Passive Treatment System Design

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(Collection Pond, SAPS, Settling Pond, Wetland, Limestone Beds) — **Middle Branch** — MTS

Note: Shaded areas represent input variables

Design flow rate =	50	gpm	Total Acidity =	750	mg/l
	189	L/min			
	0.072	MGD			

Collection Pond (TC-1) Design

(Detention Volume + Iron Removal Volume)

Design flow rate =	50	gpm	
Detention Time =	12	hours	
Fe to be removed =	0	mg/l	*(use 0, because minimal oxidation of iron in this pond)*
Pond Life =	0	yrs.	
Required Water Vol. =	4,813	ft^3	*(Design Flow Rate x Detention Time)*
Required Iron Vol. =	-	ft^3	*(Flow x Fe to be removed x Basin Life / sp. wt. water)*
Required Total Vol. =	**4,813**	ft^3	*(Req. Water Vol. + Req. Iron Vol.)*
Assumed depth =	5	ft	
Required Area =	963	ft^2	*(Required Total Volume / Assumed Depth)*
	0.0221	acres	

Design dimensions : (using 2H :1V sideslopes)

Midpoint Width =	22	ft	Bottom Width =	12 ft
Midpoint Length =	44	ft	Bottom Length =	34 ft
Surface overflow rate:	75	gal/day/ft^2		

SAPS (TC-2, TC-3) Design

(Two SAPS in Parallel)

Note: The calculation of limestone needed is referenced from Chapter 6, ANOXIC LIMESTONE DRAINS, p.21-22, "A Handbook of Constructed Wetlands", Volume 4 Coal Mine Drainage.

Equation: $M = (Q * (p_b)td)/Vv) + ((Q*C*T)/x)$

$M = A + B$

where:

*A= mass of limestone to achieve required **detention** time*

*B = mass of limestone added due to **dissolution** losses*

M = mass of limestone per SAP in metric tons

Q = flow rate in L/min

p_b = density of limestone in kg/m^3

td = detention time in hours
Vv = bulk void volume of limestone (decimal)
C = predicted concentration of alkalinity in SAP (ALD) effluent (mg/l)
T = design life of the SAP (years)
x = Calcium carbonate content of limestone (decimal)

Q =	25	gpm	(per SAP)
Q =	95	L/min	
p_b =	1600	kg/m^3	2,694 lbs/yd^3
td =	15	hours	
Vv =	0.5		
C =	250	mg/l	*(generally 150- 300 mg/l)*
T =	20	years	
x =	0.9		

Therefore, the mass of limestone required is:

A=	273	metric tons	
B=	276	metric tons	
M=	549	metric ton	*(per SAP)*
	605	tons	*(per SAP)*
	449	yd^3	*(per SAP)*

Surface area of Limestone:

water depth desired =	3	ft
limestone placement thickness =	3	ft.
surface area of limestone =	**4,044**	ft^2
	0.0928	acres

Design dimensions : (using 2H :1V sideslopes)

Midpoint Width Limestone =	45	ft		
Midpoint Length Limestone =	90	ft		
Top Width Limestone =	**51**	ft	Bottom Width lime. =	**39** ft
Top Length Limestone =	**96**	ft	Bottom length lime. =	**84** ft

Volume of compost needed:

compost thickness = 2 ft.

Midpoint Width Compost =	55 ft	*(using 2H : 1V sideslopes)*
Midpoint Length Compost =	100 ft	*(using 2H : 1V sideslopes)*
Compost Volume =	10,985 ft^3	
	407 yd^3	

water depth = 3 ft

Settling Pond (TC-4) Design *(Detention Volume + Iron Removal Volume)*

Design flow rate =	50	gpm	Total Acidity =	750 mg/l
	189	L/min		
	0.072	MGD		

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Detention Time =	48	hours							
Fe to be removed =	15	mg/l							
Pond Life =	25	yrs.							
Required Water Vol. =	19,251	ft^3	*(Design Flow Rate x Detention Time)*						
Required Iron Vol. =	1,318	ft^3	*(Flow x Fe to be removed x Pond Life / sp. wt. water)*						
Required Total Vol. =	**20,569**	ft^3	*(Req. Water Vol. + Req. Iron Vol.)*						
Assumed depth =	5	ft							
Required Area =	4,114	ft^2	*(Required Total Volume / Assumed Depth)*						
	0.0944	acres							
Design dimensions : (using 2H :1V sideslopes)									
Midpoint Width =	45	ft			Bottom Width =	35	ft		
Midpoint Length	91	ft			Bottom Length =	81	ft		
Surface overflow rate:	18	gal/day/ft^2							

Settling Pond (TC-4) Alternate Design

Settling pond volume required = quantity, gpm x 1 ft^3/7.48 gal x 60 min/hr x detention time

Volume = **19,251** ft^3

Adding for sludge accumulation (iron and aluminum only) :

Fe(mg/l) = 15 Al(mg/l) = 75 Fe + Al = 90

(Assuming sludge density of 1.09 g/cm^3, from USBM)

Volume = Q, gal/min x 90 mg/l x 3.785 L/gal x g/1000 mg x $1cm^3$/1.09 g x $(1in/2.54cm)^3$ x $(1ft/12in)^3$ x 60min/hr x 24hr/day x 365day/yr x design life

Volume = **7,251** ft^3

Therefore, total volume of settling pond = **26,502** ft^3

Assumed depth =	5	ft							
Required Area =	5,300	ft^2	*(Required Total Volume / Assumed Depth)*						
	0.1217	acres							
Design dimensions : (using 2H :1V sideslopes)									
Midpoint Width =	51	ft			Bottom Width =	41	ft		
Midpoint Length	103	ft			Bottom Length =	93	ft		

Aerobic Wetland (TC-5) Design *(Detention Volume)*

Detention Time =	6	hours							
Standing Water =	6	inches							
Compost Layer =	1	ft							
Required Water Volume =	2,406	ft^3	*(Design Flow Rate x Detention Time)*						
Surface Area =	**1,604**	ft^2							

				0.0368	acres					
		Surface overflow rate=		44.9	gal/day/ft^2					
	Aerobic Wetland (TC-5) Alternate Design									
	Sizing criteria =		20 g/m^2/day removal rate			*(EADS Group study for USBM used 25 g/m^2/day)*				
	Surface Area = Q, gal/min x 15 mg/L x 3.785 L/ gal x 1g/1000 mg x 60 min/hr x 24 hr/day / (20 g/m^2/day) x 10.76 ft^2/m^2									
		Surface Area =		**2,199**	ft^2					
				0.0505	acres					
		Assumed depth =		1.5	ft					
	Design dimensions :		(using 2H :1V sideslopes)							
	Midpoint Width =		33	ft			Bottom Width =		30	ft
	Midpoint Length =		66	ft			Bottom Length =		63	ft
	Limestone Bed (TC-6, TC-7) Design					*(For Manganese Removal)*				
	Sizing criteria =		1000	ft^3 (limestone) / gpm of flow						
	Design flow rate =		50	gpm						
	Required Limestone Volume =			50,000	ft^3	*(Design Flow Rate x 1000 ft^3 / gpm of flow)*				
	Using 2 Limestone Beds in Parallel									
	Required Volume Per Bed =			25,000	ft^3	*(Required limestone volume / 2 limestone beds)*				
	Assumed depth =		5	ft						
	Required Area =		5,000	ft^2		*(Required Volume Per Bed / Assumed Depth)*				
			0.1148	acres						
	Design dimensions :		(using 2H :1V sideslopes)							
	Midpoint Width =		50	ft			Bottom Width =		40	ft
	Midpoint Length =		100	ft			Bottom Length =		90	ft