TVA TENNESSEE
VALLEY
AUTHORITY

1101 Market Street, BR 2C, Chattanooga, Tennessee 37402

May 31, 2023

Mr. Jason Hurt, Manager (JasonM.Hurt@ky.gov)
Surface Water Permits Branch
Department for Environmental Protection
Division of Water
300 Sower Boulevard, 3rd Floor
Frankfort, Kentucky 40601

Dear Mr. Hurt:

TENNESSEE VALLEY AUTHORITY (TVA) – SHAWNEE FOSSIL PLANT (SHF) – KPDES PERMIT NO. KY0004219 – INITIAL CERTIFICATION STATEMENT

Section 5.14.1 of the current permit requests an Initial Certification Statement for sources seeking to discharge bottom ash transport water pursuant to §423.13(k)(2)(i). TVA is finalizing the design for the bottom ash transport water recirculation system. Via email and phone conversations with Andrew Parish, KDOW granted TVA an extension to submit the Initial Certification Statement on or before May 31, 2023. Enclosed is the required Initial Certification Statement.

If you have questions or need additional information, please contact Callan Pierson by email at cpierson@tva.gov.

Sincerely,

Paul Pearman

Paul Pearman
Senior Manager
Water Permits, Compliance, and Monitoring

Enclosure
cc: Andrew.Parrish@ky.gov

2100 Norman Drive West
Waukegan, IL 60085
Phone: 847.473.5900
uccenvironmental.com

Initial Certification Statement

Prepared for:

Attention:

Rev 0

Initial Submittal: 5/30/2023

Installation:

Shawnee Fossil Plant, Units 1-9

Paducah, KY

Subject: UCC Project Number: 54718-27

Document Number:MG-54718-27-003

TVA Project Number: 611846

Signature and Certification Statement

This statement is to confirm the following.

I am a professional engineer licensed in the state of Kentucky.

I am familiar with the regulation requirements as described in 40 CFR Part 423.

I am familiar with the Shawnee Fossil Plant.

CHARLES D.
TOY
34117

Engineer of Record: 2023.05.30 15:28:57-05'00'
Charles D. Toy, PE

Table of Contents

Abbreviations

BADW - Bottom Ash Dewatering

CYDB - Coal Yard Drainage Basin

DWF - Bottom Ash Dewatering Facility

KPDES - Kentucky Pollutant Discharge Elimination System

O&G - Oil and Grease

PWB - Process Water Basin

SFC - Submerged Flight Conveyor

SHF - Shawnee Fossil Plant

TDS – Total Dissolved Solids

TSS - Total Suspended Solids

TVA - Tennessee Valley Authority

VFD - Variable Frequency Drive

Glossary

Bottom Ash Dewatering Facility (DWF) - This is the area which contains the SFCs, the Clarifiers, and underflow pumps. These items are located outside of the main plant.

Bottom Ash Dewatering Bunker - There are a total of two bunkers, one per Submerged Flight Conveyor, located at the discharge end of the Submerged Flight Conveyors. The bunker(s) will receive the ash discharged from the SFC; additional dewatering of the ash occurs in the bunker.

Bottom Ash Hopper - The Bottom Ash Hopper collects and stores ash which drops into it from the furnace above. The seal plates from the boiler extend from the bottom of the furnace into the seal trough below the water level, creating an airtight seal with the boiler to accommodate changes in pressure and expansion.

Gates /Valves - The terms gate and valve are often used interchangeably. They provide a means of shut off or isolation between two items.

JETPULSION® Pump - The JETPULSION Pump provides the motive force to transport material from the Bottom Ash Hopper to the Submerged Flight Conveyor. The JETPULSION Pump consists of three main parts: the nozzle and manifold section, the inlet section, and the combining tube. The required pressure and water flow in the sluice line is created in the pump by the water flow through the nozzle and combining tube. Ash enters the pump through the inlet section, where it is mixed with the JETPULSION Pump nozzle water. The ash/water slurry is then discharged through the combining tube into the sluice line and is transported to the disposal point.

MAX® Type Remote SFC - The Mechanical Ash Extractor Type Remote Submerged Flight Conveyor (SFC) is a mechanical ash conveyor that removes wet ash from the water-impounded section of the submerged flight conveyor by using chain-driven flights. Ash collects between the flights of the SFC. The ash is continuously removed from the SFC as the flights move through the trough of the SFC. The ash is discharged at the end of the SFC by gravity, dropping into the Dewatering Bottom Ash Bunker (not supplied by UCC) for later removal.

Clarifier - A settling tank that collects all the ash particles not collected in the SFC. The clarifier is built with mechanical means for continuous removal of ash particles that are collected at the bottom of the tank by means of sedimentation.

Coagulant - A chemical used to neutralize the charge of ash particles being conveyed thus making it so the ash particles can be brought together.

Chemical - A substance that is used in, or produced by, a reaction involving a change to atoms or molecules.

Alum - The type of coagulant chemical that is used for this system.

Flocculent - A chemical that promotes agglomeration of ash particles by charged site binding and by molecular bridging thus taking destabilized particles and binding them together to create large particles that will accelerate the particle settling time.

Floc - A large agglomeration of particles that have been combined by chemical flocculants.

Lamella Assembly - A group of inclined plates in the trough of the SFC that increase the settling time and reduce particulate carryover. Particles will settle on the plates as the water moves over the top of the plates and through the weir.

1.0 Primary Active Wetted Bottom Ash System Volume

1.1 System Volume

Equipment Description	Quantity	Unit Volume (gallons)	Total Volume (gallons)	Notes
Bottom Ash Hopper	18	6244	112,392	Two (2) Bottom Ash Hoppers per Unit
Bottom Ash Hopper Overflow Tank	9	993	8937	One (1) per Unit
Remote SFC	2	121,629	243,258	
Clarifier Tank	2	535,837	1,071,674	
Process Water Tank	1	13,616	13,616	
Recirculation Tank	1	487,311	487,311	
Pipeline Volumes Total	-	-	150,308	
Total			2,087,496	

Table 1 System Volumes

1.2 Assumptions

1.2.1 General Assumptions

1.2.1.1 Included Volumes

- Volumes are the maximum volumetric capacity of the bottom ash system transport water.
- Piping includes all non-redundant piping including recirculation piping.
- Bottom ash collection and recirculation loop tanks.

1.2.1.2Excluded Volumes

- Volumes of surface impoundments
- Installed spares.
    - Spare sluice line
    - Redundant pump suction and discharge lines
- Non bottom ash transport systems that direct water to the system.

1.3 Calculations

1.3.1 Bottom Ash Hopper

There are two bottom ash hoppers per unit for a total of eighteen hoppers. The hopper geometry is identical for all 9 units. The hoppers are a step bottom design.

1.3.1.1 Method of Calculation

The volume was calculated scaling cross-sectional areas for the different stepped sections of the bottom ash hopper.

Bluebeam Revu (a construction software package) that allows the user to scale and measure drawings, was used to scale the cross-sectional areas. This area is multiplied by the length of the section to determine the volume of the section. These volumes are added to together to determine the total volume. Additional volumes are also subtracted and added based on the geometry.

1.3.1.2 Specific Assumptions

- Active water level is up to the normal water level of the hopper.
    - This elevation is 312'-11.
- Volume of the sluice door enclosure is not included in the calculated volume.
- General dimensions
- UCC drawings 427-54718-3 & 427-54718-4 are used to determine dimensions.

1.3.1.3 Results

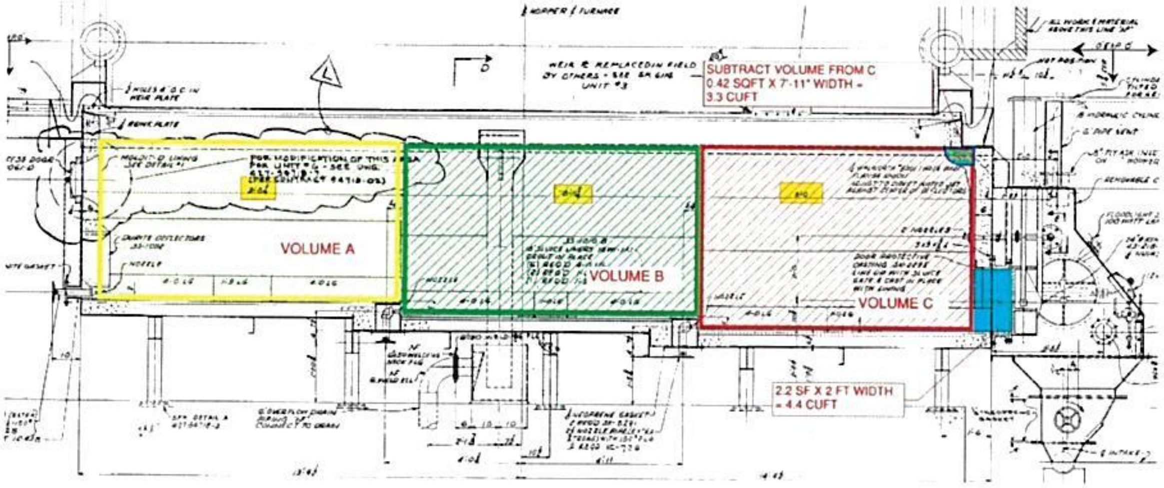


Figure 1: Elevation Bottom Ash Hopper (ref drawing: 427-54718-4)

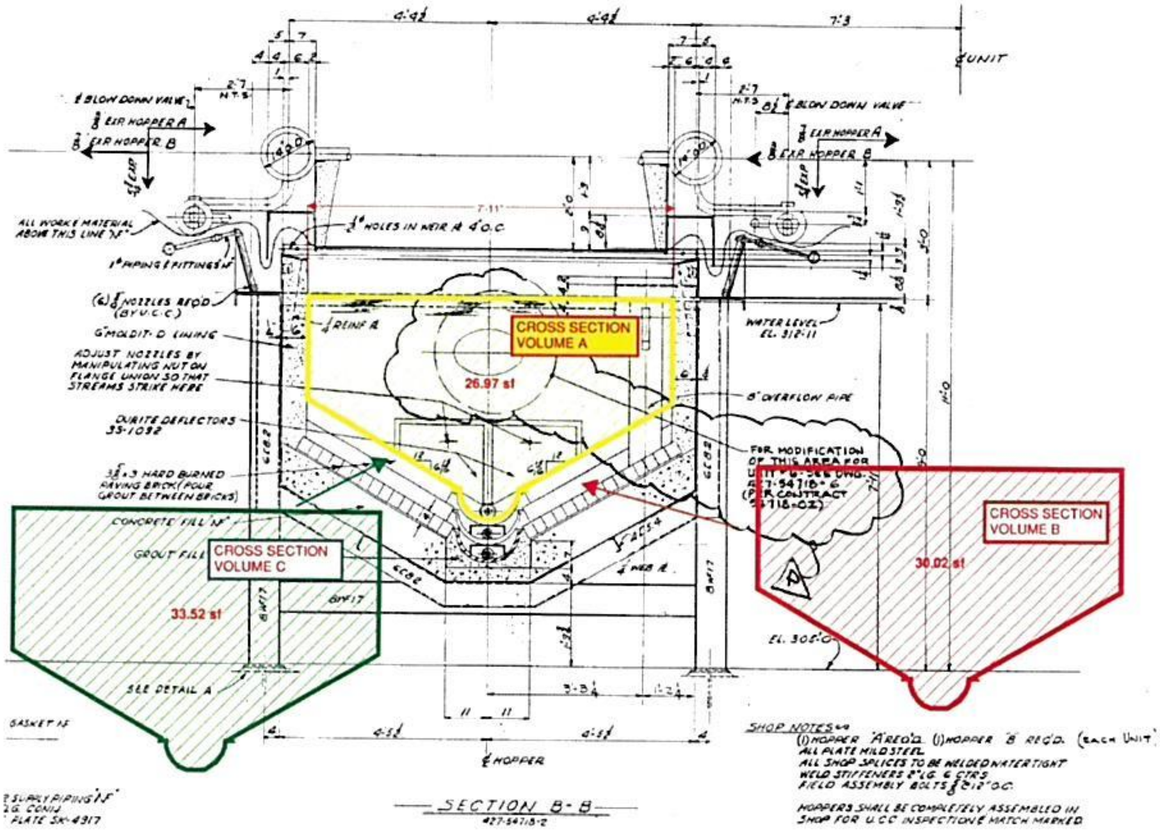


Figure 2 Bottom Ash Hopper Cross Sections (ref. UCC drawing 427-54718-3)

$$Volume = Cross\ sectional\ Area \times Length \times 7.48\ \frac{gallons}{cuft} = gallons$$

	Cross -sectional Area (SQFT)	Length (FT)	Volume (cuft)	Volume (gallons)
Volume A	26.97	9.73	262.4	1,963
Volume B	30.02	8.98	269.6	2,016
Volume C	33.52	9	301.7	2,257
Sluice Gate Entrance	2.20	2	4.4	33
Volume C subtract	0.42	7.92	-3.3	-25
Total			**835**	**6,244**

Table 2 Bottom Ash Hopper Volume

1.3.2 Bottom Ash Overflow Tanks

Overflow from each pair of bottom ash hoppers is collected in a single overflow tank per Unit. There are nine total bottom ash overflow tanks. The overflow tank is a rectangular tank with sloped lower section.

1.3.2.1 Method of Calculation

The volume was calculated by first calculating the trapezoidal lower section then the rectangular upper section.

1.3.2.2 Specific Assumptions

- Drawing 18W225-404 (UCC drawing S-54718-27-004) was used for tank dimensions.
- Water Height to determine wetted volume was taken from the height of the overflow weir.
- During normal operation, the tank will typically be full.

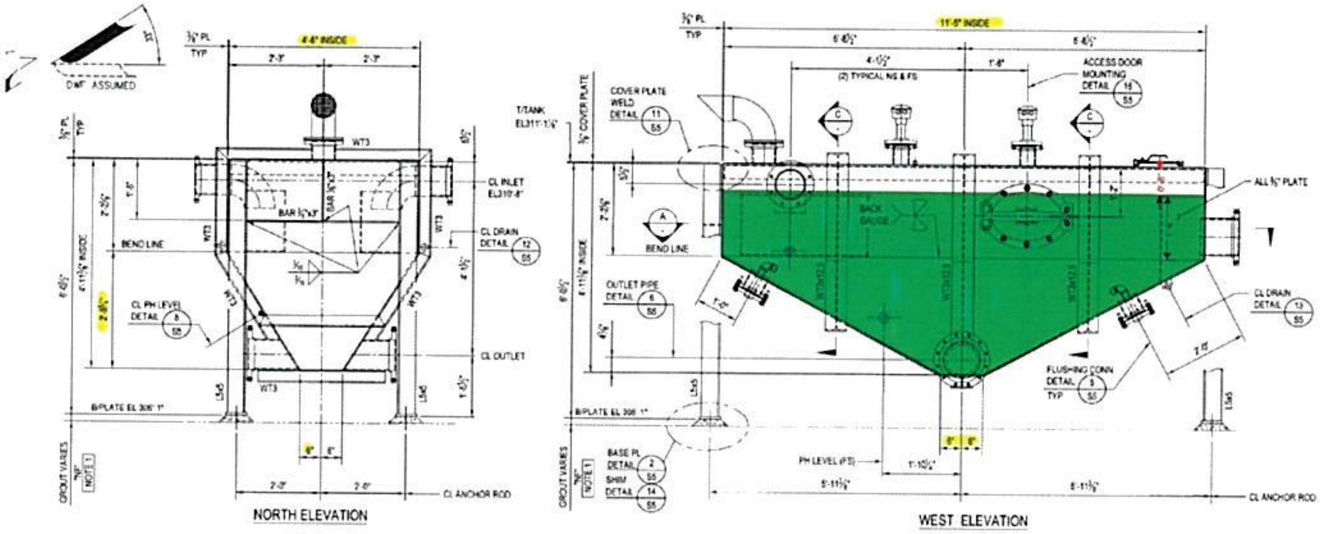
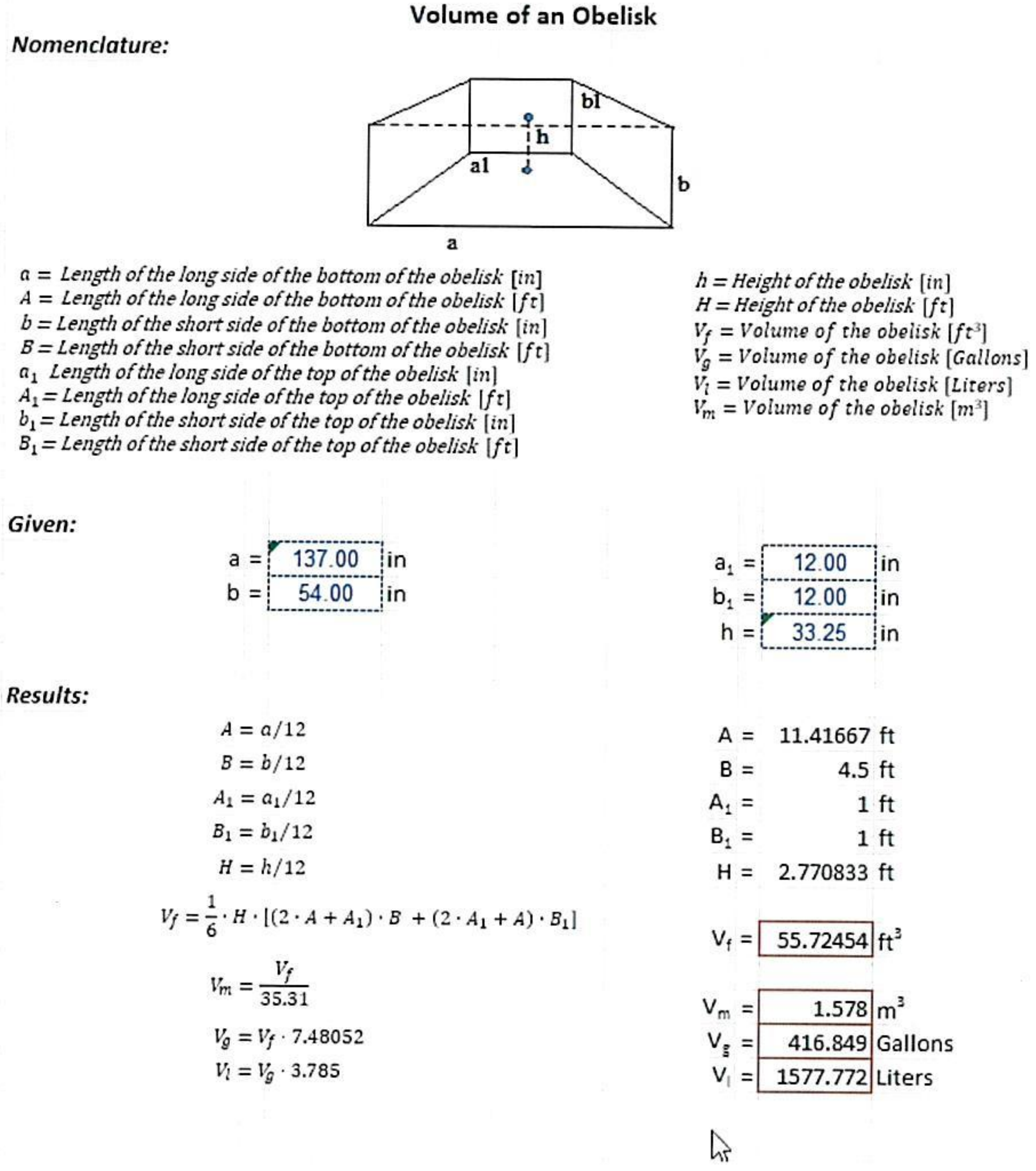


Figure 3 Bottom Ash Hopper Overflow Tank (ref. UCC drawing S-54718-27-004)

1.3.2.3 Results



Volume of an Obelisk

Nomenclature:

a = *Length of the long side of the bottom of the obelisk* [in]
A = *Length of the long side of the bottom of the obelisk* [ft]
b = *Length of the short side of the bottom of the obelisk* [in]
B = *Length of the short side of the bottom of the obelisk* [ft]
a_1 *Length of the long side of the top of the obelisk* [in]
A_1 = *Length of the long side of the top of the obelisk* [ft]
b_1 = *Length of the short side of the top of the obelisk* [in]
B_1 = *Length of the short side of the top of the obelisk* [ft]

h = *Height of the obelisk* [in]
H = *Height of the obelisk* [ft]
V_f = *Volume of the obelisk* [ft^3]
V_g = *Volume of the obelisk* [Gallons]
V_l = *Volume of the obelisk* [Liters]
V_m = *Volume of the obelisk* [m^3]

Given:

a = 137.00 in
b = 54.00 in

a_1 = 12.00 in
b_1 = 12.00 in
h = 33.25 in

Results:

$A = a/12$
$B = b/12$
$A_1 = a_1/12$
$B_1 = b_1/12$
$H = h/12$

$$V_f = \frac{1}{6} \cdot H \cdot [(2 \cdot A + A_1) \cdot B + (2 \cdot A_1 + A) \cdot B_1]$$

$$V_m = \frac{V_f}{35.31}$$

$V_g = V_f \cdot 7.48052$
$V_l = V_g \cdot 3.785$

A = 11.41667 ft
B = 4.5 ft
A_1 = 1 ft
B_1 = 1 ft
H = 2.770833 ft

V_f = 55.72454 ft^3

V_m = 1.578 m^3
V_g = 416.849 Gallons
V_l = 1577.772 Liters

Figure 4 Bottom Ash Overflow Tank Obelisk Volume Calculation

Bottom Ash Overflow Tank Volume		
Upper Section Dimensions		
Length	11.42	feet
Width	4.5	feet
Water Depth	1.5	feet
$Volume = Length \times Width \times Water\ Depth \times 7.48\ \frac{gallons}{cuft} = gallons$		
Volume of Upper Section	77.06	cuft
	576.43	gallons
Volume of Obelisk (Lower Section)	416.85	gallons
Total Volume	**993.28**	**gallons**

Table 3 Bottom Ash Overflow Tank Volume

1.3.3 Submerged Flight Conveyor Volume

There is a total of two SFCs. Both are considered active volumes.

1.3.3.1 Method of Calculation

The volume was calculated by finding the volumes of individual sections of the SFC. Using the Bluebeam software, the cross-sectional areas were measured and used to produce the section volumes. These volumes are added together for total volume of the SFC. To account for the lamellas and trough structures the displaced volume of these is calculated and subtracted from the total.

1.3.3.2 Specific Assumptions

- Drawings used for volume calculations: UCC Drawings: S-54718-16-005, S-54718-16-012 & S-54718-16-017.
- During typical operation both SFCs are active and used.

1.3.3.3 Results

$$Volume\ =\ Cross\ sectional\ Area\ \times\ Width\ \times 7.48\ \frac{gallons}{cuft}\ =\ gallons$$

	Cross Section Area (SQFT)	**Length or Width (FT)**	**Volume (cuft)**	**Volume (gallons)**
Center Section Total				
Volume A Conveying Trough	14	58.5	819	6,126
Volume B Hopper Angle Section	147.8	58.5	8,646.3	64,674
Volume C Hopper Straight Section	83.2	58.5	4,867.2	36,407
Center Section Total	245		14,332.5	107,207
Subtractions				
Center Trough	67.4	2.50	-168.5	-1,260.4
Lamella Plates			-240	-1,795.2
Lamella Trough			-51.1	-382.2
$Center\ Section\ Net\ Total = Center\ Section\ Total - Center\ Trough - Lamella\ Plates - Lamella\ Trough \times 7.48\ \frac{gallons}{cuft}$				
Center Trough Net Total				**103,769**
Ramp Section	340.73	5	1,705	**12,753.4**
Tail Section	136.53	5	682.6	**5,106**
Total SFC Volume				**121,629**

Table 4 SFC volume

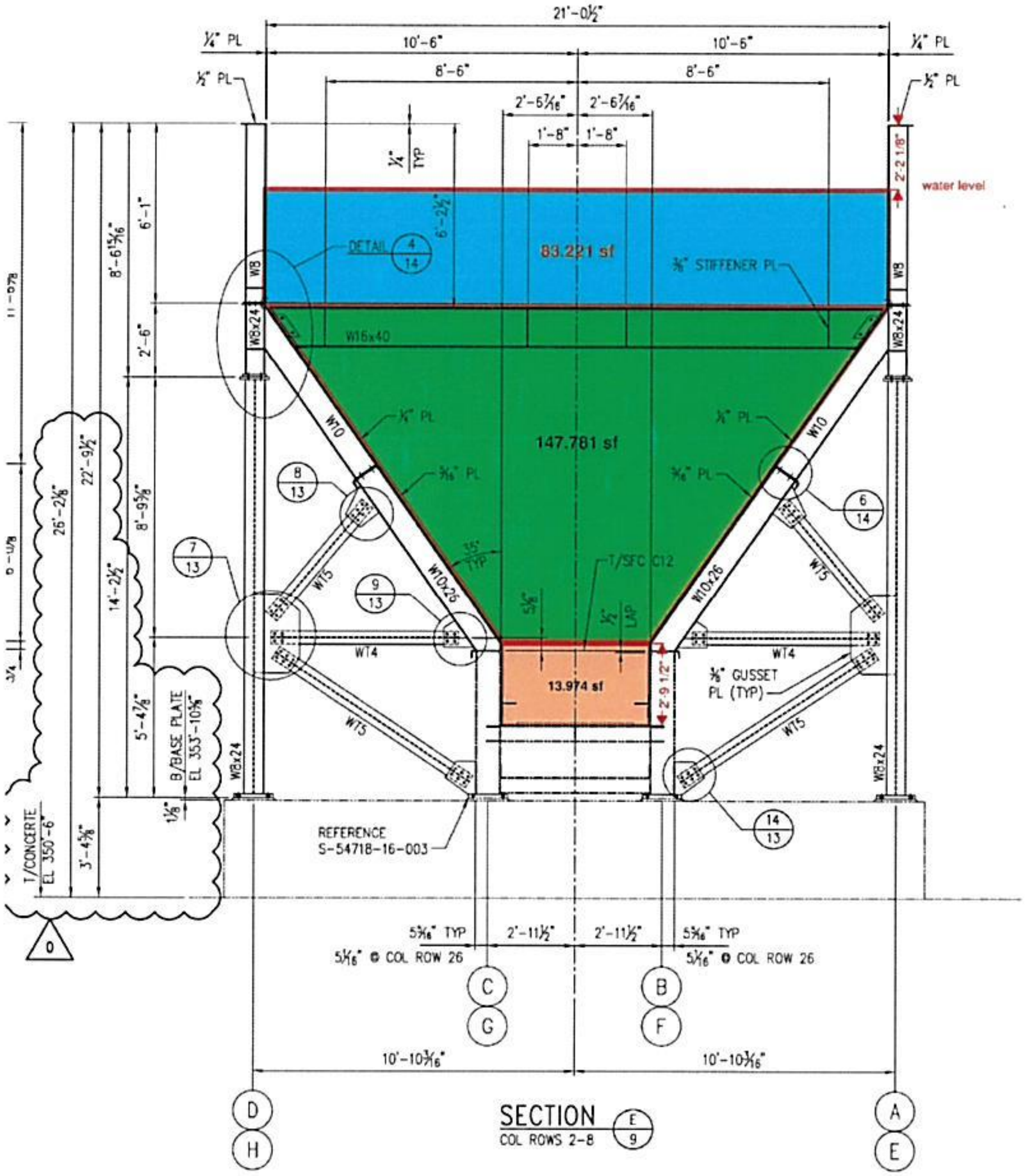


Figure 5 SFC cross sections (ref. UCC drawing S-54718-16-012)

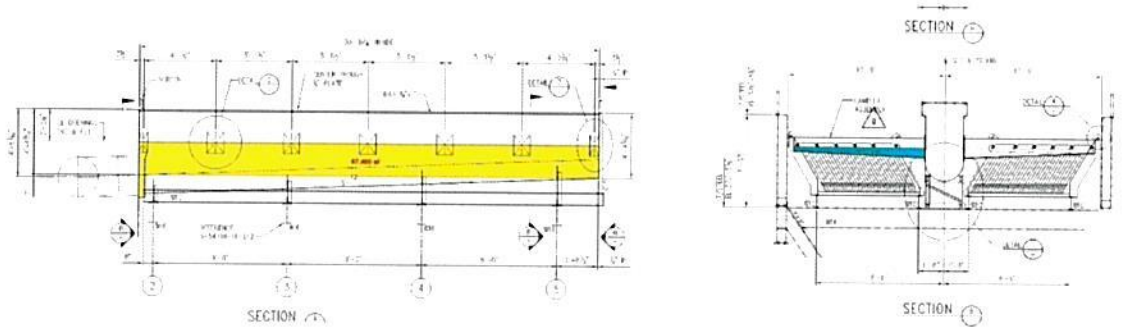


Figure 6 SFC Trough cross section (ref. UCC Drawing S-54718-16-017)

Figure 7 SFC tail and ramp section cross sections (ref. UCC Drawing S-54718-16-012)

1.3.4 Clarifier Volume

There is a total of two Clarifiers. Both are considered active volumes.

1.3.4.1 Method of Calculation

Tank geometry is used to calculate the volume. The volume of the sludge cone, sloped section and straight cylinder are calculated and added together for total volume.

1.3.4.2 Specific Assumptions

- During normal operation both clarifiers are active and used in the process.
- Drawings used for volume calculations: UCC document V-54718-16-00048
- Sludge cone
  - Upper diameter: 94" / lower diameter: 12"
  - Height: 4'-3 3/16"
- Lower cone
  - Upper diameter: 72'/ Lower Diameter: 94"
  - Height 4'-7 7/8"
- Cylinder
  - Diameter 72'
  - Cylinder height: 16'-10"
  - Water height: 16'-0" in cylinder

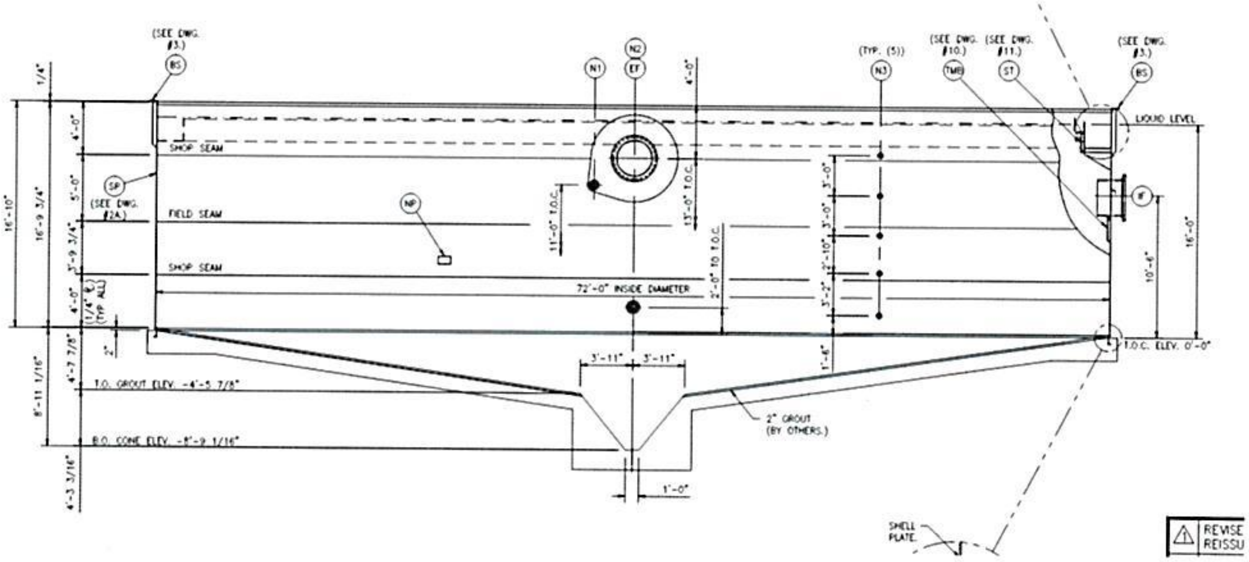
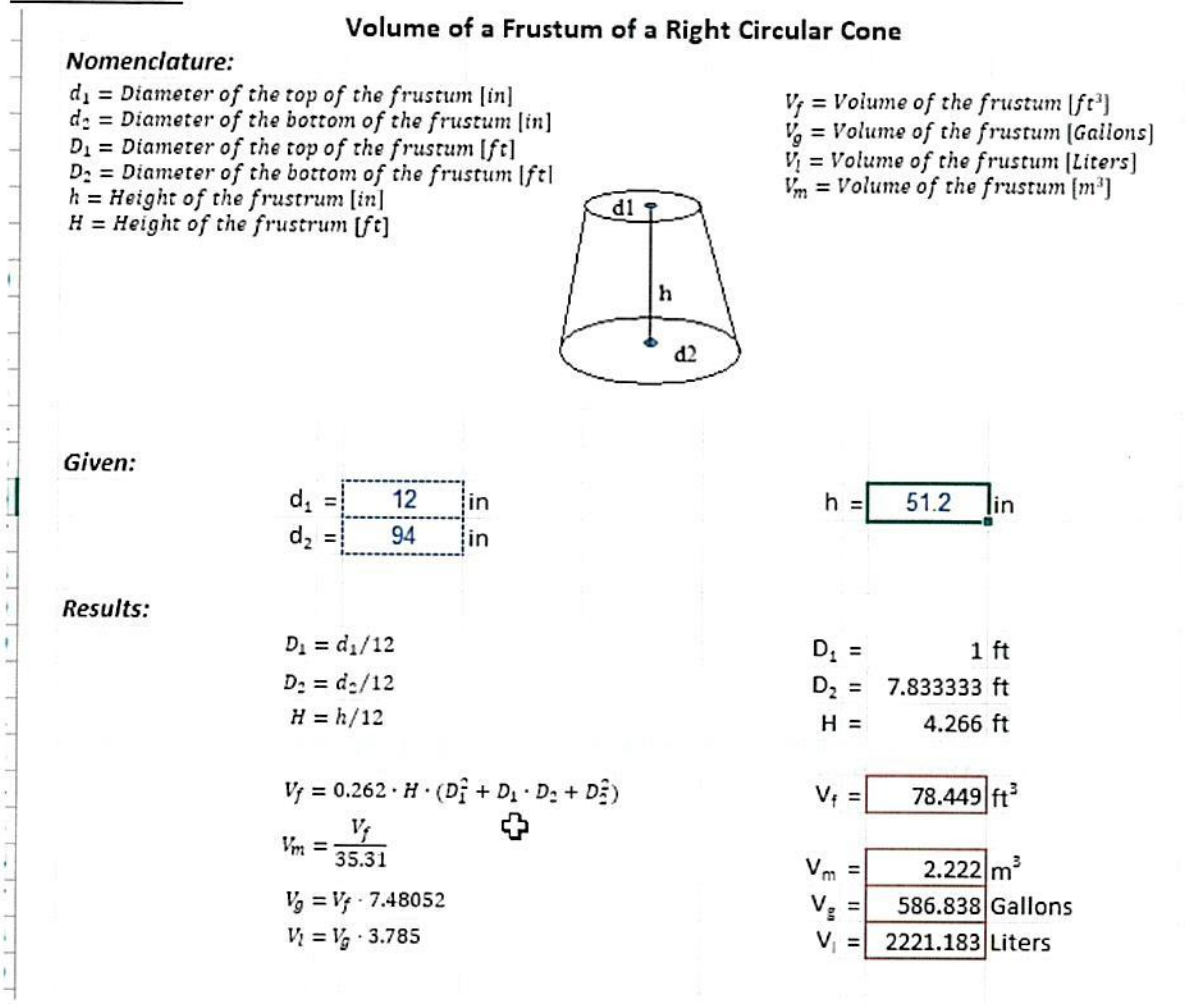


Figure 8 Clarifier cross section (ref. UCC document V-54718-16-00048)

1.3.4.2 Results



Volume of a Frustum of a Right Circular Cone

Nomenclature:

d_1 = Diameter of the top of the frustum [in]
d_2 = Diameter of the bottom of the frustum [in]
D_1 = Diameter of the top of the frustum [ft]
D_2 = Diameter of the bottom of the frustum [ft]
h = Height of the frustrum [in]
H = Height of the frustrum [ft]

V_f = Volume of the frustum [ft^3]
V_g = Volume of the frustum [Gallons]
V_l = Volume of the frustum [Liters]
V_m = Volume of the frustum [m^3]

Given:

d_1 = 12 in
d_2 = 94 in
h = 51.2 in

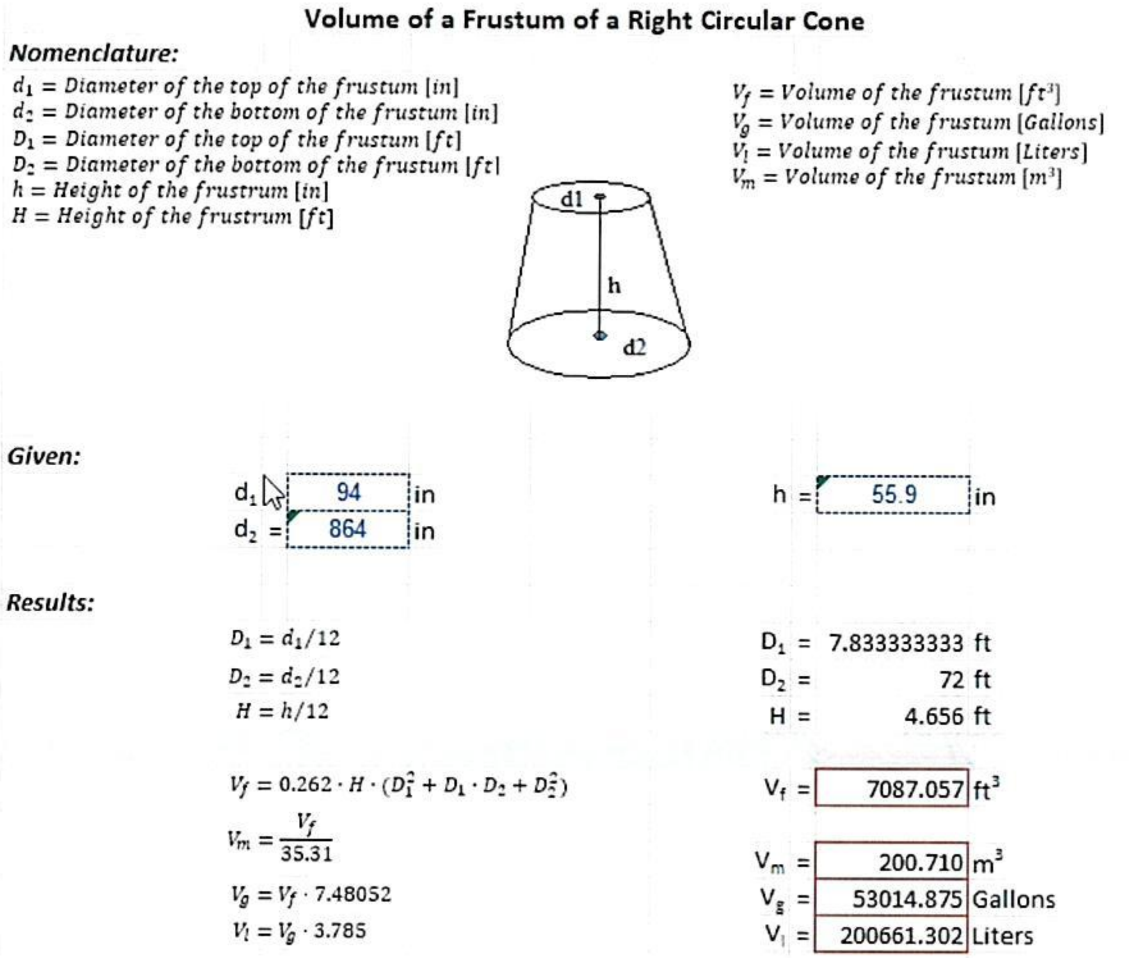
Results:

$D_1 = d_1/12$ — D_1 = 1 ft
$D_2 = d_2/12$ — D_2 = 7.833333 ft
$H = h/12$ — H = 4.266 ft

$V_f = 0.262 \cdot H \cdot (D_1^2 + D_1 \cdot D_2 + D_2^2)$ — V_f = 78.449 ft^3

$V_m = \frac{V_f}{35.31}$ — V_m = 2.222 m^3
$V_g = V_f \cdot 7.48052$ — V_g = 586.838 Gallons
$V_l = V_g \cdot 3.785$ — V_l = 2221.183 Liters

Figure 9 Sludge cone volume



Volume of a Frustum of a Right Circular Cone

Nomenclature:

$d_1 = Diameter\ of\ the\ top\ of\ the\ frustum\ [in]$
$d_2 = Diameter\ of\ the\ bottom\ of\ the\ frustum\ [in]$
$D_1 = Diameter\ of\ the\ top\ of\ the\ frustum\ [ft]$
$D_2 = Diameter\ of\ the\ bottom\ of\ the\ frustum\ [ft]$
$h = Height\ of\ the\ frustrum\ [in]$
$H = Height\ of\ the\ frustrum\ [ft]$

$V_f = Volume\ of\ the\ frustum\ [ft^3]$
$V_g = Volume\ of\ the\ frustum\ [Gallons]$
$V_l = Volume\ of\ the\ frustum\ [Liters]$
$V_m = Volume\ of\ the\ frustum\ [m^3]$

Given:

$d_1 =$ 94 in
$d_2 =$ 864 in
$h =$ 55.9 in

Results:

$D_1 = d_1/12$ — $D_1 =$ 7.833333333 ft
$D_2 = d_2/12$ — $D_2 =$ 72 ft
$H = h/12$ — $H =$ 4.656 ft

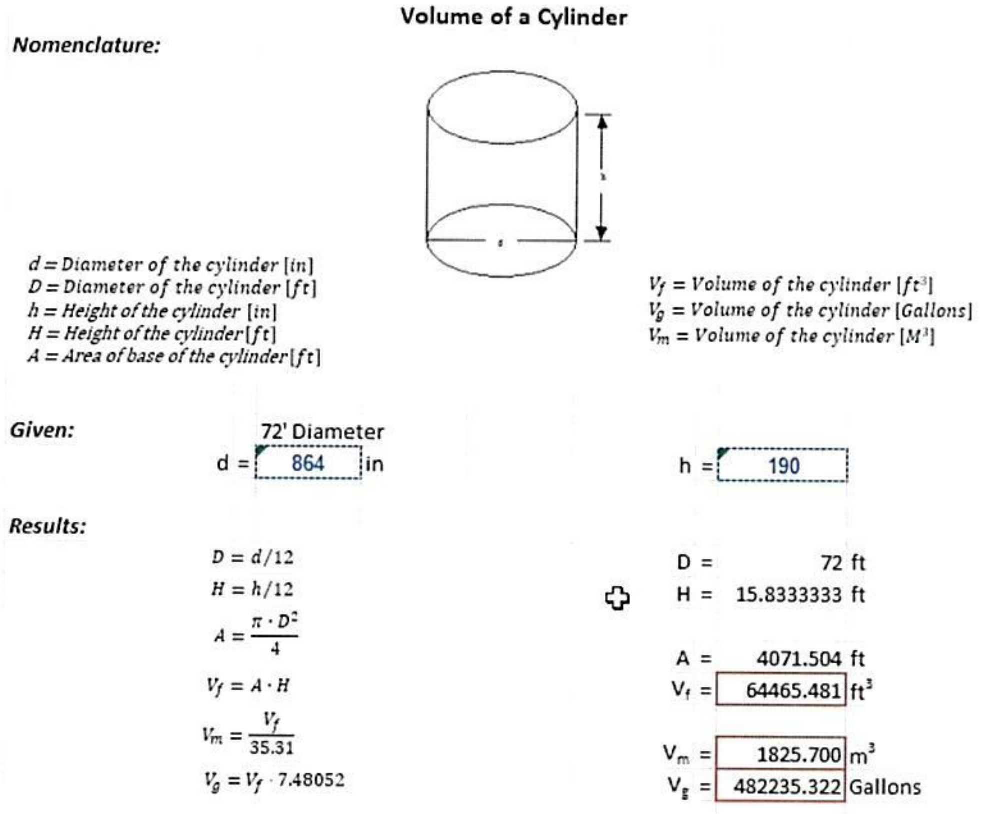
$V_f = 0.262 \cdot H \cdot (D_1^2 + D_1 \cdot D_2 + D_2^2)$ — $V_f =$ 7087.057 ft^3

$V_m = \frac{V_f}{35.31}$ — $V_m =$ 200.710 m^3

$V_g = V_f \cdot 7.48052$ — $V_g =$ 53014.875 Gallons

$V_l = V_g \cdot 3.785$ — $V_l =$ 200661.302 Liters

Figure 10 Lower Cone Volume



Volume of a Cylinder

Nomenclature:

$d = \text{Diameter of the cylinder [in]}$
$D = \text{Diameter of the cylinder [ft]}$
$h = \text{Height of the cylinder [in]}$
$H = \text{Height of the cylinder [ft]}$
$A = \text{Area of base of the cylinder [ft]}$

$V_f = \text{Volume of the cylinder } [ft^3]$
$V_g = \text{Volume of the cylinder [Gallons]}$
$V_m = \text{Volume of the cylinder } [M^3]$

Given:

72' Diameter
d = 864 in

h = 190

Results:

$D = d/12$
$H = h/12$
$A = \frac{\pi \cdot D^2}{4}$
$V_f = A \cdot H$
$V_m = \frac{V_f}{35.31}$
$V_g = V_f \cdot 7.48052$

D = 72 ft
H = 15.8333333 ft

A = 4071.504 ft
V_f = 64465.481 ft^3

V_m = 1825.700 m^3
V_g = 482235.322 Gallons

Figure 11 Clarifier Upper Cylinder Volume

Section	
Sludge Cone	587 gallons
Slope Section	53,015 gallons
Cylinder Section	482,235 gallons
Total	535,837 gallons

Table 5 Clarifier Volume

1.3.5 Process Water Tank Volume

1.3.5.1 Method of Calculation

The volume is calculated from the geometry of the tank. The process water tank is rectangular.

1.3.5.2 Specific Assumptions

Drawings used for volume calculations: TNK-88-6003 reference Figure 12.

Length: 23'-10" / Width: 7'10" / Water Height: 9'4"

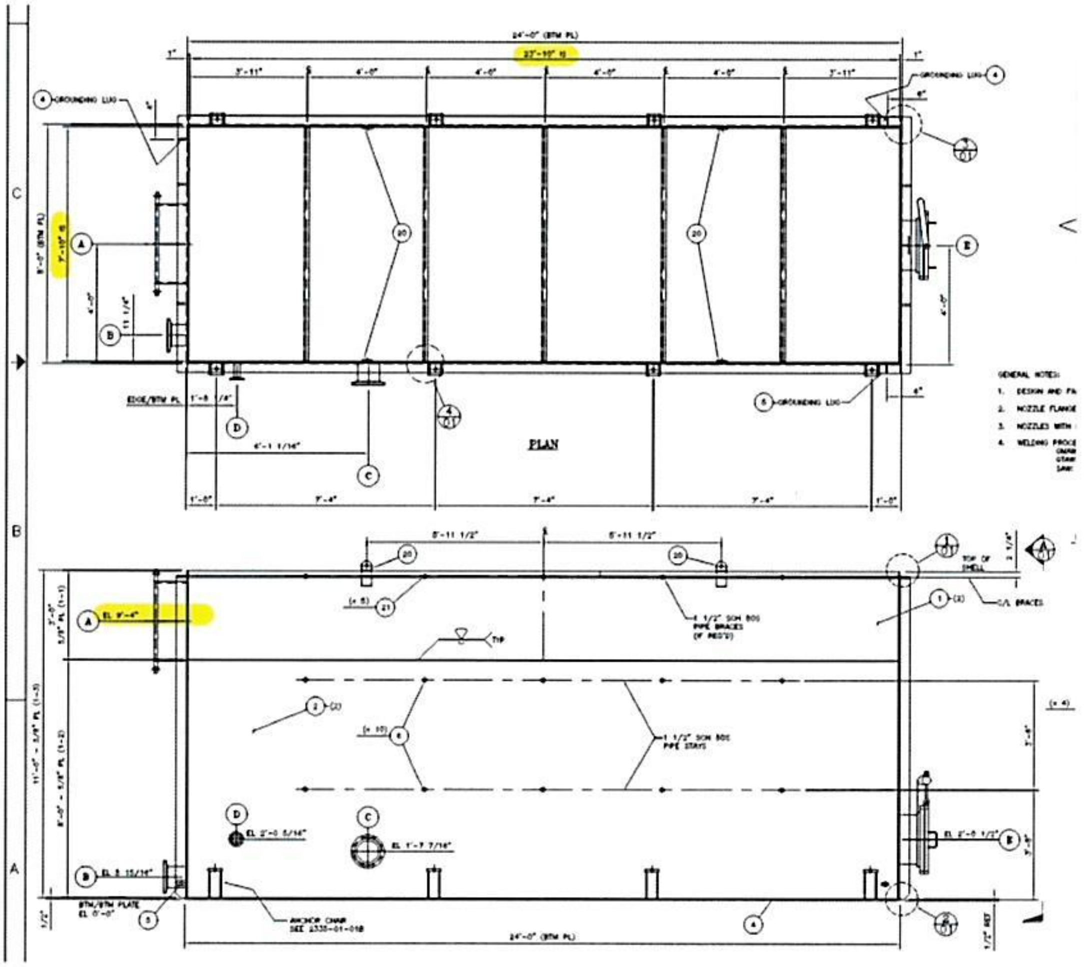


Figure 12 Process Water Tank Plan and Elevation (ref Drawing TVA: TNK-88-6003)

1.3.5.3 Results

$$Volume\ =\ Length\ x\ Width\ X\ Water\ Height\ =\ 1802.3\ cuft\ =\ 13{,}616\ gallons$$

1.3.6 Recirculation Tank Volume

1.3.6.1 Method of Calculation

The volume is calculated from the geometry of the tank.

1.3.6.2 Specific Assumptions

Diameter: 72’

Total height: 17’

Water height: 16’

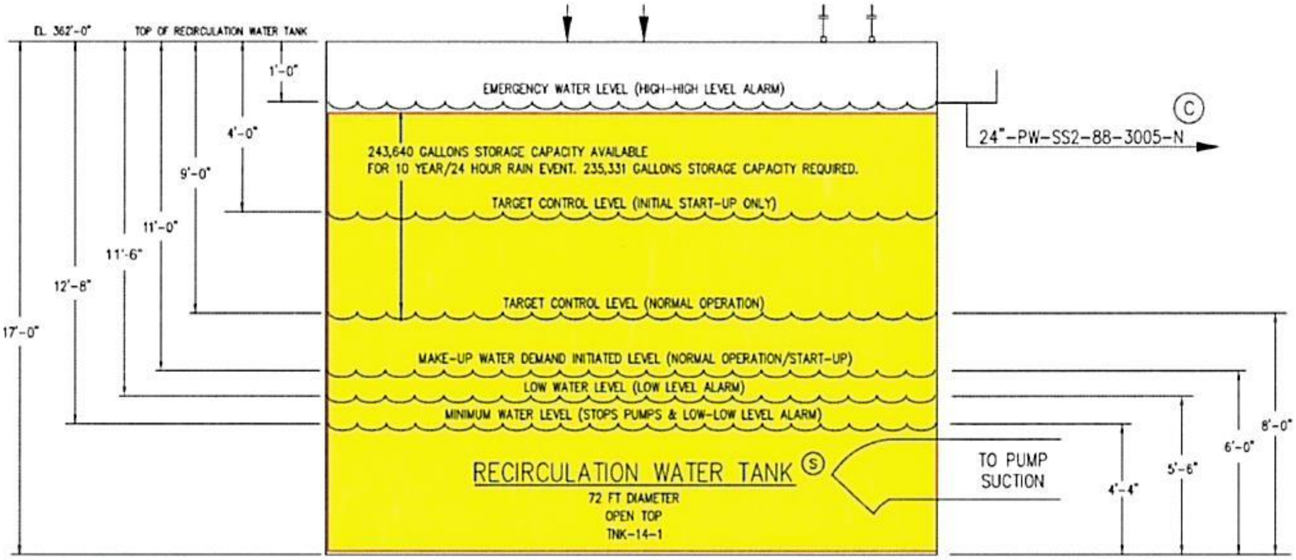
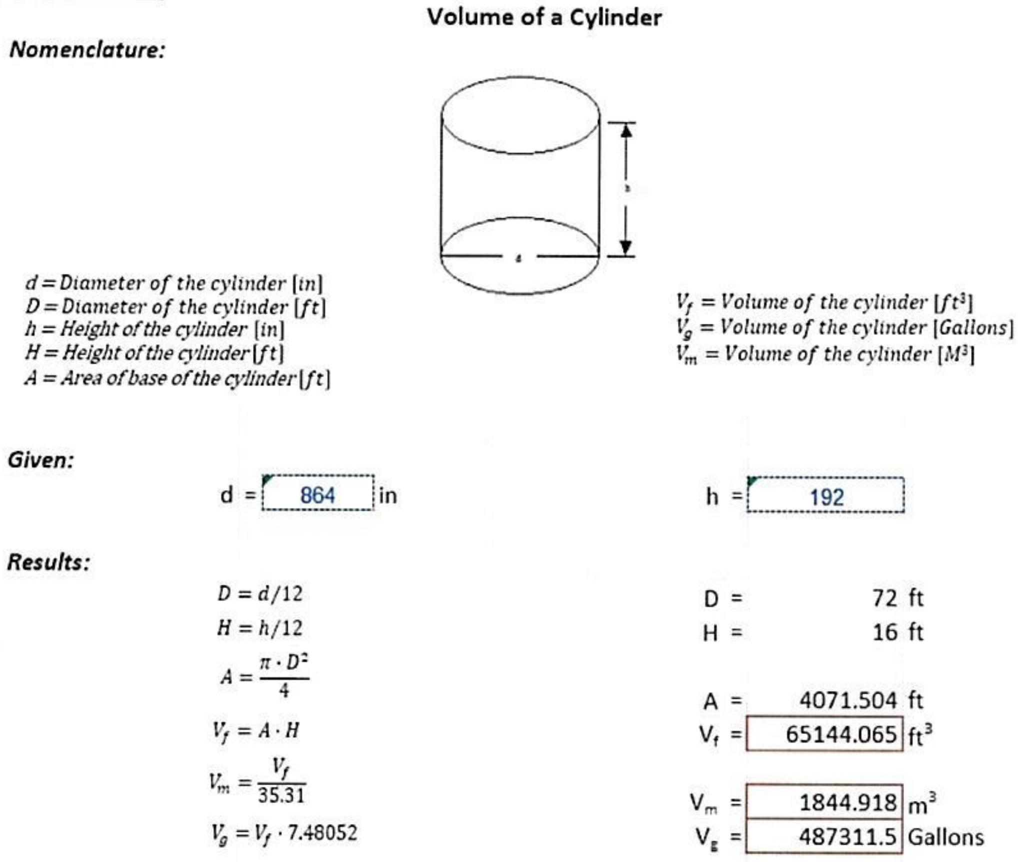


Figure 13 Recirculation Tank Diagram

1.3.6.3 Results



Volume of a Cylinder

Nomenclature:

d = Diameter of the cylinder [in]
D = Diameter of the cylinder [ft]
h = Height of the cylinder [in]
H = Height of the cylinder [ft]
A = Area of base of the cylinder [ft]

V_f = Volume of the cylinder [ft^3]
V_g = Volume of the cylinder [Gallons]
V_m = Volume of the cylinder [M^3]

Given:

d = 864 in
h = 192

Results:

$D = d/12$ — D = 72 ft
$H = h/12$ — H = 16 ft
$A = \frac{\pi \cdot D^2}{4}$ — A = 4071.504 ft
$V_f = A \cdot H$ — V_f = 65144.065 ft^3
$V_m = \frac{V_f}{35.31}$ — V_m = 1844.918 m^3
$V_g = V_f \cdot 7.48052$ — V_g = 487311.5 Gallons

Figure 14 Recirculation Tank Volume Emergency Height

Volume: 487,311 gallons

1.3.7 Pipeline Volumes

1.3.7.1 Method of Calculation

The volume is calculated by taking the total length of the non-redundant pipelines.

$$Pipe\ Flow\ Area\ (ft^2) \times Length(ft) \times 7.48\ \frac{gallons}{ft^3} = Pipe\ Volume\ (gallons)$$

1.3.7.2 Results

Total volume: 150,308 gallons

Service	Pipe Line Tag Number	Size	Drawings	Pipe Area (ft^2)	Length (feet)	Total Volume (gallons)	Notes
Process Water Tank to Reciruclation Tank	32"-PW-CS-88-3001-N	32" STD WGT	C-54718-27-004	5.3263	241.0	9601	
Recirculation Pump Suction Lines	24"-PW-SS2-88-3004-H3	24" STD WGT	C-54718-27-006	2.9483	25.5	562	
		16" STD WGT		1.2684	5.6	53	
	24"-PW-SS2-88-3001-H3	24" STD WGT		2.9483	25.5	562	
		16" STD WGT		1.2684	5.6	53	
Common BAH overflow line U 1-5	8"-PW-CS-88-3014-N	8" SCH 40	C-54718-27-027	0.34741	176.4	458	
	10"-PW-CS-88-3019-N	10" SCH 40	C-54718-27-028	0.5476	273.5	1120	
	8"-PW-CS-88-3014-N	8" SCH 40	C-54718-27-028	0.34741	4.7	12	
	10"-PW-CS-88-3019-N	10" SCH 40	C-54718-27-029, -042, -043, -060, -061, -062 ,-008,-009, -010	0.5476	2430.7	9956	
Common BAH overflow line U6-9	8"-PW-CS-88-3003-N	8" SCH 40	C-54718-27-027	0.34741	176.4	458	
	10"-PW-CS-88-3013-N	10" SCH 40	C-54718-27-028	0.5476	269.3	1103	
	10"-PW-CS-88-3013-N	10" SCH 40	C-54718-27-029, -042, -043, -060, -061, -062 ,-008,-009, -010	0.5476	2485.7	10181	
BAH Overflow Unit 1	6"-PW-CS-88-3001-N	6" SCH 40	C-54718-27-026, -027	0.20063	162.0	243	
BAH Overflow Unit 1 Pump Suction Line	10"-PW-CS-88-3006/3005-N	10" SCH 40	C-54718-27-026	0.5476	12.7	52	
BAH Overflow Unit 2	6"-PW-CS-88-3002-N	6" SCH 40	C-54718-27-030, -031	0.20063	167.4	251	
BAH Overflow Unit 2 Pump Suction Line	10"-PW-CS-88-3007/3008-N	10" SCH 40	C-54718-27-030	0.5476	12.7	52	
BAH Overflow Unit 3	8"-PW-CS-88-3003-N	6" SCH 40	C-54718-27-032, -033	0.20063	131.2	197	
BAH Overflow Unit 3 Pump Suction Line	10"-PW-CS-88-3009/3010-N	10" SCH 40	C-54718-27-032	0.5476	12.7	52	
BAH Overflow Unit 4	8"-PW-CS-88-3004-N	6" SCH 40	C-54718-27-034, -035	0.20063	162.7	244	
BAH Overflow Unit 4 Pump Suction Line	10"-PW-CS-88-3009/3010-N	10" SCH 40	C-54718-27-034	0.5476	12.7	52	
BAH Overflow Unit 5	6"-PW-CS-88-3005-N	6" SCH 40	C-54718-27-045, -046	0.20063	171.7	258	
BAH Overflow Unit 5 Pump Suction Line	10"-PW-CS-88-3014/3015-N	10" SCH 40	C-54718-27-045	0.5476	12.7	52	
BAH Overflow Unit 6	6"-PW-CS-88-3006-N	6" SCH 40		0.20063	154.8	232	
BAH Overflow Unit 6 Pump Suction Line	10"-PW-CS-88-3016/3017-N	10" SCH 40		0.5476	12.6875	52	
BAH Overflow Unit 7		6" SCH 40	C-54718-27-049, -050	0.20063	160.9	241	
BAH Overflow Unit 7 Pump Suction Line		10" SCH 40	C-54718-27-049	0.5476	12.6875	52	
BAH Overflow Unit 8		6" SCH 40	C-54718-27-053, -054	0.20063	157.2	236	
BAH Overflow Unit 8 Pump Suction Line		10" SCH 40	C-54718-27-053	0.5476	12.6875	52	
BAH Overflow Unit 9		6" SCH 40		0.20063	151.8	228	
BAH Overflow Unit 9 Pump Suction Line		10" SCH 40		0.5476	12.6875	52	
Reciculation Water Line HP Unit 1-5		20" STD WGT	C-54718-27-018, -019, -020,- 040,-041,-047,-048,-057,-059	2.0211	2715.4	41051	
		10" SCH 40		0.20063	100	150	20ft per Unit
		6" SCH 40		0.5476	100	410	20ft per Unit
Reciculation Water Line HP Unit 6-9		20" STD WGT	C-54718-27-018, -019, -020,- 040,-041,-047,-048,-057,-059	2.0211	2658.6	40192	
		10" SCH 40		0.20063	80	120	20ft per Unit
		6" SCH 40		0.5476	80	328	20ft per Unit
Bottom Ash Conveying Line Per Unit		8"		0.3491	589.5	1539	65.5ft per Unit
		10"		0.5454	468.9	1913	52.1ft per Unit
Conveying Common Lines		12"		0.7854	4746.6	27885	
TOTAL						150308	gallons

Figure 15 Pipeline Volumes

2.0 Recirculation Tank Water Storage Capacity

2.1 Description of Recirculation Tank Water Storage Capacity

The recirculation tank provides the water source for the recirculation pumps and serves the function of holding excess water in the system.

The volume of water that the recirculation tank can store at any point is limited by the current water level in the tank when the storage is needed. Typically, the water level should be at the target control level. If the water level is at the emergency overflow level, the tank is full and no maintenance storage is available. If water storage is needed during a maintenance event, the storage volume available can be maximized by restricting make up water to the system until the water level drops to the desired level.

The size of the recirculation tank is limited by physical constraints of the system. The water coming into the recirculation tank flows by gravity from the process water tank, limiting the maximum height of the Recirculation Tank. Space constraints in the location of the BADW system limited the footprint of the tank, therefore limiting the diameter for this tank.

2.1.1 Recirculation Tank Storage Calculation

2.1.1.1 Recirculation Tank Dimensions

- Diameter: 72ft
- Height: 17ft
- Target Water Level: 8ft (from bottom of tank)
- Emergency Overflow weir elevation: 16ft (from bottom of tank)

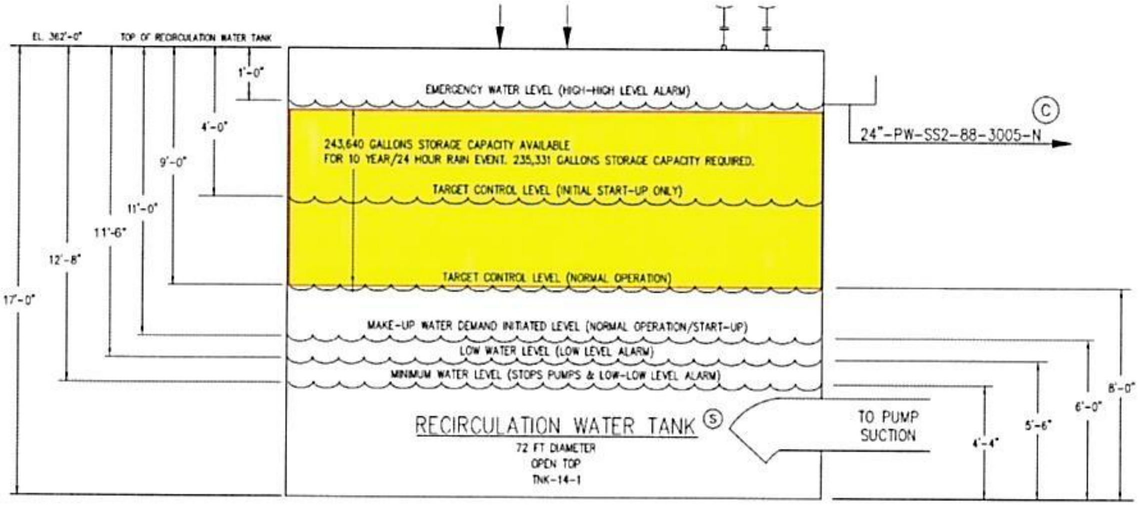


Figure 16 Recirculation Tank Diagram

2.1.1.2 Storage Volume Available

$$\begin{aligned}&Storage\ Height\ Available\\&= Emergency\ Overflow\ Connection\ Elevation - Target\ Control\ Water\ Elevation\\&= 16ft - 8\ ft\ = \ 8ft\end{aligned}$$

$$Normal\ Water\ Level\ Storage\ Volume\ =\ 8\ ft\ X\ \left[\frac{\pi}{4} \times (72ft)^2\right]\ =\ 243{,}640\ gallons$$

If the water level is at the Emergency water level in the Recirculation Tank there is no maintenance storage volume available in the Recirculation Tank.

3.0 Potential Discharges

3.1 List of Potential Reasons for Discharges

- Recirculation tank maintenance
- Clarifier maintenance
- Other maintenance
- Rain event
- Water chemistry maintenance

3.2 Recirculation Tank Maintenance Discharge

3.2.1 Recirculation Tank Discharge Description and Need

Maintenance of the recirculation tank may require the tank to be drained. This is both for safety and to access areas of the tank that are under water.

The recirculation tank provides the only additional water storage capability in the system. If Recirculation Tank maintenance requires the Recirculation Tank to be drained, the volume of water in the Recirculation Tank would need to be discharged.

For planned maintenance events the operator can make sure the tank was operating at the normal water level prior to shutting the system down and draining the tank.

For unplanned maintenance events, there is the potential that the recirculation tank is completely full when the system is shut down and the tank is drained.

3.2.2 Recirculation Tank Maintenance Discharge Volume Calculation

$$\begin{aligned}Normal\ Water\ Level\ Discharge\ Volume &= 8ft\ (water\ elevation)\ X\ \left[\frac{\pi}{4} \times (72ft)^2\right]\\&= 243{,}640\ gallons\end{aligned}$$

$$\begin{aligned}Maxium\ Water\ Level\ Discharge\ Volume &= 16ft\ (water\ elevation)\ X\ \left[\frac{\pi}{4} \times (72ft)^2\right]\\&= 487{,}280\ gallons\end{aligned}$$

3.2.3 Recirculation Tank maintenance discharge frequency

The need to drain the recirculation tank is an abnormal event. Recirculation tank maintenance is typically only expected during planned outages. Normally, there are two planned outages per year. Additionally, there is the potential for unplanned outages or maintenance events that could require additional maintenance discharges from the recirculation tank. The number of unscheduled outages or maintenance events is not known. These events have the potential to add to additional maintenance discharges per year.

3.3 Clarifier Maintenance Discharge

3.3.1 Clarifier Maintenance Discharge Description and Need

Maintenance on a clarifier may require that a clarifier be drained. This is needed to safely perform work and to allow access to areas that are typically under water.

The clarifiers contain the largest water volume in the BADW system. The volume of water in the clarifier exceeds the storage volume available in the recirculation tank (See section 2.1 for limitations on the volume for the recirculation tank). This results in the need for water to be discharged during maintenance of the Clarifier.

3.3.2 Clarifier Maintenance Discharge Volume Calculation

For clarifier maintenance only one clarifier is assumed to drained at any time. Water loss from the system is not considered in the calculation.

$$Discharge\ Volume = Clarifier\ Volume - Recirculation\ Storage\ Available$$

$$Clarifier\ Volume\ = 535{,}837\ gallons$$

- Minimum Discharge occurs with the Recirculation Tank available for storage at the Target Control Water Level.
    - Storage at Target Control Level = 243,640 gallons (see section 2.2.2)

$$Discharge\ Volume = 535{,}837\ gallons - 243{,}640 gallons = 292{,}197\ gallons$$

- Maximum discharge occurs it the Recirculation Tank is at the Emergency Water level or is not available for storage.

$$Discharge\ Volume = 535{,}837\ gallons - 0\ gallons = 535{,}837\ gallons$$

- Discharge Volume Range:
    - 292,197 to 535,837 gallons

3.3.3 Clarifier maintenance discharge frequency

The need to drain a Clarifier is an infrequent occurrence. Typically, this would only occur during planned outages, which are typically scheduled twice per year. Planned clarifier maintenance would be scheduled when the recirculation tank should have water storage capacity available for a portion of the clarifier water volume.

Unscheduled outages or maintenance events have the potential to occur when there is not storage available in the recirculation tank. For example, if maintenance is needed during or after a rain event there may not be storage available. In these cases, the full volume of the clarifier could need to be discharged.

3.4 Other Maintenance Discharges

3.4.1 Other Maintenance Discharge Description and Need

The volumes of the other components in the BADW system are lower than the clarifier volume. With the recirculation tank at normal water levels these volumes can be stored in the recirculation tank and would not require a discharge.

If the Recirculation Tank is full and maintenance of any of this equipment is needed there is a potential need to discharge water from the system.

3.4.2 Other Maintenance Discharge Calculations

Reference section 1.0 for calculations.

Volume	**Quantity**	**Volume (gallons) each**	**Max Discharge Volume (gallons) All.**
Bottom Ash Hopper	18	6244	112,392
Bottom Ash Hopper Overflow Tank	9	993	8937
Remote SFC	2	121,629	242,258
Process Water Tank	1	13,616	13,616

3.4.3 Other Maintenance Discharge Frequency

The need to discharge water for maintenance of these components would be rare and would only occur when the tank is not operating at normal water level due to a rain even or another maintenance event.

3.5 Rain Event Discharge

3.5.1 Rain Event Discharge Description and Need

A portion of the BADW area drains to the dewatering sumps. These sumps send this water back into the BADW system. Because of this redirection and the tanks/vessels are open topped, rainwater is added into the BADW system. The recirculation tank is allotted storage volume to hold this rainwater. If the total amount of rainwater collected is greater than the storage available in the recirculation tank the excess will need to be discharged.

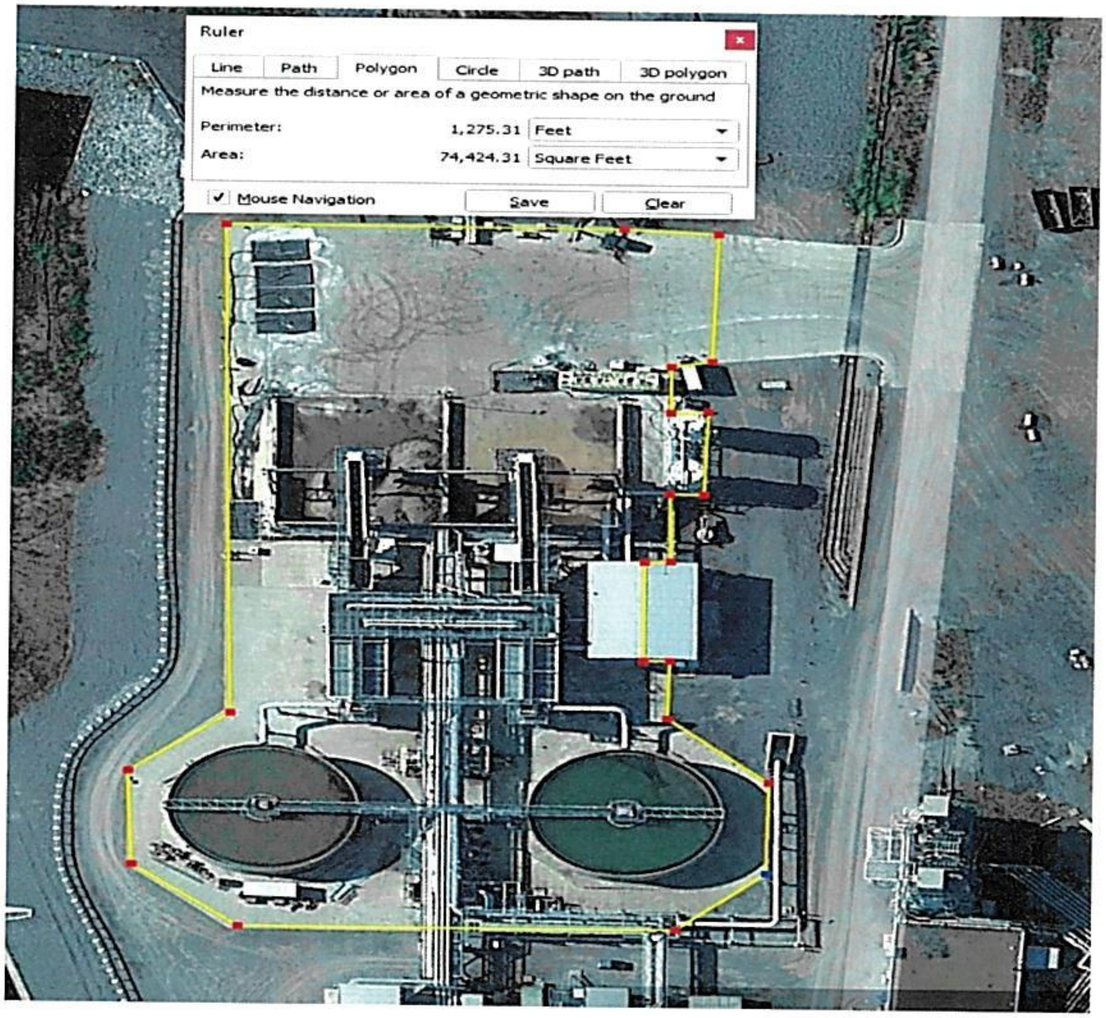
The recirculation tank is designed with a maximum storage volume of 243,640 gallons (see section 2.0). This is enough to hold the volume from a 10-year 24-hour rain event (See Appendix A).

A larger rain event or one that occurs when storage is being used for a maintenance event may result in a discharge from the BADW system.

3.5.2 Rain Event Discharge Calculations

3.5.2.1 Rain Event discharge calculation assumptions

- BADW area to collect rainwater 74,424 sqft.
    - This area includes SFCs, clarifiers, and process water tank.



Measure the distance or area of a geometric shape on the ground

Perimeter: 1,275.31 Feet

Area: 74,424.31 Square Feet

☑ Mouse Navigation

Figure 17 Rain Collection Area BADW

- Other rain collection areas
    - Recirculation Tank surface area= 4,072 sqft

Area from satellite	74,424	sqft	
Clarifier A Area	4,072	sqft	
Clarifier B Area	4,072	sqft	
SFC A area	1,500	sqft	
SFC B area	1,500	sqft	
Process Water Tank	187	sqft	
Approximate Concrete Area	63,093	sqft	
Collection Coefficient Concrete	0.9		range 0.7-0.95
Effective Area Concrete	56,784	sqft	
Drainage Area Net	**68,115**	sqft	
Recirculation Tank	4,072	sqft	
Total Net Area	**72,187**	sqft	

Table 6 Rain Collection Areas

3.5.3 Rain Event Calculation Results

$$Rain\ Water\ Collected\ =\ collection\ area\ (ft^2) \times\ rain\ fall\ total(ft) \times 7.48\ \frac{gallons}{ft^3}$$

$$Potential\ Discharge = Rain\ Water\ Collected -\ 243{,}640 gallons\ (reciculation\ tank\ storage)$$

Rain Total (inches)	Rainwater collected (gallons)	Potential Discharge (gallons)	
2	89,993	-	
4	179,985	-	
5.23	**235,331**	-	**10 Year 24-hour event**
6	269,978	26,338	
8	359,971	116,331	
10	44,9964	206,324	

Table 7 Rainfall total and discharge volume

Occurrences of these are dependent on expected frequency of rain events see APPENDIX A for rain event frequency reference.

3.5.4 10 Year 24-hour event discharge volume calculation.

For the 10-year 24-hour event the rain total is 5.23 inches.

$$Rain\ Water\ Collected = 72{,}187ft^2 \times 5.23\ inches \times \frac{1\ ft}{12\ inches} \times 7.48\ \frac{gallons}{ft^3}$$
$$= 235{,}331 gallons$$

$$Potential\ Discharge = 235{,}331\ gallons - 243{,}640\ gallons\ (recirculation\ tank\ storage)$$
$$= -8{,}309\ gallons\ (negative\ value\ indicates\ extra\ storage)$$

Since there is additional storage available the potential discharge from the 10-year 24-hour rain event is zero gallons when the tank is operating at a normal water level.

If the storage volume of the Recirculation Tank is unavailable due to maintenance or previous rain events water would need to be discharged for the occurring rain event.

3.6 Water Chemistry Blowdown Discharge

3.6.1 Water Chemistry Blowdown Description and Need

Various chemical constituents can be introduced into the system from water treatment reactions and from the bottom ash itself. These will build over time as the water is recirculated in the system. In addition, the makeup water added to the BADW system contains some of these elements. As water is lost through evaporation these constituents will concentrate in the recirculated water.

TDS, Calcium and Bicarbonate will need to be monitored and managed to minimize scale formation in the BADW system. In addition, chloride levels will need to be monitored. Elevated levels of chlorides increase the risk of metallurgical corrosion.

Discharging water through blowdown will allow fresh water to be introduced into the system which can be used to reduce chemical concentrations before they become an issue.

3.6.2 Water Chemistry Blowdown Discharge Calculation

This calculation demonstrates the effect of a blowdown of 10% of the system volume has on the concentration of CaCO3 in the system.

System Volume = 2,087,000 gallons = 17,410,027 lbs (see section 1.0)

10% of volume = 1,741,027 lbs

Assume total hardness (CaCO3) = 1,000ppm

$$Total\ Hardness\ as\ CaCO_3\ (ppm) = \frac{Total\ Hardness\ as\ CaCO_3\ \ (lbs)}{lbs\ of\ H_2O} \times 10^6$$
$$= \frac{Total\ Hardness\ as\ CaCO_3\ \ (lbs\,)}{17{,}410{,}027 lbs} \times 10^6 = 1{,}000 ppm$$

$$Total\ Hardness\ as\ CaCO_3(lbs) = 17{,}410\ lbs$$

Assume dilution (make-up) water is 20 ppm Total Hardness

$$20\ ppm = \frac{Total\ Hardness\ as\ CaCO_3(lbs)}{1{,}741{,}027 lbs\ of\ H_2O} \times 10^6$$

$$lbs\ of\ CaCO_3(in\ make\ up\ water) = 35 lbs$$

$CaCO_3$ after blowdown and make up = 35lbs + 17410lbs X.90 = 15704 lbs

$$\begin{aligned} ppm &= \frac{Total\ Hardness\ as\ CaCO_3(lbs)}{lbs\ of\ H_2O} \times 10^6 \\ &= \frac{15{,}704\ Total\ Hardness\ as\ CaCO_3(lbs)}{17{,}641{,}027 lbs\ H2O} \times 10^6 \\ &= 890\ Total\ Hardness\ as\ CaCO_3(ppm) \end{aligned}$$

Blowing down 10% of the volume and replacing with outside water reduces the concentration from 1,000ppm to 890ppm.

3.6.3 Water Chemistry Blowdown Discharge Frequency

Bottom ash chemical composition and generation rates will change over time and will affect how the chemistry of the system is changed. This is best determined with field testing after the system is in operation. Regular water sampling can be done to determine this frequency.

4.0 Wastewater Treatment Systems

4.1 List of systems at Facility

- Bottom Ash Dewatering System
- Process Water Basin

4.2 Bottom Ash Dewatering System (BADW)

4.2.1 Bottom Ash Hoppers

Units 1-9 bottom ash and pyrites are conveyed from their hoppers to the Submerged Flight Conveyers (SFC) via two of the three sluice lines. Units 1-5 are conveyed to one line and units 6-9 are conveyed through the second sluice line. The third sluice line is a spare line for all the Units.

It is in the Units 1 – 9 bottom ash and pyrites hoppers where the ash is collected and stored until conveyed to the SFCs. Each hopper section has its own discharge equipment (sluice gate, enclosure, crusher, and Jetpulsion Pump). This system is designed to convey sluice water from two bottom ash hoppers into one SFC at any time (parallel conveying). Normal operation is conveying one bottom ash hopper at a time (sequential operation).

Design Capacity – One unit BAH conveying per sluice line. Normal flow is 3,000gpm (sequential conveying). Maximum flow is 6,000gpm (parallel conveying) one BAH from Units 1-5 and one from Units 6-9.

4.2.2 Bottom Ash Hopper Overflow Tanks and Pumps

Each Bottom Ash Overflow System is located at its respective unit's Bottom Ash Hopper inside the boiler building. Each system consists of one Bottom Ash Overflow Tank and a set of two Bottom Ash Overflow Pumps. One pump operates when the boiler for that unit is on, one is a spare. The system is designed to collect all overflow water from the bottom ash hopper and convey it to the SFCs.

Design Capacity – Overflow Tank Pump - 800gpm design flow rate (single pump operating).

4.2.3 Bottom Ash Submerged Flight Conveyor (SFC)

The Submerged Flight Conveyors are located remotely inside the Dewatering Facility (DWF).

The ash from the bottom ash hoppers that is sluiced to one of the SFCs using a Jetpulsion Pump is discharged into the SFC at the baffle ring. The baffle ring and impact plate dissipate and contain the energy of the incoming slurry. Within this baffle ring is where the Alum Coagulant will be injected if needed. This coagulant will help promote the conglomeration of the ash particles in the SFC and reduce the overall carryover of ash particles into the clarifier. After the slurry works its way out the baffle ring, the bottom ash settles out in the transition hopper and is collected between the flights of the SFC. A pair of conveyor chains attached to the flights continuously remove the ash along the upper trough of the SFC and then up the dewatering ramp. After the ash reaches the top of the ramp it discharges by gravity into the Bottom Ash Dewatering Bunker located under the discharge end of the SFCs where the dewatering process continues. Each SFC has a Bottom Ash Dewatering Bunker which allows storage time for additional dewatering of the ash.

Any suspended ash particles in the water that do not immediately settle out in the SFC trough area will go through the lamella assemblies located in the rear of the SFC. There are a total of twelve (12) lamella assemblies in each SFC. These lamella assemblies will reduce the carryover of the suspended solids from the SFC to Clarifier by allowing the suspended solids to settle and collect on the inclined plates eventually settling out to the bottom of the SFC as the water continues over the plates, through the lamella weirs, and out of the SFC overflow.

Design Capacity – SFC conveying rate 30 tons per hour. Water flow 7,000gpm.

4.2.4 Bottom Ash Clarifier

The clarifiers are located directly behind their dedicated SFC.

These clarifiers receive all the carryover water with any suspended solids that did not settle out in the SFC. The water enters the clarifier though the influent pipe and into the feedwell through the inlet diffuser. The inlet diffuser reduces the incoming velocity of the water as well as disperse the flow within the feedwell. It is the feedwell where most of the mixing of the suspended solids in the water and the flocculent happens. The flocculent causes the suspended solids to bind together decreasing their settling time. These bonded together suspended solids, also known as flocs, fall to the clarifier floor where they will be thickened as the clarifier rake pushes the material from the outside of the clarifier to the clarifier center where the discharge cone is located. From there the underflow (the thickened suspended solids from the clarifier) is conveyed from the clarifier back to the SFC via a centrifugal, screw, underflow pump for removal from the system. Now that the suspended solids have settled out on the bottom of the clarifier, the effluent passes over the clarifier weir and to the process water tank.

Design Capacity – Water flow 7,000gpm.

4.2.5 Process Water Tank

The process water tank provides water to both the Process Water pumps and the SFC Chain Wash pumps. The Process Water pumps provide pressurized water for both the Bottom Ash Dewatering Sump Agitation Nozzles and the Underflow Flush water while the Chain Wash pumps provide cleaning water to clear off any ash/pyrites that might be clinging to the SFC chains.

Design Capacity –Volume 13,616 gallons

4.2.6 Bottom Ash Underflow System

The bottom ash underflow system is from the discharge cone of the clarifiers to the SFC baffle ring.

The underflow system consists of two underflow pumps, one running and the other on standby, and one, 6" weld overlay pipe per clarifier. The underflow line conveys the settled ash particles from the clarifier discharge cone to a SFC via the underflow pumps. On the underflow line, there is a flow transmitter meter monitoring the flow of the underflow slurry.

The underflow pump runs continuously to make sure that a bed of material does not form on the bottom of the clarifier tank. Normal operation is to have the underflow pumps conveying to the SFC not receiving material from the Bottom Ash Hoppers.

Design Capacity – Underflow pump design flowrate – 700gpm.

4.2.7 Recirculation Water System

The Process Water Tank discharge pipe is routed on a pipe rack, to a Recirculation Tank. The tank has level instrumentation to monitor water level within the tanks. The tank feeds the individual Recirculation Water Pump Suction lines.

A total of four (4) Recirculation Water Pumps are provided. Depending on the water usage, up to 3 of the 4 Recirculation Pumps can run at a time. They supply both the continuous low-pressure water demands for the Bottom Ash Hopper Seal Trough/Cooling Water and Economizer Water supply for Units 1-9, as well as any necessary High-Pressure Water demands required for sluicing operation.

There are two (2) Recirculation System Transport lines. Each transport water return line is routed from the Recirculation Water Tank area and to the powerhouse along the existing BADW Pipe Rack. Once the transport pipes enter the powerhouse basement, the lines branch off to the Bottom Ash High Pressure Ash Sluice Header and Economizer HYDROVEYOR Water supply lines for Units 1-9. Each of the transport water return lines have a startup/bypass line that is routed back to a Recirculation tank to maintain minimum flow requirements for the Recirculation Pumps.

Design Capacity – Recirculation Tank Volume 517,768 gallons, usable volume 243,640 gallons. Recirculation Pumps- Design Flow two operating 5,500 gpm each, total flow 11,000gpm.

4.2.8 Polymer Injection Skids

This system has a total of two polymer injection skids, one running while the other is on standby. Each skid has two, neat polymer, variable speed, feed pumps with one running while the other is standby, and a flow transmitter.

Each skid uses a multi-staged mixing regime to disperse and activate the polymer and a primary and secondary dilution water train. An onboard controller manages the mixing of the water and polymer.

It is in the influent pipe just outside of the clarifier tank that the flocculent polymer is added to the system. The flocculent promotes a conglomeration of the suspended solids thus decreasing the settling time in the clarifier. This flocculated suspended solids material or underflow will settle into the bottom of the clarifier where the clarifier rake will push the underflow towards the center of the clarifier.

Design Capacity – Raw Polymer 0.075gpm X 2 skids

4.2.9 Coagulant Injection Skid

The Coagulant Injection skid is a Coagulant Feed system. that consists of two, neat coagulant, variable speed, feed pumps with one running while the other is standby. The system is managed by the Chemical Injection Controller which is location on the Polymer Injection skid.

The Alum Coagulant is injected in the SFC baffle rings. The coagulant is used to neutralize the charge of ash particles being conveyed thus making it so the ash particles can be brought together increasing the settling rate of the particles.

There is another Coagulant Injection Skid inside the basement of the boiler building. The Outage Wash In-Line Coagulant Injection Skid is used to inject coagulant into bottom ash sluice lines. This is a single train skid with a single pump.

Design Capacity – 0.3gpm BADW injection skid; 0.7 gpm Outage Wash In Line Coagulant Skid.

4.2.10 Caustic Injection Skid

At the BATW the Caustic Injection skid consists of two neat caustic, variable speed, feed pumps with one running while the other is standby.

In the clean effluent water discharge line (the pipe that runs from the Clarifiers to the Process Water Tank) is a pH transmitter. This transmitter controls the Caustic Injection system. If the pH of the water goes below 6, it dictates to the Caustic system's controller (mounted on the polymer injection skid) to start dosing caustic to balance the water's pH. The controller maintains a process water's pH value by regulating the speed of the pump based on the difference between the process value and system pH reading.

There is another Caustic Injection Skid inside the basement of the boiler building. The pH Outage Wash Skid injects caustic into bottom ash sluice lines. This is a single train skid with a single pump.

Design Capacity – 3.2gpm BADW injection skid; 1.32 gpm pH Outage Wash Skid

4.2.11 Bottom Ash Dewatering Sumps

This sump collects the water from the Bottom Ash Dewatering Bunker and the BADW area. Rainwater in the area also collects in this sump. Sump pumps send water to the SFCs.

Design Capacity – Sump 22,000 gallons; Pump Flow 200gpm

4.3 Process Water Basin (PWB)

The PWB includes two lined operational cells, approximately 5.1 acres each. The PWB reduces total suspended solids for a variety of low volume wastewater flows and stormwater flows prior to their ultimate discharge into Outfall 001.

The PWB cells are lined with a geosynthetic liner system to reduce infiltration of liquids into the underlying subsoils and with riprap slope protection to protect the liner during periodic hydraulic dredging of the cells to remove accumulated solids. The PWB cells operate in series with the process flows routed to the north cell then gravity draining to the south cell through pipes in the divider dike. Effluent is then pumped from the south cell to the Kentucky Pollutant Discharge Elimination System (KPDES) permitted Outfall 001 via the Discharge Channel.

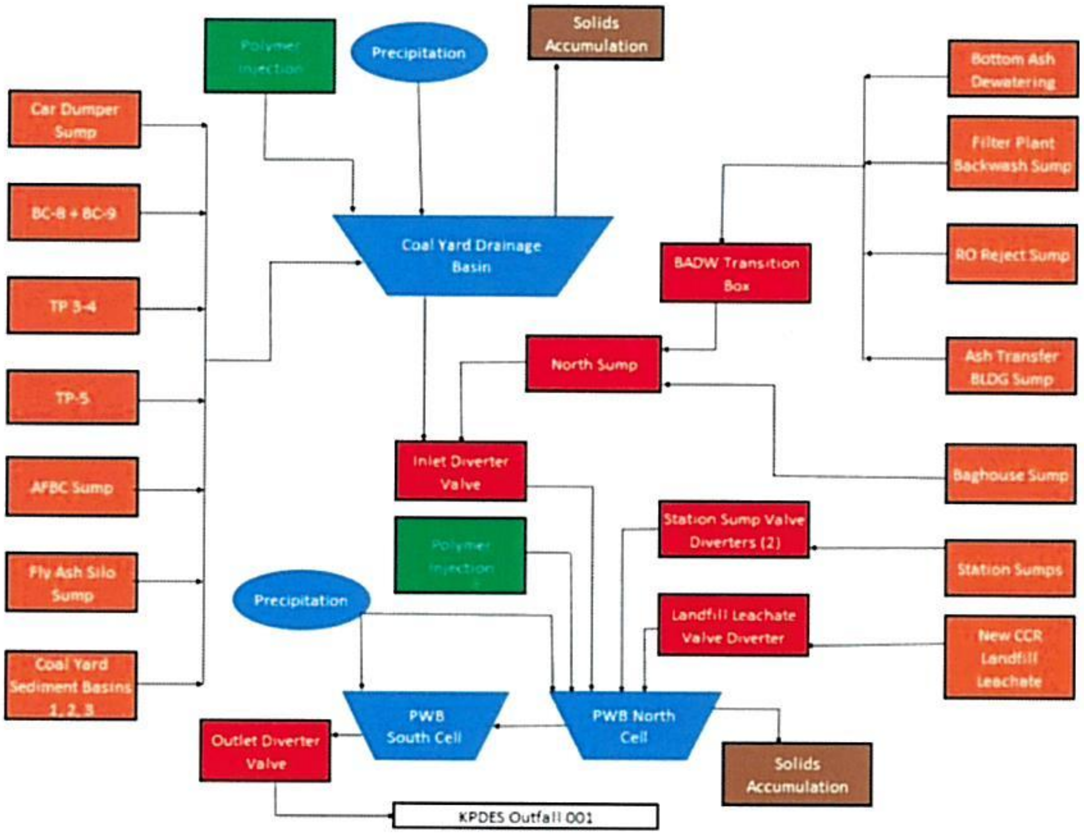


Figure 18 PWB Flow Schematic

Process Water Basin (PWB) Treatment Systems at the Shawnee Fossil Plant are installed to improve total suspended solids (TSS) removal in each basin. In addition, the PWB Treatment System provides pH control.

4.3.1 Transition Box and North Sump

Process Flows (see Figure 18.) are routed the Bottom Ash Dewatering (BADW) transition box. These process flows include discharges from the Filter Plant Backwash Sump, RO Reject Sump, and Ash Transfer Sumps. The combined flows discharge to the North Sump through three below ground gravity pipes.

The Baghouse Sump discharges directly to the North Sump. The North Sump is designed to collect all the process flows mentioned above and pump them to the PWB. It consists of 3 x 50% forwarding pumps rated at 5,100gpm.

4.3.2 Coal Yard Drainage Basin Pump

The Coal Yard Drainage Basin (CYDB) pumping platform is designed to manage the basin level by periodically pumping to the PWB. It consists of 2 x 100% forwarding pumps rated at 10,500gpm.

4.3.3 PWB Inlet Valve Diverter

The PWB Inlet Valve Diverter is an above grade valve station that receives flow from both the North Sump Pumps and CYDB Pumps. The incoming flows combine in a header, then directed to either the North or South PWB basin.

4.3.4 PWB Outlet Pump

The PWB pump structure maintain acceptable basin level by periodically pumping toward the KPDES outfall. It consists of 3x50% forwarding pumps rated at 19,500gpm.

4.3.5 Outfall Valve Diverter

The Outfall Valve Diverter serves three primary functions. First, it combines flow from the three redundant force mains so that only one force main discharges to the KPDES outfall location as required by the KPDES permit.

4.3.6 Station Sump Valve Diverter

The station sump will discharge valve diverter boxes. The lines are routed south toward a valve diverter box (one valve box for each sump discharge pipe). Within each valve diverter box there is a tee with two knife gate valves that can divert the flow to either the North or South PWB cell.

4.3.7 Landfill Leachate Valve Diverter

The landfill leachate pumps are located offsite and discharge into the PWB. A valve diverter box allows the flow to be diverted to either the North or South PWB cell.

4.3.8 Chemical Treatment Coal Yard Drainage Basin

The Coal Yard Drainage Basin chemical treatment system includes polymer and coagulant chemical storage vessels, redundant chemical injection pumps, chemical distribution valve station, basin injection nozzles and instrumentation.

The Coal Yard Drainage Basin treatment system monitors TSS in three sediment basins that feed into the coal yard drainage basin and to match chemical dosing with water flow from the CYDB to improve removal of TSS under varying flow conditions. During rain events, each basin receives variable amounts of flow and TSS depending on quantity and frequency of rainfall.

The system includes coagulant and polymer dosing pumps. Chemical is distributed to each basin as required through a multi-valve control station. Both polymer and coagulant can be sent to any of the three sediment basins by opening one of six remotely operated control valves.

4.3.9 Chemical Treatment Process Water Basin

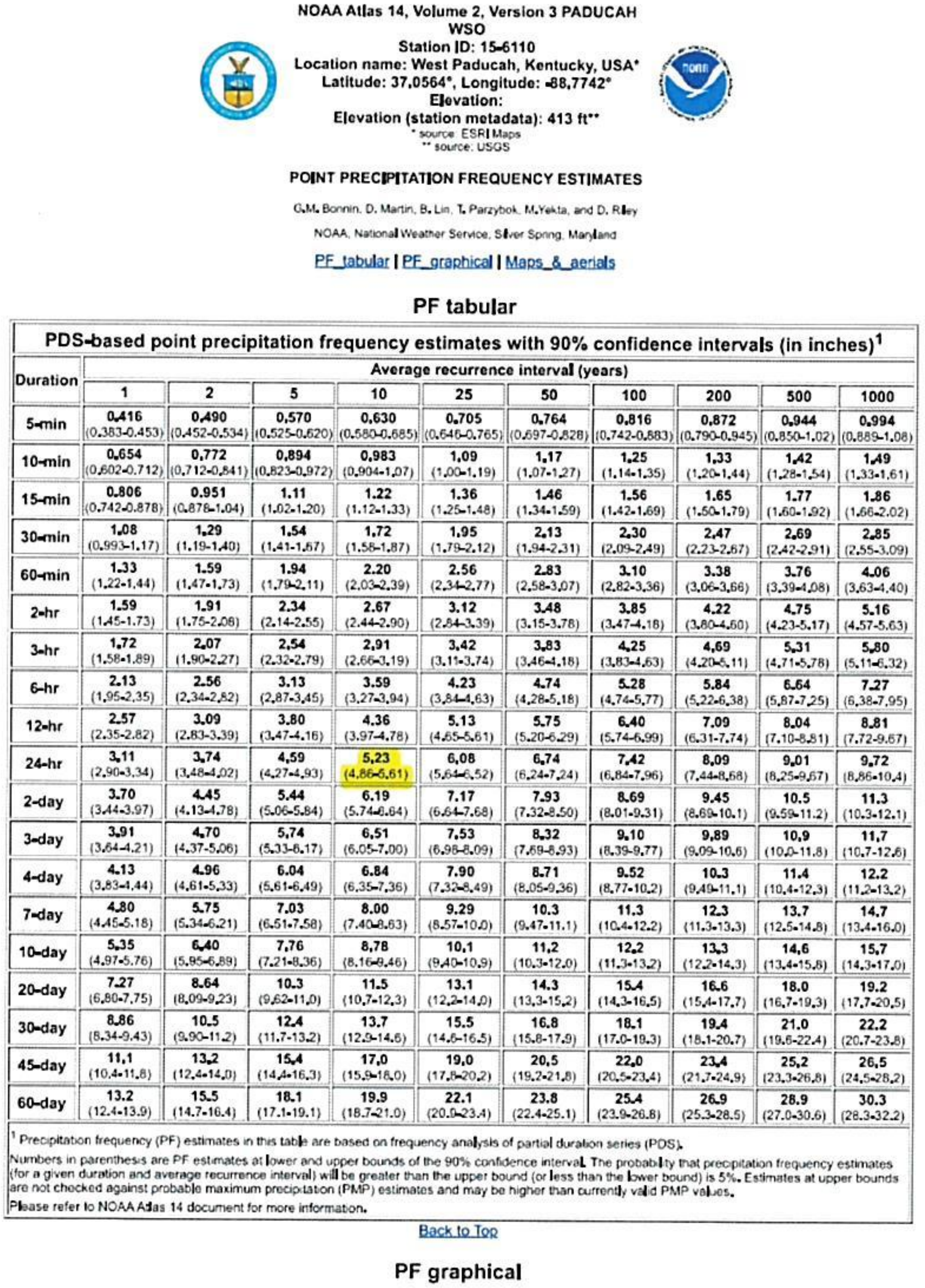
The process water basin chemical treatment system includes polymer, coagulant, and acid chemical storage vessels, redundant chemical injection pumps and instrumentation.

The treatment system monitors pH and TSS discharged to the process water discharged from multiple force mains and to match chemical dosing with water flow to improve removal of TSS under varying flow conditions. In addition, it uses acid injection to keep the pH within limits at the outfall 001.

The coagulant, polymer, and acetic acid metering pump speeds can feed a variable flow of chemical from the storage tank and deliver it to the PWB Injection Box based on the TSS measured and measured flow from the PWB sump pumps.

APPENDIX A Rain Data

https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_printpage.html?st=ky&sta=15-6110&data=depth&units=english&series=pds



NOAA Atlas 14, Volume 2, Version 3 PADUCAH WSO
Station ID: 15-6110
Location name: West Paducah, Kentucky, USA*
Latitude: 37.0564°, Longitude: -88.7742°
Elevation:
Elevation (station metadata): 413 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.416 (0.383-0.453)	0.490 (0.452-0.534)	0.570 (0.525-0.620)	0.630 (0.580-0.685)	0.705 (0.646-0.765)	0.764 (0.697-0.828)	0.816 (0.742-0.883)	0.872 (0.790-0.945)	0.944 (0.850-1.02)	0.994 (0.889-1.08)
10-min	0.654 (0.602-0.712)	0.772 (0.712-0.841)	0.894 (0.823-0.972)	0.983 (0.904-1.07)	1.09 (1.00-1.19)	1.17 (1.07-1.27)	1.25 (1.14-1.35)	1.33 (1.20-1.44)	1.42 (1.28-1.54)	1.49 (1.33-1.61)
15-min	0.806 (0.742-0.878)	0.951 (0.878-1.04)	1.11 (1.02-1.20)	1.22 (1.12-1.33)	1.36 (1.25-1.48)	1.46 (1.34-1.59)	1.56 (1.42-1.69)	1.65 (1.50-1.79)	1.77 (1.60-1.92)	1.86 (1.66-2.02)
30-min	1.08 (0.993-1.17)	1.29 (1.19-1.40)	1.54 (1.41-1.67)	1.72 (1.58-1.87)	1.95 (1.79-2.12)	2.13 (1.94-2.31)	2.30 (2.09-2.49)	2.47 (2.23-2.67)	2.69 (2.42-2.91)	2.85 (2.55-3.09)
60-min	1.33 (1.22-1.44)	1.59 (1.47-1.73)	1.94 (1.79-2.11)	2.20 (2.03-2.39)	2.56 (2.34-2.77)	2.83 (2.58-3.07)	3.10 (2.82-3.36)	3.38 (3.06-3.66)	3.76 (3.39-4.08)	4.06 (3.63-4.40)
2-hr	1.59 (1.45-1.73)	1.91 (1.75-2.08)	2.34 (2.14-2.55)	2.67 (2.44-2.90)	3.12 (2.84-3.39)	3.48 (3.15-3.78)	3.85 (3.47-4.18)	4.22 (3.80-4.60)	4.75 (4.23-5.17)	5.16 (4.57-5.63)
3-hr	1.72 (1.58-1.89)	2.07 (1.90-2.27)	2.54 (2.32-2.79)	2.91 (2.66-3.19)	3.42 (3.11-3.74)	3.83 (3.46-4.18)	4.25 (3.83-4.63)	4.69 (4.20-5.11)	5.31 (4.71-5.78)	5.80 (5.11-6.32)
6-hr	2.13 (1.95-2.35)	2.56 (2.34-2.82)	3.13 (2.87-3.45)	3.59 (3.27-3.94)	4.23 (3.84-4.63)	4.74 (4.28-5.18)	5.28 (4.74-5.77)	5.84 (5.22-6.38)	6.64 (5.87-7.25)	7.27 (6.38-7.95)
12-hr	2.57 (2.35-2.82)	3.09 (2.83-3.39)	3.80 (3.47-4.16)	4.36 (3.97-4.78)	5.13 (4.65-5.61)	5.75 (5.20-6.29)	6.40 (5.74-6.99)	7.09 (6.31-7.74)	8.04 (7.10-8.81)	8.81 (7.72-9.67)
24-hr	3.11 (2.90-3.34)	3.74 (3.48-4.02)	4.59 (4.27-4.93)	5.23 (4.86-5.61)	6.08 (5.64-6.52)	6.74 (6.24-7.24)	7.42 (6.84-7.96)	8.09 (7.44-8.68)	9.01 (8.25-9.67)	9.72 (8.86-10.4)
2-day	3.70 (3.44-3.97)	4.45 (4.13-4.78)	5.44 (5.06-5.84)	6.19 (5.74-6.64)	7.17 (6.64-7.68)	7.93 (7.32-8.50)	8.69 (8.01-9.31)	9.45 (8.69-10.1)	10.5 (9.59-11.2)	11.3 (10.3-12.1)
3-day	3.91 (3.64-4.21)	4.70 (4.37-5.06)	5.74 (5.33-6.17)	6.51 (6.05-7.00)	7.53 (6.98-8.09)	8.32 (7.69-8.93)	9.10 (8.39-9.77)	9.89 (9.09-10.6)	10.9 (10.0-11.8)	11.7 (10.7-12.6)
4-day	4.13 (3.83-4.44)	4.96 (4.61-5.33)	6.04 (5.61-6.49)	6.84 (6.35-7.36)	7.90 (7.32-8.49)	8.71 (8.05-9.36)	9.52 (8.77-10.2)	10.3 (9.49-11.1)	11.4 (10.4-12.3)	12.2 (11.2-13.2)
7-day	4.80 (4.45-5.18)	5.75 (5.34-6.21)	7.03 (6.51-7.58)	8.00 (7.40-8.63)	9.29 (8.57-10.0)	10.3 (9.47-11.1)	11.3 (10.4-12.2)	12.3 (11.3-13.3)	13.7 (12.5-14.8)	14.7 (13.4-16.0)
10-day	5.35 (4.97-5.76)	6.40 (5.95-6.89)	7.76 (7.21-8.36)	8.78 (8.16-9.46)	10.1 (9.40-10.9)	11.2 (10.3-12.0)	12.2 (11.3-13.2)	13.3 (12.2-14.3)	14.6 (13.4-15.8)	15.7 (14.3-17.0)
20-day	7.27 (6.80-7.75)	8.64 (8.09-9.23)	10.3 (9.62-11.0)	11.5 (10.7-12.3)	13.1 (12.2-14.0)	14.3 (13.3-15.2)	15.4 (14.3-16.5)	16.6 (15.4-17.7)	18.0 (16.7-19.3)	19.2 (17.7-20.5)
30-day	8.86 (8.34-9.43)	10.5 (9.90-11.2)	12.4 (11.7-13.2)	13.7 (12.9-14.6)	15.5 (14.6-16.5)	16.8 (15.8-17.9)	18.1 (17.0-19.3)	19.4 (18.1-20.7)	21.0 (19.6-22.4)	22.2 (20.7-23.8)
45-day	11.1 (10.4-11.8)	13.2 (12.4-14.0)	15.4 (14.4-16.3)	17.0 (15.9-18.0)	19.0 (17.8-20.2)	20.5 (19.2-21.8)	22.0 (20.5-23.4)	23.4 (21.7-24.9)	25.2 (23.3-26.8)	26.5 (24.5-28.2)
60-day	13.2 (12.4-13.9)	15.5 (14.7-16.4)	18.1 (17.1-19.1)	19.9 (18.7-21.0)	22.1 (20.0-23.4)	23.8 (22.4-25.1)	25.4 (23.9-26.8)	26.9 (25.3-28.5)	28.9 (27.0-30.6)	30.3 (28.3-32.2)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical