ANNEX

NATIONAL WATER QUALITY STANDARDS FOR MALAYSIA

PARAMETER	UNIT	CLASS				
		I	IIA/IIB	III#	IV	V
Al	mg/l		-	(0.06)	0.5	
As	mg/l		0.05	0.4 (0.05)	0.1	
Ba	mg/l		1	-	-	
Cd	mg/l		0.01	0.01* (0.001)	0.01	
Cr (IV)	mg/l		0.05	1.4 (0.05)	0.1	
Cr (III)	mg/l	N	-	2.5	-	L
Cu	mg/l	A	0.02	-	0.2	E
Hardness	mg/l	T	250	-	-	V
Ca	mg/l	U	-	-	-	E
Mg	mg/l	R	-	-	-	L
Na	mg/l	A	-	-	3 SAR	S
K	mg/l	L	-	-	-	
Fe	mg/l		1	1	1 (Leaf) 5 (Others)	A
Pb	mg/l	L	0.05	0.02* (0.01)	5	B
Mn	mg/l	E	0.1	0.1	0.2	O
Hg	mg/l	V	0.001	0.004 (0.0001)	0.002	V
Ni	mg/l	E	0.05	0.9*	0.2	E
Se	mg/l	L	0.01	0.25 (0.04)	0.02	
Ag	mg/l	S	0.05	0.0002	-	IV
Sn	mg/l		-	0.004	-	
U	mg/l	O	-	-	-	
Zn	mg/l	R	5	0.4*	2	
B	mg/l		1	(3.4)	0.8	
Cl	mg/l	A	200	-	80	
Cl_2	mg/l	B	-	(0.02)	-	
CN	mg/l	S	0.02	0.06 (0.02)	-	
F	mg/l	E	1.5	10	1	
NO_2	mg/l	N	0.4	0.4 (0.03)	-	
NO_3	mg/l	T	7	-	5	
P	mg/l		0.2	0.1	-	
Silica	mg/l		50	-	-	
SO_4	mg/l		250	-	-	
S	mg/l		0.05	(0.001)	-	
CO_2	mg/l		-	-	-	
Gross-α	Bq/l		0.1	-	-	
Gross-β	Bq/l		1	-	-	
Ra-226	Bq/l		< 0.1	-	-	
Sr-90	Bq/l		< 1	-	-	
CCE	g/l		500	-	-	-
MBAS/BAS	g/l		500	5000 (200)	-	-
O & G (Mineral)	g/l		40; N	N	-	-
O & G (Emulsified Edible)	g/l		7000; N	N	-	-
PCB	g/l		0.1	6 (0.05)	-	-
Phenol	g/l		10	-	-	-
Aldrin/Dieldrin	g/l		0.02	0.2 (0.01)	-	-
BHC	g/l		2	9 (0.1)	-	-
Chlordane	g/l		0.08	2 (0.02)	-	-
t-DDT	g/l		0.1	(1)	-	-
Endosulfan	g/l		10	-	-	-
Heptachlor/Epoxide	g/l		0.05	0.9 (0.06)	-	-
Lindane	g/l		2	3 (0.4)	-	-
2,4-D	g/l		70	450	-	-
2,4,5-T	g/l		10	160	-	-
2,4,5-TP	g/l		4	850	-	-
Paraquat	g/l		10	1800	-	-

Notes :

* = At hardness 50 mg/l $CaCO_3$
\# = Maximum (unbracketed) and 24-hour average (bracketed) concentrations
N = Free from visible film sheen, discolouration and deposits

NATIONAL WATER QUALITY STANDARDS FOR MALAYSIA

PARAMETER	UNIT	CLASS					
		I	IIA	IIB	III	IV	V
Ammoniacal Nitrogen	mg/l	0.1	0.3	0.3	0.9	2.7	> 2.7
Biochemical Oxygen Demand	mg/l	1	3	3	6	12	> 12
Chemical Oxygen Demand	mg/l	10	25	25	50	100	> 100
Dissolved Oxygen	mg/l	7	5 - 7	5 - 7	3 - 5	< 3	< 1
pH	-	6.5 - 8.5	6 - 9	6 - 9	5 - 9	5 - 9	-
Colour	TCU	15	150	150	-	-	-
Electrical Conductivity*	S/cm	1000	1000	-	-	6000	-
Floatables	-	N	N	N	-	-	-
Odour	-	N	N	N	-	-	-
Salinity	%	0.5	1	-	-	2	-
Taste	-	N	N	N	-	-	-
Total Dissolved Solid	mg/l	500	1000	-	-	4000	-
Total Suspended Solid	mg/l	25	50	50	150	300	300
Temperature	^{o}C	-	Normal + 2 ^{o}C	-	Normal + 2 ^{o}C	-	-
Turbidity	NTU	5	50	50	-	-	-
Faecal Coliform**	count/100 ml	10	100	400	5000 (20000)[a]	5000 (20000)[a]	-
Total Coliform	count/100 ml	100	5000	5000	50000	50000	> 50000

Notes :

N : No visible floatable materials or debris, no objectional odour or no objectional taste
* : Related parameters, only one recommended for use
** : Geometric mean
a : Maximum not to be exceeded

WATER CLASSES AND USES

CLASS	USES
Class I	Conservation of natural environment. Water Supply I – Practically no treatment necessary. Fishery I – Very sensitive aquatic species.
Class IIA	Water Supply II – Conventional treatment required. Fishery II – Sensitive aquatic species.
Class IIB	Recreational use with body contact.
Class III	Water Supply III – Extensive treatment required. Fishery III – Common, of economic value and tolerant species; livestock drinking.
Class IV	Irrigation
Class V	None of the above.

DOE WATER QUALITY CLASSIFICATION BASED ON WATER QUALITY INDEX

SUB INDEX & WATER QUALITY INDEX	INDEX RANGE		
	CLEAN	SLIGHTLY POLLUTED	POLLUTED
Biochemical Oxygen Demand (BOD)	91 - 100	80 - 90	0 - 79
Ammoniacal Nitrogen (NH$_3$-N)	92 - 100	71 - 91	0 - 70
Suspended Solids (SS)	76 - 100	70 - 75	0 - 69
Water Quality Index (WQI)	81 - 100	60 - 80	0 - 59

DOE WATER QUALITY INDEX CLASSIFICATION

PARAMETER	UNIT	CLASS				
		I	II	III	IV	V
Ammoniacal Nitrogen	mg/l	< 0.1	0.1 – 0.3	0.3 – 0.9	0.9 – 2.7	> 2.7
Biochemical Oxygen Demand	mg/l	< 1	1 – 3	3 – 6	6 – 12	> 12
Chemical Oxygen Demand	mg/l	< 10	10 – 25	25 – 50	50 – 100	> 100
Dissolved Oxygen	mg/l	> 7	5 – 7	3 – 5	1 – 3	< 1
pH	-	> 7.0	6.0 – 7.0	5.0 – 6.0	< 5.0	> 5.0
Total Suspended Solid	mg/l	< 25	25 – 50	50 – 150	150 – 300	> 300
Water Quality Index (WQI)		> 92.7	76.5 – 92.7	51.9 – 76.5	31.0 – 51.9	< 31.0

WQI FORMULA AND CALCULATION

FORMULA

WQI = (0.22 * SIDO) + (0.19 * SIBOD) + (0.16 * SICOD) + (0.15 * SIAN) + (0.16 * SISS) + (0.12 * SIpH)

where;
  SIDO   = Subindex DO (% saturation)
  SIBOD = Subindex BOD
  SICOD = Subindex COD
  SIAN   = Subindex NH_3-N
  SISS   = Subindex SS
  SIpH   = Subindex pH
  $0 \leq WQI \leq 100$

BEST FIT EQUATIONS FOR THE ESTIMATION OF VARIOUS SUBINDEX VALUES

Subindex for DO (in % saturation)

SIDO = 0	for $x \leq 8$
SIDO = 100	for $x \geq 92$
SIDO = -0.395 + 0.030x^2 - 0.00020x^3	for $8 < x < 92$

Subindex for BOD

SIBOD = 100.4 - 4.23x	for $x \leq 5$
SIBOD = 108 * exp(-0.055x) - 0.1x	for $x > 5$

Subindex for COD

SICOD = -1.33x + 99.1	for $x \leq 20$
SICOD = 103 * exp(-0.0157x) - 0.04x	for $x > 20$

Subindex for NH3-N

SIAN = 100.5 - 105x	for $x \leq 0.3$
SIAN = 94 * exp(-0.573x) - 5 * I x – 2 I	for $0.3 < x < 4$
SIAN = 0	for $x \geq 4$

Subindex for SS

SISS = 97.5 * exp(-0.00676x) + 0.05x	for $x \leq 100$
SISS = 71 * exp(-0.0061x) - 0.015x	for $100 < x < 1000$
SISS = 0	for $x \geq 1000$

Subindex for pH

SIpH = 17.2 - 17.2x + 5.02x^2	for $x < 5.5$
SIpH = -242 + 95.5x - 6.67x^2	for $5.5 \leq x < 7$
SIpH = -181 + 82.4x - 6.05x^2	for $7 \leq x < 8.75$
SIpH = 536 - 77.0x + 2.76x^2	for $x \geq 8.75$

*Note: * means multiply with*

MWQI FORMULA AND CALCULATION

MWQI = SI $DO^{0.2}$ x SI $NH_3^{0.16}$ x SI $FC^{0.14}$ x SI $TSS^{0.14}$ x SI $O\&G^{0.13}$ x SI $NO_3^{0.12}$ x SI $PO_4^{0.11}$
where;
SIDO   = Subindex Dissolved Oxygen
SINH3   = Subindex Unionized Ammonia
SIFC   = Subindex Faecal Coliform
SITSS   = Subindex Total Suspended Solids
SIO&G   = Subindex Oil and Grease
$SINO_3$ = Subindex Nitrate
$SIPO_4$ = Subindex Phosphate
$0 \leq MWQI \geq 100$

BEST FIT EQUATIONS FOR THE ESTIMATION OF VARIOUS SUBINDEX VALUES

Dissolved Oxygen (DO) in mg/L

For DO between 3 and 7

$SI(DO) = -85.816 + 55.476(DO) – 4.142(DO)^2$

If DO is less than 3, or more than 10, SI = 10%

Ammonia (Unionized) (NH_3) in mg-N/L*

$SI(NH_3) = 100exp\text{-}4.6(NH_3)$

* If Ammoniacal Nitrogen (NH_3+-N) is measured, convert the value into unionized ammonia.

Faecal Coliform (FC) in MPN/100ml

$SI(FC) = 100exp^{-0.005(FC)}$

If FC $\geq$ 500 MPN, SI = 8%

Total Suspended Solids (TSS in mg/L)

$SI(TSS) = 95.8exp^{-0.0043(TSS)}$

If TSS > 100 mg/L, SI = 20%

Oil & Grease (OG) in mg/L

$SI(OG) = 98exp-0.21(OG)$

Nitrate (NO$_3$) in mg-N/L

$SI(NO_3) = 94.83exp^{-0.35(NO3)}$

Phosphate (PO$_4$) in mg-P/L

$SI(PO_4) = 95.2exp^{-0.002(PO4*1000)}$

UNIONIZED AMMONIA CALCULATION

In order to convert the concentration of total ammoniacal nitrogen into unionized ammonia, calculate (a), (b), (c) and (d). Substitute the results into equation 1.

a. Calculation of Ionic Strength (IS)

$$IS = \frac{19.9273*Salinity}{(1000 - 1.005109*Salinity)}$$

Salinity in part per thousand (ppt)

b. Calculation of PKa
$$PKa = (0.0901821 + \frac{2729.92}{(Temp+273.15)}) + IS(0.1552-0.000314*Temp)$$
Temperature in °C

c. Calculation of working pH
$$pH_{sw} = pH - (0.0007 \times IS) - 0.131$$

d. Calculation of mole fraction for unionized ammonia
$$Mole\ Fraction = \frac{1}{1+10^{(PKa-pHsw)}}$$

Equation:

Unionized ammonia = Total ammoniacal nitrogen x mole fraction

Total ammoniacal nitrogen should be measured in µg/l