MODIFIED SOIL LOSS EQUATION

(a) Rainfall Factor (R)

R = $(E \times I_{30}) / 170.2$ MSMA(15.11a)

Where,

I_{30} = is the rainfall's maximum 30-minute intensity

196 mm/hr Refer to rainfall intensity MASMA 14-25

P = annual rainfall (mm)

2812.80 mm

E = annual erosivity (J/m²)

E = 9.28 P - 8 883.15 MSMA(15.11b)

E = 17,264.63 J/m²

Therefore,

R = (17,264.63 x 173) / (170.2)

= 19,907.08 ton.m/ha.hr

Soil Erodibility (K)

The soil erodibility (K) is the rate of soil loss per unit of rainfall erosivity actor for a specified soil. It is based on five soil parameters. There are percent silt, percent sand, organic matter content (OM), soil structure (S) and permeability (P) of the soil profile.

K = K = 2.1 x 10-6 (12 - OM) M1.14 + 0.0325 (S - 2) + 0.025 (P - 3)

= 2.1 x 10-6 (12 - OM) M1.14 + 0.0325 (S - 2) + 0.025 (P - 3)

OM = Organic matter (%)

M = (% Silt + % Sand) (100 - % Clay) (% Silt + % Sand) (100 - % Clay)

S = Structural Code

Length-Slope Factor (LS)

The length steepness factor (LS) is a combination between the effects of slope and length of eroding surface. It is the ratio of soil loss per unit area from a slope land to that from a standardized measured plot (MSMA, 2000). Slope length was measured from the highest point to the centre or sediment basin. Percent of slope (S) is obtained from diversification between highest and lowest point and divided with slope length. The exponent m is based on percent of slope on.

Vegetation management factor (VM)

The vegetation management factor (VM) is defined as the ratio of soil loss from a field subject to a system of control measures to that from the same site without any control provision.The fraction are originated from of three sub-factor i) canopy cover, ii) mulch cover, iii) bare ground and VM factor can be tabulated as multiplying all the sub-factor. At present there is insufficient data to give detail guidance on suitable values of VM or C. For urban area, assuming that impervious areas would not produce any sediment. Its is recomended that calculation is as below

VM = Canopy Subfactor x Mulch Subfactor x Bare Subfactor OR

VM = C x (1 - I A) C=1(Bare Soil), 0.45(Establish Grass Cover)

Sediment Delivery ratio (SDR)

SDR% = $77.34xA^{-0.065}x(R/L)^{0.213}$

A = Area (acre)

R/L = relief ratio to length (LS/100)

Length-Slope Factor (LS)

$LS = (\lambda / 22.13)^{m} (0.065 + 0.0465 \sin\theta + 0.0065 \sin^2\theta)$

The Modified Soil Loss Equation (MSLE)

A = R x K x LS x VM

R = Rainfall factor

K = Soil Erodibility

LS = Length- Slope Factor

VM = Vegetation management

Estimating LS factor existing condition

	Area	Slope length, λ	Slope Gradient, S (%)	LS
1	SB1	215.55	12.05	4.879
2	SB2	293.40	5.20	1.748
3	SB3	233.69	15.22	7.456
4	SB4	182.62	17.14	7.936
5	SB5	118.03	2.25	0.332

Estimating LS factor during site clearing

	Area	Slope length, λ	Slope Gradient, S (%)	LS
1	SB1	1038.00	0.0327	0.144
2	SB2	1155.00	0.0536	0.149
3	SB3	855.00	0.0397	0.139
4	SB4	818.00	0.0567	0.139
5	SB5	555.00	0.0381	0.127

Estimating LS factor after development

	Area	Slope length, λ	Slope Gradient, S (%)	LS
1	SB1	1038.15	1.69	0.511
2	SB2	1155.03	0.69	0.221
3	SB3	855.01	0.41	0.176
4	SB4	818.02	0.61	0.197
5	SB5	555.01	0.72	0.193
6				
7				
8				

Soil loss at existing conditions (before site clearing)

	Area	Area (ac)	Area (ha)	R	K	LS	VM	A or qc ton/ha.yr	E ton/yr
	SB1	43.71	17.69	19,907.08	0.0496	4.879	0.2363	1137.2846	20118.56
	SB2	28.44	11.51	19,907.08	0.0496	1.748	0.2363	407.4732	4690.02
	SB3	46.85	18.96	19,907.08	0.0496	7.456	0.2363	1737.8087	32948.85
	SB4	25.60	10.36	19,907.08	0.0496	7.936	0.2363	1849.8698	19164.65
	SB5	10.67	4.32	19,907.08	0.0496	0.332	0.2363	77.4471	334.57
	Total	155.28	62.84						

Soil loss without mitigation measure

	Area	Area (ac)	Area (ha)	R	K	LS	VM	A or qc ton/ha.yr	E ton/yr
	SB1	43.71	17.690	19,907.08	0.0496	0.144	1.0000	141.672	2,506.17
	SB2	28.44	11.510	19,907.08	0.0496	0.149	1.0000	146.843	1,690.22
	SB3	46.85	18.960	19,907.08	0.0496	0.139	1.0000	136.948	2,596.53
	SB4	25.60	10.360	19,907.08	0.0496	0.139	1.0000	137.351	1,422.96
	SB5	10.67	4.320	19,907.08	0.0496	0.127	1.0000	125.469	542.03
	Total	155.28	62.84						

Soil loss with mitigation measure (90% Grassed)

	Area	Area (ac)	Area (ha)	R	K	LS	VM	A or qc ton/ha.yr	E ton/yr
	SB1	43.71	17.690	19,907.08	0.0496	0.511	0.11	54.422	962.90
	SB2	28.44	11.510	19,907.08	0.0496	0.221	0.11	23.497	270.45
	SB3	46.85	18.960	19,907.08	0.0496	0.176	0.11	18.792	356.30
	SB4	25.60	10.360	19,907.08	0.0496	0.197	0.11	20.957	217.12
	SB5	10.67	4.320	19,907.08	0.0496	0.193	0.11	20.608	89.02
	Total	155.28	62.84						

Sediment yield and resulted suspended solid concentration at existing landuse

Area	Area (ac)	E ton/yr	SDR (%)	Sediment Yield (tonne/yr) - Silt Trap Efficiency				Suspended Solid (mg/l)			
				0% No Silt Trap	25% Efficiency	50% Efficiency	90% Efficiency	0% No Silt Trap	25% Efficiency	50% Efficiency	90% Efficiency
SB1	43.71	20118.56	32.24	6490.49	4864.86	3243.24	1297.30	920.59	690.44	460.30	184.12
SB2	28.44	4690.02	26.62	1248.26	936.19	624.13	249.65	177.16	132.87	88.58	35.43
SB3	46.85	32948.85	35.14	11576.87	8682.65	5788.44	2315.37	1643.04	1232.28	821.52	328.61
SB4	25.60	19164.65	36.98	7090.59	5314.94	3543.30	1417.32	1005.76	754.32	502.88	201.15
SB5	10.67	334.57	19.87	66.47	49.85	33.23	13.29	9.43	7.08	4.72	1.89
Total	155.28	77256.66		26484.67	19848.51	13232.34	5292.93	3755.99	2816.99	1877.99	751.20
		497.53		170.43	127.82	85.22	34.09	24.19	18.14	12.09	4.84
		ton/ac.yr		ton/ac.yr	ton/ac.yr	ton/ac.yr	ton/ac.yr	ton/ac.yr	mg/ac.l	mg/ac.l	mg/ac.l

Sediment yield and resulted suspended solid concentration without mitigation measure

Area	Area (ac)	E ton/yr	SDR (%)	Sediment Yield (tonne/yr) - Silt Trap Efficiency				Suspended Solid (mg/l)			
				0% No Silt Trap	25% Efficiency	50% Efficiency	90% Efficiency	0% No Silt Trap	25% Efficiency	50% Efficiency	90% Efficiency
SB1	43.71	2,506.17	15.21	381.31	285.98	190.65	76.26	54.12	40.59	27.06	10.82
SB2	28.44	1,690.22	16.75	266.19	199.64	133.10	53.24	37.78	28.33	18.89	7.56
SB3	46.85	2,596.53	15.04	390.82	292.89	195.26	78.10	55.42	41.57	27.71	11.08
SB4	25.60	1,422.96	15.83	222.30	166.70	111.19	44.48	31.56	23.67	15.78	6.31
SB5	10.67	542.03	16.19	87.76	65.82	43.83	17.55	12.46	9.34	6.23	2.49
Total	155.28	8,757.92		1,348.17	1,011.13	674.08	269.63	191.34	143.50	95.67	38.27
		56.40		8.68	6.51	4.34	1.74	1.23	0.92	0.62	0.25
		ton/ac.yr		ton/ac.yr	ton/ac.yr	ton/ac.yr	ton/ac.yr	ton/ac.yr	mg/ac.l	mg/ac.l	mg/ac.l

Sediment yield and resulted suspended solid concentration with mitigation measure (90% Grassed)

Area	Area (ac)	E ton/yr	SDR (%)	Sediment Yield (tonne/yr) - Silt Trap Efficiency				Suspended Solid (mg/l)			
				0% No Silt Trap	25% Efficiency	50% Efficiency	90% Efficiency	0% No Silt Trap	25% Efficiency	50% Efficiency	90% Efficiency
SB1	43.71	962.90	19.94	191.97	143.98	95.99	38.39	27.26	20.45	13.62	5.45
SB2	28.44	270.45	17.12	46.31	34.73	23.16	9.26	6.57	4.93	3.29	1.31
SB3	46.85	356.30	15.83	56.39	42.29	28.20	11.28	8.00	6.00	4.00	1.60
SB4	25.60	217.12	16.82	36.52	27.39	18.26	7.30	5.18	3.89	2.59	1.04
SB5	10.67	89.02	17.70	15.76	11.82	7.63	3.15	2.24	1.68	1.12	0.45
Total	155.28	1,895.79		346.96	260.22	173.48	69.39	49.24	36.93	24.62	9.85
		12.21		2.23	1.68	1.12	0.45	0.32	0.24	0.16	0.06
		ton/ac.yr		ton/ac.yr	ton/ac.yr	ton/ac.yr	ton/ac.yr	ton/ac.yr	mg/ac.l	mg/ac.l	mg/ac.l

(Estimated Calculation for Overall Area Of Development)

Scenario	Area (ac)	Erosion, E ton/yr	Sediment Yield (tonne/yr)				Suspended Solid (mg/l)			
			No Silt Trap	25% Efficiency	50% Efficiency	90% Efficiency	No Silt Trap	25% Efficiency	50% Efficiency	90% Efficiency
1	155.28	77256.66	26484.67	19848.51	13232.34	5292.93	3755.99	2816.99	1877.99	751.20
2	155.28	8757.92	1348.17	1011.13	674.08	269.63	191.34	143.50	95.67	38.27
3	155.28	1895.79	346.96	260.22	173.48	69.39	49.24	36.93	24.62	9.85

(Estimated Calculation For 1 Acre Area Of Development)

Scenario	Erosion, E ton/yr/ac	Sediment Yield (tonne/yr/ha)				Suspended Solid (mg/l/ha)			
		No Silt Trap	25% Efficiency	50% Efficiency	90% Efficiency	No Silt Trap	25% Efficiency	50% Efficiency	90% Efficiency
1	497.53	170.432	127.82	85.22	34.086	24.163	18.141	12.094	4.83766
2	56.40	8.632	6.51	4.34	1.732	1.232	0.924	0.616	0.246
3	12.21	2.234	1.68	1.12	0.447	0.317	0.238	0.159	0.063

Soil Erodibility (K)

K = 2.1 x 10-6 (12 - OM) $M^{1.14}$ + 0.0325 (S - 2) + 0.025 (P - 3)

Vegetation management factor (VM) or C

VM = Canopy Subfactor x Mulch Subfactor x Bare Subfactor

Estimating K Factor

Area	k
Overall	0.0496

Area (ac)
155.28

VM = C x (1 - IA)

Area	Area (ac)	VM
SB1	17.69	0.2363
SB2	11.51	0.2363
SB3	18.96	0.2363
SB4	10.36	0.2363
SB5	4.32	0.2363
VMc	62.84	1.0000
VMp	62.84	0.1000

Assume that C=1(Bare Soil), 0.45(Establish Grass Cover)

Rainfall Intensity

Input from Jurutera JRK Sdn. Bhd.

(b) Determination of Q_{10}

Eq. 2.2

$$i = \frac{\lambda T^{\kappa}}{(d+\theta)^{\eta}} \qquad (2.2)$$

where,

i = Average rainfall intensity (mm/hr);

T = Average recurrence interval - ARI ($0.5 \leq T \leq 12$ month and $2 \leq T \leq 100$ year);

d = Storm duration (hours), $0.0833 \leq d \leq 72$; and

λ, κ, θ and η = Fitting constants dependent on the raingauge location (Table 2.B1 in Appendix 2.B).

Location & Station ID	ARI, T (years)	Storm duration 'd'	Derived Parameters			
			λ	K	θ	η
Johor Silica 1541139	10	12	59.060	0.202	0.128	0.660

$$Q_1 \quad \frac{C.^{10}I_{tc}.A}{360} \quad ; \qquad 196.25 \quad \text{mm/hr}$$

Source: Sediment basin Calculation, Jurutera JRK Sdn. Bhd., 2013.

196.25 mm/hr

LS Factor

Catchment were into divided to 10 area

S	<1	1<Slope<3	3<Slope<5	>5
m	0.2	0.3	0.4	0.5

$LS = (A / 22.13)^{m} (0.065 + 0.045S + 0.0065S^{2})$

Estimating LS factor existing condition **SpotLevel**

Area	X	Y_{max}	Y_{min}	Y	Slope length, A	Slope Gradient, S (%)	m	LS
SB1	214	46.64	20.85	25.79	215.5	12.05	0.5	4.879
SB2	293	29.08	13.84	15.24	293.4	5.20	0.5	1.748
SB3	231	46.67	13.29	35.38	233.7	15.32	0.5	7.456
SB4	180	53.45	22.60	30.85	182.6	17.14	0.5	7.936
SB5	118	20.45	17.80	2.65	118.0	2.25	0.3	0.332

slope existing

1
2
3
4
5

Estimating LS factor during site clearing **Slope ED**

Area	X	Y_{max}	Y_{min}	Y	Slope length, A	Slope Gradient, S (%)	m	LS
SB1	1038				1038	0.033	0.2	0.144
SB2	1155				1155	0.054	0.2	0.149
SB3	855				855	0.040	0.2	0.139
SB4	818				818	0.057	0.2	0.139
SB5	555				555	0.038	0.2	0.127

slope earthdrain

1 refer escp drawing
2
3
4
5

Estimating LS factor after development **Platform Level**

Area	X	Y_{max}	Y_{min}	Y	Slope length, A	Slope Gradient, S (%)	m	LS
SB1	1038	50.00	32.50	17.5	1038	1.69	0.3	0.511
SB2	1155	32.00	24.00	8	1155	0.69	0.2	0.221
SB3	855	25.00	21.50	3.5	855	0.41	0.2	0.176
SB4	818	27.00	22.00	5	818	0.61	0.2	0.197
SB5	555	24.00	20.00	4	555	0.72	0.2	0.193

slope proposed earthwork

1
2
3
4

K Factor

Catchment were into divided to 5 phase

$$K = 2.1 \times 10\text{-}6\ (12 - OM)\ M^{1.14} + 0.0325\ (S - 2) + 0.025\ (P - 3)$$

Assume organic matter, OM =	5	%
Assume Structure Class, S =	2	- Medium or coarse granular FRIM Technical Information Handbook No.25
Assume Permeability Class, P =	5	- Moderate FRIM Technical Information Handbook No.25
Assume Sand Content =	60	%
Assume Silt Content =	20	%
Assume Clay Content =	20	%

Refer SI report
Silt, Clay and Sand

Structure Class

S	Very fine	Fine	Medium	Massive
MSLE Code	1	2	3	4

Permeability Class

Permeability	<0.2	0.2-0.5	0.5-1.5	1.5-5.0	5.0-15	15-50
MSLE Code	6	5	4	3	2	1

	Surface Grain Size (%)								
P	Gravel	Sand	Silt	Clay	OM	M	S	P	K
1	10	60	15	15	0.05	6375.00	2	5	0.0496

Estimating K Factor

Area	K
#REF!	0.0496

All proposed area are similar in general and consider have the similar soil erodibility factor (k) for all cacthment area

Vm Factor

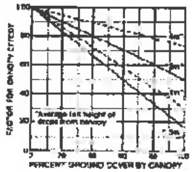

Figure 5a. [illegible]

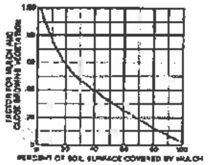

Figure 5b. [illegible] VM factor

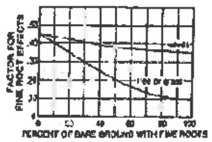

Figure 5c. Effects of [illegible] on the VM [illegible] values do [illegible] to cropland and construction sites

Assume based on picture reference above - Tree located scatterred at the boundary of the proposed site.

	Area	Canopy %	Mulch %	Root Cover %
1	SB1	30	10	5
2	SB2	30	10	5
3	SB3	30	10	5
4	SB4	30	10	5
5	SB5	30	10	5

VM = Canopy Subfactor x Mulch Subfactor x Bare Subfactor

Estimating VM Factor

	Area	Area	Area with canopy		Area with mulch		Fine Root		VM
		(ac)	(%)	Factor	(%)	Factor	(%)	Factor	
1	SB1	17.7	30	0.75	10	0.70	5	0.45	0.2363
2	SB2	11.5	30	0.75	10	0.70	5	0.45	0.2363
3	SB3	19.0	30	0.75	10	0.70	5	0.45	0.2363
4	SB4	10.4	30	0.75	10	0.70	5	0.45	0.2363
5	SB5	4.3	30	0.75	10	0.70	5	0.45	0.2363

VMc	62.84	0	1.00	0	1.00	0	1.00	1.0000
VMp	62.84	30	0.72	35	0.50	35	0.30	0.1080

VM = C x (1 - /A) C=1(Bare Soil), 0.45(Establish Grass Cover)

VMc construction
VMp Post development

SEDIMENT BASIN SIZE

Sediment Basin	Catchment (ha)	Side Slope (H):(V)	Total Depth (m)	Area W(m)	Area L (m)	Sediment y1 (m)	Sediment y2 (m)	Emergency 8 (m)	Emergency Hp (m)
SB1	17.69	2(H):1(V)	2.10	35.00	75.00	0.60	0.85	3.50	0.50
SB2	11.51	2(H):1(V)	2.00	70.00	140.00	0.80	0.80	8.00	0.60
SB3	18.96	2(H):1(V)	2.10	75.00	150.00	0.80	0.80	8.50	0.60
SB4	10.36	2(H):1(V)	2.10	50.00	100.00	0.75	0.75	4.50	0.60
SB5	4.32	2(H):1(V)	2.00	65.00	130.00	0.80	0.80	8.00	0.60