



# The Regional Organization for Conservation of the Environment of the Red Sea and Gulf of Aden

## Trainer Booklet



## Manual for Monitoring Indicators of the Impact of Wastewater Discharge on Coral Reefs



**Regional Organization for Conservation of the Environment of the Red Sea and Gulf of Aden “PERSGA” is an intergovernmental organization dedicated to the conservation of the coastal and marine environments in the Region.**

Legal basis of PERSGA stems from Article XVI of the Regional Convention for Conservation of the Red Sea and Gulf of Aden, known as Jeddah Convention, signed in Jeddah, Kingdom of Saudi Arabia in 1982: PERSGA Member States are Djibouti, Egypt, Jordan, Saudi Arabia, Somalia, Sudan and Yemen.

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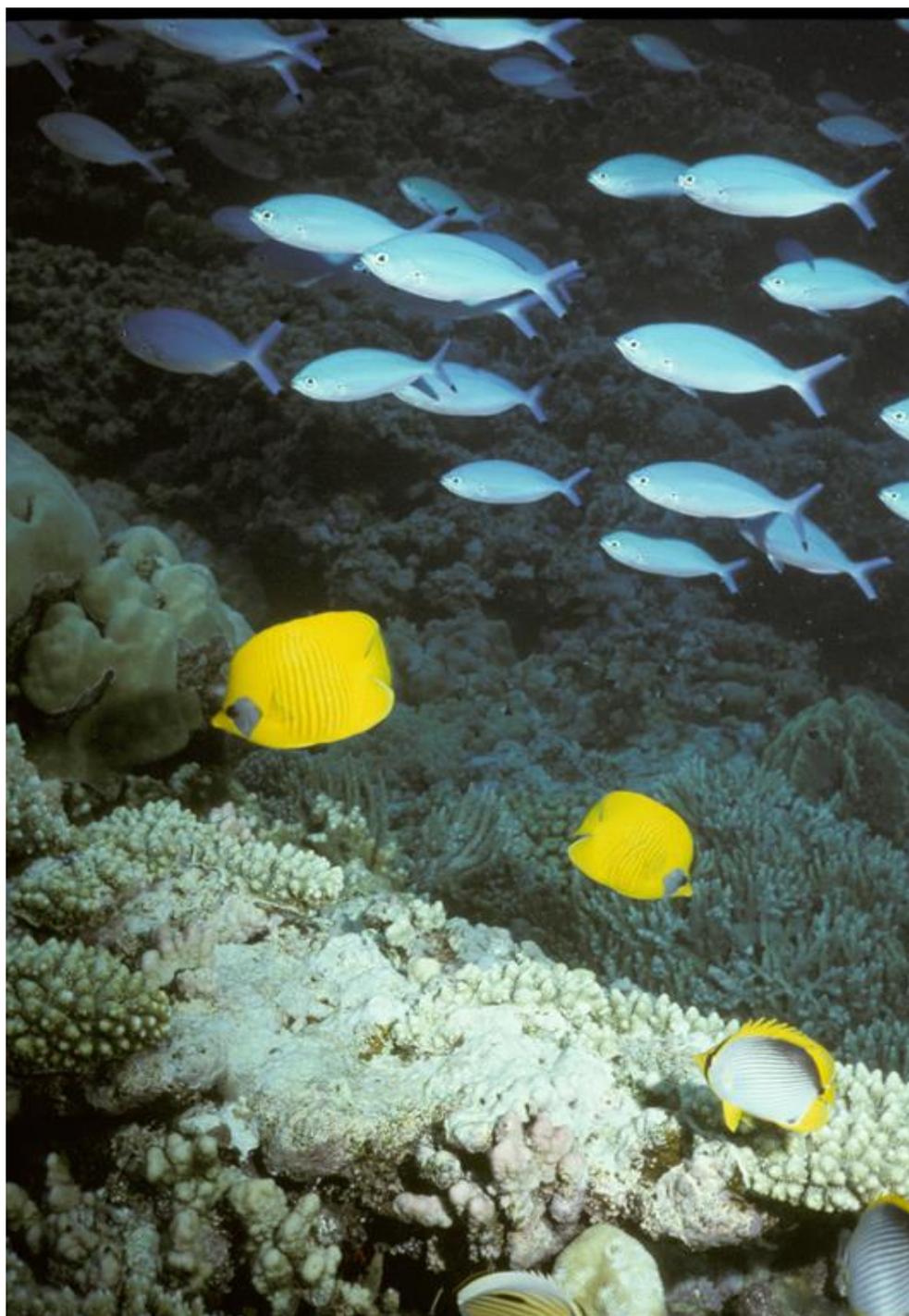
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**MANUAL FOR MONITORING INDICATORS OF THE IMPACT OF  
WASTEWATER DISCHARGE ON CORAL REEFS  
MODULE 1 : PURPOSE AND KEY TERMS**



Outer Farasan Bank 1980's



## JUSTIFICATION FOR THIS MANUAL

### Importance of Coral Reefs

Whilst there is some objective evidence of the importance of healthy coral reefs to supporting social and economic development within the Red Sea and Gulf of Aden there is more subjective evidence including the numbers employed in the fisheries sector in the countries of the region, the large size of the marine tourism sector particularly within Egypt and the level of compensation payments made for ship groundings on coral reefs<sup>1</sup>. Indeed the reason for collecting objective information on the value of coral reefs using this manual, and other relevant tools, is to provide evidence for advocacy for action leading to more effective management.

In global terms the importance of coral reefs can be summarized as:

#### - **Economic**

*“Economic valuation of ecosystems needs to be treated with caution but annual values per km<sup>2</sup> have been calculated at US\$100 000-600 000 for reefs...<sup>2</sup>”.*

#### - **Food security**

*“A healthy, well-managed reef can yield between 5 and 15 tons of fish and seafood per square kilometer per year.<sup>3</sup>”*

#### - **Biodiversity**

*“Coral reefs are not only major storehouses of incredible biodiversity (32 of the 34 recognised animal Phyla are found on coral reefs compared to 9 Phyla in tropical rainforests) ...<sup>4</sup>”.*

<sup>1</sup> PERSGA. 2009. Guidelines for Compensation Following Damage to Coral Reefs by Ship or Boat Grounding. Part 1. PERSGA Technical Series Number 15. PERSGA, Jeddah. [http://www.persga.org/Files///Common/Flipping\\_Books\\_Downloads/Guidelines\\_for\\_Compensation\\_Following\\_Damage\\_to\\_Coral\\_Reefs\\_by\\_Ship\\_Grounding.pdf](http://www.persga.org/Files///Common/Flipping_Books_Downloads/Guidelines_for_Compensation_Following_Damage_to_Coral_Reefs_by_Ship_Grounding.pdf)

<sup>2</sup> UNEP-WCMC (2006) In the front line: shoreline protection and other ecosystem services from mangroves and coral reefs. UNEP-WCMC, Cambridge, UK 33 pp.

<sup>3</sup> Burke, L., K. Reytar, M. Spalding and A. Perry. 2011. Reefs at Risk Revisited. World Resources Institute. Washington DC. 114 pp

<sup>4</sup> Wilkinson, C.R. (Editor), 2002. Status of coral reefs of the world. Global Coral Reef Monitoring Network (GCRMN), Australian Institute of Marine Science (AIMS), Townsville, Australia.



*“Although they occupy less than one quarter of 1 percent of the marine environment, coral reefs are home to more than a quarter of all known marine fish species.”<sup>5</sup>*

## **Significance of Wastewater**

There is some objective evidence of the significance of wastewater on society, economy and the environment within the Red Sea and Gulf of Aden<sup>6</sup>. This evidence includes the significant investment in wastewater treatment in the region to maintain human health. However, evidence of the impact of wastewater on coral reefs is more subjective. Indeed the reason for collecting objective information on the linkages between wastewater and coral reefs using this manual, and other relevant tools, is to provide evidence for advocacy for action leading to more effective management.

## **Policy justification**

### **2030 Agenda for Sustainable Development**

The 2030 Agenda for Sustainable Development adopted in September 2015<sup>7</sup> updates the millennium development goals. It contains seventeen (17) goals all have which have some relevance to this manual but two of which, goal 6 and goal 14 are of particular relevance to this manual.

Goal 6 is *“Ensure availability and sustainable management of water and sanitation for all”*. The manual aims to enhance capacity to deliver all the targets for this goal but two targets, target 6.3 and 6.6, are particularly relevant. Target 6.3 includes the requirement that water quality be improved by 2030 and target 6.6 includes the requirement that water-relates ecosystems, including wetlands (though coral reefs are not mentioned) be protected and restored by 2020.

Goal 14 is *“Conserve and sustainably use the oceans, seas and marine resources for sustainable development”*. The manual aims to enhance capacity to deliver all the targets for this goal but targets 14.1 and 14.2 are particularly relevant. Target 14.1 requires that marine pollution of all kinds be significantly

<sup>5</sup> Cited in: Bryant, D., L. Burke, J. McManus and M. Spalding, 1998. Reefs at Risk: A map-based indicator of threats to the world’s coral reefs. World Resources Institute. 56pp.

<sup>6</sup> PERSGA (2014). Regional Workshop on Wastewater Management and Pollution Loads Assessment in Coastal Cities of the Red Sea and Gulf of Aden. June 16th – 18th 2014, Jeddah, Saudi Arabia. Regional Organisation for the Conservation of the Environment of the Red Sea and Guf of Aden (PERSGA).



reduced by 2030. Target 14.2 requires that marine and coastal ecosystems be sustainably managed to avoid significant adverse impacts. As indicated above coral reefs are a significant component of tropical marine and coastal ecosystems.

### **The Manila Declaration 2012**

The Manila Declaration 2012 identifies wastewater as a priority source category of land-based pollution in the marine environment. Coral reefs are vulnerable to wastewater pollution, which poses a threat both to coral reef ecosystem health and to the health and wellbeing of people that depend on their ecosystem services. However, awareness of wastewater pollution impacts of coral reefs are limited, monitoring of wastewater pollution and its impacts remains weak in most reef regions, and many island countries, especially in the Pacific, are on a path to miss the sanitation target of the Millennium Development Goals.....<sup>8</sup>.

### **PERSGA Wastewater Management Project**

This manual for monitoring indicators of the impact of wastewater discharge on coral reefs is delivered under the “*Wastewater Management and Pollution Loads Assessment in Coastal Cities of PERSGA Region Project*” which contributes to implementation of two UNEP projects: 321.2 “*Global Coral Reef Partnership*” and in particular Output A: Indicators, methods, planning tools and strategic frameworks for management of coral reefs that builds resilience in the face of climate change and Project 322 “*Managing Wastewater through a Global Partnership*” Component 1: Strengthening the normative basis for managing and monitoring the impacts of wastewater on the marine environment.

### **Optimal status: Wastewater**

The optimal status of wastewater depends on the conditions for which it is to be used. For drinking water it should comply with the World Health Authority conditions for drinking water. Generally speaking wastewater management should comply with the principles<sup>9</sup> of integrated water resources management (IWRM) with no net negative impact on society, the economy and the environment.

<sup>8</sup> Extract from UNEP (2015). Wastewater Pollution & Coral Reefs. Science-to-Policy Brief for UNEP DRAFT September 2015. C<sub>2</sub>O. UNEP.

<sup>9</sup> <http://www.gwp.org/en/>



### Optimal status: Coral reef

The definition of what is a suitable environment for optimizing coral reef health is very wide ranging and depends on the baseline conditions the coral reef is used to and the resilience of the coral reef to impacts. GBRM water quality triggers<sup>10</sup> provide a basis for determining suitable conditions for maintaining coral reef health.

### Other pressures on coral reefs

Other stressors can act together (cumulatively) with wastewater to adversely affect the health of coral reefs. Reducing, or removing, wastewater stressors may provide coral reefs with greater resilience to and capacity to adapt to these other stressors, some of which may become significant in the future<sup>11</sup>.

## TRAINING FOR TRAINER NOTES

The training for trainer notes are designed to provide additional clarification to help in training since the learning points in the trainee materials above are very brief. The notes are colour coded according to the same coding used in the above trainee materials.

Notes are numbered according to the section and sub-section numbers in the first column of the module tables. Additional learning point information to be used for training of trainers is provided in the table below against a white background.

### Colour code:

<b>1. Learning points</b>	Key pieces of information that need to be learned.
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“*Learning points*” are presented under the amber coloured learning point header. Each of the learning points presented in the training materials above summarises a key piece of information that needs to be learned. The trainer can adapt or use alternative information to that provided in the training for trainer notes to get across the learning points.

<sup>10</sup> Water quality guidelines for the Great Barrier Reef Marine Park 2010 [electronic resource] / Great Barrier Reef Marine Park Authority. [http://www.gbrmpa.gov.au/data/assets/pdf\\_file/0017/4526/GBRMPA\\_WQualityGuidelinesGBRMP\\_RevEdition\\_2010.pdf](http://www.gbrmpa.gov.au/data/assets/pdf_file/0017/4526/GBRMPA_WQualityGuidelinesGBRMP_RevEdition_2010.pdf)

<sup>11</sup> ISRS (2015). ISRS Consensus Statement on Climate Change and Coral Bleaching, October 2015. Prepared for the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change, Paris, December 2015. The International Society for Reef Studies (ISRS). <http://coralreefs.org/wp-content/uploads/2014/03/ISRS-Consensus-Statement-on-Coral-Bleaching-Climate-Change-FINAL-14Oct2015-HR.pdf>



<b>2. Tools</b>	Equipment to be used.
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Information on “*Tools*” is presented under the light blue coloured tools header. A summary of the key tools to be used to apply the learning points are present in the trainee part of the manual. Some additional information is provided on key tools below in this notes section on training for trainers.

<b>3. Indicators of training</b>	Indicators of training uptake.
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Indicators of training uptake are presented under the yellow coloured “*Indicators of training*” header. A summary of the key indicators of training uptake are present in the trainee part of the manual. Some additional information is provided on indicators of training below in this notes section on training for trainers.

<b>4. Further information</b>	Sources of further information
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Sources of further information are presented under the purple coloured “*Further information*” header. Some key additional sources of information are also provided in the text in the trainee part of the manual. Some additional sources of information are also provided below in this notes section on training for trainers.

<b>5. Group exercise</b>	Use of knowledge gained through a group exercise.
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Information to support a group exercise to test and apply use of one or more learning points from the module is presented under the green coloured “*Group exercise*” header.

<b>6. Training uptake test</b>	Test of knowledge gained.
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The training uptake test should be taken before and after training to show the extent to which the learning points have been understood by individuals in the target group and the target group as a whole.



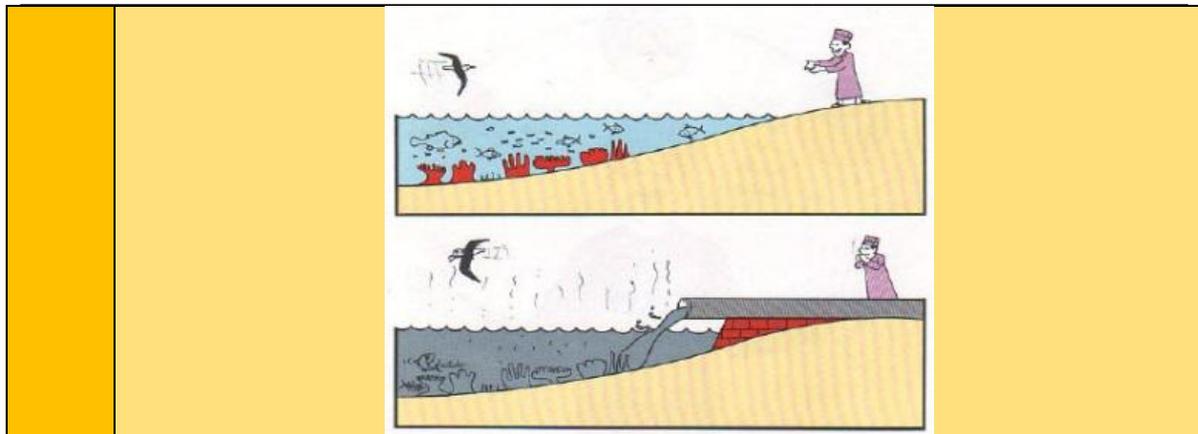
1.1	LEARNING POINTS
1.1.01	<p><b>About this manual:</b> The rationale for developing this manual is presented as a preface to this module. This “<i>Manual for monitoring indicators of the impact of wastewater discharge on coral reefs</i>” comprises a sequence of 5 modules reflecting the process from problem identification to problem solution. The manual should, therefore, be used in this sequence. The purpose of this manual is to determine whether wastewater is a problem for living coral reefs using a citizen-science approach (module 2-4), to advocate for improved wastewater management and to plan for improved wastewater management if it is a problem (module 5). In general improved wastewater management will reduce the stress on coral reefs so that they may have a better chance of coping with other stresses such as increased sea-temperatures and ocean acidification resulting from the burning of fossil fuels (human induced climate change). In these respects it needs to be appreciated that the priority for investment has to be to reduce or reverse human induced climate change due to the burning of fossil fuels.</p> <p>It is important to convey to the target group trainees that the manual comprise 5 modules and that each module is part of a sequence. The purpose of the manual is specified above and includes the nature of, and need for, evidence based advocacy and action which is further detailed in the other modules. The issue of climate change should be raised and the possible effects of sea-temperature increase (coral bleaching) and ocean acidification (calcium carbonate deposition) presented. The concept of <b><u>cumulative impact</u></b> (see below) should be demonstrated. For further information on coral reefs and ocean acidification see <a href="http://coralreefs.org/wp-content/uploads/2014/05/ISRS-Briefing-Paper-5-Coral-Reefs-and-Ocean-Acidification.pdf">http://coralreefs.org/wp-content/uploads/2014/05/ISRS-Briefing-Paper-5-Coral-Reefs-and-Ocean-Acidification.pdf</a>. For further information on coral bleaching see Obura, D.O. and Grimsdith, G. (2009). Resilience Assessment of coral reefs – Assessment protocol for coral reefs, focusing on coral bleaching and thermal stress. IUCN working group on Climate Change and Coral Reefs. IUCN, Gland, Switzerland. 70 pages. <a href="http://cmsdata.iucn.org/downloads/resilience_assessment_final.pdf">http://cmsdata.iucn.org/downloads/resilience_assessment_final.pdf</a></p>
1.1.02	<p><b>The target audience:</b> The target audience for the manual is people who have basic secondary level foundation training in science and an interest in the subject matter. The learning points are supported by basic training for trainer notes. However, it is expected that these training notes will be adapted and expanded by trainers to meet local conditions. Local communities can participate but need to do so within a citizen science framework and using a sub-set of the indicators presented in this</p>



	<p>manual. Trainers will have to produce “<i>community friendly</i>” guidelines for training communities by adapting the materials in this manual.</p> <p>It is understood that the target audience for wastewater impact indicators is middle-level managers /secondary level trained civil society advocates (NGOs’ dive operators etc). It follows that the indicators should not require a laboratory level of analysis but would be assessed using simple field kits.</p> <p>The secondary school level education sector and unemployed women with secondary education and above could also be a target audience for more objective /quantitative sampling system if it was to be included as “field studies” in community based monitoring programs or university entrance pre-qualification exams.</p> <p>Any of these target audiences can collect samples under guidance from suitably qualified scientists and send them to these scientists for more detailed laboratory analyses.</p> <p>It is suggested that location (place and date) and the presence/absence of wastewater odor and presence/absence of living hard coral should be the minimal community monitoring indicators.</p>
1.1.03	<p><b>Module 1 - Purpose and key terms:</b> By the end of this module target group will be able to demonstrate an understanding of the key learning points presented below. Training in this module should take approximately four hours of presentation, an hour for the group exercise and 15 minutes for the test. Any fieldwork should be added to this time.</p> <p>This module is entitled “<i>Purpose and key terms</i>” and is the first of 5 modules forming the “<i>Manual for monitoring indicators of the impact of wastewater discharge on coral reefs</i>”. The purpose of the manual is presented in this module under 1.1 above. This module also provides a number of key terms used throughout the manual and elaborated below.</p>
1.1.04	<p><b>Precautionary principle:</b> Specified in the preamble to the international convention on biological diversity “<i>Noting also that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat</i>”.</p> <p><a href="http://www.cbd.int/doc/legal/cbd-un-en.pdf">http://www.cbd.int/doc/legal/cbd-un-en.pdf</a></p> <p>Application of the precautionary principle is a requirement under international law to which most PERSGA countries are a party and to</p>



	<p>which PERSGA is an observer. The principle requires that action should be taken to reduce possible threats even if there is a lack of full scientific certainty as to the nature of, and need for, the action. The debate over climate change is a case in point. There is still a minority that suggest that climate change is due to natural factors rather than the human burning of fossil fuels over the last couple of centuries. The precautionary principle requires that, despite the continuing debate, action should be taken to reduce fossil fuel emissions. Unfortunately concerted international action on human induced climate change, reflecting the precautionary principle, is still deficient.</p>
<p>1.1.05</p>	<p><b>Cumulative environmental impact:</b> Where two or more factors act together to create an impact that is greater than the impact if they act independently.</p>
	<p>Cumulative impact can be demonstrated using a set of balance scales. Adding weights cumulatively to one side of the scales eventually causes the scales to tip. Each weight, on its own, cannot tip the scales. The weights together tip the scales. Cumulative impacts are particularly significant in respect of ecosystem function because the functions are so closely interlinked. Sea-temperature warming and ocean acidification act cumulatively on living coral reefs since both reduce the capacity of living coral reefs to produce their calcium carbonate skeletons.</p>
<p>1.1.06</p>	<p><b>Environmental Impact Assessment (EIA):</b> Often a legal requirement EIA is “<i>a process of evaluating the likely environmental impact of a proposed project or development taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse</i>”.</p> <p><a href="https://www.cbd.int/impact/problem.shtml">https://www.cbd.int/impact/problem.shtml</a></p>
	<p>EIA is a requirement under Article 14.1 of the International Convention on Biological Diversity, Article XI of the Jeddah Convention and Article 15 of the PERSGA MPAs protocol. It is also a requirement, under national legislation, of all parties to the Jeddah Convention.</p> <p>For more information on EIA see the UNEP web site (<a href="http://www.unep.ch/etb/publications/enviImpAsse.php">http://www.unep.ch/etb/publications/enviImpAsse.php</a>) and the Convention on Biological Diversity (CBD) website (<a href="https://www.cbd.int/impact/">https://www.cbd.int/impact/</a>).</p> <p>Citizen scientists can have a role in supporting the EIA process by ensuring that it is transparent and accountable.</p>



MRME (1995). Understanding Beaches (Arabic and English). Ministry of Regional Municipalities and the Environment (MRME). Sultanate of Oman.

The cartoon above and the picture below introduce the next section of learning points. The upper part of the cartoon illustrates a healthy living coral reef and associated fish and bird populations. The lower part of the cartoon illustrates the effect of a wastewater discharge on the same coral reef. The water becomes grey, the reef dies, the fish and birds try to escape and there is a smell.



Settlement ponds, near Hodaidah, Yemen 1986

The picture above shows settlement ponds near Hodaidah in 1986. This shows that there was investment in wastewater treatment even in these days. There has been significant investment in wastewater treatment subsequently in Djibouti, Egypt, Jordan, and Saudi Arabia.

For more information on wastewater discharge in the Red Sea see: “*PERSGA/UNEP (2014). Technical Report. Regional Workshop n Wastewater Management and Pollution Loads Assessment in Coastal Cities of the Red Sea and Gulf of Aden. June 16th-18th 2014. Jeddah,*



	<i>Kingdom of Saudi Arabia. July 2014</i> ".
1.1.07	<p><b>Ecosystem</b> means “a dynamic complex of plant, animal and micro-organism communities interacting with their non-living environment as an ecological unit”.</p> <p>The above definition comes from PERSGA (2005). The Protocol Concerning the Conservation of Biological diversity and the Establishment of a Network of Protected Areas the Red Sea and Gulf of Aden. PERSGA. <a href="http://www.persga.org/Documents/Doc_62_20090211123942.pdf">http://www.persga.org/Documents/Doc_62_20090211123942.pdf</a></p> <p>The Convention on Biological Diversity gives a slightly different definition “<i>“Ecosystem” means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit</i>” (Article 2 of the Convention).</p> <p>UN (1992) Convention on Biological Biodiversity with Annexes. Concluded at Rio de Janeiro on 5th June 1992 <a href="http://www.cbd.int/doc/legal/cbd-un-en.pdf">http://www.cbd.int/doc/legal/cbd-un-en.pdf</a></p>
1.1.08	<p><b>Wastewater</b> is water whose quality has been negatively affected by human activity.</p> <p>The above definition is not cited. There are many other definitions. Two are presented below:</p> <ol style="list-style-type: none"> <li>1. “<i>Wastewater can mean different things to different people with a large number of definitions in use. The “Sick Water” report has taken a broad perspective, and defined wastewater as “a combination of one or more of: domestic effluent consisting of blackwater (excreta, urine and faecal sludge) and greywater (kitchen and bathing wastewater); water from commercial establishments and institutions, including hospitals; industrial effluent, storm water and other urban run-off; agricultural, horticultural and aquaculture effluent, either dissolved or as suspended Matter</i>”. See Corcoran, E.C., et. al., (2010). See Section 4 “<i>Further information</i>” for the full citation.</li> <li>2. “<i>Used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff/stormwater, and any sewer inflow/infiltration</i>” See Tilley, E., et. al., (2014). See Section 4 “<i>Further information</i>” for the full citation.</li> </ol>
1.1.09	<p><b>Zero discharge:</b> “<i>Wastewater that is not directly or indirectly discharged to a navigable water (e.g., wastewater that is land disposed</i></p>



	<p><i>through spray irrigation) under CWA (USA Clean Water Act).”</i></p> <p>See the definition at <a href="http://www2.epa.gov/sites/production/files/2015-07/documents/rom.pdf">http://www2.epa.gov/sites/production/files/2015-07/documents/rom.pdf</a></p>
1.1.10	<p><b>A living coral reef</b> is any solid structure that is maintained by living hard (calcium carbonate, hermatypic/reef building) coral.</p> <p>Coral reefs can be fossil or living. The key requirement of a living coral reef is that it contains calcium carbonate deposits with a <b>living</b> veneer of calcium carbonate producing hard coral principally from the biological order of Scleractinia. The important role of coralline algae in consolidating coral reefs is becoming increasingly apparent but a reef of coralline algae alone is not a living coral reef.</p> <p>For further information see: <a href="http://www.reefbase.org/main.aspx">http://www.reefbase.org/main.aspx</a></p>
1.1.11	<p><b>Living coral reef sensitivity to wastewater:</b> Most coral reefs in the Red Sea have evolved in nutrient poor areas due to generally low water exchange with the Indian Ocean and limited freshwater inputs from the land. Wastewater introduces nutrients, sediment and low salinity water. An increasing human population in the coastal zone of the Red Sea produces increased wastewater.</p> <p>The entrance to the Red Sea through the Bab-el-Mandeb between Djibouti and Yemen is relatively narrow and limits water and nutrient exchange between the Red Sea and Gulf of Aden. Occasional flash floods do occur in the Red Sea and many of channels through reefs are often associated with the discharge areas of flash floods. However, the Red Sea area is generally dry and natural freshwater input is generally limited. There have been substantial increases in human populations in the coastal zone of the Red Sea and this, combined, with increased freshwater use results in an increase in production of wastewater.</p> <p>For more information see ISRS (2004) The effects of terrestrial runoff of sediments, nutrients and other pollutants on coral reefs. Briefing Paper 3, International Society for Reef Studies, pp: 18. <a href="http://coralreefs.org/wp-content/uploads/2014/05/ISRS-Briefing-Paper-3-Water-Quality.pdf">http://coralreefs.org/wp-content/uploads/2014/05/ISRS-Briefing-Paper-3-Water-Quality.pdf</a></p>
1.1.12	<p><b>Importance of coral reefs:</b> Coral reefs provide a source of food, living sea-defences and nature tourism.</p> <p>There are many papers about the importance of coral reefs. For more information see <a href="http://wwf.panda.org/about_our_earth/blue_planet/coasts/coral_reefs/coral_facts/">http://wwf.panda.org/about_our_earth/blue_planet/coasts/coral_reefs/coral_facts/</a></p>



1.1.13	<p><b><u>Coral bleaching</u></b>: The disruption of the symbiotic relationship between polyps and zooxanthellae, resulting in the expulsion of zooxanthellae and loss of photosynthetic pigments (corals become white and weaken, and may ultimately die).</p> <p>There are many definitions of coral bleaching. This one comes from Grimsditch, Gabriel D. and Salm, Rodney V. (2006). Coral Reef Resilience and Resistance to Bleaching. IUCN, Gland, Switzerland. 52pp. ISBN-10: 2-8317-0950-4. ISBN-13: 978-2-8317-0950-5. <a href="http://www.iucn.org/dbtw-wpd/edocs/2006-042.pdf">http://www.iucn.org/dbtw-wpd/edocs/2006-042.pdf</a> The source is cited as Douglas 2003 but is not a direct quote.</p>
1.1.14	<p><b><u>Eutrophic waters</u></b>: Nutrient rich waters.</p> <p>Eutrophic waters occur as a result of eutrophication. Eutrophication (nutrification) can occur when nutrient rich waters are brought from deep sunless waters into shallower waters where sunlight supports plant growth (the photic zone). Eutrophication can also occur as a result of run-off from the land in flash-floods and in rivers and streams. Eutrophication can also occur as a result of wastewater inputs. High levels of eutrophication can cause “<i>algal blooms</i>” (rapid growth of algae to plague proportions, for example to produce a “<i>red tide</i>”).</p>
1.1.15	<p><b><u>Oligotrophic waters</u></b>: Nutrient poor waters.</p> <p>Oligotrophic waters are waters that are nutrient poor. Plants and animals take nutrients from surface waters to grow. When these plants and animals die they sink into deeper water, where there is no sunlight, taking the nutrients within their tissues with them. The waters that remain at the surface are nutrient poor.</p>
1.1.16	<p>A <b><u>point source</u></b> of wastewater pollution is a source from a single identifiable location.</p> <p>One definition of “<i>point source</i>” is that it “<i>means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture</i>”.</p> <p>See <a href="http://water.epa.gov/lawsregs/guidance/wetlands/sec502.cfm">http://water.epa.gov/lawsregs/guidance/wetlands/sec502.cfm</a></p>
1.1.17	<p>A <b><u>dispersed/diffuse/non-point source</u></b> of wastewater pollution arises</p>



	from multiple locations.
	For more information see <a href="http://water.epa.gov/polwaste/nps/whatis.cfm">http://water.epa.gov/polwaste/nps/whatis.cfm</a>
1.1.18	<p><b><u>Black water, brown water, foul water, sewage</u></b>: water containing faecal material and urine.</p> <p>“ <b>Blackwater</b> is the mixture of Urine, Faeces and Flushwater along with Anal Cleansing Water (if water is used for cleansing) and/or Dry Cleansing Materials..... Blackwater contains the pathogens of Faeces and the nutrients of Urine that are diluted in the Flushwater.” See Tilley, E., et. al., (2014). See Section 4 “Further information” for the full citation.</p> <p>“<b>Brownwater</b> is the mixture of Faeces and Flushwater, and does not contain Urine. It is generated by Urine-Diverting Flush Toilets..... and, therefore, the volume depends on the volume of the Flushwater used. The pathogen and nutrient load of Faeces is not reduced, only diluted by the Flushwater. Brownwater may also include Anal Cleansing Water (if water is used for cleansing) and/or Dry Cleansing Materials..... ” See Tilley, E., et. al., (2014). See Section 4 “Further information” for the full citation.</p>
1.1.19	<p><b><u>Grey water, sullage</u></b>: water from non-industrial processes without sewage. Sullage is an historical term for greywater.</p> <p>“ <b>Greywater</b> is the total volume of water generated from washing food, clothes and dishware, as well as from bathing, but not from toilets. It may contain traces of Excreta (e.g., from washing diapers) and, therefore, also pathogens. Greywater accounts for approximately 65% of the wastewater produced in households with flush toilets”. See Tilley, E., et. al., (2014). See Section 4 “Further information” for the full citation.</p>
1.1.20	<p><b><u>Primary (mechanical) treatment</u></b>: “The first major stage in wastewater treatment that removes solids and organic matter mostly by the process of sedimentation or flotation”.</p> <p>“See Tilley, E., et. al., (2014). See Section 4 “Further information” for the full citation.</p>
1.1.21	<p><b><u>Secondary (biological) treatment</u></b>: “Follows primary treatment to achieve the removal of biodegradable organic matter and suspended solids from effluent. Nutrient removal (e.g., phosphorus) and disinfection can be included in the definition of secondary treatment or</p>



	<i>tertiary treatment, depending on the configuration”.</i>	
	See Tilley, E., et. al., (2014). See Section 4 “ <i>Further information</i> ” for the full citation.	
1.1.22	<b>Tertiary (additional) treatment:</b> “ <i>Follows secondary treatment to achieve enhanced removal of pollutants from effluent. Nutrient removal (e.g., phosphorus) and disinfection can be included in the definition of secondary treatment or tertiary treatment, depending on the configuration”.</i>	
	See Tilley, E., et. al., (2014). See Section 4 “ <i>Further information</i> ” for the full citation.	
1.1.23	<b>Sewage sludge:</b> Sewage sludge refers to the residual, semi-solid material that is produced as a by-product of sewage treatment.	
	<p>“<b>Sludge</b> is a mixture of solids and liquids, containing mostly Excreta and water, in combination with sand, grit, metals, trash and/or various chemical compounds. A distinction can be made between faecal Sludge and wastewater Sludge. Faecal Sludge comes from onsite sanitation technologies, i.e., it has not been transported through a sewer. It can be raw or partially digested, a slurry or semisolid, and results from the Collection and Storage/Treatment of Excreta or Blackwater, with or without Greywater.....</p> <p>Wastewater Sludge (also referred to as sewage Sludge) is Sludge that originates from sewer-based wastewater collection and (Semi-) Centralized Treatment processes. The Sludge composition will determine the type of treatment that is required and the end-use possibilities.”</p> <p>See Tilley, E., et. al., (2014). See Section 4 “<i>Further information</i>” for the full citation.</p>	
1.1.24	<b>Kipling method:</b> “I keep six honest serving men (they taught me all I knew); their names are What and Why and When and Where and Who” <a href="http://www.kiplingsociety.co.uk/poems_serving.htm">http://www.kiplingsociety.co.uk/poems_serving.htm</a>	
	The poem, by Kipling, is a simple way of remembering the checklist for ensuring that a proposed action includes all the relevant components (the “how” component (the method) can be included under “what”).	
1.1.25	<b>Garbage in garbage out:</b>	
	The value of information to evidence based decision-making depends on how relevant and good the	

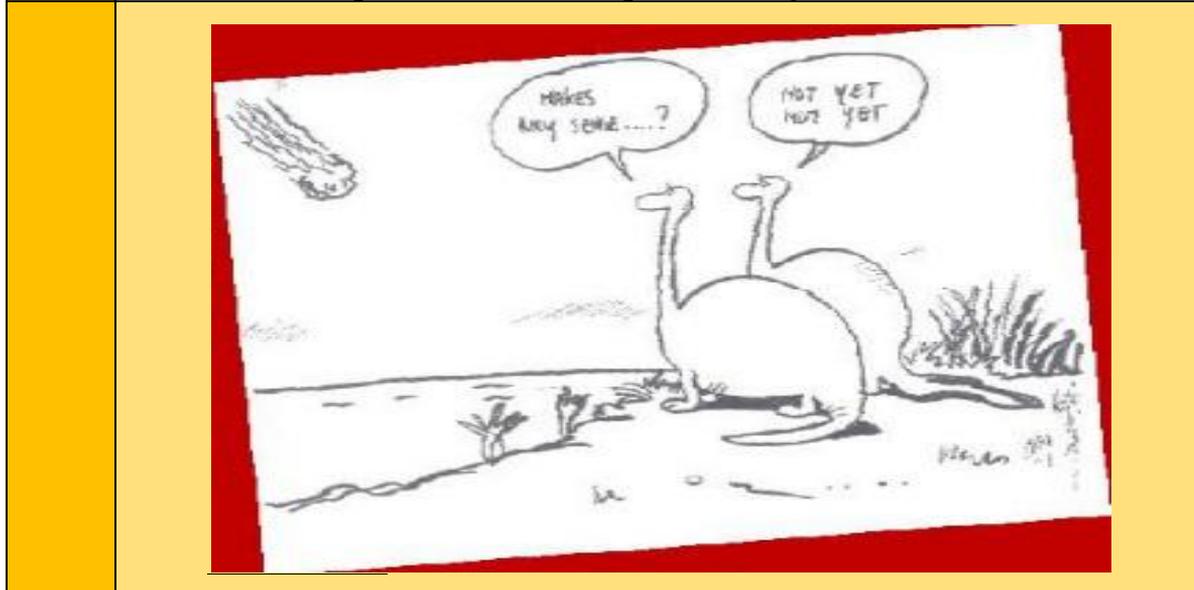


information is.

The cartoon aims to illustrate that the information that you get out of a computer (or other information management system) is as good as the information that you put in. Usually this means how well the information is. For example if you don't put a date on the information then the computer cannot tell you when it was collected and if you don't put a location you can't tell where it was collected. The image was sourced from <http://i.imgur.com/D2wJB.jpg> and is acknowledged accordingly.

**1.1.26 Polluter pays Principle:** “...the polluter should bear the cost of measures to reduce pollution according to the extent of either the damage done to society or the exceeding of an acceptable level (standard) of pollution.”  
 (United Nations Statistics Division 2006  
<http://unstats.un.org/unsd/environmentgl/gesform.asp?getitem=902>)

Basically the principle requires that the party that does the polluting should pay for the cost of restoring any damage and providing compensation for any economic and social losses incurred as the result of the pollution. The principle can be applied to accidents, to deliberate acts or to damage identified through the EIA process.





	<p>The cartoon illustrates the next section of learning points. Two dinosaurs presumably observing the arrival of the catastrophic meteorite strike in the Gulf of Mexico some 66 million years ago that is reported to have led to the extinction of the dinosaurs. The cartoon is used here to imply the link between cause and effect and the use of deduction to predict and understand cause and effect. It introduces the next section of learning points. The cartoon can be sourced from <a href="https://evaluationrevisited.files.wordpress.com/2010/03/cartoon-flyer.jpg">https://evaluationrevisited.files.wordpress.com/2010/03/cartoon-flyer.jpg</a> and is acknowledged accordingly.</p>
1.1.27	<p><b>Citizen-science</b> is scientific research conducted by amateur (non-professional) scientists from civil society usually under the direction of professional scientists.</p> <p><i>"In citizen science people who are not professional scientists take part in one or more aspects of science—systematic collection and analysis of data, development of technology, testing of natural phenomena and dissemination of the results of activities. They mainly participate on a voluntary basis"</i>. For further information see <a href="http://www.unep.org/yearbook/2014/PDF/chapt6.pdf">http://www.unep.org/yearbook/2014/PDF/chapt6.pdf</a></p>
1.1.28	<p><b>Scientific method:</b> An approach comprising:</p> <ul style="list-style-type: none"> <li>- development of objective <b>hypothesis</b> concerning links</li> <li>- experiments to test the hypothesis statistically;</li> </ul> <p>For further information see: <a href="http://www.livescience.com/20896-science-scientific-method.html">http://www.livescience.com/20896-science-scientific-method.html</a></p>
1.1.29	<p><b>Hypothesis:</b> A proposed explanation for an event or problem often in terms of <b>cause</b> and <b>effect</b>. The hypothesis can be tested through an <b>experiment</b> which alters, or observes, cause or effect <b>indicator</b> variables to see whether they are <b>dependent</b> or <b>independent</b>.</p> <p>The definition of “hypothesis” above comprises many terms which are elaborated below. See also <a href="http://www.livescience.com/21490-what-is-a-scientific-hypothesis-definition-of-hypothesis.html">http://www.livescience.com/21490-what-is-a-scientific-hypothesis-definition-of-hypothesis.html</a></p>
1.1.30	<p>A <b>stressor</b> is a causal factor that has an <b>effect/ impact</b> on a <b>receptor</b>. In the case of these guidelines the stressor is <b>wastewater</b>. The receptor is <b>living coral reef</b>, coral reef associated life, and living coral reef dependent services such as fisheries and tourism.</p> <p>It is important, in the context of this manual, that the target audience understands the link between cause and effect and the associated link</p>



	<p>between the technical word “<i>stressor</i>” and “<i>receptor</i>” in respect of assessing risk. A stressor is a causal factor and a receptor is something that is affected by a stressor.</p> <p>For further information see:  <a href="http://www.epa.gov/risk_assessment/basicinformation.htm">http://www.epa.gov/risk_assessment/basicinformation.htm</a></p> <p>A definition of stressor is: “<i>any physical, chemical, or biological entity that can induce an adverse response. Stressors may adversely affect specific natural resources or entire ecosystems, including plants and animals, as well as the environment with which they interact.</i>”</p> <p><a href="http://ofmpub.epa.gov/sor_internet/registry/termreg/searchandretrieve/termsandacronyms/search.do">http://ofmpub.epa.gov/sor_internet/registry/termreg/searchandretrieve/termsandacronyms/search.do</a></p>
1.1.31	<p>An <b>indicator of change</b> comprises a set of two or more attributes at least one of which remains constant whilst one, or more, of the others may show change.</p> <p>The above definition has no citation. It is intended to support this manual in respect of dependent and independent variables and cause-effect relationships. A named person remains the same whilst some of his/her attributes such as age and weight can change. All are indicators but need to be combined to be an indicator of change.</p> <p>A definition of “<i>Environmental Indicator</i> is “<i>An environmental indicator is a parameter, or a value derived from parameters, that points to, provides information about and/or describes the state of the environment, and has a significance extending beyond that directly associated with any given parametric value. The term may encompass indicators of environmental pressures, conditions and responses.</i>”</p> <p><a href="https://stats.oecd.org/glossary/detail.asp?ID=830">https://stats.oecd.org/glossary/detail.asp?ID=830</a></p>
1.1.32	<p><b>Dependent variable:</b> A variable that is <b>affected</b> by the independent variable such as an effect on a receptor.</p> <p>A dependent variable is one that changes in response to the independent variable. In the context of this manual the dependent variable is the health of the living coral reef since the living coral reef has little control over wastewater discharge though some might argue that living coral reef has a limited wastewater treatment role. Whether a variable is dependent or independent is determined using <b>controls</b> (see below).</p>
1.1.33	<p><b>Independent variable:</b> A variable, such as a cause/stressor, that is <b>not affected</b> by the dependent variable such as a receptor.</p>



	<p>An independent variable is one that has an effect on a dependent variable and is independent of that variable. In the context of this manual the independent variable is wastewater since wastewater can affect the health of the living coral reef whilst the living coral reef has little control over wastewater discharge though some might argue that living coral reef has a limited wastewater treatment role. Whether a variable is dependent or independent is determined using <b>controls</b> (see below).</p>
<p>1.1.34</p>	<p><b>Control (scientific):</b> a situation that is identical in every possible way except for the absence of the independent variable that is being monitored.</p> <p>A control can sometimes be referred to as a “<i>Reference (control)</i>”. The above definition of “<i>Control (scientific)</i>” has no citation but is intended to meet the requirements of this manual in respect of dependent and independent variables and cause-effect relationships. A control is a dependent variable that is outside the influence of the independent variable for which it is a control. For example a coral reef outside of the influence of a wastewater discharge could be viewed as a control for wastewater discharge.</p>  <p>The cartoon above is intended to illustrate an experiment with a control. The mice in the left hand tank are suggested to be the control since they are not affected by the “shaking” shown by the mice in the right hand tank which, it is presumed, have been affected by a stressor (independent variable) which is absent from the left hand tank. The cartoon may be sourced from <a href="http://lenagroeger.com/blog/img/posts/controlgroup.jpg">http://lenagroeger.com/blog/img/posts/controlgroup.jpg</a> and is acknowledged accordingly.</p>



1.1.35	<p><b>Geographic information system</b> (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth’s surface. GIS can show many different kinds of data on one map. This enables people to more easily see, analyze, and understand patterns and relationships.</p> <p>For more information see <a href="http://education.nationalgeographic.co.uk/encyclopedia/geographic-information-system-gis/">http://education.nationalgeographic.co.uk/encyclopedia/geographic-information-system-gis/</a></p>
1.1.36	<p><b>Data table, grid or matrix:</b> Information placed in a framework of columns and rows according to objective criteria set for each column and row. At least one column should relate to an independent variable and one to a dependent variable.</p> <p>The above table illustrates a table, grid or matrix. The information in the table does <b>not</b> reflect real data. The table comprises rows and columns and the data can be analysed in a graph as shown in module 4.</p> <p>The second column “<i>Distance from wastewater source</i>” is the <b>independent variable</b> since wastewater is minimally influenced by living coral reef. The third column “<i>% cover of live hard coral</i>” is the <b>dependent variable</b> given the hypothesis being tested that wastewater adversely affects living coral reef.</p> <p>To some extent the <b>control</b> is provided by the assumption that the further the site is from the independent variable the more likely it is to be a control.</p>
1.1.37	<p><b>Grievance redress:</b> The process by which stakeholders can complain about a problem and have their complaints addressed by the party causing the problem, initially bilaterally, and, if that fails, by independent arbitration (through a, bilaterally agreed, unbiased, third party).</p>



	<p>Proposed activities and actions should comply with national and local laws and regulations.</p> <p>Grievance redress is a term used by international donors but is also widely used in government, business and civil society. It is basically a transparent and objective, usually timed (action to be taken within a specified period), complaints mechanism by which those that may be affected by an activity have the opportunity to raise concerns and have these concerns addressed by the party implementing that activity. The grievance redress mechanisms allows for concerns to be addressed before they alienate the community. For more information see <a href="http://siteresources.worldbank.org/EXTSOCIALDEVELOPMENT/Resources/244362-1193949504055/4348035-1298566783395/7755386-1301510956007/GRM-P1-Final.pdf">http://siteresources.worldbank.org/EXTSOCIALDEVELOPMENT/Resources/244362-1193949504055/4348035-1298566783395/7755386-1301510956007/GRM-P1-Final.pdf</a></p>
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<b>1.2</b>	<b>TOOLS</b>
<b>1.2.1</b>	<p>The tools for this module comprise the module, writing materials, and extra paper.</p> <p>The target group will need to take notes. Sufficient copies of the training uptake test should be provided for use by the trainee group.</p>

<b>1.3</b>	<b>TRAINING UPTAKE INDICATORS</b>
<b>1.3.01</b>	<p>The indicators for this module comprise the training uptake test scores.</p> <p>The change in score before and after training should indicate the effectiveness of training uptake.</p>

<b>1.4</b>	<b>FURTHER INFORMATION</b>
<b>1.4.01</b>	<p>Corcoran, E., C. Nellemann, E. Baker, R. Bos, D. Osborn, H. Savelli (eds). 2010. Sick Water? The central role of wastewater management in sustainable development. A Rapid Response Assessment. United Nations Environment Programme, UN-HABITAT, GRID-Arendal. <a href="http://www.grida.no">www.grida.no</a> <a href="http://www.unep.org/pdf/SickWater_screen.pdf">http://www.unep.org/pdf/SickWater_screen.pdf</a></p>
<b>1.4.02</b>	<p>PERSGA (in prep). Standard Survey Methods for Key Habitats and Key Species in the Red Sea and Gulf of Aden. Regional Organisation for the Conservation of the Environment of the Red Sea and Gulf of Aden. PERSGA, Jeddah.</p> <p>This is a draft document in preparation at the time of writing of this</p>



	<p>manual. The current survey manual is “<i>PERSGA/GEF 2004. Standard Survey Methods for Key Habitats and Key Species in the Red Sea and Gulf of Aden. PERSGA Technical Series No. 10. PERSGA, Jeddah. <a href="http://www.persga.org/Files/Publications/Technical/TS/TS10_SSM_for_Key_Habitat.pdf">http://www.persga.org/Files/Publications/Technical/TS/TS10_SSM_for_Key_Habitat.pdf</a></i></p>
1.4.03	<p>PERSGA (2015). Draft Regional Guidelines on Wastewater Management in Coastal Cities on the Red Sea And Gulf of Aden. August 2015. Regional Intergovernmental Organisation for the Conservation of the Environment of the Red Sea and Gulf of Aden.</p> <p>This is a draft document.</p>
1.4.04	<p>Tilley, E., Ulrich, L., Lüthi, C., Reymond, Ph., Zurbrügg, C. (2014). Compendium of Sanitation Systems and Technologies – (2nd Revised Edition). Swiss Federal Institute of Aquatic Science and Technology (Eawag), Duebendorf, Switzerland. p. 175. ISBN 978-3-906484-57-0. <a href="http://www.sswm.info/sites/default/files/reference_attachments/TILLEY%20et%20al%202014%20Compendium%20of%20Sanitation%20Systems%20and%20Technologies%202nd%20Revised%20Edition.pdf">http://www.sswm.info/sites/default/files/reference_attachments/TILLEY%20et%20al%202014%20Compendium%20of%20Sanitation%20Systems%20and%20Technologies%202nd%20Revised%20Edition.pdf</a></p>
1.4.05	<p>UNEP (2015). Wastewater Pollution &amp; Coral Reefs. Science-to-Policy Brief for UNEP DRAFT September 2015. C2O. UNEP.</p> <p>This was in draft form at the time of preparation of this manual.</p>
1.4.06	<p>Other modules in this manual</p> <p>This module provides the first of five modules forming the manual with each module forming a numbered sequence delivering the manual and each module should be delivered in context. The text of the training for trainer notes for this module also contains links to additional materials.</p>

1.5	<b>GROUP EXERCISE</b>
1.5.01	<p>Break into groups. Discuss the opportunities and constraints to the module. Agree and present a set of review recommendations.</p> <p>How the target audience is broken into groups depends on the overall size of the group and how the group would like to be broken-up. Groups should be of approximately equal size and comprise a balanced mixture of skills and experience. The group should elect a chairperson and spokesperson.</p> <p>The group exercise is a mechanism by which the target audience can</p>



explore and test the learning points. Each group should consider each learning point and propose, discuss, agree and present possible changes. After each group has presented there should be agreement about key recommendations.

1.6	<b>TRAINING UPTAKE TEST</b> <b>(expand/continue on separate sheets as necessary)</b>	<b>0-10</b>
	<p>The training uptake test should be undertaken before the training to act as a baseline and after the training to determine training uptake. Each learning point response should be scored from 0-10 with a maximum of 10. The total score for the test should be the sum of the scores for each learning point. It is suggested that the training test take no more than <b>15 minutes</b>. Sufficient copies of the training uptake test should be provided. The answers can be expanded on additional sheets against the question number.</p>	

Pre		Post		If the test is taken before training tick (✓) the “pre” box and if it is taken after training tick (✓) the “post” box.
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Tick box as appropriate.

1.6.01	Explain the purpose of this manual.	The purpose of this manual is presented in learning point 1.1.01	
1.6.02	Give an example of a wastewater and explain why it is wastewater.	The trainee should answer this question showing an understanding of learning point 1.08 with an example showing an understanding of learning point 1.18 and/or 1.1.19.	
1.6.03	Explain when a reef is not a living coral reef.	The answer to this question should reflect an understanding of learning point 1.1.10.	
1.6.04	List some examples of point and non-point/diffuse sources and explain why you chose them	The answer to this question should reflect an understanding of learning point 1.1.16 and 1.1.17 and application of this learning point to a real-world example.	
1.6.05	What are the main differences between primary,	The answer to this question should reflect an understanding of learning points 1.1.20, 1.1.21 and 1.1.22	



	secondary and tertiary treated wastewater		
1.6.06	What are the key elements of the kipling method?	The answer to this question should reflect an understanding of learning point 1.1.24	
1.6.07	Specify who should be involved in citizen science.	The answer to this question should reflect an understanding of learning point 1.1.27	
1.6.08	Give an everyday example of a stressor and associated receptor.	The answer to this question should reflect an understanding of learning point 1.1.30 and application of this learning point to a real-world example.	
1.6.09	What is the difference between a dependent and an independent variable?	The answer to this question should reflect an understanding of learning points 1.1.32 and 1.1.33.	
1.6.10	Give an example of an indicator of change and why it is an indicator of change.	The answer to this question should reflect an understanding of learning point 1.1.31 and application of this learning point to a real-world example.	
1.6.11	Describe what makes a control.	The answer to this question should reflect an understanding of learning points 1.1.34	
1.6.12	Describe the key elements of grievance redress.	The answer to this question should reflect an understanding of learning point 1.1.37	
1.6.13	Group presentation.	The individual should be scored reflecting his/her understanding of the issues being discussed and the individuals' contribution to helping to deliver consensus within the group.	
1.6.14	Examinee, name, signature and date	Examiner, name, signature and date	Total



<p>Comments by examinee: The examinee should add any comments here.</p>		<p>Comments by examiner: The examiner should add any comments here.</p>	



**MANUAL FOR MONITORING INDICATORS OF THE IMPACT OF WASTEWATER DISCHARGE ON CORAL REEFS**  
**MODULE 2 : MONITORNG CAUSES (sources and nature of wastewater)**



Outfall of wastewater discharge in the region early 1980's



WASTEWATER CAUSAL INDICATORS						
Indicator	Location	Biological	Chemical	Physical	Social	Community*
BOD			✓			
Clarity (water)			✓	✓		✓
COD			✓			
Date	✓					✓
Discharge quantity				✓		
Distance to shore		✓				✓
Enterococci		✓				
Escherichia coli		✓				
Latitude	✓					✓
Longitude	✓					✓
Odour (water)			✓			✓
Sludge (fate)						✓
Agriculture					✓	
Landfill					✓	
Incineration					✓	
Power generation					✓	
Sea				✓		
Other						
Unknown						
TDS				✓		
TSS				✓		
Wastewater fate						✓
Potable					✓	
Home					✓	
Industry					✓	
Irrigation					✓	
Sea				✓		
Other						
Unknown						
Wastewater sector						
Commercial					✓	
Educational					✓	
Industrial					✓	
Residential					✓	
Sport					✓	
Tourism					✓	
Transport					✓	
Other						
Unknown						
Wastewater source						
Channel/drain					✓	
Cesspit					✓	
Desalination					✓	
Outfall					✓	
Septic tank					✓	
Sewer					✓	
Stormwater				✓		
Other						
Unknown						
Wastewater treatment						✓
None					✓	
Primary					✓	
Secondary					✓	
Tertiary					✓	
Other						
Unknown						

\*Priority Community monitoring indicators

The above table lists the wastewater causal indicators associated with this module to be collected using the form presented under learning point 2.1.05 Priority indicators for local communities to monitor with support from citizen science groups are highlighted in green and include: the location of the information in terms of date, latitude and longitude and distance to the shore; physical attributes of the wastewater such as water clarity and chemical characteristics such as odour. It is also suggested that communities can qualitatively assess the fate of sludge, the fate of wastewater including any wastewater treatment. Additional indicators from the list can, of course, be monitored if there is interest and resources are available for training.



**TRAINING FOR TRAINER NOTES**

2.1	Learning points
2.1.01	<p><b>Module 2 – Monitoring cause (sources and nature of wastewater):</b> By the end of this module students will be able to identify information on wastewater discharge and complete and prepare a questionnaire on wastewater discharge. Training in this module should take approximately four hours of presentation, an hour for the group exercises and 30 minutes for completing a questionnaire. Any fieldwork should be added to this time.</p> <p>It is important to summarise to the trainees the reason for the module in the context of the 6 modules forming the manual. The focus of this module is on collecting information about the location and nature of wastewater sources. Without this information it is not possible to link wastewater discharges to any adverse impacts on coral reefs. Such a linkage is necessary to justify and advocate for investments in managing wastewater to reduce any adverse impacts.</p>
2.1.02	<p><b>Form a citizen science group:</b> The group should contain people who can use/train others to use the tools specified below and people who are willing to be trained and to do the surveys.</p> <p>Citizen science is defined in module 1 and tools for advocacy that might be used by a Citizen’s science group are presented in module 5.</p>
2.1.03	<p><b>Obtain permission:</b> Always get permission from the owner of information to collect information!</p> <p>Information can be obtained from published sources, from the agency responsible for environment, and by visiting areas and meeting owners of wastewater discharge sites.</p> <p>Proposed activities and actions should comply with national and local laws and regulations.</p> <p>Information on wastewater discharge is provided by facilities that are treating wastewater, by the owners of property producing wastewater and by the Government agency responsible for wastewater management. It is important that permission to access and use information is obtained in writing from the permitting authority and particularly so if site access is required and/or a marker is to be placed. Ensure that the permitting</p>



	authority also signs-off that there is <b>no grievance</b> at the end of a site visit.			
2.1.04	<b>Permanent (fixed) markers:</b> These are less necessary in a terrestrial versus marine environment but do allow for accurate repeat-monitoring. Make sure that the marker is located securely and has a unique identification number that will not disappear.			
	Relocating a wastewater source will be more difficult without a permanent marker. The marker can be cement, metal or plastic plate engraved with a unique identification number and nailed or screwed or cemented into a solid structure in the discharge area. Using automatic monitoring stations can be within the scope of citizen science through citizens giving support to automatic monitoring by protecting, checking on/cleaning monitoring equipment on behalf of professional scientists.			
2.1.05	<b>Complete a survey questionnaire</b>	<b>Date</b>		<b>Form</b>
	A questionnaire should be completed for each discharge. The date the information collected should be given as yyyy/mm/dd. The form should be given a unique number.			
1	<b>Information collector</b>	<b>Contact details</b>		
	The full name of the person collecting the information.	The full name and contact details of the person collecting the information including address, mobile number and email.		
2	<b>Information provider</b>	<b>Contact details</b>		
	The full name of the person/organisation providing the information.	The full name and contact details of the person/organisation providing the information including address, mobile number and email.		
3	<b>Full address of the place the questionnaire applies to:</b>	Provide the full geographic/postal address including country, province, district and location where the discharge is being assessed.		



4	Discharge location	Latitude (deg.decdeg)	Degrees decimal degrees N/S	Longitude (deg.decdeg)	Degrees decimal degrees E/W	Distance to shore (m)	
<p>Use an accurate global positioning system (GPS) to locate the discharge. If the discharge is in the northern hemisphere then latitude and longitude should indicate “N” and if the discharge is in the southern hemisphere then the latitude and longitude should indicate south. If the latitude is west of Greenwich then it should be a negative number (-1 to -180) and indicate “W” and if it is east of Greenwich it should be a positive number (+1 to +180) and indicate “E”.</p> <p>For a <b>point source</b> enter the latitude and longitude of the discharge source in degrees decimal degrees (set the GPS to show this display and if you have not done so and the figures in degrees/minutes/seconds or some other format go on the web to find a site than can convert the figures). Enter the distance of the discharge from the shoreline in meters. This can be taken from a map, using a distance measure (tape etc) or visually estimated.</p> <p><b>Non-point</b> sources basically comprise the diffusion from multiple point-sources whose individual locations and discharges cannot be determined for logistical reasons. This issue could be addressed by specifying the area around a centrally determined location reflecting the non-point sources and determining/estimating the discharge accordingly and using the central location to estimate the distance from the non-point discharge area. The area can be as big or small as logistics allow. The same rule can be used if several point sources are combined.</p>							
<b>Permanent marker at discharge point</b>		<b>Code</b>		The unique number on the permanent marker located at the discharge.			
<b>Images</b> (label image properties with form number, date, and marker ID)							
<b>Video URL (Uniform Resource Identifier)</b>		The web address of any video taken of the discharge location. Please label the image properties with the form number, date and nearest marker ID			<b>Photo URL (Uniform Resource Identifier)</b>		The web address of any photo taken of the discharge location. Please label the image properties with the form number, date and nearest marker ID



	<b>Description of discharge location</b>	Sufficient description of the discharge location including lines of sight with buildings and other features to ensure that the site can be re-found by a person who has not physically visited it before.				
5	<b>Wastewater sector (circle what applies and add note)</b>	Commercial	Education	Industrial	Residential	Sport
		Tourism	Transport	Unknown	Other	
		Enter here any notes relating to the sector producing the wastewater discharge. If the sector is “ <i>other</i> ” then specify it in these notes.				
<p><b>Commercial sector</b> includes offices and shops. <b>Education sector</b> means schools and universities. <b>Industrial sector</b> means workshops and factories. <b>Residential sector</b> means homes. <b>Sports sector</b> means stadia, gyms, swimming pools. <b>Tourism sector</b> means hotels and vessels directly supporting tourism. <b>Transport sector</b> means airports, ports, fuel stations, vessels and vehicles providing non-tourism sector services. <b>Unknown</b> means that the sector cannot be specified. <b>Other</b> means that the sector can be specified but is not listed above. If the sector is “<i>other</i>” then specify it in these notes.</p>						
6	<b>Wastewater source (circle what applies and add note)</b>	Channel/drain	Cesspit	Desalination	Outfall	Septic tank
		Sewer	Stormwater	Unknown	Other	
		Enter here any notes relating to the wastewater discharge source. If the wastewater discharge source is “ <i>other</i> ” then specify it in these notes.				
<p>A <b>channel/drain</b> may be defined as any confined route taken by wastewater from the point of production to the point of discharge. A <b>cesspit</b> (cesspool, leach-pit, soak pit or holding tank) is basically a soak away with no treatment. An <b>outfall</b> is where the wastewater discharges from a channel/drain. A <b>septic tank</b> is a tank, typically underground, in which sewage (black water) is collected and allowed to decompose through bacterial activity before draining by means of a soak away. A <b>sewer</b> is normally a lined channel or drain constructed underground to convey sewage from the point of production to the point of discharge. <b>Unknown</b> means that the source cannot be specified. <b>Other</b> means that the source can be specified but is not listed above. If the source is “<i>other</i>” then specify it in these notes.</p>						



	See Tilley et. al., (2014). Main citation in Section 4 Further Information for more details on cesspits, septic tanks and sewers).								
7	<b>Odour</b> (0-5 where 0 is no odour/smell and 5 is very odorous/smelly)						Enter estimated number from 0-5		
8	<b>Clarity</b> (0-5 where 0 is clear and 5 is completely opaque)						Enter estimated number from 0-5		
9	<b>Maximum quantity of discharge in m<sup>3</sup> per day</b> (circle what applies and add note)								
	0	1-9	10-99	100-999	1000-9999	10000-99999	>100,000		
	Circle the value range that most closely matches your estimate. There are approximately 6.3 oil barrels to 1 m <sup>3</sup> . The discharge can be visually estimated from the size of the discharge opening and the rate of flow. Imagine how quickly a barrel will be filled by the flow and multiply up for the day. Alternatively measure the discharge opening with a measuring tape or stick and the flow using a flow-meter or the rate at which a floating item passes between two known points in the discharge area.								
10	<b>Wastewater treatment</b>	<b>Fate of wastewater (%).</b> <b>Total for all fates should be 100%.</b>							
		<b>Potable</b>	<b>Home</b>	<b>Industry</b>	<b>Irrigation</b>	<b>Sea</b>	<b>Other</b>	<b>Unknown</b>	<b>Total</b>
	None								
	Primary								
	Secondary								
	Tertiary				70			30	100
	Other								
	Unknown								
<b>Total</b>				70			30	100	
	See module 1 for definitions of treatment types. In this artificial example case all the wastewater is subject to tertiary treatment. 70% of the tertiary treated wastewater is used for irrigation and the use of the 30% balance is not known.								
11	<b>Fate of sludge (%).</b> <b>Total for all fates should be 100%.</b>								
	<b>Agriculture</b>	58	<b>Landfill</b>				<b>Incineration</b>	16	
	<b>Power generation</b>	3.5	<b>Sea</b>				<b>Other/unknown</b>	22.5	
	See module 1 for the definition of sludge. In this example 58% of the								



sludge has gone for agriculture, 16% for incineration, 3.5% for power generation and the balance of 22.5% is unknown.  
See  
[http://www.biomassenergycentre.org.uk/portal/page?\\_pageid=75,18722&\\_dad=portal&\\_schema=PORTAL](http://www.biomassenergycentre.org.uk/portal/page?_pageid=75,18722&_dad=portal&_schema=PORTAL)

Human waste has long been seen as a by-product, but Thames Water claims it saved £15m last year, and generated 14% of its power, from either burning sludge or methane derived from its 13 million customers' toilets.  
<http://news.bbc.co.uk/1/hi/england/8456879.stm>

12	Other water quality indicators (Tick frequency that applies. Add value for this survey, if any)							
	Indicator	None	Daily	Weekly	Monthly	Annual	Unknown	This survey/value
	<i>E. coli</i>					✓		200 cfu/100ml
	<i>Enterococci</i>					✓		100 cfu/100ml
	BOD				✓			5mg/L <sup>-1</sup>
	COD				✓			2mg/L <sup>-1</sup>
	TDS				✓			-
	TSS				✓			50mg/L <sup>-1</sup>
	Other							-

It is not expected that the volunteers in a citizen science group would undertake the analysis of water quality indicators. However, they can collect samples and should have some understanding as to why the indicators are important.

In this theoretical example some variables are analysed monthly and others annually. All the indicators are sampled during the survey.

***E. coli* and *Enterococci*** are bacteria associated with faecal (black-water/sewage) material. They are indicative of sewage pollution and are a health risk. The Blue Beach flag system sets thresholds for these bacteria in bathing waters of:

- *Escherichia coli* (Faecal Colibacteria) 250 cfu/100 ml (cfu = colony forming unit)
- Intestinal *Enterococci* (*Streptococci*) 100 cfu/100 ml (cfu = colony forming unit).

For more information see “FEE (2011). Blue Flag Beach Criteria and explanatory notes. Pp. 39.  
<http://www.blueflag.org/Menu/Criteria/Beaches/Beach+Criteria+and+Ex>



[pl+notes+2011](#)

*E. coli* and *Enterococci* are not mentioned as a Great Barrier Marine Park Australia (GBRMP) water quality trigger.

**BOD** (biological oxygen demand) is indicative of the amount of organic material in the wastewater. A low BOD is an indicator of good quality water, whilst a high BOD indicates polluted water. BOD is not explicitly specified as a Blue Flag criterion and is not mentioned as a GBRMP water quality trigger. Unpolluted waters typically have BOD values of 2 mg L<sup>-1</sup> or less, whereas water bodies receiving wastewater may have BOD values up to 10 mg L<sup>-1</sup> or more.

“Mocuba, J., J., (2010). Dissolved Oxygen and Biochemical Oxygen Demand in the waters close to the Quelimane sewage discharge. Master thesis in Chemical Oceanography NOMA. Geophysical Institute, University of Bergen – Norway. School of Marine and Coastal Sciences, Eduardo Mondlane University –Quelimane.

<https://bora.uib.no/bitstream/handle/1956/7063/71955008.pdf?sequence=1>

**COD** (Chemical oxygen demand) is indicative of the amount of chemical material in the wastewater that could remove oxygen. COD is not explicitly specified as a Blue Flag criterion and is not mentioned as a GBRMP water quality trigger.

**TDS** (Total dissolved solids) is indicative of the amount of micro-solid material (“*The quantity of dissolved material in a given volume of water*” <http://bcn.boulder.co.us/basin/data/NEW/info/TSS.html>). It is usually not used in saline water assays. It is not mentioned in the blue flag criteria or as a GBRMP water quality trigger. TDS is not generally considered a primary pollutant. It is used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of the presence of a broad array of chemical contaminants.

**TSS** (Total suspended solids) are solids in water that can be trapped by a filter. TSS can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. High concentrations of suspended solids can cause many problems for stream health and aquatic life.

<http://bcn.boulder.co.us/basin/data/NEW/info/TSS.html>

TDS is not explicitly specified as a Blue Flag criterion. Suspended solids are indicated as a trigger for receiving water quality in the Great Barrier



	<p>Reef Marine Park. See <a href="http://www.gbrmpa.gov.au/_data/assets/pdf_file/0017/4526/GBRMPA_WQualityGuidelinesGBRMP_RevEdition_2010.pdf">http://www.gbrmpa.gov.au/_data/assets/pdf_file/0017/4526/GBRMPA_WQualityGuidelinesGBRMP_RevEdition_2010.pdf</a></p> <p>The trigger value for enclosed coastal areas is 5.0/15mg/L, for open coastal areas is 2.0mg/L and offshore is 0.7mg/L.</p> <p><b>Other</b> indicators can be added following consultation and, if accepted, included in future versions of the module. Hydrocarbons have been suggested to be included by one group in the regional workshop on monitoring indicators of wastewater discharge in Hurgada, Egypt in October 2015.</p>				
13	<b>Level of treatment (%) proposed by end of next 5 years.</b>				
	<b>Total for all treatments should be 100%</b>				
	None		Primary		Secondary
	Tertiary	100	Other		Unknown
	<p>In this theoretical example tertiary treatment is proposed to be delivered for all the wastewater at the assessed discharge site within 5 years of the date of current assessment.</p>				
14	<b>Grievance redress issues (provide detail against this number on additional sheets)</b>				<b>Yes /No</b>
	<p>Proposed activities and actions should comply with national and local laws and regulations.</p> <p>In this theoretical example the operator of the wastewater site has indicated, preferably in writing, that there is no outstanding grievance concerning and following the assessment.</p>				
15	<b>Additional question/comments</b>				
	<p>This part of the questionnaire is left blank so that, if required, additional questions can be addressed.</p>				

<b>2.2</b>	<b>TOOLS</b>
<b>2.2.01</b>	<p>The tools for this module comprise: this module; high resolution map of the study area; Global positioning system (GPS); Flowmeter; permanent marker and tools for installation and maintenance; digital video/still camera, water sampling bottles.</p>
	Waterproof and shockproof still and video cameras that can also acquire



GPS information are becoming increasingly available.

2.3	INDICATORS OF TRAINING UPTAKE
2.3.01	The training uptake indicators for this module comprise: the score for completing a sample questionnaire and the score for participation in group exercises.
	The change in score before and after training should indicate the effectiveness of training uptake.

2.4	FURTHER INFORMATION
2.4.01	Corcoran, E., C. Nellemann, E. Baker, R. Bos, D. Osborn, H. Savelli (eds). 2010. Sick Water? The central role of wastewater management in sustainable development. A Rapid Response Assessment. United Nations Environment Programme, UN-HABITAT, GRID-Arendal. <a href="http://www.grida.no">www.grida.no</a> <a href="http://www.unep.org/pdf/SickWater_screen.pdf">http://www.unep.org/pdf/SickWater_screen.pdf</a>
2.4.02	PERSGA (in prep). Standard Survey Methods for Key Habitats and Key Species in the Red Sea and Gulf of Aden. Regional Organisation for the Conservation of the Environment of the Red Sea and Gulf of Aden. PERSGA, Jeddah.  This is a draft document in preparation at the time of writing of this manual. The current survey manual is “PERSGA/GEF 2004. Standard Survey Methods for Key Habitats and Key Species in the Red Sea and Gulf of Aden. PERSGA Technical Series No. 10. PERSGA, Jeddah. <a href="http://www.persga.org/Files//Publications/Technical/TS/TS10_SSM_for_Key_Habitat.pdf">Http://www.persga.org/Files//Publications/Technical/TS/TS10_SSM_for_Key_Habitat.pdf</a>
2.4.03	PERSGA (2015). Draft Regional Guidelines on Wastewater Management in Coastal Cities on the Red Sea And Gulf of Aden. August 2015. Regional Intergovernmental Organisation for the Conservation of the Environment of the Red Sea and Gulf of Aden.  This is a draft document.
2.4.04	Tilley, E., Ulrich, L., Lüthi, C., Reymond, Ph., Zurbrügg, C. (2014). Compendium of Sanitation Systems and Technologies – (2nd Revised Edition). Swiss Federal Institute of Aquatic Science and Technology (Eawag), Duebendorf, Switzerland. p. 175. ISBN 978-3-906484-57-0. <a href="http://www.sswm.info/sites/default/files/reference_attachments/TILLEY%20et%20al%202014%20Compendium%20of%20Sanitation%20Syst">http://www.sswm.info/sites/default/files/reference_attachments/TILLEY%20et%20al%202014%20Compendium%20of%20Sanitation%20Syst</a>



	<a href="#">ems%20and%20Technologies%202nd%20Revised%20Edition.pdf</a>
2.4.05	<p>UNEP (2015). Wastewater Pollution &amp; Coral Reefs. Science-to-Policy Brief for UNEP DRAFT September 2015. C2O. UNEP.</p> <p>This was in draft form at the time of preparation of this manual.</p>
2.4.06	<p>Other modules in this manual</p> <p>This module provides the second of five modules forming the manual with each module forming a numbered sequence delivering the manual and each module should be delivered in context. The text of the training for trainer notes for this module also contains links to additional materials.</p>

<b>2.5</b>	<b>GROUP EXERCISE</b>
2.5.01	<p>Field trip: To a wastewater treatment facility and to locations of point and non-point sources of wastewater.</p> <p>A field trip is a very good way of enhancing training uptake of the learning points. Many large facilities will allow access for educational purposes provided the request is made in the right way and there is sufficient notice. Do not impose any pre-conditions on numbers and activities. Ensure that a grievance redress statement is provided at the end of the field visit and resolve any grievances. Use the field trip to demonstrate key learning points and to show the geographic relationship between the wastewater treatment facility, the point and/or non-point sources of wastewater that are being treated and the closest living coral reef and other sensitive marine habitats and marine social and economic uses.</p>
2.5.02	<p>Complete a questionnaire</p> <p>The questionnaire should be completed. If it is not possible to use a real life situation during a field visit then try to make the classroom situation as realistic as possible. Allow about 30 minutes for completing the questionnaire.</p>
2.5.03	<p>Break into groups: Discuss the opportunities and constraints to the survey questionnaire in the context of what it is supposed to achieve. Present and agree a set of review recommendations.</p> <p>How the target audience is broken into groups depends on the overall</p>



	<p>size of the group and how the group would like to be broken-up. Groups should be of approximately equal size and comprise a balanced mixture of skills and experience. The group should elect a chairperson and spokesperson.</p> <p>The group exercise is a mechanism by which the target audience can explore and test the learning points. Each group should consider each learning point and propose, discuss, agree and present possible changes. After each group has presented there should be agreement about key recommendations.</p>
2.5.04	<p>Break into groups: Prepare and present a questionnaire based on the set of review recommendations.</p> <p>See comments under 2.5.03. Training of the target audience to prepare a questionnaire will take significant time and understanding of the issues. This group activity should, therefore, just be an exercise to see how the existing questionnaire might be modified to reflect the recommendations made under 2.5.03.</p>

2.6	<b>TRAINING UPTAKE TEST</b> <b>(expand/continue on separate sheets as necessary)</b>	0-10
	<p>The above questionnaire should be completed before the training to act as a baseline and after the training to determine training uptake. Participation in each activity should be scored by the trainer and/or an independent evaluator from 0-10 with a maximum of 10. The total score for the test should be the sum of the scores for each activity. It is suggested that approximately <b>30 minutes</b> should be allowed for completing the questionnaire.</p>	

Pre		Post		<p>If the test is taken before training tick (✓) the “pre” box and if it is taken after training tick (✓) the “post” box.</p>
-----	--	------	--	---

Tick box as appropriate.

2.6.01	Field trip	<p>Add any comments here about the individuals’ performance. The individual should be given a score out of ten reflecting the extent to which the individual has participated in, and learnt from the field visit.</p>	
2.6.02	Complete the above questionnaire	<p>Add any comments here about the individuals’ performance. The individual should be given a score out of ten reflecting the extent to which the individual has understood and correctly</p>	



		completed the questionnaire.	
2.6.03	Group presentation of module review	Add any comments here about the individuals' performance. The individual should be scored reflecting his/her understanding of the issues being discussed and their contribution to helping to deliver consensus within the group.	
2.6.04	Group preparation of a questionnaire	Add any comments here about the individuals' performance. The individual should be scored reflecting his/her understanding of the issues being discussed and their contribution to helping to deliver consensus within the group about the questionnaire being prepared.	
2.6.05	Examinee, name, signature and date	Examiner, name, signature and date	Total
Comments by examinee:		Comments by examiner:	



**MANUAL FOR MONITORING INDICATORS OF THE IMPACT OF WASTEWATER DISCHARGE ON CORAL REEFS**  
**MODULE 3 : MONITORING EFFECTS (impact of wastewater on coral reefs)**



Reef monitoring, northern Saudi Red Sea, early 1980's



WASTEWATER EFFECTS INDICATORS						
Indicator	Location	Biological	Chemical	Physical	Social	Community*
Calcareous algae		✓				
Chlorophyll a		✓				
Date	✓					✓
Distance to 50+m deep water				✓		
Distance to open sea				✓		
Dissolved oxygen			✓			
Enterococci		✓				
Escherichia coli		✓				
Fishing boats					✓	
Hydrocarbons			✓			
Latitude	✓					✓
Living hard coral		✓				✓
Living soft coral		✓				
Longitude	✓					✓
Non-calcareous algae		✓				
Other						
Algal bloom		✓				
Coral bleaching		✓				
Disease		✓				
Fish kills		✓				
Red Tide		✓				
Spawning (coral, grouper etc)		✓				
Whales/dolphins		✓				
Parrotfish		✓				
Particulate nitrogen (PN)			✓			
Particulate phosphorus (PP)			✓			
pH			✓			
Sedimentation				✓		
Salinity				✓		
Solid waste					✓	
Spiny sea-urchin		✓				
Time	✓					
Tourist boats					✓	
Total suspended solids (TSS)				✓		
Wastewater pollution (qualitative)			✓			✓
Water current speed				✓		
Water temperature				✓		
Water visibility				✓		

**\*Priority Community monitoring indicators**

The above table lists the wastewater effects indicators associated with this module to be collected using the form presented under learning point 3.1.09. Priority indicators for local communities to monitor with support from citizen science groups are highlighted in green and include: the location of the information in terms of date, latitude and longitude; the presence of living hard coral in respect of biological organisms; and a qualitative estimation of whether there is any wastewater pollution at the location. Additional indicators from the list can, of course, be monitored if there is interest and resources are available for training.



**TRAINING FOR TRAINER NOTES**

3.1	LEARNING POINTS
3.1.01	<p><b><u>Module 3 – Monitoring effects (impacts of wastewater on coral reefs)</u></b>: By the end of this module the target group will be able to provide, locate and place permanent markers on a living coral reef and monitor the reef to detect change in key indicators of coral reef health that may be affected by wastewater. Training in this module should take approximately four hours of presentation, one to two hours for the group exercises, 30 minutes to complete the survey form and 15 minutes for the test. Any fieldwork should be added to this time.</p> <p>It is important to summarise to the trainees the reason for the module in the context of the 6 modules forming the guideline. The focus of this module is on collecting information about the change in state of certain types of life along 20m transects located between permanent markers. Monitoring change requires that sampling is repeated over time and the results from each sampling are compared to see if there is any change. Without this information it is not possible to link wastewater discharges to any adverse impacts on coral reefs. Such a linkage is necessary to justify and advocate for investments in managing wastewater to reduce any adverse impacts.</p>
3.1.02	<p><b><u>Form a citizen science group</u></b>: The group should contain people who can use/train others to use the tools specified below and people who are willing to be trained and to do the surveys.</p> <p>Citizen science is defined in module 1 and tools for advocacy that might be used by a Citizen’s science group is presented in module 5.</p>
3.1.03	<p><b><u>Site selection</u></b>: The sites selected for monitoring should be on living coral reef areas and, to the extent possible, include a possible wastewater impact site and a control site.</p> <p>There is no point in selecting monitoring sites where there is no existing living hard coral (the dependent variable) unless there is objective evidence that there was living hard coral before wastewater was discharged. Any possible wastewater impact site should be as close to a known wastewater discharge as possible. The definition of a control is given in module 1. It should be an area where all conditions are the same as for the impact site but without any wastewater</p>

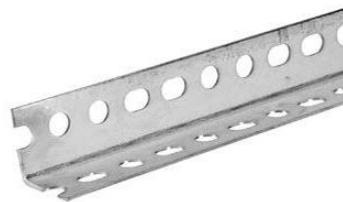


	influence (the independent variable).	
3.1.04	<p><b>Obtain permission:</b> Always get permission from the management authority, often the Ministry responsible for Environment, for the sampling area to place permanent markers and monitor the reef around the markers.</p>	
	<p>Proposed activities and actions should comply with national and local laws and regulations.</p> <p>It is important that permission to access and use information is obtained in writing from the permitting authority and particularly so if site access is required and/or a marker is to be placed. Ensure that the permitting authority also signs-off that there is <b>no grievance</b> at the end of a site visit.</p>	
3.1.05	<p><b>Safety and operational considerations:</b></p> <ol style="list-style-type: none"> <li>1. Tell people where you are going and when you are due back.</li> <li>2. Make sure that the boat has water, a radio and lifesaving equipment.</li> <li>3. Show consideration for other users of the area you are monitoring.</li> <li>4. Use the Greenfins code including neutral buoyancy to minimise damage to the environment.</li> </ol>	 <p><a href="http://www.greenfins.net/">http://www.greenfins.net/</a></p>
	<p>There are numerous guidelines for safety and operational considerations including care for the environment when snorkelling and SCUBA diving. The Greenfins system is supported by UNEP</p> <p><a href="http://www.unep.org/roap/NewsandEvents/SuccessStories/GuardingtheSeas/tabid/6678/Default.aspx">http://www.unep.org/roap/NewsandEvents/SuccessStories/GuardingtheSeas/tabid/6678/Default.aspx</a></p>	
3.1.06	<p><b>Permanent (fixed) markers:</b> Markers should comprise: stainless steel stakes for open architecture reefs and stainless steel eyed screws for solid areas of reef with replaceable tags each with a unique marker number. Details are provided in the training for trainer notes.</p>	
	<p>Markers should be placed 5m apart along one depth contour to cover 20m. Additional markers can be provided to extend the transect at the same depth or for transects at other depths. There should be sufficient description using GPS, maps, depth, line of sight and photographs to relocate the markers. Using automatic monitoring stations could be</p>	



considered within the scope of citizen science through citizens providing support to automatic monitoring by protecting, checking on/cleaning monitoring equipment on behalf of professional scientists. There are many ways of permanently marking a site.

For an **open architecture** reef hammer each marker into a crack in the reef in a way that minimises damage to the reef and the amount of marker that is exposed but allows the ties to be attached. Tags and a floating marker line can then be tied through the eyelet.



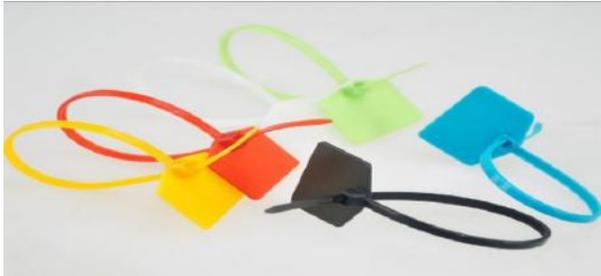
If the substrate is **solid** then drill a hole, insert a plastic plug and then screw the eyed screw into the hole. Tags and a floating marker line can then be tied through the eyelet.



Care should be taken when using the plastic plugs not to leave them at the site since this will become plastic litter which can harm aquatic life.

Robust non-friable, sunlight resistant ties and tags should be attached to the permanent marker. The tags should be of sufficient size to take an heavily inscribed (punched or melted) legible unique marker number that will not disappear when regularly cleaned.



									
3.1.07	<p><b>Survey technique:</b> Carefully lay a tape measure as a guide if needed between the markers. One form should be completed for each 20m section. Estimate the number, and/or percent area, of each indicator within 2.5m (5m wide band) of the line connecting the four markers.</p> <p>See references in “<i>Further information</i>” and details in the elaboration of the “<i>Survey form</i>” in this training for trainer notes for additional information.</p>								
3.1.08	<p><b>Other methods:</b> More sophisticated survey methods are available from PERSGA and can be used if there is capacity to do so but all can use the same permanent markers as fixed survey points.</p> <p>See references in “<i>Further information</i>” and details in the elaboration of the “<i>Survey form</i>” in the training for trainer notes for additional information.</p>								
3.1.09	<b>Survey form</b>								
	<p>A form should be completed for each transect. The date the information collected should be given as yyyy/mm/dd. The hours should be recorded according to 24 hour clock. Each form should be given a unique number.</p>								
1	<b>Information collector</b>		<b>Contact details</b>						
	The full name and contact details		The full name and contact details of the person collecting the information including address, mobile number and email.						
2	Date	2018/01/24	Start time	09.10	Finish time	11.30	Form ID	12345	
3	Name/location of site					Transect length/width (m)			



4	<p>The name/location of the site including the country, province and district and sufficient information for somebody who hasn't visited the site to relocate it. A site <b>selection criteria checklist</b> can be developed and consider the following:</p> <ul style="list-style-type: none"> <li>- accessibility (how easy is the site to get to – depth profile, permissions, physical exposure etc.)</li> <li>- control or a dependent variable site (site needs to be one or other of these)</li> <li>- distance from wastewater source (should be a range of distances)</li> <li>- existing monitoring site (to provide a historic record etc)</li> <li>- representativeness (depth, exposure, geology, profile)</li> <li>- relocation (possible compensation site, discharge site etc.)</li> <li>- status (control and pre-impact assessment sites should be healthy)</li> <li>- other</li> </ul> <p>The higher the score the higher the suitability although there must be control sites.</p> <p>Boxes are provided to enter transect length and width if they do not match with the standard. The standard of 20m by 5m centred on the transect line proposed for standard surveys.</p>									
	<b>Start marker ID</b>	123456	<b>Latitude (N/S)</b>	Degrees, decimal degrees	<b>Longitude (-W/+E)</b>	Degrees, decimal degrees				
	<b>End marker ID</b>	123457	<b>Latitude (N/S)</b>	Degrees, decimal degrees	<b>Longitude (-W/+E)</b>	Degrees, decimal degrees				
	<p>Use an accurate global positioning system (GPS) to locate the site. If the site is in the northern hemisphere then the latitude should indicate "N" and if the site is in the southern hemisphere then the latitude should indicate "S". If the site is west of the Greenwich meridian the longitude should indicate negative (-) degrees from 1-180 W and if the site is east of the Greenwich the longitude should indicate positive (+) degrees from 1-180 E.</p>									
<p><b>Wastewater pollution (estimate from start marker and tick relevant box)</b></p>										
None		low	✓	Medium		High		Unknown		
<p>This is a subjective estimate. In this case the information collector has indicated that there is <b>low</b> wastewater pollution in the vicinity of the <b>start marker</b>. In fact this is more of an awareness raising activity since it is so subjective and can be determined by other indicators. However,</p>										



	it gets the target audience to appreciate the distance from possible wastewater discharge and the monitoring site. Details of actual discharges can be obtained from the completed questionnaires from module 2.				
5	<b>Video</b> (start to finish marker including tags. Label video with form ID, date and marker IDs)				
	<b>URL (Uniform Resource Identifier)</b>		<b>Length/width (m)</b>		
	The <b>URL (Uniform Resource Identifier)</b> is the web address of any video taken along the transect. Please ensure that the transect is swum slowly to avoid blurring and that it starts and ends with a readable close-up of the marker IDs. Please also make sure that the video properties are labelled with the form ID, data and marker IDs of the transect location.				
	Boxes are provided to enter transect length and width if they do not match with the standard. The standard of 20m by 5m centred on the transect line is proposed for standard surveys. However, the camera is likely to need to get closer to the transect line to maximise resolution so the width covered may be less and does not need to follow the standard but the width should be recorded.				
6	<b>Geomorphology/Oceanography</b> (from start marker)				
	<b>Distance to 50+m deep water (m)</b>	1200m	<b>Distance to open sea (m)</b>	1200m	<b>High currents y/n or speed ms<sup>-1</sup>?</b>
	The distance to deep water and distance to the open sea can be estimated from maps. These geomorphological characteristics can give a qualitative indication of the water exchange potential of the site and the extent to which wastewater might be diluted (the solution is dilution). Whether or not there are high currents can also give an indication of water exchange. This can be visually estimated or determined more objectively by releasing a floating object and seeing how long it takes to move between two markers that are a known distance apart. Alternatively a flowmeter can be used. The boxes show that 50+m deep water and the open sea are both 1200m (1.2km) away and the water currents are estimated to be high.				
	<b>Visibility (m) (secchi)</b>	<b>Visibility (m) (markers)</b>	<b>Temperature (°C)</b>	<b>Salinity (ppt)</b>	<b>Other</b>
	12m	10m	28.5	36	-
Visibility can be measured using a secchi disc (see below) or by					



estimating the number of markers that can be seen along a transect. Visibility/water clarity, measured by a secchi disc, and temperature are triggers for water quality in the Great Barrier Reef Marine Park (GBRMP):

[http://www.gbrmpa.gov.au/data/assets/pdf\\_file/0017/4526/GBRMP\\_A\\_WQualityGuidelinesGBRMP\\_RevEdition\\_2010.pdf](http://www.gbrmpa.gov.au/data/assets/pdf_file/0017/4526/GBRMP_A_WQualityGuidelinesGBRMP_RevEdition_2010.pdf)

The GBRMP trigger for water clarity is 1.0-1.5m in enclosed coastal areas, 10m in open coastal areas and 17m offshore. The GBRMP trigger for temperature is that there is no increase of more than 1°C above the long-term average maximum. Temperature is also an indicator of global warming. Salinity could be indicative of freshwater input if the salinity is lower than the open sea norm and of low water circulation if it is higher. Salinity is not a trigger for water quality in the Great Barrier Reef Marine Park (GBRMP).

The drawings of the secchi disc and the salinometer are from:  
 “AIMS (1997). *Survey Manual for Tropical Marine Resources*. 2nd edition. P.390. Ed: S. English, C. Wilkinson and V. Baker”.

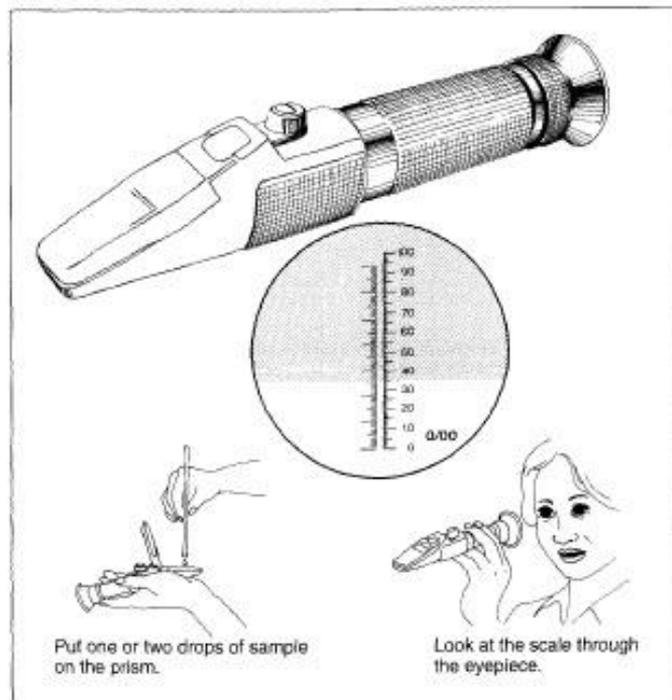


Figure 2.1 A diagram of a refractometer showing its use for measuring salinity.

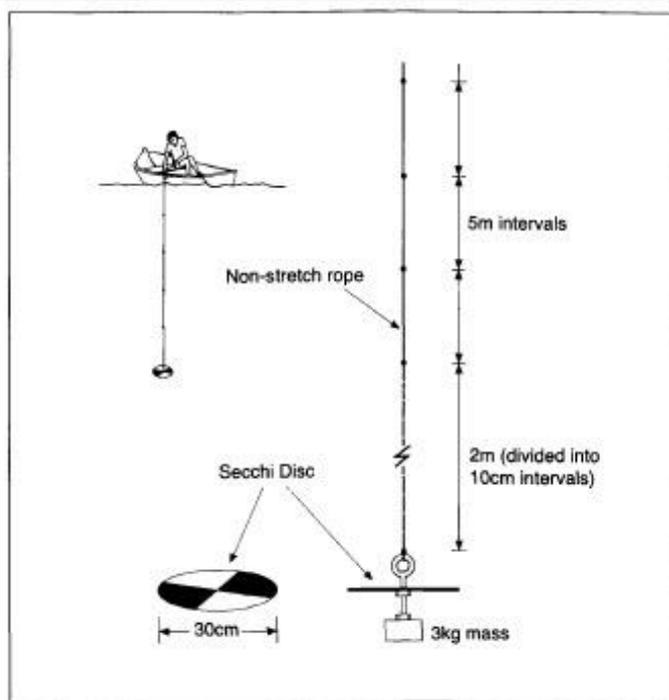
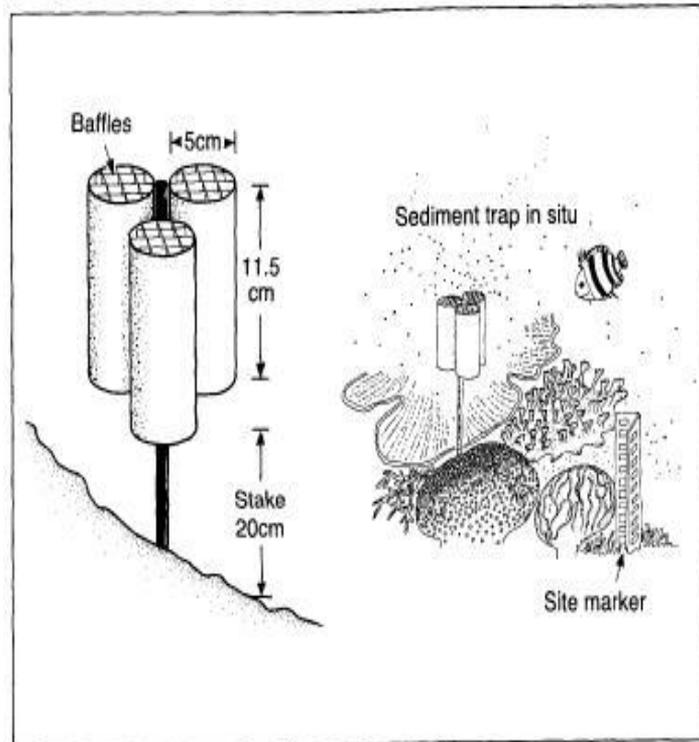


Figure 2.2. Diagram of Secchi disc showing its use.

7	<b>Sediment trap near start marker (label samples with Form ID and marker ID)</b>				
	Start date	Finish date	Oven dry weight (milligrams/cm <sup>2</sup> )		
			Total	Organic	CaCO <sub>3</sub>
2018/01/24	2018/01/25	90mg	9.5mg	80mg	0.5mg
<p>The start date in yyyy/mm/dd is the date on which the sediment trap is placed and the finish date in yyyy/mm/dd is the date on which the sediment is removed. The figures above are artificial but indicate that most of the sediment is likely to be from the reef (CaCO<sub>3</sub>) unless terrestrial run-off is from a high CaCO<sub>3</sub> terrestrial geology. Sediment is a trigger for water quality in the Great Barrier Reef Marine Park (GBRMPA):</p> <p><a href="http://www.gbrmpa.gov.au/_data/assets/pdf_file/0017/4526/GBRMP_A_WQualityGuidelinesGBRMP_RevEdition_2010.pdf">http://www.gbrmpa.gov.au/_data/assets/pdf_file/0017/4526/GBRMP_A_WQualityGuidelinesGBRMP_RevEdition_2010.pdf</a></p> <p>The GBRMP trigger for sediment is a maximum mean annual sedimentation rate of 3 mg/cm<sup>2</sup>/day, and a daily maximum of 15 mg/cm<sup>2</sup>/day. The drawings of the sediment trap are from “AIMS (1997). Survey Manual for Tropical Marine Resources. 2nd edition. P.390. Ed: S. English, C. Wilkinson and V. Baker”.</p>					



8

### Other water quality indicators

(Tick frequency that applies. Add value for this survey, if any)

Indicator	None	Daily	Weekly	Monthly	Annual	Unknown	This survey/value
<i>E. coli</i>					✓		100 cfu/100ml
<i>Enterococci</i>					✓		50 cfu/100ml
DO	✓						20 ppm
pH	✓						8.1
Chl <i>a</i>	✓						0.45 µg/L
TSS	✓						1.0 mg/L
PN	✓						17 µg/L
PP	✓						1.9 µg/L

It is not expected that the volunteers in a citizen science group would undertake the analysis of water quality indicators. However, they can collect samples using techniques and containers provided by expert scientists and should have some understanding as to why the indicators are important.

In this theoretical example two indicators are analysed annually. The others have not been analysed. All the indicators are sampled during this survey.

*E. coli* and *Enterococci* are bacteria associated with faecal (black-water/sewage) material. They are indicative of sewage pollution and



are a health risk. Blue Beach flag system sets thresholds for these bacteria in bathing waters of:

- *Escherichia coli* (Faecal Colibacteria) 250 cfu/100 ml (cfu = colony forming unit)
- Intestinal *Enterococci* (*Streptococci*) 100 cfu/100 ml (cfu = colony forming unit).

For more information see “FEE (2011). *Blue Flag Beach Criteria and explanatory notes*. Pp. 39.

<http://www.blueflag.org/Menu/Criteria/Beaches/Beach+Criteria+and+Expl+notes+2011>

*E. coli* and *Enterococci* are not mentioned as a Great Barrier Marine Park Australia (GBRMP) water quality trigger. For GBRMP water quality triggers see:

[http://www.gbrmpa.gov.au/\\_data/assets/pdf\\_file/0017/4526/GBRMP\\_A\\_WQualityGuidelinesGBRMP\\_RevEdition\\_2010.pdf](http://www.gbrmpa.gov.au/_data/assets/pdf_file/0017/4526/GBRMP_A_WQualityGuidelinesGBRMP_RevEdition_2010.pdf)

**DO** (Dissolved Oxygen) is an indicator of the amount of oxygen that is dissolved in the water. Living coral Reefs require and have very high levels of dissolved oxygen, close to saturation. Reduced DO levels can indicate that organic matter is decomposing and using up the oxygen. DO is not explicitly specified as a Blue Flag criterion and is not mentioned as a GBRMP water quality trigger.

**pH** is a measure of the acidity or alkalinity. In seawater it should be in the range of 7.5 to 8.5. It will only change under extreme conditions and in the immediate vicinity of certain acidic wastewater discharges. In the long term ocean acidification is likely to increase due to increased carbon dioxide due to the human burning of fossil fuels (climate change). Measuring pH with high accuracy is not easy. It has more value in raising awareness about climate change and ocean acidification when measured by citizen scientists. Measuring pH to monitor for climate change is best left to specialists. pH is not explicitly specified as a Blue Flag criterion and is not mentioned as a GBRMP water quality trigger.

**Chlorophyll *a*** is a photosynthetic pigment found in plants and shows the amount of plants in the water that can produce oxygen. Low chlorophyll *a* means that the water body will have limited resilience if it faces a biological oxygen demand from organic matter decomposition since it will have low capacity to produce oxygen. High chlorophyll *a*



can also put a respiratory load on oxygen during the night when photosynthesis is not taking place. Chlorophyll *a* is a proxy for dissolved organic nitrogen and is measured in  $\mu\text{g/L}$ . The GBRMP has set trigger values for chlorophyll *a*. These are  $2.0 \mu\text{g/L}$  in enclosed coastal waters,  $0.45 \mu\text{g/L}$  in open coastal waters, and  $0.4 \mu\text{g/L}$  in offshore waters. Chlorophyll *a* is not identified as a Blue Flag criterion.

The effects of Total Suspended Solids (TSS), Particulate Nitrogen (PN) and Particulate Phosphorus (PP) on ecosystem health are difficult to distinguish so measuring them all, until such time as their discrete effects are determined provides a cross-check.

**TSS** (Total Suspended Solids) are solids in water that can be trapped by a filter. TSS can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. High concentrations of suspended solids can cause many problems for stream health and aquatic life

<http://bcn.boulder.co.us/basin/data/NEW/info/TSS.html>

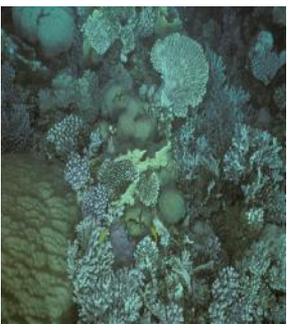
TSS are not explicitly specified as a Blue Flag criterion. Suspended solids are indicated as a trigger for receiving water quality in the Great Barrier Reef Marine Park. The trigger value for enclosed coastal areas is  $5.0\text{-}15\text{mg/L}$ , for open coastal areas is  $2.0\text{mg/L}$  and offshore is  $0.7\text{mg/L}$ .

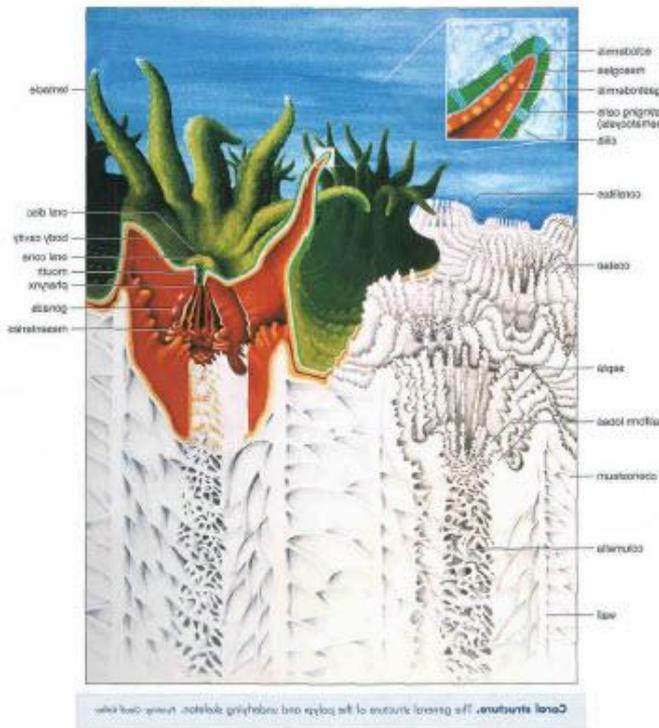
**Particulate Nitrogen (PN)** and **Particulate Phosphorus (PP)** are nutrients associated with wastewater and enhance the growth of plants such as non-calcareous algae on the seabed and in the plankton over slower growing plants such as seagrass. These fast growing algal species are indicated to influence crown-of-thorns starfish outbreaks, to prevent settlement of the young of living hard corals on the reef, and to encourage algal grazers such as sea-urchins that can incidentally scrape newly settled young of living hard corals off the reef. The result of this process is considered to be reduced living coral reef health.

PN is not explicitly specified as a Blue Flag criterion. PN is indicated as a trigger for receiving water quality in the Great Barrier Reef Marine Park. There is no trigger value for enclosed coastal areas. The trigger value for open coastal areas is  $20 \mu\text{g/L}$  and offshore is  $17 \mu\text{g/L}$ .

PP is not explicitly specified as a Blue Flag criterion. PP is indicated as a trigger for receiving water quality in the Great Barrier Reef Marine



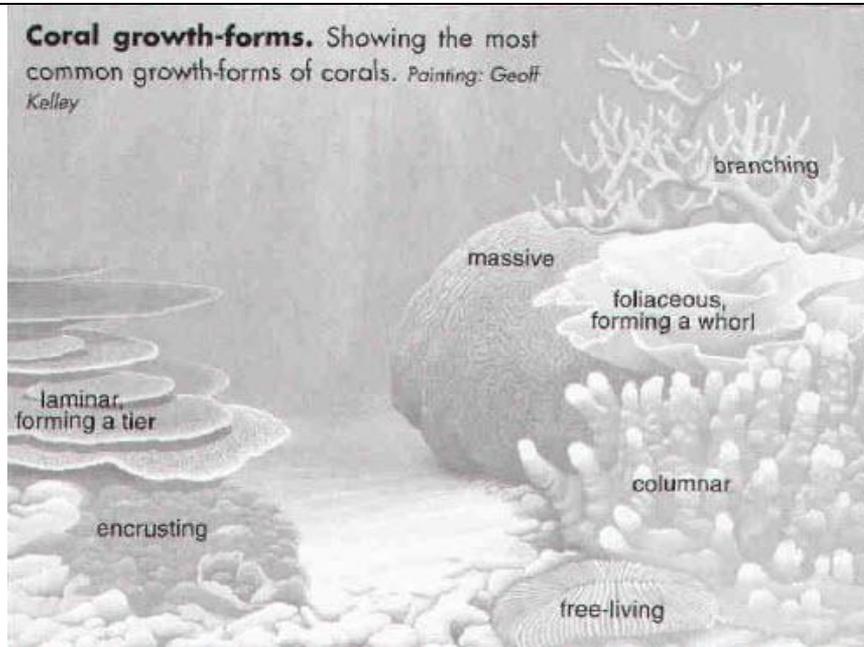
	Park. There is no trigger value for enclosed coastal areas. The trigger value for open coastal areas is 2.8 µg/L and offshore is 1.9 µg/L.							
<b>9</b>	<b>Living hard coral (Hard endo-skeleton with thin fleshy veneer. Polyps visible)</b>							
		<b>Images URL (Uniform Resource Identifier)</b>		The web page where the image is held. Please ensure that the form ID, date and marker IDs for is included in the image properties (image file).				
		<b>Number of colonies</b>						<b>% cover</b>
		<b>0</b>	<b>+</b>	<b>1+</b>	<b>10+</b>	<b>100+</b>	<b>1000+</b>	
	✓			✓		<b>10</b>		
	No evidence of coral bleaching.							
								
	Living hard coral dominated reef with massive and branching corals. Central Saudi Arabian Red Sea.							
	Living hard coral is a key indicator and component of coral reef ecosystem health under Reef Check and under the Blue Flag criteria which defers to Reef Check in respect of coral reefs within 500m of a Blue Flag Beach. Healthy coral reefs tend to be dominated by hard corals. Hard reef building corals are characterised by a hard endo-skeleton built from calcium carbonate and a fleshy veneer with the presence of coral polyps, with tentacles situated in depressions in the skeleton known as calyx.							



Veron, J.E.N., (2000). Corals of the World. Volumes, 3. Ed. Stafford Smith, M. Australian Institute of Marine Sciences.

Living hard corals are vulnerable to nutrients and sediment from wastewater and to ocean acidification projected to result from climate change.

Hard corals can take many forms including massive such as brain corals which look like a human brain, branching corals, laminar, columnar, foliar, encrusting corals and solitary free living corals.



From Veron, 2000

Tick box for absence (0) or presence (+). If possible enter the absolute number or tick the relevant abundance box and the estimated percent cover in the transect area. In this theoretical example more than 100 and less than 999 living hard corals were observed in the transect area and the estimated percent cover of living hard coral in the transect area is estimated at 10%.

<b>10</b>	<b>Living soft coral (Fleshy. No hard skeleton. Polyps visible)</b>						
		<b>Images URL (Uniform Resource Identifier)</b>		The web page where the image is held. Please ensure that the form ID, date and marker IDs for is included in the image properties (image file).			
<b>Number of colonies</b>						<b>% cover</b>	
0		+	1+	10+	100+		1000+
		✓		✓			1
No comment							



Courtesy

[http://www.teachoceanscience.net/modulepopup/coral\\_reefs\\_and\\_climate\\_change/compare\\_all\\_4\\_parks/](http://www.teachoceanscience.net/modulepopup/coral_reefs_and_climate_change/compare_all_4_parks/)

K. Lindsey Kramer, NPS

Living soft coral is a key indicator and component of coral reef ecosystem health under Reef Check and under the Blue Flag criteria which defers to Reef Check in respect of coral reefs within 500m of a Blue Flag Beach. Soft corals are fleshy. They do not have a calcium carbonate skeleton but they do have polyps with tentacles. Healthy coral reefs tend to be dominated by hard corals. Large numbers and a high percent cover of soft coral can be suggestive of a less healthy coral reef. Some soft coral is usually present on a healthy coral reef.

Tick box for absence (0) or presence (+). If possible enter the absolute number or tick the relevant abundance box and the estimated percent cover in the transect area. In this theoretical example more than 10 and less than 100 living soft corals were observed in the transect area and the estimated percent cover of living soft coral in the transect area is estimated at 1%.



<b>11</b>	<b>Non-calcareous algae</b> (Fleshy. No hard skeleton. Green red or brown colour. No polyps)						
		<b>Images URL (Uniform Resource Identifier)</b>		The web page where the image is held. Please ensure that the form ID, date and marker IDs for is included in the image properties (image file).			
		<b>Number of colonies</b>					<b>% cover</b>
		<b>0</b>	<b>+</b>	<b>1+</b>	<b>10+</b>	<b>100+</b>	<b>1000+</b>
No comment							
							
<p>Courtesy</p> <p><a href="http://www.teachoceanscience.net/modulepopup/coral_reefs_and_climate_change/compare_all_4_parks/">http://www.teachoceanscience.net/modulepopup/coral_reefs_and_climate_change/compare_all_4_parks/</a></p> <p>K. Lindsey Kramer, NPS</p>							
<p>Non-calcareous algae are a key indicator and component of coral reef ecosystem health under Reef Check and under the Blue Flag criteria which defers to Reef Check in respect of coral reefs within 500m of a Blue Flag Beach. Non-calcareous algae are simple plants. They do not</p>							



contain a calcium carbonate skeleton and tend to be fleshy and do not have a hard skeleton. They do not have polyps though sometimes things grow on them that have polyps. Unlike seagrasses they do not have roots and are attached to the seabed at a single point. The non-calcareous algae take very many forms and range from small filamentous turf/grass-like algae through to large leaved algae. They can be a range of colours from green through red and brown. Non-calcareous algal growth can be encouraged by the nutrients from wastewater and the lack of competition from hard and soft corals. Large numbers, and a high percent cover, of non-calcareous algae can be suggestive of a less healthy coral reef.

Tick box for absence (0) or presence (+). If possible enter the absolute number or tick the relevant abundance box and the estimated percent cover in the transect area. In this theoretical example more than 10 and less than 100 non-calcareous algae were observed in the transect area and the estimated percent cover of non-calcareous algae in the transect area is estimated at 1%.

12	<b>Calcareous algae</b>																							
	<b>(Hard skeleton. Green red or brown colour. No polyps)</b>																							
	 	<b>Images URL (Uniform Resource Identifier)</b>	The web page where the image is held. Please ensure that the form ID, date and marker IDs for is included in the image properties (image file).																					
			<table border="1"> <thead> <tr> <th colspan="5">Number of colonies</th> <th>% cover</th> </tr> <tr> <th>0</th> <th>+</th> <th>1+</th> <th>10+</th> <th>100+</th> <th>1000+</th> </tr> </thead> <tbody> <tr> <td></td> <td style="text-align: center;">✓</td> <td></td> <td style="text-align: center;">✓</td> <td></td> <td></td> <td style="text-align: center;">10</td> </tr> </tbody> </table>					Number of colonies					% cover	0	+	1+	10+	100+	1000+		✓		✓	
Number of colonies					% cover																			
0	+	1+	10+	100+	1000+																			
	✓		✓			10																		
No comment																								
																								
Courtesy: <a href="http://greenaquarium.com/tag/coralline-algae-growth/">http://greenaquarium.com/tag/coralline-algae-growth/</a>				Courtesy: <a href="http://www.sdreefs.com/forums/showthread.php?108862-Halimeda-Algae-Plant">http://www.sdreefs.com/forums/showthread.php?108862-Halimeda-Algae-Plant</a>																				



	<p>Calcareous algae, including coralline algae are not a key indicator and component of coral reef ecosystem health under Reef Check and under the Blue Flag criteria which defers to Reef Check in respect of coral reefs within 500m of a Blue Flag Beach. However, calcareous algae are included here because of their vulnerability to ocean acidification and their importance in consolidating the coral reef structure and in producing coral sand.</p> <p>Calcareous algae contain a calcium carbonate skeleton. They do not have polyps though sometimes things grow on them that have polyps. Calcareous algae take very many forms and range from encrusting to plant-like. As for non-calcareous algae the non-encrusting forms do not have roots and are attached to the seabed at a single point. They can be found in a range of colours from green through red and brown. Large numbers, and a high percent cover, of calcareous algae, particularly encrusting forms, can be suggestive of a healthy coral reef.</p> <p>Tick box for absence (0) or presence (+). If possible enter the absolute number or tick the relevant abundance box and the estimated percent cover in the transect area. In this theoretical example more than 10 and less than 100 calcareous algae were observed in the transect area and the estimated percent cover of calcareous algae in the transect area is estimated at 10% (the number of encrusting colonies may be relatively small but the area of coverage relatively large).</p>							
13	<p><b>Parrotfish (Parrot-like beak)</b></p>							
		<p><b>Images URL (Uniform Resource Identifier)</b></p>		<p>The web page where the image is held. Please ensure that the form ID, date and marker IDs for is included in the image properties (image file).</p>				
		<p><b>Number of parrotfish</b></p>						
		0	+	1+	10+		100+	1000+
			✓		✓			
						<p>Feeding scars observed on living hard coral.</p>		
<p>Parrotfish are a key indicator and component of coral reef ecosystem health under Reef Check and under the Blue Flag criteria which defers to Reef Check in respect of coral reefs within 500m of a Blue Flag Beach.</p>								



Parrotfish are relatively easily identified because of their parrot-like beak and are also relatively common so making observation of any change easier. Parrotfish use the parrot-like beak primarily to scrape algae off the reef although some also scrape off living hard coral. Their feeding activity can remove algae that might otherwise prevent the settlement of hard corals. The presence of parrotfish on a living coral reef is a sign that the reef is healthy.

Tick box for absence (0) or presence (+). If possible enter the absolute number or tick the relevant abundance box in the transect area. The percent cover box is not relevant. In this theoretical example more than 10 and less than 100 parrotfish in the transect area.



Courtesy:  
[https://commons.wikimedia.org/wiki/File:Chlorurus\\_sordidus\\_by\\_Jaroslav\\_Barski.jpg](https://commons.wikimedia.org/wiki/File:Chlorurus_sordidus_by_Jaroslav_Barski.jpg)

<b>14</b>	<b>Spiny sea-urchin (black-long spines)</b>	
		<p><b>Images URL (Uniform Resource Identifier)</b></p> <p>The web page where the image is held. Please ensure that the form ID, date and marker IDs for the each image is included in the image properties.</p>
	<b>Number of sea-urchins</b>	



		0	+	1+	10+	100+	1000+	
				✓		✓		
15	<p><b>Spiny</b> sea urchins are a key indicator and component of coral reef ecosystem health under Reef Check and under the Blue Flag criteria which defers to Reef Check in respect of coral reefs within 500m of a Blue Flag Beach.</p> <p>Spiny sea-urchin are relatively easily identified because of their spines. Spiny sea-urchins are also relatively common so making observation of any change easier. They graze on algae scraping it off the reef. Their feeding activity can remove algae that might otherwise prevent the settlement of hard corals but if they are too abundant they can also scrape newly settled hard corals off the reef. Large numbers of spiny urchin can be encouraged by good algal growth from excess nutrients. The presence of large numbers of spiny sea-urchin on a living coral reef can be a sign that the reef is under pressure.</p> <p>Tick box for absence (0) or presence (+). If possible enter the absolute number or tick the relevant abundance box in the transect area. The percent cover box is not relevant. In this theoretical example more than 10 and less than 100 spiny urchin in the transect area.</p>							
					<p>Courtesy:  <a href="https://commons.wikimedia.org/wiki/File%3ACommon_Longspined_Sea_Urchin%2C_Diadema_paucispinum_at_Abu_Dabab_Reefs%2C_Red_Sea%2C_Egypt_SCUBA.jpg">https://commons.wikimedia.org/wiki/File%3ACommon_Longspined_Sea_Urchin%2C_Diadema_paucispinum_at_Abu_Dabab_Reefs%2C_Red_Sea%2C_Egypt_SCUBA.jpg</a>            Derek Keats.</p>			
	<b>Solid waste</b>							
		<p><b>Images URL (Uniform Resource Identifier)</b></p>		<p>The web page where the image is held. Please ensure that the form ID, date and marker IDs for the each image is included in the image properties.</p>				
<b>Number of items of solid waste</b>								



		0	+	1+	10+	100+	1000+	
			✓	✓				
		<b>1 net. 3 fishing lines and 1 plastic bag</b>						
								
		<p>Courtesy: <a href="http://www.teachoceanscience.net/teaching_resources/education_modules/coral_reefs_and_climate_change/how_are_land_and_sea_connected/">http://www.teachoceanscience.net/teaching_resources/education_modules/coral_reefs_and_climate_change/how_are_land_and_sea_connected/</a></p> <p>Solid waste is indicative of human pressure on the reef. In some cases it can also include material that might be found in wastewater suggesting wastewater impact.</p> <p>Tick box for absence (0) or presence (+). If possible enter the absolute number or tick the relevant abundance box in the transect area. The percent cover box is not relevant. In this theoretical example more than 1 and less than 10 pieces of solid waste are recorded in the transect area.</p>						
16	<b>Other</b> <b>(Please note/describe and try to photograph any unusual numbers of/impact on other life.)</b>							
	Algal bloom, Coral bleaching, Disease, Fish kills, Hydrocarbons, Red tide. Spawning (coral, grouper etc),	<b>Images URL (Uniform Resource Identifier)</b>	The web page where the image is held. Please ensure that the form ID, date and marker IDs for the each image is included in the image properties.					% cover
			Number of incidents					
		0	+	1+	10+	100+	1000+	



	Whales/dolphins, Other							
	<p>This learning point can be used to record any other unusual observations in the transect area. If necessary the box can be copied and filled if there are several unusual observations. If observations are to be made of indicators seen outside the transect area then this must be specified in the notes section including the distance from the transect area.</p> <p>Tick box for absence (0) or presence (+). If possible enter the absolute number or tick the relevant abundance box in the transect area and, where appropriate enter the estimated percent cover.</p>							
17	<b>Number of fishing boats fishing in the vicinity (1km) during the observation period</b>						1	
	Note/ image	<p>An indicator as to whether the monitoring site has social and economic significance is whether there is fishing in the area. The simplest indication of this is the number of fishing boats fishing within 1km of the survey transect during the observation period. Observations should not be duplicated for the same time period for every transect if the transects are close together. Such observations can provide more general background information for more detailed surveys. In this theoretical case 1 fishing vessel was observed fishing within 1km of the transect during the observation period. Such observations can provide more general background information for more detailed surveys such as fishing method and catch, number of persons employed and revenue.</p> <p>The web page url where any images of fishing observed should be provided. Please ensure that the form ID, date and marker IDs for the each image is included in the image properties.</p>						
18	<b>Number of tourist boats visiting the vicinity during the observation period</b>						2	
	Note/ image	<p>An indicator as to whether the monitoring site has social and economic significance is whether there is nature tourism in the area. The simplest indication of this is the number of tourist boats using the area (nature watching, fishing) within 1km of the transect during the observation period. Observations should not be duplicated for the same time period for every transect if the transects are close together. Such observations can provide</p>						



	<p>more general background information for more detailed surveys such as nature of tourism, number of persons employed and revenue. In this theoretical case 2 tourist vessels were observed nature watching within 1km of the transect during the observation period.</p> <p>The web page url where any images of tourism observed should be provided. Please ensure that the form ID, date and marker IDs for the each image is included in the image properties.</p>								
19	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="background-color: #FFD700; text-align: center;"><b>Grievance redress issues (note in a separate form with this form code)</b></th> <th style="background-color: #FFD700; text-align: center;">Yes/ No</th> <th style="background-color: #FFD700; text-align: center;">No</th> </tr> </thead> <tbody> <tr> <td colspan="4" style="padding: 5px;"> <p>Proposed activities and actions should comply with national and local laws and regulations.</p> <p>In this theoretical example the operator of the coral reef monitoring site has indicated, preferably in writing, that there is no outstanding grievance concerning and following the assessment.</p> </td> </tr> </tbody> </table>	<b>Grievance redress issues (note in a separate form with this form code)</b>		Yes/ No	No	<p>Proposed activities and actions should comply with national and local laws and regulations.</p> <p>In this theoretical example the operator of the coral reef monitoring site has indicated, preferably in writing, that there is no outstanding grievance concerning and following the assessment.</p>			
<b>Grievance redress issues (note in a separate form with this form code)</b>		Yes/ No	No						
<p>Proposed activities and actions should comply with national and local laws and regulations.</p> <p>In this theoretical example the operator of the coral reef monitoring site has indicated, preferably in writing, that there is no outstanding grievance concerning and following the assessment.</p>									

<b>3.2</b>	<b>TOOLS</b>
<b>3.2.01</b>	<p>The tools for this module comprise: this module, high resolution map of study area; Global Positioning System (GPS); SCUBA diving equipment including adjustable buoyancy life jacket, surface marker buoy and emergency position transmitter; Greenfins guides; dive support boat and safety equipment; secchi disk; permanent markers and replacement ties and tags, number engraving/stamping kit, heavy hammer; waterproof digital video/still camera with GPS; water sampling bottles; A4 waterproof questionnaire paper; A4 waterproof writing board and electrical marking tape/rubber bands for holding paper on board; pop-a-point pencils; 20m transect line; Buoyant line to see the marker.</p> <p>Waterproof and shockproof still and video cameras that can also acquire GPS information are becoming increasingly available. Some other key tools are presented in the text above and in the PERSGA survey manual that is under preparation.</p>

<b>3.3</b>	<b>TRAINING UPTAKE INDICATORS</b>
<b>3.3.01</b>	<p>The training uptake indicators for this module comprise: The scores from the training uptake test including the group work.</p>



The change in score before and after training should indicate the effectiveness of training uptake.

3.4 FURTHER INFORMATION	
3.4.01	Corcoran, E., C. Nellemann, E. Baker, R. Bos, D. Osborn, H. Savelli (eds). 2010. Sick Water? The central role of wastewater management in sustainable development. A Rapid Response Assessment. United Nations Environment Programme, UN-HABITAT, GRID-Arendal. <a href="http://www.grida.no">www.grida.no</a> <a href="http://www.unep.org/pdf/SickWater_screen.pdf">http://www.unep.org/pdf/SickWater_screen.pdf</a>
3.4.02	<p>PERSGA (in prep). Standard Survey Methods for Key Habitats and Key Species in the Red Sea and Gulf of Aden. Regional Organisation for the Conservation of the Environment of the Red Sea and Gulf of Aden. PERSGA, Jeddah.</p> <p>This is a draft document in preparation at the time of writing of this manual. The current survey manual is “<i>PERSGA/GEF 2004. Standard Survey Methods for Key Habitats and Key Species in the Red Sea and Gulf of Aden. PERSGA Technical Series No. 10. PERSGA, Jeddah.</i> <a href="http://www.persga.org/Files//Publications/Technical/TS/TS10_SSM_for_Key_Habitat.pdf">Http://www.persga.org/Files//Publications/Technical/TS/TS10_SSM_for_Key_Habitat.pdf</a></p>
3.4.03	<p>PERSGA (2015). Draft Regional Guidelines on Wastewater Management in Coastal Cities on the Red Sea And Gulf of Aden. August 2015. Regional Intergovernmental Organisation for the Conservation of the Environment of the Red Sea and Gulf of Aden.</p> <p>This is a draft document.</p>
3.4.04	Tilley, E., Ulrich, L., Lüthi, C., Reymond, Ph., Zurbrügg, C. (2014). Compendium of Sanitation Systems and Technologies – (2nd Revised Edition). Swiss Federal Institute of Aquatic Science and Technology (Eawag), Duebendorf, Switzerland. p. 175. ISBN 978-3-906484-57-0. <a href="http://www.sswm.info/sites/default/files/reference_attachments/TILLEY%20et%20al%202014%20Compendium%20of%20Sanitation%20Systems%20and%20Technologies%202nd%20Revised%20Edition.pdf">http://www.sswm.info/sites/default/files/reference_attachments/TILLEY%20et%20al%202014%20Compendium%20of%20Sanitation%20Systems%20and%20Technologies%202nd%20Revised%20Edition.pdf</a>
3.4.05	<p>UNEP (2015). Wastewater Pollution &amp; Coral Reefs. Science-to-Policy Brief for UNEP DRAFT September 2015. C2O. UNEP.</p> <p>This was in draft form at the time of preparation of this manual.</p>



<b>3.4.06</b>	Other modules in this manual
	This module provides the third of five modules forming the manual with each module forming a numbered sequence delivering the manual and each module should be delivered in context. The text of the training for trainer notes for this module also contains links to additional materials.

<b>3.5</b>	<b>GROUP EXERCISE</b>
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<b>3.5.01</b>	Field trip: To a living coral reef monitoring site.
	A field trip is a very good way of enhancing training uptake of the learning points. The authority responsible for managing the monitoring site should allow access for educational purposes provided the request is made in the right way and there is sufficient notice. Do not impose any pre-conditions on numbers and activities. Ensure that a grievance redress statement is provided at the end of the field visit and resolve any grievances. Use the field trip to demonstrate key learning points and to show the geographic relationship between the living coral reef monitoring site, the closest large point and/or non-point wastewater sources, any treatment, and other sensitive marine habitats and marine social and economic uses.
<b>3.5.02</b>	Complete a survey form
	The survey form should be completed. If it is not possible to use a real life situation during a field visit then try to make the classroom situation as realistic as possible.
<b>3.5.03</b>	Break into groups. Discuss the opportunities and constraints to the survey form in the context of what it is supposed to achieve. Present and agree a set of review recommendations.
	How the target audience is broken into groups depends on the overall size of the group and how the group would like to be broken-up. Groups should be of approximately equal size and comprise a balanced mixture of skills and experience. The group should elect a chairperson and spokesperson.
	The group exercise is a mechanism by which the target audience can explore and test the learning points. Each group should consider each learning point and propose, discuss, agree and present possible



	changes. After each group has presented there should be agreement about key recommendations.
<b>3.5.04</b>	Break into groups. Prepare and present a survey from based on the set of review recommendations.
	See comments under 3.5.03. Training of the target audience to prepare a survey from will take significant time and understanding of the issues. This group activity should, therefore, just be an exercise to see how the existing questionnaire might be modified to reflect the recommendations made under 3.5.03.

<b>3.6</b>	<b>TRAINING UPTAKE TEST</b> (expand/continue on separate sheets as necessary)	<b>0-10</b>
	The training uptake test should be undertaken and the survey form completed before the training to act as a baseline and after the training to determine training uptake. Each learning point response should be scored by the trainer and/or an independent evaluator from 0-10 with a maximum of 10. The total score for the text should be the sum of the scores for each learning point. It is suggested that completing the survey form should take no more than <b>30 minutes</b> (in the lecture hall) and the training test take no more than <b>15 minutes</b> . Sufficient copies of the survey form and training uptake test should be provided. The answers can be expanded on additional sheets against the question number.	

Pre		Post		If the test is taken before training tick (✓) the “pre” box and if it is taken after training tick (✓) the “post” box.
-----	--	------	--	--

Tick box as appropriate.

<b>3.6.01</b>	Give two examples of safety/operational considerations.	See learning point 3.1.05. Add any comments here about the individuals’ performance in respect of this learning point.	
<b>3.6.02</b>	What are the key requirements of a permanent marker?	See learning point 3.1.06. Add any comments here about the individuals’ performance in respect of this learning point.	
<b>3.6.03</b>	What are the key requirements of a transect?	See learning points 3.1.06 and 3.1.07. Add any comments here about the individuals’ performance in respect of these learning points.	



3.6.04	How can you measure visibility?	See learning point 3.9.06. Add any comments here about the individuals' performance in respect of this learning point.	
3.6.05	How can you measure sedimentation?	See learning point 3.9.07. Add any comments here about the individuals' performance in respect of this learning point.	
3.6.06	What should you do if you want to collect water samples?	See learning point 3.9.08. Add any comments here about the individuals' performance in respect of this learning point.	
3.6.07	How can you tell a hard coral from a soft coral?	See learning points 3.9.09 and 3.9.10. Add any comments here about the individuals' performance in respect of these learning points.	
3.6.08	How can you tell a coral from an algae?	See learning points 3.9.09-3.9.12. Add any comments here about the individuals' performance in respect of these learning points.	
3.6.09	How can you tell that a fish is a parrotfish?	See learning point 3.9.13. Add any comments here about the individuals' performance in respect of this learning point.	
3.6.10	What sort of unusual other observations might you record?	See learning point 3.9.16. Add any comments here about the individuals' performance in respect of this learning point.	
3.6.11	Give examples of indicators to show that the monitoring site has social and economic importance.	See learning points 3.9.17 and 3.9.18. Add any comments here about the individuals' performance in respect of these learning points.	
3.6.12	Field trip	Add any comments here about the individuals' performance in respect of this learning point. The individual should be given a score out of ten reflecting the extent to which the individual has participated in, and learnt from the field	



		visit.	
3.6.13	Complete a survey form	Add any comments here about the individuals' performance in respect of this learning point. The individual should be given a score out of ten reflecting the extent to which the individual has understood and correctly completed the questionnaire.	
3.6.14	Group presentation of module review	Add any comments here about the individuals' performance in respect of this learning point. The individual should be scored reflecting his/her understanding of the issues being discussed and their contribution to helping to deliver consensus within the group.	
3.6.15	Group preparation of a survey form	Add any comments here about the individuals' performance in respect of this learning point. The individual should be scored reflecting his/her understanding of the issues being discussed and their contribution to helping to deliver consensus within the group about the questionnaire being prepared.	
3.6.16	Examinee, name, signature and date	Examiner, name, signature and date	Total
Comments by examinee:		Comments by examiner:	



**MANUAL FOR MONITORING INDICATORS OF THE IMPACT OF WASTEWATER DISCHARGE ON CORAL REEFS**  
**MODULE 4 : INFORMATION MANAGEMENT**



← Columns →

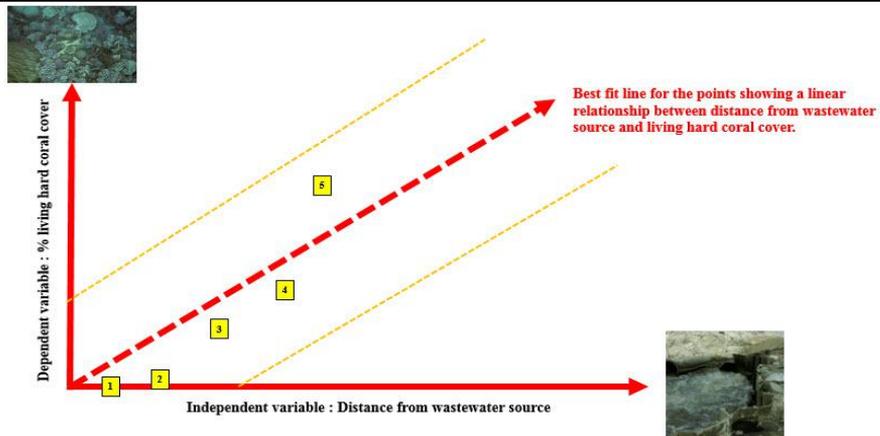
Site*	Distance from wastewater source*	% cover of live hard coral*
1	1	0
2	2	1
3	3	20
4	4	40
5	5	70

↑ ROWS ↓

\* Numbers do not reflect real data



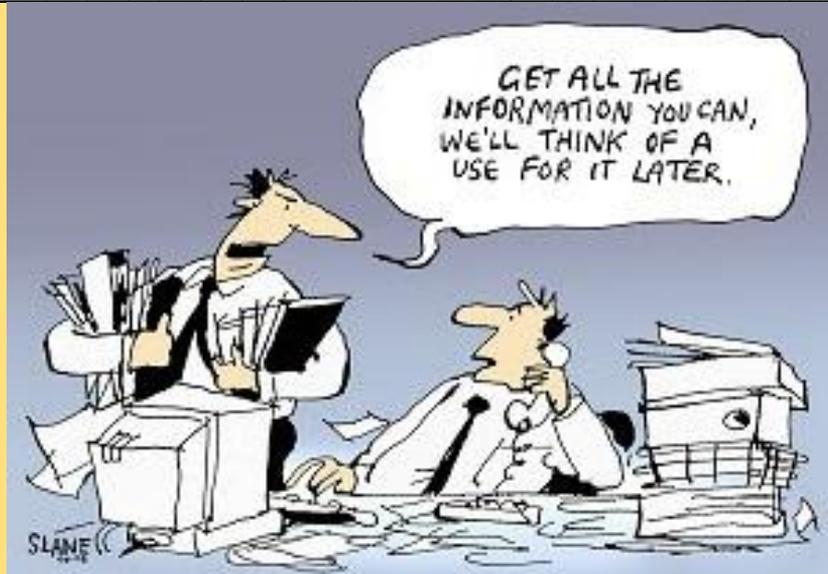
**Relationship between distance from wastewater source and % living hard coral cover**  
(note: diagrammatic not based on real data)  
■ = sample site    - - - = best fit    - - - = statistical confidence





**TRAINING FOR TRAINER NOTES**

4.1	LEARNING POINTS
4.1.01	<p><b>Module 4 – Information management:</b> By the end of this module the target group will understand the key elements of the information management process and the opportunities and constraints to information management. Training in this module should take approximately three hours of presentation, an hour for the group exercise and 15 minutes for the test.</p> <p>This module is entitled “<i>Information Management</i>” and is the fourth of 5 modules forming <i>Manual for monitoring indicators of the impact of wastewater discharge on coral reefs</i>”. The purpose of the <b>manual</b> is presented module 1. The purpose of <b>module 4</b> is to present learning points in support of more effective information management. There is little value in investing time in collecting information, including the type of information described in modules 2 and 3, unless the information is readily available and is used to support advocacy for management and management action as described in module 5.</p>
4.1.02	<p><b>Form a citizen science group:</b> The group should contain people who can use/train others to deliver the tools specified below and people who are willing to be trained and to apply the tools.</p> <p>Citizen science is defined in module 1 and tools for advocacy that might be used by a Citizen’s science group are presented in module 5.</p>
4.1.03	<p><b>Information management:</b> Information management comprises a process containing the following 8 key elements:</p> <ol style="list-style-type: none"> <li>(1) Asking the right question(s);</li> <li>(2) Identification of required information (why, what);</li> <li>(3) Collection of information (who, when where, how);</li> <li>(4) Storage of information;</li> <li>(5) Retrieval of information;</li> <li>(6) Analysis of information (data);</li> <li>(7) Use of information;</li> <li>(8) Review and revision of the process.</li> </ol> <p>The above 8 points are elaborated below and are considered to be the key elements of information management.</p>



Courtesy: <http://1.bp.blogspot.com/-3FxAjPjHx3U/UURGPXF8III/AAAAAAAAAgY/QR7LIdXNr9M/s400/DataCartoon.jpg>

This cartoon illustrates that collecting information for its own sake can be counterproductive. Asking the right question is the first important stage of effective information management.

**(1) Asking the right question**

4.1.04

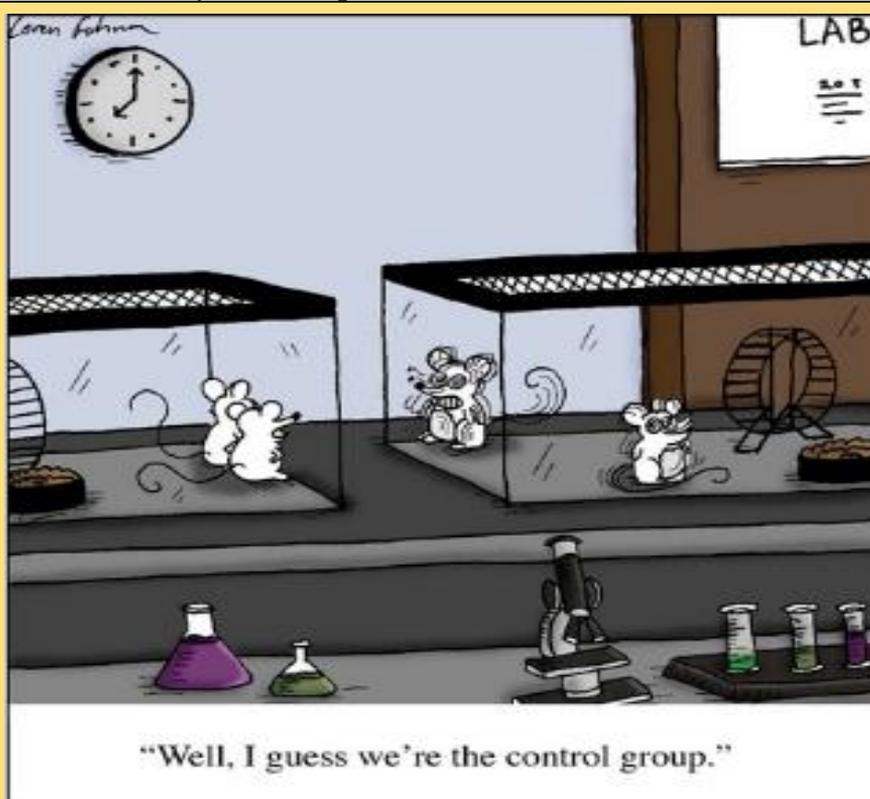
Information needs to be collected to help answer a question specified in terms of an **hypothesis** (a proposed explanation for an event or problem often in terms of cause and effect). The hypothesis can be tested through an **experiment** which alters cause or effect factors/variables to see whether they are **dependent** or **independent**.

An experiment involving dumping wastewater on a living coral reef is not appropriate because it could seriously damage the coral reef. This is avoided by using living coral reef **control sites** where wastewater is unlikely to be present and comparing their condition with living coral reef sites where wastewater is likely to be present.

Asking the right question is the first key stage of the process of effective information management. The scientific approach requires that the question be asked in terms of a hypothesis which is often tested, proved or disproved through an experiment. Experiments in natural systems often answer questions about whether there is a cause-effect relationship between independent and dependent and variables. For example wastewater can be considered to be the independent



variable since it is only incidentally affected by living coral reefs (certain ecosystem processes in coral reefs can “treat” wastewater). The dependent variable is living coral reef health since it is affected by wastewater. However, experiments that artificially alter a cause-effect relationship in natural systems, for example dumping wastewater on a reef, can cause significant damage that exceeds the benefits from doing the experiment. Undertaking experiments using control sites can help avoid unnecessary damage. However, this requires that the control site is not influenced by the independent variable.



Courtesy: <http://lenagroeger.com/blog/img/posts/controlgroup.jpg>

The cartoon above is intended to illustrate an experiment with a control. The mice in the left hand tank are suggested to be the control since they are not affected by the “shaking” shown by the mice in the right hand tank which, it is presumed, have been affected by a stressor (independent variable) which is absent from the left hand tank.

4.1.05

**(2) Identification of required information**

Required information characterises a **problem** and can be used to develop, deliver and monitor delivery of a **solution**. This is the “Why and what” of the Kipling approach.

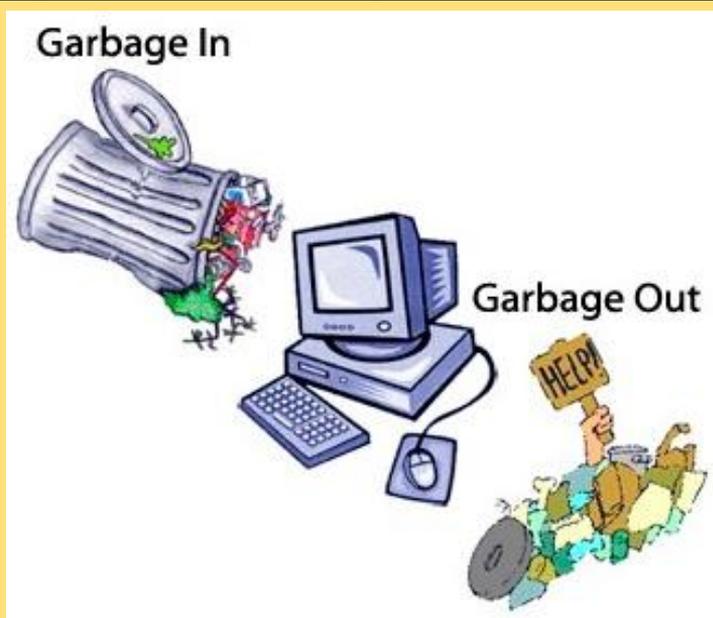


**Why (module 1):** The justification for the selected indicators in terms of their relevance to the problem, delivering the solution and monitoring delivery of the solution.

**What (modules 2, 3):** Clear specification of the indicators and their attributes.

The problem has been identified as the impact of wastewater on coral reefs. Use of information to provide a solution is given in module 5.

Identifying the required information that will answer the right question is the second key stage of the process of effective information management. Required information indicates what the problem is, supports identification, delivery and monitoring delivery of the solution according to the Kipling approach (What/how and Why and When and Where and Who). The “why”, the justification for the manual is presented in module 1 and the “what” is presented in modules 2 (stressors/independent variables/wastewater) and 3 (receptors/dependent variables/living coral reef).



Courtesy: <http://i.imgur.com/D2wJB.jpg>

The above cartoon illustrates that incorrect or poor information can lead to incorrect or poor solutions.

4.1.06

**(3) Collection of information**

**Collection of information:** Collection of information requires the



completion of the questionnaires/ forms presented in modules 2 and 3. A system for information collection also requires the remaining four elements of the Kipling approach:

**Who:** Who is going to collect the information (the people)?

**When:** When will the information be collected (frequency)

**Where:** Where will the information be collected (location)

**What/How:** Primarily the tools specified in the modules.

Collecting the required information that will answer the right question is the third key stage of the process of effective information management. As indicated above the quality of information that is collected about a problem determines its value in identifying and implementing a solution. Module 2 specifies the information to be collected about the stressor/independent variable/wastewater. Module 3 specifies the information to be collected about the receptor/dependent variable/living hard coral reef. Good quality information is necessary to identify and deliver management solutions to objective problems. This requires good documentation of the information including: **who** has collected the information (to ensure accountability if the information is correct; **when** the information is collected (to allow for monitoring change over time); **where** it was collected (to allow geographic comparisons using a geographic information system (GIS)); what information was collected (the indicator and attributes including dimensions and units of the information) including how it was collected (the methodology used to ensure that the information collected at different times and locations is collected using the same tools and so is comparable.



Courtesy: <https://johelia444.files.wordpress.com/2013/02/signpost-who-what-where-when-why-how.jpg>

This picture illustrates that the directions to finding the right questions



to ask and to provide the answers includes the Kipling approach of “*What/how and Why and When and Where and Who*”.

**(4) Storage of information**

4.1.07 Storage of information that will answer the right question is the fourth key stage of the process of effective information management.

1. **Non-indexed information:** Discrete pieces of information for which one, or more, common characteristics still have to be identified.

One piece of information ABCDE cannot be indexed with another piece of information FGHIJ, other than they are both part of the same alphabet, since there are no letters common to both. Free text information is, by definition, non-structured so that if different passages of free text are to be compared then the text elements that are comparable need to be identified and standardised. This takes time.

2. **Indexed information:** Discrete pieces of information for which one, or more, common characteristics have been identified. A simple index is one linking data using common criteria by columns and rows in a table. Such a table is a simple database.

One piece of information ABCDE can be indexed with another piece of information AGHIJ because the letter “A” is common to both. Information that is indexed is easier to retrieve because the index helps you to know where to get it. An index for location includes the latitude and longitude of each location. An index for library books includes the accession number. The accession number tells you where to look on the book shelf. Date is an indexing system for a diary. Data are placed in a table, based on meeting the criteria specified by each row and column. The row and column criteria can be used to access the information for one or more rows and columns.

Note: The table below presents simulated, and not real, information.

		← Columns →		
↑ R O W S ↓	Site*	Distance from wastewater source*	% cover of live hard coral*	
	1	1	0	
	2	2	1	
	3	3	20	
	4	4	40	
	5	5	70	

\* Numbers do not reflect real data



The above table illustrates a table, grid or matrix. The information in the table does **not** reflect real data. The table comprises rows and columns and the data can be analysed in a graph as shown below.

The second column “*Distance from wastewater source*” is the **independent variable** since wastewater is minimally influenced by living coral reef. The third column “*% cover of live hard coral*” is the **dependent variable** given the hypothesis being tested that wastewater adversely affects living coral reef.

To some extent the **control** is provided by the assumption that the further the site is from the independent variable the more likely it is to be a control.

**3. Hard copies:** Hard copies of the information (completed questionnaire forms)

Apart from learning the information by heart, hard copies of information are the simplest way to store information. Hard copies comprise the completed questionnaire forms described in modules 2 and 3. The constraints with using a hard copy “*paper*” system for filing information are deterioration in hot and humid climates and the risk that the person who knows where the information is may not be available to provide it.



Courtesy: [https://upload.wikimedia.org/wikipedia/commons/8/87/Old\\_book\\_bindings.jpg](https://upload.wikimedia.org/wikipedia/commons/8/87/Old_book_bindings.jpg)

The above cartoon indicates that storage of information is nothing new though in the past it could be somewhat cumbersome. This system is extremely bulky and time consuming to record and can only hold limited information!

**4. Digital electronic “soft-copy” data:** Information held in binary



digital “off” and “on” (010101.....) electronic form in:

- a single **computer** (with back-up discs)
- between computers in a **local area network** (LAN)
- through the **internet** in the **digital cloud** (Dropbox, One drive etc).

The “**digital cloud**” is a repository of digital information stored at multiple physical locations and connected by the internet. Information can be managed from computers at different locations without the risk of loss should one, or more, of these computers malfunction.

Holding information in electronic form is the most effective way of storing information. At the simplest level it can involve scanning the completed questionnaires. The constraint to holding the information on an individual computer is if that computer goes wrong. Back-ups on pen drivers or CD-Rom can reduce this risk but there is still the risk that the person who knows where the information is may not be available to provide it. Using a local area network (LAN) where several computers are connected together allows for individual computers to go wrong although there is usually only one current back-up.

The most secure way of holding digital information is in the digital cloud where there are multiple copies kept at secure locations accessible through the internet. The constraint here is internet access.



Courtesy: <http://www.onemetric.com.au/sites/default/files/CloudComputing.png>

This cartoon shows how multiple computers can be connected through the internet cloud. It needs to be appreciated that the internet and the cloud are based on physical servers at multiple locations and the internet/cloud refers to the electronic communications between these servers.



**5. Digital electronic database:** A digital electronic database is one in which digital electronic data are indexed to allow for ease of retrieval and analyses. Microsoft Excel, Microsoft Access, and other specially designed databases, including geographic information systems (GIS), support such indexing.

Many digital electronic database platforms can operate through the internet/cloud.



Microsoft Excel supports tabular databases with simple relational functionality between sheets and multiple functions for sorting, filtering, summarising and presenting information. Microsoft Access supports more complex relational databases with multiple tables linked/indexed by rows in one to many relationships. These and other databases, if designed accordingly, can be accessed and used from multiple computers via the cloud/internet.

4.1.08

**(5) Retrieval of information**

Retrieving information that will answer the right question is the fifth key stage of the process of effective information management.

Information is more easily retrieved and used if it is:

- (1) well documented in respect of what/how, why, who, when, and where
- (2) well indexed
- (3) digital electronic
- (4) managed in the digital cloud.

The order of priority for the management of data to ensure its effective retrieval is listed from (1) to (4). If information is not well documented it is rubbish in-rubbish out. If information is not indexed then it will have to be indexed in some way before it is analysed. If information is in digital electronic format then it can be more easily stored and shared. If information is in the digital cloud then it has multiple secure back-ups and can be accessed from any computer with internet access and access authority.



**4.1.09**

### (6) Analysis of information (data)

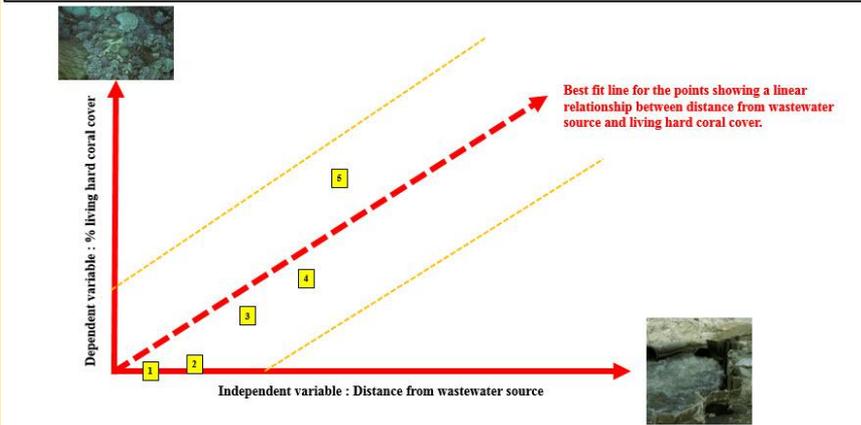
Data (information) need to be analysed to test hypotheses/to answer questions. Graphic illustrations of cause and effect relationships are particularly useful. A geographic information system (GIS) can be a useful tool for analysing and presenting information spatially. The graph opposite presents information from two columns in a simple table by row (site) as part of the process of analysing the possible relationship between distance from wastewater source and % cover of live hard coral\*.

Analysing information in a way that helps to answer the right question is the sixth key stage of the process of effective information management.

\*Note: The graph below presents simulated, and not real, information and is based on the figures from the hypothetical table of data presented in 1.07 above (Storage of information).

**Relationship between distance from wastewater source and % living hard coral cover**  
(note: diagrammatic not based on real data)

■ = sample site    - - - = best fit    - - - = statistical confidence



Dependent variable : % living hard coral cover  
 Independent variable : Distance from wastewater source

Best fit line for the points showing a linear relationship between distance from wastewater source and living hard coral cover.

The above graph shows a hypothetical relationship between the independent variable “*Distance from wastewater source*” on the “X”/horizontal axis (the second column in the table) and the dependent variable “% living hard coral cover” on the “Y”/vertical axis (the third column in the table). Data points are labelled by Site 1-5 (the first column in the table). Regression analysis has been used to provide a best fit line (red-dashed-line) and statistical confidence limits are shown (yellow-dashed line). Sites 3,4, and 5 fall within the confidence limits and 1 and 2 fall outside. This would suggest reasonable confidence that the hypothesis that wastewater is a stressor on living



hard coral is correct.

Other examples:

Cause/stressor/ independent variable	Effect/receptor/ dependent variable
Co2 in atmosphere	Temperature
Ocean acidity	Hard coral growth
Snorkelers	Hard coral damage
Fishing	Catch
?	?

It is up to the citizen science group to identify a professional who can assist in identifying the best statistical framework for testing an hypothesis. The table and graphical presentation shown in the module of distance versus percent cover for multiple sites can of course be adapted to show time versus percent cover for a single site (or for multiple sites using multivariate analysis). For more information on statistical techniques see basic statistical tools.

<http://www.fao.org/docrep/w7295e/w7295e08.htm#6>

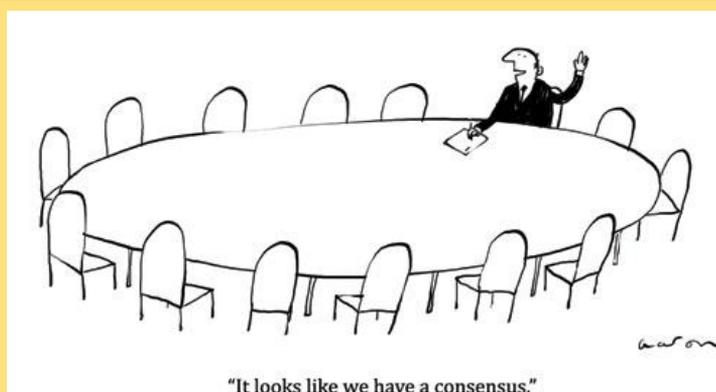
### (7) Use of information

4.1.10

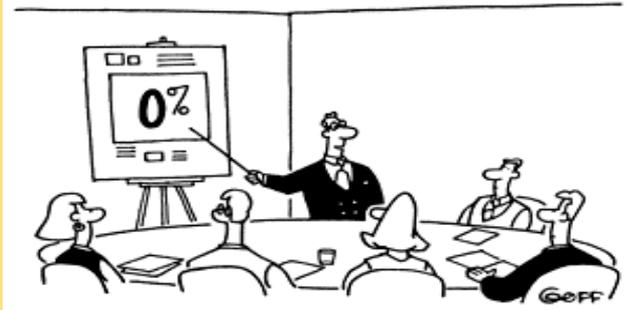
Information needs to be used to support evidence based advocacy for action, action planning, management of the delivery, and monitoring of the delivery of actions to ensure accountability as described in **module 5**.

Use of information to deliver solutions is the seventh key stage of the process of effective information management.

There is little value, other than pure academic or philosophical value, in collecting information that is not used for management purposes. Manual 5 describes how information can be used to advocate for, deliver, and monitor delivery of action.





	<p>Courtesy: <a href="http://huwaaron.com/blog/2012/05/01/recent-cartoons-from-the-oldie-magazine/">http://huwaaron.com/blog/2012/05/01/recent-cartoons-from-the-oldie-magazine/</a></p> <p>The above cartoon indicates how important it is that action planning is participatory and is based on consensus.</p>
<p><b>4.1.11</b></p>	<p><b>(8) Review and revision of the process</b></p>
	<p>The process of information management needs to be revised based on lessons learned to be applied so that mistakes are not repeated (no need to re-invent the wheel) and information management becomes more relevant and effective in helping to solve real problems.</p>
	<p>Review and revision of the information management process is the eighth stage of the process of effective information management.</p> <p>All 7 key stages of the information management process should be reviewed as they are delivered to provide lessons learned to be applied to improving the information management process in the future and so deliver more effective solutions to real problems.</p> <div data-bbox="570 1120 1198 1641" style="border: 1px solid black; padding: 10px; text-align: center;"> <p>© 1999 Ted Goff tedgoff@tedgoff.com <a href="http://www.tedgoff.com">http://www.tedgoff.com</a></p>  <p>"Our study concludes that this is the percentage of our customers who will buy from us without any effort whatsoever on our part."</p> </div> <p>Courtesy: <a href="https://joshsang.files.wordpress.com/2013/03/sales_cartoon.gif?w=490">https://joshsang.files.wordpress.com/2013/03/sales_cartoon.gif?w=490</a></p>
<p>The above cartoon suggests that marketing is necessary to achieve sales which seem obvious. However, the course of action depends on the question that has been asked. If the question is not right then the whole process is flawed and should be corrected accordingly to avoid wasting marketing resources.</p>	

<b>4.2</b>	<b>TOOLS</b>
<b>4.2.01</b>	The tools for this module comprise: this module and data management



	tools such as data management software.
	The target group will need to take notes. Sufficient copies of the training uptake test should be provided for use by the trainee group.

<b>4.3</b>	<b>INDICATORS OF TRAINING UPTAKE</b>
<b>4.3.01</b>	The indicators for this module comprise the score from the training uptake test.
	The change in score before and after training should indicate the effectiveness of training uptake.

<b>4.4</b>	<b>FURTHER INFORMATION</b>
<b>4.4.01</b>	Corcoran, E., C. Nellemann, E. Baker, R. Bos, D. Osborn, H. Savelli (eds). 2010. Sick Water? The central role of wastewater management in sustainable development. A Rapid Response Assessment. United Nations Environment Programme, UN-HABITAT, GRID-Arendal. <a href="http://www.grida.no/http://www.unep.org/pdf/SickWater_screen.pdf">www.grida.no http://www.unep.org/pdf/SickWater_screen.pdf</a>
<b>4.4.02</b>	PERSGA (in prep). Standard Survey Methods for Key Habitats and Key Species in the Red Sea and Gulf of Aden. Regional Organisation for the Conservation of the Environment of the Red Sea and Gulf of Aden. PERSGA, Jeddah.
	This is a draft document in preparation at the time of writing of this manual. The current survey manual is “ <i>PERSGA/GEF 2004. Standard Survey Methods for Key Habitats and Key Species in the Red Sea and Gulf of Aden. PERSGA Technical Series No. 10. PERSGA, Jeddah.</i> <a href="http://www.persga.org/Files//Publications/Technical/TS/TS10_SSM_f_or_Key_Habitat.pdf">Http://www.persga.org/Files//Publications/Technical/TS/TS10_SSM_f_or_Key_Habitat.pdf</a>
<b>4.4.03</b>	PERSGA (2015). Draft Regional Guidelines on Wastewater Management in Coastal Cities on the Red Sea And Gulf of Aden. August 2015. Regional Intergovernmental Organisation for the Conservation of the Environment of the Red Sea and Gulf of Aden.
	This is a draft document.
<b>4.4.04</b>	Tilley, E., Ulrich, L., Lüthi, C., Reymond, Ph., Zurbrügg, C. (2014). Compendium of Sanitation Systems and Technologies – (2nd Revised Edition). Swiss Federal Institute of Aquatic Science and Technology (Eawag), Duebendorf, Switzerland. p. 175. ISBN 978-3-906484-57-0.



	<a href="http://www.sswm.info/sites/default/files/reference_attachments/TILLEY%20et%20al%202014%20Compendium%20of%20Sanitation%20Systems%20and%20Technologies%202nd%20Revised%20Edition.pdf">http://www.sswm.info/sites/default/files/reference_attachments/TILLEY%20et%20al%202014%20Compendium%20of%20Sanitation%20Systems%20and%20Technologies%202nd%20Revised%20Edition.pdf</a>
4.4.05	UNEP (2015). Wastewater Pollution & Coral Reefs. Science-to-Policy Brief for UNEP DRAFT September 2015. C2O. UNEP.  This was in draft form at the time of preparation of this manual.
4.4.06	Other modules in this manual  This module provides the fourth of five modules forming the manual with each module forming a numbered sequence delivering the manual and each module should be delivered in context. The text of the training for trainer notes for this module also contains links to additional materials.

4.5	<b>GROUP EXERCISE</b>	
4.5.01	Break into groups. Discuss the opportunities and constraints to the module in the context of what it is supposed to achieve. Present and agree a set of review recommendations.  How the target audience is broken into groups depends on the overall size of the group and how the group would like to be broken-up. Groups should be of approximately equal size and comprise a balanced mixture of skills and experience. The group should elect a chairperson and spokesperson.  The group exercise is a mechanism by which the target audience can explore and test the learning points. Each group should consider each learning point and propose, discuss, agree and present possible changes. After each group has presented there should be agreement about key recommendations.	

4.6	<b>TRAINING UPTAKE TEST</b>	<b>0-10</b>
	The training uptake test should be undertaken before the training to act as a baseline and after the training to determine training uptake. Each learning point response should be scored from 0-10 with a maximum of 10. The total score for the text should be the sum of the scores for each learning point. It is suggested that the training test take no more than <b>15 minutes</b> .	



	Sufficient copies of the training uptake test should be provided. The answers can be expanded on additional sheets against the question number.	
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Pre		Post		If the test is taken before training tick (✓) the “pre” box and if it is taken after training tick (✓) the “post” box.
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Tick box as appropriate.

4.6.01	List the 8 key elements of the information management process.	The trainee should answer this question showing an understanding of learning point 4.1.03.	
4.6.02	Give an example of an hypothesis	The trainee should answer this question showing an understanding of learning point 4.1.04.	
4.6.03	Explain what allows information to be indexed.	The trainee should answer this question showing an understanding of learning point 4.1.07.01 and 4.1.07.02.	
4.6.04	Explain the difference between a hard copy and a digital electronic copy	The trainee should answer this question showing an understanding of learning point 4.1.07.03 and 4.1.07.04.	
4.6.05	What is the digital cloud?	The trainee should answer this question showing an understanding of learning point 4.1.07.04.	
4.6.06	Give a reason for managing information in the digital cloud	The trainee should answer this question showing an understanding of learning point 4.1.07.04.	
4.6.07	Name four attributes of information that allow it to be retrieved and used more easily.	The trainee should answer this question showing an understanding of learning point 4.1.08.	
4.6.08	Give a reason for analysing information.	The trainee should answer this question showing an understanding of learning point 4.1.09.	
4.6.09	Draw a graph	The trainee should answer this question	



	specifying a dependent and independent variable and showing a relationship.	showing an understanding of learning point 4.1.09.	
4.6.10	Explain why it may be necessary to review and revise the information management process.	The trainee should answer this question showing an understanding of learning point 4.1.11.	
4.6.11	Group module review exercise	The individual should be scored reflecting his/her understanding of the issues being discussed and the individuals' contribution to helping to deliver consensus within the group.	
4.6.12	Examinee, name, signature and date	Examiner, name, signature and date	Total
Comments by examinee:		Comments by examiner:	



**MANUAL FOR MONITORING INDICATORS OF THE IMPACT OF  
WASTEWATER DISCHARGE ON CORAL REEFS  
MODULE 5 : INFORMATION USE**



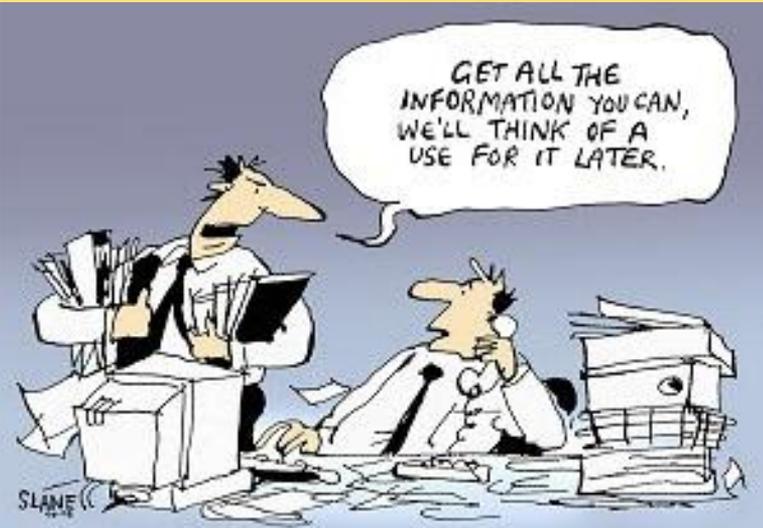
PERSGA Regional Taskforce Visit to Aqaba Wastewater Treatment Plant,  
Aqaba, Hashemite Kingdom of Jordan  
4<sup>th</sup> May 2015.



**TRAINING FOR TRAINER NOTES**

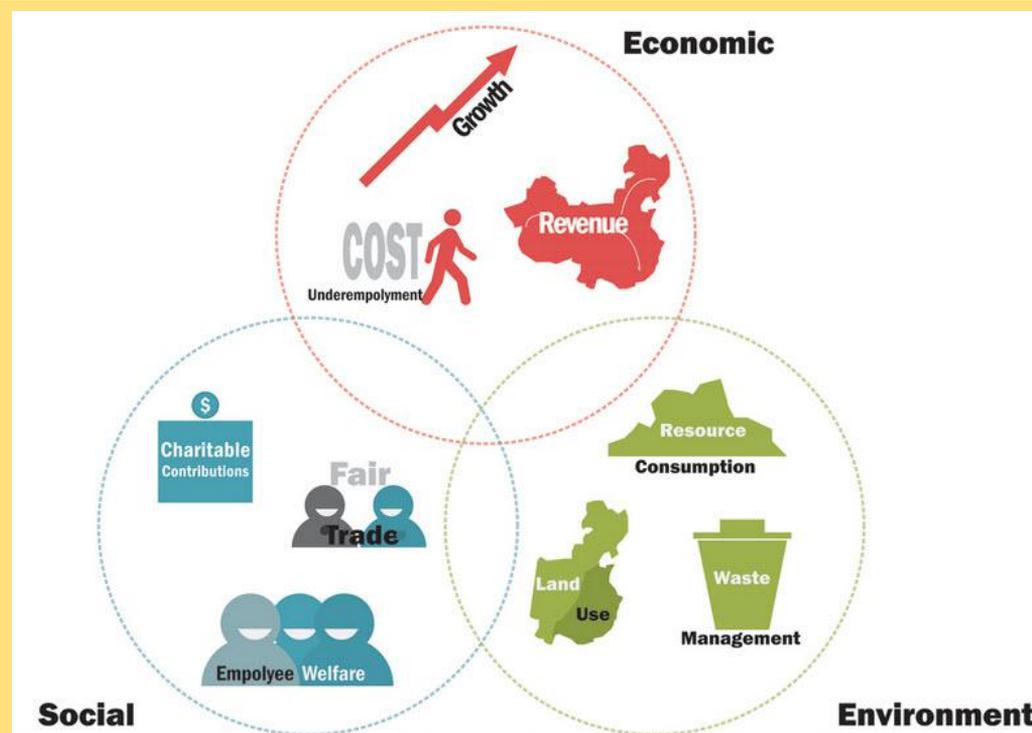
5.1	LEARNING POINTS
5.1.01	<p><b>Module 5 – Information use:</b> By the end of this module the target group will understand how to use information to identify and suggest solutions to a problem and how to advocate for delivery of these suggested solutions. Training in this module should take approximately three hours of presentation, an hour for the group exercise and 15 minutes for the test. The debate on a hypothetical wastewater development and any fieldwork should be added to this time.</p> <p>This module is entitled “Information” and is the final module of 5 modules forming the “<i>Manual for monitoring indicators of the impact of wastewater discharge on coral reefs</i>”. The purpose of the manual is described in Module 1. This module aims to help citizen science groups to advocate for and support delivery of actions to solve problems of concern.</p>
5.1.02	<p><b>Form a citizen science group:</b> The group should contain people who can help deliver a scientific approach to identifying and proposing solution(s) to a problem and then advocating for and supporting delivery of the proposed solution(s).</p> <p>Citizen science is defined in module 1 and tools for advocacy that might be used by a Citizen’s science group are presented in this module.</p>
5.1.03	<p><b>Scientific approach:</b> An approach comprising:</p> <ul style="list-style-type: none"> <li>- development of objective <b>hypotheses</b> concerning links;</li> <li>- experiments to test the hypotheses statistically.</li> </ul> <p>For further information see:  <a href="http://www.livescience.com/20896-science-scientific-method.html">http://www.livescience.com/20896-science-scientific-method.html</a></p>
5.1.04	<p><b>Information use:</b> Information use comprises a process containing the following key elements delivered using a scientific, evidence based, approach:</p> <ol style="list-style-type: none"> <li>(1) Characterising the problem;</li> <li>(2) Identifying solutions</li> <li>(3) Advocating action;</li> <li>(4) Action planning;</li> <li>(5) Decision-making;</li> </ol>



	<p>(6) Delivery of action</p> <p>The six key elements of information listed above are elaborated in learning points 1.05 to 1.10 below.</p>  <p>Courtesy: <a href="http://1.bp.blogspot.com/-3FxAnJpHx3U/UURGPXF8III/AAAAAAAAAgY/QR7LldXNr9M/s400/DataCartoon.jpg">http://1.bp.blogspot.com/-3FxAnJpHx3U/UURGPXF8III/AAAAAAAAAgY/QR7LldXNr9M/s400/DataCartoon.jpg</a></p>
	<p>This cartoon illustrates that collecting information for its own sake can be counterproductive. Information needs to be used to deliver something. There is little value, other than pure academic or philosophical value, in collecting information that is not used for specified management purposes.</p>
<p>5.1.05</p>	<p><b>(1) Characterising the problem (what is the problem?)</b></p> <p>The first key element of information use is to characterise the problem.</p> <p>The problem should be characterised in terms of one, or more, hypotheses. The hypotheses should propose links between objective indicators of possible cause(s) and associated stressors and social, economic and environmental effect(s) on receptors. Information should be collected and analysed to statistically prove, or disprove the hypotheses, as presented in the process under modules 2, 3 and 4.</p> <p>This learning point relates to the first of six proposed elements of information use, namely the need to specify what the problem is. A number of the terms used above are elaborated in modules 1 and 4 including: hypothesis, stressor, and receptor.</p> <p>The information should determine the social, economic and environmental <b>significance</b> (triple bottom line accounting) of the</p>



problem to be used to justify investment in the proposed solution.

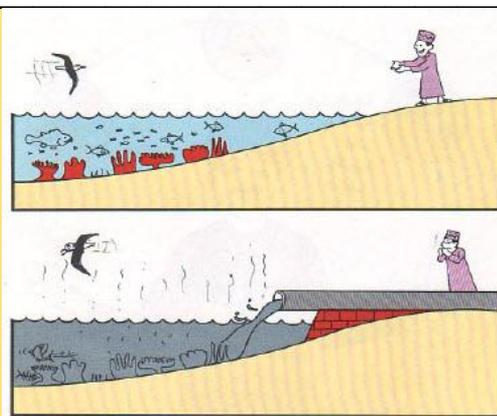


Courtesy: [https://upload.wikimedia.org/wikipedia/commons/2/2a/Triple\\_Bottom\\_Line\\_graphic.jpg](https://upload.wikimedia.org/wikipedia/commons/2/2a/Triple_Bottom_Line_graphic.jpg)

Social issues include culture, gender, governance, potential for conflict etc. Economic issues include financial issues such as income generation and expenditure. Environmental issues include habitat destruction, and other forms of overexploitation including pollution. All contribute to the overall significance of a problem.

**Significance** can be determined using a risk assessment approach in which the level of risk can be calculated as the **probability** (likelihood) that an event will occur multiplied by the **severity** of the consequences if it does. Whilst probability can be identified relatively objectively the severity of the consequences is much more of a subjective value judgement.

An assessment of the significance of a problem is necessary to decide whether one problem is more important than another problem so as to prioritise action. The probability that something will happen is relatively easy to determine as a percent value. Severity is more subjective since it is a matter of what is valuable and this is often determined by social attitudes which may vary from individual to individual and community to community.



MRME (1995). Understanding Beaches (Arabic and English). Ministry of Regional Municipalities and the Environment (MRME). Sultanate of Oman.

The upper part of the cartoon above illustrates a healthy living coral reef and associated fish and bird populations. The lower part of the cartoon illustrates the effect of a wastewater discharge on the same coral reef. The water becomes grey, the reef dies, the fish and birds try to escape and there is a smell. However, even if the probability is 100% that this will happen determining the significance is more subjective. On the one side there is the health impact of not having a discharge on the human community. On the other hand the amenity value of a healthy coral reef may depend on whether you are a fisher, a local resident, or a holidaymaker. Is a sick child more important than a fisher who can support his/her family? Of course there are solutions that can reduce all these risks but this still requires that the risks are identified and prioritised in respect of their significance.

**(2) Identifying solutions (what is the solution?)**

5.1.06

The second key element of information use is identifying solutions.

**The following were identified as possible management measure at the Hurghada workshop in October 2015:-**

**Biological control** is the use of biological agents (diseases, parasites, predators) to control the population of one or more species. There are no biological control measures that have been proven to be effective on coral reefs and the release of biological control measures into the marine environment should be considered with great caution. Removal of biological stressors (removing sea-urchins, removing starfish, etc) is a management option but can detract from focusing on solving the root-cause of the problem if it is wastewater.



**Environmental Impact Assessment (EIA)** is “a process of evaluating the likely environmental impact of a proposed project or development taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse” (<https://www.cbd.int/impact/problem.shtml>). It is a requirement under Article 14.1 of the International Convention on Biological Diversity, Article XI of the Jeddah Convention and Article 15 of the PERSGA MPAs protocol. It is also a requirement, under national legislation, of all parties to the Jeddah Convention. For more information on EIA see the UNEP web site (<http://www.unep.ch/etb/publications/enviImpAsse.php>) and the Convention on Biological Diversity (CBD) website (<https://www.cbd.int/impact/>).

**Integrated Coastal Zone Management (ICZM)/Integrated Coastal Area Management (ICAM)** is a spatial management tool that separates compatible and non-compatible activities into different zones. One example is the location of polluting activities in areas where there is minimal impact on coastal and marine biological resources such as impact of wastewater on coral reefs. The extent of the coastal zone/coastal area depends on the nature of the transboundary processes (across the shoreline between the land and the sea) that are being considered. For more information see the PERSGA ICZM web page (currently <http://www.persga.org/inner.php?id=122>).

**Integrated Water Resources Management (IWRM)**: “*Integrated Water Resources Management (IWRM) is a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*”. It comprises 5 principles based on the 4 Dublin Principles presented at the Rio de Janeiro World Summit in 1992 and 3 pillars (enabling environment, institutional framework and management instruments. For more information see <http://www.gwp.org/en/>.

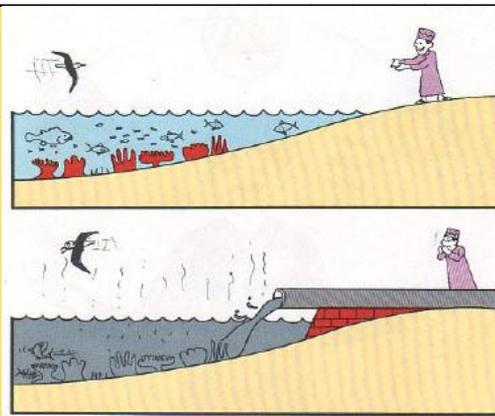
**Natural Resources Damage Assessment (NRDA)**: “*The Natural Resource Damage Assessment process evaluates and restores wildlife, habitats, and human resources impacted by oil spills, hazardous waste sites, and vessel groundings*”. For more information see <http://oceanservice.noaa.gov/facts/nrda.html>. See also PERSGA. 2009. Guidelines for Compensation Following Damage to Coral Reefs by Ship



	<p>or Boat Grounding. Part 1. PERSGA Technical Series Number 15. PERSGA, Jeddah.  <a href="http://www.persga.org/Files///Common/Flipping_Books_Downloads/Guidelines_for_Compensation_Following_Damage_to_Coral_Reefs_by_Ship_Grounding.pdf">Http://www.persga.org/Files///Common/Flipping_Books_Downloads/Guidelines_for_Compensation_Following_Damage_to_Coral_Reefs_by_Ship_Grounding.pdf</a></p>		
	<table border="1" style="width: 100%;"> <tr> <td style="width: 50%; padding: 5px;"> <p>The basic solutions for reducing wastewater impacts include:</p> <ul style="list-style-type: none"> <li>- removal of discharge stressor(s)</li> <li>- reduction of discharge stressor(s)</li> <li>- relocation of discharge stressor(s)</li> <li>- relocation of receptor(s)</li> <li>- adaptation of receptor(s)</li> <li>- compensation</li> </ul> </td> <td style="width: 50%; text-align: center; vertical-align: middle;">  </td> </tr> </table>	<p>The basic solutions for reducing wastewater impacts include:</p> <ul style="list-style-type: none"> <li>- removal of discharge stressor(s)</li> <li>- reduction of discharge stressor(s)</li> <li>- relocation of discharge stressor(s)</li> <li>- relocation of receptor(s)</li> <li>- adaptation of receptor(s)</li> <li>- compensation</li> </ul>	
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	<p>This learning point identifies 6 options for reducing the significance of wastewater discharge. These options are elaborated below.</p>		
	<p><b>↓ Removal of discharge stressor(s)</b></p>		
	<p>If the wastewater (stressor) is shown to be causing an adverse effect on the living coral reef (receptor) then the wastewater should be treated to a point where it does not adversely affect the living coral reef. Zero (wastewater) discharge to the sea is an optimal, and potentially viable, precautionary solution. Zero discharge can be achieved by treating the wastewater inland and reusing the treated water for irrigation and industry and the sludge for energy production. Some of the costs of treatment could be recovered by selling the treated wastewater and energy production from sludge.</p>		
	<p>It is understood that PERSGA is considering proposing a zero wastewater discharge standard for signatory countries to the Jeddah Convention. A number of PERSGA member countries are already supporting a zero discharge policy including Egypt and Jordan.</p> <p>There is no clear economic costing for a zero discharge policy. However, ecosystem goods and services supporting fisheries, tourism and coastal protection are maintained and have economic value. The costs of wastewater treatment can be partly recovered by the sale of treated wastewater for irrigation and reducing the energy cost of treatment by using sewage sludge to generate electricity.</p> <p>Thames Water (a UK based utility) claims it saved £15m last year, and generated 14% of its power, from either burning sludge or methane</p>		



	<p>derived from its 13 million customers' toilets.  <a href="http://news.bbc.co.uk/1/hi/england/8456879.stm">http://news.bbc.co.uk/1/hi/england/8456879.stm</a></p>
	<p>↓ <b>Reduction of discharge stressor(s)</b></p> <p>Reduction of the discharge <u>impact</u> by setting discharge criteria to comply with receiving water quality criteria including those set by Blue Flag and the Great Barrier Reef Marine Park Authority:</p> <ul style="list-style-type: none"> <li>- partial treatment of all wastewater</li> <li>- full removal of selected components of the wastewater</li> <li>- wastewater conservation (reduced water consumption)</li> </ul> <p>The constraint to this solution is that the living coral reefs may continue to deteriorate because one, or more, stressors are not sufficiently reduced.</p> <p>Receiving water quality triggers for a number of wastewater indicators are presented in module 2.</p> <p>Options for treating wastewater include:</p> <ul style="list-style-type: none"> <li>- <b><u>partial treatment of all wastewater</u></b>: This is practically extremely difficult because a treatment that effectively removes one item from wastewater may not remove another.</li> <li>- <b><u>full removal of selected components of the wastewater</u></b>: There are treatments that can remove selected components of wastewater such as phosphorus. However, the cost of doing so can be large.</li> <li>- <b><u>wastewater conservation (reduced water consumption)</u></b> : Wastewater conservation is the most practical solution to reducing discharge stressor(s). The less wastewater produced the less there is to be managed. However, wastewater conservation can increase the concentration of stressor(s).</li> </ul> <p>The optimal precautionary solution is to have zero wastewater discharge to the marine environment. Even if certain wastewater components are minimised at discharge this does not mean that some wastewater components that may have significant cumulative. Long-term, impacts on coral reefs are not released.</p>
	<p>↓ <b>Relocation of discharge stressor(s)</b></p> <p>Relocation of the discharge to an area away from coral reefs so that it does not negatively impact on living coral reefs.</p>



MRME (1995). Understanding Beaches (Arabic and English). Ministry of Regional Municipalities and the Environment (MRME). Sultanate of Oman.

The upper part of the cartoon above illustrates a healthy living coral reef and associated fish and bird populations. The lower part of the cartoon illustrates the effect of a wastewater discharge on the same coral reef. The water becomes grey, the reef dies, the fish and birds try to escape and there is a smell. However, even if the probability is 100% that this will happen determining the significance is more subjective. On the one side there is the health impact of not having a discharge on the human community. On the other hand the amenity value of a healthy coral reef may depend on whether you are a fisher, a local resident, or a holidaymaker. Is a sick child more important than a fisher who can support his/her family? Of course there are solutions that can reduce all these risks but this still requires that the risks are identified and prioritised in respect of their significance.

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5.1.06

The second key element of information use is identifying solutions.

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not be exactly the same.

Marine systems are very different to terrestrial systems because water is a much more stable medium than air. The marine environment does not have to cope with significant changes in temperature, with changes in humidity and with varying rainfall. Marine life has evolved to cope with some change but nothing like the change faced by most terrestrial systems. Stressors from human activity including stressors from wastewater are relatively recent and marine communities are not resilient to them and have had no time to become resilient to them through adaptation.

### ↓ Compensation

Ideally the mechanism for compensation should follow the “*polluter pays*” principle.

Compensation for the deterioration and/or loss of living coral reefs due to the negative impact of wastewater stressors can take several forms:

1. Investment in a more effective environmental management of the area negatively impacted by wastewater (in-situ) to reduce other stressors that might otherwise work cumulatively with wastewater so reducing the overall cumulative negative impact giving the reef more chance to survive;
2. Sacrificing any negatively impacted areas and providing compensation to enhance the protection of **other (ex-situ)** living coral reef areas to give these other areas more of a chance to survive;
3. Investment in alternative livelihoods and/or financial compensation for those who can no longer use the ecosystem goods and services that were provided by the living coral reef before it was negatively impacted by wastewater;
4. **Use of wastewater** for social, economic and environmental benefit rather than wasting it.

The processes of Environmental Impact Assessment (EIA), Natural Resources Damage Assessment (NRDA), Risk Assessment (RA) and Grievance Redress, in compliance with the “*polluter pays*” principle, will determine the “*What and Why and When and Where and Who*” of compensation (Kipling method).



The “***polluter pays***” principle states that “...*the polluter should bear the cost of measures to reduce pollution according to the extent of either the damage done to society or the exceeding of an acceptable level (standard) of pollution.*” (United Nations Statistics Division 2006 <http://unstats.un.org/unsd/environmentgl/gesform.asp?getitem=902>).

The developer of a project such as a wastewater facility may be required to pay compensation for damage through the Environmental Impact Assessment (EIA) process. Natural Resources Damage Assessment (NRDA) is a tool that can be used to assess the impact and compensation requirements from an accidental action. For more information see the notes on learning point 1.06 above. For grievance redress and the Kipling method see module 1.

Compensation, by the wastewater facility developer, for loss of living coral reef due to the impact of wastewater is the final proposed solution. Compensation can include investment in:

- (1) **In-situ** compensation: more effective management of the wastewater discharge area to reduce other impacts and the overall cumulative impact. For example a living hard coral may survive wastewater impact if there is no sediment from coastal construction, no physical damage from recreational use and no fishing pressure. Of course elevated water temperatures and ocean acidification from projected climate change require global action and are likely to be very significant cumulative impacts in the short to medium term;
- (2) **Ex-situ** compensation: improved management of other living coral reef areas away from the wastewater impact area so reducing the cumulative impact on these areas and giving them more chance to survive;
- (3) **Alternative livelihoods** or payments for loss of existing livelihoods for individuals and communities that can no longer access the ecosystem goods and services such as fishing and nature tourism provided by the coral reef in the wastewater impact area because it is deteriorated;
- (4) **Use of wastewater**: The Hurghada Workshop in October 2015 identified use of suitable wastewater for irrigation, including for agriculture, as a possible compensation option. In addition sewage sludge can be used for power generation. Use of the wastewater in this



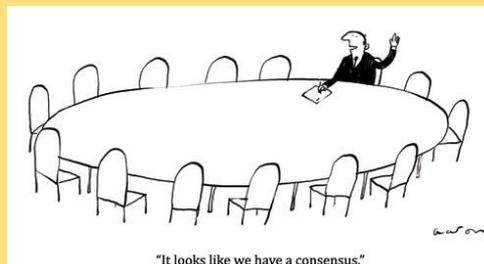
	<p>way can reduce the level of discharge to the sea and of sewage sludge the amount of landfill required. These uses can be linked to possible generation of alternative livelihoods.</p>
<p>5.1.07</p>	<p style="text-align: center;"><b>(3) Advocating action</b></p> <p>The third key element of information use is advocating action.</p> <p>Advocacy for action is best developed using a citizen’s science group or some other civil society organisation that is formed and operates according to a constitution.</p> <p>Make sure that all advocates are “on message” to avoid any impression of disagreement.</p> <p>Many of the solutions identified above require significant investment and the investment needs to be justified in legal and investment terms. If there is no legal basis for the proposed actions then legal change needs to be advocated for.</p> <p>Advocacy needs to be pragmatic, science based and presented in terms that can be understood and appreciated by decision-makers who may have many other calls on their time. Social, economic and environmental costs and benefits to affected communities from action need to be made clear with an emphasis on economic costs and benefits from live coral reefs such as for food, coastal protection and nature tourism. Where possible use representatives of communities affected by the outcome of the advocacy should advocate.</p> <p>Advocating action can be supported by <b>social media</b>. Social media is a way for people to communicate and interact online. Social Media tools include Facebook, Instagram, Twitter and YouTube. For more information see <a href="https://moz.com/beginners-guide-to-social-media">https://moz.com/beginners-guide-to-social-media</a>.</p> <p>Advocacy for action needs to propose clear action as to what should be done. A decision maker does not want to hear about a problem unless a clear, reasonable and achievable solution is proposed.</p> <p>A checklist for advocating action should include the following 5 elements:</p> <ol style="list-style-type: none"> <li>1. <b>Citizen science group support:</b> Advocate action(s) with the support of a duly constituted citizen science group;</li> </ol>



	<p>2. <b>Objective message:</b> Make sure that the action(s) are advocated on the basis that it/they will deliver an efficient, effective, high impact and sustainable solution that can be communicated to, and by, decision makers (those who can influence and support delivery of the proposed action(s)).</p> <p>3. <b>Consistent message:</b> Make sure that you have a consistent message concerning the action(s) you are advocating in respect of justification and proposed action(s);</p> <p>4. <b>Legal basis:</b> Ensure that proposals for significant action include a legal basis if there is a legal basis;</p> <p>5. <b>Legal strengthening:</b> If there is <b>no</b> significant legal basis for your proposed action(s) then advocate for a change in the law to support the advocated action(s).</p> <p>For more information on advocacy see: <a href="http://www.action.org/take-action/toolkits/advocacy-tools">http://www.action.org/take-action/toolkits/advocacy-tools</a> and at <a href="http://capacityforconservation.org/">http://capacityforconservation.org/</a></p>
5.1.08	<p style="text-align: center;"><b>(4) Action planning</b></p> <p>The fourth key element of information use is action planning.</p> <p>Action planning represents the process of developing an action plan and comprises the following key elements:</p> <ul style="list-style-type: none"> <li>↓ development of terms of reference for a planning group</li> <li>↓ formation of a planning group of relevant stakeholder representatives and technical experts</li> <li>↓ develop proposed objective actions with each action following the “<i>Kipling method</i>” (What, Why, When, Where and Who) including costs, inputs, activities, outputs and outcomes and a “<i>SMART</i>” system for monitoring delivery of actions and holding those responsible for delivering actions</li> <li>↓ production of an action plan according to planning regulations/ requirements</li> <li>↓ review and approval of the action plan by the planning group</li> <li>↓ submission to the planning authority for approval</li> <li>↓ submission to the funding authority for funding</li> </ul> <p>For certain activities the action plan may require <b>Strategic Environmental Assessment</b> (SEA) if it relates to actions to deliver a</p>



	<p>proposed policy and <b>Environmental Impact Assessment</b> if it relates to actions to deliver a proposed physical project.</p> <p>Action planning can also be supported by social media tools. See learning point 5.1.07 above.</p> <p>“SMART”: Specific; measurable; achievable and attributable; relevant and realistic; Time-bound; timely; trackable and targeted  <a href="https://www.thegef.org/gef/Policies_and_Guidelines">https://www.thegef.org/gef/Policies_and_Guidelines</a></p> <p>The Planning Authority will vary depending on the country and the nature of the proposed action(s). The Planning group should seek advice locally on the relevant planning authority/authorities that the proposed action(s) should be sent to for approval.</p>
5.1.09	<p style="text-align: center;"><b>(5) Decision-making</b></p> <p>The fifth key element of information use is decision-making.</p> <p>Decision-making needs to be representative and objective. In respect of decisions by an advocacy group the decisions should follow the constitution of the advocacy group.</p> <p>A decision should be taken:-</p> <ul style="list-style-type: none"> <li>↓ by at least a quorum (half) of the duly constituted members of the decision-making group</li> <li>↓ against a decision statement that allows a response “agree, disagree, or abstain” proposed as an agenda item</li> <li>↓ there should be an opportunity for debate</li> <li>↓ a move to a vote should be proposed and seconded</li> <li>↓ the vote should be taken and noted in meeting minutes</li> </ul> <p>It is important that an advocacy group (citizens’ science group) operates according to a written constitution complying with any national legal requirements to maximise transparency and ensure consistency. This constitution should include arrangements for proposing, discussing and agreeing decisions.</p> <p>A decision statement is one that allows the response to the statement to be “<i>Agree (yes), Disagree (no) and Abstain</i>”.</p> <p>A decision statement might be “<i>Should we approve construction of the wastewater treatment plant as proposed?</i>” This statement can be answered by “yes”, “no”, or “abstain”.</p>



Courtesy: <http://huwaaron.com/blog/2012/05/01/recent-cartoons-from-the-oldie-magazine/>

The above cartoon indicates how important it is that decision-making is participatory and is based on consensus. In this case there is only one participant.

### (6) Delivery of action

5.1.10

The sixth key element of information use is delivery of action.

The main reason for using information is to deliver necessary action to solve a problem. The action plan should include a system for monitoring delivery of actions and holding those responsible for delivering actions accountable.

There is little value, other than pure academic or philosophical value, in collecting information that is not used for management purposes and this includes the sixth element of information use which is the delivery of action.

Delivering action also requires providing the objective evidence that the action has been delivered has been provided. Unfortunately there are many cases where evidence that action has been delivered has not been provided. This is a common problem with the environmental management plans (EMP) of environmental impact assessments (EIA). Such EMP, which contains mechanisms to monitor compliance with the conditions of the permission to proceed with the development, is not always delivered.

5.2

## TOOLS

5.2.01

The tools for this module comprise: this module.

The target group will need to take notes. Sufficient copies of the training uptake test should be provided for use by the trainee group.



5.3 INDICATORS OF TRAINING UPTAKE	
5.3.01	The training uptake indicators for this module comprise the score from the training uptake test.
	The change in score before and after training should indicate the effectiveness of training uptake.

5.4 FURTHER INFORMATION	
5.4.01	Corcoran, E., C. Nellemann, E. Baker, R. Bos, D. Osborn, H. Savelli (eds). 2010. Sick Water? The central role of wastewater management in sustainable development. A Rapid Response Assessment. United Nations Environment Programme, UN-HABITAT, GRID-Arendal. www.grida.no <a href="http://www.unep.org/pdf/SickWater_screen.pdf">http://www.unep.org/pdf/SickWater_screen.pdf</a>
5.4.02	PERSGA (in prep). Standard Survey Methods for Key Habitats and Key Species in the Red Sea and Gulf of Aden. Regional Organisation for the Conservation of the Environment of the Red Sea and Gulf of Aden. PERSGA, Jeddah.  This is a draft document in preparation at the time of writing of this manual. The current survey manual is “ <i>PERSGA/GEF 2004. Standard Survey Methods for Key Habitats and Key Species in the Red Sea and Gulf of Aden. PERSGA Technical Series No. 10. PERSGA, Jeddah.</i> <a href="http://www.persga.org/Files//Publications/Technical/TS/TS10_SSM_for_Key_Habitat.pdf">Http://www.persga.org/Files//Publications/Technical/TS/TS10_SSM_for_Key_Habitat.pdf</a>
5.4.03	PERSGA (2015). Draft Regional Guidelines on Wastewater Management in Coastal Cities on the Red Sea And Gulf of Aden. August 2015. Regional Intergovernmental Organisation for the Conservation of the Environment of the Red Sea and Gulf of Aden.  This is a draft document.
5.4.04	Tilley, E., Ulrich, L., Lüthi, C., Reymond, Ph., Zurbrügg, C. (2014). Compendium of Sanitation Systems and Technologies – (2nd Revised Edition). Swiss Federal Institute of Aquatic Science and Technology (Eawag), Duebendorf, Switzerland. p. 175. ISBN 978-3-906484-57-0. <a href="http://www.sswm.info/sites/default/files/reference_attachments/TILLEY%20et%20al%202014%20Compendium%20of%20Sanitation%20Systems%20and%20Technologies%202nd%20Revised%20Edition.pdf">http://www.sswm.info/sites/default/files/reference_attachments/TILLEY%20et%20al%202014%20Compendium%20of%20Sanitation%20Systems%20and%20Technologies%202nd%20Revised%20Edition.pdf</a>
5.4.05	UNEP (2015). Wastewater Pollution & Coral Reefs. Science-to-Policy



<b>5.4.06</b>	<p>Brief for UNEP DRAFT September 2015. C2O. UNEP.</p> <p>This was in draft form at the time of preparation of this manual.</p> <p>Other modules in this manual</p> <p>This module provides the fifth of five modules forming the manual with each module forming a numbered sequence delivering the manual and each module should be delivered in context. The text of the training for trainer notes for this module also contains links to additional materials.</p>
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<b>5.5</b>	<b>GROUP EXERCISE</b>
<b>5.5.01</b>	<p>Break into groups: Discuss the opportunities and constraints to the module in the context of what it is supposed to achieve. Present and agree a set of review recommendations.</p> <p>How the target audience is broken into groups depends on the overall size of the group and how the group would like to be broken-up. Groups should be of approximately equal size and comprise a balanced mixture of skills and experience. The group should elect a chairperson and spokesperson.</p> <p>The group exercise is a mechanism by which the target audience can explore and test the learning points. Each group should consider each learning point and propose, discuss, agree and present possible changes. After each group has presented there should be agreement about key recommendations.</p>
<b>5.5.02</b>	<p>Break into two groups: One group should make a presentation advocating construction of a wastewater treatment facility discharging into a mersa in the context of maintaining living coral reef health and the other should review the presentation and solicit questions. At the end the two groups should vote on a decision statement to decide whether, or not, the investment is justified and set basic conditions.</p> <p>The first group should take the role of the project proponent making a presentation to the permitting authority and should advocate for the project on the basis of how it will maximise social and economic benefits whilst minimising environmental costs. The second group should take the role of the permitting authority. After the presentation the groups should work together to prepare a decision statement as to whether activity should go ahead and set basic conditions to ensure that</p>



environmental damage is minimised.

<b>5.6</b>	<b>TRAINING UPTAKE TEST</b>	<b>0-10</b>
<p>The training uptake test should be undertaken before the training to act as a baseline and after the training to determine training uptake. Each learning point response should be scored from 0-10 with a maximum of 10. The total score for the text should be the sum of the scores for each learning point. It is suggested that the training test take no more than <b>15 minutes</b>. Sufficient copies of the training uptake test should be provided. The answers can be expanded on additional sheets against the question number.</p>		

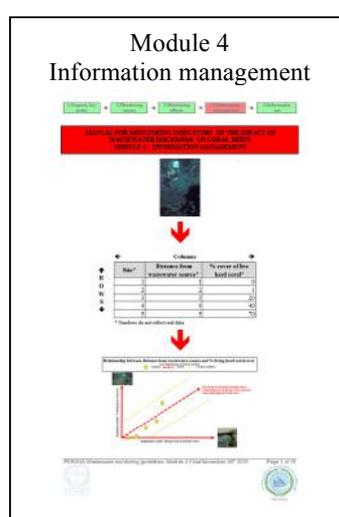
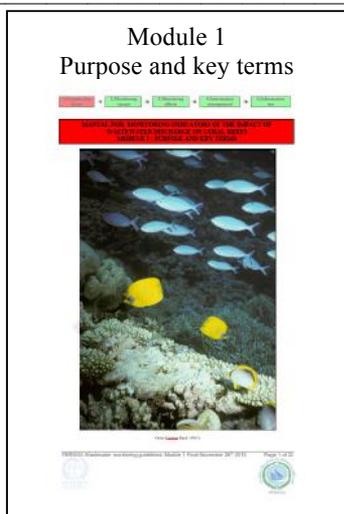
Pre	Post	<p>If the test is taken before training tick (✓) the “pre” box and if it is taken after training tick (✓) the “post” box.</p>
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Tick box as appropriate.

<b>5.6.01</b>	List the 6 elements of information use.	The trainee should answer this question showing an understanding of learning point 5.1.04.	
<b>5.6.02</b>	List the two characteristics determining the significance of an impact.	The trainee should answer this question showing an understanding of learning point 5.1.05.	
<b>5.6.03</b>	What is the constraint to reducing wastewater discharge as a tool for wastewater management?	The trainee should answer this question showing an understanding of learning point 5.1.06.	
<b>5.6.04</b>	What are the constraints to adaptation of receptors as a tool for wastewater management?	The trainee should answer this question showing an understanding of learning point 5.1.06.	
<b>5.6.05</b>	How might compensation be used as one of the wastewater management solutions	The trainee should answer this question showing an understanding of learning point 5.1.06.	
<b>5.6.06</b>	Describe the 5 elements of the checklist for advocating action.	The trainee should answer this question shoeing an understanding of learning point 5.1.07	
<b>5.6.07</b>	Who should develop an action plan?	The trainee should answer this question showing an understanding of learning point 5.1.08.	



5.6.08	What are the key requirements for an action within an action plan?	The trainee should answer this question showing an understanding of learning point 5.1.08.	
5.6.09	Propose a decision statement.	The trainee should answer this showing an understanding of learning point 5.1.09.	
5.6.10	How should a decision be taken?	The trainee should answer this question showing an understanding of learning point 5.1.09.	
5.6.11	What is the main reason for an action plan?	The trainee should answer this question showing an understanding of learning point 5.1.10.	
5.6.12	Group review of module	The individual should be scored reflecting his/her understanding of the issues being discussed and the individuals' contribution to helping to deliver consensus within the group.	
5.6.13	Group debate of wastewater treatment facility discharging into a mersa.	The individual should be scored reflecting his/her understanding of the issues being discussed and the individuals' contribution to helping to deliver consensus within the group.	
5.6.14	Examinee, name, signature and date	Examiner, name, signature and date	Total
Comments by examinee:		Comments by examiner:	



For more information contact PERSGA.  
[www.persga.org](http://www.persga.org)





