ELGs, then come into compliance with the 2024 revision. The 2024 ELGs require no discharge of BATW no later than December 31, 2029, except under certain exclusions such as unit retirement by December 31, 2034.

In the 2020 ELGs, EPA defines BATW as any wastewater that is used to convey bottom ash or economizer ash (when collected with bottom ash) from the ash collection or storage equipment, or boiler, and has direct contact with the ash. Transport water does not include low volume, short duration discharges of wastewater from minor leaks (e.g., leaks from valve packing, pipe flanges, or piping), minor maintenance events (e.g., replacement of valves or pipe sections), flue gas desulfurization (FGD) paste equipment cleaning water, or bottom ash purge water. The 2020 ELGs establish an allowable 30-day rolling average BATW purge of up to ten percent of the primary active wetted system volume. This volume of allowable system purge is to be determined on a case-by-case basis by the permitting authority.

Discharge of pollutants in bottom ash transport water from a properly installed, operated, and maintained bottom ash system is authorized in the 2020 ELG rule under conditions outlined in Section 423.13(k)(2)(i)(A)(1 through 4):

- To maintain system water balance when not achievable through spares, redundancies, maintenance tanks and other secondary equipment after precipitation events exceeding a 10-year storm event lasting 24 hours or longer; or,
- To maintain system water balance when waste streams other than bottom ash transport water exceed the ability of the system to accept recycled water and segregating the other waste streams is not feasible; or
- To maintain system water chemistry where existing equipment is unable to manage pH, corrosive substances, substances, or conditions causing scaling, or fine particulates to below levels which impact system operation or maintenance; or
- To conduct maintenance when water volumes cannot be managed by spares, redundancies, maintenance tanks or other secondary equipment.

The total volume allowable from the activities described above should be reduced or eliminated using control measures that are technologically available and economically achievable. EPA excludes the following types of activities from the definition of BATW:

- Incidental, short-duration discharges of BATW;
- Water used in the FGD as makeup water (if applicable); and
- Other no-discharge uses.

- In the 2024 ELGs, rain events exceeding the 10-year, 24-hour event are also excluded if reported in accordance with 40 CFR 423.19(o).

3.0 SITE DESCRIPTION

GAF is located in Gallatin, Sumner County, Tennessee. GAF is a coal-fired steam electric generating facility that consists of four units with a net generating capacity of 976 megawatts located on the Cumberland River. GAF currently sluices bottom ash, clinkers (larger pieces of bottom ash that are ground), and economizer ash from the powerhouse to a remote mechanical drag system (rMDS) that is used to dewater these materials. Outage washes and mill rejects from pulverizing coal prior to combustion are also routed to the rMDS. The rMDS allows GAF to dispose of, or potentially beneficially reuse, dewatered materials and recycle much of the water to the powerhouse for continued sluicing.

Treated flows from the BATW system rMDS are discharged to the Flow Management System (FMS) that discharges via Outfall 010 to the receiving stream. Discharges at this site are regulated under National Pollutant Discharge Elimination System (NPDES) permit no. TN0005428. GAF has a dry scrubber that is not subject to the 2020 ELGs.

4.0 CURRENT BOTTOM ASH TRANSPORT WATER SYSTEM

4.1 SYSTEM DESCRIPTION

BATW operations are comprised of two systems: (1) the equipment at the powerhouse and (2) the equipment at the rMDS. Water is used to transport materials from the powerhouse to the rMDS. The type of rMDS used at GAF are submerged flight conveyors, or SFCs.

4.1.1 Powerhouse Bottom Ash Operations

Bottom ash is collected in a hopper under each generating unit's boiler. The hopper collects and stores bottom ash which drops from the boiler's furnace. This ash may be fine, coarse, clinker, or any combination thereof. The water in the hopper rapidly cools and tends to fracture the entering ash.

Each hopper section has its own discharge equipment (sluice gate, enclosure, crusher, and JETPULSION® pump). The grinder further reduces the size of the ash so it can be sluiced to the rMDS.

Bottom ash (BA) is typically not continuously sluiced. Sluicing schedules may vary based on generation demand, type of coal burned, and/or other operations. BA is collected and stored in the hopper until sufficient volume is accumulated. The BA sluice procedure begins at the start of each twelve-hour shift such that each boiler bottom is sluiced twice per day as needed. This usually consists of sluicing thirty minutes per hopper, with two hoppers per each of the four units.

In contrast, economizer ash is continuously sluiced. Mill rejects from the coal preparation process are also sluiced to the SFCs. Each mill reject hopper is sluiced for approximately one hour per day, for a total of four hours per day. Mill rejects are sluiced via a jet pump that is fed from the bottom ash recycle loop, thus no additional water is introduced to the BATW loop.

Figure 1 shows the powerhouse BATW sluice and return water operations in a simplified block flow diagram. BA and economizer ash are pumped directly to the SFCs. Outage washes are routed to an area known as the Alligator Pits and then sent to BA dewatering.

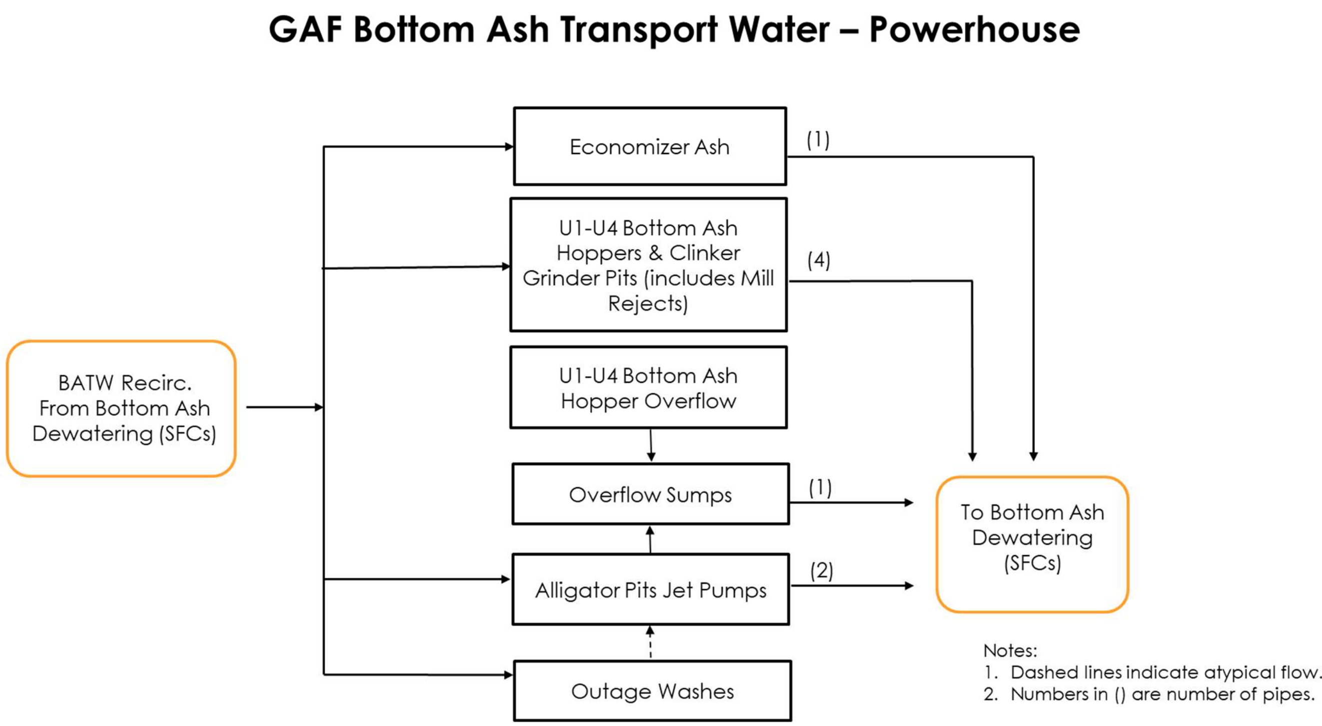

Figure 1 - BATW Sluicing from Powerhouse and Return Water

4.1.2 Remote Mechanical Drag System (rMDS)

The rMDS consists of two SFCs in routine service and a third SFC as a spare. There are also three clarifiers with two in routine service and the third as a spare. Similarly, the Process Water tanks are operated as two in service and the third as a spare. The Recirculation Tanks are operated with one in service and one as a spare.

The sluice water flows to two primary SFCs where the materials are dewatered, and the solids are stockpiled after traveling up the incline housed in the SFC. These stockpiled materials may be disposed of or beneficially reused. Overflow from the in service SFCs is sent to the two primary service clarifiers with chemical injection to enhance the settling of suspended solids (the bulk of solids are removed in the SFCs). Flow from the clarifiers is sent to the Process Water Tanks and then to the Recirculation Tanks. Flow from the Recirculation Tanks is sent to the powerhouse to be reused for sluicing. If system makeup water is needed, it is added at the Recirculation Tanks.

If excess water needs to be purged from the BATW loop, it will be discharged from a line leaving the Recirculation Tanks. This blowdown has been treated and is sent to the FMS for comingling with other plant flows. Flow from the FMS is monitored at Outfall 010.

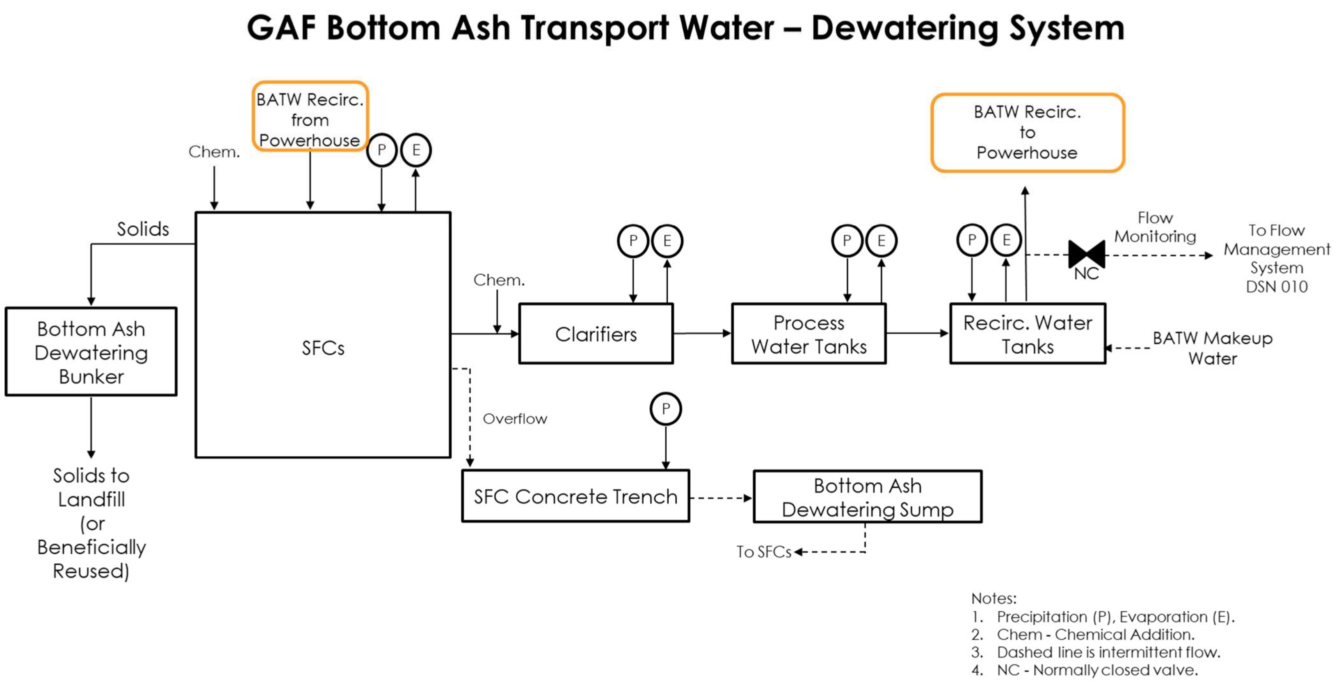

Figure 2 - Remote Mechanical Drag System Diagram

4.2 ADDITIONAL INFLOWS TO BOTTOM ASH TRANSPORT WATER SYSTEM

GAF has flows that are introduced into the BATW loop that are not explicitly used for bottom ash (BA) transport, although allowed by the ELGs to be comingled. Economizer ash sluice is a flow that is allowed to be managed with BA as BATW. Other flows that are not strictly BATW flows are outage washes and mill rejects from coal crushing operations. Flows such as outage washes are allowed to be commingled with BATW as long as they are managed as BATW. Outage washes at GAF do not contribute additional flow into the BATW system as the source of the wash water is from the BATW recirculation line. Outage washes include boiler fireside and air preheater washes. Outage washes are intermittent, so their contribution is not expected to interfere with blowdown volume management and are not being considered for segregation from the BATW system. Mill rejects from the type of coal that GAF typically burns (Powder River Basin coal) are typically less than that from eastern bituminous coal. Mill reject source water is also from the BATW recirculation system, hence does not contribute additional water volume.

5.0 PRIMARY WETTED BOTTOM ASH SYSTEM VOLUME AND POTENTIAL DISCHARGES

5.1 PRIMARY WETTED BOTTOM ASH SYSTEM VOLUME

The primary active wetted volume is defined in the 2020 ELGs as the maximum capacity of the wetted volume of BATW equipment in all non-redundant piping (including recirculation piping), primary bottom ash collection and recirculation loop tanks such as bins, troughs, clarifiers, and dedicated sumps and hoppers. The primary wetted volume does not include any spares, maintenance tanks, redundancies, volume of surface impoundments, or non-bottom ash transport systems that may direct process water to the bottom ash loop. The primary active wetted bottom ash system volume was calculated using engineering drawings; the supporting calculations of the volumes are also included in Appendix A. The primary wetted volume calculation is summarized in Table 1. Redundant tanks are shown in red, but associated equipment (i.e., pumps and piping) was omitted for clarity.

Table 1 - Primary Active Wetted Volume by System Components

COMPONENT	CATEGORY	PRIMARY WETTED VOLUME		NOTES
		(ft^3)	(gallons)	
Powerhouse				
Unit 1 Bottom Ash Hopper A	Equipment	1,253	9,373	
Unit 1 Bottom Ash Hopper B	Equipment	1,253	9,373	
Unit 1 Bottom Ash Hopper A Crusher	Equipment	13	95	
Unit 1 Bottom Ash Hopper B Crusher	Equipment	13	95	
Unit 2 Bottom Ash Hopper A	Equipment	1,253	9,373	
Unit 2 Bottom Ash Hopper B	Equipment	1,253	9,373	
Unit 2 Bottom Ash Hopper A Crusher	Equipment	13	95	
Unit 2 Bottom Ash Hopper B Crusher	Equipment	13	95	
Unit 3 Bottom Ash Hopper A	Equipment	1,575	11,781	
Unit 3 Bottom Ash Hopper B	Equipment	1,575	11,781	
Unit 3 Bottom Ash Hopper A Crusher	Equipment	13	95	
Unit 3 Bottom Ash Hopper B Crusher	Equipment	13	95	
Unit 4 Bottom Ash Hopper A	Equipment	1,575	11,781	
Unit 4 Bottom Ash Hopper B	Equipment	1,575	11,781	
Unit 4 Bottom Ash Hopper A Crusher	Equipment	13	95	
Unit 4 Bottom Ash Hopper B Crusher	Equipment	13	95	
Unit 1-4 Bottom Ash Jet Pumps	Equipment	6	46	
Unit 1-4 Alligator Pits	Equipment	5,345	39,988	
Unit 1-4 Alligator Pit Jet Pumps	Equipment	3	21	
Unit 1-4 Bottom Ash Hopper Overflow Sump	Equipment	1,127	8,434	
Unit 1-4 Bottom Ash Hopper Overflow Sump Pump	Equipment	2	15	
Unit 1-4 Hydroveyor Exhausters	Equipment	2	16	
Bottom Ash Dewatering System				
Bottom Ash Dewatering Sump A/B	Equipment	2,376	17,775	
Bottom Ash Dewatering Sump C/D	Equipment	2,376	17,775	
Dewatering Area Sump A/B Pump A	Equipment	0	1	
Dewatering Area Sump C/D Pump A	Equipment	0	1	
Remote Dewatering Bottom Ash SFC A	Equipment	16,664	124,660	
Remote Dewatering Bottom Ash SFC B	Equipment	16,664	124,660	
Remote Dewatering Bottom Ash SFC C	Equipment			Redundant
Clarifier A	Equipment	68,841	515,000	
Clarifier B	Equipment	68,841	515,000	
Clarifier C	Equipment			Redundant
Process Water Tank A	Equipment	4,524	33,843	
Process Water Tank B	Equipment	4,524	33,843	
Process Water Tank C	Equipment			Redundant
Process Lift Pump A1	Equipment	4	31	
Process Lift Pump B1	Equipment	4	31	
Process Water Pump A	Equipment	0	3	
Process Water Pump B	Equipment	0	3	
Chain Wash Pump A	Equipment	0	2	
Bottom Ash Clarifier A Underflow Pump	Equipment	2	15	
Bottom Ash Clarifier B Underflow Pump	Equipment	2	15	
Dewatering Area Trench	Equipment			Only wet during rain events or equipment drainage
Bottom Ash Transport Water Recirc				
Recirculation Water Tank A	Equipment	43,138	322,715	
Recirculation Water Supply Pump A	Equipment	9	65	
Recirculation Water Supply Pump B	Equipment	9	65	
Recirculation Water Tank B				Redundant
BADW and BATW Piping	Piping	23,730	177,523	
UNIT 1-4 TOTALS		**269,608**	**2,016,939**	
CONVERSION FACTOR	1 ft^3 =	7.481	gal.	

For purposes of calculating the estimated total primary wetted volume of the BATW system, the following assumptions were made:

1. Wetted volume for hoppers is up to normal water demarcation line.
2. Hopper is comprised of two (2) cross sections: (1) rectangular prism and (2) truncated rectangular hopper.
3. Crusher is flooded full.
4. Crusher wet end is a rectangular prism.
5. Volume of Bottom Ash Hopper JETPULSION® pump is equivalent to 6" diameter, schedule 40 pipe, 3.95' long.
6. Volume of Alligator Pit JETPULSION® pump is equivalent to 8" diameter, schedule 40 pipe, 3.95' long.
7. Volume of Hydroveyor exhauster is equivalent to 8" diameter, schedule 40 pipe, 3.98' long.
8. Wetted volume for submerged flight conveyors is up to normal operating water level.
9. Conveyor is comprised of five (4) cross sections: (1) upper rectangular prism, (2) trapezoidal prism, (3) front rectangular prism, (4) front triangular prism, and (5) rear rectangular prism.
10. SFC normal water level is 20', 8.5" above the top of the concrete slab.
11. Pumps are flooded full.
12. Assumed pump volume is equivalent to pump casing estimated as cylinder.
13. Overflow sump is comprised of geometrical shape: (1) rectangular prism.
14. Alligator Pit normal water level is 6' above bottom of pit.
15. Dewatering Area Sump normal water level is 5' below top of sump.
16. Piping is flowing full.
17. Small bore pipes with a nominal pipe size (NPS) of 2-1/2 inches and under were deemed to not be part of the primary wetted system volume due to intermittent service. These are not of a significant volume and thus were not included as part of the overall system volume.
18. Piping reducer volume is the length of the reducer using the smaller pipe diameter.
19. Tank volume provided by the clarifier manufacturer was used.

5.2 POTENTIAL BATW DISCHARGES

Based on the 2020 ELGs, discharges of up to 10% as determined by the permitting authority of the primary wetted BATW volume may occur on a 30-day rolling average. The NPDES permit for GAF includes a provision to allow the discharge of up to 10% of the primary wetted volume on a thirty-day rolling average (NPDES Permit TN0005428, page 9 of 40.) The total BATW primary wetted volume has been calculated to be approximately 2.01 million gallons. This calculation includes primary but not spare SFCs, clarifiers, process water and recirculation tanks, piping/trenches to the SFCs from the powerhouse, return piping/trenches from the powerhouse, sump volumes, and wetted boiler surfaces.

Based on the total system volume, a 10% allowable discharge volume would be 201,693 gallons per day on a 30-day rolling average. There are several factors creating a need to discharge BATW water. Potential discharge factors, estimated volumes, and frequency are shown in Table 2. Actual discharge volumes may vary significantly but will remain within allowance. There is additional language in the 2020 ELGs and reflected in GAF’s NPDES permit that requires that “the total volume that may be discharged …shall be reduced or eliminated to the extent practicable using control measures… that are technologically available and economically achievable in light of best industry practice.” (2020 ELGs - 40 CFR 423.13(k)(2)(i)(B) and Page 9 of 40 of the NDPES permit).

Storm events may create a need to discharge from the BATW loop due to the potential for significant inflows into the BATW system. Overall, the drainage areas that flow into two sumps are approximately 1.3 acres for one sump and 1.1 acres to the second. The open tanks were also included in the rainfall volume estimate. The total estimated volume of stormwater introduced into the BATW system was calculated at approximately 378,950 gallons for a 10-year, 24-hour storm event of 4.99 inches based on a total acreage of approximately 2.8 acres, inclusive of the open tanks. This rainfall amount was obtained from the current National Oceanic and Atmospheric Administration (NOAA) Atlas 14 precipitation frequency data for the specific site coordinates. Storm events from extended precipitation periods that do not qualify as a 10-year, 24-hour event may also create a need to discharge to maintain the BATW system operations. Note that the 10-year, 24-hour event precipitation would consume more than the 10% discharge allowance for that day; thus, other flows need to be minimized to the extent necessary to comply with the 10% allowable volume on the 30-day rolling average.

There may also be a need to discharge BATW due to maintenance events such as safely taking an SFC, clarifier, or other piece of equipment out of service. Other reasons may include discharges necessary to maintain water chemistry. For example, some TVA BATW systems have experienced corrosion in a high-recycle BATW loop. Even if not currently experienced at a site, this could occur due to variability in coal as a raw material or due to changes in coals being burned. Varying concentrations of constituents may be present (e.g., higher sulfur) which could cause scaling. Or higher chloride coal may cause acidity that may exceed a pH adjustment system’s ability to neutralize the water. This may necessitate system blowdown to maintain system chemistry to prevent damage to the BATW equipment and to prevent chemistry issues from becoming a safety concern. Purge discharges will also result when volumes exceed existing BATW system storage and may vary due to system losses due to evaporation or entrained water.

Table 2 - Expected Potential Operations That May Cause BATW Purge Discharges

Name of Potential Discharge	Approximate Volume of Discharge (gallons)	Expected Frequency of Planned Discharge
rMDS: SFC - Maintenance not requiring complete evacuation	<125,000 per SFC	Annually for each of 3 SFCs
rMDS: SFC – Outage requiring complete drainage such as for chain repair or replacement, idler wheel maintenance, pump suction valve maintenance, etc.	125,000 per SFC	Expected every 2-4 years for each of 3 SFCs
rMDS: Clarifier Dewatering for maintenance	515,000 per clarifier	Three clarifiers. One clarifier per year (i.e., an individual clarifier would be planned to be drained once every three years).
rMDS: Process Water Tank Dewatering for maintenance	34,000 per tank	Three Process Water Tanks. One tank per year (i.e., an individual process tank would be planned to be drained once every three years).
rMDS: Recirculation Water Tank Dewatering for maintenance	323,000 per tank	Two Recirculation Water Tanks. One tank per year (i.e., an individual recirculation tank would be planned to be drained every other year).
Powerhouse – Boiler hopper/crusher dewatering.	18,900 to 23,800 per unit	Annually for each of 4 units
System - Routine storm events; 10-year, 24-hour events	Varies for routine storm events. ~378,950 gallons for a 10-year, 24-hour event	Could need to discharge depending upon volume, timing, or frequency of precipitation
System - Chemistry issues (e.g., fines, corrosion/scaling, pH) or excess volume	To be determined based on actual closed loop operational experience	Could be routine discharges depending upon source water or coal chemistry variability.
System - Other flows routed to BATW loop that are currently included	Outage Washes Mill Rejects	Flows depend upon outage wash frequency and type of equipment being washed. Both outage wash and mill rejects are sourced from BATW so do not introduce additional volume.

For purposes of estimating the volume and frequency of discharges from the BATW loop and reasons they may be necessary, the following were considered:

1. Prior discharge volumes and frequency are not reliable indicators of future need for discharge.
2. Discharges resulting from planned equipment outages do not reflect other outages needing evacuation of water such as emergency outages.
3. This ICS is being submitted prior to the BATW ELG applicability date of December 31, 2025. The recirculation system was placed into service in August 2023. Operational experience will be gained to facilitate improved discharge management. Operations are expected to vary by season.
4. Precipitation events are expected to be the most difficult to plan for and manage. The current 10-year, 24-hour event is expected to contribute approximately 378,950 gallons to the BATW system. This amount of rain in design events is currently under review and being updated by the NOAA. There can be other sustained precipitation patterns in this region of the country that could contribute water volume to the system.
5. Once the ELG applicability date has occurred, discharges from the BATW loop will be actively managed to maintain compliance with the allowable purge volume of up to 10% of the primary active wetted volume on a 30-day rolling average.

6. The potential for significant precipitation and uncertainty about future loop chemistry support the continuation in the GAF NPDES permit allowing 10% of the primary active wetted volume on a 30-day rolling average as the allowable purge volume.

5.3 BATW DISCHARGE LOCATION AND FLOW MEASUREMENT

GAF will monitor the purge stream from the BATW system, after treatment, downstream of the recirculation tank, and prior to the FMS where commingling with other plant flows and additional treatment occurs. Flow monitoring from the BATW blowdown is reported using a magnetic flowmeter that transmits data to the plant's distributed control system (DCS). Purge flows will be totalized into a daily volume, tracked, and reported for compliance purposes. The control logic will further include alarms to alert operators if readings stop. There will be a backup flow meter available in the event of a primary meter failure.

The site will manage the permitted 30-day rolling average blowdown volumes. Forecasted rain events will be taken into consideration such that allowance is made to manage blowdown or purge flow volumes. BATW equipment dewatering and outage washing schedules will be managed to the extent practicable such that operations are not planned to occur when major storm events are forecast. Local rain gages that have been installed previously will be utilized to determine the actual precipitation levels occurring locally.

6.0 SYSTEM MODIFICATIONS AND MATERIAL ASSUMPTIONS ABOUT FUTURE SYSTEM OPERATION/MODIFICATIONS

Some modifications to the BATW loop have been completed in advance of the ELG applicability date included in the GAF NPDES permit of December 31, 2025. There was a project to change fire pump source water from bottom ash sluice water to a raw water source. This project was undertaken to ensure that BATW did not escape the loop during a fire protection test or in response to a fire. Pulverizer cooling water discharge also has been rerouted to the station sump away from the Alligator Pit sump. The Alligator Pit sump is part of the BATW system in the powerhouse. This cooling water flow was not BATW, and this modification reduced the amount of non-BATW water introduced into the BATW loop.

Another change completed was to use treated BATW for outage washes instead of raw water. Since the BATW SFC and clarifiers are being used to treat outage washes, the use of treated BATW reduces the volume of (new) water introduced into the loop from this activity. Similarly, the water used for mill reject sluicing is also drawn from the BATW system such that no new inflows occur. Since these are currently commingled with BATW, these flows will be managed the same as BATW flows.

There do not appear to be potential modifications of stormwater drainage areas that send flows into the BATW dewatering system at the rMDS that are economical. Modifications such as placing the rMDS facility under roof would be unreasonably expensive and would not provide measurable environmental benefit. Modifications to exclude outage washes from the BATW system would also be prohibitively expensive. These flows were routed to the BATW system in the first place to provide tank-based treatment to manage the wastewater characteristics from this operation. A modification to remove mill rejects from the BATW system is also not deemed necessary as those operations generally contribute insignificant constituents based on low mill reject quantities in PRB coal. Capital projects to cease sluicing mill rejects would not be justified by the resulting reductions in constituent contribution, especially since these flows are sourced from the BATW system and do not introduce additional volume.

7.0 BATW PURGE WASTEWATER TREATMENT SYSTEM

Samples were collected from the flows going into the SFCs from bottom ash sluicing and economizer ash sluicing. Samples were also collected at the BATW clarifier overflow to determine the quality of wastewater that could potentially be discharged prior to mixing with other flows. The sampling plan was approved by TDEC and specified that samples were to be collected twice monthly over four months and then monthly. Economizer ash sluice samples were collected for five events; this flow was sampled to determine the contribution of metals and other constituents to the overall loading to the dewatering system.

The GAF BATW management system utilizes SFCs and clarifiers to settle out solids in preparation for recycling water back to the powerhouse for reuse in sluicing, or for potential blowdown. Additional treatments such as coagulant, polymer, and acid or caustic injection are utilized as needed within the BATW loop. However, should new issues arise with the BATW loop's water chemistry once the loop is closed and more operational experience has been gained, the need for additional treatment would be evaluated.

A summary of sampling results from clarifier overflow showing solids and metals removal are shown in Table 3. Table 4 shows percent removals on a concentration basis. These results indicate that effective treatment is occurring with the existing equipment.

Table 3 - Summary of Analytical Results for Inputs and Clarifier Overflow

		Influents (Econ + BA)								Clarified BATW	
Constituent	**Units**		**Max Econ**		**Avg Econ**		**Max BA**		**Avg BA**		**Avg Clarifier Overflow**
Total Suspended Solids	mg/l		388		103		6280		1290		24.2
Total Dissolved Solids	mg/l		576		513		713		592		518
Aluminum, T	ug/L		22200		10000		171000		48700		7000
Antimony, T	ug/L		2.00	<	1.41		2.33	<,J	1.37	<,J	1.30
Arsenic, T	ug/L		1.54	J	1.20		24.3	<,J	6.05	<,J	1.04
Barium, T	ug/L		1170		494		8780		2260		365
Cadmium, T	ug/L	<	1.00	<,J	0.642		1.63	<,J	0.833	<,J	0.830
Calcium, T	ug/L		195000		154200		701000		270000		144000
Chromium, T	ug/L		38.0	B	27.6		149	B	56.1	B	25.7
Cobalt, T	ug/L		4.43	J	1.28		61.4	J	12.6	J	0.615
Copper, T	ug/L		21.8		7.98		283		62.0	J	4.22
Iron, T	ug/L		7900		1930		60400		14790	J	749
Lead, T	ug/L		2.86	<,J	1.19		14.0	<,J	3.72	<,J	0.919
Magnesium, T	ug/L		11700		9080		98600		26700		8000
Manganese, T	ug/L		30.0		11.5		317	J	70.9		11.8
Mercury (low level), T	ng/L		1.64		1.34		2.85		1.25	J	0.852
Molybdenum, T	ug/L		69.6		52.1		80.4		57.8		49.1
Nickel, T	ug/L		8.21	J	2.58		123	J	25.5	<,J	6.54
Selenium, T	ug/L		3.75	J	2.51		3.61		2.50	J	2.21
Silver, T	ug/L	<	1.00	<	1.00	<	1.00	<	1.00	<	1.00
Thallium, T	ug/L	<	1.00	<	1.00	<	1.00	<,J	0.867	<	1.00
Tin, T	ug/L	<	5.00	<	5.00	<	5.00	<,J	4.79	<	5.00
Titanium, T	ug/L		1420		343		9760	,J	2380		116
Vanadium, T	ug/L		61.0		30.7		512	,J	142		23.4
Zinc, T	ug/L		24.9	<,J	15.9		113	<,J	31.9	<,J	16.6
Boron, T	ug/L		2630		1950		3960		2340		1830
Strontium, T	ug/L		4740		3350		10200		4890		3140
Beryllium, T	ug/L		1.00	<,J	0.950		7.94	<,J	2.30	<,J	0.917

< : Analyte concentration is less than the RL (Reporting Limit)
J : Result is < the RL but ≥ the method detection level (MDL); the concentration is an approximate value.
B : Compound was found in the blank and sample.

Table 4 - Minimum, Maximum, and Average Percent Removals Based on Concentration

Constituent	Min % Removal	Max % Removal	Avg % Removal (Concentration Based)
Total Suspended Solids	48.1	99.8	79
Aluminum, total	35.2	95.7	73
Antimony, total	23.2	64.3	43
Arsenic, total	42.1	93.8	71
Barium, total	2.5	94.0	60
Beryllium, total	0.0	94.7	50
Cadmium, total	0.0	66.0	32
Calcium, total (as Ca)	20.1	74.6	55
Chromium, total	18.6	78.0	58
Cobalt, total (as Co)	54.4	98.9	78
Copper, total	54.4	99.5	75
Iron, total	39.3	99.9	82
Lead, total	1.2	90.7	55
Magnesium, total	13.6	92.0	57
Manganese, total	23.4	95.2	59
Mercury (low level), total	27.1	82.7	58
Molybdenum, total	23.3	60.3	45
Nickel, total	50.7	98.2	73
Selenium, total	14.5	64.1	46
Silver, total (as Ag)	0.0	50.0	36
Thallium, total	0.0	50.0	36
Tin, total	0.0	50.0	36
Titanium, total	47.2	99.9	84
Vanadium, total	29.8	96.4	68
Zinc, total	0.0	88.2	56
Boron	24.3	58.5	48
Silicon	54.7	99.4	75
Strontium	19.1	67.1	52

8.0 BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE (BAT) DISCHARGE LIMITATIONS BY BEST PROFESSIONAL JUDGMENT (BPJ)

In the 2020 ELG rulemaking, EPA declined to set national BAT limitations for BATW blowdown or purges. EPA stated that development of national standards for blowdown would be difficult as there were many site-specific factors that could come into play. Instead, responsibility was delegated to NPDES permit writers to establish BAT limits by best professional judgment (BPJ). EPA also determined during the development of the ELGs for BATW that the reduction in volume of BATW discharges by requiring high recycle systems as BAT would reduce the loadings of all pollutants. EPA did not go as far as establishing no discharge of BATW as BAT in the 2020 ELGs..

In general, the process for establishing BAT by BPJ requires an assessment of:

1. Pollutants of concern,
2. Existing treatment the wastewater receives,
3. Age of equipment and facilities involved,
4. The process employed and potential system changes,
5. Proposed treatment and its total costs and related benefits, and
6. The non-water quality environmental impacts including energy.

For GAF BATW, typical parameters of concern are listed in Table 4. These consist primarily of metals, along with total suspended solids and total dissolved solids. In establishing numeric limits, EPA guidance reports that EPA does not typically establish BAT limits on constituents that are found in treatment chemicals such as iron used for iron co-precipitation or aluminum when alum also may be used in wastewater treatment.

An overview of the treatment that BATW blowdown receives is found in Section 7.0. The establishment of BAT by BPJ requires that the permit writer consider factors that are unique to the applicant. In GAF's case, the existence of clarifiers in the BATW loop appears to be somewhat unique as not all coal-fired sites on a national basis have installed this level of treatment for their return water and/or potential discharge of BATW. Some sites in the United States only use basins for BATW recirculation collection, others use only hydrobins where BA is dewatered and sluice water returned, and still others recirculate the water directly from SFCs. In any of these other cases, blowdown quality is potentially higher in constituents of concern than at GAF.

GAF's recirculation system has already had the effect of reducing constituent loading to the receiving waters after the in-service date of the BATW recirculation system in August 2023. Annualized average flow from the previous NPDES permit application flow schematic, prior to the recirculation project completion, was approximately 13.2 million gallons per day (MGD). With the inclusion of treatment and the reduction in metals and flow, there has already been a significant reduction in constituent loading to the receiving stream. The maximum allowable BATW blowdown rate of 201,693 gallons per day at GAF on a 30-day rolling average (See Section 5.2) will result in a approximate reduction in flow of over 99 percent after the ELG applicability date. Figures 3 and 4 show the approximate average flow before and after the ELG applicability date, assuming that 10% of the primary wetted volume on a 30-day rolling average blowdown is allowed.

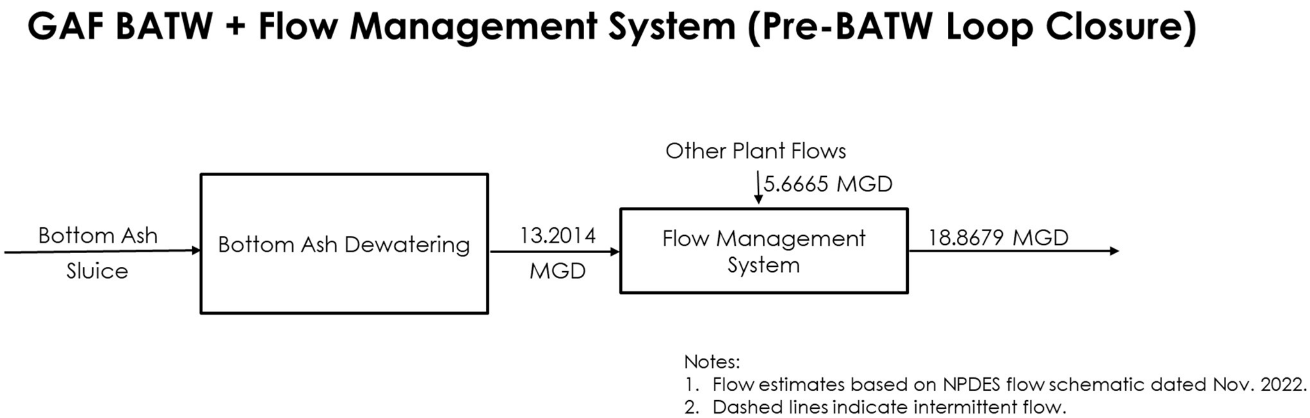

Figure 3 - Average Flows Before ELG Applicability Date

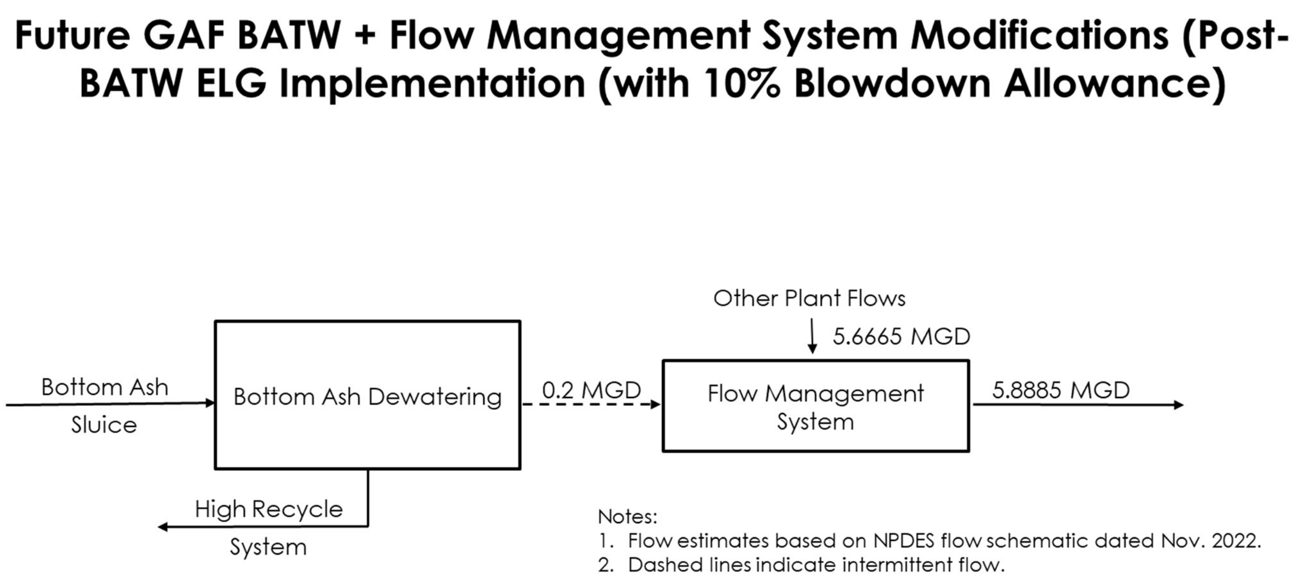

Figure 4 - Average Flows After ELG Applicability Date

EPA's 2020 rulemaking included analytical data for selected total metals in BATW. EPA's results were compared to the clarifier overflow results at GAF and are summarized in Table 5. Most parameters in this table are less than EPA's BATW discharge data, indicating that treatment in the clarifiers is effective in removing significant quantities of certain parameters.

Table 5 - EPA BATW Data Compared to GAF Treated BATW Values

			GAF Treated Clarifier Overflow (09/2023 - 12/2023)	
Constituent	**Units**	**EPA Value**	**Qualifiers**	**Average**
Total Suspended Solids	mg/l	13.4		24
Total Dissolved Solids	mg/l	1290		508
Aluminum, total	ug/L	854		7000
Antimony, total	ug/L	17.3	<, J*	1.3
Arsenic, total	ug/L	9.32	<, J*	1.0
Barium, total	ug/L	106		365
Cadmium, total	ug/L	0.721	<, J*	0.83
Calcium, total (as Ca)	ug/L	154000		144,000
Chromium, total	ug/L	5.08	B	25.7
Cobalt, total (as Co)	ug/L	9.19	J	0.62
Copper, total	ug/L	3.95	J*	4.22
Iron, total	ug/L	676	<	749
Lead, total	ug/L	10.4	<, J*	0.92
Magnesium, total	ug/L	55700	J*	8000
Manganese, total	ug/L	153		11.8
Mercury (low level), total	ng/L	102	J*	0.85
Molybdenum, total	ug/L	28.3		49.1
Nickel, total	ug/L	17.5	<, J*	6.5
Selenium, total	ug/L	12.3	J	2.2
Thallium, total	ug/L	1.13	<	1.0
Titanium, total	ug/L	35.9		116
Zinc, total	ug/L	33.8	<, J*	16.6
Boron	ug/L	5310		1830
Strontium	ug/L	1430		3140

< : Analyte concentration is less than the RL (Reporting Limit).
B : Compound was found in the blank and sample.
J : Result is < the RL but ≥ to the MDL and the concentration is an approximate value.
Letter/number qualifier with *: Applies to some analyses.

The estimated cost of equipment for the BATW recirculation and treatment projects was compiled from the recently installed equipment. This equipment included tanks, pumps, piping, chemical injection systems, and controls that were installed and placed in operation in August 2023. This cost estimate does not include costs associated strictly with outage wash treatment. The total cost for the BATW recirculation project was approximately 43 million dollars.

Another unique factor for GAF's BATW system is that treated blowdown from the BATW system is subsequently sent to GAF's FMS. The FMS collects various plant flows from GAF along with coal pile and barge unloader area stormwater runoff. This FMS is comprised of a (separate) series of tanks that also achieves chemical precipitation. Unit operations include pH adjustment, flocculant, and coagulant addition, mixing, and settling. The discharge from the FMS is routed to Outfall 010 of the NPDES permit. TDEC was notified that the FMS was placed into service in June 2019.

As stated earlier, the BATW recirculation project was placed in service in late August 2023. A review of the discharge monitoring data from Outfall 010 from August to November 2023 indicates that most metals were non-detect (arsenic, beryllium, cadmium, chromium, lead, nickel, antimony, zinc, silver, and selenium). Reported values for total suspended solids and other metals were low. Table 6 includes the available discharge monitoring data from Outfall 010 for that period.

Table 6 - Discharge Monitoring Data from FMS System (Outfall 010) – August – November 2023

Average	9.9	8.0	11.7		0.004	<	0.043		0.001	<	0.001	<
Max	21	8.2	36		0.005		0.069		0.001		0.001	
Min	4.72	7.8	3.0		0.001		0.031		0.001		0.001	
Stnd Dev	5.2	0.1	11.2		0.002		0.017		0.00		0.00	
Monitoring Period End Date	**Flow, MGD**	**pH**	**TSS, mg/L**	Qual.	**Arsenic, mg/L**	Qual.	**Barium, mg/L**	Qual.	**Beryllium, mg/L**	Qual.	**Cadmium, mg/L**	Qual.
8/31/2023	20.8	8.1	3.0	=	0.001	<	0.069	=	0.001	<	0.001	<
8/31/2023	12.2	7.8	3.0	=	-		-		-		-	
9/30/2023	7.3	8	7.0	=	0.005	<	0.035	=	0.001	<	0.001	<
9/30/2023	9.2	8.1	7.0	=	-		-		-		-	
10/31/2023	5.6	8.2	36.0	=	0.005	<	0.031	=	0.001	<	0.001	<
10/31/2023	4.7	7.9	14.0	=	-		-		-		-	
11/30/2023	7.1	8	4.0	=	0.005	<	0.036	=	0.001	<	0.001	<
11/30/2023	12.7	8.2	4.0	=	-		-		-		-	

Average	0.004	<	0.005		0.196		0.001	<	0.001	<	0.002	<
Max	0.005		0.005		0.235		0.001		0.001		0.002	
Min	0.002		0.004		0.133		0.001		0.001		0.001	
Stnd Dev	0.002		0.001		0.045		0		0E+00		0.001	
Monitoring Period End Date	**Chromium, mg/L**	Qual.	**Copper, mg/L**	Qual.	**Iron, mg/L**	Qual.	**Lead, mg/L**	Qual.	**Thallium, mg/L**	Qual.	**Nickel, mg/L**	Qual.
8/31/2023	0.002	<	0.005	=	0.235	=	0.001	<	0.001	<	0.001	<
8/31/2023	-		-		-		-		-		-	
9/30/2023	0.005	<	0.005	=	0.221	=	0.001	<	0.00106	=	0.002	<
9/30/2023	-		-		-		-		-		-	
10/31/2023	0.005	<	0.004	=	0.195	=	0.001	<	0.001	<	0.002	<
10/31/2023	-		-		-		-		-		-	
11/30/2023	0.005	<	0.005	=	0.133	=	0.001	<	0.00111	<	0.002	<
11/30/2023												

Average	0.001	<	0.019	<	0.002	<	0.404		0.004	<	1.5E-06	
Max	0.001		0.02		0.002		0.69		0.005		2.76E-06	
Min	0.001		0.015		0.002		0.27		0.002		8.4E-07	
Stnd Dev	0.00		0.003		0.00		0.193		0.002		8.96E-07	
Monitoring Period End Date	**Silver, mg/L**	Qual.	**Zinc, mg/L**	Qual.	**Antimony, mg/L**	Qual.	**Aluminum, mg/L**	Qual.	**Selenium, mg/L**	Qual.	**Mercury, mg/L**	Qual.
8/31/2023	0.001	<	0.015	<	0.002	<	0.69	=	0.005	<	8.4E-07	=
8/31/2023	-		-		-		-		-		-	
9/30/2023	0.001	<	0.02	<	0.002	<	0.27	=	0.005	<	2.76E-06	=
9/30/2023	-		-		-		-		-		-	
10/31/2023	0.001	<	0.02	<	0.002	<	0.337	=	0.005	<	1.52E-06	=
10/31/2023	-		-		-		-		-		-	
11/30/2023	0.001	<	0.02	<	0.002	<	0.319	=	0.002	<	8.8E-07	=
11/30/2023	-		-		-		-		-		-	

Qual. = Qualifier

< : At least one result reported as non-detect (ND)

< (with shading): All results reported as ND

During EPA's proposed 2023 ELG rulemaking in which no discharge of BATW was suggested as the generally applicable case, TVA obtained rough order of magnitude costs for converting the high recycle system to a no discharge system. The design basis was to use reverse osmosis (RO) for preliminary treatment to produce a high quality permeate that could be recycled into the BATW system that would reduce the need for discharge. The reject from the RO system would be sent to a thermal concentrator for evaporation, with dewatered salts being landfilled. The estimated rough order of magnitude cost to install this additional equipment was between 49.5 to 63.6 million dollars which will vary based on various conditions.

The 2024 ELGs contain the no discharge requirement to be implemented no later than December 31, 2029 for sites continuing to operate past the new retirement date of December 31, 2034. Given this new ELG and the reductions that have already occurred, additional treatment of these discharges is not warranted at this time.

8.1 PROPOSED BAT BY BPJ LIMITATIONS FOR BATW

EPA commonly uses indicator pollutants as surrogates for other pollutants. For example, there were multiple constituents of concern considered in the development of FGD wastewater ELGs for the steam electric power sector. However, EPA chose to regulate only a few parameters while still achieving reductions in overall pollutant loadings. In the case of BATW blowdown treatment, management of total suspended solids (TSS) serves as a good surrogate for many metals at GAF. That is, if TSS is well managed, reductions in metals are also achieved.

TSS appears to be a good indicator pollutant for a variety of metals and could easily be applied at an internal monitoring point for BATW prior to mixing with other flows in the FMS. This would be similar to the permitted outfall monitoring requirements described for the low utilization subcategory in GAF's NPDES permit.

TVA requests a BATW blowdown allowance of 10% of the primary wetted volume on a 30-day rolling average. These flows will be measured by flow meter(s) and will be reported with discharge monitoring reports when these ELGs become applicable. TVA requests using TSS as an indicator pollutant at the proposed internal monitoring point (IMP) for BATW, and establishing the daily maximum limit at 100 milligrams per liter (mg/L) and the monthly average at 30 mg/L. TVA requests limits not be established for any other pollutants at the IMP for BATW. The BATW treatment system was originally developed to meet these limits with appropriate margins of safety for compliance purposes. Compliance with these parameters at the appropriate internal monitoring point will serve as an indication that the treatment system is being properly operated and maintained.

APPENDIX A

Bottom Ash Transport Water System
Primary Wetted Volume Calculations

Wetted Volume Calculations

Unit 1 Bottom Ash Hopper A Crusher
Unit 1 Bottom Ash Hopper B Crusher
Unit 2 Bottom Ash Hopper A Crusher
Unit 2 Bottom Ash Hopper B Crusher
Unit 3 Bottom Ash Hopper A Crusher
Unit 3 Bottom Ash Hopper B Crusher
Unit 4 Bottom Ash Hopper A Crusher
Unit 4 Bottom Ash Hopper B Crusher

Assumptions:

1. Crusher is flooded full.
2. Crusher wet end is rectangular prism.

Calculation:

1. Calculate the volume of the crusher, V_c:

$$V_c = l \times w \times h$$

where,

l	=	2.50	ft	[length]
w	=	2.75	ft	[width]
h	=	1.85	ft	[height]
V_c	=	12.75	ft^3	[volume]

Wetted Volume Calculations

Unit 1 Bottom Ash Hopper A Jet Pump
Unit 1 Bottom Ash Hopper B Jet Pump
Unit 2 Bottom Ash Hopper A Jet Pump
Unit 2 Bottom Ash Hopper B Jet Pump
Unit 3 Bottom Ash Hopper A Jet Pump
Unit 3 Bottom Ash Hopper B Jet Pump
Unit 4 Bottom Ash Hopper A Jet Pump
Unit 4 Bottom Ash Hopper B Jet Pump

Assumptions:

1 Volume of Alligator Pit JETPULSION® pump is equivalent to 6" diameter, schedule 40 pipe, 3.95' long.

Calculation:

1 Calculate the volume of the cylinder, V_c:

where,

r	=	0.25	ft	[radius]
l	=	3.95	ft	[length]
V_c	=	0.78	ft^3	[volume]

V_{JP1A}	0.78	ft^3	[volume]
V_{JP1B}	0.78	ft^3	[volume]
V_{JP2A}	0.78	ft^3	[volume]
V_{JP2B}	0.78	ft^3	[volume]
V_{JP3A}	0.78	ft^3	[volume]
V_{JP3B}	0.78	ft^3	[volume]
V_{JP4A}	0.78	ft^3	[volume]
V_{JP4B}	0.78	ft^3	[volume]

Wetted Volume Calculations

Recirculation Water Supply Pump A
Recirculation Water Supply Pump B

Assumptions:

1 Assume pumps are flooded full.
2 Assume pump volume is equivalent to pump casing estimated as cylinder.

Calculation:

1 Calculate the volume of the cylinder, V_c:

$$V_C = \pi \times r^2 \times l$$

where,

r	=	0.92	ft	[radius]
l	=	3.28	ft	[length]
Vc_A	=	8.66	ft^3	[volume]
Vc_B	=	8.66	ft^3	[volume]

Wetted Volume Calculations
Remote Dewatering Bottom Ash SFC A
Remote Dewatering Bottom Ash SFC B

Assumptions:

1 Wetted volume for submerged flight conveyors is up to normal water level.
2 Conveyor is comprised of four (4) cross sections: (1) upper rectangular prism, (2) trapezoidal prism, (3) front rectangular prism, (4) front triangular prism, and (5) rear rectangular prism
3 SFC normal water level is 20'-8.5" above the top of the concrete slab.

Calculation:

1 Calculate the volume of the upper rectangular prism, V_1:

$$V_1 = l \times w \times h$$

where,

l	=	58.50	ft	[length]
w	=	21.00	ft	[width]
h	=	5.00	ft	[height]
V_1	=	6,142.50	ft^3	[volume]

2 Calculate the volume of the trapezoidal prism, V_2:

$$V_2 = \frac{(b_1+b_2)}{2} \times h \times l$$

where,

b_1	=	21.00	ft	[length, upper base]
b_2	=	5.00	ft	[length, lower base]
h	=	11.38	ft	[height]
l	=	58.50	ft	[length]
V_2	=	8,650.69	ft^3	[volume]

3 Calculate the volume of the front rectangular prism, V_3:

$$V_3 = l \times w \times h$$

where,

l	=	5.00	ft	[length]
w	=	5.00	ft	[width]
h	=	14.21	ft	[height]
V_3	=	355.21	ft^3	[volume]

4 Calculate the volume of the front triangular prism, V_4:

$$V_4 = \frac{1}{2} \times b\ x\ h\ x\ l$$

where,

b	=	5.00	ft	[length, base]
h	=	14.21	ft	[height]
l	=	24.88	ft	[length]
V_4	=	883.58	ft^3	[volume]

5 Calculate the volume of the rear rectangular prism, V_5:

$$V_5 = l \times w \times h$$

where,

l	=	9.91	ft	[length]
w	=	5.00	ft	[width]
h	=	12.75	ft	[height]
V_5	=	631.52	ft^3	[volume]

6 Calculate the conveyor volume, V_c:

$$V_c = V_1 + V_2 + V_3 + V_4$$

V_c = 16,663.50 ft^3 [volume]

Wetted Volume Calculations
Unit 1 & 2 Alligator Pit
Unit 3 & 4 Alligator Pit

Assumptions:

1. Alligator pit is a rectangular sump
2. Alligator pit normal water level is 6' above bottom of pit

Calculation:

1. Calculate the volume of the rectangular prism, V_1:

$$V_1 = l \times w \times h$$

where,

l	=	29.58	ft	[length]
w	=	14.75	ft	[width]
h	=	6.13	ft	[height]
V_1	=	2,673	ft^3	[volume]
$V_{P1\text{-}4}$	=	5,345	ft^3	[volume]

Wetted Volume Calculations

Unit 1-2 Bottom Ash Hopper Overflow Sump

Unit 3-4 Bottom Ash Hopper Overflow Sump

Assumptions:

1 Overflow sump is a rectangular sump

2 Sump normal water level is 6' above bottom of sump.

Calculation:

1 Calculate the volume of the rectangular prism, V_S:

$$V_S = l \times w \times h$$

where,

l	=	14.50	ft	[length]
w	=	6.48	ft	[width]
h	=	6.00	ft	[height]
V_S	=	564	ft^3	[volume]
V_{S1-4}	=	1,127	ft^3	[volume]

Wetted Volume Calculations
Unit 1-2 Bottom Ash Hopper Overflow Sump Pump
Unit 3-4 Bottom Ash Hopper Overflow Sump Pump

Assumptions:

1. Assume pumps are flooded full.
2. Assume pump volume is equivalent to pump casing estimated as cylinder.

Calculation:

1. Calculate the volume of the cylinder, V_c:

$$V_C = \pi \times r^2 \times l$$

where,

r	=	0.67	ft	[radius]
l	=	0.70	ft	[length]
$V_{C1\text{-}2}$	=	0.98	ft^3	[volume]
$V_{C3\text{-}4}$		0.98	ft^3	[volume]

Wetted Volume Calculations
Clarifier A Underflow Pump A
Clarifier B Underflow Pump A

Assumptions:

1 Assume pumps are flooded full.
2 Assume pump volume is equivalent to pump casing estimated as cylinder.

Calculation:

1 Calculate the volume of the cylinder, V_c:

$$V_C = \pi \times r^2 \times l$$

where,

r = 0.67 ft [radius]
l = 1.42 ft [length]

V_{CA} = 1.98 ft^3 [volume]
V_{CB} = 1.98 ft^3 [volume]

Wetted Volume Calculations
Process Lift Pump A1
Process Lift Pump B1

Assumptions:

1 Assume pumps are flooded full.
2 Assume pump volume is equivalent to pump casing estimated as cylinder.

Calculation:

1 Calculate the volume of the cylinder, V_c:

$$V_C = \pi \times r^2 \times l$$

where,

r = 0.92 ft [radius]
l = 1.55 ft [length]

V_{CA} = 4.11 ft^3 [volume]
V_{CB} = 4.11 ft^3 [volume]

Wetted Volume Calculations
Process Water Pump A
Process Water Pump B

Assumptions:
1 Assume pumps are flooded full.
2 Assume pump volume is equivalent to pump casing estimated as cylinder.

Calculation:
1 Calculate the volume of the cylinder, V_c:

$$V_C = \pi \times r^2 \times l$$

where,

r	=	0.33	ft	[radius]
l	=	1.17	ft	[length]
V_c	=	0.41	ft^3	[volume]
V_{CA}, V_{CB}	=	0.81	ft^3	[volume]

Wetted Volume Calculations
Dewatering Area Sump A/B
Dewatering Area Sump C/D

Assumptions:

1 Dewatering Area Sump normal water level is 5' below top of sump.

Calculation:

1 Calculate the volume of the rectangular prism, V_S:

$$V_S = l \times w \times h$$

where,

l	=	12	ft	[length]
w	=	22	ft	[width]
h	=	9	ft	[height]
V_s	=	2,376	ft^3	[volume]
$V_{S_{A/B}}$, $V_{S_{C/D}}$	=	4,752	ft^3	[volume]

Wetted Volume Calculations

Dewatering Area Sump A/B Pump A

Dewatering Area Sump C/D Pump A

Assumptions:

1 Assume pumps are flooded full.

2 Assume pump volume is equivalent to pump casing estimated as cylinder.

Calculation:

1 Calculate the volume of the cylinder, V_c:

$$V_C = \pi \times r^2 \times l$$

where,

r	=	0.19	ft	[radius]
l	=	1.61	ft	[length]
V_c	=	0.18	ft^3	[volume]
Vc_A , Vc_B	=	0.37	ft^4	[volume]

Wetted Volume Calculations
Chain Wash Pump A

Assumptions:

1 Assume pumps are flooded full.
2 Assume pump volume is equivalent to pump casing estimated as cylinder.

Calculation:

1 Calculate the volume of the cylinder, V_c:

$$V_C = \pi \times r^2 \times l$$

where,

r	=	0.33	ft	[radius]
l	=	0.88	ft	[length]
Vc	=	0.31	ft^3	[volume]

Wetted Volume Calculations

Recirculation Water Tank A

Assumptions:

1 Recirculation Water Tank is a cylindrical tank.

2 Normal operating water level is 13’ above the tank base plate.

Calculation:

1 Calculate the volume of the cylinder, V_c:

$$V_C = \pi \times r^2 \times l$$

where,

r	=	32.50	ft	[radius]
l	=	13.00	ft	[length]

V_C = 43,138 ft^3 [volume]

Wetted Volume Calculations
Process Water Tank A
Process Water Tank B

Assumptions:

1 Process Water Tank is a cylindrical tank
2 Normal operating water level is 10' above the tank base plate

Calculation:

1 Calculate the volume of the cylinder, V_c:

$$V_C = \pi \times r^2 \times l$$

where,

r	=	12.00	ft	[radius]
l	=	10.00	ft	[length]

V_{cA}	=	4,523.89	ft^3	[volume]
V_{cB}	=	4,523.89	ft^3	[volume]

Wetted Volume Calculations

Clarifier A
Clarifier B

Assumptions:

1 Tank volume provided by the clarifier manufacturer was used.

Calculation:

Vc_A = 515,000 gal
Vc_B = 515,000 gal

Wetted Volume Calculations

Unit 1-2 Alligator Pit Jet Pump

Unit 3-4 Alligator Pit Jet Pump

Assumptions:

1 Volume of Alligator Pit JETPULSION® pump is equivalent to 8" diameter, schedule 40 pipe, 3.95' long.

Calculation:

1 Calculate the volume of the cylinder, V_c:

where,

r	=	0.33	ft	[radius]
l	=	3.95	ft	[length]
$V_{C1\text{-}2}$	=	1.38	ft^3	[volume]
$V_{C3\text{-}4}$		1.38	ft^3	[volume]

Wetted Volume Calculations

Unit 1 Bottom Ash Hopper 1A

Unit 1 Bottom Ash Hopper 1B

Unit 2 Bottom Ash Hopper 1A

Unit 2 Bottom Ash Hopper 1B

Unit 3 Bottom Ash Hopper 1A

Unit 3 Bottom Ash Hopper 1B

Unit 4 Bottom Ash Hopper 1A

Unit 4 Bottom Ash Hopper 1B

Assumptions:

1 Hopper dimensions for Unit 2 are the same as those shown on drawings for Unit 1.
2 Hopper is comprised of two (2) cross sections: (1) rectangular prism and (2) truncated rectangular hopper.

Reference Drawings:

1 427-54719-2F
2 427-54719-3F
3 427-54719-4F

Calculation:

1 Calculate the volume of the rectangular prism, V_1:
where,

l	=	9.25	ft	[length]
w	=	8.00	ft	[width]
h	=	3.88	ft	[height]
V_1	=	286.75	ft^3	[volume]

2 Calculate the volume of the truncated rectangular hopper, V_2:
where,

l_1	=	9.25	ft	[length, upper base]
l_2	=	9.24	ft	[length, lower base]
w_1	=	8.00	ft	[width, upper base]
w_2	=	1.92	ft	[width, lower base]
h	=	4.17	ft	[height between bases]
V_2	=	191.02	ft^3	[volume]

3 Calculate the volume of the rectangular prism, V_3:
where,

l	=	9.83	ft	[length]
w	=	8.00	ft	[width]
h	=	3.04	ft	[height]
V_3	=	239.28	ft^3	[volume]

4 Calculate the volume of the truncated rectangular hopper, V_4:
where,

l_1	=	9.83	ft	[length, upper base]
l_2	=	9.82	ft	[length, lower base]
w_1	=	8.00	ft	[width, upper base]
w_2	=	1.92	ft	[width, lower base]
h	=	3.83	ft	[height between bases]
V_4	=	186.83	ft^3	[volume]

5 Calculate the volume of the rectangular prism, V_5:

where,

l	=	10.21	ft	[length]
w	=	8.00	ft	[width]
h	=	2.21	ft	[height]
V_5	=	180.35	ft^3	[volume]

6 Calculate the volume of the truncated rectangular hopper, V_6:

where,

l_1	=	10.21	ft	[length, upper base]
l_2	=	10.20	ft	[length, lower base]
w_1	=	8.00	ft	[width, upper base]
w_2	=	1.92	ft	[width, lower base]
h	=	3.33	ft	[height between bases]
V_6	=	168.66	ft^3	[volume]

7 Calculate the hopper volume, V_h:

V_{1A}	=	1,252.88	ft^3	[volume]
V_{1B}	=	1,252.88	ft^3	[volume]
V_{2A}	=	1,252.88	ft^3	[volume]
V_{2B}	=	1,252.88	ft^3	[volume]
Total		5,011.51	ft^3	

Reference Drawings:

1 427-54719-6F
2 427-54719-7G
3 427-54719-8F

Assumptions:

1 Hopper dimensions for Unit 4 are the same as those shown on drawings for Unit 3.
2 Hopper is comprised of two (2) cross sections: (1) rectangular prism and (2) truncated rectangular hopper.

Calculation:

1 Calculate the volume of the rectangular prism, V_1:

where,

l	=	8.25	ft	[length]
w	=	8.00	ft	[width]
h	=	4.81	ft	[height]
V_1	=	317.63	ft^3	[volume]

2 Calculate the volume of the truncated rectangular hopper, V_2:

where,

l_1	=	8.25	ft	[length, upper base]
l_2	=	8.24	ft	[length, lower base]
w_1	=	8.00	ft	[width, upper base]
w_2	=	1.92	ft	[width, lower base]
h	=	3.44	ft	[height between bases]
V_2	=	140.55	ft^3	[volume]

3 Calculate the volume of the rectangular prism, V_3:
where,

l	=	11.25	ft [length]
w	=	8.00	ft [width]
h	=	4.08	ft [height]
V_3	=	367.50	ft^3 [volume]

4 Calculate the volume of the truncated rectangular hopper, V_4:
where,

l_1	=	11.25	ft [length, upper base]
l_2	=	11.24	ft [length, lower base]
w_1	=	8.00	ft [width, upper base]
w_2	=	1.92	ft [width, lower base]
h	=	3.67	ft [height between bases]
V_4	=	204.46	ft^3 [volume]

5 Calculate the volume of the rectangular prism, V_5:
where,

l	=	12.08	ft [length]
w	=	8.00	ft [width]
h	=	3.38	ft [height]
V_5	=	326.25	ft^3 [volume]

6 Calculate the volume of the truncated rectangular hopper, V_6:
where,

l_1	=	12.08	ft [length, upper base]
l_2	=	12.07	ft [length, lower base]
w_1	=	8.00	ft [width, upper base]
w_2	=	1.92	ft [width, lower base]
h	=	3.65	ft [height between bases]
V_6	=	218.36	ft^3 [volume]

7 Calculate the hopper volume, V_h:

V_{3A}	=	1,574.74	ft^3 [volume]
V_{3B}	=	1,574.74	ft^3 [volume]
V_{4A}	=	1,574.74	ft^3 [volume]
V_{4B}	=	1,574.74	ft^3 [volume]
Total		6,298.97	ft^3

Wetted Volume Calculations

Unit 1-2 Hydroveyor Exhauster

Unit 3-4 Hydroveyor Exhauster

Assumptions:

1 Volume of hydroveyor exhauster is equivalent to 8" diameter, schedule 40 pipe, 3.98' long.

Calculation:

1 Calculate the volume of the cylinder, V_c:

where,

r	=	0.29	ft	[radius]
l	=	4.00	ft	[length]
$V_{C1\text{-}2}$	=	1.07	ft^3	[volume]
$V_{C3\text{-}4}$		1.07	ft^3	[volume]

Service/Reference Drawing	NPS (in.)	LENGTH (ft.)	VOLUME (ft^3)	(gallons)	NOTES
BATW PIPING					
17W520-107					
Recirculation Tank A Discharge to Elbow 54719-21-C006-300-30	30	13	62	467	Pipe Spec:SS02
Recirculation Tank B Discharge to Elbow 54719-21-C006-300-30	30	13	62	467	Pipe Spec:SS02
From Elbow 54719-21-C006-300-30 (Recirc Tank A) to Tee C-54719-21-D01 (Recirc Pump A)	30	20	94	700	Pipe Spec:SS02
From Elbow 54719-21-C006-300-30 (Recirc Tank B) to Tee C-54719-21-D01 (Recirc Pump B)	30	49	231	1,730	Pipe Spec:SS02
From C-54719-21-D01 (Recirc Pump A) to C-54719-21-D01 (Recirc Pump B)	30	33	155	1,162	Pipe Spec:SS02
Tee C-54719-21-D01 (Recirc Pump A) to 00-EXJ 88 A1 (Recirc Pump A)	16	11	15	109	Pipe Spec:SS02
Tee C-54719-21-D01 (Recirc Pump B) to 00-EXJ 88 A1 (Recirc Pump B)	16	11	15	109	Pipe Spec:SS02
00-EXJ 88 A1 (Recirc Pump A) to Recirc Pump A Inlet FLG	16	2	3	20	Pipe Spec:SS02
00-EXJ 88 B1 (Recirc Pump A) to Recirc Pump B Inlet FLG	16	2	3	20	Pipe Spec:SS02
17W520-109					
20"x10" Reducer at Recirc Pump A Discharge	10	2	1	7	Pipe Spec:CS
From 00-EXJ 88 C2 to 171049-200-40-S12-04-P086 (20" 90 Deg Elbow)	20	7	14	105	Pipe Spec:CS
From 171049-200-40-S12-04-P086 (20" 90 Deg Elbow) to 171049-200-40-S12-04-P086 (20" 90 Deg Elbow)	20	25	50	370	Pipe Spec:CS
From 171049-200-40-S12-04-P086 (20" 90 Deg Elbow) to 20" 300# Manual Gate Valve	20	14	27	204	Pipe Spec:CS
From 171049-200-40-S12-04-P086 (20" 90 Deg Elbow) to 171268-20020003-S12-04-P085 (20" STR TEE)	20	20	39	295	Pipe Spec:CS
From 171050-200-40-S12-04-P085 (20" 90 Deg Elbow) to 171050-200-40-S12-04-P085 (20" 90 Deg Elbow)	20	11	21	160	Pipe Spec:CS
From 171050-200-40-S12-04-P085 (20" 90 Deg Elbow) to Matchline A	20	44	89	669	Pipe Spec:CS
20"x10" Reducer at Recirc Pump B Discharge	10	2	0	0	Pipe Spec:CS
From 00-EXJ 88 C2 to 171049-200-40-S12-04-P086 (20" 90 Deg Elbow)	20	7	14	105	Pipe Spec:CS
From 171049-200-40-S12-04-P086 (20" 90 Deg Elbow) to 171049-200-40-S12-04-P086 (20" 90 Deg Elbow)	20	25	50	370	Pipe Spec:CS
From 171049-200-40-S12-04-P086 (20" 90 Deg Elbow) to 20"-PW-CS-88-102-H3 CL	20	14	27	204	Pipe Spec:CS
20"-PW-CS-88-102-H3 CL to 171268-20020003-S12-04-P085 (20" STR TEE)	20	8	17	126	Pipe Spec:CS
From 171050-200-40-S12-04-P085 (20" 90 Deg Elbow) to 171050-200-40-S12-04-P085 (20" 90 Deg Elbow)	20	14	28	212	Pipe Spec:CS
From 171050-200-40-S12-04-P085 (20" 90 Deg Elbow) to Matchline A	20	42	85	635	Pipe Spec:CS
17W520-110					
Matchline A to Matchline B	20	191	386	2,887	Pipe Spec:CS
Matchline B to Matchline C	20	190	384	2,873	Pipe Spec:CS
Matchline C to Matchline D	20	199	403	3,015	Pipe Spec:CS
Matchline D to Matchline E	20	188	381	2,847	Pipe Spec:CS
17W520-111					
Matchline E to Matchline F	20	322	651	4,871	Pipe Spec:CS
Matchline F to Matchline G	20	263	531	3,973	Pipe Spec:CS
Matchline G to Matchline H	20	110	222	1,663	Pipe Spec:CS
17W520-113					
Matchline H to Matchline J	20	160	324	2,421	Pipe Spec:CS
Matchline J to Matchline K	20	180	364	2,722	Pipe Spec:CS
Matchline K to Matchline M	20	180	364	2,722	Pipe Spec:CS
Matchline M to Matchline N	20	180	364	2,722	Pipe Spec:CS
Matchline N to Matchline P	20	177	358	2,677	Pipe Spec:CS
17W520-114					
Matchline P to Matchline S	20	180	364	2,721	Pipe Spec:CS
Matchline S to Matchline T	20	180	364	2,721	Pipe Spec:CS
Matchline T to Matchline U	20	180	364	2,722	Pipe Spec:CS
Matchline U to Matchline V	20	174	352	2,631	Pipe Spec:CS
Matchline V to Matchline W	20	176	356	2,661	Pipe Spec:CS
17W520-115					
Matchline W to Matchline X	20	170	344	2,570	Pipe Spec:CS
Matchline X to Matchline Y	20	199	402	3,006	Pipe Spec:CS
Matchline Y to Matchline Z	20	194	391	2,927	Pipe Spec:CS
Matchline Z to Matchline AA	20	151	304	2,276	Pipe Spec:CS
17W520-116					
Matchline AA to Matchline AB	20	250	505	3,780	Pipe Spec:CS
Matchline AB to Matchline AC	20	178	360	2,691	Pipe Spec:CS
Matchline AC to Matchline AD	20	180	364	2,722	Pipe Spec:CS
Matchline AD to Matchline AE	20	179	362	2,709	Pipe Spec:CS
17W520-117					
Matchline AE to Matchline AF	20	180	364	2,722	Pipe Spec:CS
Matchline AF to Matchline AG	20	181	366	2,737	Pipe Spec:CS
Matchline AG to Matchline AH	20	159	322	2,407	Pipe Spec:CS
Matchline AH to Matchline AJ	20	182	368	2,752	Pipe Spec:CS
Matchline AJ to Matchline AK	20	180	364	2,722	Pipe Spec:CS
17W520-118					
Matchline AK to Matchline AM	20	156	315	2,359	Pipe Spec:CS
Matchline AM to Matchline AN	20	198	400	2,992	Pipe Spec:CS
Matchline AN to Matchline AP	20	189	381	2,854	Pipe Spec:CS
Matchline AP to Matchline AS	20	174	352	2,635	Pipe Spec:CS
17W520-119					
Matchline AS to Matchline AT	20	181	366	2,740	Pipe Spec:CS
Matchline AT to Matchline AU	20	177	358	2,675	Pipe Spec:CS
Matchline AU to Matchline AV	20	193	391	2,923	Pipe Spec:CS
47W504-021					
Matchline AV to Matchline AX	20	256	517	3,868	Pipe Spec:CS
Matchline AV to Matchline AW	14	42	40	296	Pipe Spec:CS
47W504-022					
Matchline AX to Matchline AY	20	109	220	1,644	Pipe Spec:CS
Matchline AY to Matchline AZ	14	117	110	824	Pipe Spec:CS
47W504-026					
Matchline AY to Jet Pumps U1-U4	14	137	129	966	Pipe Spec:CS
		Sum	16,025		

BADW PIPING					
17W520-004					
12"-BA-CS2-88-001	12	146	113	847	Pipe Spec:CS2
12"-BA-CS2-88-004	12	147	114	852	Pipe Spec:CS2
12"-BA-CS2-88-005	12	147	114	855	Pipe Spec:CS2
12"-BA-CS2-88-006	12	150	117	872	Pipe Spec:CS2
12"-BA-CS2-88-007	12	150	117	874	Pipe Spec:CS2
12"-BA-CS2-88-008	12	151	118	879	Pipe Spec:CS2
17W520-005					
12"-BA-CS2-88-001	12	270	210	1,571	Pipe Spec:CS2
12"-BA-CS2-88-004	12	270	210	1,571	Pipe Spec:CS2
12"-BA-CS2-88-005	12	270	210	1,571	Pipe Spec:CS2
12"-BA-CS2-88-006	12	270	210	1,571	Pipe Spec:CS2
12"-BA-CS2-88-007	12	270	210	1,571	Pipe Spec:CS2
12"-BA-CS2-88-008	12	270	210	1,571	Pipe Spec:CS2
17W520-006					
12"-BA-CS2-88-001	12	128	100	747	Pipe Spec:CS2
12"-BA-CS2-88-004	12	130	101	755	Pipe Spec:CS2
12"-BA-CS2-88-005	12	130	101	754	Pipe Spec:CS2
12"-BA-CS2-88-006	12	132	102	765	Pipe Spec:CS2
12"-BA-CS2-88-007	12	132	103	769	Pipe Spec:CS2
12"-BA-CS2-88-008	12	134	104	779	Pipe Spec:CS2
17W520-007					
12"-BA-CS2-88-001	12	103	80	598	Pipe Spec:CS2
12"-BA-CS2-88-004 to 12"-BA-CS2-88-012	12	103	80	598	Pipe Spec:CS2
12"-BA-CS2-88-005 to 12"-BA-CS2-88-013	12	103	80	598	Pipe Spec:CS2
12"-BA-CS2-88-006 to 12"-BA-CS2-88-014	12	103	80	598	Pipe Spec:CS2
12"-BA-CS2-88-007 to 12"-BA-CS2-88-015	12	103	80	598	Pipe Spec:CS2
12"-BA-CS2-88-008 to 12"-BA-CS2-88-016	12	103	80	598	Pipe Spec:CS2
12"-BA-CS2-88-009 to 12"-BA-CS2-88-017	12	103	80	598	Pipe Spec:CS2
17W520-008					
12"-BA-CS2-88-010	12	111	86	644	Pipe Spec:CS2
12"-BA-CS2-88-011	12	107	83	622	Pipe Spec:CS2
12"-BA-CS2-88-012	12	103	80	599	Pipe Spec:CS2
12"-BA-CS2-88-013	12	99	77	576	Pipe Spec:CS2
12"-BA-CS2-88-014	12	95	74	552	Pipe Spec:CS2
12"-BA-CS2-88-015	12	91	71	529	Pipe Spec:CS2
12"-BA-CS2-88-016	12	87	68	506	Pipe Spec:CS2
12"-BA-CS2-88-017	12	83	65	483	Pipe Spec:CS2
17W520-010					
12"-BA-CS2-88-010	12	81	63	469	Pipe Spec:CS2
12"-BA-CS2-88-011	12	82	64	477	Pipe Spec:CS2
12"-BA-CS2-88-012	12	83	64	482	Pipe Spec:CS2
12"-BA-CS2-88-013	12	83	64	482	Pipe Spec:CS2
12"-BA-CS2-88-014	12	83	65	483	Pipe Spec:CS2
12"-BA-CS2-88-015	12	80	62	465	Pipe Spec:CS2
12"-BA-CS2-88-016	12	85	66	494	Pipe Spec:CS2
12"-BA-CS2-88-017	12	89	69	518	Pipe Spec:CS2
17W520-012					
BADW Sump A/B (Pump 7A) to SFC A	6	128	26	192	Pipe Spec:SS4
17W520-011					
BADW Sump B/C to SFC B	6	208	42	312	Pipe Spec:SS4
(17W520-015)					
SFC A Piping to Clarifier A	32	64	342	2,560	Pipe Spec:CS05
SFC B Piping to Clarifier B	32	65	347	2,595	Pipe Spec:CS05
(17W520-014 & 016)					
Clarifier A to Process Tank A	32	8	45	335	Pipe Spec:CS05
Clarifier B to Process Tank B	32	8	45	335	Pipe Spec:CS05
(17W520-017/018/123)					
Process Tank A to Process Lift Pump A	24	11	32	237	Pipe Spec:SS4
Process Tank B to Process Lift Pump B	24	11	32	237	Pipe Spec:SS4
Process Lift Pump A2 Discharge to Recirculation Tank A	18	270	458	3,426	Pipe Spec:SS4
Process Lift Pump B2 Discharge to Recirculation Tank B	18	361	612	4,579	Pipe Spec:SS4
17W520-022					
Process Tank A to Process Water Pump A	10	156	58	430	Pipe Spec:HDPE
Process Water Pump B Inlet Piping	10	15	6	41	Pipe Spec:HDPE
Process Tank B to Tee (Tie Point with line from Process Water Tank A)	10	4	1	10	Pipe Spec:HDPE
Process Water Pump A&B to Clarifier A&B Underflow Pump	6	446	98	735	Pipe Spec:SS4
87W402-008					
Unit 4 Hopper Discharge to Matchline G (87W402-007)	12	149	115	864	Pipe Spec:CS2
Unit 3 Hopper Discharge to Matchline G (87W402-007)	12	19	15	109	Pipe Spec:CS2
87W402-007					
U4 Matchline G (87W402-008) to Matchline F (87W402-006)	12	150	116	869	Pipe Spec:CS2
U3 Matchline G (87W402-008) to Matchline F (87W402-006)	12	149	116	868	Pipe Spec:CS2
Unit 2 Hopper Discharge (87W402-007) to Matchline F (87W402-006)	12	36	28	209	Pipe Spec:CS2
87W402-006					
U4 Matchline F (87W402-007) to Matchline E (87W402-005)	12	150	116	871	Pipe Spec:CS2
U3 Matchline F (87W402-007) to Matchline E (87W402-005)	12	150	116	871	Pipe Spec:CS2
U2 Matchline F (87W402-007) to Matchline E (87W402-005)	12	150	116	871	Pipe Spec:CS2
Unit 1 Hopper Discharge (87W402-006) to Matchline E (87W402-005)	12	49	38	282	Pipe Spec:CS2
87W402-005					
U4 Matchline E (87W402-006) to Powerhouse Wall Penetration	12	107	83	619	Pipe Spec:CS2
U3 Matchline E (87W402-006) to Powerhouse Wall Penetration	12	107	83	619	Pipe Spec:CS2
U2 Matchline E (87W402-006) to Powerhouse Wall Penetration	12	107	83	619	Pipe Spec:CS2
U1 Matchline E (87W402-006) to Powerhouse Wall Penetration	12	107	83	619	Pipe Spec:CS2
47W510-3					
10"-BA-CS-14-002 (Economizer/Hydroveyor Piping)	10	77	42	315	Pipe Spec:CS
12"-BA-CS-14-007 (Economizer/Hydroveyor Piping)	12	94	73	549	Pipe Spec:CS
47W510-4					
10"-BA-CS-14-002 (Economizer/Hydroveyor Piping)	10	8	4	31	Pipe Spec:CS
8"-BA-CS-14-003 (Economizer/Hydroveyor Piping)	8	27	9	69	Pipe Spec:CS
8"-BA-CS-14-004 (Economizer/Hydroveyor Piping)	8	37	13	96	Pipe Spec:CS
12"-BA-CS-14-007 (Economizer/Hydroveyor Piping)	12	10	7	56	Pipe Spec:CS
47W510-5					
12"-BA-CS-14-007 (Economizer/Hydroveyor Piping)	12	79	62	464	Pipe Spec:CS
		Sum	7,704		
		Total	23,730		