CIVIL CHAPTER 17: WATER RESOURCE QUALITY MANAGEMENT

17.1 Introduction of the Unit of Learning

This unit covers the competencies required to manage water resources quality. It involves monitoring, managing water resources quality, managing groundwater quality, managing wastewater quality and treating and disposing of wastewater.

17.2 Performance Standard

Monitor water resources' quality, surface water quality management, ground water quality management, and manage waste water quality based on the need, reconnaissance survey, SOPs, monitoring protocol, and best practice.

17.3 Learning Outcomes

17.3.1 List of Learning Outcomes

a) Monitor water resources quality
b) Surface Water quality management
c) Ground Water quality management
d) Manage wastewater quality

17.3.2 Learning Outcome No 1: Monitor Water Resources Quality

17.3.2.1 Learning Activities

Learning Outcome No 1: Monitor Water Resources Quality	
Learning Activities	**Special Instructions**
1.1 Carry out ***water quality reconnaissance survey*** 1.2 Identify ***environmental water sampling sites*** and ***water resource quality indicators*** 1.3 Identify ***matrices*** (Sediments) for water resource quality monitoring 1.4 Identify ***tools and equipment*** (GPS receiver, water quality testing instruments: UV-Vis) 1.5 Operate and maintain tools and equipment 1.6 Prepare water quality ***monitoring protocol*** 1.7 Implement water quality monitoring ***schedules*** 1.8 To prepare and submit water quality monitoring report	• Detailed labouratory water tests. • Use of customized computer software for data analysis • Field Trips • Demonstration by the trainer

17.3.2.2 Information Sheet No17/LO1: Monitor Water Resources Quality

Introduction to learning outcome

This section deals with the processes of ensuring a high degree of water quality. The quality that to be assessed is that of the receiving water on the surface including rivers, streams, or ocean, and that at the subsurface level that includes underground springs, and aquifers.

Definition of key terms

Environmental water sampling sites: - Refers to those specific locations at which surface water and subsurface water can be collected and preserved awaiting quality assurance.

Water resource quality indicators: - This is parameters that determine water quality

Matrices: - This are tables that indicate stages of water analysis relative to the parameters being investigated and their removal efficiencies

Content/Procedures/Methods/Illustrations

1.1 Carry out *water quality reconnaissance survey* (upstream, hot spots, effluent discharge points) based on the need.

The aim of this survey is to obtain water quality of the receiving water that includes surface water and subsurface water. Representative samples are obtained at points that represent conditions at the most unfavorable or at points of contamination.

Water quality monitoring process

1. **Physical monitoring**

Physical characteristics of the water are visually inspected or deductions made by sensory observation to ascertain its quality. This includes algae, sediment, suspended solids, odor, and stream bank. The channel geometry characteristics also can be instrumental in deciding which methods to employ.

2. **Chemical monitoring**

This is conducted as a microbial analysis measure to a rational health-based perspective to quality monitoring. The parameters include pH, chloride, phosphate, turbidity, and nitrates.

3. **Biological monitoring**

A sampling of micro-invertebrates (bugs) at points or sections of a stream. The microinvertebrates are grouped according to sensitivity levels to pollution

1.1 Identify *environmental water sampling sites* (boreholes, wells) and *water resource quality indicators* based on the reconnaissance survey

Environmental water sampling sites are the locations at which samples are picked. They are normally pointing of the source. The points selected should yield samples that represent the whole system. Automatic samplers collect samples on an hourly basis however manual sampling is also required especially at locations where automatic systems cannot be installed. Boreholes and wells are used to monitor contaminant flow in aquifer formations by introducing a tracer dye in the well upstream and then observe its path which represents the way dissolved pollutants move. The use of underground water quality modeling like Phreeq has enabled easier preparation of water quality matrices

Water resource quality indicators are the aspects of physical, chemical, and biological nature that depict the level of contamination or pollution. The table below shows the biological indicator commonly tested.

Table 37: The biological indicator commonly tested.

Physical	Chemical	Biological
Turbidity	Dissolved oxygen	Bacteria
Electric conductivity	Pesticide content	Parasites
Viscosity	Salts, phosphates, nitrates,	Viruses
Temperature	heavy metals	Protozoa
	pH	

1.2 Identify *matrices* for water resource quality monitoring based on the reconnaissance survey

Water quality monitoring matrices are correlations used to determine water quality status by testing water quality parameters using surrogate relations.

The correlation is between two or more parameters that have been tested, for example, the relationship between TSS might have a high or low correlation with BOD, NO3, COD, and turbidity. The chemicals which should never be discharged into the receiving water include: calcium carbonate, chloroform, Condensing water, Degreasing solvents, and color. WASREB has laid down the criteria for wastewater treatment, discharge, and reuse.

Water quality parameters correlation matrix

	Temp.	pH	EC	TDS	Cl	ALK.	TH	Ca	Mg	Na	K	F	NO_3	SO_4	PO_4	DO
Temp	1.00	-0.43^a	-0.90^a	0.89^a	-0.79^a	0.58^a	0.85^a	-0.60^a	0.86^a	0.93^a	0.93^a	0.53^a	0.52^a	0.88^a	0.67^a	-0.56^a
pH		1.00	-0.46^a	-0.46^a	-0.33^b	-0.34^b	-0.50^a	0.23^c	-0.48^a	-0.42^b	-0.42^b	-0.15^c	-0.06^c	0.27^c	-0.45^a	0.80^a
EC			1.00	1.00^a	0.91^a	0.78^a	0.97^a	-0.56^a	0.96^a	0.99^a	0.97^a	0.56^a	0.59^a	0.84^a	0.72^a	-0.63^a
TDS				1.00	0.91^a	0.78^a	0.97^a	-0.56^a	0.96^a	0.99^a	0.97^a	0.56^a	0.59^a	0.84^a	0.72^a	-0.63^a
Cl					1.00	0.80^a	0.85^a	-0.34^b	-0.82^a	0.91^a	0.85^a	0.55^a	0.65^a	0.83^a	0.64^a	-0.57^a
ALK.						1.00	0.75^a	-0.22^c	0.71^a	0.77^a	0.76^a	0.49^a	0.74^a	0.59^a	0.58^a	-0.57^a
TH							1.00	0.53^a	0.99^a	0.95^a	0.93^a	0.49^a	0.50^a	0.76^a	0.69^a	-0.61^a
Ca								1.00	-0.66^a	-0.57^a	-0.61^a	-0.20^c	-0.02^c	-0.53^a	-0.41^a	0.22^c
Mg									1.00	0.063^c	-0.07^c	-0.18^c	0.05^c	0.02^c	-0.07^c	-0.08^c
Na										1.00	0.98^a	0.59^a	0.61^a	0.86^a	0.71^a	-0.60^a
K											1.00	0.59^a	0.65^a	0.87^a	0.72^a	-0.60^a
F												1.00^a	0.46^a	0.54^a	0.46^a	-0.36^b
NO_3													1.00	0.56^a	0.49^a	-0.40^b
PO_4														1.00	0.55^a	-0.53^a
SO_4															1.00	-0.50^a
DO																1.00

$^a r > 0.46$ ($p < 0.001$); $^b r > 0.33$ ($p < 0.05$); $^c r < 0.22$ Not Significant; $df = 40$.

Figure 177: Water quality parameters correlation matrix

Source: Central Pollution Control Board (CPCB), Water quality status of Yamuna River, Parivesh Bhawan, Delhi, 1999–2000.

1.3 Identify *tools and equipment* (GPS receiver, water quality testing instruments: UV-Vis) based on the need.

The tools and equipments are the aids for monitoring. GPS tools can be used to monitor pollutant movement from the point of generation and the path it follows as it flows along the stream. The pollutant can be classified in arc map and identified in a particular color. Water quality instruments are used to test and indicate water quality parameters either real time or over a certain period. They include pH meters, BOD manometers, thermometers, and jar test equipment. The manometric method is used to test the sample for microbiological contaminants. Other instruments include multi-parameter water quality sonde, which is an automatic sampler that allows for discrete sampling of water quality parameters.

1.4 Operate and maintain tools and equipment based on standard operating procedures.

The equipment that requires operation and maintenance includes labouratory testing equipment, automatic samplers, analytical balance, glassware, fume hoods, ovens, and refrigerators. The Kenya Bureau of standards outlines the operational and maintenance standards required for such equipment. Automatic samplers are maintained and calibrated following the YSI user's manual.

1.5 Prepare water quality monitoring protocol (Surveillance, Pollution control) based on need

Monitoring aims to regulate and prohibit the discharge of effluent into the aquatic environment. The water quality guidelines as stipulated in the WHO guidelines on effluent monitoring, (2008), stipulates the conditions for discharge into surface water or injection or leaching into groundwater aquifers. The surveillance mechanisms include scheduled monitoring, unscheduled monitoring, self-monitoring, and demand monitoring.

Monitoring Protocol for pollution control

- Determination of water-course system standard conditions
- Detection of a decline in water quality
- Identify inflow streams that do not meet standards
- Identify the point and non-point sources for either surface or groundwater
- Determine the extent of contamination
- Estimate the pollution load transported to surface systems and groundwater
- Develop the water quality guidelines for specific use
- Develop sustainable quality assurance and quality control processes
- Develop a water pollution control protocol

1.6 Implement water quality monitoring *schedules* (Monthly, Quarterly, Annually) based on the monitoring protocol

Quarterly schedule on Water and Effluent Monitoring

Table 38: Quarterly schedule on Water and Effluent Monitoring

Issue	**Status**
Issue Status Water production to town [m3]	
Number of WSPs	
Number of separate networks	
Number of registered effluent dischargers	
Number of overflowing/broken sewers including a period of overflow	
Number of bacteriological tests within norm	
Summary of major deviations	

Guidelines on Water Quality and Effluent Monitoring, (2017)

Table 39: Annual Water and Effluent Monitoring schedule

Issue	**Status**
Water production to town [m3]	
Number of WSPs	
Number of separate networks	
Number of registered effluent dischargers	
Name (s) of labouratories where the analysis was carried out	
Number of tests conducted	
Other activities are undertaken to improve water and effluent quality	

Source: Guidelines on Water Quality and Effluent Monitoring, (2017)

1.7 Prepare and submit water quality monitoring report based on best practice

Table 40: System Description

Amount of effluent discharge (m3/yr)	
Number of separate networks	
Effluent discharge through network 1(m3/yr)	
Effluent discharge through network 2(m3/yr	

Guidelines on Water Quality and Effluent Monitoring

Table 41: Test reports

Network 1	No of Tests per year	No of tests conduct	No of tests within KS
BOD5			
COD			
pH			
Suspended solids			
Ammonia, NH4, Nitrate NO3, Nitrite NO			
Total Dissolved Solids			
E.Coli			

Network 2	No of Tests per year	No of tests conduct	No of tests within KS
BOD5			
COD			
pH			
Suspended solids			
Ammonia, NH4, Nitrate NO3, Nitrite NO			
Total Dissolved Solids			

Guidelines on Water Quality and Effluent Monitoring (2017)

Conclusion

This learning outcome covered the quality of water resources. Water is a very important natural resource in our daily lives

Further Reading

1. Changing trends in sampling methods
2. How to allocate monitoring wells in a potentially contaminated network
3. Wastewater treatment plant design

17.3.2.3 Self-Assessment

Written Assessment

1. After samples are collected from the source, how much time is allowed before the samples are tested.
    a) 12 hours – 1 day
    b) – 4 days
    c) – 24 hours
    d) 48 – 72 hours
2. When preparing water quality assessment parameters, which one is allowed to discharge freely into receiving water?
    a) Cyanide
    b) 30 mg/L BOD
    c) 5 mg/L Chromium V
    d) 100 mg/L COD
3. Identify the one which is not a criterion for water sampling frequency
    a) source of the water
    b) The volume produced and population
    c) Number of tests to be conducted
    d) Aquatic life population in the water
4. Evaluate the matrix concerning Nairobi River and compare with WHO or NEMA standards.
5. Summarize the roles of local authorities in control of pollution of water.
6. Distinguish the organizations responsible for water quality monitoring in Kenya.
7. Explain environmental management plan
8. Differentiate between point and non- point sources
9. Based on your knowledge of water resources explain the source of pollutants, their removal method, and mitigation measures to minimize their discharge into water bodies
10. Differentiate the stages of the non-conventional wastewater treatment process using well-labelled diagrams indicating the contaminants removed at each stage.

Practical Assessment

1. In a wastewater treatment plant evaluate the critical areas where sampling must be done
2. Determine BOD5 using samples obtained from your Kitchen water following the monitoring protocol

Oral Assessment

Prepare six slides on monitoring technologies adaptation in water sampling to be presented in class.

Project Assessment

By applying WHO and NEMA standards determine water quality parameters for a borehole in your vicinity and prepare a water quality correlation matrix.

17.3.2.4 Tools, Equipment, Supplies and Materials

- Computers
- Stationery
- water sampling kit (manual, automated)
- sampling equipment (sampling bottles, boats)
- Standard operating procedures
- Portable water quality test kits (with Thermometers, pH, EC, turbidity, DO meters,
- Microbial test kits for resent/absent etc.)
- GIS Software
- Digital cameras
- GPS
- Glass ware
- Marking devices

17.3.2.5 References

Cotruvo, J. A. (2017). 2017 WHO guidelines for drinking water quality: first addendum to the fourth edition. Journal-American Water Works Association, 109(7), 44-51.

James, C. A., Miller-Schulze, J. P., Ultican, S., Gipe, A. D., & Baker, J. E. (2016). Evaluating contaminants of emerging concern as tracers of wastewater from septic systems. Water Research, 101, 241-251.

Behmel, S., Damour, M., Ludwig, R., & Rodriguez, M. J. (2016). Water quality monitoring strategies—A review and future perspectives. Science of the Total Environment, 571, 1312-1329.

17.3.3 Learning Outcome No 2: Surface Water Quality Management

17.3.3.1 Learning Activities

Learning Outcome No 2: Surface Water Quality Management	
Learning Activities	**Special Instructions**
2.1 Identify surface ***water quality challenges and issues*** 2.2 Characterize surface water resources quality 2.3 Develop surface water quality management plan 2.4 Implement surface water quality management plan	• Surface water collection • Trainer demonstration • Detailed lab experiments • Use of standard equipment for testing

17.3.3.2 Information Sheet No17/LO2 Surface Water Quality Management

Introduction to learning outcome

Surface water forms a large percentage of water that is readily available for human consumption. Its quality should, therefore, be of great concern and the challenges and issues that arise be addressed.

Definition of key terms

Water quality challenges and issues – these are problems facing the efforts put in place by relevant stakeholders in ensuring there is the availability of clean water in accordance to the set standards.

Content/Procedures/Methods/Illustrations

2.1 Identify surface *water quality challenges and issues* based on management need

Challenges faced by stakeholders in the management of surface water quality are:

- Human Ambitions and Earth's Limits – humans have continued to modify the planet, and at some point, there is ignorance in conserving the surface water bodies which many at times are used as disposal points.
- Research needs and directions – even with the availability of improved technology over time, research on newer methods of conserving water quality is still slow as compared to the rate of pollution and contamination

- Urban and industrial water demands – water is an essential need for any livelihood, the high demand of such a commodity forces all lives(both human and wildlife) to tamper with the source risking and in most cases polluting them.

Surface water includes streams, rivers, lakes, dams, oceans, seas, and all visible water bodies on land. The main challenge facing the quality of water in these bodies is pollution which can be in different ways as shown in the table below:

Table 42: Quality of water

PROCESS TYPE	MAJOR PROCESS WITHIN WATER BODY	BRIEF EXPLANATION
Hydrological	Dilution	Occurs when water is saturated by a soluble pollutant
	Suspension and settling of particles	None soluble pollutants in surface water
Physical	diffusion	If one point of a surface water is polluted, it spreads onto the whole water body
Chemical	Photodegradation	A reaction where chemical compounds in water are broken down by photons
	Acid-base reaction	The reaction of alkaline compounds with acids in water
Biological	Decomposition of organic matter	The dead organic substance in water bodies when broken down release bacterial pollutants in the water body
	Bioaccumulation	An organism accumulates a substance from water or a suspended particle
	Biomagnification	Increase in concentration of a substance within a food chain

All of the above processes may as a result of human activities that discharge waste into the surface water bodies and also from natural causes.

2.1 Characterize surface water resources quality based on challenges and issues identified

Table 43: Surface Water Recourses

SURFACE WATER RECOURCES	CHALLENGES FACED
Lakes and reservoirs	Stratification. This is caused by a difference in solute concentration (discharged as waste from human activities) causing the water to split in two different layers due to differences in densities causing difference in quality of water in the two layers.
Rivers and streams	Nonsoluble sediments suspended in water. Can be from industrial, agricultural or municipal waste
Oceans and seas	Oil spills, dumping of plastic waste, and garbage patches are challenges facing the quality of water in the ocean and seas.
Dams and manmade water resources	Dumping of garbage.

2.2 Develop surface water quality management plan based on challenges and issues identified

Water quality management plan can be developed by the following steps

i. Examine current understanding
ii. Define community values and management goals
iii. Define relevant indicators
iv. Determine water quality guideline values
v. Define draft water quality objectives
vi. Assess if water quality objectives are met
vii. Consider additional indicators or refine water quality objectives
viii. Consider alternative management strategies
ix. Assess if water quality objectives are achievable
x. Implement agreed management strategy

Table 44: Example of a water quality management plan

TARGETED OBJECTIVES TO ADDRESSED RISKS	STRATEGIES	WATER MANAGEMENT SOLUTIONS AND MECHANISMS	MANAGEMENT PLAN.
Reduce the dumping of garbage to water bodies	Create an area for dumping garbage where they can be recycled	Dump all garbage at the dumping site	Garbage area plan
Stop discharge of domestic wastewater into water bodies	Develop a wastewater treatment site for domestic wastewater	Direct all domestic wastewater into the treatment site	Wastewater treatment plan

2.3 Implement surface water quality management plan based on challenges and issues identified

Based on the challenges and issues, the water quality management plan is implemented practically.

Conclusion

This learning outcome covered the creation of a quality management plan for surface water

Further Reading

Forms of surface water quality control for future changes in quality parameters

17.3.3.3 Self-Assessment

Written Assessment

1. Which of the following is not a surface water resource?
    a) Rivers
    b) Lakes
    c) Aquifers
    d) Dams

2. Choose a chemical process within a water body
    a) Dilution
    b) Decomposition
    c) Biomagnification
    d) Photodegradation
3. Evaluate the challenges facing the quality of surface water resources
4. Compare 4 surface water resources
5. Summarize the steps to follow when developing a water quality management plan
6. Explain how stratification occurs on water body.
7. Explain how the following affect water quality
    a) Human ambition and earth limits
    b) Urban and industrial water demands
    c) Research needs and directions

Oral Assessment
Explain biological processes that face water quality.

Case Study Assessment
In your residential area, how has the water quality situation been handled?

Performance-Based Evidence
Oral Assessment
Come up with a water quality management plan for your residential area

Practical Assessment
Visit a nearby water source and check the quality in terms of insoluble solutes and sediments.

Project Assessment
Visit a nearby water treatment plant and write a report on methods the use to improve water quality

17.3.3.4 Tools, Equipment, Supplies and Materials

- Computers
- Stationery
- Water sampling kit (manual, automated)
- Sampling equipment (sampling bottles, boats)
- Standard operating procedures
- Portable water quality test kits (with Thermometers, ph, EC, turbidity, DO meters,

- Microbial test kits for resent/absent etc.)
- GIS Software
- Digital cameras
- GPS

17.3.3.5 References

Water Quality: An Introduction (2019) By Claude E. Boyd.

Hydrodynamics and Water Quality: Modeling Rivers, Lakes, and Estuaries (2017) By Zhen-Gang Ji.

Surface Water Quality: Have the Laws Been Successful? (2014) By Ruth Patrick, Faith Douglass, Drew M. Palavage, Paul M. Stewart.

17.3.4 Learning Outcome No 3: Ground Water Quality Management

17.3.4.1 Learning Activities

Learning Outcome No 3: Ground Water Quality Management	
Learning Activities	**Special Instructions**
3.1 Identify ***groundwater quality challenges and issues*** 3.2 Characterize groundwater resources quality 3.3 Develop a groundwater quality management plan 3.4 Implement a groundwater quality management plan	• Conduct borehole drilling tests • Conduct ionic balance charge analysis

17.3.4.2 Information Sheet No17/LO3 Ground Water Quality Management

Introduction to learning outcome

This learning outcome covers the identification of ground water, quality challenges and issues, characterization of ground water resources, development of groundwater quality management plan and implementation of groundwater quality management plan.

Definition of key terms

Groundwater quality challenges and issues - these are problems facing the efforts put in place by relevant stakeholders in ensuring groundwater is maintained as pure as possible.

Content/Procedures/Methods/Illustrations

3.1 Identify *groundwater quality challenges and issues* (Over-abstraction and groundwater pollution) based on management need.

Groundwater refers to the water below the earth surface, an example of around water are aquifers.

Ground water challenges and issues

1. Contamination – agricultural chemicals that leach into the soil may contaminate groundwater other contaminants are from industrial and municipal wastes
2. Poor quality of the water source- groundwater mainly comes from percolation of surface water or when streams and rivers reach a point where they get into the ground, if these streams and rivers are polluted the quality of groundwater will be affected
3. Poor site selection or protection of where the groundwater exists

3.2 Characterize groundwater resources quality based on challenges and issues identified

Quality of groundwater is based on features such as temperature, ph., color, and smell when these characteristics cause the challenges faced by the quality of groundwater.

Table 45: Quality of groundwater is based on features

CHARACTERISTICS	CHALLENGES
Temperature	This should be equal to mean air temperature above the surface, this can be altered by poor site selection.
Colour	Quality groundwater should be colourless, contamination by chemicals and leaching may alter this
Ph.	Should be neutral
Odour/smell	Quality groundwater should be odourless, this can be altered by contamination.

3.3 Develop a groundwater quality management plan based on challenges and issues identified.

This is similar to surface water quality management planning, the only change is strategies

Table 46: Example of a water quality management plan

TARGETED OBJECTIVES TO ADDRESSED RISKS	STRATEGIES	WATER MANAGEMENT SOLUTIONS AND MECHANISMS	MANAGEMENT PLAN.
Reduce the dumping of garbage to water bodies	Create an area for dumping garbage where they can be recycled	Dump all garbage at the dumping site	Garbage area plan
Stop discharge of domestic wastewater into water bodies	Develop a wastewater treatment site for domestic wastewater	Direct all domestic wastewater into the treatment site	Waste water treatment plan

3.4 Implement a groundwater quality management plan based on challenges and issues identified.

Based on the challenges and issues, the water quality management plan is implemented practically.

Conclusion

Groundwater quality is therefore vital as has been covered above. Our aquifers have to be protected against over-abstraction and pollution as they are a great source of groundwater.

Further Reading

How to conduct groundwater monitoring using PhreeQ software

17.3.4.3 Self-Assessment

Written Assessment

1. Categorize types of groundwater resources
2. Compare and contrast between physical and chemical characteristics of groundwater,
3. Which of the following is not a groundwater challenge?
    a) Contamination
    b) Poor site selection
    c) Dumping of garbage
    d) Poor water source
4. Evaluate how contamination of groundwater occur?
5. How does temperature affect the quality of groundwater
6. Briefly explain the term groundwater
7. Summarize how does following affect the quality of groundwater
    a) Temperature
    b) Ph7 multiple-choice questions
    c) Smell
    d) Color

Case Study Assessment

Research on how geological location affects the quality of groundwater

Practical Assessment

Using data from a known source of groundwater, check on the required standard of groundwater.

Oral Assessment

Explain 3 groundwater challenges and issues

Project Assessment

In groups discuss how standards of groundwater can be reached

17.3.4.4 Tools, Equipment, Supplies and Materials

- Computers
- Stationery
- Water sampling kit (manual, automated)
- Sampling equipment (sampling bottles, boats)
- Standard operating procedures
- Portable water quality test kits (with Thermometers, ph, EC, turbidity, DO meters,
- Microbial test kits for resent/absent etc.)
- GIS Software
- Digital cameras
- GPS

17.3.4.5References

Septic Tank System Effects on Ground Water Quality (2017) ByCanter.

Artificial Recharge of Groundwater (2016) edited by Takashi Asano.

Groundwater around the World: A Geographic Synopsis (2013) By Jean Margat, Jac van der Gun.

17.3.5 Learning Outcome No 4: Manage Wastewater Quality

17.3.5.1 Learning Activities

Learning Outcome No 4: Manage wastewater quality	
 **Learning Activities**	**Special Instructions**
4.1 Identify sources of wastewater 4.2 Assess wastewater quality 4.3 Prepare wastewater quality assessment report 4.4 Treat and dispose of wastewater 4.5 Interpret wastewater quality assessment report 4.6 Submit wastewater quality assessment report	• Proper wastewater collection • Proper wastewater treatment • Compliance with the wastewater quality treatment standards

17.3.5.2 Information Sheet No17/LO4 Manage Wastewater Quality

Introduction to learning outcome

This learning outcome covers the identification of sources of wastewater, assessing wastewater quality, preparation of wastewater quality assessment report, treating and disposing of waste water interpretation of waste water quality report and the submission of the waste water quality report.

Definition of key terms

Wastewater quality- These include indicators or labouratory tests done to wastewater to assess its suitability for disposal or future re-use. The indicators measure the physical, chemical, or even biological characteristics of wastewater.

Content/Procedures/Methods/Illustrations

4.1 Identify sources of wastewater based on characteristics

Table 47: Sources of wastewater based on characteristics

SOURCE	CHARACTERISTIC
Domestic/residential	Mainly greywater due to detergents for washing
Commercial	Used in garages, salons, etc.
Industrial	Chemical: Presence of heavy metals
Stormwater and runoff	Physical; Brown, High turbidity.

4.2 Assess wastewater quality based on selected parameters

The important characteristics measured in wastewater include:

- Biochemical Oxygen Demand (BOD) [100-300 mg/L as O2]
- Suspended solids (SS) [100 – 350 mg/L]
- Settleable solids [5-20 mL/L]
- Total Kjeldahl nitrogen (TKN) [20-80 mg/L]
- Total Phosphorus [5-20 mg/L as P]

A typical solids analysis of wastewater, of the total solids, 50% is dissolved, 50% suspended. Of the suspended solids, 50% will settle.

Industrial activity changes the composition of wastewater, often introducing toxic substances such as chromium and cadmium from plating operations

4.3 Prepare wastewater quality assessment report based on monitoring sites

Analysis of the influent and effluent of wastewater in a treatment plant in India produced the following data on wastewater quality;

Table 48: Wastewater quality assessment report based on monitoring sites

PARAMETER	INFLUENT	EFFLUENT
pH	7.75	7.8
TSS (mg/l)	251.5	81.5
COD (mg/l)	415.6	129.2
BOD (mg/l)	211.8	82.3
DO (mg/l)	6.6	4.4

The effluent concentrations of the above data exceeded the effluent standards indicating failure to meet quality standards set.

This could be due to operational problems in the biological treatment stage.

4.4 Treat and dispose of wastewater as per the environmental standards.

How is Wastewater Treated?

Wastewater treatment involves two major steps:

1. Gravity settling of solids (called primary treatment)
2. Microbial transformation of organics and ammonia to reduce BOD (called secondary treatment).

A typical treatment train in a wastewater treatment plant involves:

1. Bar racks to remove large debris
2. Primary treatment where Type II sedimentation for flocculated particles. The SOR ranges from 25-60 m/d, td ranges from 1.5 to 2.5 hours.
3. Secondary treatment involving the use of microorganisms to remove BOD of any solids that pass primary treatment. Oxygen is limited and must be supplied. The most common secondary treatment process is activated sludge.

4. Secondary sedimentation to remove microorganisms from secondary treatment.
5. Disinfection to kill pathogens using chlorine (typically HOCl)

Effluent standards are concentration pollutants expressed in terms of parts per million of wastewater discharged through outfall pipes

The following is a table showing wastewater parameter concentrations before and after treatment

Table 49: Wastewater parameter concentrations before and after treatment

PARAMETER	INFLUENT	EFFLUENT
pH	7.75	7.8
TSS (mg/l)	251.5	81.5
COD (mg/l)	415.6	129.2
BOD (mg/l)	211.8	82.3
DO (mg/l)	6.6	4.4

(Minimum) Goals of wastewater treatment plants include;

- Less than 30mg/l of BOD_5
- Less than 30mg/l of suspended solids
- Less than 200CFU/ 100ml of fecal coliforms

Anything greater than these values is disposed of.

4.5 Interpret the wastewater quality assessment report based on the monitoring plan

Table 50: Wastewater quality assessment report based on the monitoring plan

PARAMETER	INFLUENT	EFFLUENT
pH	7.75	7.8
TSS (mg/l)	251.5	81.5
COD (mg/l)	415.6	129.2
BOD (mg/l)	211.8	82.3
DO (mg/l)	6.6	4.4

From the above table one can deduce that;

The wastewater quality parameters reduce in volume after treatment. Thus, a well-functioning treatment plant meets the required standards on the parameter volumes during discharge i.e.

(Minimum) Goals of wastewater treatment plants include;

- Less than 30mg/l of BOD_5
- Less than 30mg/l of suspended solids
- Less than 200CFU/ 100ml of fecal coliforms

4.6 Submit the wastewater quality assessment report based on best practices

Best practices on wastewater quality assessment report include;

1. Sustainability -The treatment practices should meet the needs of today without compromising the future.
2. Finance and efficiency- Should be affordable to reduce billing charges levied on the users.
3. Reliability-The system should be dependable and robust in the execution of its duties
4. Security of service- Should have a proportional and secure design.

Conclusion

This learning outcome covered ways of proper management of wastewater before being discharged into water bodies

Further Reading

Read further on water quality modelling using remote sensing

17.3.5.3 Self-Assessment

Written Assessment

1. Which one is not a parameter of water quality?
    a) BOD
    b) COD
    c) Ph
    d) density
2. Which of the following is not a best practice on wastewater quality assessment.
    a) Sustainability
    b) Service quality
    c) Reliability
    d) Toxicology report
3. Which of the following is not part of a wastewater treatment plant.
    a) Bar racks
    b) Primary treatment chamber
    c) Secondary treatment chamber
    d) Tertiary chamber

4. Summarize waste water quality in terms of BOD and COD.
5. Categorize the sources of wastewater based on characteristics
6. Interpret wastewater quality assessment report based on monitoring plan

Essay Questions

1. Best practices in waste water quality is a concern. Discuss
2. Denmark is a pioneer in best water practices. Elabourate
3. Discuss the scenario of African economies in terms of wastewater quality and treatment.

Case Study Assessment

Basing on the Nairobi waste water treatment plant, discuss the shortcomings on waste water quality.

Oral assessments

Based on the experiment below, what are the observations?
What conclusions can be drawn?

Practical Assessment

Set up an experiment to measure the parameters in wastewater**.**

Project Assessment

Compare the effluents of the wastewater treatment plant nearby with the ideal environment standards and tabulate your findings.

Case Study Assessment

Basing on the Nairobi wastewater treatment plant, discuss the shortcomings of wastewater quality.

17.3.5.4 Tools, Equipment, Supplies and Materials

- Computers
- Stationery
- Water sampling kit (manual, automated)
- Sampling equipment (sampling bottles, boats)
- Standard operating procedures
- Portable water quality test kits (with thermometers, ph, ec, turbidity, do meters,
- Microbial test kits for resent/absent etc.)
- Gis software
- Digital cameras
- Gps

17.3.5.5References

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