PE civil: water resources and environmental practice exam
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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 Civil: Water Resources and 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 have 8 hours to complete the actual exam.

In addition to traditional multiple-choice questions with one correct answer, the 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 video tutorials on the NCEES YouTube channel.

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.
7. A bridge footing is to be constructed in sand. The groundwater level is at the ground surface. The ultimate bearing capacity is based on what type of soil unit weight?

- A. Buoyant unit weight
- B. Saturated unit weight
- C. Dry unit weight
- D. Total unit weight

8. The figure shows two identical building footings with the same load but constructed in two different soil types. Which of the following statements is most correct?

- A. The long-term settlement for Case I is less than Case II.
- B. The long-term settlement for Case II is less than Case I.
- C. The long-term settlements are the same for both cases.
- D. Settlement is not a concern for either case.
12. An 8-in.-diameter domestic sanitary sewer line with gravity flow (normally only partially full) is being designed. The pipe will be buried less than 10 ft deep and will be subjected to no live load. Based on the piping guide shown, which of the following types of piping should be considered for use?

Select the three that apply.

- □ A. Reinforced concrete pipe–unlined (RCP)
- □ B. Polyvinyl chloride pipe (PVC)
- □ C. Steel pipe–unlined
- □ D. Vitrified clay pipe (VCP)
- □ E. Ductile iron pipe–mortar lined (DIP)
- □ F. Prestressed concrete cylinder pipe (PCCP)

<table>
<thead>
<tr>
<th>Piping (Material) Type</th>
<th>Abbreviation</th>
<th>Diameter Available Minimum (inches)</th>
<th>Diameter Available Maximum (inches)</th>
<th>Corrosion Resistance</th>
<th>Strength</th>
<th>Joints</th>
<th>Relative Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforced concrete–unlined</td>
<td>RCP</td>
<td>12</td>
<td>96</td>
<td>Poor</td>
<td>High</td>
<td>B&amp;S/T&amp;G</td>
<td>Moderate</td>
</tr>
<tr>
<td>Reinforced concrete–PVC lined</td>
<td>RCP Lined</td>
<td>12</td>
<td>96</td>
<td>Good</td>
<td>High</td>
<td>B&amp;S</td>
<td>Moderate</td>
</tr>
<tr>
<td>Ductile iron–mortar lined</td>
<td>DIP</td>
<td>4</td>
<td>60</td>
<td>Moderate</td>
<td>Moderate</td>
<td>B&amp;S</td>
<td>High</td>
</tr>
<tr>
<td>Ductile iron–glass lined</td>
<td>DIP Glass Lined</td>
<td>6</td>
<td>60</td>
<td>Excellent</td>
<td>Moderate</td>
<td>B&amp;S</td>
<td>Very High</td>
</tr>
<tr>
<td>Fiber-reinforced polyester</td>
<td>FRP</td>
<td>10</td>
<td>48</td>
<td>Excellent</td>
<td>Low</td>
<td>B&amp;S</td>
<td>Moderate</td>
</tr>
<tr>
<td>High-density polyethylene</td>
<td>HDPE</td>
<td>&lt;1</td>
<td>36</td>
<td>Excellent</td>
<td>Low</td>
<td>Fused</td>
<td>Low</td>
</tr>
<tr>
<td>Prestressed concrete cylinder</td>
<td>PCCP</td>
<td>16</td>
<td>144</td>
<td>Poor</td>
<td>Moderate</td>
<td>B&amp;S</td>
<td>High</td>
</tr>
<tr>
<td>Polyvinyl chloride</td>
<td>PVC</td>
<td>&lt;1</td>
<td>48</td>
<td>Excellent</td>
<td>Low</td>
<td>B&amp;S</td>
<td>Low</td>
</tr>
<tr>
<td>Steel–mortar lined</td>
<td>Stl Lined</td>
<td>12</td>
<td>120</td>
<td>Moderate</td>
<td>Low</td>
<td>Welded</td>
<td>Moderate</td>
</tr>
<tr>
<td>Steel–unlined</td>
<td>Stl</td>
<td>&lt;1</td>
<td>120</td>
<td>Poor</td>
<td>Low</td>
<td>Welded</td>
<td>Low</td>
</tr>
<tr>
<td>Vitrified clay</td>
<td>VCP</td>
<td>3</td>
<td>48</td>
<td>Excellent</td>
<td>Low</td>
<td>B&amp;S</td>
<td>Low</td>
</tr>
</tbody>
</table>

Legend:
- B&S Bell and Spigot
- T&G Tongue and Groove
- Fused Fused Joints
- Welded Metal Welded
18. A small midwestern community experiences excessive infiltration and inflow into its separated sanitary sewer system. The wastewater treatment facility (WWTF) is rated for a maximum daily flow rate of 0.500 MGD. The following flows have been documented at the WWTF:

- Average daily flow = 0.350 MGD
- Average daily wet weather flow = 0.680 MGD
- 30-day maximum wet weather flow = 0.552 MGD
- Maximum daily wet weather flow = 1.850 MGD
- Peak-hour wet weather flow = 2.500 MGD

The regulatory agency has dictated that the WWTF store excess flows above the plant rating on a monthly basis or expand the entire facility to handle maximum daily wet weather flows. If the WWTF were to use equalization instead of expansion, which basins would provide adequate storage to meet the regulatory requirements while limiting costs of construction?

Select the two that apply.

- □ A. Basin A: circular concrete basin 175 ft in diameter with a 10-ft side water depth
- □ B. Basin B: rectangular concrete basin 120 ft × 115 ft with a 12-ft side water depth
- □ C. Basin C: circular concrete basin 250 ft in diameter with a 16-ft side water depth
- □ D. Basin D: 0.65-acre earthen lagoon at average depth with a high water level of 8 ft
- □ E. Basin E: 2.2-acre earthen lagoon at average depth with a high water level of 8 ft
- □ F. Basin F: 16-acre earthen lagoon at average depth with a high water level of 8 ft

19. An extended aeration activated sludge treatment facility needs new aerobic sludge digesters. The facility already has existing tankage that will be reused for supernatant separation and a belt filter press used to dewater digested sludge. According to TSS Wastewater Facilities 2014, if the population equivalent served by the facility is 15,000 people, the minimum aerobic digester volume (ft³) required is _________.

Enter your response in the blank.
20. An industrial facility wants to more accurately measure flows in its facility. The primary process water flow diagram is shown. Select the location in the diagram where a magnetic flowmeter should be placed to produce the most accurate flow measurement.

21. A western community uses a water treatment facility to treat raw well water for iron and manganese removal. The water plant is no longer allowed to direct discharge backwash waste to the local receiving stream. The facility has four 12-ft² gravity filters. A new red water lagoon is proposed to contain all backwash waste. Assume the average backwash rate is 15 gpm/ft² and the facility backwashes each filter in a single day once per week for 25 min. each. According to TSS Water Works 2018, the minimum lagoon size (ft) required is most nearly:

- A. 31 ft × 124 ft
- B. 50 ft × 200 ft
- C. 156 ft × 624 ft
- D. 312 ft × 312 ft
50. Match the following statements about confined and unconfined aquifers with the correct aquifer description.

<table>
<thead>
<tr>
<th>Description</th>
<th>Type of Aquifer</th>
</tr>
</thead>
<tbody>
<tr>
<td>The well site will usually be within the recharge area.</td>
<td>Confined aquifer</td>
</tr>
<tr>
<td>The well site may not be within the recharge area.</td>
<td>Unconfined aquifer</td>
</tr>
<tr>
<td>The well should fully penetrate between two impervious (usually clay) layers.</td>
<td></td>
</tr>
<tr>
<td>A large unit drawdown change is required to produce large yields.</td>
<td></td>
</tr>
<tr>
<td>Contamination is likely to reach the well water more quickly.</td>
<td></td>
</tr>
</tbody>
</table>

51. Selected water quality parameters for a river and a tributary are as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>River</th>
<th>Tributary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow rate (cfs)</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>Total phosphorus (mg/L)</td>
<td>0.02</td>
<td>0.5</td>
</tr>
<tr>
<td>Chlorophyll (mg/L)</td>
<td>0.05</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Recognizing that algae growth in this system is limited by phosphorus concentrations less than 0.015 mg/L, the longitudinal profile of the algae concentration in the main river downstream of the confluence point will probably:

- A. stay the same
- B. decrease continuously
- C. decrease first and then increase
- D. increase first and then decrease
5. The solution is based on the knowledge that consolidation settlement is the result of the expulsion of pore water from saturated soil due to imposed load. Therefore, the volume of the wick drain effluent (water) to be treated equals the consolidation settlement volume over the affected site area, and is computed as follows:

Affected area = 21.5 acres × 43,560 ft²/acre = 936,540 ft²

Mean consolidation settlement over affected area = 22 in. = 1.83 ft

Settlement volume = effluent volume = 936,540 ft² × 1.83 = 1,713,868 ft³

Convert to gal: 1,713,868 ft³ × 7.48 gal/ft³ = 12,819,733 gal

Cost for effluent treatment and disposal = 12,819,733 gal × $0.25/gal = $3,204,934

THE CORRECT ANSWER IS: B

6. The wall translation (or strain) required to achieve the passive state is at least twice that required to reach the active state.

THE CORRECT ANSWER IS: D

7. The ultimate bearing capacity would be based on buoyant unit weight, also referred to as the effective unit weight.

Effective unit weight = saturated unit weight – unit weight of water

THE CORRECT ANSWER IS: A

8. The long-term settlement for Case I is less than Case II because clay is subject to long-term settlement.

THE CORRECT ANSWER IS: A
9. The minimum factor of safety for permanent slopes is 1.5. Other references use a factor of safety greater than or equal to 1.3, but of the options presented, 1.5 is the closest.

THE CORRECT ANSWER IS: C

10. An early-strength concrete is needed with a minimum compressive strength of 3,500 psi. To achieve the requirements, a Type III cement and chemical accelerators would be necessary.

THE CORRECT ANSWER IS: D

11. Area = \( \pi d^2/4 = 28.3 \text{ in}^2 \)

Compressive stress = axial load/area

Sample 1 \( f'_c = \frac{65,447}{28.3} = 2,313 \text{ psi} \)

Sample 2 \( f'_c = \frac{63,617}{28.3} = 2,248 \text{ psi} \)

Sample 3 \( f'_c = \frac{69,872}{28.3} = 2,469 \text{ psi} \)

Average \( = \frac{(2,313 + 2,248 + 2,469)}{3} = 2,343 \text{ psi} \)

THE CORRECT ANSWER IS: C

12. The following options are correct.

Option B: Polyvinyl chloride pipe (PVC) is commonly used for small sewers.

Option D: Vitrified clay pipe (VCP) is old technology but could be used.

Option E: Ductile iron pipe–mortar lined (DIP) is available in 8-in-diameter pipe and is commonly used for small sewers.

THE CORRECT ANSWERS ARE: B, D, E
18. The maximum total flow over a 30-day period is the 30-day max wet weather flow of 0.552 MGD.

Total flow to store: 0.552 MGD – 0.500 MGD = 0.052 MGD × 30 days = 1.56 MG or 200,535 ft³

Calculate volume of each basin:

A. 175 ft² × 3.14/4 × 10 ft = 240,406 ft³—provides adequate storage
B. 120 ft × 110 ft × 14 ft = 184,800 ft³—too small
C. 250 ft² × 3.14/4 × 16 ft = 785,000 ft³—too large
D. 0.65 acre × 43,560 × 8 ft = 226,512 ft³—provides adequate storage
E. 2.2 acres × 43,560 × 8 ft = 766,656 ft³—too large
F. 16 acres × 43,560 × 8 ft = 5,575,680 ft³—too large

THE CORRECT ANSWERS ARE: A, D

19. Refer to TSS Wastewater Facilities 2014, Section 85.3.

Extended aeration activated sludge requires 3.0 ft³/PE since supernatant separation will be performed in a separate tank and no thickening facilities are mentioned.

15,000 × 3 = 45,000 ft³

THE CORRECT ANSWER IS: 44,900 to 45,100
20. The proper location is in pressure flow (not gravity flow) and away from bends, fittings, and valves.

![Diagram of water treatment system]

**THE CORRECT ANSWER IS SHADED ABOVE.**


Lagoons must have ten times the total quantity of backwash water in any 24-hr period, a minimum depth of 3 ft, and a length four times the width.

Water Volume

\[
12 \text{ ft} \times 12 \text{ ft} = 144 \text{ ft}^2 \text{ filter area} \times 4 \text{ filters} = 576 \text{ ft}^2
\]

\[
576 \text{ ft}^2 \times 15 \text{ gpm/ft}^2 \times 25 \text{ min} = 216,000 \text{ gal} \times 10 = 2,160,000 \text{ or } 288,770 \text{ ft}^3
\]

Lagoon Size

\[
288,770 \text{ ft}^3/3\text{-ft depth} = 96,256.7 \text{ ft}^2
\]

\[
L = 4 \times W \text{ so } 4W \times W = 96,256.7 \text{ or } 4W^2 = 96,256.7 \text{ or } W = 155.13 \text{ ft}
\]

\[
L = 4 \times 155.13 \text{ ft or } 620.51 \text{ ft}
\]

**THE CORRECT ANSWER IS: C**
50. **Description**

The well site will usually be within the recharge area.  
- Unconfined aquifer

The well site may not be within the recharge area.  
- Confined aquifer

The well should fully penetrate between two impervious (usually clay) layers.  
- Confined aquifer

A large unit drawdown change is required to produce large yields.  
- Confined aquifer

Contamination is likely to reach the well water more quickly.  
- Unconfined aquifer

**THE CORRECT ANSWERS ARE SHOWN ABOVE.**

51. **Flow after mixing = 50 + 20 = 70 cfs**
**Mass balance on phosphorus, P:**

\[
(50)(0.02) + (20)(0.5) = 70 P
\]

\[
P = \frac{(50)(0.02) + (20)(0.5)}{70} = 0.16 \text{ mg/L}, \text{ which is greater than } 0.015 \text{ mg/L}
\]

Therefore, algae will grow and consume the P. As the phosphorus drops below 0.015 mg/L, algae will begin to die off. Therefore, the algae concentration will increase first and then decrease.

**THE CORRECT ANSWER IS: D**