



Ministry of Energy, Science, Technology,
Environment & Climate Change

MALAYSIAN MARINE WATER QUALITY STANDARDS AND INDEX

Photo By : Naqibah Rosli



DEPARTMENT OF ENVIRONMENT

PREFACE

A major element in the effective management of the nation's rich and diverse marine resources is the determination of its water quality characteristics with respect to a variety of environmental values and beneficial uses. In this regard, the development of relevant water quality criteria and standards appropriate to the protection of ecological functions and the sustainable use of marine resources is essential in order to allow for the assessment of marine waters.

This booklet represents an informative summary of a study commissioned by the Department of Environment under the 11th Malaysia Plan entitled *Study on the Review of the Marine Water Quality Criteria and Standards*.

In addition to the application of the Malaysian Marine Water Quality Standards (MMWQS) related to: Class 1 - Sensitive Marine Habitats, Class 2 - Fisheries (including Mariculture), Class 3 - Industry, Commercial Activities & Coastal Settlements, Class E (Interim) - Estuaries and Class R - Recreation, this booklet also provides the basis for the formulation of the Malaysian Marine Water Quality Index (MMWQI). The index allows for a convenient means to assess and report the prevailing marine water quality and its appropriateness to its designated environmental values and beneficial uses.

It is my sincere hope that the information contained in this booklet would provide a better understanding and appreciation of the basis and applications of the MMWQS and the MMWQI to all stakeholders related to the preservation and management the nation's marine waters.



DATO' DR AHMAD KAMARULNAJUJIB BIN CHE IBRAHIM
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Department of Environment Malaysia



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INTRODUCTION

Malaysia has a relatively long coastline and numerous islands all of which contribute to the abundant and diverse marine resources of the nation. Indeed, the nation's marine resources are of one of the most diverse and richest in the world. At the same time, the marine environment is also susceptible to a variety of land-based as well as sea-based sources of pollution that can lead to a degradation of water quality.

One of the key elements in environmental management, including the management of the marine environment, is the monitoring of environmental quality. In that context, data generated from monitoring activities of ambient waters are used to assess the health of the ecosystem, as well as the suitability of the water quality with respect to specific beneficial uses.

Water quality standards are an essential means to assess the suitability of a water body for specific beneficial uses and/or to sustain specific ecosystems. These standards comprise numerative or narrative threshold values of numerous water quality parameters deemed relevant to the beneficial uses of interest and/or to the protection of ecosystem health. Exceedance or deviation from these values imply that the corresponding beneficial use/ecosystem health has been compromised to some degree.

While it is necessary to monitor all the relevant water quality characteristics in order to make an accurate assessment, it is also useful to provide an indicator of water quality data that can be conveniently used for the general public. This is achieved by the use of a Water Quality Index.

The Malaysian Marine Water Quality Standards (MMWQS) is used principally for the protection of the rich and diverse marine ecosystems of the nation while the Malaysian Marine Water Quality Index (MMWQI) represents a convenient means of communicating water quality status of marine waters not only to relevant stakeholders, but also to the general public.

Designed to introduce and provide guidance to the application of the MMWQS and the MMWQI, this booklet is aimed at relevant government agencies, NGOs, community-based organizations and other stakeholders.



MALAYSIAN MARINE WATER QUALITY STANDARDS

The Malaysian Marine Water Quality Standards (MMWQS) are ambient standards, developed with a focus on the protection of aquatic biodiversity and related ecological functions of marine waters. The overall goals of the MMWQS, consistent with the Water Quality Objectives, are to protect and sustain ambient aquatic ecosystems and the services those ecosystems provide to society and to accomplish it in an economical, practical and socially relevant manner.

The application of the MMWQS is based on a pre-determined classification of the marine waters of interest. MMWQS comprises five classes:

CLASS 1 Sensitive Marine Habitats



CLASS 2 Fisheries (Including Mariculture)

CLASS 3 Industry, Commercial Activities & Coastal Settlements



CLASS E (Interim) Estuaries

CLASS R Recreation



Class 1: Sensitive Marine Habitats

Class 1 represents the most stringent set of standards consistent with the level of protection required of sensitive marine habitats. Class 1 waters comprises the following:

i) Gazetted & Statutory Protected Waters

These are marine waters that are legally demarcated for special protection and management or marine waters that are subjected to some form of statutory or legislative protection. Examples include (but are not limited to) the following:

- Marine Protected Areas : Marine Parks and Fisheries Prohibited Areas
- State parks
- Ramsar sites
- Other marine protected areas

ii) Un-gazetted waters

These are patches of sensitive marine habitats that require special protection afforded by Class I standards. Examples include (but not limited to) the following:

- Coral reefs
- Seagrass
- Turtle landing route & sites
- Waters related to specific habitats/feeding grounds/species

Class 2: Fisheries (Including Mariculture)

Class 2 encompasses both fisheries and mariculture activities, identified based on the fishing zones established by the Department of Fisheries as a guide. Its waters comprises the conservation zone (notwithstanding 'Fisheries Prohibited Areas') right up to the EEZ. Mariculture activities defined are those within the marine water body (such as marine cage culture and cockle farming) and excludes on-land aquaculture activities.

The standards associated with Class 2 are related to the protection of aquatic ecosystems, in addition to considerations of impact on human health related to the consumption of tainted/contaminated sea food.

Class 3: Industry, Commercial Activities & Coastal Settlements

Class 3 is the standard for marine waters that is exposed to direct discharge of effluent from anthropogenic activities. Hence, the ecosystems in these waters are subjected to some degree of degradation. Examples of such activities that have the potential to impact the health of marine ecosystems are provided below:

- Ports, jetties, marinas
- Power plants
- Mineral exploitation
- Hotels & resorts
- Coastal settlements
- Oil & gas exploration and production activities
- Shipyards
- Land based aquaculture
- Land-reclamation activities

The corresponding level of protection is therefore aimed at sustaining the health of the remaining ecosystems and to improve the overall water quality of the affected areas.

Class E (Interim): Estuaries

Class E (Interim) is the standard for estuarine waters subjected to both seasonal and diurnal variations. In addition, the geological characteristics and water circulation patterns also contribute to the dynamic nature of these waters. Based on these natural variabilities, the standard derived from the water quality characteristics of estuarine waters deemed to represent relatively undisturbed environment. These sites, which are referred to as Reference Sites, are selected to represent the three major estuary types in Malaysia.

Hence, Class E1 is taken to be representative of coastal plain, Class E2 represents the lagoon type estuary while Class E3 is to be referred to when assessing estuaries with large and complex distributary network.





Class E1: Coastal Plain (Sg. Bernam)



Class E2: Lagoon (Setiu)

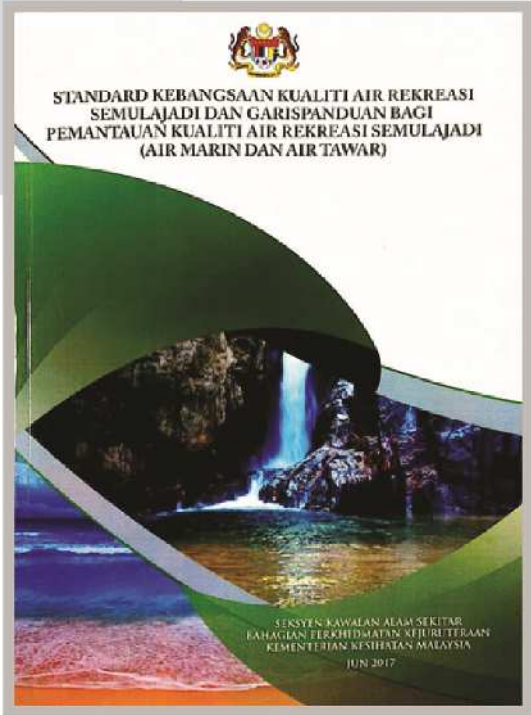


Class E3 :Complex Distributary Network (Sg. Rajang)

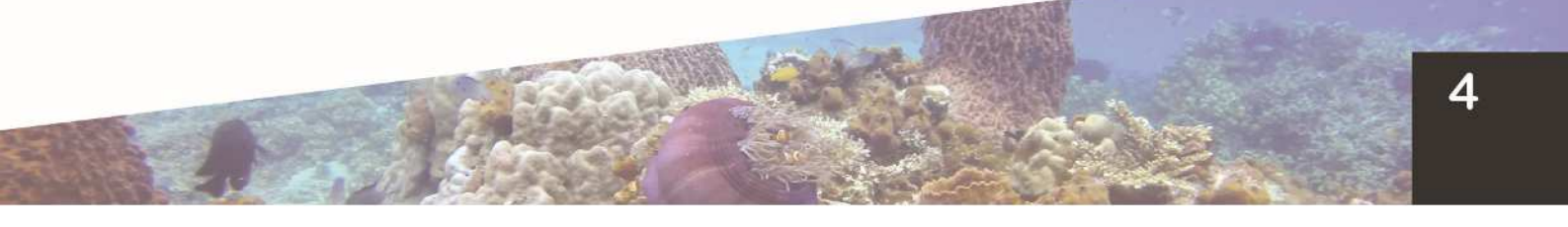
As these sets of standards require further extensive research, Class E is to be considered as interim standards. The types of estuaries are as shown above.

Class R: Recreation

Class R is the standards for recreational use of marine waters. It refers to the *Standard Kebangsaan Kualiti Air Rekreasi Semulajadi dan Garispanduan bagi Pemantauan Air Rekreasi Semulajadi (Air Marin & Air Tawar)* published by the Ministry of Health, Malaysia. Standards for both primary and secondary body contact is defined in this document.



Source: Ministry of Health Malaysia, 2017



MALAYSIAN MARINE WATER QUALITY STANDARDS (MMWQS)

PARAMETER ($\mu\text{g/l}$) unless otherwise stated	CLASSIFICATION					
	CLASS 1	CLASS 2	CLASS 3	INTERIM CLASS E1	INTERIM CLASS E2	INTERIM CLASS E3
	Sensitive Marine Habitats	Fisheries (including Mariculture)	Industry, Commercial Activities & Coastal Settlements	Estuaries		
				Coastal Plain	Lagoon	Complex Distributary Network
Dissolved Oxygen (mg/l)	>6.0	>5.0	>3.0	>5.0	>5.0	>5.0
Total Suspended Solids (mg/l)	25.0	50.0	100.0	30.0	30.0	30.0
Phosphate	5.0	75.0	670.0	100.0	180.0	180.0
Nitrate	10.0	60.0	700.0	200.0	570.0	430.0
Ammonia	35.0	50.0	320.0	5.0	10.0	10.0
Mercury	0.04	0.04	0.04	0.04	0.04	0.04
Cadmium	0.50	2.00	3.00	1.00	1.00	1.00
Chromium (VI)	0.14	10.00	20.00	10.00	10.00	10.00
Copper	1.30	2.90	8.00	1.00	1.00	1.00
Cyanide	2.00	7.00	14.00	5.00	5.00	5.00
Lead	2.20	8.50	12.00	1.30	2.00	2.00
Zinc	7.00	50.00	100.00	16.00	5.00	5.00
Arsenic (III)	1.00	3.00	3.00	3.00	1.00	1.00
Aluminium	27.00	27.00	55.00	27.00	27.00	27.00
TBT	0.001	0.010	0.050	0.002	0.002	0.002
PAH	100.0	200.0	1000.0	5.0	5.0	5.0
Total Phenol	1.0	10.0	100.0	10.0	10.0	10.0
Oil & Grease mg/l	0.01	0.14	5.00	1.00	1.00	1.00
Faecal Coliform (Cfu/100ml)	70	70	70	70	70	70
Temperature ($^{\circ}\text{C}$)	$\leq 2^{\circ}\text{C}$ increase over maximum ambient					
pH	6.5 - 9.0					
Marine litter	Free from marine litter					



**MALAYSIAN MARINE WATER QUALITY STANDARDS (MMWQS)
SUPPLEMENTARY LIST
(Pesticide)**

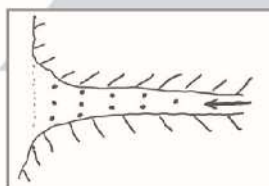
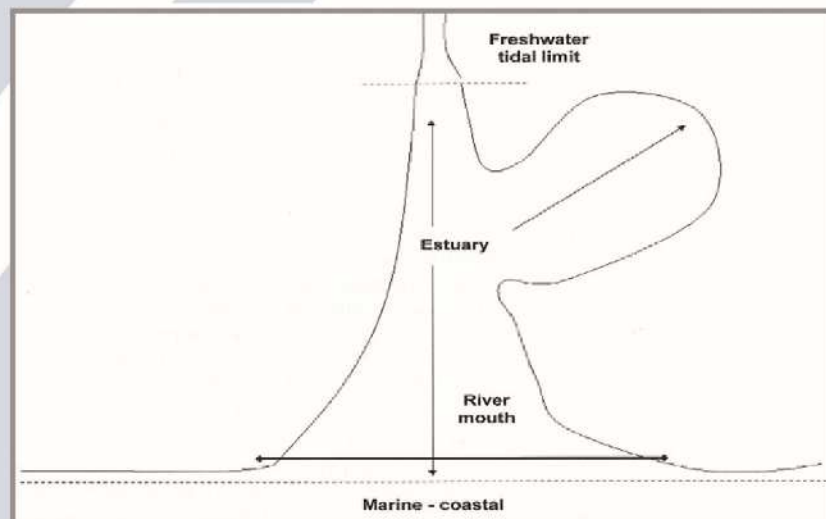
PESTICIDE TYPE	ACTIVE INGREDIENT	STANDARD (µg/l)
Herbicide	Atrazin	10
	Bentazone	5000
	2,4 D	200
	2,4 D (ester)	10
	Diuron	0.2
	Metolachlor	0.020
Insecticide	Paraquat	0.5
	Carbaryl	5.7
	Chloropyrifos	0.011
	Dichlorvos	0.6
	Dimethoate	1
	Malathion	0.5
	Temephos	0.0004

GUIDANCE NOTES

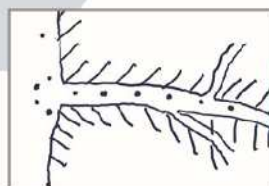
- i. The application of the MMWQS is based on a predetermined classification of the marine waters of interest.
- ii. The process of classification should not result in the application of a class of lower water quality compared to the existing ambient water quality.
- iii. In situations where there exists the possible application of more than one class, the more stringent class should take precedent.
- iv. In situations where the adjacent body of water is subjected to a more stringent water quality requirement compared to the waters of interest, then the class with the more stringent water quality requirement shall apply.
- v. Application of standards imposed in EIA approval conditions shall take precedent over any classification.
- vi. The proper and meaningful application of the MMWQS requires that the corresponding ambient data is generated by employing the appropriate standard methods of water sampling protocols, *in situ* measurements and analysis. Special considerations should be taken into account with respect to the application of Class E¹
- vii. The analytical methodology² to be adopted for the determination of the respective MMWQS parameters is required to comply to the following criteria:
 - Represents a recognized standard method such as those published by APHA, USEPA or other equivalent sources.
 - Allows for a Level of Reporting (LoR) equal or less than the corresponding threshold value of the respective MMWQS parameter.
 - Conducted at a laboratory accredited for the respective MMWQS parameter.
- viii. Class R³
 The *Standard Kebangsaan Kualiti Air Rekreasi Semulajadi dan Garispanduan bagi Pemantauan Air Rekreasi Semulajadi (Air Marin & Air Tawar)*², Ministry of Health, Malaysia, is applied in relation to recreational use of marine waters.
- ix. Application of standards related to pesticide residues as presented in the Supplementary List is most relevant in estuarine waters and waters in the vicinity of agricultural areas.

1 Advisory notes on the application of Interim Class E

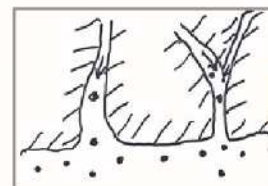
- a. Application of Class E (Interim) requires selection of most appropriate Reference Site to be used for assessment of the waters of interest
- b. Particular care needs to be exercised in the sampling works, specifically with regards to the following:
 - Sampling location in relation to the tidal zone
 - Time of sampling with respect to the tidal cycle
 - Salinity at time of sampling should be 10-25 ppt
- c. Application of Class E require special considerations in the presence of man-made structures such as breakwater
- d. Sampling requirements:



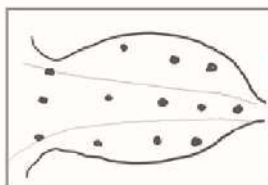
Long Tidal River



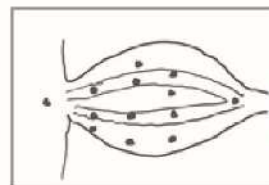
Narrow Tidal River



Coastal



Estuary of Bay, wide open mouth



Narrow Inlet

Guidance in establishing sampling locations in estuaries such as those recommended in the *ASEAN Marine Water Quality: Management Guidelines & Monitoring Manual*, ASEAN Secretariat, 2008 are to be referred to.

²Advisory notes on the methods of analysis

The appropriate standard analytical methods are to be employed, corresponding to a Limit of Reporting (LoR) that is equal or lower than the respective standards. With respect to oil & grease, the recommended method of analysis is APHA 5520B or equivalent with a LoR of 1 mg/L. Waters exhibiting detectable level of oil & grease is recommended to be assessed for Total Petroleum Hydrocarbons (TPH) and other detailed analysis if appropriate.

³STANDARD KEBANGSAAN KUALITI AIR REKREASI SEMULAJADI BAGI PARAMETER PRIMA

NO.	Parameter	Unit	Standard	
			Marine Water	
			Primary Contact	Secondary Contact
Microbial				
1.	Enterococci	Count/100 ml	35 ^c	230 ^c
2.	Faecal Coliforms	Count/100 ml	100 ^b	1000 ^c
3.	Leptospira species	-	Not Detected	
Nuisance Algae				
4.	Cyanobacteria	Cyanobacteria Cells/ml	15000 ^c	15000 ^c
Physical and Chemical				
5.	pH	-	5.0 – 9.0 ^c	5.0 – 9.0 ^c
6.	Temperature	°C	15 – 35 ^c	15 – 35 ^c
Aesthetics				
7.	Colour	TCU	-	-
8.	Turbidity	NTU	-	-
9.	Dissolved oxygen (DO)	mg/l	-	-
10.	Total dissolved solid (TDS)	mg/l	1000 ^f	1000 ^f

^bASEAN

^cANZECC

^fPiawai Mutu Air Minum Kebangsaan, KKM

Note: Please refer to the *Standard Kebangsaan Kualiti Air Rekreasi Semulajadi dan Garispanduan bagi Pemantauan Air Rekreasi Semulajadi (Air Marin & Air Tawar)*, Ministry of Health, Malaysia for the standards related to Secondary Parameters as well as other information pertaining to the application of the standards and management of recreational waters.

MALAYSIAN MARINE WATER QUALITY INDEX

The Malaysian Marine Water Quality Index (MMWQI) is aimed at providing water quality information in a convenient and concise manner to all stakeholders related to protecting and preserving the marine environment.

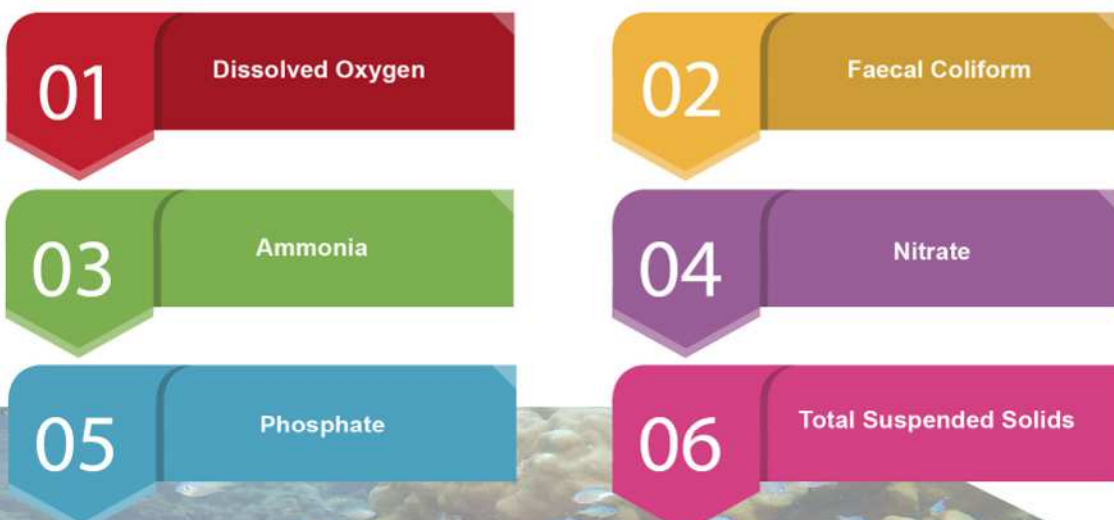
The MMWQI is formulated based on an arithmetic approach. It encompasses a selective set of water quality parameters deemed most relevant to the prevailing water quality status of the marine waters. The parameters chosen are based on the following criteria:

Considered to be the key parameters that are relevant to the protection of the designated environmental values and beneficial uses

Sensitive to the index; significant changes in the value of the parameter results in significant changes in the index

Routinely measured in a monitoring program

The water quality parameters chosen to represent the MMWQI are:



As the chosen parameters differ in their respective degree of effects on the beneficial uses and protection needs of aquatic ecosystems, a weightage factor is associated with each parameter. Assignment of weight is based on a severity rating for the designated protection needs.

The MMWQI is calculated as follows:

$$\text{MMWQI}^* = q_{i\text{DO}}^{0.18} \times q_{i\text{FC}}^{0.19} \times q_{i\text{NH}_3}^{0.15} \times q_{i\text{NO}_3}^{0.16} \times q_{i\text{PO}_4}^{0.17} \times q_{i\text{TSS}}^{0.15}$$

Whereby,

$q_{i\text{DO}}$	=	$-85.816 + 55.4768(\text{DO}) - 4.142(\text{DO}^2)$	When DO is < 3 mg/l, $q_{i\text{DO}}$	= 10
			When DO is > 10 mg/l, $q_{i\text{DO}}$	= 10
$q_{i\text{FC}}$	=	$100 * \text{EXP}^{-0.005(\text{Faecal coliform})}$	IF FC > 500 Faecal coliform count/100ml, $q_{i\text{FC}}$	= 8
$q_{i\text{NH}_3}$	=	$100 \text{EXP}^{-0.0046(\text{Unionized Ammonia})}$		
$q_{i\text{NO}_3}$	=	$94.8 \text{EXP}^{-0.00035(\text{Nitrate})}$		
$q_{i\text{PO}_4}$	=	$95.2 \text{EXP}^{-0.002(\text{Phosphate})}$	When $\text{PO}_4 > 900 \mu\text{g/l}$, $q_{i\text{PO}_4}$	= 10
$q_{i\text{TSS}}$	=	$95.8 \text{EXP}^{-0.0043(\text{Total Suspended Solid})}$	When TSS > 100 mg/l, $q_{i\text{TSS}}$	= 20

*Salinity of the marine water quality data shall be higher than 10 ppt

The index will then be referring to its respective classification:

MMWQI	CLASS
90 - 100	Excellent
80 - 89	Good
50 - 79	Moderate
0 - 49	Poor

Given the limitation of an index to represent the overall water quality of a water body it is advised that the MMWQI is read together with other data representing other parameters that may indicate non-compliance and more specific pollution issues of potential concern.



NOTE



NOTE





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