Appendix B

SAPS Design Calculation

STEP 1: Data Collection

Sample	Flow(Q)	pH	DO	Fe	Mn	Al	Acidity	Non-Mn Acidity
	GPM	su	mg/l	mg/l	mg/l	mg/l	mg/l *	mg/l * **
1	6.0	3.5	6.2	26.8	10.7	1.6	62.0	42.5
2	5.0	3.1	6.6	36.6	14.1	0.7	134.0	108.4
3	1.5	3.1	7.0	44.7	19.2	1.0	182.0	147.1
4	0.5	3.0	7.9	25.5	20.9	0.9	186.0	148.0
5	1.5	3.2	7.5	27.2	12.0	1.1	104.0	82.2
6	3.0	4.7	6.5	13.2	5.9	1.5	44.0	33.3
7	1.2	3.8	6.8	12.0	9.7	1.3	74.0	56.4
8	11.8	3.7	6.5	31.9	6.4	0.9	60.0	48.3
9	5.5	3.2	5.3	27.3	5.0	0.8	58.0	48.9
10	4.7	3.3	5.9	42.4	10.2	0.9	104.0	85.5
11	12.0	4.3	7.2	30.1	6.7	0.3	48.0	35.8
12	4.5	3.4	6.2	51.7	14.9	1.1	130.0	102.9

*$CaCO_3$ equivalent ** Determined by (Acidity - 1.818Mn)

STEP 2: Development of the 95% Confidence limit

	Flow(Q)	pH	DO	Fe	Mn	Al	Acidity	Non-Mn Acidity
n =	12	12	12	12	12	12	12	12
χ =	4.77	3.35*	6.63	30.78	11.31	1.01	98.83	78.27
$t_{.05[n-1]}$ =	1.796	1.796	1.796	1.796	1.796	1.796	1.796	1.796
s =	3.81	*NA***	0.71	11.80	5.17	0.35	50.01	41.04

*median value **not applicable

$$L_{upper} = \chi + t_{.05[n-1]}\, s\, n^{-0.5}$$

	Flow(Q)	pH	DO	Fe	Mn	Al	Acidity	Non-Mn Acidity
L_{upper} =	6.74	*NA*	7.00	36.90	13.99	1.19	124.76	99.54

STEP 3: Residence Time Calculation

ONE CELL

$\ln(t_r)_{1cell}$ = (-0.017x36.90) + (0.012x99.54) + 2.21 = 2.78 ln hours

$t_{r\ 1\ cell} = e^{\ln(t_r)_{1\ cell}}$ = 16.07 hours

using a bulk void volume of 0.50

Volume of limestone = $0.227 \times 6.74\text{GPM} \times 16.07\text{hr} \times 0.50^{-1}$ = 49.19 m^3

using a bulk density of 0.8 MT/m^3

Tonnage of Limestone = $49.19m^3 * 0.8\ MT/m^3$ = 39.35 MT

20 YEAR DESIGN LIFE

Volume of limestone = $V_{ls} = \frac{1.99\ Q\ C\ T}{\rho_b \times}$

$$\frac{1.99\ (6.74\ GPM)(149.54\ mg/l)(20\ yr)}{0.9 \times 1600\ kg/m^3}$$

= 27.85 m^3

Tonnage of Limestone = $27.85m^3 \times 0.8\ MT/m^3$ = 22.28 MT

TOTAL LIMESTONE = $49.19m^3 + 27.85m^3$ = **77.04** m^3

39.35MT + 22.28MT = **61.63** MT

TWO CELLS

$\ln(t_r)_{2\ cell}$ =	$\ln(t_r)_1 / 2$	=	1.39 ln hours
$t_{r\ 2\ cell}$ =	$e^{\ln(t_r)_{2\ cell}}$	=	4.01 hours

using a bulk void volume of 0.50

Volume of limestone =	$0.227 \times 6.74 GPM \times 34.01 hr \times 0.50^{-1}$	=	12.27 m^3

using a bulk density of 0.8 MT/m^3

Tonnage of Limestone =	$12.27 m^3 \times 0.8 MT/m^3$	=	9.81 MT

20 YEAR DESIGN LIFE

Volume of limestone = $\dfrac{1.99\ Q\ C\ T}{\rho_b}$ x

$$\frac{1.99\ (6.74\ GPM\ )(149.54\ mg/l)(20\ yr)}{0.9 \times 1600\ kg/m^3}$$

		=	27.85 m^3
Tonnage of Limestone =	$13.93 m^3 \times 0.8 MT/m^3$	=	22.28 MT
Per Cell Basis =	27.85 / 2	=	13.93 m^3
	22.28 / 2	=	11.14 MT
Total Limestone per cell =	$12.27 m^3 + 13.93 m^3$	=	26.19 m^3
	9.81MT + 11.14MT	=	20.96 MT
TOTAL LIMESTONE =	$26.19 m^3 \times 2$	=	**52.39** m^3
	20.96MT x 2	=	**41.91** MT

STEP 4: Organic Matter Calculation

Volume of Organic Matter = $0.227\ Q\ t_{rom}\ V_v^{-1}$

$0.227 \times 6.74 \times 25 \times 0.59^{-1}$ = 64.83 m^3*

* Since this calculation is independent of the number of cells, this volume of organic matter should be used in each cell.