Public Health Training Network

SELF-STUDY COURSE 3010-G

Lesson 3

Wastewater Treatment and Disposal

Environmental Health Sciences
Self-Study Course SS3010

Lesson 3: *Wastewater Treatment and Disposal*

I. Lesson Consists of

A. Part I: 25 multiple choice questions
B. Part II: 25 multiple choice questions
C. Part III: 25 multiple choice questions
D. Part IV: 15 multiple choice questions, 10 true-false questions

Note: These questions are not in sequence due to the interrelated nature of the subject. The student must complete the reading assignment before attempting to complete the questions.

II. Reference

Salvato, J. A. *Environmental Engineering and Sanitation.* 4th ed. New York: John Wiley & Sons, 1992.

III. Topics and Reading Assignments

1. Chapter 3 - Wastewater Treatment and Disposal	**(Page No.)**
A. Disease Hazard	473 to 477
B. Definitions	477 to 481
C. Stream Degradation and Recovery	482 to 484
D. Water Quality Classification	484 to 487
E. Eutrophication	487 to 489
F. Small Wastewater Disposal Systems	489 to 537
G. Small Wastewater Disposal Systems for Unsuitable Soils or Sites	538 to 578
H. Sewage Works Design - Small Treatment Plants	578 to 607
I. Typical Designs of Small Plants	607 to 621
J. Sewage Works Design - Large Systems	621 to 647
K. Low Cost Sanitation	647 to 655
M. Industrial Waste	655 to 661

IV. Suggested Supplementary Readings

Kapland, O. B., *Septic Systems Handbook.* 2nd ed., Lewis Publishers, 1991.
McCelland, N. I., ed. *Individual Onsite Wastewater Systems*, Vols. 1-6, Ann Arbor, Michigan: Ann Arbor Science Publishers, 1974-80.

On-site Wastewater Management. Denver Colorado: National Environmental Health Association, 1979.

Patterson, A. R. *A First Course in Fluid Dynamics*, New York: Cambridge University Press, 1983.

V. Objectives

Upon successful completion of Lesson 3, students should be able to correctly

- demonstrate a basis understanding of the relationship of quantity, design, distribution, and economics of wastewater management
- demonstrate a basic knowledge of the issues of disease control associated with wastewater management
- recognize the unique problems and principles involved in small wastewater treatment systems
- demonstrate a general knowledge of principles of large system development and specialized treatment systems
- demonstrate and understanding of the meaning of percolation test, soil analysis, and site evaluation programs.

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Lesson 3: *Wastewater Treatment and Disposal*

Part I: Multiple Choice

1. It is known that some common pathogenic organisms found in wastewater will survive more than _____ of harsh temperature extremes

   a. 2 months
   b. 5 months
   c. 2 years
   d. 5 years.

2. Trickling filters can remove 90 to 95 percent of the ____ found in soil, water, and wastewater.

   a. bacteria
   b. viruses
   c. cholera vibrio
   d. all of the above.

3. Primary sedimentation can remove ____ found in soil, water, and wastewater.

   a. 50 to 90 percent of the bacteria
   b. 30 to 50 percent of the ascaris
   c. 80 percent of the schistosomes
   d. all of the above.

4. Chemical coagulation, flocculation, sedimentation, and filtration remove

   a. most bacteria
   b. most viruses and protozoa
   c. most helminths
   d. all of the above.

5. Chlorination of untreated wastewater is typically **NOT** an effective treatment for

   a. entamoeba histolytica cysts
   b. giardia cysts
   c. tapeworm eggs
   d. all of the above.

6. The exposure of excreta or sewage on the surface of the ground sets the stage for disease transmission by both direct contact or

   a. indirect contact
   b. vector
   c. vehicle or fomite
   d. all of the above.

7. Excreta typically is defined as containing

   a. 2000 million fecal coliform, 450 million fecal streptococci, and 400 billion E. coli per 100 to 200 grams
   b. 250 million fecal coliform, 100 million fecal streptococci, and 40 billion E. coli per 550 grams
   c. significant levels of heavy metals and toxic chemicals
   d. 400 ppm chlorinated hydrocarbon.

8. Wastewater is the used water from a home or community and the strength is expressed in terms of

   a. BOD
   b. COD
   c. suspended solids
   d. all of the above.

9. A storm sewer is used to

   a. remove rain other standing surface water
   b. remove sewage and storm water
   c. remove household water waste and gutter drain water
   d. remove non-toxic, non-hazardous wastewater.

10. Stream pollution is sometimes apparent by

    a. increased levels of available oxygen in the water
    b. a zone of degradation
    c. large numbers of crayfish and cristivomer species
    d. large numbers of small fish.

11. A young lake is considered to be

    a. eutrophic
    b. mesotrophic
    c. oligotrophic
    d. ohytotrophic.

12. Nutrients associated with eutrophication include

    a. phosphates
    b. nitrogen
    c. organic carbon
    d. all of the above.

13. The National Pollutant Discharge Elimination System (NPDES) prohibits the discharge of pollutants into U.S. waters unless a permit is issued by

    a. EPA
    b. the State
    c. wastewater treatment agency
    d. a or b.

14. The favored method of disposal of domestic wastewater is

    a. septic tank seepage field
    b. community package system
    c. buried sand filter
    d. connection to public sewer system.

15. The wastewater from a water closet and latrine or aqua privy flushing is referred to as

    a. gray water
    b. black water
    c. green water
    d. red water.

16. The permeability of soil is directly related to the _____ of the soil.

    a. chemical composition
    b. color and texture
    c. granular structure
    d. all of the above.

17. A water leak no larger than 1/8 inch in diameter can result in a loss of up to:

    a. 50 gallons in 24 hours
    b. 100 gallons in 24 hours
    c. 200 gallons in 24 hours
    d. 400 gallons in 24 hours

18. Grease traps are installed for the purpose of minimizing grease in the sewer system. The trap

    a. is not of proven value in many commercial applications
    b. requires yearly scheduled cleaning
    c. should be installed close to dishwashing machines
    d. should always discharge behind the septic tank.

19. The septic tank primarily functions as a

    a. a biological treatment system
    b. a sedimentation tank
    c. a conditioning tank
    d. all of the above.

20. The detention time for wastewater in a septic tank is recommended to be

    a. 6 to 12 hours
    b. 24 to 72 hours
    c. 1 week
    d. none of the above.

21. If the septic tank will have a garbage disposal unit feeding into it

    a. the size of the tank should be increased 50 percent
    b. the tank should have an agitator
    c. the tank should not be equipped with a gas baffle
    d. the tank should not be constructed with precast concrete.

22. Septic tanks serving commercial operations should be inspected for the need for cleaning

    a. once per month
    b. once per year
    c. twice per year
    d. every 3 to 5 years.

23. Sludge accumulation in a tank serving a normal home has been estimated at

    a. 40 to 50 liters per person per year
    b. 69 to 80 gals. per person per year
    c. 18 to 21 gals. per person per year
    d. 2.2 gals. per person per year.

24. Septage is best defined as

    a. sludge
    b. scum
    c. gray water
    d. a mixture of all of the above.

25. If a septic tank is pumped in a wet period

a. the tank may be crushed by the wet earth
b. the water will flow into the tank
c. the tank may float out of the ground
d. the field may flood the tank.

Part II: Multiple Choice

1. How often should a septic tank for a private home be serviced?

   a. every year
   b. every 5 to 10 years
   c. every 3 to 5 years
   d. every 10 years.

2. Human disease from aerosols of wastewater

   a. is related primarily to wastewater treatment by the activated sludge, trickling filter, and spray irrigation processes
   b. has been demonstrate from pathogens recovered in aerosols from the spray irrigation of treated wastewater
   c. may be caused by very small numbers of organisms
   d. is a hazard even to those who have had subclinical infections, and thus should have been immunized.

3. The plans for an area to be sewered should

   a. be prepared by a licensed professional engineer
   b. include specifications and an engineering report
   c. include the problem, objectives and design details
   d. all of the above.

4. Sewage treatment plants should be designed for

   a. the population at the present time
   b. a per capita flow of not less than 100 gpd plus institutional wastes and all industrial wastes
   c. the population **at least** 10 years in the future
   d. a per capita flow of 100 gpd, plus institutional wastes and all industrial wastes.

5. Final disposal of sludge may include all of the following **except**

   a. composting
   b. sanitary landfill
   c. land application
   d. vegetable dumping.

6. Chemical coagulation, flocculation, sedimentation, and filtration will remove nearly all bacteria, viruses, protozoa, and helminths if supplemented by

   a. desalination
   b. chlorination
   c. over 4 feet of loamy soil
   d. all of the above.

7. Why should sewage sludge not be used as a soil builder or fertilizer supplement for crops for forage if it has not been properly tested?

   a. it may make the vegetables taste bad
   b. it may result in higher levels of toxic metals in the vegetation and in the animals eating the vegetation
   c. the community may be offended at the smell
   d. all of the above.

8. Loam is a mixture of gravel, sand, silt, and clay containing what?

   a. highly toxic metals
   b. potassium and ammonium
   c. decayed plant and animal matter
   d. dirt.

9. The degree of eutrophication of a lake is indicated by

   a. the quantity of planktonic algae
   b. reduced water transparency
   c. dissolved oxygen in the water near the surface
   d. all of the above.

10. What is the best assurance of satisfactory operation of a properly designed and constructed septic tank system?

    a. proper maintenance
    b. large dosages of bacteria
    c. one quart of lime down the line every month
    d. the use of numerous additives available.

11. After a septic tank has been cleaned, it should not be scrubbed and disinfected. Why?

    a. the sludge sticking to the insides would have a seeding effect and assist in renewing the bacterial activity
    b. you cannot pay anybody enough money to crawl inside one to clean it
    c. it would be considered a safety hazard
    d. a and c above.

12. One of the most important factors contributing to disease transmission of microbiological agents is

    a. chlorination
    b. concentration or dose of microorganisms
    c. filtration
    d. flocculation.

13. When storm water and domestic sewage enter the same sewer it is known as a

    a. sanitary sewer
    b. combined sewer
    c. separate sewer
    d. storm sewer.

14. Loam is composed of which of the following?

    a. sand
    b. gravel
    c. silt
    d. all of the above.

15. A watertight tank designed to slow down the movement of raw sewage and wastes passing through to the soils is known as a

    a. pit privy
    b. spring house
    c. septic tank
    d. grease trap.

16. The volume of the dose from a properly sized dosing tank should be equal to:

    a. 20% of the volume of the lines dosed
    b. 40% of the volume of the lines dosed
    c. 60% of the volume of the lines dosed
    d. 100% of the volume of the lines dosed

17. What is the most common method of applying wastewater to land?

    a. waste stabilization pond
    b. land over-land flow
    c. spray irrigation
    d. wetland treatment.

18. Plants employing trickling filters, activated sludge, and spray irrigation present a possible health hazard to their employees due to

    a. strong caustic chemicals
    b. diseases due to handling of fecal matter
    c. microorganisms entering the skin through pores
    d. inhalation of airborne microorganisms.

19. Which of the following is an explosive component of sewer gas?

    a. carbon dioxide
    b. carbon monoxide
    c. hydrogen sulfide
    d. methane

20. Which of the following is **not true** concerning sewage and disease hazards?

    a. all sewage should be considered contaminated with disease-producing organisms
    b. entamoeba histolytica, hepatitis viruses, and giardia cysts are easily destroyed by normal chlorination of sewage
    c. sewage sludge may not be safe to use as a soil builder or fertilizer supplement
    d. it cannot be assumed that relationships between sewage discharge and diseases do not exist if no clinical cases are reported.

21. Which of the following soils would be most suitable for subsurface absorption of wastewater

    a. a mottled brown and red soil
    b. a blue soil
    c. a grayish soil
    d. a yellow, brown, or red soil.

22. Which of the following are **least** important in reducing sewage to "soil," liquids, and gases?

    a. anaerobic bacteria
    b. earthworms
    c. protozoa
    d. aerobic bacteria.

23. The amount of dissolved oxygen required in aerobic bacterial decomposition, measured in ppm or mg/l and used in determining the strength of wastewater is

    a. chemical oxygen demand
    b. total organic carbon
    c. biochemical oxygen demand
    d. oxygen-reduction ration.

24. The reliability and interpretation of the soil percolation test are affected by all of the following except

    a. evaluation of site investigation, soil profile, and suitability
    b. shape of the test hole
    c. size or diameter of the test hole
    d. saturation of soil.

25. Disinfection or chlorination of sewage effluent is

    a. always necessary
    b. a substitute for adequate wastewater treatment
    c. an added safeguard to reduce the risk of disease transmission where the probability exists
    d. usually non-toxic to freshwater, marine, and estuarine aquatic organisms in minute concentrations.

Part III: Multiple Choice

1. Plants absorb certain constituents of wastewater; using wastewater for irrigation of consumable plant products may present a health hazard to humans if the water contains

   a. nitrates
   b. iron
   c. cadmium
   d. chlorides.

2. A measure of the relativity constant rate at which clear water, maintained at a relatively constant depth, will seep out of a standard size test hole that has been previously saturated is the

   a. hydraulic conductivity
   b. soil permeability test
   c. soil percolation test
   d. Baird-Parker saturation test.

3. The ability of a soil to absorb and allow water and air to pass through is related to all of the following except

   a. chemical composition
   b. texture
   c. cation exchange capacity
   d. granular structure.

4. Bacteria that require oxygen for their growth are called

   a. anaerobic bacteria
   b. aerobic bacteria.
   c. viruses
   d. fungi.

5. The ability of the soil to absorb and allow water and air to pass through is called

   a. unloading
   b. infiltration
   c. permeability
   d. soil aeration.

6. The most effective method discovered for running a percolation test is

   a. to make tests in holes that have been filled with water overnight
   b. to make at least 4 tests for the average area being tested
   c. to make 12 tests where the soil is relatively uniform
   d. to take a reading every 5 minutes.

7. Sludge depth, scum thickness, and the appearance of particles of solids in the effluent from a septic tank is an indication of what?

   a. a failure in the absorption field
   b. a septic tank in need of cleaning
   c. a water line leak
   d. the need to replace the septic tank.

8. After the absorption field has failed, which of the following will **NOT** correct or repair the field?

   a. reduce the amount of water used in the home
   b. increase the water pressure
   c. pump the septic tank
   d. use low-flow shower heads.

9. Which of the following is non-toxic to aquatic organisms, a good viricide, and adds oxygen to treated wastewater effluents?

   a. ozone
   b. calcium hypochlorine
   c. sulfur dioxide
   d. chlorine dioxide.

10. The suitability of soil for the subsurface disposal of sewage and other wastewater can be determined by a study of soil characteristics and the

    a. soil survey
    b. soil percolation test
    c. rate of sewage flow
    d. amount of rainfall.

11. Each water quality class has a ___ standard established.

    a. physical
    b. chemical
    c. biological
    d. all of the above.

12. A soil which is mottled brown and red would indicate

    a. saturation for extended periods
    b. adequate air and water passage
    c. a soil suitable for subsurface groundwater absorption
    d. a tight soil probably due to a fluctuating water table or lack of aeration.

13. Sand filters, elevated systems in suitable fill, evapotranspiration absorption systems, evapotranspiration beds, aeration systems, stabilization ponds or lagoons, recirculating toilets and the like, are

    a. less effective than subsurface soil absorption systems
    b. used prior to soil absorption when soil is poor
    c. sometimes used where soil is rocky
    d. required for treatment in areas of high risk.

14. While it is arguably preferable to conduct a soil analysis for sizing absorption fields percolation tests are sometimes used. In order to obtain "reproducible results" with a soil percolation test, it is very important to:

    a. add at least 2 inches of gravel to the bottom of the test pit
    b. cross-reference results with reliable soil maps
    c. soak the hole with water before the test is made
    d. repeat the test or use dual pits.

15. The accumulation of sludge in a normal home septic tank has been estimated at

    a. 130 to 175 liters per person per year
    b. 69 to 80 liters per person per year
    c. 81 to 96 gallons per person per year
    d. 17.4 to 53.4 decimeters^3 per person per year.

16. Ozone disinfection has many advantages. Which of the following is not true?

    a. ozone is non-toxic to aquatic organisms
    b. ozone can be a source of dissolved oxygen
    c. ozone is a good viricide
    d. ozone is approximately equal in cost to chlorine.

17. By USEPA Standards, the pH of secondary treatment effluent shall be in the range of

    a. 6.8 to 7.4
    b. 5 to 7
    c. 6.5 to 7.4
    d. 6 to 9.

18. Which of the following would be a cause of septic-tank failure?

    a. lack of routine cleaning of the septic tank
    b. leaking plumbing fixtures
    c. improper design and construction of the absorption system
    d. all of the above.

19. In the usage of septic-tank additives, which of the following compounds is not recommended and why?

    a. sulfuric acid-causes clogging of the septic tank
    b. sodium hydroxide-decreases anaerobic digestion
    c. trichloroethane-cause the sewer to boil in the tank
    d. methylene chloride-suspected of being carcinogenic.

20. The effectiveness of disinfection depends on

    a. the degree of treatment the sewerage has received
    b. the amount of chlorine used, and the residual chlorine maintained
    c. the mixing and retention period
    d. all of the above.

21. Which of the following is typically used at a residential sewage treatment system with a surface discharge?

    a. sodium hypochlorite
    b. calcium hypochlorite
    c. liquid chlorine
    d. a or b above.

22. Combined chlorine

    a. is effective in reducing fecal coliforms to 200 mg/l or less
    b. removes all fecal coliforms
    c. reduces fecal coliforms to 250 mg/l or less
    d. does not reduce any fecal coliforms.

23. Why is the proper disposal of sewage necessary?

    a. it reduces illness in the population
    b. it provides comfort for individuals
    c. it reduces the pollution of surface groundwater
    d. all of the above.

24. Facultative bacteria can

    a. live under both aerobic and anaerobic condition
    b. live only under aerobic conditions
    c. live and reproduce with or without moisture
    d. live only in the soil.

25. Man-made organic compounds that degrade very slowly are referred to as

a. total organic compounds
b. fractory compounds
c. refractory organics
d. anaerobic organic compounds.

Part IV: Multiple Choice and True-False

1. The sand filter is used to

   a. remove suspended solids from water
   b. remove bacteria from water
   c. sterilize water
   d. a and b above.

2. Sewer gas may contain

   a. H_2S
   b. methane
   c. chlorine
   d. all of the above.

3. Any excavation in clay, loam, silt or sand more than _____ in depth should have side wall protection to prevent a cave-in.

   a. 5 feet
   b. 4 feet
   c. 3 feet
   d. 2 1/2 feet.

4. Brine from water softening units as low as _____ may inhibit bacterial action in septic tanks.

   a. 1.2 percent
   b. 5.6 percent
   c. 8.9 percent
   d. none of the above.

5. Which of the following is true regarding the use of septic-tank cleaners?

   a. additives have been shown to be cost-effective alternatives to annual cleaning
   b. their use is not advised
   c. there is no evidence that the chemicals used eventually reach groundwater
   d. the greasing compounds used have proven to be completely safe.

6. The use of a cesspool is prohibited due to

   a. potential for odor
   b. cost
   c. space required
   d. greater potential for groundwater contamination.

7. The typical limitation of use of the septic tank absorption field system is due to

   a. cost
   b. land use considerations
   c. soil type and size requirements
   d. appearance.

8. Based on a study conducted in Ontario, Canada, the septic tank sand filter relies on what process for most of the liquid removal?

   a. filtration
   b. infiltration
   c. lateral seepage
   d. vegetative transpiration.

9. The NODAK system is designed to

   a. protect ground water
   b. decrease surface area
   c. allow evaporation of most liquids
   d. none of the above.

10. Low-pressure, vacuum and cluster systems may be used

    a. where soil is unsuitable for septic-tank systems
    b. in hilly areas
    c. in high-density recreational areas
    d. all of the above.

11. Common causes of failure of septic tank seepage field systems include improper sizing, nonsuitable soil, nonservicing, and

    a. insufficient nutrients in tank
    b. excessive use of laundry detergents
    c. leaking fixtures
    d. use of wetting agents.

12. The traditional absorption field should be laid in trenches not more than ____ below the ground surface.

    a. 18 inches
    b. 42 inches
    c. 24 inches
    d. 63 inches.

13. The top of the absorption field gravel should be covered with

    a. tar paper
    b. permeable material
    c. plastic
    d. treated paper.

14. The field distribution piping should be surrounded with ____ and at least 2 inches deep under the pipe.

    a. washed gravel, 3/4 inches to 2 1/2 inches
    b. broken limestone, 1 inches to 2 inches
    c. fine marble chips
    d. a mixture of sand and gravel.

15. The distance between the field lines or tiles must be a minimum of ____ in a treatment absorption field arrangement.

    a. 3 feet
    b. 6 feet
    c. 9 feet
    d. 12 feet.

True-False: Mark the answer sheet under Column A if the statement is true, or under column B if the statement is partially or totally false.

16. The recommended backfill over the absorption field is 12 inches.

17. The recommended distance from the bottom of the trench to the ground water table or rock is 62 inches.

18. The recommended maximum length of the system materials is 75 feet.

19. The placement of the distribution box is not critical as long as it is water tight.

20. The use of a serial distribution system is considered to have disadvantages over the use of distribution boxes.

21. Yeast added to a new septic tank speeds up digestion by a factor of 2.7.

22. The depth of septic tanks and ratio of width to length recommended by most health departments are very similar.

23. Soil containing loam will remove most of the phosphorus in sewage effluent.

24. The examination of road cuts, stream embankments, and/or building excavations provides only marginal information about soils due to oxidation.

25. A lump of soil with good characteristics will break apart with little pressure along definite cleavage plains and should be blue or grayish in color.

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Answer Keys

Self-Study Course SS3010
Environmental Health Sciences
Answer Keys (Page No.)

Lesson 3: Part I

1. C (473)	6. D (475)	11. C (488)	16. D (492)	21. A (519)
2. D (474)	7. A (475)	12. D (488)	17. D (507)	22. C (519)
3. D (474)	8. D (478)	13. D (484)	18. A (510)	23. C (519)
4. D (474)	9. A (480)	14. D (490)	19. D (512)	24. D (520)
5. D (475)	10. B (482)	15. B (491)	20. B (519)	25. C (519)

Part II

1. C (519)	6. B (474)	11. D (520)	16. C (572)	21. D (493)
2. A (595)	7. B (476)	12. B (474)	17. C (601)	22. A (493)
3. D (579)	8. C (492)	13. B (480)	18. D (595)	23. C (477)
4. C (629)	9. D (488)	14. D (492)	19. ~~K~~ (640) wrong	24. B (500)
5. D (631)	10. A (519)	15. C (512)	20. B (475)	25. C (582)

Part III

1. C (601)	6. [redacted] (500) A	11. D (485)	16. D (586)	21. D (585)
2. C (499)	7. B (519)	12. D (493)	17. D (623)	22. A (584)
3. C (492)	8. [redacted] (534) B	13. C (490)	18. D (523)	23. D (479)
4. B (477)	9. A (586)	14. C (500)	19. D (524)	24. A (478)
5. C (492)	10. B (500)	15. B (519)	20. D (582)	25. C (480)

Part IV

1. D (543)	6. D (535)	11. C (523)	16. A; true (529)	21. B; false (526)
2. D (521)	7. C (518)	12. C (529)	17. B; false (530)	22. ~~B; false~~ A True (518)
3. C ~~(491)~~ 521	8. D (565)	13. B (531)	18. A: true (529)	23. A; true (518)
4. A (522)	9. A (554)	14. A (530)	19. B; false (525)	24. B; false (578)
5. B (520)	10. D (575)	15. B (529)	20. B; false (526)	25. B; false (493)