PE
environmental practice exam
CONTENTS

Introduction to NCEES Exams ................................................................. 1
   About NCEES
   Exam format
   Examinee Guide
   Scoring and reporting
   Updates on exam content and procedures

   Exam Specifications................................................................. 3

   PE Environmental Practice Exam ........................................... 7

   PE Environmental Solutions .................................................. 53
About NCEES
NCEES is a nonprofit organization made up of the U.S. engineering and surveying licensing boards in all 50 states, the U.S. territories, and the District of Columbia. We develop and score the exams used for engineering and surveying licensure in the United States. NCEES also promotes professional mobility through its services for licensees and its member boards.

Engineering licensure in the United States is regulated by licensing boards in each state and territory. These boards set and maintain the standards that protect the public they serve. As a result, licensing requirements and procedures vary by jurisdiction, so stay in touch with your board (ncees.org/licensing-boards).

Exam Format
The PE Environmental exam is computer-based. It contains 80 questions and is administered year-round via computer at approved Pearson VUE test centers. A 9-hour appointment time includes a tutorial, the exam, and a break. You will have 8 hours to complete the actual exam.

In addition to traditional multiple-choice questions with one correct answer, the PE Environmental exam uses common alternative item types such as

- Multiple correct options—allows multiple choices to be correct
- Point and click—requires examinees to click on part of a graphic to answer
- Drag and drop—requires examinees to click on and drag items to match, sort, rank, or label
- Fill in the blank—provides a space for examinees to enter a response to the question

To familiarize yourself with the format, style, and navigation of a computer-based exam, view the demo on ncees.org/ExamPrep.

Examinee Guide
The NCEES Examinee Guide is the official guide to policies and procedures for all NCEES exams. During exam registration and again on exam day, examinees must agree to abide by the conditions in the Examinee Guide, which includes the CBT Examinee Rules and Agreement. You can download the Examinee Guide at ncees.org/exams. It is your responsibility to make sure you have the current version.

Scoring and reporting
Results for computer-based exams are typically available 7–10 days after you take the exam. You will receive an email notification from NCEES with instructions to view your results in your MyNCEES account. All results are reported as pass or fail.

Updates on exam content and procedures
Visit us at ncees.org/exams for updates on everything exam-related, including specifications, exam-day policies, scoring, and corrections to published exam preparation materials. This is also where you will register for the exam and find additional steps you should follow in your state to be approved for the exam.
NCEES Principles and Practice of Engineering Examination
ENVIRONMENTAL CBT Exam Specifications
Effective Beginning with the April 2019 Examinations

- The exam topics have not changed since April 2018 when they were originally published.
- The PE Environmental exam is computer-based. It is closed book with an electronic reference.
- Examinees have 9 hours to complete the exam, which contains 80 questions. The 9-hour time includes a tutorial and an optional scheduled break. Examinees work all questions.
- The exam uses both the International System of units (SI) and the U.S. Customary System (USCS).
- The exam is developed with questions that will require a variety of approaches and methodologies, including design, analysis, and application.
- The knowledge areas specified as examples of kinds of knowledge are not exclusive or exhaustive categories.

### Number of Questions

#### 1. Water 21–35

A. Principles 3–5
   1. Hydraulics/fluid mechanics
   2. Chemistry
   3. Biology/microbiology
   4. Fate and transport
   5. Sampling and measurement methods
   6. Hydrology/hydrogeology
   7. Codes, standards, regulations, and guidelines

B. Wastewater 7–11
   1. Sources of pollution and minimization/prevention
   2. Treatment technologies and management
   3. Collection systems
   4. Residuals (sludge) management
   5. Water reuse

C. Stormwater 2–4
   1. Sources of pollution
   2. Treatment technologies and management
   3. Collection systems

D. Potable Water 7–11
   1. Source water quality
   2. Treatment technologies and management
   3. Distribution systems
   4. Residuals management (solid, liquid, and gas)
E. Water Resources 2–4
   1. Sources of pollution
   2. Watershed management and planning
   3. Source supply and protection

2. Air 14–22
   A. Principles 7–11
      1. Sampling and measurement methods
      2. Codes, standards, regulations, and guidelines
      3. Chemistry
      4. Fate and transport
      5. Atmospheric science and meteorology
   B. Pollution Control 7–11
      1. Sources of pollution
      2. Emissions characterization, calculations, and inventory
      3. Treatment and control technologies
      4. Pollution minimization and prevention

3. Solid and Hazardous Waste 11–18
   A. Principles 5–8
      1. Chemistry
      2. Fate and transport
      3. Codes, standards, regulations, and guidelines
      4. Risk assessment
      5. Sampling and measurement methods
      6. Minimization, reduction, and recycling
      7. Mass and energy balance
      8. Hydrology, hydrogeology, and geology
   B. Municipal and Industrial Solid Waste 4–6
      1. Storage, collection, and transportation systems
      2. Treatment and disposal technologies and management
   C. Hazardous, Medical, and Radioactive Waste 2–4
      1. Storage, collection, and transportation systems
      2. Treatment and disposal technologies and management

4. Site Assessment and Remediation 12–19
   A. Principles 5–8
      1. Codes, standards, regulations, and guidelines
      2. Chemistry/biology
      3. Hydrology/hydrogeology
      4. Sampling and measurement methods
   B. Applications 7–11
      1. Site assessment and characterization
      2. Risk assessment
      3. Fate and transport
      4. Remediation alternative identification
      5. Remediation technologies and management
5. **Environmental Health and Safety**  7–11
   A. Principles  3–5
      1. Health and safety
      2. Security, emergency plans, and incident response procedures
      3. Codes, standards, regulations, and guidelines
   B. Applications  4–6
      1. Industrial hygiene
      2. Exposure assessments (e.g., chemical, biological, radiation, noise)
      3. Indoor air quality

6. **Associated Engineering Principles**  5–9
   A. Principles  2–4
      1. Statistics
      2. Sustainability
   B. Applications  3–5
      1. Engineering economics
      2. Project management
      3. Mass and energy balance
      4. Data management (e.g., GIS mapping, asset management, data visualization)
PE ENVIRONMENTAL PRACTICE EXAM
4. A wastewater treatment plant discharges to a receiving stream. After mixing of the wastewater effluent and the receiving stream, the following data apply:

\[
\begin{align*}
\text{CBOD}_5 &= 6 \text{ mg/L} & \text{Wastewater temperature} &= 24^\circ\text{C} \\
\text{BOD}_5 &= 8 \text{ mg/L} & \text{Upstream temperature} &= 18^\circ\text{C} \\
\text{BOD}_{ult} &= 10 \text{ mg/L} & \text{Downstream temperature} &= 20^\circ\text{C}
\end{align*}
\]

- Reaeration rate constant (base e at 20°C) = 0.40 day\(^{-1}\)
- Deoxygenation rate constant (base e at 20°C) = 0.23 day\(^{-1}\)
- Reaeration temperature correction coefficient = 1.024
- Deoxygenation temperature correction coefficient = 1.047
- Dissolved oxygen = 6 mg/L
- Stream velocity = 1 fps

Assuming the time of travel required to achieve the maximum dissolved oxygen deficit in the stream is 1.8 days, the minimum dissolved oxygen concentration (mg/L) is most nearly:

- A. 2.9
- B. 5.2
- C. 6.2
- D. 7.3
6. Shown below is a schematic diagram of a conventional wastewater treatment plant. Place the treatment plant components in their correct positions on the diagram.

[Diagram of wastewater treatment plant with labeled components]

WASTEWATER TREATMENT PLANT COMPONENTS

- Biological Aeration
- Disinfection
- Preliminary Treatment
- Primary Settling
- Recirculation
- Secondary Settling
- Sludge Thickening and Disposal
24. The maximum contaminant level for nitrate is 10 mg/L. Assuming an uncertainty factor of 100, the maximum daily consumption [mg/(kg•day)] that will produce no adverse effects in an adult male is most nearly:

- A. 0.14
- B. 0.28
- C. 14.3
- D. 29.5

33. Which of the following will control NOx formation for internal combustion engines?

Select all that apply.

- A. A positive crankcase ventilation system
- B. A three-way catalytic converter
- C. An exhaust gas recirculation system
- D. Oxygenated fuels
- E. Valve timing
42. Adsorption and retention of organic chemical pollutants by soil is strongly affected by which soil characteristic?

- A. Soil organic content
- B. Depth of vadose zone
- C. Hydrostatic pressure
- D. Cation exchange capacity

44. A 25-year-old landfill has been capped, and a gas recovery system has been installed. The landfill received an average daily waste load of 1,000 tons. The landfill gas production rate averages 0.30 ft³/lb of refuse received. The landfill gas has been characterized as:

<table>
<thead>
<tr>
<th>Component</th>
<th>Dry Volume Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>47.5%</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>47.0%</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>3.7%</td>
</tr>
<tr>
<td>Oxygen</td>
<td>0.8%</td>
</tr>
<tr>
<td>Other</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

The potential methane gas production (ft³) from this landfill is most nearly:

- A. $2.6 \times 10^9$
- B. $5.5 \times 10^9$
- C. $7.8 \times 10^9$
- D. $8.7 \times 10^9$
45. An existing landfill has 50 undeveloped acres available for new landfill expansion. The locations and groundwater elevations for the three open wells shown in the figure are given in the table. The average hydraulic conductivity of the aquifer is 0.28 m/day, and the porosity of the strata is 35%. If the groundwater flow is directly from OW1 to OW6, the groundwater flow actual velocity (ft/day) between OW1 and OW6 is most nearly:

<table>
<thead>
<tr>
<th>Open Well</th>
<th>Groundwater Elevation (ft)</th>
<th>Distance (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OW1</td>
<td>936.0</td>
<td>OW1 to OW4: 2,000</td>
</tr>
<tr>
<td>OW4</td>
<td>934.0</td>
<td>OW4 to OW6: 2,500</td>
</tr>
<tr>
<td>OW6</td>
<td>932.0</td>
<td>OW6 to OW1: 1,500</td>
</tr>
</tbody>
</table>

- A. 0.002
- B. 0.005
- C. 0.007
- D. 0.014
46. A characteristic hazardous waste can only be rendered nonhazardous by which of the following methods?

- A. Delisting the waste
- B. Blending the characteristic hazardous waste with nonhazardous waste
- C. Removing the characteristic that caused the waste to be hazardous
- D. Removing the lead and benzene

49. Sources of leachate in a well-designed landfill cell can come from which of the following sources?

Select all that apply.

- A. Precipitation
- B. Water in the solid waste
- C. Overland flow from other landfill cells
- D. Water entering the side of the landfill cell from the surrounding cells and area
- E. Water entering the bottom of the landfill cell

59. Tetraethyl lead is a liquid at 15°C and 1 atm with a vapor pressure of 0.036 kPa at 20°C. Its density is 1.650 g/mL. Its solubility in water is 0.8 mg/L at 20°C. If 500 gal of tetraethyl lead is spilled on soil from an aboveground storage tank, it will:

- A. spread on the surface and penetrate the soil at a rate dependent on the soil type and water content
- B. disperse laterally through the soil
- C. remain on the surface and gradually volatilize
- D. remain above the saturated zone
62. Benzene is attenuating in petroleum-contaminated soil at the rate of 0.2%/day. If benzene natural attenuation follows first-order kinetics, the time (years) required for the average benzene concentration in soil to decrease from 17 mg/kg to 5 mg/kg is most nearly:

- A. 0.5
- B. 1.12
- C. 1.67
- D. 2.33

64. If the chronic daily intake of benzene in a contaminated groundwater source is 0.002 mg/(kg•day) and the oral cancer slope factor is 0.029 [mg/(kg•day)]\(^{-1}\), the expected number of increased cancer cases in a community of 50,000 people consuming the groundwater is __________.

Enter your response in the blank.

77. A subsurface remedial treatment technology costs $245,000 to construct initially with annual operation and maintenance costs of $9,000 for a 5-year operational life. Using an annual interest rate of 6% and no equipment salvage value, the annualized cost for the remedial treatment technology is most nearly:

- A. $57,000
- B. $59,000
- C. $63,000
- D. $67,000
80. A municipal wastewater pump station has an initial cost of $47,000. Other related costs are as follows:

- Each of two pumps = $4,500
- Control panel = $4,000
- Yearly operation and maintenance = $550
- Salvage value = $10,000
- Discount rate = 8%

Assume the pump life is 10 years and the control panel life is 20 years. The present worth of the pump station for 20 years of operation is most nearly:

- A. $55,000
- B. $63,000
- C. $65,000
- D. $67,000
4. \[ D_{\text{max}} = \frac{k}{k_2} L_0 e^{-kt_{\text{max}}} \]
\[ = \frac{0.23}{0.40} 10e^{-0.23(1.8 \text{ days})} \]
\[ = 3.8 \text{ mg/L} \]

Look up or calculate DO saturation at 20°C = 9.02 mg/L
\[ DO = DO_{\text{sat}} - D_{\text{max}} = 9.02 - 3.8 = 5.2 \text{ mg/L} \]

THE CORRECT ANSWER IS: B

6. THE CORRECT POSITION OF EACH COMPONENT IS SHOWN ABOVE.
24. \[ DWEL = \frac{RfD\cdot W}{Q} \]
\[ DWEL = \frac{(NOAEL)(78)}{(UF)(2.3L/D)} \]
\[ 10 \text{ mg/L} = \frac{(NOAEL)(78\text{ kg})}{(100)(2.3L/D)} \]
\[ \frac{(100)(2.3L/D)(10 \text{ mg/L})}{78\text{ kg}} = NOAEL \]
\[ = 29.5 \text{ mg/(kg\cdot day)} \]

THE CORRECT ANSWER IS: D

33. The positive crankcase ventilation system adjusts the rate of removal of blowby gases to maintain the air/fuel ratio. NOX formation is affected by the A/F.

A three-way catalytic converter simultaneously converts hydrocarbons and carbon monoxide to carbon dioxide and reduces NOX to N2.

An exhaust gas recirculation system recirculates a portion of the exhaust stream to the incoming air/fuel mixture to reduce the combustion temperature and decrease the production of NOX.

Oxygenated fuels are required by the Clean Air Act Amendments of 1990 to address high levels of carbon monoxide emissions in nonattainment areas. They do not affect NOx formation.

Adjustments to valve timing in internal combustion engines can reduce residence time at peak temperature to control NOX formation.

THE CORRECT ANSWERS ARE: A, B, C, E
42. Natural organic content determines organic pollutant absorption and retention.

THE CORRECT ANSWER IS: A

44. (0.30 \text{ ft}^3/\text{lb}) \left( \frac{1,000 \text{ tons}}{\text{day}} \right) \left( \frac{365 \text{ days}}{\text{year}} \right) (25 \text{ years}) \left( \frac{2,000 \text{ lb}}{\text{ton}} \right) (0.475) = 2.6 \times 10^9 \text{ ft}^3

THE CORRECT ANSWER IS: A

45. Using Darcy's Law

\[ v = \frac{k(h_1 - h_2)}{L} \]

where

\[ k = 2.8 \times 10^{-1} \text{ m/day} \]
\[ h_1 = 936.0 \text{ ft} \]
\[ h_2 = 932.0 \text{ ft} \]
\[ L = 1,500 \text{ ft} \]
\[ n = 0.35 \]

\[ v = \frac{(0.28)(936.0 - 932.0)}{(1,500)(0.35)} = 0.00213 \text{ m/day} \]

or converting to ft/day

\[ v = (0.00213)(3.28) = 0.006986 \text{ ft/day} \]

THE CORRECT ANSWER IS: C

46. A characteristic waste can only be rendered nonhazardous by removing the contaminant concentration below the regulatory level.

THE CORRECT ANSWER IS: C

49. Although all are potential sources of leachate, the design of the liner system should preclude Options D and E. Proper cell design should eliminate overland flow of water from one landfill cell to another (Option C).

THE CORRECT ANSWERS ARE: A, B
59. Because of its density, downward transport when spilled is a concern.

THE CORRECT ANSWER IS: A

62. \[
C_t = C_0 e^{-kt} \\
\frac{C_t}{C_0} = e^{-kt} \\
\ln \frac{C_t}{C_0} = -kt \\
k = 0.002 \ \text{day}^{-1} \\
C_0 = 17 \ \text{mg/kg} \\
C_t = 5 \ \text{mg/kg} \\
t = \frac{\ln \left( \frac{C_t}{C_0} \right)}{-k} = \frac{\ln \left( \frac{5}{17} \right)}{-0.002} = \frac{\ln 0.294}{-0.002} = \frac{-1.22}{-0.002} = 610 \ \text{days} = 1.67 \ \text{years}
\]

THE CORRECT ANSWER IS: C

64. The expected number of increased cancer cases in the community from people consuming the groundwater is:

Given: Population is 50,000
Chronic Daily Intake of Benzene (CDI) = 0.002 mg/kg•day
Oral Cancer Potency Factor (CPF) = 0.029[mg/(kg•day)]⁻¹

Number of Additional Cancer Cases (NACC)
\[
NACC = \text{(population)}(\text{CDI})(\text{CPF}) \\
= (50,000)(0.002 \ \text{mg/kg•day})(0.029[\text{mg/(kg•day)]}^{-1}) \\
= 2.9 \\
NACC = 3 \ \text{additional cancer cases}
\]

THE CORRECT ANSWER IS: 3
77.  
\[ i = 6\% \]
\[ n = 5 \text{ years} \]
\[ P = $245,000 \]

From Interest Tables, \( A = 0.2374 \)

Annualized Cost  
\[ = 0.2374 \times (245,000) + 9,000 \]
\[ = 58,163 + 9,000 \]
\[ = $67,163 \]

THE CORRECT ANSWER IS: D

80.  
Initial cost  
\[ = \text{pump station} + 2 \text{ pumps} + \text{control panel} \]
\[ = $47,000 + 2($4,500) + $4,000 \]
\[ = $60,000 \]

Operating costs  
\[ $550 \times \frac{(1+i)^n - 1}{i(1+i)^n} = 9.8181 \]
\[ = 550 (9.8181) = $5,400 \]

Replacement pump costs  
\[ $9,000 \times \frac{1}{(1+i)^n} = 0.4632 \]
\[ = 9,000 (0.4632) = $4,169 \]

Salvage costs  
\[ $10,000 \times \frac{1}{(1+i)^n} = 0.2145 \]
\[ = 10,000 (0.2145) = $2,145 \]

Present worth  
\[ = 60,000 + 5,400 + 4,169 - 2,145 \]
\[ = $67,424 \]

THE CORRECT ANSWER IS: D