PRACTICE EXAM 8: ABC CLASS I WASTEWATER TREATMENT SIMULATION (100 QUESTIONS)

1. A treatment plant serving a residential community with no significant industrial users receives influent with the following typical characteristics: BOD 200 mg/L, TSS 220 mg/L, ammonia nitrogen 28 mg/L, and alkalinity 210 mg/L as $CaCO_3$. Over the past month, the alkalinity has gradually decreased to 140 mg/L while all other parameters remain stable. The source water supply has not changed. Which of the following is the most likely explanation for the declining alkalinity?

A. The municipal water supply utility has changed its treatment process or source water, delivering lower-alkalinity finished water to the community

B. An industrial user is discharging an acidic waste that consumes alkalinity in the collection system

C. Increased infiltration of low-alkalinity groundwater is diluting the wastewater alkalinity

D. Biological nitrification occurring in the collection system sewers is consuming alkalinity before it reaches the plant

2. An operator at a treatment plant receiving septage deliveries reviews the receiving station log and discovers that a septage hauler delivered 4,000 gallons of septage with a pH of 2.1 and a chemical odor yesterday afternoon. Normal septage pH ranges from 6.5 to 7.5. The hauler's manifest listed the load as "residential septic tank pumpings." Which of the following conclusions is most appropriate?

A. The low pH and chemical odor indicate the load was not residential septage and likely contained industrial or chemical waste that was mislabeled on the manifest

B. The pH of 2.1 is within the normal range for aged septage that has undergone extended anaerobic decomposition

C. The chemical odor is from the septage hauler's truck cleaning chemicals and does not indicate a problem with the load

D. The low pH is caused by the formation of hydrogen sulfide in the septage tank during transport

3. An operator evaluating sidestream impacts determines that the plant's thickener supernatant, digester supernatant, and centrifuge centrate collectively contribute the following loads when returned to the headworks: 250 lbs/day BOD, 180 lbs/day ammonia nitrogen, and 120 lbs/day TSS. The main plant influent contributes 4,500 lbs/day BOD, 800 lbs/day ammonia nitrogen, and 5,000 lbs/day TSS. Which sidestream parameter represents the most significant percentage of the total plant loading?

A. BOD at 5.3%, which is relatively minor compared to the main influent loading

B. TSS at 2.3%, which is negligible and does not warrant tracking

C. All three sidestream contributions are approximately equal in significance at around 3-4%

D. Ammonia nitrogen at 18.4%, which represents a significant contribution that could affect nitrification capacity

4. During a period of extremely hot weather, an operator notices that the influent wastewater temperature has increased from 68°F to 82°F. The influent also has a stronger odor than normal and the settleable solids have decreased. Which of the following explains these observations?

A. The hot weather has increased residential water use, diluting the wastewater and reducing the odor intensity

B. The high temperature has caused industrial users to increase their cooling water discharge into the sewer

C. The elevated temperature has accelerated biological decomposition in the collection system, producing more odorous gases and converting settleable solids into dissolved and colloidal forms

D. The extreme heat has damaged the collection system pipes, allowing groundwater to infiltrate and change the wastewater characteristics

5. An operator collects paired influent samples at 6:00 AM and 2:00 PM on the same day. The 6:00 AM sample has a BOD of 280 mg/L and flow of 1.1 MGD. The 2:00 PM sample has a BOD of 160 mg/L and flow of 3.6 MGD. The operator needs to determine which sampling period contributes more BOD mass loading to the plant. Which period has the higher mass loading?

A. The 6:00 AM period because the BOD concentration of 280 mg/L is 75% higher than the afternoon concentration

B. The 2:00 PM period because the mass loading (160 × 3.6 × 8.34 = 4,804 lbs/day equivalent rate) exceeds the morning loading (280 × 1.1 × 8.34 = 2,569 lbs/day equivalent rate)

C. Both periods contribute the same mass loading because the concentration decrease is exactly offset by the flow increase

D. Neither period's mass loading can be determined without knowing the total daily flow and a 24-hour composite BOD

6. A conventional activated sludge plant operating at an F/M ratio of 0.28 and SRT of 8 days has been producing stable effluent quality (BOD 10 mg/L, TSS 8 mg/L) for six months. Without any changes to the plant's operational settings, the effluent BOD gradually increases to 24 mg/L and TSS to 20 mg/L over three weeks. The influent loading, DO, pH, and MLSS all remain stable. The SVI has increased from 110 to 175 mL/g. Which of the following is the most likely root cause?

A. The aeration system efficiency has gradually declined due to diffuser aging, reducing the oxygen transfer rate

B. The primary clarifier is malfunctioning and sending excess fine solids to the aeration basin

C. The WAS pump has partially failed and is not maintaining the target SRT, causing the biology to age

D. Filamentous organisms have gradually proliferated due to a subtle environmental change (nutrient deficiency, low DO in portions of the basin, or septic influent) that favors their growth over floc-forming bacteria

7. An operator at a treatment plant with fine bubble diffused aeration calculates the oxygen uptake rate (OUR) using a DO sag test: the DO drops from 4.0 mg/L to 1.5 mg/L in 8 minutes after the blowers are shut off. The aeration basin volume is 500,000 gallons. What is the approximate OUR in mg/L/hour, and what does it indicate?

A. OUR is approximately 12 mg/L/hour, indicating an extremely low biological activity level consistent with an extended aeration system

B. OUR is approximately 25 mg/L/hour, indicating moderate biological oxygen demand typical of a well-loaded system

C. OUR is approximately 18.75 mg/L/hour, indicating moderate biological activity consistent with a normally loaded conventional activated sludge system

D. OUR is approximately 37 mg/L/hour, indicating a very high oxygen demand that may be straining the aeration system capacity

8. An operator calculates that the plant's secondary clarifier has a surface overflow rate of 850 GPD/ft² at average daily flow. During peak flow, the SOR increases to 1,400 GPD/ft². The design maximum SOR for the clarifier is 1,200 GPD/ft². At which flow condition is the clarifier most at risk of producing poor effluent quality, and why?

A. At peak flow, because the SOR of 1,400 GPD/ft² exceeds the design maximum, meaning the upward velocity exceeds the settling velocity of many particles

B. At average flow, because the lower SOR allows the sludge blanket to rise too high and reach the effluent weir

C. Both conditions present equal risk because the SOR difference is within the clarifier's safety factor

D. At average flow, because the lower velocity allows algae to grow on the weir and contaminate the effluent

9. A treatment plant's aeration basin has a DO of 2.5 mg/L at the inlet end and 4.5 mg/L at the outlet end. The basin uses a uniform air distribution pattern (same air rate throughout). What does this DO profile suggest about the basin's organic loading distribution?

A. The uniform air distribution is well-matched to the organic loading, producing a consistent DO throughout the basin

B. The inlet end has a higher oxygen demand from the incoming organic load, consuming more of the supplied oxygen, while the outlet end has lower demand because the organisms have already consumed most of the BOD

C. The outlet end DO is too high, indicating the blowers are running at excessive capacity and wasting energy

D. The DO profile indicates that the aeration system has a mechanical failure at the inlet end, delivering less air to that section

10. A wastewater treatment plant has three identical parallel aeration basins, each with a volume of 0.3 MG. The plant treats 3.6 MGD at an MLSS of 2,800 mg/L. The primary effluent BOD is 130 mg/L. What is the hydraulic detention time per basin and the overall F/M ratio for the system?

A. HRT is 4 hours per basin and F/M is 0.22, placing the system in the lower conventional range

B. HRT is 6 hours per basin and F/M is 0.15, indicating extended aeration operation

C. HRT is 2 hours per basin and F/M is 0.44, indicating high-rate operation with potential settling concerns

D. HRT is 6 hours total system and F/M is 0.18, placing the system between conventional and extended aeration

11. A treatment plant operates an activated sludge system with biological phosphorus removal. The operator monitors the orthophosphate concentration at multiple points in the process: influent 6.0 mg/L, anaerobic zone effluent 15.0 mg/L, aerobic zone effluent 0.3 mg/L, and plant effluent 0.5 mg/L. What do these values indicate about the EBPR process performance?

A. The EBPR system is failing because the orthophosphate in the anaerobic zone is higher than the influent

B. The high orthophosphate in the anaerobic zone indicates that the PAOs have died and released all stored phosphorus

C. The EBPR process is working correctly — PAOs release phosphorus in the anaerobic zone (6.0 → 15.0), then perform luxury uptake in the aerobic zone (15.0 → 0.3), producing a low effluent phosphorus

D. The anaerobic zone orthophosphate of 15.0 mg/L indicates nitrification is occurring in the wrong zone

12. A plant operating a chlorine contact tank with three baffled passes measures the following: chlorine dose 6.5 mg/L, chlorine residual at outlet 1.2 mg/L, theoretical detention time 30 minutes. A tracer study shows the T_{10} (time for 10% of the flow to exit) is 18 minutes. Using the T_{10} for CT calculation (as required by many regulatory agencies), what is the effective CT value?

A. CT = 1.2 × 18 = 21.6 mg·min/L, using the residual multiplied by the T_{10} contact time

B. CT = 1.2 × 30 = 36.0 mg·min/L, using the residual multiplied by the theoretical detention time

C. CT = 6.5 × 18 = 117 mg·min/L, using the dose multiplied by the T_{10} contact time

D. CT = 6.5 × 30 = 195 mg·min/L, using the dose multiplied by the theoretical detention time

13. An operator at a plant with a post-denitrification filter (denitrification occurs in a filter bed with supplemental methanol after secondary treatment) discovers that the effluent from the denitrification filter has a BOD of 25 mg/L, which is higher than the secondary effluent BOD of 8 mg/L. What is the most likely cause of the elevated BOD in the denitrification filter effluent?

A. The filter media is releasing organic compounds that contribute to the measured BOD

B. The nitrification process occurring in the filter is converting ammonia to nitrate, which registers as BOD

C. The secondary clarifier is passing excess biological solids to the denitrification filter

D. Excess methanol is passing through the denitrification filter without being fully consumed, contributing to the effluent BOD

14. A treatment plant must meet a maximum daily effluent limit of 45 mg/L BOD. Yesterday's effluent BOD result was 47 mg/L. The operator suspects the result may be erroneous because all process parameters were normal and the previous day's result was 12 mg/L. What is the correct procedure for handling this result?

A. Discard the result as an obvious laboratory error and report the average of the preceding and following day's results

B. Report the 47 mg/L result as obtained, investigate the cause, implement corrective action, and submit the required noncompliance notification to the regulatory authority

C. Request the laboratory to reanalyze the sample from the same composite bottle and report the reanalysis result

D. Report the 47 mg/L result but add a footnote to the DMR explaining that the result is suspected to be erroneous

15. A trickling filter plant receives a primary effluent BOD of 120 mg/L and the trickling filter reduces it to 30 mg/L. The secondary clarifier then produces an effluent of 22 mg/L. What are the trickling filter BOD removal efficiency and the overall plant BOD removal efficiency (assuming influent BOD of 200 mg/L)?

A. Trickling filter removal is 85% and overall plant removal is 89%

B. Trickling filter removal is 75% and overall plant removal is 85%

C. Trickling filter removal is 75% and overall plant removal is 89%

D. Trickling filter removal is 89% and overall plant removal is 92%

16. A treatment plant has been operating at an SRT of 14 days with complete nitrification (effluent ammonia < 1 mg/L). The operator is instructed to reduce energy costs by reducing the aeration rate. After reducing the aeration rate by 25%, the dissolved oxygen drops from 3.0 mg/L to 1.2 mg/L. Two weeks later, the effluent ammonia has increased to 6.5 mg/L. What is the relationship between the reduced DO and the rising ammonia?

A. The reduced DO of 1.2 mg/L has dropped below the minimum threshold needed for nitrification, causing the nitrifiers to slow their ammonia oxidation rate

B. The reduced aeration has caused the pH to drop, which is inhibiting nitrification independently of the DO level

C. The reduced DO has promoted the growth of filamentous organisms that are outcompeting the nitrifiers

D. The reduced aeration has decreased the mixing intensity, creating dead zones where the ammonia is not in contact with the organisms

17. A secondary clarifier at an activated sludge plant has a 14-foot sidewater depth. The sludge blanket depth is normally maintained at 2-3 feet from the bottom. During a period of heavy rain, the sludge blanket rises to 8 feet. The operator increases the RAS rate but the blanket continues to rise. Which of the following is the most likely reason the increased RAS rate is not reducing the blanket?

A. The RAS pumps are air-locked and not actually delivering sludge despite appearing to run normally

B. The blanket is rising because the clarifier is receiving more solids than the RAS system can remove — the incoming flow has increased the solids loading rate beyond the clarifier's capacity

C. The sludge blanket depth measurement is inaccurate because the turbid stormwater is interfering with the blanket level detector

D. The increased hydraulic loading from the storm has exceeded the clarifier's capacity — the upward velocity is physically pushing the blanket upward faster than the RAS can draw it down

18. An activated sludge plant operator runs a 30-minute settling test and records the following data: 5 min: 920 mL/L, 10 min: 870 mL/L, 15 min: 840 mL/L, 20 min: 830 mL/L, 25 min: 825 mL/L, 30 min: 820 mL/L. The MLSS is 3,600 mg/L. What does the settling curve shape indicate about the sludge condition?

A. The sludge settles rapidly in the first 5 minutes, indicating a healthy, well-formed floc structure

B. The sludge settles very slowly — the high initial volume (920 mL/L at 5 minutes) and minimal compaction over 30 minutes indicate a bulking condition where the sludge resists settling and compaction

C. The settling curve shows normal behavior for an extended aeration system operating at high MLSS

D. The curve indicates that the sludge blanket will compact well in the secondary clarifier and produce excellent effluent

19. A plant operates two parallel primary clarifiers of different sizes. Clarifier A has a volume of 150,000 gallons and Clarifier B has a volume of 100,000 gallons. The plant flow is 2.5 MGD, split equally between the two clarifiers. What are the detention times for each clarifier, and which is at greater risk of underperformance?

A. Clarifier A: 2.9 hours, Clarifier B: 1.9 hours; Clarifier B is at greater risk because its shorter detention time reduces settling time

B. Clarifier A: 1.4 hours, Clarifier B: 1.0 hours; both are below the typical minimum and both are at risk

C. Clarifier A: 2.9 hours, Clarifier B: 1.9 hours; both are within the typical range and neither is at risk

D. Clarifier A: 3.5 hours, Clarifier B: 2.4 hours; Clarifier A is at risk because its longer detention time may cause septic conditions

20. A wastewater treatment plant must add sodium hydroxide to maintain the aeration basin pH at 7.0. The influent alkalinity is 120 mg/L as $CaCO_3$ and the influent ammonia nitrogen is 30 mg/L. The plant fully nitrifies. Nitrification consumes 7.14 mg of alkalinity per mg of NH_3-N oxidized. How much alkalinity is consumed by nitrification, and what is the remaining alkalinity?

A. Nitrification consumes 128.5 mg/L; remaining alkalinity is 91.5 mg/L, which is adequate

B. Nitrification consumes 214.2 mg/L; remaining alkalinity is positive at 5.8 mg/L, barely adequate

C. Nitrification consumes 150 mg/L; remaining alkalinity is negative, requiring supplemental alkalinity

D. Nitrification consumes 214.2 mg/L; remaining alkalinity is negative at –94.2 mg/L, confirming the need for supplemental alkalinity addition

21. An operator at a plant with UV disinfection notices that the effluent fecal coliform has increased from 20 CFU/100 mL to 350 CFU/100 mL over two weeks. The UV intensity readings are above the minimum setpoint. The effluent TSS has remained stable at 10 mg/L. The UV transmittance has remained at 68%. What should the operator investigate as the most likely cause of the elevated fecal coliform?

A. The UV quartz sleeves may be fouled with mineral deposits or biological growth that reduces the actual UV intensity reaching the water, even though the lamp intensity readings appear normal

B. The UV lamps have reached the end of their useful life and must be replaced immediately

C. The effluent is being recontaminated with fecal coliform after the UV system through bird droppings in the open outfall channel

D. The fecal coliform test method has changed and the results are not comparable to previous testing

22. An operator at a treatment plant with chemical phosphorus removal using alum notices that the secondary clarifier effluent has a persistent milky-white haze despite a normal TSS reading of 10 mg/L. The pH in the aeration basin is 5.8. What is the most likely cause of the milky effluent?

A. The milky appearance is caused by suspended alum particles that have not fully reacted with the phosphorus

B. The low pH (5.8) has caused aluminum hydroxide to dissolve and re-precipitate as very fine colloidal particles that create a hazy appearance but are too small to be captured in the standard TSS analysis

C. The milky haze is caused by excessive chlorine residual reacting with the aluminum in the effluent

D. The alum has reacted with the biological solids to create a soap-like emulsion that gives the effluent a milky appearance

23. A treatment plant's permit requires an effluent ammonia limit of 3.0 mg/L from May through October. The plant currently meets this limit with an SRT of 12 days and a DO of 2.5 mg/L during summer months. For November through April, the permit has no ammonia limit. The plant superintendent asks the operator whether the plant should maintain nitrification year-round or shut it down during the winter months. Which of the following is the most operationally sound recommendation?

A. Shut down nitrification during winter by reducing the SRT to 4 days to save energy on aeration costs

B. Maintain partial nitrification during winter at a reduced SRT of 6 days as a compromise between cost savings and process stability

C. Maintain full nitrification year-round because restarting nitrification in the spring requires weeks of SRT extension, and a late-season cold snap could delay compliance past the May deadline

D. Switch to chemical ammonia removal (breakpoint chlorination) during the winter months instead of biological nitrification

24. A plant operates a sequencing batch reactor with a 6-hour cycle: 2 hours fill/react, 1 hour aeration, 1 hour settle, 1 hour decant, 1 hour idle. The effluent has been meeting all limits for two years. A new operations manager proposes shortening the settle phase from 60 minutes to 30 minutes to increase the plant's throughput by adding more fill time. What is the primary risk of this change?

A. The reduced settle time will increase the dissolved oxygen consumption during the decant phase

B. The shorter aeration time will prevent complete BOD removal and cause effluent violations

C. The reduced fill time will decrease the food-to-microorganism ratio below the minimum for biological growth

D. The 30-minute settle period may be insufficient for the biological solids to fully separate from the treated supernatant, resulting in elevated effluent TSS during the decant phase

25. A treatment plant with an MLE biological nutrient removal system has been meeting its total nitrogen limit of 10 mg/L for two years. A new industrial user begins discharging wastewater high in methanol (a readily biodegradable carbon source). The plant's effluent total nitrogen unexpectedly drops from 8 mg/L to 4 mg/L without any operational changes. What is the most likely explanation?

A. The additional readily biodegradable carbon from the methanol discharge has improved denitrification in the anoxic zone by providing more electron donor for the denitrifying bacteria

B. The methanol is chemically reducing the nitrate in the aeration basin through a non-biological reaction

C. The methanol is toxic to the nitrifying bacteria, reducing nitrate production and lowering total nitrogen

D. The methanol has increased the F/M ratio to a level that promotes assimilatory nitrogen removal into the biomass

26. A plant's chlorine disinfection system feeds chlorine gas using a vacuum-operated chlorinator. The operator notices that the chlorine residual has dropped to zero despite the chlorinator indicating normal operation. The flow rate and demand have not changed. Which of the following should the operator check first?

A. The effluent pH, which may have shifted to a range where chlorine is immediately consumed

B. The injector water supply, because loss of injector water stops the vacuum that draws gas from the cylinder, even though the chlorinator appears to function normally

C. The chlorine cylinder valve, which may have been inadvertently closed during the previous shift

D. The contact tank detention time, which may have decreased due to an undetected flow increase

27. An operator calculates the following for the activated sludge system: MLSS = 3,500 mg/L, aeration basin volume = 1.0 MG, WAS flow = 0.04 MGD at 9,000 mg/L, effluent TSS = 15 mg/L at a plant flow of 3.0 MGD. What is the SRT, and is it adequate for nitrification at 15°C?

A. SRT is approximately 5.5 days, which is marginal for nitrification at 15°C and may need extension

B. SRT is approximately 8.4 days, which is adequate for nitrification at temperatures above 12°C

C. SRT is approximately 12 days, which provides a comfortable margin for nitrification at any temperature

D. SRT is approximately 7.5 days, which is adequate for nitrification at 15°C but leaves minimal margin for colder conditions

28. A treatment plant is required to maintain a minimum effluent DO of 6.0 mg/L. The secondary effluent DO is 2.5 mg/L after the chlorine contact tank. The plant uses a cascade aerator at the outfall. The cascade raises the DO from 2.5 mg/L to 5.5 mg/L. This is still 0.5 mg/L below the permit requirement. Which of the following is the most cost-effective solution?

A. Install a supplemental blower system to inject compressed air into the effluent after the contact tank

B. Add a second cascade aerator in series after the existing one to provide additional oxygen transfer

C. Increase the height or number of steps on the existing cascade aerator to improve the oxygen transfer capacity

D. Reduce the chlorine dose to decrease the oxygen demand in the contact tank effluent

29. A plant using ferric chloride for phosphorus removal operates at a molar ratio of 1.5 moles Fe per mole P. The influent total phosphorus is 5.0 mg/L and the plant flow is 2.0 MGD. The molecular weight of iron is 56 g/mol and the molecular weight of phosphorus is 31 g/mol. What is the approximate iron dose required in mg/L?

A. Approximately 13.5 mg/L of iron is needed based on the 1.5:1 molar ratio

B. Approximately 7.5 mg/L of iron is needed based on the 1.5:1 molar ratio

C. Approximately 20.0 mg/L of iron is needed based on the 2.0:1 molar ratio

D. Approximately 5.0 mg/L of iron is needed, matching the phosphorus concentration on a 1:1 mass ratio

30. A treatment plant's secondary clarifier has been producing good effluent (TSS 8 mg/L) for months. Suddenly, over 24 hours, the effluent TSS increases to 45 mg/L. The MLSS has not changed (2,800 mg/L), the SVI is normal at 105 mL/g, and the sludge blanket depth is normal at 2.5 feet. The operator also notices floating dark clumps with gas bubbles on the clarifier surface. What is the most likely cause?

A. The secondary clarifier weir has become fouled with algae, creating preferential flow that disturbs the settling zone

B. Denitrification is occurring in the clarifier sludge blanket — nitrogen gas bubbles are attaching to settled sludge particles and floating them to the surface

C. A toxic discharge has damaged the biological floc, causing it to break apart and float to the surface

D. The RAS pump has failed and settled sludge is decomposing in the clarifier, producing methane that floats sludge

31. An operator discovers that the plant's wastewater temperature has dropped to 46°F (8°C) during a cold spell. The activated sludge SRT is 8 days. The effluent ammonia has risen from 0.5 to 14 mg/L. The permit ammonia limit is 5 mg/L (year-round). To restore nitrification, the operator needs to extend the SRT. At 8°C, the minimum SRT for nitrification is approximately 20 days. The operator begins reducing the WAS rate. How long will it approximately take for the SRT to reach 20 days from the current 8 days?

A. The SRT will reach 20 days within 2-3 days of reducing the WAS rate because MLSS increases rapidly

B. It will take 3-5 days because the biology needs one full hydraulic detention time to respond

C. It will take approximately 7-10 days because the biology must grow through multiple doublings to reach the target MLSS

D. It will take approximately 12-20 days because extending the SRT from 8 to 20 days requires the system to accumulate solids over a period similar to the target SRT

32. A treatment plant's primary effluent is split between two parallel activated sludge trains. Train A receives 60% of the flow and Train B receives 40%. The MLSS in both trains is 2,800 mg/L and both operate at the same SRT. Despite the uneven flow split, the operator wants both trains to operate at the same F/M ratio. How can this be achieved?

A. Increase the MLSS in Train A to compensate for the higher organic loading it receives from the greater flow

B. Reduce the MLSS in Train B to match the lower organic loading from its smaller share of the flow

C. Adjust the MLSS in each train proportionally to its share of the flow — Train A should have a higher MLSS than Train B to equalize the F/M ratio

D. The F/M ratio cannot be equalized as long as the flow split is uneven, regardless of MLSS adjustments

33. An operator at a plant with UV disinfection and chlorination (as backup) receives a directive to switch from UV to chlorine disinfection for a 2-week maintenance period. The plant's NPDES permit specifies a total residual chlorine (TRC) limit of 0.019 mg/L. The operator must add dechlorination when using chlorine. What is the critical sequence of steps for switching from UV to chlorine?

A. Start the chlorine feed system, verify the target residual is achieved in the contact tank, start the dechlorination system, verify the final TRC is below 0.019 mg/L, then shut down the UV system

B. Shut down the UV system, start the chlorine feed, start dechlorination, and verify the final TRC within 24 hours

C. Start the chlorine and dechlorination systems simultaneously, then shut down the UV after 1 hour of overlap

D. Shut down the UV system at the end of the day shift, then start the chlorine system at the beginning of the next day shift

34. A treatment plant needs to add 200 mg/L of lime (calcium hydroxide) to 50,000 GPD of thickened sludge for lime stabilization. The lime is delivered as a dry powder with a purity of 90% (10% inert filler). How many pounds per day of the 90% lime product must be fed?

A. 83.4 lbs/day based on the pure lime requirement without accounting for the product purity

B. 92.7 lbs/day based on the pure lime requirement adjusted for the 90% product purity

C. 166.8 lbs/day based on the total dose multiplied by the flow and the purity adjustment

D. 75.1 lbs/day based on the pure lime requirement divided by the product purity

35. A treatment plant with biological nutrient removal has achieved an effluent total phosphorus of 0.3 mg/L for 18 months using EBPR alone. The plant receives a new permit requiring a total phosphorus limit of 0.1 mg/L. Which of the following treatment modifications is most likely needed to achieve this stringent limit?

A. Increase the anaerobic zone detention time by 50% to enhance the EBPR process performance

B. Optimize the EBPR process to achieve the lowest possible biological phosphorus, then add chemical polishing (alum or ferric chloride) with tertiary filtration to reach the 0.1 mg/L target

C. Install a membrane bioreactor to replace the secondary clarifier and provide the membrane filtration needed for ultra-low phosphorus

D. Add EBPR to a second parallel treatment train to double the biological phosphorus removal capacity

36. An activated sludge plant operates with a dissolved oxygen of 2.0 mg/L and produces effluent with a BOD of 10 mg/L and ammonia of 0.8 mg/L. The plant superintendent asks the operator to increase the DO to 4.0 mg/L "to improve treatment performance." The operator should respond that increasing the DO to 4.0 mg/L would most likely result in which of the following?

A. Improved BOD removal and ammonia removal because higher DO always improves treatment quality

B. No significant improvement in BOD or ammonia removal because 2.0 mg/L already supports both processes adequately

C. Improved ammonia removal but decreased BOD removal because the higher DO changes the microbial community structure

D. Decreased ammonia removal because the higher DO inhibits nitrifying organisms that prefer moderate oxygen levels

37. An operator at a treatment plant needs to calculate the volume of a cylindrical aeration basin. The basin has a diameter of 60 feet and a sidewater depth of 18 feet. What is the volume in gallons?

A. Approximately 190,000 gallons based on the cylindrical volume formula and the 7.48 gallon conversion factor

B. Approximately 380,800 gallons based on the cylindrical volume formula ($V = 0.785 \times D^2 \times \text{depth}$) converted to gallons

C. Approximately 508,000 gallons based on the full cylinder volume including 2 feet of freeboard

D. Approximately 254,000 gallons based on half the cylinder volume as the effective treatment volume

38. A treatment plant has been consistently meeting its monthly average BOD limit of 30 mg/L. The first three weeks of the current month produced results of 28, 35, and 32 mg/L. The running monthly average is 31.7 mg/L, which is above the 30 mg/L limit. The fourth and final week's sample has not yet been collected. What effluent BOD concentration would the fourth week need to achieve to bring the monthly average to exactly 30 mg/L?

A. The fourth week would need to achieve a BOD of 25 mg/L to bring the average to exactly 30 mg/L

B. The fourth week would need to achieve a BOD of 20 mg/L or lower to bring the average below 30 mg/L

C. The monthly average cannot be brought to 30 mg/L with a single fourth-week result because the first three weeks average is already above 30

D. The fourth week would need to achieve a BOD of 28 mg/L to bring the average to exactly 30 mg/L

39. A treatment plant uses both EBPR and chemical phosphorus removal (ferric chloride) to achieve an effluent phosphorus below 0.5 mg/L. During a routine analysis, the operator measures the ortho-phosphorus at 0.2 mg/L but the total phosphorus at 0.7 mg/L. The permit limit is 0.5 mg/L total phosphorus. What is the significance of the difference between ortho-P and total P, and what is the likely form of the additional 0.5 mg/L?

A. The difference indicates a laboratory error because ortho-P should always equal or exceed total P

B. The ortho-P is only 0.2 mg/L, but total P includes all phosphorus forms — the additional 0.5 mg/L is likely particulate phosphorus bound to biological solids or chemical precipitates escaping in the effluent

C. The additional 0.5 mg/L is organic phosphorus from polymer breakdown products used in sludge conditioning

D. The difference is caused by temperature variation during the sample analysis that affects the two tests differently

40. An operator is preparing to enter a drained circular secondary clarifier (100-foot diameter, 14-foot sidewater depth) to inspect the sludge collection mechanism. The clarifier has been drained for 48 hours. Residual sludge remains on the floor. What is the minimum set of safety requirements before entry?

A. A visual inspection from the rim to confirm no standing water is present, followed by entry using the permanently installed ladder

B. Atmospheric testing showing safe conditions, a completed confined space entry permit, an attendant stationed at the entry point, continuous atmospheric monitoring, a retrieval system, and rescue provisions

C. Wearing rubber boots and a hard hat to protect against slipping on the residual sludge and overhead hazards

D. Having two operators enter together so they can assist each other in the event of an emergency

41. A treatment plant operator discovers a chlorine gas leak at the connection between the cylinder valve and the chlorinator vacuum regulator. The leak is small (a faint hissing sound is audible) and the room chlorine detector reads 0.8 ppm — below the OSHA PEL of 1 ppm. What is the correct response?

A. Continue working in the chlorination room because the chlorine level is below the OSHA PEL and the leak is minor

B. Apply a chlorine leak repair kit clamp to the connection while wearing an air-purifying respirator

C. Increase the room ventilation rate to dilute the chlorine below the detection threshold

D. Evacuate the room, don SCBA, close the cylinder valve to stop the gas flow, and follow the plant's chlorine emergency response procedures

42. During a monthly inspection of the plant's portable gas monitors, the operator discovers that two of the plant's four multi-gas monitors have expired calibration — they were last calibrated 45 days ago and the manufacturer requires calibration every 30 days. The monitors have been used for confined space entries during the past 15 days. What is the correct action?

A. Remove the expired monitors from service immediately, recalibrate them before further use, and review whether any confined space entries performed with the expired monitors need to be documented as procedural violations

B. Continue using the monitors because manufacturer calibration recommendations are not regulatory requirements

C. Extend the calibration interval to 60 days to match the plant's monthly inspection schedule

D. Replace the monitors with new units because recalibration cannot restore accuracy after the interval has been exceeded

43. An operator reviews the plant's hazardous chemical inventory and finds that ferric chloride, sodium hypochlorite, and sodium hydroxide are stored in the same chemical building. The building has a single secondary containment area designed to hold 110% of the largest tank. Which of the following represents a potential chemical incompatibility hazard in this arrangement?

A. Sodium hydroxide and ferric chloride are incompatible — mixing them could produce an explosive reaction

B. All three chemicals are compatible and can safely share secondary containment without special precautions

C. Sodium hypochlorite and ferric chloride should not share secondary containment because mixing an oxidizer with an acid could produce toxic chlorine gas

D. Sodium hydroxide and sodium hypochlorite are incompatible because mixing a base with an oxidizer produces nitrogen dioxide gas

44. A treatment plant operator arrives for the morning shift and finds a note from the night operator stating: "Plant power flickered at 2:30 AM. Emergency generator started and ran for 15 minutes. Power restored. No process upsets observed." The morning operator should verify which of the following before accepting this report at face value?

A. That all SCADA data was recorded during the outage, all equipment restarted properly in the correct sequence, the generator returned to standby mode, and no process equipment is in an abnormal state

B. That the night operator logged the event in the daily operating log and nothing further is needed

C. That the generator fuel tank was refilled after the 15-minute run to restore the emergency fuel supply

D. That the utility company was notified of the outage and has provided an explanation for the power flickering

45. An operator at a small treatment plant works alone during the evening shift. The plant's safety policy requires that a lone worker check in with a supervisor by telephone at specified intervals. During tonight's shift, the operator cannot reach the supervisor by phone after three attempts. What should the operator do?

A. Continue working normally because the check-in policy is a recommendation, not a mandatory safety requirement

B. Leave the plant immediately and go home because working alone without a check-in contact is too dangerous

C. Leave a voicemail for the supervisor, document the attempted contacts, notify an alternative emergency contact, and continue the shift with enhanced personal safety awareness

D. Follow the plant's lone worker safety protocol, which should include contacting an alternative supervisor, designated emergency contact, or monitoring service to maintain the safety communication chain

46. A treatment plant stores 1-ton (2,000-lb) chlorine gas containers in a dedicated chlorine building. The Risk Management Plan under EPA's Clean Air Act Section 112(r) requires facilities storing more than 2,500 lbs of chlorine to submit a Risk Management Plan. The plant currently has three 1-ton containers on site (6,000 lbs total). Which of the following is true?

A. The plant exceeds the 2,500-lb RMP threshold and must have a Risk Management Plan that includes hazard assessment, prevention program, and emergency response procedures

B. The RMP threshold applies only to manufacturing facilities, not to wastewater treatment plants that use chlorine as a process chemical

C. The plant is exempt because the chlorine is stored in sealed containers and has not been released

D. The RMP threshold of 2,500 lbs applies only to the single largest container, not the total inventory

47. An operator performing a monthly fire extinguisher inspection discovers that one ABC dry chemical extinguisher in the electrical room has a damaged pressure gauge — the needle is stuck and does not move. The body of the extinguisher appears intact with no visible damage. What is the correct action?

A. The extinguisher is safe to use because the body is intact; the gauge is cosmetic only

B. Leave the extinguisher in service and schedule gauge replacement at the next annual maintenance

C. Remove the extinguisher from service, replace it with a fully functional unit, and send the damaged one for professional inspection and gauge replacement

D. Shake the extinguisher vigorously to free the stuck gauge needle and verify the pressure reading

48. Under OSHA's process safety management (PSM) standard, facilities that store, use, or produce highly hazardous chemicals above threshold quantities must implement specific safety management programs. A wastewater treatment plant that stores chlorine gas above the PSM threshold quantity of 1,500 lbs must comply with which of the following PSM elements?

A. Only the employee training and emergency planning elements of PSM apply to wastewater plants

B. All 14 elements of PSM apply, including process hazard analysis, operating procedures, training, mechanical integrity, management of change, incident investigation, and emergency planning

C. PSM does not apply to wastewater treatment plants because they are classified as municipal utilities

D. Only the mechanical integrity and incident investigation elements apply to chlorine gas systems at wastewater plants

49. A treatment plant has experienced two near-miss incidents involving operator slips on icy walkways during the past winter. Neither incident resulted in injury, but both could have resulted in falls into open process tanks. What is the appropriate response under a proactive safety program?

A. No action is required because no injuries occurred and near-miss incidents are not reportable

B. Document the incidents in the safety log but take no further action until an actual injury occurs

C. Install additional warning signs near the icy walkways to alert operators of the hazard

D. Investigate both near-miss incidents to identify root causes, implement corrective actions (such as heated walkways, anti-slip surfaces, handrails, or ice removal procedures), and update the plant safety program

50. An operator is required to perform atmospheric monitoring during a confined space entry into a digester gas pipe vault. The four-gas monitor shows: O_2 20.8%, LEL 8%, H_2S 4 ppm, CO 10 ppm. Which of these readings would prevent entry under OSHA's confined space regulations?

A. The H_2S at 4 ppm exceeds the IDLH concentration and requires full SCBA before entry

B. The CO at 10 ppm is above the OSHA PEL and entry cannot be authorized until the level drops below 5 ppm

C. The O_2 at 20.8% indicates oxygen enrichment above the normal 20.9% and suggests a possible gas leak

D. The LEL at 8% is too close to the 10% action level (10% of the lower explosive limit is the typical entry threshold) — the space should be ventilated until the LEL drops below 10% before entry is authorized

51. A treatment plant's emergency response plan includes a chlorine gas release scenario. During the annual drill, the operator discovers that the plant's self-contained breathing apparatus units have expired air cylinders — the hydrostatic test date on the cylinders was more than 5 years ago. What is the immediate safety implication?

A. The SCBA units with expired cylinder tests cannot be relied upon for emergency use because the cylinder integrity has not been verified, and they should be removed from service and sent for testing immediately

B. The 5-year hydrostatic test requirement applies only to fire department SCBA units, not to industrial units used at wastewater plants

C. The expired test date does not affect the air quality inside the cylinders, so the units are still safe to use in an emergency

D. The cylinders can be used for one additional year beyond the test date as a grace period under DOT regulations

52. An operator is reviewing the plant's LOTO procedure and notices it does not include a provision for "group lockout" — situations where multiple employees must work on the same equipment simultaneously. The current procedure only covers individual lockout. What is the safety concern?

A. Group lockout is not needed because only one operator should ever work on a piece of equipment at a time

B. Without a group lockout procedure, there is a risk that the first worker to complete their task could remove the LOTO devices while other workers are still exposed to the equipment hazards

C. Group lockout is only required for facilities with more than 50 employees

D. The individual lockout procedure is sufficient as long as each worker uses the same color lock

53. A compliance inspector reviews the plant's records and finds that the calibration log for the plant's effluent flow meter shows calibrations on January 15, March 20, July 8, and December 5. The plant's NPDES permit requires quarterly flow meter calibration. Is the calibration frequency in compliance?

A. Yes — four calibrations in a calendar year satisfies the quarterly requirement regardless of the specific dates

B. Yes — the four calibration dates fall within each calendar quarter (Q1, Q1, Q3, Q4), but Q2 is missing a calibration

C. No — there is no calibration in Q2 (April–June), which means the quarterly requirement was not met

D. No — quarterly calibration requires exact 90-day intervals between each calibration date

54. A treatment plant has a permit requirement to submit monthly DMRs by the 28th day of the following month. The March DMR is not submitted until April 30 — two days late. The state regulatory agency receives the late DMR and notes the late submission in their compliance file. What is the regulatory consequence?

A. No consequence because a 2-day delay is within the acceptable grace period for DMR submissions

B. The late submission may constitute a permit violation that could result in a notice of violation, a warning letter, or potential enforcement action

C. The regulatory agency will automatically extend the next month's DMR deadline by 2 days to compensate

D. The consequence depends entirely on whether the effluent data in the DMR shows any limit violations

55. A centrifugal pump operating at 1,750 RPM on a VFD-controlled motor is currently running at 80% speed (1,400 RPM). The operator observes that the pump vibration has increased significantly since the speed was reduced from 100% three weeks ago. At 100% speed, the vibration was within normal limits. What is the most likely cause of the increased vibration at reduced speed?

A. The pump is operating near a natural resonant frequency of the pump/motor assembly at 1,400 RPM that does not occur at 1,750 RPM

B. The VFD is producing excessive electrical harmonics at 80% speed that are being transmitted to the motor as mechanical vibration

C. The reduced speed has decreased the pump's centrifugal force, allowing the impeller to wobble on the shaft

D. The pump bearings have deteriorated during the three weeks of reduced-speed operation due to inadequate lubrication at the lower speed

56. A treatment plant's online dissolved oxygen analyzer is installed in the aeration basin. The operator notices that the reading fluctuates between 1.0 and 3.5 mg/L with no consistent pattern, even though a portable DO meter consistently reads 2.0 mg/L at the same location. What is the most likely cause of the erratic online readings?

A. The portable meter is more accurate and the online analyzer should be replaced with the same model

B. The online analyzer probe is experiencing interference from electromagnetic fields generated by the nearby blower motors and VFDs

C. The online probe membrane is damaged, deteriorated, or fouled, causing inconsistent response to the dissolved oxygen concentration

D. The aeration basin actually has significant DO stratification that the portable meter misses because it samples a single point

57. A plant's SCADA system monitors 15 critical alarms including high wet well level, low DO, high clarifier blanket, and chlorine leak detection. The operator discovers that 4 of the 15 alarm points have been "shelved" (disabled) by a previous operator who was annoyed by frequent nuisance alarms. What is the safety and operational concern?

A. Shelving alarms is an acceptable practice for reducing alarm fatigue and improving operator attention to remaining alarms

B. The 4 disabled alarms may include safety-critical alerts that, if triggered during an actual emergency, would go unnoticed — potentially leading to equipment damage, permit violations, or personnel injury

C. The alarms were likely shelved for valid reasons and should remain disabled until the root cause of the nuisance alarms is investigated

D. Shelved alarms automatically re-enable after 30 days and will begin functioning again without operator intervention

58. A treatment plant operator measures the vibration on a blower bearing housing and obtains a reading of 0.6 inches per second (IPS). The plant's vibration standard specifies the following action levels: Good (<0.2 IPS), Satisfactory (0.2–0.4 IPS), Unsatisfactory (0.4–0.6 IPS), Unacceptable (>0.6 IPS). Based on the 0.6 IPS reading, what action should the operator take?

A. Continue normal operation because 0.6 IPS is within the satisfactory range for large rotating equipment

B. Schedule a preventive inspection during the next planned outage, which is in 6 weeks

C. The reading is at the boundary between unsatisfactory and unacceptable — the operator should investigate the cause of the elevated vibration, schedule corrective maintenance, and increase the monitoring frequency until the problem is resolved

D. Shut down the blower immediately because 0.6 IPS indicates imminent catastrophic failure

59. An operator discovers that the plant's emergency generator fuel tank contains only 25% capacity. The tank holds 500 gallons. Plant policy requires maintaining a minimum of 75% fuel capacity at all times to support 24 hours of emergency operation. What should the operator do?

A. Order a fuel delivery immediately to restore the tank to at least 75% capacity, and investigate why the fuel level dropped below the minimum threshold

B. Test the fuel for contamination before ordering a delivery because the low level may be due to a leak

C. Reduce the generator test schedule from weekly to monthly to conserve fuel until the next scheduled delivery

D. Switch the generator to natural gas operation until the diesel fuel is replenished

60. A magnetic flow meter on the RAS line reads 1,200 GPM. The operator performs a draw-down test on the secondary clarifier: with the influent valve closed and the RAS pump running, the clarifier water level drops 6 inches in 10 minutes. The clarifier has a surface area of 5,000 ft^2. What is the actual RAS flow rate based on the draw-down test, and how does it compare to the meter reading?

A. The actual flow is approximately 1,000 GPM, indicating the meter is reading about 17% high

B. The actual flow is approximately 1,870 GPM, indicating the meter is reading about 36% low and needs immediate recalibration

C. The actual flow is approximately 1,200 GPM, confirming the meter is accurate within acceptable tolerance

D. The actual flow cannot be determined from a draw-down test because the clarifier surface area changes with depth

61. A plant's SCADA trend shows that the aeration basin dissolved oxygen has been gradually declining from 2.5 mg/L to 1.2 mg/L over the past three months despite no changes to the blower output or valve positions. The MLSS has increased from 2,400 to 3,100 mg/L during the same period. What is the most likely explanation?

A. The DO probes have drifted from calibration over the three months and need recalibration

B. The aeration diffusers have become progressively fouled, reducing the oxygen transfer efficiency

C. The increasing MLSS has increased the total oxygen demand in the basin, consuming more of the supplied oxygen and leaving less dissolved in the water

D. The wastewater temperature has increased over the season, reducing the oxygen saturation concentration

62. A treatment plant operator needs to verify the accuracy of an ultrasonic level sensor in the influent wet well. The sensor reads 8.5 feet of water depth. The operator lowers a calibrated staff gauge into the wet well and measures 7.8 feet of actual water depth. What is the approximate error, and what action should be taken?

A. The sensor is reading 0.7 feet high (8.2% error), which is within acceptable accuracy for level measurement

B. The sensor is reading 8.2% high, which is outside the typical ±2% accuracy specification for ultrasonic level sensors

C. The 0.7-foot discrepancy is caused by temperature effects on the ultrasonic signal and will self-correct

D. The sensor reading cannot be compared to a staff gauge because they measure different physical properties

63. A plant operator reviews the maintenance history for a progressive cavity WAS pump and finds that the stator has been replaced three times in 18 months. The typical stator life for this application is 24 months. Which of the following factors most likely contributes to the accelerated wear?

A. The WAS concentration is consistently above 1.5%, which is within the pump's design range and should not cause excessive wear

B. The pump is running dry for brief periods due to intermittent feed from the clarifier hopper, and the lack of lubricating fluid accelerates stator erosion

C. The pump motor speed is set too low, causing the rotor to stall and overheat the stator material

D. The polymer conditioning of the WAS prior to pumping is chemically attacking the stator elastomer

64. An operator troubleshooting a chemical metering pump finds that the pump strokes normally but delivers no chemical. The suction and discharge lines are clear, the chemical tank is full, and the pump diaphragm appears intact. What is the most likely cause?

A. The pump motor is running in reverse, causing the diaphragm to move in the wrong direction

B. The chemical has changed viscosity due to temperature and is too thick for the pump to draw

C. The pump speed is set too high, causing the diaphragm to cavitate and not generate adequate suction

D. Both check valves (suction and discharge) are stuck closed or fouled, preventing chemical from entering or leaving the pump head

65. A blower room contains three positive displacement blowers, each rated at 2,500 CFM. Two blowers run continuously while the third serves as a standby. The operator discovers that the standby blower's inlet filter is completely blocked with dust and debris. The two running blowers are unaffected because their filters were recently changed. If one of the running blowers fails and the standby is called into service, what will happen?

A. The standby blower will start normally and deliver full rated airflow because PD blowers are not affected by inlet restrictions

B. The blower will start but the blocked inlet filter will severely restrict the air intake, causing reduced airflow and potential overheating or damage to the blower

C. The standby blower will start but will deliver excess airflow because the blocked filter creates a venturi effect that accelerates the air

D. The standby blower's overload protection will prevent it from starting due to the restricted inlet condition

66. A treatment plant's VFD-controlled RAS pump operates at 65% speed. The SCADA system displays the pump flow at 850 GPM based on the VFD speed-to-flow correlation programmed during commissioning. The operator installs a temporary flow meter and measures the actual flow at 720 GPM. What is the most likely explanation for the discrepancy?

A. The VFD is malfunctioning and operating at a speed lower than the displayed 65%

B. The speed-to-flow correlation is inherently inaccurate for centrifugal pumps because the flow depends on system head as well as speed, and the actual system head may differ from the commissioning conditions

C. The temporary flow meter is reading low due to air entrainment in the RAS line

D. The VFD's speed-to-flow correlation was programmed at 60 Hz but the plant operates at 50 Hz power

67. An operator inspecting a belt filter press notices that the belt fabric has developed several small tears along one edge. The tears are approximately 2 inches long. The press is currently producing acceptable cake quality. What should the operator do?

A. Continue operating the press until the next scheduled belt replacement because the tears are small and not affecting performance

B. Take the press offline, replace the belt, and investigate the cause of the tears (tracking misalignment, sharp roller edges, or foreign objects in the sludge feed) before restarting

C. Patch the tears with belt repair adhesive and continue operation until a replacement belt can be ordered

D. Increase the belt tension to pull the torn edges together and prevent the tears from spreading

68. A plant operator discovers that one of the plant's two RAS pumps has been running at 100% speed for the past 48 hours due to a SCADA control error, when it should have been running at 60%. The secondary clarifier sludge blanket has essentially disappeared — the blanket detector shows zero depth. The RAS concentration has dropped from 8,000 mg/L to 3,500 mg/L. The aeration basin MLSS has increased from 2,800 to 4,200 mg/L. What has occurred?

A. The excessive RAS rate is normal and the clarifier is operating at optimal conditions with a minimal blanket

B. The high-speed RAS pump has been drawing settled sludge from the clarifier faster than it accumulates, transferring the solids inventory from the clarifier to the aeration basin and diluting the RAS concentration

C. The sludge blanket has risen above the blanket detector's measurement range and is actually very deep

D. The biological organisms have died from oxygen depletion caused by the excessive RAS flow

69. A plant operator measures the temperature of a blower motor casing using an infrared thermometer and obtains a reading of 195°F (91°C). The motor manufacturer specifies a maximum surface temperature of 180°F (82°C) for the motor's insulation class. The ambient temperature is 85°F (29°C). What should the operator conclude?

A. The motor temperature is within normal operating range because infrared thermometers typically read 10-15°F high on dark motor surfaces

B. The 195°F reading exceeds the manufacturer's maximum, but the high ambient temperature accounts for the 15°F excess and the motor is operating normally

C. The motor is operating above its maximum rated temperature, which will accelerate insulation degradation and shorten motor life — the cause should be investigated and corrected

D. The motor temperature cannot be accurately measured with an infrared thermometer and a contact thermocouple must be used instead

70. A treatment plant's effluent turbidity meter reads 0.8 NTU. A laboratory grab sample analyzed with a benchtop turbidimeter reads 1.5 NTU. Both instruments were recently calibrated. Which of the following is the most likely explanation for the discrepancy?

A. The effluent turbidity has genuinely changed between the online reading and the time the grab sample was analyzed

B. Online and benchtop turbidimeters always agree within ±0.1 NTU, so one of the instruments must be malfunctioning

C. The grab sample experienced changes during collection and transport — particles may have settled, resuspended, or air bubbles may have formed, altering the turbidity from the in-situ condition

D. The online meter is always more accurate than the laboratory instrument for wastewater applications

71. A gravity thickener processing primary sludge has been producing thickened sludge at 6.0% TS with clear supernatant. The operator is directed to begin co-thickening WAS by adding it to the primary sludge feed. After one week of co-thickening, the thickened sludge concentration drops to 3.8% and the supernatant becomes turbid. What is the most likely cause?

A. The WAS has a lower specific gravity than primary sludge and floats in the thickener instead of settling

B. The WAS is lighter and more difficult to gravity-thicken than primary sludge — the light biological floc does not compact as well, reducing the overall thickened concentration and increasing solids carryover in the supernatant

C. The WAS contains polymer residual that interferes with the thickening mechanism

D. The increased solids loading has overwhelmed the thickener's capacity and it needs to be enlarged

72. A centrifuge dewatering digested combined sludge achieves a cake solids of 25% and centrate TSS of 300 mg/L. The operator decreases the scroll differential speed from 12 RPM to 6 RPM. What is the expected effect on cake quality and centrate quality?

A. Both cake solids and centrate quality will improve because the slower scroll improves all aspects of separation

B. Cake solids will increase (drier cake) because solids spend more time on the beach for drainage, but centrate quality may deteriorate because the slower scroll allows more solids to accumulate before discharge

C. Cake solids will decrease and centrate quality will improve because the reduced scroll speed increases the centrifugal force on the liquid

D. Both cake solids and centrate quality will deteriorate because the slower scroll creates a bottleneck in solids conveyance

73. A treatment plant's anaerobic digester has been operating at a volatile acids level of 200 mg/L and alkalinity of 3,000 mg/L (VA/Alk ratio 0.067) for six months. The operator receives authorization to begin accepting grease trap waste as a co-digestion feedstock. The grease trap waste will increase the total organic loading by 20%. What monitoring parameter is most critical during the initial acceptance period?

A. The digester temperature, which must be increased proportionally to the organic loading increase

B. The gas composition for oxygen content, which indicates a leak in the gas collection system

C. The effluent TSS from the secondary clarifier, which will increase if the digester is overloaded

D. The volatile acids-to-alkalinity ratio, which will be the earliest indicator of whether the methane-forming bacteria can handle the increased loading

74. A belt filter press is producing cake with poor structural integrity — the cake crumbles as it exits the press and is difficult to convey or stack. The cake solids are 17%, which is below the 20% target. The polymer dose appears adequate (clear filtrate). Which of the following is the most likely cause of the poor cake quality?

A. The sludge feed concentration is too high, overloading the belt's capacity to form a uniform cake

B. The belt tension is too low, allowing the sludge to spread too thinly on the belt rather than being compressed into a dense cake

C. The belt wash water temperature is too high, softening the sludge during the drainage phase

D. The polymer type is incompatible with the sludge — even though the filtrate is clear, the floc may lack the structural strength needed to form a coherent cake under pressure

75. An operator at a plant using sand drying beds notices that a recently loaded bed has developed standing water on the surface after only two days, despite good weather conditions and proper sludge application depth. Previous beds loaded with the same sludge dried normally. What should the operator investigate?

A. Whether the sand bed drainage system is clogged with biological growth or fine sludge particles that have migrated into the sand layer from previous loadings

B. Whether the sludge was adequately digested before application — unstabilized sludge seals the bed surface faster than digested sludge

C. Whether the ambient temperature has dropped below the dew point, causing condensation on the bed surface

D. Whether the sludge application was too thick, preventing sunlight from reaching the sand below

76. A composting operation blends dewatered biosolids with wood chips and places the mixture in windrows. After two weeks, the operator measures the pile temperature at only 90°F (32°C), well below the thermophilic range needed for pathogen reduction. The moisture content is 55% (within range) and the C:N ratio is 28:1 (within range). What is the most likely cause of the low temperature, and what corrective action should the operator take?

A. The pile is too small and is losing heat to the environment faster than biological activity can generate it — increase the pile size or combine piles

B. The wood chip particle size is too large, creating excessive porosity that allows heat to escape rapidly from the pile

C. The moisture is too high at 55% and is suppressing aerobic activity — reduce the moisture to 40%

D. The C:N ratio of 28:1 is too high, creating a carbon-limited condition that slows biological decomposition

77. A treatment plant's anaerobic digester produces 15,000 cubic feet of gas per day with a methane content of 60%. The plant installs a cogeneration engine that converts the digester gas to electricity at an efficiency of 30%. What is the approximate electrical energy output in kWh per day?

A. Approximately 500 kWh/day

B. Approximately 2,640 kWh/day

C. Approximately 1,320 kWh/day

D. Approximately 790 kWh/day

78. An operator managing a biosolids land application program receives soil test results showing that the pH at one application site has dropped from 6.5 to 5.8 over three years of biosolids application. The biosolids have a pH of 7.0 after digestion. What is the primary concern with the declining soil pH?

A. The declining pH will cause odor complaints from neighbors because acidic conditions promote the release of volatile sulfur compounds

B. The biosolids will become more difficult to apply at lower soil pH because the sludge viscosity increases in acidic environments

C. As soil pH drops below 6.0, the bioavailability and plant uptake of heavy metals increases significantly, potentially causing metals to enter the food chain or leach to groundwater

D. The declining pH indicates that the biosolids are decomposing too slowly in the soil and the application rate should be increased

79. A treatment plant incinerator operates a multiple hearth furnace. The operator observes that the exhaust gas temperature has increased from the normal 1,400°F to 1,650°F despite no change in the sludge feed rate or auxiliary fuel input. What is the most likely cause, and what is the primary concern?

A. The increased exhaust temperature indicates improved combustion efficiency and no corrective action is needed

B. The sludge cake solids have increased significantly (drier cake has more combustible material per unit weight), causing higher combustion temperatures that may damage the refractory lining and downstream air pollution control equipment

C. The combustion air blower has failed, causing incomplete combustion that paradoxically raises the exhaust temperature

D. The ash removal system has failed and accumulated ash is insulating the combustion zone, trapping heat

80. A plant operator calculates the hydraulic detention time for an anaerobic digester. The digester volume is 350,000 gallons and the daily sludge feed is 14,000 gallons per day. What is the HRT, and is it within the typical range for mesophilic anaerobic digestion?

A. HRT is approximately 25 days, which is within the typical range of 15–30 days for mesophilic digestion

B. HRT is approximately 15 days, which is at the minimum of the acceptable range and may need extension

C. HRT is approximately 35 days, which exceeds the typical maximum and indicates the digester is underloaded

D. HRT is approximately 10 days, which is below the minimum and insufficient for adequate volatile solids reduction

81. A biosolids composting facility using the in-vessel method must maintain temperatures above 131°F (55°C) for at least 3 consecutive days to meet Part 503 requirements for the in-vessel/aerated static pile pathogen reduction alternative. The operator's temperature logs show the following daily core temperatures for the past week: Day 1: 128°F, Day 2: 133°F, Day 3: 137°F, Day 4: 140°F, Day 5: 142°F, Day 6: 139°F, Day 7: 135°F. Has the Part 503 time-temperature requirement been met?

A. No — the requirement is 7 consecutive days above 131°F, and Day 1 was below 131°F

B. No — the minimum temperature must be 140°F (60°C), not 131°F, for in-vessel composting

C. Yes — the temperature was below 131°F on Day 1 only; Days 2-7 show 6 consecutive days above 131°F, which exceeds the 3-day minimum

D. Yes — Days 2 through 7 are above 131°F for 6 consecutive days, which exceeds the 3-day minimum requirement for the ASP/in-vessel alternative

82. An operator at a treatment plant with lime stabilization of biosolids discovers that the quicklime (CaO) supply has been exhausted and the next delivery is 3 days away. The plant has hydrated lime ($Ca(OH)_2$) available in the dewatering building. Can hydrated lime be substituted for quicklime for lime stabilization?

A. No — quicklime and hydrated lime produce different chemical reactions and are not interchangeable for stabilization

B. No — hydrated lime does not produce the exothermic reaction needed for pathogen reduction in lime stabilization

C. Yes — hydrated lime can be used for lime stabilization, but a higher dose is needed because hydrated lime has a lower calcium oxide equivalent weight per pound than quicklime

D. Yes — hydrated lime is a direct 1:1 substitute for quicklime with no dose adjustment needed

83. An operator reviews the CPLR tracking records for a land application site and discovers that the cumulative zinc loading has reached 2,500 kg/hectare. The Part 503 CPLR limit for zinc is 2,800 kg/hectare. How much additional zinc loading can this site receive before the lifetime limit is reached?

A. 300 kg/hectare of additional zinc, after which the site can never receive biosolids again — regardless of the zinc concentration in future applications

B. The CPLR limit resets every 5 years, so the site will be available for renewed loading after the reset period

C. 2,800 kg/hectare of additional zinc, because the CPLR limit applies per application cycle, not cumulatively

D. The site has exceeded the CPLR limit because the 2,500 kg/hectare already exceeds the 2,200 kg/hectare lifetime limit

84. A belt filter press operator is processing WAS at 1.2% total solids feed concentration and achieving cake solids of 15%. The plant manager wants to increase the cake solids to 18% to reduce hauling costs. Which of the following is the most effective first step?

A. Increase the polymer dose to create stronger floc particles that release more water during compression

B. Thicken the WAS feed to 3–4% total solids before the belt press, which provides a denser feed that dewaters more effectively

C. Decrease the belt speed to half the current rate to allow more gravity drainage time on the belt

D. Replace the belt fabric with a finer weave that retains more solids and produces a denser cake

85. An anaerobic digester that has been operating stably receives a large batch of grease trap waste that increases the volatile solids loading by 40% in a single day. Within 48 hours, the volatile acids spike to 1,500 mg/L and the pH drops to 6.4. The operator responds by immediately stopping all sludge feed to the digester. Three days later, the volatile acids have dropped to 800 mg/L and the pH has risen to 6.6. What should the operator do next?

A. Resume full sludge feeding immediately because the declining volatile acids indicate the digester has recovered

B. Resume sludge feeding at 50% of the normal rate and gradually increase over 7–10 days while monitoring VA/Alk ratio, gas production, and pH daily

C. Continue withholding all sludge feed for at least 14 more days to ensure complete recovery

D. Resume sludge feeding at 100% of the normal rate but add supplemental alkalinity to maintain the pH above 6.8

86. A treatment plant composting facility receives a complaint that the windrow compost has developed a strong ammonia odor detectable at the property boundary, 500 feet from the nearest pile. The pile

moisture is 52%, the temperature is 145°F, and the C:N ratio was calculated at 18:1 at the time of mixing. What is the most likely cause of the ammonia odor?

A. The moisture content of 52% is too high and is promoting anaerobic conditions that release ammonia

B. The pile temperature of 145°F is causing thermal decomposition of proteins that releases ammonia

C. The C:N ratio of 18:1 is too low — insufficient carbon is available to assimilate the nitrogen being released during decomposition, resulting in excess ammonia volatilization

D. The windrow has been turned too frequently, disrupting the biological community and releasing stored ammonia

87. A treatment plant operator needs to calculate how many dry tons of biosolids are produced per day. The dewatered cake flow is 8,000 gallons per day at 22% total solids. Assume 8.34 lbs per gallon. How many dry tons per day are produced?

A. Approximately 7.3 dry tons per day based on the cake volume, solids concentration, and unit conversions

B. Approximately 14.7 dry tons per day based on the total wet weight divided by 2,000 lbs/ton

C. Approximately 3.7 dry tons per day based on the cake volume, concentration, and the wet-to-dry weight conversion

D. Approximately 29.4 dry tons per day based on the total wet weight of the dewatered cake

88. An operator collects an effluent sample for metals analysis (total recoverable metals). The sample must be preserved with nitric acid to pH < 2.0. The operator adds the acid at the time of collection and stores the sample at room temperature. The analysis is performed 5 months later. The maximum holding time for preserved metals samples is 6 months. Is this sample valid?

A. No — metals samples must be refrigerated even when acid-preserved, and room temperature storage invalidates the sample

B. Yes — acid-preserved metals samples at pH < 2.0 are stable for up to 6 months at room temperature, and this sample was analyzed within the holding time

C. No — the sample must be analyzed within 28 days regardless of preservation method

D. Yes — but the room temperature storage may have caused some metals to precipitate, potentially biasing the results low

89. An operator reviewing laboratory QC data discovers that the pH meter calibration slope has declined from 98% to 85% over the past two months. The meter still reads within ±0.1 unit of the buffer values during calibration. What does the declining slope indicate?

A. The pH meter electronics are functioning properly and no action is needed since the buffer readings are acceptable

B. The pH electrode is aging — the glass membrane or reference junction is degrading, and while the meter can still be calibrated to read correctly at the buffer points, its accuracy between calibration points is decreasing

C. The calibration buffers have degraded and should be replaced with fresh solutions

D. The declining slope indicates that the meter needs a firmware update from the manufacturer to restore full accuracy

90. A laboratory analyst performs an effluent BOD_5 analysis using three dilutions. The results are: 50% dilution = 14 mg/L BOD, 25% dilution = 15 mg/L BOD, 10% dilution = 18 mg/L BOD. The dilution blanks and GGA standard are all within acceptable ranges. What should the analyst report?

A. Report the average of all three valid results: (14 + 15 + 18) ÷ 3 = 15.7 mg/L

B. Report only the 50% dilution result (14 mg/L) because the highest dilution provides the most representative result

C. Report the average of the two dilutions with the closest agreement (14 and 15 mg/L): average = 14.5 mg/L

D. Report the 10% dilution result (18 mg/L) because the lowest sample volume provides the most conservative estimate

91. An operator collects an effluent composite sample and splits it into two bottles — one for the plant laboratory and one for the contract laboratory. The plant lab reports BOD_5 = 18 mg/L and the contract lab reports BOD_5 = 26 mg/L. Both laboratories have current certifications and acceptable QC data. The NPDES permit limit is 30 mg/L. Which result should be used for DMR reporting?

A. The plant should follow its NPDES permit language and standard operating procedures, which typically specify which laboratory's results are used for compliance reporting — if not specified, the more conservative (higher) result should be reported

B. Always report the lower result from the plant laboratory because the plant has more control over sample handling

C. Average the two results and report 22 mg/L to minimize the discrepancy

D. Report both results on the DMR and let the regulatory agency determine which to use for compliance

92. A treatment plant's chlorine residual analyzer consistently reads 0.2 mg/L lower than the grab sample analysis performed using the DPD method. The DPD analysis is performed within 30 seconds of collecting the grab sample directly from the analyzer sample line. What is the most likely cause of the discrepancy?

A. The DPD reagent has degraded and is producing falsely high results compared to the analyzer

B. The online analyzer is reading low due to probe fouling, calibration drift, or reagent depletion that reduces its sensitivity

C. The 30-second delay between collection and DPD analysis allows the chlorine residual to decrease

D. The analyzer and DPD method measure different forms of chlorine and cannot be directly compared

93. A laboratory performs monthly proficiency testing (PT) for BOD_5. The PT sample is a known-concentration standard sent by an accredited proficiency testing provider. The laboratory's result is 185 mg/L. The PT provider's acceptance range for this sample is 168–208 mg/L. Is the laboratory's result acceptable?

A. No — the result exceeds the midpoint of the acceptance range and indicates a positive bias

B. Yes — the result of 185 mg/L falls within the acceptance range of 168–208 mg/L, demonstrating acceptable analytical accuracy

C. No — PT results must fall within ±10% of the true value, and 185 mg/L exceeds this tolerance

D. Yes — but the laboratory should investigate why the result is above the midpoint to identify any systematic bias

94. An operator needs to calculate the percent volatile solids in a sludge sample. The laboratory reports the following: wet sample weight 100.0 g, weight after drying at 103°C (total solids) = 4.2 g, weight after ignition at 550°C (ash) = 1.5 g. What is the percent volatile solids on a dry-weight basis?

A. 1.5% volatile solids based on the ash weight divided by the wet sample weight

B. 2.7% volatile solids based on the difference between wet weight and ash weight divided by wet weight

C. 64.3% volatile solids based on the volatile fraction (4.2 – 1.5 = 2.7 g) divided by the total solids (4.2 g)

D. 35.7% volatile solids based on the ash fraction (1.5 g) divided by the total solids (4.2 g)

95. An operator performs a chlorine demand study by adding progressively increasing chlorine doses to effluent samples and measuring the residual after 30 minutes of contact. The results are: Dose 2 mg/L = Residual 0.0, Dose 4 mg/L = Residual 0.0, Dose 6 mg/L = Residual 0.3, Dose 8 mg/L = Residual 1.5, Dose 10 mg/L = Residual 3.2. At what dose is the breakpoint approximately reached, and what is the chlorine demand?

A. The breakpoint is approximately at a dose of 6 mg/L with a demand of approximately 5.7 mg/L

B. The breakpoint is at 10 mg/L with a demand of 6.8 mg/L

C. The breakpoint is at 4 mg/L with a demand of 4.0 mg/L

D. The breakpoint cannot be determined from these data because the residual does not show the characteristic rise-and-fall pattern

96. An operator calibrates the laboratory turbidimeter using calibration standards of 0.1 NTU, 20 NTU, 100 NTU, and 800 NTU. The meter reads within ±2% of all four standards. The operator then measures an effluent sample and obtains a reading of 3.2 NTU. Is this reading reliable?

A. No — the calibration should have included a standard close to the expected sample range (1-5 NTU) for maximum accuracy at the measurement point

B. Yes — the calibration demonstrates acceptable accuracy across the full measurement range, and 3.2 NTU falls within the calibrated range between the 0.1 and 20 NTU standards

C. No — turbidimeters must be calibrated with at least 6 standards to cover the full measurement range

D. Yes — but the result should be reported as 3.2 ± 2% (3.14–3.26 NTU) to reflect the calibration uncertainty

97. An operator performs a total suspended solids analysis and obtains the following data: clean filter weight = 1.5200 g, filter + dried residue weight = 1.5245 g, sample volume = 200 mL. However, the operator notices that the drying oven was set at 180°C instead of the standard 103–105°C. What effect would the higher temperature have on the result?

A. No effect — the result is valid because higher temperatures dry the sample faster without changing the measured weight

B. The result would be unaffected because all water has already been removed at 103°C, and additional heating only reduces drying time

C. The result may be unreliable because the sample was dried at the wrong temperature and should be repeated

D. The higher temperature may have volatilized or decomposed organic matter from the residue, producing a falsely low TSS result that underestimates the actual suspended solids concentration

98. When performing the BOD_5 analysis, the incubation temperature must be maintained at 20°C ± 1°C. If the incubator temperature drifts to 23°C during the 5-day incubation period, what effect would this have on the BOD results?

A. The results would be lower because higher temperatures reduce the metabolic rate of the seed organisms

B. The results would be unaffected because the ±1°C tolerance allows for temperature fluctuations up to 23°C

C. The results would be higher because the elevated temperature accelerates biological decomposition of the organic matter, causing more oxygen to be consumed during the 5-day period

D. The results would be lower because higher temperatures reduce the oxygen solubility, making less oxygen available for consumption

99. An operator analyzing effluent TSS filters 500 mL of sample through a pre-weighed glass fiber filter, then dries the filter at 103°C for 1 hour, cools it in a desiccator, and weighs it. The weight gain is 3.0 mg. The operator then places the filter back in the oven for another 30 minutes, cools, and reweighs. The weight gain is now 2.8 mg. What should the operator do?

A. Report the TSS based on the 2.8 mg weight gain (5.6 mg/L) because the second drying cycle produced the more accurate result — the sample needed additional drying time to reach constant weight

B. Report the TSS based on the 3.0 mg weight gain (6.0 mg/L) because the first weighing is always the official result

C. Average the two results and report 5.8 mg/L

D. Repeat the analysis on a new sample because the discrepancy between the two weighings indicates an analytical error

100. A laboratory analyst runs a method blank (reagent water processed through the entire analytical procedure) alongside the effluent samples for ammonia nitrogen analysis. The method blank shows an ammonia concentration of 0.3 mg/L. The effluent sample result is 2.8 mg/L. The method detection limit is 0.1 mg/L. What is the significance of the elevated method blank?

A. The 0.3 mg/L blank result is acceptable because it is below the effluent concentration and does not affect the sample result

B. The elevated blank indicates contamination in the analytical system (reagents, glassware, or laboratory atmosphere) that may be biasing all sample results high — the analyst should investigate the source, correct it, and re-analyze the affected samples

C. The blank result should be subtracted from the sample result, reporting the ammonia as 2.5 mg/L (2.8 – 0.3)

D. The method blank is unrelated to the sample results and serves only as a laboratory record-keeping requirement

Practice Exam 8: Answer Key and Explanations

1. A — With no industrial users and no change in source water, the most likely explanation for gradually declining influent alkalinity is a change at the municipal water supply level. Water utilities periodically change treatment processes, source wells, or blending ratios, which directly affects the alkalinity of the finished water distributed to the community and subsequently appearing in the wastewater.

2. A — A pH of 2.1 is far outside the normal septage range of 6.5–7.5 and, combined with a chemical odor, is a clear indicator that the load contains industrial or chemical waste — not residential septage. The hauler has likely mislabeled the manifest, which is a pretreatment violation. The operator should reject future loads from this hauler and report the incident to the pretreatment coordinator.

3. D — Ammonia nitrogen percentage = 180 ÷ (800 + 180) × 100 = 18.4%. Compare to BOD at 250 ÷ (4,500 + 250) = 5.3% and TSS at 120 ÷ (5,000 + 120) = 2.3%. The ammonia sidestream contribution of 18.4% is by far the most significant, potentially affecting the plant's nitrification capacity and requiring careful scheduling of sidestream returns.

4. C — Elevated wastewater temperature accelerates biological decomposition in the collection system — bacteria consume organic matter more rapidly, converting settleable solids into dissolved and colloidal forms (reducing settleable solids) and producing hydrogen sulfide and other odorous gases from anaerobic decomposition in gravity sewer pipes. This is a well-known warm-weather operational challenge.

5. B — Morning mass loading = 280 × 1.1 × 8.34 = 2,569 lbs/day rate. Afternoon mass loading = 160 × 3.6 × 8.34 = 4,804 lbs/day rate. Despite the lower concentration, the afternoon period delivers nearly

twice the BOD mass due to the much higher flow. This demonstrates why mass loading (not concentration alone) is the critical parameter for evaluating biological process capacity.

6. D — The gradual SVI increase from 110 to 175 mL/g over three weeks — with all other parameters stable — is the signature of filamentous organism proliferation. Filamentous bacteria grow slowly and respond to subtle environmental conditions (low DO in portions of the basin, nutrient deficiency, septic influent, or low F/M) that may not be immediately apparent in routine monitoring.

7. C — DO depletion rate = (4.0 – 1.5) ÷ 8 minutes = 0.3125 mg/L/min = 18.75 mg/L/hour. This OUR indicates moderate biological activity consistent with a normally loaded conventional system. Higher OUR values (>25) suggest heavy loading, while lower values (<10) suggest extended aeration or underloading.

8. A — At peak flow, the SOR of 1,400 GPD/ft^2 exceeds the design maximum of 1,200 GPD/ft^2. The upward velocity of water in the clarifier exceeds the settling velocity of lighter particles, carrying them over the weir into the effluent. At average flow (850 GPD/ft^2), the SOR is well within the design range and presents no settling concerns.

9. B — The DO profile (2.5 mg/L at the inlet, 4.5 mg/L at the outlet) indicates that the oxygen demand is highest at the inlet — where the incoming primary effluent delivers its full organic load — and decreases along the basin as the organisms consume the BOD. The uniform air distribution is supplying the same air everywhere, but the demand is concentrated at the inlet end.

10. D — Total basin volume = 3 × 0.3 = 0.9 MG. HRT = 0.9 ÷ 3.6 = 0.25 days = 6 hours total system. BOD Loading = 130 × 3.6 × 8.34 = 3,903 lbs/day. MLVSS ≈ 2,800 × 0.8 = 2,240 mg/L. MLVSS (lbs) = 2,240 × 0.9 × 8.34 = 16,813 lbs. F/M = 3,903 ÷ 16,813 = 0.23, approximately 0.18–0.23 depending on methodology. This places the system between conventional and extended aeration.

11. C — The orthophosphate profile demonstrates textbook EBPR operation: PAOs release phosphorus in the anaerobic zone (increasing from 6.0 to 15.0 mg/L), then perform luxury uptake in the aerobic zone (decreasing from 15.0 to 0.3 mg/L), absorbing far more phosphorus than they released. The slight increase from 0.3 to 0.5 mg/L in the effluent represents minor phosphorus release during clarification.

12. A — CT = Residual × T_{10} = 1.2 × 18 = 21.6 mg·min/L. The T_{10} value represents the time it takes for the fastest 10% of the flow to traverse the contact tank, accounting for short-circuiting. Using T_{10} instead

of theoretical detention time provides a conservative CT calculation that ensures even the fastest-traveling portion of the flow receives adequate disinfection.

13. D — Post-denitrification filters use supplemental carbon (methanol, ethanol, or glycerol) as the electron donor for denitrifying bacteria. If the methanol feed rate exceeds the consumption rate of the denitrifiers, unconsumed methanol passes through the filter and appears as BOD in the effluent. The operator should reduce the methanol dose until the excess BOD disappears.

14. B — Under the Clean Water Act and NPDES permit requirements, all monitoring results — including suspected erroneous ones — must be reported as obtained. The 47 mg/L result exceeds the 45 mg/L daily maximum limit and constitutes a permit violation requiring investigation, corrective action, and regulatory notification. The operator cannot discard, reanalyze from the same bottle, or modify the result.

15. C — Trickling filter BOD removal = [(120 – 30) ÷ 120] × 100 = 75%. Overall plant removal = [(200 – 22) ÷ 200] × 100 = 89%. The trickling filter removes 75% of the BOD in the primary effluent, and the overall plant (including primary treatment, trickling filter, and secondary clarifier) removes 89% of the raw influent BOD.

16. A — Nitrifying bacteria require a minimum DO of approximately 1.5–2.0 mg/L to maintain their maximum oxidation rate. At 1.2 mg/L, the DO is below this threshold, and the nitrifiers become oxygen-limited — they cannot oxidize ammonia at the rate needed to keep the effluent below the permit limit. The BOD-removing heterotrophs, being less oxygen-sensitive, continue to function at this lower DO.

17. D — During a storm, the clarifier receives both increased hydraulic loading (higher SOR, faster upward velocity) AND increased solids loading (more MLSS entering at higher flow). The upward water velocity physically pushes the sludge blanket upward faster than gravity can settle the particles and faster than the RAS can withdraw them. The blanket rises because the hydraulic force overwhelms the settling force.

18. B — An initial settled volume of 920 mL/L at 5 minutes (only 80 mL of clear supernatant) and a 30-minute settled volume of 820 mL/L indicates the sludge barely settles and compacts very poorly. SVI = 820 × 1,000 ÷ 3,600 = 228 mL/g — well above the 150 mL/g threshold. This is characteristic of filamentous bulking sludge that resists both initial settling and subsequent compaction.

19. C — Clarifier A: DT = 150,000 ÷ (1,250,000/24) = 150,000 ÷ 52,083 = 2.88 hours. Clarifier B: DT = 100,000 ÷ 52,083 = 1.92 hours. Clarifier B's 1.92-hour detention time is at the lower end of the typical 1.5–2.5 hour range for primary clarifiers. With equal flow distribution to unequal volumes, the smaller clarifier is at greater risk of reduced performance.

20. D — Alkalinity consumed = 30 mg/L NH_3-N × 7.14 = 214.2 mg/L. Remaining = 120 – 214.2 = –94.2 mg/L. The alkalinity is severely negative, confirming that nitrification consumes nearly twice the available alkalinity. Without supplemental alkalinity addition, the pH will crash well below 6.0, inhibiting both nitrification and general biological treatment.

21. A — UV intensity readings measure the lamp output at the sensor — not the intensity reaching the pathogens through the water. If the quartz sleeves between the lamps and the water have become fouled with mineral scale, biological growth, or iron deposits, the actual UV energy entering the water is reduced even though the sensor behind the sleeve still reads normal lamp output.

22. B — At pH 5.8, the aluminum chemistry shifts — aluminum hydroxide floc that was formed at neutral pH begins to dissolve back into solution as colloidal aluminum species. These extremely fine colloidal particles scatter light and create a milky haze but are too small (<0.45 µm) to be captured by the standard glass fiber filter used in the TSS analysis, explaining the normal TSS reading.

23. C — Maintaining nitrification year-round is the operationally sound choice because restarting nitrification in the spring requires gradually extending the SRT from a non-nitrifying level (4–5 days) to a nitrifying level (10–15 days at cold temperatures). This transition takes 2–4 weeks of careful SRT management. If a late cold spell delays the transition, the plant may not achieve compliance by the May deadline.

24. D — The settle phase allows the biological solids to separate from the treated supernatant by gravity before the decanter begins withdrawing liquid. Reducing the settle time from 60 to 30 minutes may not allow adequate separation — the decanter may begin drawing liquid while the sludge-supernatant interface is still above the decant level, pulling solids into the effluent.

25. A — Methanol is a readily biodegradable carbon source that denitrifying bacteria can immediately use as an electron donor in the anoxic zone. The additional carbon source allows the denitrifiers to reduce more nitrate to nitrogen gas than they could with the influent BOD alone. This improvement in denitrification directly reduces the effluent nitrate and total nitrogen.

26. B — In a vacuum-operated chlorine gas system, the injector (eductor) creates the vacuum that draws gas from the cylinder through the chlorinator. If the injector water supply is lost (pump failure, valve closure, low water pressure), the vacuum disappears and gas flow stops — even though the chlorinator appears to function normally on its local indicators.

27. D — System MLSS = 3,500 × 1.0 × 8.34 = 29,190 lbs. WAS = 9,000 × 0.04 × 8.34 = 3,002 lbs/day. Effluent = 15 × 3.0 × 8.34 = 375 lbs/day. Total out = 3,377 lbs/day. SRT = 29,190 ÷ 3,377 = 8.6 days, approximately 7.5–8.6 depending on rounding. At 15°C, the minimum SRT for nitrification is approximately 6–8 days, so this SRT provides adequate capacity but minimal margin.

28. C — Increasing the height, number of steps, or adding roughness elements to the existing cascade increases the total energy dissipation, turbulence, and air-water contact area. This is the most cost-effective modification because it improves the existing infrastructure rather than requiring new mechanical or chemical systems. The incremental improvement of 0.5 mg/L is achievable with relatively minor cascade modifications.

29. A — Moles of P = 5.0 ÷ 31 = 0.161 mol/L. Iron required = 0.161 × 1.5 = 0.242 mol/L. Iron dose = 0.242 × 56 = 13.5 mg/L as iron. This molar ratio calculation ensures the stoichiometric excess of iron needed for effective phosphorus precipitation — some iron reacts with phosphorus while the excess forms iron hydroxide floc.

30. B — Dark floating clumps with gas bubbles on the clarifier surface is the classic presentation of denitrification in the sludge blanket. Bacteria in the settled sludge convert nitrate to nitrogen gas under the anoxic conditions present in the blanket. The nitrogen gas bubbles attach to settled sludge particles and float them to the surface. Increasing the RAS rate reduces the sludge detention time in the clarifier.

31. D — Extending the SRT from 8 to 20 days requires accumulating approximately 2.5 times the current system solids inventory. Since solids accumulate gradually through biological growth minus wasting, the transition takes approximately one to two SRT-lengths — roughly 12–20 days. The biology cannot grow instantaneously; it must reproduce through successive generations to build the required population.

32. C — F/M = BOD Loading ÷ MLVSS. Since Train A receives 60% of the organic load and Train B receives 40%, equalizing the F/M requires proportionally adjusting the MLVSS in each train. Train A should maintain a higher MLVSS (proportional to its 60% flow share) and Train B should maintain a lower MLVSS. This keeps the F/M identical in both trains.

33. A — The critical sequence is: (1) start chlorine, (2) verify adequate residual and CT in the contact tank, (3) start dechlorination, (4) verify TRC < 0.019 mg/L at the discharge point, (5) ONLY THEN shut down the UV system. Starting chlorine and dechlorination and verifying both are working properly before shutting down UV ensures zero gap in disinfection coverage.

34. B — Pure lime needed = 200 mg/L × 0.05 MG × 8.34 = 83.4 lbs/day. Since the product is 90% pure, the adjusted dose = 83.4 ÷ 0.90 = 92.7 lbs/day. The purity adjustment ensures that enough product is fed to deliver the required mass of active calcium hydroxide, accounting for the 10% inert filler in the delivered product.

35. D — Achieving 0.1 mg/L total phosphorus requires multiple treatment barriers. EBPR alone (currently achieving 0.3 mg/L) cannot reliably reach 0.1 mg/L. The standard approach is to optimize EBPR for maximum biological removal, add chemical polishing (alum or ferric chloride) to precipitate the remaining phosphorus, and use tertiary filtration to capture the fine chemical precipitate particles.

36. C — At a DO of 2.0 mg/L, the plant is already achieving excellent effluent quality (BOD 10 mg/L, ammonia 0.8 mg/L). Increasing to 4.0 mg/L would consume significantly more energy (blower costs increase proportionally to DO setpoint) without meaningful treatment improvement. The 2.0 mg/L already supports both BOD removal and nitrification adequately.

37. B — Volume = 0.785 × D^2 × depth = 0.785 × 60^2 × 18 = 0.785 × 3,600 × 18 = 50,868 ft^3. Gallons = 50,868 × 7.48 = 380,493 gallons, approximately 380,800 gallons. This is the standard cylindrical volume calculation for wastewater treatment tanks.

38. A — Monthly average = (28 + 35 + 32 + X) ÷ 4 = 30. Solving: 95 + X = 120, so X = 25 mg/L. The fourth week's result must be 25 mg/L to achieve a monthly average of exactly 30.0 mg/L. This calculation is essential for operators managing borderline compliance situations — understanding how one result affects the monthly average enables proactive process adjustments.

39. C — The difference between ortho-P (0.2 mg/L) and total P (0.7 mg/L) is 0.5 mg/L, which represents phosphorus bound in particulate form — biological solids or chemical precipitates that have escaped the clarifier. Improving TSS removal (better clarifier performance or adding tertiary filtration) would capture these particles and reduce the total phosphorus to match the low ortho-P level.

40. B — A drained secondary clarifier with residual sludge meets all three confined space criteria (large enough to enter, limited entry/exit via ladder, not designed for continuous occupancy) and is permit-

required due to the potential for hazardous atmospheres from decomposing sludge. Full confined space entry procedures — atmospheric testing, permit, attendant, continuous monitoring, retrieval system, and rescue provisions — are mandatory.

41. D — Even a small chlorine gas leak at 0.8 ppm can rapidly worsen if the connection fails completely. The correct response follows the chlorine emergency procedure: evacuate the room (don't attempt repairs in a contaminated atmosphere), don SCBA (full respiratory protection), return to close the cylinder valve (stopping the gas at its source), and then follow the emergency response plan.

42. A — Gas monitors used for confined space entry must be calibrated per the manufacturer's specifications. Using monitors with expired calibration for confined space entries means the atmospheric readings may have been inaccurate — the entries were potentially performed without valid atmospheric data. The monitors must be removed from service, recalibrated, and the affected entries documented.

43. C — Sodium hypochlorite is an oxidizer and ferric chloride is an acid. If both chemicals leaked into shared secondary containment and mixed, the oxidizer-acid reaction could produce toxic chlorine gas. These two chemicals must have separate secondary containment areas to prevent mixing in the event of simultaneous failures. Sodium hydroxide is compatible with both.

44. A — A power outage — even a brief one — can cause complex disruption: equipment may restart in the wrong sequence, VFDs may fault, chemical feed pumps may not auto-restart, SCADA data gaps may mask process upsets, and the generator must be verified as properly returned to standby. The morning operator must systematically verify all systems before assuming normal operation.

45. D — The plant's lone worker safety protocol should include multiple layers of communication: attempting the primary supervisor, escalating to an alternative supervisor or designated emergency contact, and/or utilizing a monitoring service. The protocol exists specifically for this situation — the operator follows the established chain of communication and continues the shift with enhanced safety awareness.

46. A — The plant has 6,000 lbs of chlorine on site — well above the 2,500-lb RMP threshold. Under Section 112(r) of the Clean Air Act, the plant must have a Risk Management Plan that includes a worst-case release scenario analysis, a 5-year accident history, a prevention program, and an emergency response program coordinated with the local emergency planning committee.

47. C — A stuck pressure gauge cannot confirm whether the extinguisher is properly charged. Without a functional gauge, the operator cannot verify the extinguisher is ready for emergency use. The unit must be removed from service and replaced with a fully functional extinguisher. The damaged unit should be professionally inspected, the gauge replaced, and the unit recharged before returning to service.

48. B — OSHA's PSM standard (29 CFR 1910.119) applies to facilities that store highly hazardous chemicals above threshold quantities — including wastewater treatment plants with chlorine gas above 1,500 lbs. All 14 elements apply, including process hazard analysis, operating procedures, employee training, mechanical integrity, management of change, incident investigation, and emergency planning.

49. D — Near-miss incidents are leading indicators of future injuries. A proactive safety program investigates near-misses with the same rigor as actual injuries to identify root causes and implement corrective actions before someone is hurt. Installing anti-slip surfaces, improving ice removal procedures, adding handrails, and modifying walkway designs address the root causes of the slip hazard.

50. D — The LEL reading of 8% approaches the typical entry threshold of 10% of the lower explosive limit. Most confined space programs prohibit entry when LEL exceeds 10% because the atmosphere contains a combustible gas concentration approaching the explosive range. The space should be ventilated to reduce the LEL below 10% before entry is authorized.

51. A — SCBA cylinders must undergo hydrostatic testing every 5 years (for steel or aluminum) or 3 years (for composite) to verify the cylinder can safely contain pressurized air. An expired test date means the cylinder's structural integrity has not been verified and it could fail under pressure during emergency use. The units must be removed from service and the cylinders sent for testing.

52. B — Without a group lockout procedure, the first worker to complete their task may remove the lockout devices — believing the work is finished — while other workers remain inside the equipment or within the danger zone. A group lockout procedure ensures that every worker applies their own lock and that no locks are removed until every worker has completed their work and verified their safety.

53. C — Quarterly calibration means at least one calibration per calendar quarter (Q1: Jan–Mar, Q2: Apr–Jun, Q3: Jul–Sep, Q4: Oct–Dec). With calibrations on January 15 and March 20 (both in Q1), July 8 (Q3), and December 5 (Q4), there is no calibration during Q2 (April–June). This gap constitutes a violation of the quarterly calibration requirement.

54. B — Late DMR submission is a permit violation regardless of the data content. NPDES permits specify submission deadlines, and missing them — even by 2 days — constitutes noncompliance. The regulatory agency may issue a notice of violation, a warning letter, or pursue enforcement action depending on the facility's compliance history and the state's enforcement discretion.

55. A — Increased vibration at a specific speed that was not present at a different speed is characteristic of a structural resonance. Every mechanical assembly has natural frequencies at which vibration is amplified. If the pump operating speed at 80% (1,400 RPM) coincides with a natural frequency of the pump, motor, baseplate, or piping assembly, the vibration is dramatically amplified.

56. C — A damaged, deteriorated, or fouled DO probe membrane cannot respond consistently to changes in dissolved oxygen concentration. The membrane may have pinholes, biological growth, or air bubbles that cause erratic signal generation. The portable meter reads consistently at 2.0 mg/L because it has a clean, intact membrane. Cleaning or replacing the online probe membrane should resolve the erratic readings.

57. D — The downstream system resistance has increased. A PD blower delivers constant volume and will increase pressure to overcome any downstream restriction. Common causes include fouling of fine bubble diffusers (biological growth, mineral scale), a partially closed discharge valve, or an increase in the aeration basin water level above the normal operating depth.

58. B — A dominant vibration frequency at 2× the running speed (2× RPM) is the classic signature of shaft misalignment — either angular or parallel offset between the motor and blower shafts. Misalignment generates forces that peak twice per revolution. The corrective action is precision shaft alignment using laser alignment tools or dial indicators.

59. A — Rapid wet well level oscillation with a single pump operating indicates the pump is running in an unstable region of its performance curve — likely at the far right where the curve flattens, during cavitation, or with air entrainment. Small changes in suction conditions or system head cause large flow variations, producing the rapid level cycling observed.

60. B — Volume removed = 5,000 ft^2 × 0.5 ft (6 inches) = 2,500 ft^3 × 7.48 gal/ft^3 = 18,700 gallons in 10 minutes = 1,870 GPM actual flow. The mag meter reads only 1,200 GPM — approximately 36% below the actual flow ((1,870 – 1,200) ÷ 1,870 = 35.8%). A 36% error is far outside the acceptable ±2–5% accuracy for a magnetic flow meter and requires immediate recalibration. This discrepancy means the plant has been underreporting the actual RAS flow rate, which affects all process control calculations that rely on the meter.

61. C — The MLSS increase from 2,400 to 3,100 mg/L means 29% more biological organisms in the same basin volume — each consuming oxygen. With the same air supply but 29% more oxygen demand, the DO decreases because the organisms consume the additional oxygen that was previously maintaining the higher residual. The operator should either increase the aeration rate or reduce the MLSS.

62. B — The sensor reads 8.5 feet while the actual depth is 7.8 feet — an error of 0.7 feet or 8.2%. Typical ultrasonic level sensor accuracy specifications are ±0.25% to ±2% of the range. An 8.2% error far exceeds the typical specification and indicates the sensor needs recalibration, has a fouled transducer face, or is experiencing temperature compensation errors.

63. A — Progressive cavity pumps rely on a thin fluid film between the rotor and stator for lubrication. If the pump runs dry — even briefly — the elastomer stator overheats from friction, accelerating wear and reducing its life. Intermittent feed from the clarifier hopper creates periods when the sludge level drops below the pump suction and the pump draws air, causing dry-running conditions.

64. B — If the suction and discharge lines are clear, the tank is full, and the diaphragm is intact, the most likely cause of zero output is stuck check valves. When both check valves are fouled or stuck closed, the pump strokes against sealed ports — the diaphragm flexes but no chemical enters the pump head on the suction stroke and no chemical is pushed out on the discharge stroke.

65. C — A blocked inlet filter on a PD blower severely restricts the air intake, reducing the mass of air delivered. The blower will pull a vacuum on the inlet side, which reduces airflow and can cause overheating from the compression of a smaller air volume to the same discharge pressure. The blocked filter should be replaced during routine PM — before it becomes a critical failure.

66. B — VFD speed-to-flow correlations assume a fixed system head (the head curve the pump operates against). If the actual system head has changed since commissioning — due to valve position changes, pipe scaling, or different clarifier blanket depths — the pump delivers a different flow at the same speed. Centrifugal pump flow depends on BOTH speed and system head.

67. B — Belt tears will progressively worsen during operation — each press cycle stresses the torn edges, and the tears will grow until the belt fails catastrophically, potentially damaging the rollers and creating a much more expensive repair. The belt should be replaced proactively, and the cause investigated (tracking misalignment, sharp edges, or debris) to prevent recurrence.

68. B — The excessive RAS rate has been pumping settled sludge from the clarifier back to the aeration basin faster than new solids settle. This transfers the solids inventory from the clarifier (dropping the blanket to zero) to the aeration basin (raising the MLSS from 2,800 to 4,200). The RAS concentration drops because the pump is drawing from an increasingly thin blanket, eventually pulling dilute liquid.

69. C — A motor operating above its rated surface temperature is experiencing thermal stress that progressively degrades the winding insulation. Each 10°C above the rated temperature cuts the insulation life approximately in half. At 195°F versus a 180°F maximum, the motor is running 15°F above its limit — the cause (overloading, poor ventilation, dirty cooling fins, high ambient) must be identified and corrected.

70. D — The most likely explanation for a 0.7 NTU discrepancy between online and grab sample readings is that the grab sample changed during collection and transport. Particles may settle during transport (lowering turbidity), air bubbles may form from agitation (raising turbidity), or temperature changes may affect the reading. The online meter measures the actual in-situ condition more reliably for this reason.

71. A — WAS consists of light biological floc particles that have very poor gravity-thickening characteristics compared to dense primary sludge. Adding WAS to a gravity thickener designed for primary sludge introduces light particles that do not compact well, resulting in a lower overall thickened concentration and increased solids carryover in the turbid supernatant.

72. B — Lower scroll differential speed keeps the solids in the bowl longer, allowing more time on the beach for drainage under centrifugal force — producing a drier cake. However, the slower conveyance rate means solids accumulate in the bowl, and at some point, the pool depth relative to the beach may change, potentially allowing some fine solids to escape in the centrate.

73. D — The VA/Alk ratio is the most sensitive early warning indicator for anaerobic digester upset. When organic loading increases (as with grease trap waste co-digestion), the acid-forming bacteria respond quickly by producing more volatile acids. If the methanogens cannot keep pace, volatile acids accumulate and the VA/Alk ratio rises before pH changes or gas production drops become apparent.

74. B — Clear filtrate indicates the polymer is effectively conditioning the sludge and capturing solids. However, if the belt tension is too low, the sludge is not adequately compressed during the pressure zones — the rollers cannot squeeze enough water from the conditioned cake. Increasing the belt tension applies more mechanical pressure, producing a denser, more coherent cake with higher solids content.

75. A — If the sludge characteristics, weather, and application depth are the same as previous successful loadings, the most likely cause of poor drainage on this particular bed is a clogged sand underdrain system. Fine sludge particles from previous loadings migrate into the sand pore spaces over time, progressively reducing the drainage rate until the bed can no longer effectively dewater.

76. C — With moisture and C:N ratio within range, the most likely cause of low temperature in a composting pile is insufficient pile volume. Small piles have a high surface-area-to-volume ratio, losing heat to the environment faster than biological activity generates it. Increasing the pile size or combining smaller piles into larger windrows retains more biological heat and allows the pile to reach thermophilic temperatures.

77. D — Step 1: Methane volume = 15,000 ft^3/day × 0.60 = 9,000 ft^3 CH_4/day. Step 2: Total energy content = 9,000 ft^3 × 1,000 BTU/ft^3 (heating value of methane) = 9,000,000 BTU/day. Step 3: Electrical energy produced = 9,000,000 × 0.30 (engine efficiency) = 2,700,000 BTU/day. Step 4: Convert to kWh = 2,700,000 ÷ 3,412 BTU/kWh = 791 kWh/day, approximately 790 kWh/day. This calculation demonstrates how digester gas energy is converted through the cogeneration process — only 30% of the total methane energy becomes electricity, with the remaining 70% lost as waste heat (though much of this heat can be recovered for digester heating).

78. B — Quicklime (CaO) reacts exothermically with water, generating significant heat. When combined with the pH elevation to 12.0 for 72 hours, the time-temperature-pH conditions can meet PFRP requirements for Class A pathogen reduction under certain Part 503 alternatives. The extended 72-hour contact time at pH 12+ also satisfies VAR requirements.

79. C — Standing water above the sludge cake should be removed to resume the drying process. The underdrain system is designed to handle both the initial sludge water and incidental rainfall. Draining the standing water through the underdrains and then scarifying the cake surface to reopen evaporation pathways is the standard approach for managing rain on active drying beds.

80. A — HRT = 350,000 ÷ 14,000 = 25 days. This detention time is within the typical range of 15–30 days for mesophilic anaerobic digestion. A 25-day HRT provides adequate time for the three-stage biological process (hydrolysis, acidogenesis, methanogenesis) to substantially reduce volatile solids and produce well-stabilized biosolids.

81. D — Days 2 through 7 show temperatures of 133, 137, 140, 142, 139, and 135°F — all above 131°F for 6 consecutive days. The Part 503 requirement for the ASP/in-vessel alternative is a minimum of 3

consecutive days above 131°F (55°C). With 6 consecutive days, the time-temperature requirement is clearly met, despite Day 1 being below the threshold.

82. B — Both quicklime (CaO) and hydrated lime ($Ca(OH)_2$) can be used for lime stabilization — both raise pH and provide alkalinity. However, quicklime has a higher CaO content per pound (approximately 56 g/mol) compared to hydrated lime (74 g/mol). A higher dose of hydrated lime (approximately 30% more by weight) is needed to achieve the same pH elevation and stabilization effect.

83. C — CPLR limits are cumulative lifetime limits — once the total loading at a site reaches the limit, no additional biosolids can be applied, ever. With 2,500 kg/ha already applied and a limit of 2,800 kg/ha, only 300 kg/ha of additional zinc loading can be applied. The operator must carefully manage the remaining capacity and begin planning for alternative sites.

84. A — The digester or dewatering performance is directly affected by the feed concentration. Testing the raw sludge for surfactant provides direct analytical evidence of whether an external chemical source is causing the foam. If elevated surfactant levels are confirmed, the source can be traced upstream through the collection system to identify and control the discharge.

85. D — While Part 503 does not specifically regulate phosphorus loading rates, many states have supplemental regulations that limit phosphorus application based on soil test results and crop needs. When soil phosphorus exceeds the state's agronomic recommendation, the application rate should be recalculated using phosphorus as the limiting nutrient, which typically results in a significantly lower rate.

86. C — The C:N ratio of 18:1 is well below the optimal range of 25–30:1 for aerobic composting. With insufficient carbon to assimilate all the nitrogen being mineralized during decomposition, excess nitrogen is converted to ammonia and volatilized. Adding more carbon-rich bulking agent (wood chips, sawdust, or yard waste) would raise the C:N ratio and reduce ammonia emissions.

87. A — Dry solids = 8,000 GPD × 8.34 lbs/gal × 0.22 = 14,678.4 lbs/day. Dry tons = 14,678.4 ÷ 2,000 = 7.34 dry tons/day. This calculation converts the cake volume and concentration to the dry weight of solids produced daily — a critical number for hauling contract planning, landfill disposal budgeting, and Part 503 reporting.

88. B — Total recoverable metals samples preserved with nitric acid to pH < 2.0 are stable for up to 6 months. The acid preservation prevents metals from precipitating or adsorbing to the container walls. While refrigeration is preferred for some parameters, acid-preserved metals samples are specifically approved for room temperature storage within the 6-month holding time under 40 CFR Part 136.

89. D — A pH electrode slope declining from 98% to 85% indicates the glass membrane or reference junction is aging and losing its ability to generate the full theoretical voltage response (59.16 mV per pH unit at 25°C). While the meter can still be calibrated to read correctly at the two buffer points, its accuracy at pH values between or beyond the calibration points is progressively degraded.

90. B — With three valid BOD_5 results from different dilutions showing reasonable agreement (14, 15, and 18 mg/L), Standard Methods recommends reporting the average of the results from the dilutions that meet the validity criteria (minimum 2.0 mg/L depletion, final DO > 1.0 mg/L). However, some laboratories report only the result from the dilution with the best depletion characteristics, which is typically the middle dilution (50% giving 14 mg/L).

91. A — When split samples produce different results from two certified laboratories with acceptable QC, the plant must follow its NPDES permit language and SOPs regarding which laboratory's results are authoritative for compliance reporting. If the permit or SOP doesn't specify, the more conservative (higher) result should generally be reported to avoid underreporting.

92. B — A consistent 0.2 mg/L negative bias in the online analyzer compared to a DPD grab sample collected directly from the analyzer sample line within 30 seconds indicates the analyzer is reading low. Common causes include probe fouling, calibration drift, reagent depletion, or sample conditioning issues. The analyzer should be serviced, recalibrated, and verified against the DPD method.

93. D — The laboratory's PT result of 185 mg/L falls within the provider's acceptance range of 168–208 mg/L, demonstrating that the analytical procedure produces results within the expected range for a known-concentration standard. Proficiency testing is a fundamental QC requirement for laboratory certification and NPDES compliance.

94. C — Volatile solids (dry weight basis) = (Total solids – Ash) ÷ Total solids × 100 = (4.2 – 1.5) ÷ 4.2 × 100 = 2.7 ÷ 4.2 × 100 = 64.3%. The volatile fraction represents the organic (combustible) portion of the total solids that is destroyed at 550°C. This is the basis for calculating volatile solids reduction in digesters.

95. A — The breakpoint is the dose where the chlorine residual first appears and begins increasing linearly with dose. At 6 mg/L dose, the residual first appears (0.3 mg/L), indicating the breakpoint has just been reached. The chlorine demand at the breakpoint is approximately: Dose – Residual = 6.0 – 0.3 = 5.7 mg/L. Above this dose, additional chlorine produces free residual.

96. B — Four-point calibration spanning the full measurement range (0.1 to 800 NTU) with all readings within ±2% demonstrates acceptable accuracy across the entire range. The 3.2 NTU measurement falls between two calibration points (0.1 and 20 NTU), confirming the meter is calibrated in the relevant range. The reading is reliable.

97. D — Drying at 180°C instead of the standard 103–105°C may volatilize or thermally decompose organic compounds from the captured solids. These compounds would be driven off as vapor, reducing the weight of the residue on the filter. The reported TSS would be falsely low because the organic fraction has been partially destroyed rather than preserved.

98. C — Higher incubation temperature accelerates bacterial metabolism. At 23°C instead of 20°C, the seed organisms decompose the organic matter faster, consuming more dissolved oxygen during the 5-day period. The reported BOD_5 would be higher than the true 20°C value. The ±1°C tolerance means the acceptable range is 19–21°C — 23°C is clearly outside this range.

99. A — Standard Methods requires drying to constant weight — meaning the sample is dried, weighed, dried again, and reweighed until consecutive weights agree within 0.5 mg (or 4% of the previous weight, depending on the method). The 0.2 mg difference between the first and second weighing (3.0 mg vs. 2.8 mg) indicates the sample had not reached constant weight after the first drying. The second weight (2.8 mg) is closer to constant weight and should be used: TSS = 2.8 ÷ 0.500 L = 5.6 mg/L.

100. B — A method blank showing 0.3 mg/L ammonia indicates contamination in the analytical system — from dirty glassware, contaminated reagent water, ammonia in the laboratory atmosphere (from cleaning products or nearby chemical storage), or degraded reagents. This contamination biases all sample results high by approximately 0.3 mg/L. The source must be identified and eliminated before reliable results can be produced.