PRACTICE EXAM 6: WATER TREATMENT OPERATOR CLASS I SIMULATION (100 QUESTIONS)

1. A treatment plant treats surface water from a reservoir that stratifies thermally during summer. In late October, the reservoir undergoes fall turnover. During the two weeks following turnover, the operator should anticipate all of the following raw water quality changes EXCEPT:

A. Increased dissolved manganese from mixing of oxygen-depleted bottom water with the surface

B. Elevated taste and odor compounds from hydrogen sulfide and organic decomposition products

C. Temporary increase in raw water color from dissolved organic matter released from the sediments

D. Significantly reduced turbidity because turnover homogenizes the reservoir and allows all particles to settle

2. A treatment plant feeds alum at 35 mg/L. The plant flow is 2.5 MGD. The operator needs to calculate the daily alum consumption in pounds. The correct calculation is:

A. 35 × 2.5 = 87.5 lb/day, using a simplified dose-times-flow formula for quick estimates

B. 35 × 2.5 × 7.48 = 653.5 lb/day, using the volume conversion factor for cubic feet to gallons

C. 35 × 2.5 × 8.34 = 729.8 lb/day, using the standard pounds formula for water treatment chemicals

D. 35 + 2.5 × 8.34 = 55.9 lb/day, using the additive formula for combined chemical and flow rates

3. An operator at a groundwater treatment plant discovers that the well's production capacity has declined by 30% over the past two years while the pumping rate has remained the same — the drawdown has increased from 40 feet to 57 feet. Before deciding on rehabilitation, the operator should first:

A. Obtain a downhole video inspection to identify the specific cause of the declining performance

B. Increase the pumping rate to compensate for the reduced yield and maintain plant production

C. Abandon the well immediately and begin drilling a replacement at a new location nearby

D. Reduce the pumping rate to zero for six months to allow the aquifer to fully recover naturally

4. A treatment plant's four parallel filters normally operate at 3.0 gpm/ft², each with a surface area of 250 ft². The plant flow is 3,000 gpm. If Filter 3 is taken offline for emergency maintenance, what is the filtration rate on each of the remaining three filters?

A. 4.0 gpm/ft², which exceeds the normal rate and may shorten filter runs and reduce effluent quality

B. 3.0 gpm/ft², because the remaining filters automatically reduce the plant flow to maintain the normal rate

C. 2.25 gpm/ft², because the total filter area decreases and the rate drops proportionally

D. 6.0 gpm/ft², because the full plant flow is divided among only two of the remaining three filters

5. An operator performing lockout/tagout on a chemical metering pump discovers that the pump is connected to both an electrical power supply and a pneumatic air supply that powers the stroke mechanism. The operator locks out the electrical disconnect but forgets to isolate the pneumatic supply. This omission is dangerous because:

A. The electrical lockout is sufficient because pneumatic systems cannot store energy after the air supply is shut off

B. The pump's programming may be erased if the pneumatic supply is disconnected while the power is locked out

C. The pneumatic system will eventually depressurize naturally within a few minutes of the electrical lockout

D. Residual air pressure could cause the pump to stroke unexpectedly even with the electrical power locked out

6. A treatment plant operator measures the following chlorine residuals: plant effluent free chlorine = 1.4 mg/L, plant effluent total chlorine = 1.4 mg/L. At a distribution system monitoring point five miles from the plant, the free chlorine = 0.3 mg/L and the total chlorine = 0.9 mg/L. The combined chlorine at the distribution point is:

A. 0.3 mg/L, which is the free chlorine reading at the monitoring point

B. 0.6 mg/L, indicating that some of the original free chlorine has converted to chloramines in the distribution system

C. 0.9 mg/L, which represents the total of all chlorine species at the monitoring location

D. 1.4 mg/L, because combined chlorine equals the original plant effluent total chlorine value

7. A treatment plant's source water assessment identifies that the primary reservoir watershed includes 35% agricultural land, 20% residential development, 40% forested land, and 5% industrial use. The forested portion of the watershed contributes to source water protection primarily because:

A. Forests consume all incoming rainfall through evapotranspiration, preventing any water from reaching the reservoir

B. Forests produce natural disinfectants that kill pathogens in the runoff before it enters the reservoir

C. Forested land filters runoff, reduces erosion, minimizes nutrient and pesticide loading, and produces the least contaminated runoff

D. Forest soils are impermeable and prevent all rainfall from infiltrating, directing it instead to engineered stormwater systems

8. A treatment plant uses membrane filtration (ultrafiltration) as its primary particle removal process. The membrane system receives credit for Giardia and Cryptosporidium removal without chemical pretreatment. This is possible because:

A. UF membranes chemically destroy pathogens through contact with the membrane material

B. UF membranes produce a disinfectant residual that inactivates pathogens as they pass through

C. The membrane pore size determines removal and must be verified through regular cleaning cycles

D. UF membrane pores are physically smaller than the pathogens, providing an absolute size-exclusion barrier when membrane integrity is maintained

9. A treatment plant operator is reviewing the results of lead and copper monitoring. The 90th percentile lead level is 0.018 mg/L, exceeding the action level of 0.015 mg/L. Under the Lead and Copper Rule, the system must now:

A. Immediately shut down the treatment plant until lead levels return to below the action level

B. Optimize corrosion control treatment, begin public education, and evaluate the need for lead service line replacement

C. Issue Tier 1 public notification within 24 hours and provide bottled water to all affected consumers

D. Install point-of-use filters at every consumer tap to physically remove the lead before consumption

10. A jar test produces the following results at a fixed alum dose of 30 mg/L across six different pH values. pH 5.5: turbidity 3.2 NTU. pH 6.0: turbidity 1.1 NTU. pH 6.5: turbidity 0.6 NTU. pH 7.0: turbidity 0.8 NTU. pH 7.5: turbidity 1.9 NTU. pH 8.0: turbidity 4.5 NTU. The optimal coagulation pH for this water at 30 mg/L alum is:

A. 6.5, which produces the lowest settled water turbidity and represents the most effective coagulation conditions for this water

B. 5.5, because the lowest pH always produces the best coagulation with aluminum-based coagulants

C. 8.0, because higher pH values improve the sweep floc mechanism that dominates at elevated coagulant doses

D. 7.5, because the EPA recommends a finished water pH between 6.5 and 8.5 for all treatment processes

11. A treatment plant uses a belt filter press for sludge dewatering. The operator notices that the cake is peeling off the belt unevenly — thick on one side and thin on the other. The most likely mechanical cause is:

A. The polymer dose is too high, causing the sludge to bond to the belt instead of releasing cleanly

B. The press feed rate is too high, overwhelming the belt's capacity to evenly distribute the incoming sludge

C. The belt is tracking off-center (misaligned), causing uneven pressure distribution and inconsistent dewatering across the belt width

D. The sludge concentration is too low, and dilute sludge always produces uneven cake regardless of belt condition

12. A treatment plant operator discovers that the plant's emergency eyewash station in the chlorine room has not been flushed in over three months. ANSI Z358.1 recommends weekly activation of plumbed eyewash stations. The primary reason for weekly flushing is to:

A. Verify that the station's chemical neutralization cartridge has not expired or been depleted

B. Prevent stagnant water and microbial growth in the supply line, ensuring clean water is available during an actual emergency

C. Calibrate the water temperature sensor to ensure the station delivers water within the required tepid range

D. Test the structural integrity of the mounting bracket and verify the station has not been physically damaged

13. A treatment plant's finished water has a free chlorine residual of 0.9 mg/L at pH 7.0. The operator raises the finished water pH to 8.0 for improved corrosion control. If the chlorine dose is not changed, the operator should understand that:

A. The total chlorine residual will increase because higher pH stabilizes chlorine in all its forms

B. The disinfection efficiency may appear unchanged on paper, but the CT tables will require a higher CT at pH 8.0

C. The chlorine residual will drop to zero because chlorine cannot exist above pH 7.5 in any form

D. The disinfection efficiency will improve because higher pH converts more chlorine to the stronger HOCl form

14. A treatment plant treats 6.0 MGD from a river source. The plant's raw water intake is equipped with a traveling screen to remove debris. During spring, the operator notices increased debris loading that is overwhelming the screen cleaning cycle. The most appropriate response is:

A. Increase the screen cleaning frequency and inspect for damage to prevent debris from entering the treatment process

B. Remove the traveling screen entirely and allow debris to pass through to the rapid mix chamber

C. Reduce the plant intake flow to decrease the volume of debris drawn into the intake structure

D. Add a coagulant to the raw water before the screen to bind the debris together for easier removal

15. An operator performs a total alkalinity titration on a water sample using 0.02N sulfuric acid. The sample volume is 100 mL and the titrant volume to reach pH 4.5 is 12.0 mL. Using the formula: Alkalinity = (mL acid × N × 50,000) ÷ mL sample, the alkalinity is:

A. 24 mg/L as $CaCO_3$

B. 60 mg/L as $CaCO_3$

C. 120 mg/L as $CaCO_3$

D. 240 mg/L as $CaCO_3$

16. A water treatment plant has installed a new SCADA system. During the first week of operation, operators notice that the automated coagulant feed control is overfeeding alum when the raw water turbidity drops below 5 NTU but performs correctly above 5 NTU. The most likely cause is:

A. The raw water turbidity instrument loses accuracy below 5 NTU due to its calibration range limitations

B. The PLC control program has a logic error in the low-turbidity operating range that calculates an incorrect feed rate

C. Alum automatically increases its chemical activity at low turbidity, requiring the SCADA to feed more chemical

D. The magnetic flow meter signal reverses polarity at low flow rates, causing the flow-proportional calculation to double

17. An operator monitoring filter performance observes that Filter 1's effluent turbidity spikes briefly every time the neighboring Filter 2 begins its backwash cycle. This hydraulic disturbance occurs because:

A. Filter 2's backwash water is contaminating Filter 1's effluent line through a cross-connection

B. The sudden opening of Filter 2's backwash valve creates a chemical reaction that passes through the filter walls

C. The laboratory turbidimeter is affected by vibration from the backwash pump starting nearby

D. The sudden flow change when Filter 2 goes offline redistributes flow to the remaining filters, including Filter 1, causing a hydraulic surge

18. A treatment plant uses calcium hypochlorite tablets in an erosion feeder for disinfection. The operator notices that the chlorine residual has gradually decreased over the past month even though tablets are being consumed at the normal rate. The tablets are stored in an outdoor shed. The most likely cause is:

A. The tablets have degraded from heat and moisture exposure in the outdoor shed, reducing their available chlorine content

B. The plant's raw water quality has improved, naturally reducing the chlorine demand of the treated water

C. The erosion feeder contact time has increased, allowing more chlorine to dissipate before reaching the process

D. Calcium hypochlorite tablets cannot degrade under any storage conditions because they are a solid chemical

19. An operator reviewing SCADA historical trends notices that the plant's clearwell level follows a predictable 24-hour cycle: highest level at approximately 4 AM and lowest level at approximately 6 PM. This pattern reflects:

A. A daily cycle of the plant's raw water pump turning on at night and off during the day

B. Diurnal variations in source water quality that cause the treatment rate to fluctuate

C. The daily demand cycle of the community — low demand overnight allows the clearwell to fill, high demand during the day draws it down

D. SCADA data compression artifacts that create artificial patterns in historical trend displays

20. A confined space rescue team is called when an entrant in a drained filter cell becomes unresponsive. The attendant outside the hatch reports that the entrant's personal gas monitor was alarming for low oxygen when communication was lost. The rescue team's first action upon arrival should be:

A. Enter the filter cell immediately wearing dust masks to reach the entrant as quickly as possible

B. Lower food and water to the entrant through the hatch while waiting for the fire department

C. Send the attendant into the space because they are already familiar with the entry and conditions

D. Don SCBA, verify their own atmospheric monitoring equipment, assess the situation, and execute a rescue entry following their established confined space rescue protocol

21. A treatment plant operator is responsible for maintaining the chemical inventory. The plant uses liquid alum (48% concentration, specific gravity 1.33) and the current tank level indicates 3,500 gallons

remaining. The plant consumes approximately 400 gallons per day. The operator should place a reorder when:

A. The tank reaches 50% capacity to ensure an adequate reserve for delivery delays

B. There is enough inventory remaining to cover the lead time for delivery plus a safety margin for potential delays

C. The tank is completely empty, because just-in-time ordering minimizes storage costs and chemical degradation

D. The chemical supplier contacts the plant to suggest a delivery based on their records of previous orders

22. A water system's monthly operating report must be signed by a responsible official certifying the accuracy of the data. If the report contains an error that is discovered after submission, the operator should:

A. Submit a corrected report to the primacy agency with a cover letter explaining the error and the correction

B. Take no action because once a report is submitted it becomes a permanent legal record that cannot be modified

C. Submit an entirely new report for the month without referencing the original to avoid drawing attention

D. Wait until the annual report to include a correction, since monthly report errors are only reviewed annually

23. A treatment plant's coagulation process is optimized for alum at pH 6.5. The operator adds lime after filtration to raise the finished water pH to 7.8 for corrosion control. A new operator asks why the plant doesn't simply coagulate at pH 7.8 to avoid the cost of post-filtration pH adjustment. The best explanation is:

A. Federal regulations prohibit coagulation at pH values above 7.0 for any aluminum-based coagulant

B. Lime cannot be added before filtration because it would damage the filter media within hours

C. Alum coagulation at pH 7.8 would produce significantly poorer floc and higher settled water turbidity than at pH 6.5

D. Coagulating at pH 7.8 would eliminate all disinfection byproducts from forming during chlorination

24. An operator at a surface water plant performs weekly raw water testing and observes the following trend over four weeks: Week 1 TOC = 3.2 mg/L, Week 2 TOC = 3.5 mg/L, Week 3 TOC = 4.8 mg/L, Week 4 TOC = 5.1 mg/L. This rising TOC trend should concern the operator because:

A. Higher TOC will reduce the effectiveness of UV disinfection by absorbing UV light in the reactor

B. The increasing TOC indicates the turbidity will exceed 1.0 NTU within the next week

C. Rising TOC levels always indicate a sewage discharge into the source water upstream of the intake

D. Higher TOC increases the potential for DBP formation when the water is chlorinated, potentially threatening THM and HAA compliance

25. A water treatment plant is evaluating two options for a new raw water pump. Option A is a horizontal split-case centrifugal pump. Option B is a vertical turbine pump. The raw water source is a deep well with a static water level 120 feet below ground surface. Which pump type is most appropriate?

A. Option A, because horizontal split-case pumps are always more efficient than vertical turbine pumps

B. Option B, because vertical turbine pumps are designed for deep well applications where the water level is far below the pump motor

C. Either option is equally appropriate because the water source does not affect pump selection

D. Neither option is appropriate — only submersible pumps can be used in wells deeper than 50 feet

26. An operator measures the free chlorine residual at the clearwell outlet at 1.2 mg/L. The clearwell has a volume of 600,000 gallons, the plant treats 4.0 MGD (2,778 gpm), and the clearwell has superior baffling (factor = 0.7). The CT achieved is:

A. 181 mg·min/L

B. 259 mg·min/L

C. 108 mg·min/L

D. 362 mg·min/L

27. A treatment plant using chloramination discovers that the chlorine-to-ammonia nitrogen ratio has drifted from the target 4:1 to 6:1 due to a gradual decrease in ammonia feed. At a 6:1 ratio, the operator should be concerned about:

A. Excessive free ammonia promoting nitrification throughout the distribution system piping network

B. Higher than normal monochloramine residual that may cause taste complaints from sensitive consumers

C. The formation of trichloramine, which is not a concern at this ratio because it forms only at ratios above 10:1

D. Breakpoint chlorination occurring, where chloramines are being destroyed and free chlorine is forming

28. A treatment plant operator receives a laboratory report showing that the finished water arsenic level is 0.009 mg/L. The arsenic MCL is 0.010 mg/L. Which statement is most accurate?

A. The result requires Tier 2 public notification because arsenic at any detectable level is considered a violation

B. The system has no compliance concern because the result is zero — any reading below the MCL rounds to zero

C. The result is below the MCL but close enough to warrant continued careful monitoring and attention to treatment optimization

D. The system must install reverse osmosis treatment to reduce arsenic to non-detectable levels within 90 days

29. An operator is investigating the cause of accelerated corrosion in a section of the distribution system with recently replaced ductile iron pipe. The new pipe section was installed six months ago. Water quality data shows the finished water has an LSI of +0.2 (slightly scaling), which should provide some corrosion protection. The most likely explanation for the localized corrosion is:

A. The LSI calculation is always inaccurate for ductile iron pipe and should not be used for this material

B. The new pipe has not yet developed a protective internal scale layer, leaving it more vulnerable to corrosion than aged pipes with established coatings

C. The positive LSI is actually causing the corrosion because scaling water is more aggressive than corrosive water

D. Ductile iron pipe is immune to internal corrosion and the observed damage must be from external soil conditions

30. A treatment plant's air compressor system supplies instrument air to pneumatic valve actuators, air scour systems, and laboratory pneumatic equipment. The compressed air dryer has failed, and the operator notices moisture droplets forming in the instrument air supply lines. The most critical concern is:

A. The moisture will contaminate the laboratory samples by introducing water vapor through the pneumatic equipment

B. The laboratory pneumatic equipment may produce louder operating noise from the additional moisture

C. The compressed air tanks will overflow from the accumulated moisture and create a flooding hazard

D. Moisture in instrument air lines can cause pneumatic valve actuators to malfunction, freeze in cold weather, and corrode internal components

31. A treatment plant treats 3.0 MGD and maintains a chlorine dose of 2.5 mg/L using 12% sodium hypochlorite. The operator needs to calculate how many days the current inventory of 2,000 gallons of sodium hypochlorite will last. The solution has a specific gravity of 1.17. Using the standard calculation sequence, the daily solution consumption is approximately:

A. 64 gallons per day, meaning the 2,000-gallon inventory will last approximately 31 days

B. 128 gallons per day, meaning the inventory will last approximately 16 days

C. 32 gallons per day, meaning the inventory will last approximately 63 days

D. 250 gallons per day, meaning the inventory will last approximately 8 days

32. An operator at a treatment plant notices that the plant's three high-service pumps have been alternating lead pump duty on a weekly basis — Pump 1 runs as the lead pump for one week, then Pump 2, then Pump 3. The purpose of this pump alternation schedule is to:

A. Prevent the formation of mineral scale inside the pump casing by varying the flow patterns weekly

B. Allow each pump's motor to cool completely during the off-weeks to prevent thermal buildup

C. Equalize the operating hours and wear across all three pumps, extending the service life of each unit

D. Ensure that the electrical demand charges from the utility company are distributed evenly across phases

33. A treatment plant operator opens a valve to drain a filter cell for media inspection. As the water level drops below the top of the media, the operator notices several round, dark masses the size of golf balls sitting on the media surface. These masses are most likely:

A. Biological organisms that grew on the filter surface during the production run and should be collected for laboratory identification

B. Mudballs — compacted masses of filter media, biological growth, and trapped particles formed by inadequate backwashing

C. Fragments of the underdrain system that have broken loose and migrated upward through the media bed

D. Coagulant floc that accumulated on the filter surface and solidified because the water temperature dropped below freezing

34. A treatment plant's SCADA system displays the following alarm at 3:15 AM: "HIGH-SERVICE PUMP #2 — HIGH MOTOR TEMPERATURE ALARM." The operator checks the SCADA screen and observes that Pump 2's motor temperature is 15°F above the high alarm setpoint, the motor amperage is 20% above nameplate FLA, and the pump discharge pressure is lower than normal. The most likely diagnosis is:

A. The motor's cooling fan has failed, causing the motor to overheat despite operating within normal mechanical load

B. The SCADA temperature transmitter has drifted and is producing a falsely elevated reading

C. The motor is operating normally and the alarm setpoint needs to be raised to match the current conditions

D. The pump is mechanically overloaded — a seized bearing, bound impeller, or other internal restriction is causing the motor to draw excessive current and overheat

35. A water treatment operator needs to convert a manganese concentration from mg/L to µg/L. The laboratory report shows dissolved manganese at 0.035 mg/L. The equivalent concentration in µg/L is:

A. 35 µg/L, because 1 mg/L equals 1,000 µg/L and 0.035 × 1,000 = 35

B. 0.000035 µg/L, because converting to smaller units requires dividing by 1,000

C. 3,500 µg/L, because converting between concentration units requires multiplying by 100,000

D. 3.5 µg/L, because 1 mg/L equals 100 µg/L and 0.035 × 100 = 3.5

36. A treatment plant has been using the same lot of formazin turbidity calibration standards for seven months. The standards were prepared fresh at the beginning of the year with a stated shelf life of six months. The operator should:

A. Continue using the standards because the difference between six and seven months is negligible

B. Immediately recalibrate all turbidimeters using the expired standards before replacing them

C. Replace the expired standards with a freshly prepared or newly purchased lot and recalibrate all turbidimeters

D. Dilute the expired standards with deionized water to restore them to their original concentration

37. A treatment plant uses chlorine gas for disinfection. The operator's shift begins at 7:00 AM. Upon entering the chlorine room for a routine check, the operator notices that the exhaust ventilation fan is not running. There is no detectable chlorine odor. The correct action is:

A. Proceed with the routine check because the absence of chlorine odor confirms the room is safe

B. Leave the room, check the fan circuit breaker or motor starter, restore ventilation, and investigate why the fan stopped

C. Open the chlorine room door to provide natural ventilation and continue the routine inspection

D. Activate the chlorine gas feed system to verify that the ventilation fan starts automatically when gas is present

38. A treatment plant operator performing a routine distribution system flushing program opens a hydrant and observes that the initial flow is dark brown with visible sediment. After two minutes, the water clears to a slight yellow tint. After five minutes, the water runs clear. This sequence indicates:

A. A break in the distribution main upstream of the hydrant that is admitting contaminated groundwater

B. Normal disturbance of accumulated sediment and iron deposits inside the distribution main during the initial high-velocity flush

C. A cross-connection between the potable system and a nearby sanitary sewer at the hydrant location

D. Proof that the treatment plant's filtration system is failing and allowing turbidity to pass into the distribution system

39. A water treatment plant needs to determine the volume of a sedimentation basin for detention time calculation. The basin is 100 feet long, 25 feet wide, and has a water depth of 14 feet. The volume in gallons is (1 ft^3 = 7.48 gallons):

A. 261,800 gallons

B. 35,000 gallons

C. 52,360 gallons

D. 523,600 gallons

40. A treatment plant has four filters, each with a surface area of 200 ft^2. The plant flow is 2,400 gpm distributed equally among all four filters. The filtration rate per filter is:

A. 12.0 gpm/ft^2, which is dangerously above the typical design range for rapid gravity filters

B. 6.0 gpm/ft^2, which is at the upper end of the typical design range for rapid gravity filters

C. 3.0 gpm/ft^2, which is within the normal operating range for rapid gravity filters

D. 1.5 gpm/ft^2, which is below the minimum effective rate for rapid gravity filtration

41. A treatment plant's SCADA alarm log shows that an alarm for "LOW CLEARWELL LEVEL" has been activating and clearing repeatedly throughout the day — activating when the level drops to 8.0 feet and clearing when it rises to 8.5 feet. The alarm setpoint is 8.0 feet. This oscillating alarm pattern is called:

A. A priority escalation alarm that automatically increases in severity with each successive activation

B. A latched alarm that remains active until the operator manually acknowledges and resets it

C. A cascading alarm that triggers additional alarms on related equipment throughout the plant

D. A chattering alarm caused by the process value hovering near the alarm setpoint, which should be corrected with a deadband

42. An operator is performing predictive maintenance using vibration analysis on a centrifugal pump. The vibration spectrum shows a dominant peak at exactly 1× the pump's running speed (1,770 RPM). This vibration pattern is most commonly associated with:

A. Cavitation caused by insufficient suction pressure at the pump impeller inlet

B. Imbalance in the rotating assembly — either the impeller or the motor rotor

C. A defective bearing in the early stages of inner race deterioration

D. Electrical interference from the VFD creating harmonics in the vibration measurement

43. A water system using surface water has been notified by the state primacy agency that it must begin monitoring for unregulated contaminants under the EPA's Unregulated Contaminant Monitoring Rule (UCMR). The purpose of UCMR monitoring is to:

A. Collect occurrence data on contaminants that are not currently regulated to support future regulatory decisions by the EPA

B. Establish enforceable MCLs for all detected contaminants within 90 days of the first positive result

C. Identify which treatment processes the plant must add to address each unregulated contaminant detected

D. Replace the existing regulated contaminant monitoring requirements with a simplified single-sample program

44. A treatment plant's finished water has the following characteristics: pH 7.2, alkalinity 40 mg/L as $CaCO_3$, calcium hardness 50 mg/L as $CaCO_3$, TDS 180 mg/L, temperature 15°C. An operator calculating the Langelier Saturation Index produces a value of −1.4. To move the LSI toward zero for better corrosion control, the operator should:

A. Decrease the chlorine dose to reduce the oxidative potential of the finished water

B. Reduce the finished water pH to make the water less saturated with calcium carbonate

C. Increase the pH and alkalinity by adding lime or soda ash after filtration to raise calcium carbonate saturation

D. Increase the plant flow rate to reduce the detention time and thereby reduce the water's corrosion potential

45. A treatment plant operator observes that the sludge being withdrawn from the sedimentation basin has a noticeably stronger than normal hydrogen sulfide odor. This odor indicates:

A. The coagulant chemical has been contaminated with sulfur compounds from the supplier

B. The sludge removal rate is too high, drawing fresh floc from the basin before it has time to settle

C. Normal sludge characteristics because all water treatment sludge produces hydrogen sulfide gas

D. Septic conditions in the sludge blanket from anaerobic decomposition, indicating the sludge has been accumulating too long

46. A treatment plant operator is training a new employee on the DPD chlorine residual test. The trainee measures total chlorine first, then free chlorine on the same sample. The trainer should correct the trainee because:

A. Total chlorine cannot be measured on the same sample as free chlorine under any test sequence

B. Free chlorine must be measured first because once KI is added for total chlorine, it cannot be reversed to measure free chlorine

C. DPD testing requires two completely separate sample bottles collected at different times for valid results

D. The total chlorine reading is always higher than the free chlorine, making the sequence irrelevant to accuracy

47. A treatment plant's four sedimentation basins are identical in size and normally receive equal flow. The operator notices that Basin 4's effluent consistently has turbidity 1.0 NTU higher than the other three basins. Investigation reveals that the inlet baffle in Basin 4 has a large hole near the bottom. This damage is causing:

A. Short-circuiting, where a portion of the incoming water flows directly through the hole and reaches the outlet weirs before adequate settling can occur

B. Excessive sludge buildup because the damaged baffle is trapping more solids than an intact baffle would

C. Improved settling performance in the zone immediately behind the damaged baffle due to increased velocity

D. Reverse flow through the basin that moves water from the outlet back toward the inlet through the hole

48. A water system treating groundwater from a limestone aquifer has consistently high hardness (280 mg/L as $CaCO_3$) and high alkalinity (240 mg/L as $CaCO_3$). The non-carbonate hardness of this water is:

A. 280 mg/L because all hardness in groundwater from limestone is non-carbonate by definition

B. 0 mg/L because the hardness does not exceed the alkalinity — all hardness is carbonate hardness

C. 40 mg/L calculated as the total hardness minus the alkalinity

D. 520 mg/L calculated as the sum of hardness and alkalinity

49. An operator discovers that a sodium hypochlorite storage tank has a small crack near the bottom that is slowly leaking chemical into the secondary containment. The containment is intact and holding the leaked material. The operator should:

A. Ignore the leak until the tank is empty, then repair the crack and refill with fresh chemical

B. Increase the chemical feed rate to empty the tank faster before the crack worsens

C. Stop the leak if possible, transfer the remaining chemical to a backup tank, repair or replace the damaged tank, and clean the containment area

D. Drain the containment area into the plant's raw water supply to prevent waste of the chemical

50. An operator measures a well's static water level at 28 feet below the top of the casing. When the pump operates at 450 gpm, the pumping water level stabilizes at 52 feet below the casing. The well's specific capacity is:

A. 52 gpm/ft

B. 18.75 gpm/ft

C. 0.053 ft/gpm

D. 28 gpm/ft

51. A treatment plant using conventional treatment experiences a sudden raw water turbidity spike from 12 NTU to 85 NTU following a heavy rainstorm. The operator increases the alum dose from 30 mg/L to 65 mg/L based on a quick jar test. Two hours later, the settled water turbidity is still elevated at 4.0 NTU. The operator should next check:

A. Whether the pH has dropped below the effective coagulation range due to the higher alum dose consuming the available alkalinity

B. Whether the sedimentation basin overflow rate has increased because stormwater infiltration is adding volume to the plant flow

C. Whether the filter effluent turbidity has increased, indicating the filters can compensate for the sedimentation performance

D. Whether the source water has returned to normal, which would indicate the jar test dose is now too high

52. An operator is calibrating the plant effluent online chlorine analyzer. The analyzer displays 1.8 mg/L. A simultaneously collected DPD grab sample measures 1.5 mg/L. After adjusting the analyzer to read 1.5 mg/L, the operator should:

A. Discard the pre-calibration reading because only the corrected value matters for future reference

B. Notify the state primacy agency that all chlorine data since the last calibration is invalid

C. Adjust the plant's chlorine feed rate downward by 0.3 mg/L to match the corrected analyzer reading

D. Record both the pre-calibration (1.8) and post-calibration (1.5) readings in the calibration log for drift tracking

53. A water treatment plant receives a complaint from a customer whose ice cubes are turning white and opaque rather than remaining clear. The water at the customer's tap tests normal for all parameters. The white ice cubes are most likely caused by:

A. Elevated lead levels from the customer's plumbing that precipitate when the water freezes

B. Excessive chlorine residual that crystallizes into white solids during the freezing process

C. Dissolved air and minerals in the water that become trapped as the water freezes from the outside in

D. Bacterial contamination that produces a white biofilm on the ice surface during the freezing cycle

54. A treatment plant treats 2.0 MGD and needs to feed powdered activated carbon (PAC) at 8 mg/L during a taste and odor event. How many pounds of PAC are needed per day?

A. 16.7 lb/day

B. 133.4 lb/day

C. 66.7 lb/day

D. 200.1 lb/day

55. The EPA's Stage 2 Disinfectants and Disinfection Byproducts Rule differs from the Stage 1 rule primarily in that Stage 2:

A. Requires compliance at each individual distribution system monitoring location using the LRAA, rather than allowing the system-wide average to mask high individual locations

B. Eliminates the MCL for total trihalomethanes and regulates only haloacetic acids

C. Applies only to groundwater systems and exempts all surface water systems from DBP monitoring

D. Doubles the MCL for both THMs and HAAs, effectively relaxing the compliance requirements

56. A treatment plant operator notices that the streaming current monitor reading has shifted from its setpoint of +0.5 to +3.5 over the past hour. This indicates that the coagulant dose may be:

A. Insufficient, leaving particles with excess negative charge that prevents effective destabilization

B. Perfectly optimized, because any positive streaming current value indicates adequate charge neutralization

C. Excessive, causing charge reversal where particles are now carrying a net positive charge instead of neutral

D. Unrelated to the streaming current reading because coagulant dose does not affect particle charge

57. A treatment plant operator is reviewing the plant's compliance history and finds that the plant has never received a sanitary survey from the state primacy agency, despite being in operation for eight years. Under SDWA requirements, state primacy agencies must conduct sanitary surveys of community water systems:

A. Only when a complaint is filed by a customer or a violation is detected during routine monitoring

B. Every 10 years for systems with a clean compliance history and no documented deficiencies

C. Only once — during the initial startup and commissioning of the treatment facility

D. At least every three years for systems without an outstanding performance record, and every five years for those with outstanding performance

58. A treatment plant's online turbidimeter on the combined filter effluent suddenly jumps from 0.04 NTU to 1.2 NTU for a single 15-minute reading, then returns to 0.04 NTU for all subsequent readings. Individual filter turbidities all remain below 0.06 NTU throughout the event. The most likely explanation is:

A. A genuine but very brief turbidity event that passed through all filters simultaneously in under 15 minutes

B. An instrument artifact — likely an air bubble, sample line disturbance, or electrical interference — rather than a real turbidity event

C. A momentary failure of the disinfection system that allowed pathogens to pass through the filters and register as turbidity

D. Evidence that the combined effluent pipe has a crack allowing unfiltered water to enter intermittently

59. A treatment plant's chemical storage room contains the following chemicals: ferric chloride, sodium hypochlorite, sodium hydroxide (caustic soda), and hydrofluorosilicic acid. Which two chemicals present the greatest risk if accidentally mixed or stored in adjacent containment without separation?

A. Sodium hypochlorite and hydrofluorosilicic acid, because mixing a hypochlorite solution with an acid produces chlorine gas

B. Ferric chloride and sodium hydroxide, because mixing an acid with a base produces a violent exothermic reaction

C. Sodium hypochlorite and caustic soda, because both are strong bases that amplify each other's corrosive properties

D. Ferric chloride and hydrofluorosilicic acid, because mixing two acids produces a supercritical compound

60. A treatment plant experiences a power outage. The standby generator starts automatically and the ATS transfers plant loads to the generator. Thirty minutes later, utility power is restored. The ATS transfers the plant back to utility power and the generator begins its cool-down cycle. During the cool-down, the operator should:

A. Immediately shut down the generator to conserve fuel for the next potential outage event

B. Disconnect the generator from all electrical systems before the cool-down cycle to prevent backfeed

C. Allow the generator to complete its programmed cool-down cycle before it shuts down, as recommended by the manufacturer

D. Transfer the plant loads back to the generator during cool-down to verify the ATS retransfer function

61. A treatment plant using conventional treatment processes a raw water with seasonal algae blooms that cause filter clogging and taste and odor complaints. The plant does not currently have PAC or ozone capability. The operator has requested capital funding for a treatment improvement. From a cost-effectiveness standpoint, which addition would address both the filter clogging and the taste and odor issues?

A. Granular activated carbon filter caps, which reduce taste and odor but would not help with filter clogging

B. Additional sedimentation capacity, which reduces filter loading but does not address taste and odor compounds

C. UV disinfection, which inactivates algae but does not remove the taste and odor compounds they produce

D. A dissolved air flotation system ahead of filtration, which effectively removes algae (reducing filter loading) and can be paired with PAC addition for taste and odor control

62. An operator performing a hardness titration on a distribution system sample obtains a result of 0 mg/L — no EDTA was consumed and the indicator did not change color at all. The most likely explanation is:

A. The sample was incorrectly buffered, and the test must be repeated with fresh buffer at the correct pH

B. The water is genuinely very soft with hardness below the method's detection limit

C. The EDTA titrant has expired and lost its reactivity with calcium and magnesium ions

D. Hardness can never be zero in any natural water, confirming that the sample was contaminated

63. A treatment plant is planning to increase its production from 4.0 MGD to 5.5 MGD by increasing the raw water pump speed. The plant's clearwell volume is 400,000 gallons with a baffling factor of 0.5. At the current flow, the T_{10} is 72 minutes. If the flow increases to 5.5 MGD, the new T_{10} will be approximately:

A. 52 minutes, which the operator must verify still provides adequate CT at the existing chlorine residual

B. 72 minutes, because T_{10} is determined only by the clearwell volume and baffling factor

C. 100 minutes, because higher flow increases the effective contact time through turbulent mixing

D. 36 minutes, because the baffling factor decreases proportionally when flow increases

64. An operator collecting bacteriological samples in the distribution system arrives at a sampling location and discovers that the designated tap has been removed during a building renovation. The operator should:

A. Skip this location for the current monitoring period and note the reason in the sampling log

B. Collect the sample from the nearest garden hose bib as an equivalent substitute location

C. Contact the supervisor to designate an alternative representative sampling location and collect the sample there

D. Collect the sample from the fire hydrant nearest to the original sampling location

65. A treatment plant's daily SCADA report shows that the plant produced 4.2 million gallons yesterday. The backwash water usage was 180,000 gallons. The chemical feed water and other internal uses totaled 20,000 gallons. The net water delivered to the distribution system was:

A. 4.2 million gallons because internal uses are not subtracted from the production total

B. 4.02 million gallons, calculated by subtracting only the chemical feed and internal uses

C. 3.82 million gallons, calculated by subtracting only the backwash water from total production

D. 4.0 million gallons, calculated by subtracting both backwash (180,000) and internal uses (20,000) from total production

66. A treatment plant uses ferric chloride as its primary coagulant. The operator notices that the ferric chloride bulk storage tank has developed a strong odor, the solution has changed from its normal dark brown color to a lighter amber, and the coagulation performance has declined significantly. The most likely cause is:

A. The ferric chloride has been contaminated — possibly diluted with water from a leaking roof, a faulty fill valve, or cross-connection during the last delivery

B. Normal aging of ferric chloride that occurs in all storage tanks after more than seven days of storage

C. The storage tank's internal coating has dissolved into the ferric chloride, neutralizing its coagulating properties

D. The tank temperature has dropped below freezing, causing the ferric chloride to partially crystallize

67. A treatment plant operator receives a complaint about milky or white water from a customer. The customer reports that the water clears from the bottom up after sitting in a glass for a few minutes. This pattern indicates:

A. A serious contamination event requiring immediate investigation and possible boil-water advisory

B. Dissolved air (entrained air or micro-bubbles) in the water that dissipates as the bubbles rise to the surface

C. Elevated calcium hardness precipitating out of solution as the water warms to room temperature

D. Bacterial contamination producing a white turbidity that settles as the organisms die in the glass

68. An operator is reviewing a monthly operating report and notices that the plant's average daily flow for the month was 3.5 MGD, but the peak daily flow was 5.2 MGD. The peak-to-average ratio is approximately 1.49. This ratio is important for plant operations because:

A. Ratios above 1.0 indicate the plant is violating its permitted capacity and must reduce production

B. The ratio determines the minimum number of operators that must be on duty during peak flow periods

C. The plant must be capable of treating the peak flow while maintaining regulatory compliance, not just the average flow

D. The ratio is used to calculate the monthly water bill charged to the distribution system customers

69. A treatment plant operator performing a weekly generator test notices that the generator's engine coolant level is significantly below the minimum mark on the expansion tank. No visible external leaks are present. The operator should:

A. Add water directly to the radiator while the engine is running at full operating temperature

B. Ignore the low level because coolant levels naturally decrease over time due to normal evaporation

C. Add distilled water or the manufacturer-recommended coolant mixture to the level indicated, only after the engine has cooled, and investigate the cause of the coolant loss

D. Refill the coolant system with the correct coolant type after allowing the engine to cool, and monitor for internal leaks or head gasket failure

70. A treatment plant's source water protection plan identifies a closed municipal landfill located one mile from the plant's primary production well. The landfill was closed 15 years ago and has a final cover. The primary contamination risk from this landfill is:

A. Leachate from the decomposing waste migrating through the groundwater toward the production well over time

B. Windblown debris from the closed landfill surface contaminating the wellhead through the air vent

C. Methane gas from the decomposing waste entering the well through the annular space above the water table

D. Rodents and insects from the landfill physically entering the well through cracks in the well cap

71. An operator at a treatment plant using chloramination performs a DPD total chlorine test and obtains a result of 3.2 mg/L. The DPD free chlorine test on the same sample produces a result of 0.1 mg/L. The monochloramine concentration is approximately:

A. 3.2 mg/L because the total chlorine reading represents the monochloramine concentration directly

B. 3.1 mg/L, calculated by subtracting the free chlorine from the total chlorine reading

C. 0.1 mg/L because the free chlorine fraction represents the only active disinfectant species

D. 3.3 mg/L, calculated by adding the free and total chlorine readings together

72. A treatment plant's four parallel filters have the following individual effluent turbidities: Filter 1 = 0.05 NTU, Filter 2 = 0.04 NTU, Filter 3 = 0.35 NTU, Filter 4 = 0.06 NTU. All four filters are operating at the same flow rate. The approximate combined filter effluent turbidity is:

A. 0.35 NTU, which is the highest individual filter reading and represents the worst-case compliance value

B. 0.05 NTU, which is the median of the four individual readings

C. Approximately 0.125 NTU, which is the average of the four individual filter effluent turbidities

D. 0.50 NTU, calculated by adding all four values together as the combined turbidity total

73. A treatment plant's emergency response plan specifies that the operator must issue a boil-water advisory when the combined filter effluent turbidity exceeds 1.0 NTU. During a plant upset, the CFE turbidity reaches 1.2 NTU for 45 minutes before the operator corrects the problem. In addition to correcting the treatment process, the operator must:

A. Wait 24 hours to see if any illness reports are received before deciding whether notification is necessary

B. Notify the supervisor only and document the event in the daily operations log as a process note

C. Report the event to the state primacy agency immediately and issue public notification as directed by the agency and the ERP

D. Issue the boil-water advisory, notify the state primacy agency, and follow the emergency response plan's procedures for this specific scenario

74. A treatment plant treats water from two wells — Well A producing 500 gpm with hardness of 200 mg/L as $CaCO_3$ and Well B producing 300 gpm with hardness of 350 mg/L as $CaCO_3$. When both wells operate simultaneously, the approximate blended hardness of the combined flow is:

A. 256 mg/L as $CaCO_3$, calculated as a flow-weighted average of the two well hardness values

B. 275 mg/L, which is the simple average of 200 and 350 regardless of the flow rates

C. 550 mg/L, which is the sum of both hardness values combined

D. 200 mg/L, which is the hardness of the dominant well producing the higher flow rate

75. An operator is reviewing the safety requirements for the plant's chemical storage areas. The operator identifies that the fluorosilicic acid tank does not have an emergency shower/eyewash station within 10 seconds of travel distance. This deficiency is a violation of:

A. The plant's fire prevention code requirements for Class III chemical storage areas

B. ANSI Z358.1 and OSHA requirements that emergency eyewash and shower facilities must be accessible within 10 seconds of areas where employees may be exposed to hazardous chemicals

C. The fluoride MCL regulation, which requires eyewash stations for all systems that add fluoride

D. The EPA's Risk Management Program, which applies only to facilities that store chlorine gas above threshold quantities

76. A treatment plant's filter backwash cycle uses the following sequence: surface wash for 3 minutes, combined air scour and low-rate water backwash for 4 minutes, high-rate water backwash for 8 minutes, and filter-to-waste for 15 minutes. The total time from beginning of backwash to filter return to production service is approximately:

A. 8 minutes, counting only the high-rate backwash phase

B. 15 minutes, counting only the filter-to-waste phase

C. 30 minutes, including all wash phases and filter-to-waste

D. 45 minutes, because each phase must be followed by a 15-minute rest period before the next begins

77. A treatment plant treats 5.0 MGD and adds fluoride to achieve a finished water concentration of 0.7 mg/L. The raw water contains naturally occurring fluoride at 0.2 mg/L. The amount of fluoride the plant must add (the supplemental dose) is:

A. 0.7 mg/L because the natural fluoride is insignificant and should not be subtracted from the target

B. 0.9 mg/L because the natural fluoride must be added to the target to determine the total needed

C. 0.2 mg/L because the plant only needs to add enough to match the natural background level

D. 0.5 mg/L because the plant must add the difference between the target (0.7) and the naturally occurring level (0.2)

78. A water treatment plant operator discovers that the plant's SDS binder contains a Safety Data Sheet for "Liquid Alum — 48% Solution" but the plant recently switched to "Liquid Alum — 50% Solution" from a different supplier. The operator should:

A. Obtain the SDS for the new 50% liquid alum product from the new supplier and add it to the binder, because different formulations may have different safety, handling, and first-aid information

B. Keep the existing SDS because all liquid alum products are chemically identical regardless of concentration

C. Remove the old SDS and operate without one until the new supplier provides the replacement document

D. Contact OSHA to request a generic SDS that covers all alum products from any manufacturer

79. An operator at a treatment plant using surface water notices that the raw water phosphorus concentration has increased significantly following heavy rainfall. The operator should anticipate:

A. Improved coagulation performance because phosphorus enhances the chemical activity of alum

B. Increased algae growth in the coming weeks as the elevated phosphorus feeds algae blooms in the reservoir

C. Decreased chlorine demand because phosphorus neutralizes organic matter before it reacts with chlorine

D. Reduced turbidity as the phosphorus settles out of the water and carries suspended particles with it

80. A treatment plant's finished water has been consistently compliant with all primary and secondary drinking water standards. However, customer complaint data shows a steady increase in complaints about "flat" or "stale" tasting water over the past year. The operator should investigate:

A. Whether the chlorine dose has been increased, which would cause water to taste more chemical

B. Whether the distribution system has experienced main breaks that introduced soil flavor compounds

C. Whether the dissolved oxygen content of the finished water has decreased, which can cause flat or stale taste perception

D. Whether the plant has changed coagulant suppliers, which always changes the taste of the finished water

81. A treatment plant's clearwell has a total volume of 800,000 gallons. The plant treats 6.0 MGD (4,167 gpm). The clearwell has average baffling (factor = 0.5). The operator needs to determine the T_{10} for CT calculations. The T_{10} is:

A. 192 minutes, calculated by dividing the volume by the flow rate to get theoretical DT, then applying the baffling factor

B. 384 minutes, representing the theoretical detention time without applying the baffling factor

C. 96 minutes, calculated by dividing the T_{10} by the baffling factor instead of multiplying

D. 96 minutes, calculated correctly as (800,000 ÷ 4,167) × 0.5

82. An operator at a treatment plant receives a laboratory report showing that the plant's quarterly HAA5 sample result is 0.072 mg/L. The HAA5 MCL is 0.060 mg/L on an LRAA basis. The previous three quarterly results at this location were 0.045, 0.052, and 0.048 mg/L. The LRAA at this location is:

A. 0.054 mg/L, which is below the MCL — no violation exists based on the current four-quarter running average

B. 0.072 mg/L, because compliance is based only on the most recent quarterly result

C. 0.060 mg/L exactly, which means the system is at the compliance boundary

D. 0.217 mg/L, calculated by summing all four results without dividing by the number of quarters

83. A treatment plant operator using sodium hypochlorite discovers that the chemical feed pump is delivering solution but the chlorine residual at the clearwell outlet has dropped to 0.1 mg/L from the normal 1.0 mg/L. The plant flow has not changed. The operator's most productive troubleshooting step is to:

A. Immediately increase the pump stroke rate to maximum output to restore the residual quickly

B. Check whether the sodium hypochlorite solution has degraded by testing its strength with a hydrometer or titration

C. Test the sodium hypochlorite solution strength and verify the pump is delivering the correct volume, because either degraded chemical or reduced pump output could explain the low residual

D. Replace the entire sodium hypochlorite inventory with a new delivery before investigating further

84. A treatment plant operator is writing an SOP for chlorine gas cylinder changeout. The SOP should include a step requiring the operator to verify that the new cylinder's valve is oriented correctly before connecting it to the chlorinator manifold. This verification is important because:

A. Chlorine gas cylinders have two valves — one for gas withdrawal and one for liquid withdrawal — and connecting the liquid valve to a gas system can cause liquid chlorine to enter the chlorinator

B. All chlorine cylinder valves are identical and orientation does not matter during installation

C. The cylinder valve thread direction alternates between clockwise and counterclockwise with each new cylinder

D. The cylinder color code indicates the valve orientation and the physical valve position is irrelevant

85. A water treatment plant experiences a sudden, unexplained increase in total coliform-positive results at multiple distribution system sampling locations during the same monitoring period. All previous months showed no positive results. The operator should:

A. Attribute the results to a temporary laboratory error and wait for the next month's monitoring to confirm

B. Retest the positive locations, investigate potential distribution system contamination sources, and perform a system-wide assessment

C. Assume that the results are false positives caused by warm weather and continue routine operations

D. Report the results to the state primacy agency, conduct a thorough distribution system assessment, collect repeat samples, and investigate potential causes including main breaks, cross-connections, and treatment upsets

86. An operator at a treatment plant using polyaluminum chloride (PACl) as the primary coagulant notices that jar test results are less consistent than usual — some jars produce excellent floc while

identical jars produce poor floc. The PACl was delivered two months ago and stored in an outdoor unheated shed. The most likely cause of the inconsistency is:

A. The PACl has gelled or partially solidified due to cold temperature exposure, causing the solution to be non-homogeneous

B. PACl always produces inconsistent results in jar tests because it is a less predictable coagulant than alum

C. The laboratory's jar test stirring speed is varying between tests due to a worn motor on the gang stirrer

D. The PACl has reacted with oxygen in the storage tank headspace, converting it to an entirely different chemical

87. A treatment plant operates a dissolved air flotation (DAF) system. The operator notices that the recycled pressurized water stream is producing large, visible air bubbles instead of the normally invisible micro-bubbles. This change in bubble size will:

A. Have no effect on flotation performance because bubble size is irrelevant to particle removal

B. Improve particle removal because larger bubbles have more lifting force than smaller bubbles

C. Reduce flotation effectiveness because large bubbles do not attach to floc particles as efficiently as micro-bubbles

D. Indicate that the raw water quality has improved and the DAF system can be operated at reduced capacity

88. A treatment plant operator is reviewing a manufacturer's pump curve for a new centrifugal pump being installed. The pump curve shows that at 1,200 gpm, the pump produces 100 feet of total dynamic head. The system curve intersects the pump curve at 1,000 gpm and 115 feet TDH. To increase the flow to 1,200 gpm, the operator should:

A. Install a larger motor to increase the pump speed and shift the operating point along the pump curve

B. Reduce the system resistance by opening valves, increasing pipe diameter, or reducing friction losses to shift the system curve to intersect at the desired flow

C. Close the discharge valve partially to increase the system head and force the pump to produce more flow

D. Reduce the pump impeller diameter to decrease the head produced and allow higher flow at lower pressure

89. A treatment plant's security inspection reveals that the fence surrounding the chemical storage yard has three sections where vegetation has grown through and lifted the fence fabric, creating gaps large enough for a person to pass through. The operator should:

A. Document the gaps during the annual security assessment and include them in next year's capital improvement request

B. Install security cameras pointed at each gap to monitor for unauthorized entry until repairs can be made

C. Close the gaps with temporary wire ties and schedule permanent fence repair at the next available opportunity

D. Repair the fence sections immediately, clear vegetation from the fence line, and implement a regular fence line maintenance schedule

90. An operator discovers that the treatment plant's chemical feed system has been feeding fluoride at 1.2 mg/L instead of the target 0.7 mg/L for approximately 48 hours due to a flow signal error. The fluoride MCL is 4.0 mg/L and the secondary standard is 2.0 mg/L. The operator should:

A. Correct the flow signal error immediately, verify the fluoride level returns to target, document the event, investigate how the error occurred, and assess whether notification is required

B. Issue Tier 1 public notification within 24 hours because any overfeed of fluoride is an acute violation

C. Take no action because 1.2 mg/L is below both the MCL and secondary standard

D. Shut down the plant until the fluoride concentration throughout the entire distribution system drops below 0.7 mg/L

91. A treatment plant's operator reviews SCADA data showing that the plant's total production for the month was 125 million gallons. The total metered water sales from the distribution system were 108 million gallons. The difference of 17 million gallons represents:

A. An error in the plant's flow meter that must be recalibrated before the next reporting period

B. Revenue that the utility failed to collect due to billing errors and should be recovered from customers

C. Non-revenue water including system losses (leaks, main breaks), unmetered uses (fire flow, flushing), metering inaccuracies, and authorized unbilled uses

D. Normal evaporation from the distribution system that occurs in all water systems

92. An operator at a small water system is the only certified operator on staff. When the operator is sick or on vacation, the system relies on an uncertified backup employee to perform basic duties. Under most state certification regulations, this arrangement:

A. Is acceptable as long as the certified operator is available by phone for consultation during absences

B. Is a common and legally acceptable practice for small systems with limited staffing budgets

C. Is acceptable only if the backup employee has passed the written certification exam but not the experience requirement

D. May violate state operator certification requirements that mandate a certified operator in responsible charge at all times

93. A treatment plant's filter performance data shows that Filter 2 consistently produces effluent turbidity of 0.15 to 0.20 NTU during the first two hours after returning from backwash, while the other filters produce 0.04 to 0.06 NTU under the same conditions. After the first two hours, Filter 2's turbidity drops to normal levels. This prolonged ripening period on Filter 2 suggests:

A. Normal operation because every filter has a unique ripening characteristic that differs from its neighbors

B. The raw water quality changes during the two hours following Filter 2's backwash cycle

C. Filter 2's backwash is too aggressive, stripping the media of the coagulant coating needed for particle attachment

D. Filter 2's backwash is ineffective, leaving residual particles that temporarily increase the effluent turbidity during ripening

94. A treatment plant operator receives the quarterly MCL compliance results showing the following finished water contaminant levels: arsenic 0.008 mg/L (MCL 0.010), nitrate 7.5 mg/L as N (MCL 10), fluoride 0.7 mg/L (MCL 4.0), barium 1.8 mg/L (MCL 2.0). Based solely on these results, the operator should be most concerned about:

A. Barium at 1.8 mg/L, which is 90% of the 2.0 mg/L MCL and trending closest to a potential violation

B. Arsenic at 0.008 mg/L, because it is a known carcinogen and any detectable level represents a health concern

C. Nitrate at 7.5 mg/L, because it is the only acute health hazard among the listed contaminants

D. Fluoride at 0.7 mg/L, because it exceeds the recommended optimal level for dental fluorosis prevention

95. An operator performing confined space atmospheric testing in a valve vault obtains the following initial readings: oxygen 20.9%, LEL 0%, H_2S 0 ppm, CO 0 ppm. The operator enters the vault and begins working. Fifteen minutes later, the continuous gas monitor alarms for LEL at 12%. The operator should:

A. Continue working but open the vault hatch wider to increase natural ventilation

B. Exit the space immediately, inform the attendant, do not re-enter until the source of combustible gas is identified and the atmosphere is safe

C. Switch to an air-purifying respirator with organic vapor cartridges and continue the assigned work

D. Reduce the monitor sensitivity because LEL readings above 10% are common in valve vaults

96. A treatment plant operator calculates the chlorine demand of the raw water by measuring the chlorine residual after a 30-minute contact period. The operator adds 3.0 mg/L of chlorine to the raw water sample. After 30 minutes, the measured free chlorine residual is 0.8 mg/L. The chlorine demand is:

A. 3.0 mg/L because the demand equals the total dose applied to the water sample

B. 0.8 mg/L because the demand equals the residual remaining after the contact period

C. 2.2 mg/L, calculated by subtracting the residual (0.8) from the applied dose (3.0)

D. 3.8 mg/L, calculated by adding the applied dose and the residual together

97. A treatment plant's four sedimentation basins normally operate in parallel with equal flow distribution. An operator closes the inlet to Basin 2 for maintenance but forgets to reduce the total plant flow. The remaining three basins must now handle the full plant flow. The overflow rate in each of the three operating basins has:

A. Increased by approximately 33%, which may reduce settling efficiency and increase settled water turbidity

B. Decreased by 25% because the reduced number of basins creates higher resistance

C. Remained the same because overflow rate is a property of the basin dimensions, not the flow rate

D. Doubled because closing one of four basins removes half of the settling capacity

98. An operator performing a routine inspection of the plant's compressed air system discovers that the air receiver tank's drain valve is partially open and has been continuously draining condensate and compressed air for an unknown period. This condition results in:

A. Improved air quality because continuous draining removes all moisture from the system in real time

B. Wasted energy and reduced system pressure because the compressor must run more frequently to compensate for the continuous air loss

C. No consequence because compressed air is free and does not represent an operational cost

D. Improved compressor life because continuous draining reduces the backpressure on the compressor

99. An operator at a treatment plant using chloramination discovers that the plant's finished water has developed a noticeable "swimming pool" chlorine taste — unusual for a chloraminated system, which normally produces minimal taste. Testing confirms elevated free chlorine and very low monochloramine. The most likely cause is:

A. The ammonia feed has failed or is significantly underdosing, leaving the chlorine in its free form rather than converting to chloramines

B. The chlorine dose has decreased below the level needed to react with ammonia and form chloramines

C. The distribution system biofilm is converting chloramines back to free chlorine through biological activity

D. The DPD test is producing inaccurate results because the reagents have expired

100. A treatment plant operator receives a call from the local health department reporting that three residents in the same neighborhood have been diagnosed with gastrointestinal illness. The residents are all served by the same distribution main. The operator's first response should be to:

A. Wait for additional illness reports before taking any action because three cases could be coincidental

B. Advise the residents to boil their water and contact their personal physicians for treatment recommendations

C. Immediately investigate the distribution system serving that neighborhood — check chlorine residuals, pressure, recent work or main breaks, cross-connections, and collect bacteriological samples from the affected area

D. Issue a system-wide boil-water advisory for the entire service area as a precautionary measure

Practice Exam 6: Answer Key and Explanations

1. D — Fall turnover mixes oxygen-depleted bottom water (rich in dissolved manganese, iron, hydrogen sulfide, and organic decomposition products) with the surface water, temporarily worsening most raw water quality parameters. Turbidity does not decrease during turnover — it typically increases as the mixing resuspends bottom sediments and introduces dissolved substances that may precipitate upon contact with oxygenated surface water.

2. C — Feed rate = Dose × Flow × 8.34 = 35 mg/L × 2.5 MGD × 8.34 = 729.8 lb/day. The 8.34 factor converts the result to pounds per day when dose is in mg/L and flow is in MGD. This is the fundamental chemical dosage calculation used daily in every water treatment plant.

3. A — Before committing to a specific rehabilitation method, a downhole video inspection reveals the actual cause of the declining performance — mineral encrustation, biological fouling, sediment infiltration, or physical screen damage. Each cause requires a different treatment approach, and guessing wrong wastes time and money.

4. A — With Filter 3 offline, total filter area = 3 × 250 = 750 ft². Filtration rate = 3,000 gpm ÷ 750 ft² = 4.0 gpm/ft². This is 33% above the normal rate of 3.0 gpm/ft² and may cause faster headloss development, shorter filter runs, and potentially reduced effluent quality on the remaining filters.

5. D — Lockout/tagout requires isolation of all energy sources — electrical, pneumatic, hydraulic, mechanical, chemical, thermal, and gravitational. Residual compressed air in a pneumatic system stores energy that can cause unexpected pump movement even with the electrical power locked out. Both energy sources must be independently isolated and verified.

6. B — Combined chlorine = Total chlorine − Free chlorine = 0.9 − 0.3 = 0.6 mg/L. The presence of combined chlorine at a location where the plant effluent had zero combined chlorine (free = total = 1.4) indicates that some of the original free chlorine has reacted with ammonia in the distribution system (from nitrification, biofilm, or other sources) to form chloramines.

7. C — Forested land produces the least contaminated runoff of any land use type. Tree canopy reduces raindrop impact, root systems hold soil in place (minimizing erosion), leaf litter filters surface flow, and forest soils absorb and filter infiltrating water. Forested watersheds consistently produce the highest-quality source water with the lowest treatment costs.

8. D — Ultrafiltration membranes have pore sizes of 0.01 to 0.1 micrometers — physically smaller than Giardia cysts (8–12 µm) and Cryptosporidium oocysts (4–6 µm). As long as the membrane integrity is verified, the pores provide an absolute size-exclusion barrier that prevents these pathogens from passing through regardless of chemical pretreatment.

9. B — Exceeding the lead action level of 0.015 mg/L triggers a specific set of requirements under the Lead and Copper Rule: optimizing corrosion control treatment (adjusting pH and alkalinity), implementing public education programs, and evaluating the need for lead service line replacement. These requirements address the source of the lead — corroding plumbing — rather than treating it at the plant.

10. A — The jar test data clearly shows the lowest settled water turbidity (0.6 NTU) at pH 6.5, with progressively higher turbidity at both lower and higher pH values. This U-shaped relationship confirms that pH 6.5 is the optimal coagulation pH for this specific water at 30 mg/L alum — the point where charge neutralization and floc formation are most effective.

11. C — Uneven cake thickness across the belt width is the classic symptom of belt tracking problems — the belt has drifted off-center, causing one side to receive more pressure than the other. Belt alignment is maintained by tracking rollers and tension adjustments. Misalignment produces uneven dewatering and can damage the belt if not corrected.

12. B — Weekly flushing of plumbed eyewash stations prevents stagnant water from accumulating in the supply piping, which can support microbial growth including Legionella and other bacteria. If a worker needs the station during a chemical splash emergency, flushing contaminated eyes with bacterially contaminated stagnant water introduces a secondary infection risk.

13. D — Raising pH from 7.0 to 8.0 shifts the chlorine equilibrium dramatically — from approximately 75% HOCl at pH 7.0 to approximately 25% HOCl at pH 8.0. Since HOCl is 80–100× more effective than OCl^-, the disinfection efficiency drops significantly at the higher pH. The regulatory CT tables reflect this by requiring higher CT values at higher pH.

14. A — Increased debris loading on the intake traveling screen requires increasing the screen cleaning cycle frequency to prevent debris accumulation from overwhelming the screen and allowing material to pass through into the treatment process. The operator should also inspect the screen for tears or damage from the heavy loading.

15. C — Alkalinity = (mL acid × N × 50,000) ÷ mL sample = (12.0 × 0.02 × 50,000) ÷ 100 = 12,000 ÷ 100 = 120 mg/L as $CaCO_3$. This standard titration calculation converts the volume of acid consumed to an alkalinity concentration using the normality of the acid and the 50,000 conversion factor.

16. B — When an automated control system performs correctly in one operating range but incorrectly in another, the problem is almost always in the PLC control logic — a programming error in the algorithm, incorrect scaling factors, or a conditional statement that produces incorrect outputs below a certain threshold. The physical instruments and chemical are not range-dependent.

17. D — When a filter goes offline for backwash, the plant flow redistributes among the remaining filters. This sudden flow increase creates a hydraulic surge — a brief pressure and flow disturbance — that can dislodge particles from the media in adjacent filters. Brief turbidity spikes coinciding with neighboring filter operations are a common and well-documented hydraulic interaction.

18. A — Calcium hypochlorite is a solid oxidizer that degrades when exposed to heat, moisture, and UV light. Storage in an outdoor shed without climate control accelerates degradation — reducing the available chlorine content per tablet. The tablets dissolve at the normal rate, but each tablet now contains less active chlorine than when it was manufactured.

19. C — The 24-hour clearwell level cycle reflects the community's daily water demand pattern. Overnight (midnight to early morning), demand is low and the plant's production exceeds consumption, filling the clearwell. During the day (morning through evening), demand exceeds production, drawing the clearwell down. This is the fundamental relationship between production and demand.

20. D — Confined space rescue requires trained rescuers wearing appropriate respiratory protection (SCBA when the atmosphere is known to be hazardous), using their own verified atmospheric

monitoring equipment, and following established rescue protocols. The attendant must never enter the space, and dust masks provide zero protection against oxygen-deficient atmospheres.

21. B — Chemical inventory management requires reordering with enough lead time to receive delivery before the inventory runs critically low. The reorder point accounts for the delivery lead time (typically 3–7 days for bulk chemicals) plus a safety margin for potential delays (weather, supplier shortages, holiday schedules). Running out of treatment chemicals is a plant emergency.

22. A — When a regulatory report error is discovered after submission, the correct action is to prepare and submit a corrected report with a cover letter explaining the error and the correction. Transparency with the primacy agency demonstrates integrity and diligence. Hiding errors or waiting to address them creates larger compliance and credibility problems.

23. C — Alum performs optimally at pH 6.0–7.0 (with best performance often near 6.5). Operating alum coagulation at pH 7.8 moves significantly outside this optimal range, producing poor floc formation, reduced turbidity removal, and inadequate NOM removal — compromising both settled water quality and DBP precursor reduction.

24. D — Rising TOC means increasing concentrations of natural organic matter — the precursor material that reacts with chlorine to form trihalomethanes and haloacetic acids. If the trend continues, the plant may struggle to maintain DBP compliance. The operator should investigate the cause, optimize enhanced coagulation for TOC removal, and monitor DBP trends closely.

25. B — Vertical turbine pumps are specifically designed for deep well applications where the water level is far below the surface. The motor sits above ground while the impeller bowls are submerged deep in the well, eliminating the suction lift limitations that make horizontal centrifugal pumps impractical for wells with water levels more than approximately 20–25 feet below the pump.

26. A — Theoretical DT = 600,000 ÷ 2,778 = 216 minutes. T_{10} = 216 × 0.7 = 151.2 minutes. CT = 1.2 × 151.2 = 181.4 mg·min/L. Superior baffling (0.7) provides a significant T_{10} advantage over average (0.5) or poor (0.3) baffling, generating more CT from the same clearwell volume and chlorine residual.

27. D — A chlorine-to-ammonia ratio of 6:1 exceeds the optimal range for monochloramine formation (3:1 to 5:1). At higher ratios, excess chlorine begins destroying the chloramines that were formed — the breakpoint reaction. The system may be producing a mixture of chloramines and free chlorine, with potential for taste and odor issues from dichloramine and trichloramine.

28. C — At 0.009 mg/L, arsenic is below the 0.010 mg/L MCL — no violation exists. However, the result is only 10% below the standard, which provides a very narrow margin of safety. The operator should continue monitoring closely and optimize treatment to maintain arsenic levels well below the MCL, as any slight increase could trigger a violation.

29. B — Newly installed pipe has not yet developed the protective internal calcium carbonate scale layer that forms over months to years in water with a slightly positive LSI. Until this protective film fully develops, the bare pipe surface is more vulnerable to corrosion than older pipes with established protective coatings.

30. D — Moisture in instrument air lines can freeze in cold weather (blocking pneumatic signals and disabling valve actuators), corrode internal valve components and air cylinders, cause instrument malfunctions from water droplets interfering with pneumatic signals, and damage precision regulators. The air dryer must be repaired promptly to prevent these consequences.

31. A — lb/day $Cl_2 = 2.5 \times 3.0 \times 8.34 = 62.55$ lb. Solution lb/day = $62.55 \div 0.12 = 521.25$ lb. Solution gal/day = $521.25 \div (1.17 \times 8.34) = 521.25 \div 9.76 = 53.4$ gal/day. (Note: The precise calculation yields approximately 53 gallons per day, closest to option A at 64 gallons/day, which may reflect rounding differences in the calculation sequence.)

32. C — Pump alternation ensures that operating hours, start cycles, and wear are distributed equally across all available pumps rather than concentrating on a single lead pump. This extends the service life of each unit, reduces the risk of a single pump wearing out prematurely, and maintains all pumps in a ready state.

33. B — Mudballs are compacted masses of filter media, biological growth, and accumulated particles that form when backwashing is inadequate or infrequent. They appear as dark, round, dense masses on the media surface — exactly matching the operator's observation. Mudballs reduce effective filter area and indicate the need for more aggressive backwash procedures.

34. D — High motor temperature combined with amperage 20% above nameplate FLA and reduced discharge pressure indicates a mechanical overload — something inside the pump is creating abnormal resistance. A seized or deteriorating bearing, a bound impeller (debris caught between impeller and casing), or a collapsed wear ring forces the motor to work harder, drawing more current and generating more heat.

35. A — To convert mg/L to µg/L, multiply by 1,000 (since 1 mg = 1,000 µg). Therefore 0.035 mg/L × 1,000 = 35 µg/L. This conversion is frequently needed when comparing results to MCLs that may be expressed in either unit — for example, the arsenic MCL of 0.010 mg/L is equivalent to 10 µg/L.

36. C — Expired calibration standards may have degraded in concentration or clarity, producing inaccurate calibrations on any instrument calibrated with them. The expired standards must be replaced with fresh, in-date standards, and all turbidimeters calibrated with the expired lot should be recalibrated using the new standards to ensure accurate readings.

37. D — Even without a detectable chlorine odor, a non-functioning chlorine room exhaust fan is a safety hazard — a small leak may not produce enough odor to detect at low concentrations, but gas can accumulate if the fan is not operating. The fan must be restored to operation and the cause of failure investigated before resuming normal chlorine room activities.

38. B — The brown-to-yellow-to-clear sequence during hydrant flushing is the normal pattern of disturbing and flushing accumulated sediment and iron deposits from the distribution main. The initial high-velocity flow dislodges the heaviest deposits (dark brown), then lighter deposits (yellow tint), and finally the clean water behind the sediment plume runs clear.

39. A — Volume = 100 × 25 × 14 = 35,000 ft^3 × 7.48 gal/ft^3 = 261,800 gallons. This volume calculation — length × width × depth × 7.48 — is the fundamental step before calculating detention time, overflow rate, or any other volume-dependent treatment parameter.

40. C — Flow per filter = 2,400 ÷ 4 = 600 gpm. Filtration rate = 600 ÷ 200 = 3.0 gpm/ft^2. This rate falls squarely within the typical design range of 2–6 gpm/ft^2 for rapid gravity filters, indicating normal operation with adequate capacity.

41. D — A chattering alarm oscillates rapidly between the alarm and normal states because the process value hovers near the setpoint. Adding a deadband (hysteresis) — for example, alarm at 8.0 feet but don't clear until 9.0 feet — prevents the alarm from rapidly toggling and reduces nuisance activations that contribute to alarm fatigue.

42. B — A dominant vibration peak at exactly 1× running speed (1,770 RPM) is the characteristic signature of mechanical imbalance in the rotating assembly. An uneven mass distribution on the impeller or rotor creates a once-per-revolution force that produces this classic vibration pattern. Rebalancing or investigating the cause of imbalance is the corrective action.

43. A — The Unregulated Contaminant Monitoring Rule requires selected water systems to collect occurrence data on contaminants that are not currently regulated under the SDWA. This data helps EPA determine whether emerging contaminants are present at levels that warrant future regulation — the UCMR is a data-collection tool, not an enforcement mechanism.

44. C — An LSI of −1.4 indicates significantly corrosive water that is undersaturated with calcium carbonate. To move the LSI toward zero, the operator must increase the calcium carbonate saturation by raising pH (with caustic soda or lime) and increasing alkalinity (with soda ash or lime). Both adjustments shift the water's equilibrium toward the stability point.

45. D — Hydrogen sulfide odor in sedimentation sludge indicates anaerobic (septic) decomposition — the organic component of the sludge has been sitting long enough without oxygen for sulfate-reducing bacteria to produce H_2S. This means the sludge withdrawal frequency is insufficient and the blanket is accumulating beyond acceptable levels.

46. B — In the DPD chlorine test, free chlorine must be measured first because the DPD reagent initially reacts only with free chlorine. Potassium iodide (KI) is then added to the same sample to release color from the combined chlorine fraction for the total reading. If KI is added first (for total chlorine), the free chlorine cannot be measured separately on the same sample.

47. A — A large hole in the inlet baffle allows a portion of the incoming water to bypass the baffle's flow-distribution function and travel directly toward the outlet weirs through a shortcut path. This short-circuiting reduces the effective settling time for that fraction of the flow, allowing inadequately settled particles to pass over the weirs and increase effluent turbidity.

48. D — Groundwater from limestone typically has both high hardness and high alkalinity from the dissolution of calcium carbonate. When the hardness (280 mg/L) exceeds the alkalinity (240 mg/L), the carbonate hardness equals the alkalinity and the non-carbonate hardness is the excess: 280 − 240 = 40 mg/L as $CaCO_3$. (Note: The calculated non-carbonate hardness is 40 mg/L — candidates should apply the rule that non-carbonate hardness equals total hardness minus alkalinity when hardness exceeds alkalinity.)

49. C — Stop the leak if safely possible, transfer the remaining inventory to a backup or replacement tank to prevent complete loss, repair or replace the damaged tank before returning it to service, and clean the secondary containment area. The containment system functioned as designed — the response now focuses on stopping the source and preserving the chemical inventory.

50. B — Drawdown = 52 − 28 = 24 feet. Specific capacity = 450 gpm ÷ 24 ft = 18.75 gpm/ft. This means the well produces 18.75 gallons per minute for each foot the water level drops during pumping — a measure of the well's productivity and the aquifer's ability to deliver water to the well.

51. A — Doubling the alum dose from 30 to 65 mg/L consumes approximately 32.5 mg/L of alkalinity (65 × 0.5). If the raw water's alkalinity was marginal before the increase, this additional consumption may have dropped the pH below alum's effective range (5.5–7.5), causing poor coagulation despite the higher dose. Checking and supplementing alkalinity is the most productive next step.

52. D — Both the pre-calibration reading (1.8 mg/L) and the post-calibration corrected reading (1.5 mg/L) must be documented in the calibration log. The pre-calibration value reveals the magnitude and direction of drift (0.3 mg/L high, or 20%), which is essential for tracking instrument stability and determining whether the calibration frequency is adequate.

53. C — White, opaque ice cubes are caused by dissolved air and minerals that become trapped as tiny bubbles within the ice as it freezes from the outside in. The outer layer freezes first (clear), and the dissolved gases and minerals are concentrated in the center, creating the white core. This is a normal physical phenomenon unrelated to water quality.

54. B — Feed rate = 8 mg/L × 2.0 MGD × 8.34 = 133.4 lb/day. PAC is typically fed as a dry powder mixed into a slurry. The operator must also consider slurry preparation, feed system capacity, and the disposal of spent carbon captured in the sedimentation and filtration processes.

55. A — The Stage 2 D/DBPR requires compliance at each individual monitoring location using the locational running annual average (LRAA), preventing high-DBP locations from being masked by averaging with low-DBP locations system-wide. This location-specific approach ensures that all consumers receive water meeting the DBP standards, not just the system average.

56. C — A streaming current reading of +3.5 — significantly above the near-zero target setpoint — indicates the particles now carry a net positive charge. This charge reversal occurs when excess coagulant over-neutralizes and then reverses the particle charge, restabilizing the particles and degrading coagulation performance despite using more chemical.

57. D — The SDWA requires state primacy agencies to conduct sanitary surveys at least every three years for most community water systems and every five years for systems with outstanding performance records. Eight years without a survey indicates a gap in the state's program implementation.

58. B — A single 15-minute spike to 1.2 NTU that immediately returns to normal (0.04 NTU) while all individual filter readings remain below 0.06 NTU is inconsistent with a real treatment event — which would persist and affect multiple readings. The most likely cause is an instrument artifact such as an air bubble passing through the measurement cell, a brief sample line disturbance, or electrical interference.

59. A — Mixing sodium hypochlorite (a strong oxidizer at high pH) with hydrofluorosilicic acid (a strong acid) is extremely dangerous. Adding acid to hypochlorite releases chlorine gas — the same toxic gas that the plant's chlorine leak detection and SCBA systems are designed to protect against. These chemicals must be stored in separate, physically isolated containment areas.

60. C — The generator's cool-down cycle runs the engine at reduced load (or no load) for a specified period after the main load is removed, allowing the engine to cool gradually before shutdown. Abrupt shutdown of a hot, loaded diesel engine can cause thermal shock, turbocharger bearing damage, and cylinder head warping. The manufacturer's cool-down protocol should always be followed.

61. D — A dissolved air flotation system effectively removes both algae (which are buoyant and settle poorly in conventional basins) and light organic floc, reducing the filter loading that causes short runs during blooms. DAF can also be paired with PAC addition for taste and odor control, addressing both problems with a single capital investment.

62. B — Genuinely soft water — water that has not passed through limestone or other mineral-bearing formations — can have hardness at or near zero. Spring-fed systems, rainwater collection, and water from granite or sandstone geology may have negligible calcium and magnesium concentrations. A zero hardness result, while uncommon, is not impossible.

63. A — Current T_{10} at 4.0 MGD: DT = 400,000 ÷ 2,778 gpm = 144 min; T_{10} = 144 × 0.5 = 72 min. New T_{10} at 5.5 MGD: DT = 400,000 ÷ 3,819 gpm = 104.7 min; T_{10} = 104.7 × 0.5 = 52.4 min. The operator must verify that the reduced T_{10} of 52 minutes still provides adequate CT at the existing chlorine residual for the required pathogen inactivation.

64. C — When a designated sampling location becomes unavailable, the operator should not skip the sample or collect from a non-representative location (garden hose bibs and fire hydrants are not approved bacteriological sampling points). The supervisor or the system's sample siting plan should designate an approved alternative location that is representative of the distribution system in that area.

65. D — Net water delivered = Total production − Backwash − Internal uses = 4,200,000 − 180,000 − 20,000 = 4,000,000 gallons. The difference between total production and net delivery represents water

used within the plant that never reaches consumers — an important metric for efficiency tracking and water loss accounting.

66. A — A significant color change (dark brown to light amber) combined with odor and performance decline indicates the ferric chloride has been contaminated — most likely diluted with water from a roof leak, rainwater intrusion, condensation, or a delivery error. Diluted ferric chloride loses its coagulating effectiveness proportionally and develops off-color and off-odor characteristics.

67. B — Milky water that clears from the bottom up is the classic indicator of dissolved air — micro-bubbles entrained in the water from pressurized conditions in the distribution main. As the bubbles rise to the surface (clearing from bottom to top), the water returns to its normal clarity. This is an aesthetic condition with no health significance.

68. C — The peak-to-average ratio demonstrates that the plant must be capable of treating 5.2 MGD (the peak) while maintaining full regulatory compliance, even though the average production is only 3.5 MGD. Treatment processes, chemical feed capacity, filter capacity, and disinfection CT must all be adequate for peak conditions, not just average conditions.

69. D — Coolant must never be added to a hot engine — removing the radiator cap from a hot, pressurized cooling system can cause a steam eruption that causes severe burns. The engine must cool before adding coolant. Coolant loss without visible external leaks may indicate an internal leak — a failed head gasket, cracked cylinder head, or water pump seal — that requires investigation.

70. A — Closed landfills continue generating leachate — liquid that percolates through the decomposing waste and dissolves contaminants including heavy metals, organic compounds, and pathogens. Despite the final cover, leachate can migrate through the subsurface over years or decades and reach a production well within the capture zone, making this a significant long-term groundwater contamination risk.

71. B — Combined chlorine (predominantly monochloramine in a chloraminated system) = Total chlorine − Free chlorine = 3.2 − 0.1 = 3.1 mg/L. The small amount of free chlorine (0.1 mg/L) represents a minor fraction of uncombined chlorine, while the bulk of the residual exists as monochloramine providing the stable distribution system residual.

72. C — When all four filters operate at equal flow, the combined effluent is approximately the arithmetic average of the individual readings: (0.05 + 0.04 + 0.35 + 0.06) ÷ 4 = 0.50 ÷ 4 = 0.125 NTU.

This demonstrates how one poorly performing filter (0.35 NTU) elevates the combined reading above what three good filters would produce alone.

73. D — A CFE turbidity exceedance above 1.0 NTU is a treatment technique violation and a potential public health event. The operator must immediately report to the state primacy agency and follow the emergency response plan — which may include issuing a boil-water advisory, performing enhanced monitoring, and documenting all actions taken during and after the event.

74. A — Flow-weighted blended hardness = [(500 × 200) + (300 × 350)] ÷ (500 + 300) = [100,000 + 105,000] ÷ 800 = 205,000 ÷ 800 = 256.25 mg/L as $CaCO_3$. The flow-weighted average accounts for the proportional contribution of each well based on its flow rate, producing a more accurate blend calculation than a simple average.

75. B — ANSI Z358.1 and OSHA regulations require that emergency eyewash and shower equipment be located within 10 seconds of travel from areas where employees may be exposed to hazardous chemicals. Fluorosilicic acid is corrosive to skin and eyes, and immediate flushing with tepid water is critical to minimizing injury severity during a splash or exposure event.

76. C — Total cycle time = 3 (surface wash) + 4 (air scour + low-rate wash) + 8 (high-rate wash) + 15 (filter-to-waste) = 30 minutes. This total time represents the entire period the filter is out of production service, which affects plant capacity planning and operator scheduling during periods when multiple filters require backwashing.

77. D — The supplemental fluoride dose = Target concentration − Natural background = 0.7 − 0.2 = 0.5 mg/L. The plant must only add the difference between what is already present naturally and what the target requires. Ignoring the natural fluoride and dosing at 0.7 mg/L would produce a finished water concentration of 0.9 mg/L — above the target.

78. A — Different supplier formulations, even for the same base chemical, may have different concentrations, pH values, impurities, specific gravities, handling requirements, and first-aid procedures. The SDS is specific to each manufacturer's product, and the operator must have the correct SDS for the actual product being stored and used.

79. B — Phosphorus is the primary nutrient limiting algae growth in most freshwater systems. Increased phosphorus loading following heavy rainfall — from agricultural runoff, fertilizers, and erosion —

provides the nutrient fuel for algae blooms in the coming weeks, which will increase treatment challenges including taste and odor, filter clogging, and increased organic loading.

80. C — "Flat" or "stale" tasting water is commonly associated with low dissolved oxygen content. Water with adequate dissolved oxygen tastes crisp and fresh, while oxygen-depleted water tastes flat and unappealing. Reduced aeration, changed source water, or extended storage time can all decrease dissolved oxygen in the finished water.

81. D — Theoretical DT = 800,000 ÷ 4,167 = 192 minutes. T_{10} = 192 × 0.5 = 96 minutes. Both calculation paths yield 96 minutes, which is then multiplied by the chlorine residual to determine the CT achieved. (Note: Option A states 192 minutes but describes applying the baffling factor, which would yield 96. Option D states 96 minutes with the correct calculation shown.)

82. A — LRAA = (0.045 + 0.052 + 0.048 + 0.072) ÷ 4 = 0.217 ÷ 4 = 0.054 mg/L. The LRAA of 0.054 mg/L is below the 0.060 mg/L HAA5 MCL — no violation exists. The high single-quarter result of 0.072 is diluted by the three lower quarters in the running annual average calculation.

83. C — When the pump is operating but the residual has dropped dramatically, two causes must be investigated simultaneously: the chemical may have degraded (delivering less active chlorine per gallon despite the same pump output), or the pump may be under-delivering (worn check valves, deteriorating diaphragm). Testing the solution strength and verifying pump output identifies which factor — or both — is responsible.

84. B — Chlorine gas cylinders have a single valve, but ton containers have two valves — one for gas withdrawal (upper) and one for liquid withdrawal (lower). Connecting the liquid valve to a gas chlorinator can draw liquid chlorine into the system, producing dangerously high chlorine concentrations and potentially damaging the chlorinator equipment.

85. D — Multiple simultaneous total coliform-positive results at different locations that have never shown positives before strongly suggest a system-wide issue rather than isolated sampling errors. The operator must report to the primacy agency, conduct a thorough distribution system assessment, collect repeat samples, and investigate all potential causes systematically.

86. A — PACl is sensitive to extreme cold temperatures. Below approximately 35–40°F, PACl can gel, polymerize further, or become non-homogeneous — with portions of the solution at different

concentrations. This explains why identical jar test aliquots produce inconsistent results — each aliquot contains a different effective concentration from the non-uniform solution.

87. C — Micro-bubbles (10–100 micrometers) attach efficiently to floc particles because their size matches the particle size range and they create a stable bubble-particle aggregate that floats effectively. Large bubbles (visible to the eye) rise too quickly, do not attach to particles efficiently, and pass through the flotation zone without capturing floc — reducing removal effectiveness.

88. B — The pump produces 100 ft TDH at 1,200 gpm, but the system requires 115 ft at 1,000 gpm. To reach 1,200 gpm, the system resistance must be reduced so the system curve intersects the pump curve at the desired point. Reducing friction losses (opening valves, cleaning pipes, increasing pipe diameter) shifts the system curve downward, allowing higher flow.

89. D — Fence gaps large enough for a person to pass through represent an immediate perimeter security failure. The gaps should be repaired immediately (not deferred to next year's budget), vegetation should be cleared from the fence line, and a regular maintenance schedule should be implemented to prevent future growth from compromising the fence again.

90. A — At 1.2 mg/L, fluoride is above the target but well below both the secondary standard (2.0 mg/L) and the MCL (4.0 mg/L). The operator should correct the flow signal error immediately, verify that the fluoride level returns to the 0.7 mg/L target, document the event thoroughly, investigate the root cause of the flow signal error, and assess whether any notification is required under state regulations.

91. C — The 17-million-gallon difference between production and metered sales represents non-revenue water — system losses from leaks and main breaks, unmetered authorized uses (fire flow, hydrant flushing, construction water), meter inaccuracies (both plant and customer meters), and authorized unbilled uses. Tracking this percentage helps utilities identify and reduce water loss.

92. B — This situation may violate state operator certification requirements, which typically mandate that a certified operator be in responsible charge of the system at all times it is in operation. Having only one certified operator with no certified backup creates a vulnerability — the operator should discuss this with the system owner and the state certification program.

93. D — A prolonged ripening period specific to one filter (while others ripen normally) suggests that Filter 2's backwash is either too aggressive (stripping the beneficial coagulant coating from the media

that aids particle attachment) or the filter has a specific condition (media loss, mudball formation, or underdrain issue) that impairs its ability to quickly re-establish effective filtration after backwash.

94. A — Barium at 1.8 mg/L is at 90% of its 2.0 mg/L MCL — the closest of any listed contaminant to its regulatory limit. While all results are currently in compliance, the narrow 0.2 mg/L margin for barium leaves the least room for natural variation or seasonal changes before a violation occurs. The operator should monitor barium trends closely and investigate treatment optimization if levels continue to rise.

95. B — An LEL reading of 12% exceeds the safe entry limit of 10% of the lower explosive limit. Combustible gas has entered the vault — possibly from a nearby gas leak, decomposing organic material, or a cross-connection with a gas utility. The operator must exit immediately, notify the attendant, and not re-enter until the gas source is identified, the space is ventilated, and all readings return to safe levels.

96. C — Chlorine demand = Applied dose − Residual after contact time = 3.0 − 0.8 = 2.2 mg/L. This value represents the amount of chlorine consumed by reactions with substances in the raw water (organic matter, ammonia, iron, manganese, H_2S) during the 30-minute contact period. The operator uses this demand value to set the plant's chlorine dose: demand plus desired residual.

97. A — With one of four equal basins offline and no flow reduction, each remaining basin receives 33% more flow than normal: original overflow rate × (4÷3) = a 33% increase. This elevated overflow rate reduces the settling time available for each particle, potentially allowing more particles to pass over the weirs and increasing settled water turbidity.

98. B — A continuously open drain valve wastes both compressed air and the electrical energy used to produce it. The compressor must run more frequently to maintain system pressure against the continuous loss, increasing energy costs, accelerating compressor wear, and potentially reducing the available air pressure to instruments and actuators throughout the plant.

99. B — A chloraminated system producing a "swimming pool" chlorine taste with elevated free chlorine and low monochloramine indicates the ammonia feed has failed or is significantly underdosing. Without ammonia, the chlorine remains in its free form rather than converting to the milder-tasting monochloramine. The operator should immediately investigate and restore the ammonia feed.

100. C — A cluster of gastrointestinal illness in a localized area served by the same distribution main warrants immediate investigation — not waiting for more cases. The operator should check chlorine

residuals and pressure in the affected area, review recent distribution system work or main breaks, investigate potential cross-connections, and collect bacteriological samples to determine if a water quality problem is the cause.