Principles and Practice of Engineering (PE) Civil: Water Resources and Environmental (WRE) Practice Exam (Sample)

Study Guide

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Questions

1. What factor is NOT typically considered in the design of a wastewater treatment plant?

A. Wastewater flow

B. Project site details

C. Mass loading rate

D. Total dissolved solids concentration

2. Which of the following is NOT an assumption of the Streeter-Phelps Oxygen Sag Equation?

A. The initial deficit equals zero

B. The stream is well-mixed

C. Decomposition rates are constant

D. The only source of oxygen is atmospheric diffusion

3. In what scenario might the specific capacity of a well be reduced?

A. If the well diameter is increased

B. If drawdown decreases

C. If well loss increases

D. If the aquifer becomes confined

4. Which type of clay is generally known for having a high plasticity index?

A. Low plasticity clay

B. Fat clay

C. Lean clay

D. Sand

5. What does the term "sacrificing metal" refer to in cathodic protection systems?

A. Material that prevents corrosion

B. Metal used to enhance conductivity

C. Material that corrodes to protect other metal structures

D. A type of pipe material used

6. Which of the following best describes the relationship between flow type and sewer systems?

A. All sewers operate under supercritical flow

B. Circular sewers can operate only in subcritical flow

C. Circular sewers behave differently depending on flow conditions

D. Flow type does not impact sewer design

7. Which substance is known to increase the pH of water?

A. Carbon dioxide

B. Lime

C. Sulfuric acid

D. Chlorine

8. What fundamental principle governs fluid motion and is applicable in flow calculation?

A. Conservation of momentum

B. Conservation of mass

C. Bernoulli's principle

D. Hydraulic conductivity

9. Which of the following does the ultimate bearing capacity equation take into account?

A. Only soil properties

B. Only load characteristics

C. All of the above

D. Only external factors

10. If a water sample has a pH of 8.0 and a BOD5 of 200 mg/L, where is it most likely collected from?

A. Stormwater runoff

B. Industrial discharge

C. Domestic wastewater

D. A drinking water source

Answers

1. D
2. A
3. C
4. B
5. C
6. C
7. B
8. C
9. C
10. C

Explanations

1. What factor is NOT typically considered in the design of a wastewater treatment plant?

A. Wastewater flow

B. Project site details

C. Mass loading rate

D. Total dissolved solids concentration

In the context of wastewater treatment plant design, total dissolved solids (TDS) concentration is generally not a primary factor considered in the initial design parameters. Wastewater treatment plants are primarily designed based on factors that directly influence the treatment process and plant capacity, including the flow rate of wastewater, the characteristics of the wastewater, and the mass loading rate of contaminants. Wastewater flow refers to the volume of wastewater that must be treated and is essential for determining the size and capacity of treatment units. Project site details encompass various considerations, such as geographic features, local regulations, and proximity to populations, which are crucial for the effective placement and operation of the facility. The mass loading rate is an important design consideration as it relates to the concentration of pollutants entering the treatment system and helps in evaluating the adequacy of treatment processes to handle these pollutants effectively. While TDS concentration can have implications for the treatment process, especially in terms of salinity and its effects on certain treatment technologies, it is not a primary design factor like the other three options. Thus, it is less critical when establishing the overall framework for designing a wastewater treatment plant.

2. Which of the following is NOT an assumption of the Streeter-Phelps Oxygen Sag Equation?

A. The initial deficit equals zero

B. The stream is well-mixed

C. Decomposition rates are constant

D. The only source of oxygen is atmospheric diffusion

The assumption regarding the initial deficit equals zero is indeed not part of the Streeter-Phelps Oxygen Sag Equation. In reality, the equation is used to model the dissolved oxygen levels in a water body downstream from a pollution source, and it typically considers various scenarios including pre-existing conditions of dissolved oxygen. The other assumptions involved are integral to the application of the equation. First, the assumption that the stream is well-mixed ensures that the calculations reflect an average condition throughout the water column, which is essential for accurate modeling of oxygen levels. If mixing were inadequate, the results could be skewed due to localized variations in oxygen content. Secondly, the assumption that decomposition rates are constant enables straightforward calculations of oxygen demand over time and distance in the water body. Fluctuating rates would complicate the model significantly and could lead to inaccurate predictions of oxygen depletion. Finally, the assumption that the only source of oxygen is atmospheric diffusion simplifies the analysis, although in practice, there may be other sources or sinks of oxygen (such as photosynthesis or respiration) that could influence the overall dissolved oxygen levels. Thus, the primary focus remains on atmospheric diffusion as a theoretical basis for developing the oxygen sag curve. In summary, identifying the initial deficit as zero is not an inherent

3. In what scenario might the specific capacity of a well be reduced?

A. If the well diameter is increased

B. If drawdown decreases

C. If well loss increases

D. If the aquifer becomes confined

The specific capacity of a well, which is a measure of the ability of the well to provide water, can indeed be reduced due to increases in well loss. Well loss occurs when there is energy or head loss encountered while water is being pumped from the well. This can be caused by factors such as the clogging of well screens, the development of sediment at the well bore, or any obstructions in the flow path that restrict water movement. When well loss increases, it indicates that more energy is being used to overcome this resistance, leading to a decrease in the effective yield of the well, and resulting in a lower specific capacity. In contrast, increasing the diameter of a well generally improves its capacity by allowing for greater water flow. If drawdown decreases, this often indicates that the well is operating efficiently and can maintain a higher specific capacity. When an aquifer becomes confined, the water pressure usually increases, which can enhance the performance of the well, as confined aquifers tend to have higher hydraulic heads. Thus, an increase in well loss is the primary factor leading to a reduction in specific capacity.

4. Which type of clay is generally known for having a high plasticity index?

A. Low plasticity clay

B. Fat clay

C. Lean clay

D. Sand

Fat clay is recognized for its high plasticity index, a measure that indicates how much water a clay can retain while maintaining its plastic properties. This type of clay, often referred to in geotechnical engineering, contains a higher proportion of fine particles and can undergo significant changes in volume and shape in response to moisture content. These characteristics contribute to a greater ability to deform without cracking, making fat clay particularly useful in applications requiring flexibility, such as in embankments or earthen structures. In contrast, low plasticity clay typically retains less water and exhibits lower deformation capabilities, resulting in a low plasticity index. Lean clay contains fewer fine particles and has a plasticity index that falls between that of fat clay and low plasticity clay, but it does not reach the same levels of plasticity as fat clay. Sand, being a granular material, lacks the cohesive properties associated with clay, exhibiting no plasticity at all; thus, it cannot hold moisture in the same way. Overall, fat clay's distinctive characteristics in terms of water retention and plasticity make it the correct answer for this question.

5. What does the term "sacrificing metal" refer to in cathodic protection systems?

A. Material that prevents corrosion

B. Metal used to enhance conductivity

C. Material that corrodes to protect other metal structures

D. A type of pipe material used

The term "sacrificing metal" in cathodic protection systems refers to a specific type of metal that is intentionally corroded to protect other, more critical metal structures from corrosion. In cathodic protection, a more anodic metal is used as a sacrificial anode. When this metal is placed in proximity to a structure that needs to be protected—such as steel pipelines, storage tanks, or other underground metal structures—it will corrode instead of the protected metal. This process occurs because the more reactive (anodic) metal will preferentially oxidize, effectively redirecting the corrosive reactions away from the structures which need to be safeguarded. In cathodic protection systems, these anodes can be made from various materials, such as zinc, magnesium, or aluminum, each chosen based on the conditions of the environment they are used in. The sacrificial anode system is critical for prolonging the lifespan of metal structures exposed to harsh conditions, such as marine environments, where corrosion risks are heightened. Understanding this concept is essential for engineers working in water resources and environmental engineering since it represents a practical application of electrochemical principles to protect infrastructure and ensure its durability against corrosion.

6. Which of the following best describes the relationship between flow type and sewer systems?

A. All sewers operate under supercritical flow

B. Circular sewers can operate only in subcritical flow

C. Circular sewers behave differently depending on flow conditions

D. Flow type does not impact sewer design

The relationship between flow type and sewer systems is best captured by the statement that circular sewers behave differently depending on flow conditions. This reflects the principles of fluid mechanics and hydraulic design, which indicate that flow can be categorized as subcritical or supercritical based on the flow velocity and the specific energy of the fluid. In circular sewers, the flow characteristics can vary significantly based on whether the system is operating under subcritical or supercritical conditions. In subcritical flow, the flow is slower, and the liquid's gravitational potential energy is greater than its kinetic energy. Conversely, in supercritical flow, the velocity is higher, and the kinetic energy surpasses the gravitational potential energy. Such variations affect factors such as flow depth, velocity distribution, and the overall performance of the sewer system. Overall, this understanding is crucial for effective sewer design and management. In practice, engineers must consider these flow conditions to design systems that can handle varying flow rates, surcharges, and other operational challenges. This knowledge helps to prevent issues like blockages, flooding, and improper wastewater treatment, thereby optimizing the performance of sewer systems. Therefore, recognizing the dependence of circular sewers' behavior on flow conditions underscores the importance of hydraulic principles in civil engineering, particularly regarding water

7. Which substance is known to increase the pH of water?

A. Carbon dioxide

B. Lime

C. Sulfuric acid

D. Chlorine

Lime is specifically used to increase the pH of water due to its basic properties. It is a substance that contains calcium hydroxide (often referred to as hydrated lime) or calcium carbonate. When lime is added to water, it reacts to produce hydroxide ions, which increases the alkalinity and thereby raises the pH level of the water. This process is commonly employed in water treatment facilities to reduce acidity and improve water quality for various applications, including drinking water. In contrast, substances like carbon dioxide and sulfuric acid are acidic and will lower the pH of water when added. Carbon dioxide, when dissolved in water, forms carbonic acid, which contributes to lower pH levels. Sulfuric acid is a strong acid that directly decreases pH upon dissolution. Chlorine is primarily used for disinfection purposes and does not significantly affect pH levels in the way that lime does. Therefore, lime stands out as the substance that effectively increases water pH.

8. What fundamental principle governs fluid motion and is applicable in flow calculation?

A. Conservation of momentum

B. Conservation of mass

C. Bernoulli's principle

D. Hydraulic conductivity

The principle that governs fluid motion and is most widely applicable in flow calculation is Bernoulli's principle. This principle states that within a flowing fluid, an increase in the fluid's speed occurs simultaneously with a decrease in pressure or potential energy. Bernoulli's equation, derived from this principle, describes the relationship between the velocity of a fluid, its pressure, and its height within a flow system, making it a fundamental tool in fluid dynamics. Bernoulli's principle is particularly useful in various engineering applications such as the design of piping systems, understanding airflow over wings, and analyzing open channel flows. It provides insights into how changes in a fluid's velocity affect its pressure and can predict how fluid will behave under certain conditions, which is essential for accurate flow calculations. While conservation of momentum and conservation of mass are both important principles in fluid mechanics, they serve different functions. Conservation of mass, for example, relates to how mass is conserved in a closed system and is often encapsulated by the continuity equation. Conservation of momentum deals with the forces acting on and resulting from fluid motion but does not directly provide a relationship among pressure, velocity, and elevation as Bernoulli's principle does. Hydraulic conductivity, on the other hand, relates to how easily

9. Which of the following does the ultimate bearing capacity equation take into account?

A. Only soil properties

B. Only load characteristics

C. All of the above

D. Only external factors

The ultimate bearing capacity equation incorporates a comprehensive set of factors that influence the load-bearing potential of soil. It accounts for soil properties, such as cohesion, angle of internal friction, and density, which significantly affect how the soil interacts with applied loads. Additionally, it considers load characteristics, including the magnitude of the load and its distribution across the soil surface. Furthermore, the equation also acknowledges external factors such as water table conditions, as saturation can increase the water pressure in the soil, thereby affecting its shear strength and ultimately its bearing capacity. By integrating these various elements, the ultimate bearing capacity equation provides a holistic understanding of a soil's performance under load conditions, making it a critical tool in geotechnical engineering for designing foundations and other structures.

10. If a water sample has a pH of 8.0 and a BOD5 of 200 mg/L, where is it most likely collected from?

A. Stormwater runoff

B. Industrial discharge

C. Domestic wastewater

D. A drinking water source

A water sample with a pH of 8.0 indicates a slightly alkaline condition, which is typical for many domestic wastewater outputs due to the presence of cleaning agents and the process of biological decomposition. The BOD5 (Biochemical Oxygen Demand over 5 days) value of 200 mg/L suggests a significant level of organic matter in the water, which aligns with typical values for domestic wastewater. This level of BOD5 implies that there is a substantial amount of organic material present that requires oxygen for microorganisms to break down, a characteristic often found in sewage or wastewater from households. In contrast, stormwater runoff can have varied pH levels depending on the land use and rainfall but generally would not show such a high BOD5 due to dilution and turbulence in stormwater systems. Industrial discharge can also vary significantly in pH and BOD depending on the processes involved but often results in higher values and stronger pollution indicators than those observed in domestic wastewater. A drinking water source typically has a neutral pH (around 7) and much lower BOD values, indicating minimal organic matter presence, as drinking water is treated to remove such contaminants. Therefore, the combination of an alkaline pH and a high BOD5 suggests that the water