

PRACTICE EXAM 5: WATER TREATMENT OPERATOR CLASS I SIMULATION (100 QUESTIONS)

1. An operator at a surface water treatment plant observes that the raw water turbidity has been steady at 10 NTU for the past week, but the coagulant demand identified through jar testing has increased by 40% during the same period. Raw water color has also increased from 15 CU to 35 CU. The most likely explanation for the increased coagulant demand despite stable turbidity is:

- A. The turbidimeter is malfunctioning and the actual raw water turbidity is significantly higher
- B. The alum supplier delivered a weaker product that requires larger volumes per unit of treatment
- C. Increased dissolved natural organic matter in the source water is creating additional coagulant demand beyond what turbidity alone indicates
- D. The flocculation basin paddles have slowed down, requiring more coagulant to compensate

2. A treatment plant's distribution system has experienced three total coliform-positive samples in the past month — each from different locations, with all repeat samples negative and no *E. coli* detected in any sample. Under the RTCR, the system should be most concerned about:

- A. An immediate *E. coli* MCL violation requiring Tier 1 notification within 24 hours
- B. Triggering a Level 1 or Level 2 assessment requirement based on the frequency of positive results
- C. Exceeding the secondary standard for total coliform bacteria in the distribution system
- D. No concern is warranted because the negative repeat samples confirm each original positive was a false alarm

3. A treatment plant uses a dual-media filter with 20 inches of anthracite over 10 inches of sand. During a routine media inspection, the operator discovers that the anthracite depth has decreased to 14 inches while the sand depth remains at 10 inches. The most likely cause of the reduced anthracite depth is:

- A. Biological organisms in the filter bed are consuming the anthracite carbon as a nutrient source
- B. The anthracite is dissolving into the filtered water due to chemical incompatibility with the coagulant
- C. The sand layer has expanded upward, compressing the anthracite into a thinner layer above it
- D. Anthracite media has been lost over the wash troughs during backwash cycles due to excessive backwash rates

4. A water system's vulnerability assessment identifies that the plant's SCADA system uses default manufacturer passwords on all PLCs and HMI workstations. This finding represents:

- A. A critical cybersecurity vulnerability because default passwords are publicly known and easily exploited
- B. Standard industry practice that provides adequate security when combined with physical access controls
- C. A minor administrative issue that should be addressed during the next scheduled system upgrade
- D. No vulnerability because PLCs and HMI systems cannot be accessed remotely under any circumstances

5. A treatment plant operator feeds alum at 40 mg/L to raw water with an alkalinity of 85 mg/L as CaCO_3 . Alum consumes approximately 0.5 mg/L of alkalinity per 1.0 mg/L of alum. After coagulant addition, the remaining alkalinity is approximately:

- A. 85 mg/L as CaCO_3
- B. 65 mg/L as CaCO_3
- C. 45 mg/L as CaCO_3

D. 105 mg/L as CaCO₃

6. An operator performing a confined space entry pre-entry atmospheric test obtains the following readings: oxygen 23.8%, LEL 0%, H₂S 0 ppm, CO 0 ppm. Entry should be:

A. Approved because all toxic gas readings are at zero and conditions are safe

B. Approved because the oxygen level is above the minimum 19.5% requirement

C. Delayed until the LEL reading is verified using a secondary monitor as backup

D. Denied because the oxygen level exceeds the safe maximum of 23.5%, indicating a potentially oxygen-enriched atmosphere

7. A treatment plant treating 3.0 MGD needs to achieve a CT of 90 mg·min/L for adequate Giardia inactivation. The clearwell has a volume of 500,000 gallons and average baffling (factor = 0.5). What minimum chlorine residual must be maintained at the clearwell outlet?

A. 0.25 mg/L

B. 0.50 mg/L

C. 0.75 mg/L

D. 1.00 mg/L

8. A treatment plant switches from chlorine gas to sodium hypochlorite for disinfection. Compared to chlorine gas, sodium hypochlorite will have which effect on the finished water pH?

A. Lower the pH because sodium hypochlorite is an acidic solution with a pH below 4.0

B. Have no effect on pH because all chlorine forms produce identical pH changes in water

C. Raise the pH because sodium hypochlorite is a basic solution with a pH of approximately 11 to 13

D. Initially raise the pH but then lower it as the hypochlorite converts to hypochlorous acid

9. An operator inspecting a well site observes a new agricultural irrigation system operating approximately 100 feet from the production well. The irrigation system is connected to the well's distribution main through a garden hose with no backflow prevention device. This configuration creates a risk of:

A. Over-pumping the well by adding the irrigation demand to the domestic water demand

B. Corrosion of the distribution main from the contact between irrigation chemicals and pipe

C. Air entering the distribution system through the open end of the garden hose during low pressure

D. Cross-connection contamination if negative pressure in the main draws irrigation water, fertilizers, or pesticides into the potable supply

10. A treatment plant operates three parallel sedimentation basins. During a routine inspection, the operator finds that the sludge scraper chain on Basin 2 has broken, and the scraper is no longer moving accumulated sludge to the collection hopper. Basin 2 continues receiving water and settling floc. If the broken scraper is not repaired promptly, the most likely operational consequence is:

A. The settled water turbidity from Basin 2 will immediately increase because the scraper also functions as a baffle

B. The sludge blanket will rise progressively until it reaches the effluent weirs, causing sludge carryover into the filter influent

C. The basin will begin to overflow because the accumulated sludge reduces the basin's hydraulic capacity to zero

D. No consequence will occur because sedimentation basins function effectively without mechanical sludge removal

11. The purpose of the EPA's Ground Water Rule is to:

- A. Protect groundwater systems from fecal contamination by requiring source monitoring and corrective action when contamination indicators are found
- B. Establish MCLs for dissolved minerals including iron, manganese, and hardness in groundwater supplies
- C. Require all groundwater systems to install filtration and achieve the same treatment standards as surface water systems
- D. Prohibit the use of groundwater as a drinking water source in areas with documented agricultural contamination

12. An operator performing routine maintenance on a centrifugal pump notices that the bearing housing temperature is 30°F higher than the manufacturer's recommended maximum operating temperature. The motor amperage is normal and the pump is producing its rated flow. The operator should:

- A. Continue operating because normal amperage and flow confirm the pump is functioning correctly
- B. Shut down the pump for bearing inspection — the elevated temperature indicates potential bearing failure even though other parameters appear normal
- C. Increase the bearing lubrication quantity to reduce friction and bring the temperature down
- D. Reduce the pump speed by 10% to decrease the heat generation from normal hydraulic loading

13. A treatment plant uses a streaming current monitor after rapid mixing to provide real-time feedback on coagulation. The monitor reading has been stable at the target setpoint of +0.5 for the past three days. This morning, the reading shifted to -2.0 without any change in the coagulant feed rate. The operator should first investigate:

- A. Whether the streaming current monitor probe needs cleaning or recalibration before assuming a process change
- B. Whether the flocculation basin paddles need speed adjustment to improve particle contact downstream
- C. Whether the sedimentation basin sludge scrapers need maintenance to improve settled water quality

D. Whether the filtered water turbidity has increased, confirming that the coagulation upset has affected downstream treatment

14. A water system serves a hospital with a dialysis unit. The system is planning to switch from free chlorine to chloramine disinfection. Before making this switch, the system should:

A. Confirm that the hospital does not use the municipal water supply for any patient care activities

B. Obtain written permission from the state health department specifically authorizing the use of chloramines

C. Wait until all dialysis patients have been transferred to another facility before implementing the change

D. Notify the hospital because chloramines must be removed from water used in dialysis to prevent patient harm

15. A treatment plant treats 5.0 MGD. The raw water contains dissolved manganese at 0.15 mg/L. The operator feeds potassium permanganate to oxidize the manganese before filtration. The required permanganate dose is 1.0 mg/L. How many pounds per day of potassium permanganate are needed?

A. 41.7 lb/day

B. 83.4 lb/day

C. 20.9 lb/day

D. 6.3 lb/day

16. An operator reviews the plant's energy consumption data and identifies that the high-service pumps account for 55% of the plant's total electricity cost. All three high-service pumps currently run at full speed with discharge throttling valves partially closed to match system demand. The most effective energy reduction strategy is to:

- A. Replace the throttling valves with larger valves that create less friction loss at the same flow restriction
- B. Reduce the number of pumps running and operate one pump at maximum speed instead of three at partial
- C. Install variable frequency drives on the pumps to match motor speed to demand and eliminate throttling losses
- D. Switch to diesel-powered pumps that operate independently of the electrical grid during peak rate periods

17. A water treatment plant collects a raw water sample and measures a total hardness of 320 mg/L as CaCO₃ and an alkalinity of 320 mg/L as CaCO₃. Based on these results:

- A. All hardness is non-carbonate because the values are numerically equal and cancel each other
- B. There is 160 mg/L of carbonate hardness and 160 mg/L of non-carbonate hardness
- C. All 320 mg/L of hardness is carbonate hardness and there is zero non-carbonate hardness
- D. The alkalinity must be retested because it can never equal the hardness in a natural water sample

18. A treatment plant feeds fluorosilicic acid (hydrofluorosilicic acid) for community water fluoridation. The chemical storage tank is located in a room without secondary containment. This arrangement violates which safety principle?

- A. Chemical storage areas for dry chemicals must have sealed floors to prevent moisture contact
- B. Secondary containment applies only to chlorine gas storage rooms under the Risk Management Program
- C. All chemical storage rooms must have eyewash stations but secondary containment is optional
- D. Bulk liquid chemical storage tanks require secondary containment to prevent spills from reaching drains and the environment

19. An operator at a small groundwater system discovers that the system's well has not been inspected for sanitary defects in over three years. The well is located in an area where a new livestock operation was established two years ago within the wellhead protection area. The operator should:

- A. Conduct an immediate well inspection focusing on casing integrity, sanitary seal condition, and potential contamination pathways from the livestock operation
- B. Wait until the next scheduled state sanitary survey to address both the inspection and the livestock concern
- C. Ignore the livestock operation because animal waste only affects surface water and not groundwater supplies
- D. Contact the livestock operator and request that they voluntarily relocate their operation outside the wellhead protection area

20. A treatment plant's PLC controls the automated backwash sequence for all four filters. During a thunderstorm, a power surge causes the PLC to reboot mid-sequence while Filter 2 is in the backwash cycle with the effluent valve closed and the backwash valve open. After the PLC reboots, it returns all outputs to their default (off) positions. The operator must immediately:

- A. Wait for the PLC to complete its reboot cycle and automatically resume the backwash sequence
- B. Contact the PLC manufacturer for instructions on recovering the interrupted automated sequence
- C. Manually assess Filter 2's current valve positions and either complete the backwash manually or safely return the filter to its resting state
- D. Restart the complete backwash sequence from the beginning on all four filters simultaneously

21. A treatment plant operator discovers that the combined filter effluent turbidity has been at 0.32 NTU for the past 45 minutes — above the 0.3 NTU standard. The operator checks individual filter turbidities and finds that Filters 1, 3, and 4 read 0.04 NTU while Filter 2 reads 0.85 NTU. The most appropriate immediate action is:

- A. Increase the coagulant dose to improve particle removal across all four filters simultaneously

B. Take Filter 2 offline for immediate backwash or investigation while the remaining filters handle the plant flow

C. Reduce the plant flow rate to bring the combined turbidity below 0.3 NTU without addressing Filter 2

D. Recalibrate the combined filter effluent turbidimeter because the individual readings average below 0.3 NTU

22. A groundwater system's well produces water with the following characteristics: hardness 400 mg/L as CaCO₃, iron 2.5 mg/L, manganese 0.3 mg/L, pH 6.8, alkalinity 180 mg/L as CaCO₃, turbidity < 0.5 NTU. The operator classifies this water as:

A. Typical high-quality groundwater requiring only chlorine disinfection before distribution

B. Surface-water-influenced groundwater requiring full conventional treatment including coagulation

C. Moderately contaminated requiring advanced membrane treatment for dissolved mineral removal

D. Characteristic groundwater with elevated dissolved minerals requiring oxidation, filtration, and disinfection at minimum

23. A treatment plant's chemical delivery log shows that a 4,000-gallon delivery of 12.5% sodium hypochlorite was received six weeks ago. The operator tests the solution and finds it has degraded to 10.2% strength. The plant's chemical feed calculations are still based on 12.5%. If the operator does not correct the calculations, the actual chlorine dose being applied to the water is approximately:

A. 18% lower than the intended dose because the solution is weaker than the calculations assume

B. 18% higher than the intended dose because the degraded solution is more concentrated per unit volume

C. Identical to the intended dose because solution strength does not affect the volumetric feed rate

D. 25% lower than the intended dose because degradation follows a linear reduction of 0.5% per week

24. An operator is reviewing the plant's compliance records and discovers that the most recent lead and copper monitoring round showed lead levels at the 90th percentile of 0.012 mg/L. The action level for lead is 0.015 mg/L. The operator should conclude that:

- A. A lead action level exceedance has occurred and corrosion control optimization is immediately required
- B. The system's water quality has improved since lead levels historically exceeded the action level
- C. The system is in compliance because 0.012 mg/L is below the 0.015 mg/L action level, but the result warrants continued monitoring and attention
- D. The lead results are invalid because lead can only be measured at the treatment plant, not at consumer taps

25. A treatment plant uses ozone for primary disinfection followed by chloramines for distribution system residual. During a period of elevated source water bromide (0.12 mg/L), the operator's bromate monitoring shows results approaching the 0.010 mg/L MCL. The most appropriate operational response is:

- A. Increase the ozone dose to ensure complete oxidation of all bromide before it can form bromate
- B. Reduce the ozone dose or contact time while ensuring alternative disinfection (UV or chlorine) provides adequate pathogen inactivation
- C. Switch from chloramines to free chlorine in the distribution system to neutralize the bromate
- D. Add activated carbon after ozonation to adsorb the bromate before it reaches the distribution system

26. A treatment plant operator performing a routine walkthrough notices that the motor on a raw water pump is producing a high-pitched whining noise that was not present during the previous shift. The pump is producing its rated flow and pressure, and the motor amperage is within normal range. The operator should:

- A. Continue monitoring and record the observation but take no immediate action since all performance parameters are normal

- B. Increase the lubrication to the motor bearings to address the noise before the next scheduled PM
- C. Reduce the pump speed to determine if the noise changes with rotational velocity
- D. Document the noise change and schedule a vibration analysis or bearing inspection at the earliest opportunity, as noise changes often precede bearing failure

27. A treatment plant treats 2.0 MGD of surface water. The plant uses chlorine for disinfection, adding it after filtration. The raw water TOC is 3.8 mg/L and the finished water TOC is 2.5 mg/L. The plant's TOC removal percentage is:

- A. 34%, which should be compared against the enhanced coagulation matrix requirement for the plant's raw water TOC and alkalinity
- B. 66%, indicating that the plant is removing far more TOC than any regulatory framework requires
- C. 100% minus the ratio of finished to raw TOC, equaling 53% removal
- D. Not calculable without knowing the total volume of coagulant applied during the treatment process

28. A plant operator receives a consumer complaint about pink staining in a bathroom. The staining is most prominent on shower curtains, toilet bowls, and pet water dishes — surfaces that remain wet for extended periods. The most likely cause is:

- A. Elevated iron concentrations in the distribution system causing a reddish-pink discoloration
- B. Residual chloramine reacting with bathroom fixtures to produce a colored chemical precipitate
- C. Airborne bacteria (*Serratia marcescens*) that thrive on moist surfaces — a household condition unrelated to water quality
- D. Excessive manganese in the finished water depositing on wet surfaces during evaporation periods

29. An operator calculating the filtration rate for a filter discovers that the rate has increased from the normal 3.0 gpm/ft² to 4.5 gpm/ft². No filters have been taken offline and the plant flow has not changed. The most likely cause is:

- A. One or more filters have been taken offline without the operator's knowledge, forcing more flow through the remaining filters
- B. The plant flow has decreased and the flow controller has malfunctioned, failing to reduce the filter feed
- C. The filter media has expanded during the current run, creating more surface area for filtration
- D. The influent valve to the filter has stuck in the fully open position regardless of the controller signal

30. A treatment plant's emergency response plan includes a procedure for responding to a chemical delivery accident in which a tanker truck overturns in the plant's parking lot, spilling concentrated ferric chloride. The first priority in this response is to:

- A. Begin neutralizing the spill with soda ash to prevent the ferric chloride from reaching the storm drain
- B. Photograph the scene and collect the driver's insurance information for the utility's legal department
- C. Determine the exact volume spilled by measuring the remaining chemical in the overturned tanker
- D. Ensure the safety of all personnel, evacuate the immediate area, and don appropriate PPE before approaching the spill

31. An operator measures the free chlorine residual at three points in the distribution system. Point A (near the plant) reads 1.2 mg/L, Point B (midway) reads 0.7 mg/L, and Point C (farthest from the plant) reads 0.15 mg/L. This pattern of declining residual is most likely caused by:

- A. Chlorine consumption by reactions with pipe materials, biofilm, sediment, and NOM as water age increases with distance from the plant
- B. Dilution of the chlorine by unchlorinated groundwater leaking into the distribution mains through joint failures
- C. The DPD test kits at each location having different expiration dates, producing inconsistent results
- D. Increasing water pressure at greater distances from the plant, which suppresses chlorine's disinfecting activity

32. A treatment plant operator is troubleshooting a problem with the plant's lime feed system. The lime slaker is producing a slurry with visible grit and undissolved lumite particles. Downstream, the lime feed line is clogging frequently. The most likely cause is:

- A. The lime product has a moisture content that is too low, preventing it from hydrating completely in the slaker
- B. The slaker water temperature is too high, causing the lime to calcine rather than hydrate properly
- C. The lime product contains excessive impurities or grit, or the slaker is not providing adequate mixing and water for complete hydration
- D. The lime feed line is the wrong material and is reacting with the slurry to create precipitates

33. A treatment plant operator performing a filter inspection during backwash observes that the wash water rising above the media has a distinctly green color. This green coloration most likely indicates:

- A. The filter media has been contaminated with copper from corroded distribution system piping recycled through backwash
- B. Algae growth has accumulated in the filter media during the production run and is being washed out during backwash
- C. The anthracite media is dissolving and releasing carbon compounds that produce a green tint in the wash water
- D. The coagulant feed line has a leak that is introducing ferric chloride directly into the filter cell

34. An operator receives notification that the state primacy agency will conduct a sanitary survey of the treatment plant in two weeks. In preparation, the operator should:

- A. Prepare the plant by addressing any known deficiencies and ensuring all records, procedures, and documentation are current
- B. Ensure all operational records are organized and accessible, review compliance data for accuracy, and verify that all required SOPs are current and available

C. Repaint the facility exterior and replace all signage to create a positive impression for the inspection team

D. Contact the primacy agency to request a postponement until the plant can complete planned capital improvements

35. A treatment plant uses UV disinfection as its primary barrier against *Cryptosporidium*. The UV system's sensors indicate that the UV dose being delivered has decreased by 20% over the past month. The operator should investigate which of the following as the most likely cause?

A. Fouled quartz sleeves, aging lamps with declining output, or decreased water UV transmittance

B. Increased water temperature, which reduces the germicidal effectiveness of UV light proportionally

C. Rising chlorine residual in the UV influent, which absorbs UV light and reduces the available dose

D. Declining raw water turbidity, which allows more UV light to pass through without contacting pathogens

36. An operator discovers that the plant has been inadvertently reporting combined filter effluent turbidity readings from only three of four operating filters due to a SCADA data configuration error. The fourth filter's effluent was not being included in the combined calculation. This discovery means:

A. All previous turbidity compliance reports are accurate because three filters are sufficient for the calculation

B. No regulatory implications exist because individual filter monitoring is not required under the SWTR

C. The historical compliance data may be inaccurate and the error must be corrected, reported to the primacy agency, and investigated for potential violation implications

D. The plant should immediately shut down the fourth filter to match the SCADA configuration

37. A treatment plant's chemical metering pump for sodium hypochlorite has a maximum output of 50 gallons per hour. The plant treats 4.0 MGD and uses 12% sodium hypochlorite ($SG = 1.17$). If the plant

needs to feed a chlorine dose of 4.0 mg/L during a high-demand period, is the pump capacity sufficient? (Calculate lb/day Cl₂ needed first, then convert to gallons per day and gallons per hour of solution.)

- A. No, the pump capacity is insufficient — the required feed rate exceeds 50 gallons per hour
- B. Yes, the pump capacity is sufficient — the required feed rate is approximately 12 gallons per hour
- C. No, the pump must be replaced with a centrifugal pump that can deliver higher volumes at lower pressure
- D. Yes, the pump capacity is sufficient — the required feed rate is approximately 48 gallons per hour

38. A water treatment plant operator is investigating declining filter performance. The plant's four dual-media filters have been in service for 15 years without media replacement. Core samples reveal that the anthracite has lost approximately 25% of its original grain size due to attrition. This media degradation would most likely cause:

- A. Longer filter runs because the smaller particles create tighter pore spaces that capture material more efficiently
- B. Lower headloss development because the worn media creates less resistance to water flow through the bed
- C. Improved effluent quality because the finer anthracite provides better particle capture at all depths
- D. Shorter filter runs and increased surface blinding because the finer particles pack more tightly at the top of the bed

39. An operator collecting a water sample for metals analysis (dissolved iron and manganese) must perform which critical step at the point of collection to distinguish dissolved metals from total metals?

- A. Filter the sample through a 0.45-micrometer membrane filter to remove particulate metals, then acidify the filtrate for preservation
- B. Add sodium thiosulfate to the sample to dechlorinate it and prevent the chlorine from oxidizing dissolved metals

C. Heat the sample to 60°C for 15 minutes to convert all particulate metals to dissolved form before testing

D. Collect the sample in a pre-sterilized bottle and incubate at 35°C for 24 hours before submitting for analysis

40. A treatment plant operator reviewing the SCADA alarm history notices that the high-level alarm on Chemical Tank #3 (sodium hypochlorite) activated at 2:14 AM. No chemical delivery was scheduled overnight. The most appropriate response is to:

A. Silence the alarm and reset the tank level indicator because the sensor probably malfunctioned overnight

B. Wait for the day shift to investigate because tank level alarms do not require immediate response

C. Investigate immediately — an unexplained level increase in a chemical tank could indicate a valve leak, instrument malfunction, or unauthorized access

D. Drain Chemical Tank #3 to half capacity and refill it with fresh product to verify the level sensor accuracy

41. A treatment plant's jar test results for six alum doses show the following pH values in the settled water: 10 mg/L = pH 7.3, 20 mg/L = pH 7.0, 30 mg/L = pH 6.7, 40 mg/L = pH 6.3, 50 mg/L = pH 5.9, 60 mg/L = pH 5.5. The raw water has an alkalinity of 50 mg/L as CaCO₃. This pH trend demonstrates that:

A. Higher alum doses produce higher pH because the aluminum hydroxide formed is a basic compound

B. The raw water has excessive alkalinity that is buffering the pH against any meaningful change

C. The relationship between alum dose and pH is random and cannot be predicted from alkalinity data

D. Each increment of alum consumes alkalinity and progressively lowers pH, with the most dramatic drops occurring once the alkalinity buffer is nearly exhausted

42. An operator is calibrating a laboratory turbidimeter. After calibrating with the manufacturer's standards, the operator measures a 20 NTU check standard from a different lot. The instrument reads 21.8 NTU. The acceptable tolerance for check standard verification is $\pm 10\%$. Should the operator accept the calibration?

A. No, because 21.8 NTU is outside the $\pm 10\%$ tolerance of the 20 NTU check standard ($20 \pm 2.0 = 18.0$ to 22.0)

B. Yes, because 21.8 NTU is within the $\pm 10\%$ tolerance of the 20 NTU check standard ($20 \pm 2.0 = 18.0$ to 22.0)

C. No, because check standards must read within $\pm 1\%$ of the expected value for the calibration to be valid

D. Yes, but only if the operator recalibrates using the check standard values rather than the manufacturer's standards

43. A treatment plant uses a Parshall flume to measure raw water flow. After a heavy storm, debris accumulates in the flume approach channel, partially blocking the converging section. The operator notices that the SCADA-reported flow has increased by 15% even though the raw water pumps have not changed speed. The operator should conclude that:

A. The debris is raising the upstream water level, causing the flume to overestimate the actual flow rate

B. The storm has increased the actual raw water flow by 15% through additional runoff entering the intake

C. The Parshall flume is self-cleaning and the debris cannot affect the flow measurement accuracy

D. The debris has created a venturi effect that accelerates the water and increases the actual flow through the flume

44. An operator at a small water system is reviewing the annual budget and notices that chemical costs have increased by 35% compared to the previous year. The plant flow has remained essentially unchanged. Which of the following is the most productive first step in investigating the cost increase?

- A. Contact the chemical supplier to negotiate a lower price per unit for the next contract period
- B. Reduce all chemical feed rates by 35% to bring costs back in line with the previous year's budget
- C. Compare raw water quality data between the two years and review jar test records to determine if coagulant demand has changed
- D. Switch to the cheapest available coagulant product regardless of its performance characteristics

45. A treatment plant's SCADA system generates an alarm indicating that the UV disinfection system's UV sensor reading has dropped below the minimum validated dose. The plant also uses chlorine for CT compliance. The operator should:

- A. Shut down the plant immediately because UV failure means no disinfection barrier exists for any pathogen
- B. Verify the UV sensor reading, check lamp status and sleeve condition, and determine whether the plant's chlorine CT alone provides sufficient pathogen inactivation credit while the UV system is addressed
- C. Ignore the alarm because chlorine provides all necessary disinfection and UV is only supplemental
- D. Increase the chlorine dose to the maximum MRDL of 4.0 mg/L to compensate for the UV system failure

46. A water treatment plant has experienced two consecutive quarters of TTHM results above 0.080 mg/L at Distribution Monitoring Location #3, while the other three monitoring locations show results below 0.060 mg/L. The operator should recognize that:

- A. No violation has occurred because only the system-wide average matters for TTHM compliance
- B. The system-wide average is the sole compliance metric, and individual locations cannot trigger violations
- C. A violation has not necessarily occurred yet, but the LRAA at Location #3 may be approaching the MCL and requires focused attention

D. A violation at Location #3 is irrelevant because compliance is based on the average of all four locations

47. An operator needs to convert a flow reading from gallons per minute (gpm) to million gallons per day (MGD). The current flow is 2,500 gpm. The conversion is:

A. $2,500 \times 1,440 \div 1,000 = 3,600$ MGD

B. $2,500 \div 694 = 3.60$ MGD

C. $2,500 \times 1,440 \div 1,000,000 = 3.60$ MGD

D. $2,500 \times 60 \div 1,000,000 = 0.15$ MGD

48. A treatment plant operator discovers that the SCADA historian has not been recording data for the past 72 hours due to a database storage failure. Online instruments continued displaying real-time data on the HMI screens, and the operator has been recording hourly readings manually in the daily operations log. The primary concern about this data gap is:

A. The manually recorded hourly readings may be insufficient to satisfy regulatory requirements for continuous monitoring data at 15-minute intervals

B. The SCADA historian failure proves that the entire SCADA system is unreliable and must be replaced immediately

C. No concern exists because manual operator logs are always considered superior to electronic records for regulatory purposes

D. The plant must shut down until the historian is restored because treatment cannot legally continue without electronic data recording

49. A treatment plant uses a belt filter press for sludge dewatering. The press has been producing cake with a solids content of 20%, but over the past two weeks the cake has become wetter, with solids content declining to 12%. The polymer dose and press settings have not changed. The most likely cause is:

- A. The raw water turbidity has decreased, producing sludge with a different composition that is harder to dewater
- B. The belt press belts have stretched beyond their useful life and are no longer applying adequate pressure
- C. The sludge withdrawal rate from the sedimentation basins has decreased, producing a more concentrated sludge
- D. A change in sludge characteristics (increased organic content, different coagulant floc, or polymer degradation) is reducing the dewatering efficiency

50. A treatment plant operator measures the chlorine residual at the clearwell outlet at 1.0 mg/L. The clearwell volume is 300,000 gallons, the plant flow is 2.0 MGD (1,389 gpm), and the clearwell has superior baffling (factor 0.7). The CT achieved is:

- A. 216 mg·min/L
- B. 151 mg·min/L
- C. 108 mg·min/L
- D. 302 mg·min/L

51. A treatment plant operator is investigating why the plant's finished water has developed a noticeable chlorine taste despite the chlorine residual being within its normal range of 0.8 to 1.0 mg/L. The operator discovers that the finished water pH has recently increased from 7.2 to 8.2. The connection between pH increase and chlorine taste is:

- A. At higher pH, more chlorine exists as hypochlorite ion, which produces a stronger chlorine taste than hypochlorous acid
- B. Higher pH causes chlorine to become more volatile, increasing the amount of chlorine gas released from the water
- C. The pH increase has no relationship to chlorine taste and the cause must be investigated elsewhere

D. At higher pH, the chloramine formation reaction is accelerated, and chloramines produce a stronger taste than free chlorine

52. A water treatment plant performing enhanced coagulation achieves 30% TOC removal. The enhanced coagulation matrix based on the plant's raw water TOC of 4.0 mg/L and alkalinity of 120 mg/L as CaCO₃ requires 25% TOC removal. Based on these results:

A. The plant is in violation because it should achieve exactly 25% removal and no more to minimize chemical costs

B. The plant must increase its coagulant dose further because 30% is still below the minimum required for this TOC range

C. The plant is meeting the enhanced coagulation requirement because 30% exceeds the required 25% removal

D. The TOC monitoring data is invalid because removal percentages cannot exceed the matrix requirement

53. An operator observes that a chemical metering pump's output has gradually declined over the past month despite the stroke length and rate settings remaining unchanged. The calibration column confirms the declining output. The most likely cause is:

A. The chemical solution strength has increased, requiring less volume to deliver the same dose

B. The plant flow has increased, diluting the chemical and making it appear that less is being delivered

C. The SCADA system is reporting incorrect flow data that makes the pump output appear lower than actual

D. Worn check valves or a deteriorating diaphragm are allowing chemical to slip back through the pump on each stroke

54. An operator is preparing to enter a valve vault located below grade in the distribution system. The vault has been closed for several months. Before entry, the operator must complete which critical safety procedure?

- A. Treat the vault as a permit-required confined space, perform atmospheric testing, and follow all confined space entry requirements
- B. Open the vault hatch and visually inspect the interior from above to determine if entry is safe
- C. Enter quickly to complete the work in less than five minutes, which does not require confined space procedures
- D. Verify that the valve vault appears dry and free of standing water before entering without additional precautions

55. A treatment plant using chlorine gas for disinfection has a chlorine leak detector installed in the chlorine room. During the weekly functional test, the detector fails to alarm when exposed to the test gas. The operator should:

- A. Record the failed test and schedule detector repair during the next quarterly maintenance window
- B. Take the detector out of service, arrange for immediate repair or replacement, and implement interim safety measures including enhanced personnel monitoring
- C. Continue using chlorine gas because the detector is a backup safety device and not required for daily operations
- D. Switch the plant to sodium hypochlorite disinfection permanently to eliminate the need for a leak detector

56. A treatment plant's raw water has a pH of 7.8. The operator adds alum at the optimal dose determined by jar testing, and the coagulated water pH drops to 6.5. After filtration, the operator adds sodium hydroxide (caustic soda) to raise the pH to 7.5 for corrosion control. This two-stage pH management approach is used because:

- A. Federal regulations require pH to be measured and adjusted at exactly two points in the treatment process
- B. The plant has no other chemicals available for pH adjustment and must use caustic soda exclusively
- C. Optimal alum coagulation requires lower pH (6.5) while optimal corrosion control requires higher pH (7.5), and these conflicting requirements cannot be met at a single pH

D. The caustic soda addition neutralizes the toxicity of the aluminum hydroxide floc remaining in the filtered water

57. A treatment plant performs weekly verification of its online chlorine analyzer by comparing the analyzer reading against a simultaneous DPD grab sample. For the past three weeks, the analyzer has consistently read 0.3 mg/L higher than the DPD result. The operator should:

A. Accept the analyzer readings as more accurate because online instruments are inherently superior to manual testing

B. Average the two readings and use the average for compliance reporting each week

C. Verify the DPD reagent expiration date and test kit condition before recalibrating the online analyzer

D. Recalibrate the online analyzer immediately to match the DPD reference result

58. An operator at a treatment plant with a standby generator performs the weekly generator test. The generator starts on the first attempt, picks up the load through the ATS, and operates at rated voltage and frequency. However, the operator notices that the engine oil pressure gauge reads 10 psi below the normal operating range. The operator should:

A. Accept the test as passed because the generator started and carried the load successfully

B. Document the low oil pressure, investigate the cause (low oil level, worn oil pump, clogged filter, incorrect gauge), and correct the problem before the next scheduled test

C. Immediately perform a full engine overhaul to prevent catastrophic bearing failure during the next power outage

D. Reduce the generator's load capacity by disconnecting non-critical circuits to lower the oil pressure demand

59. A water treatment plant operator measures a well's static water level at 35 feet below the top of the casing. When the pump operates at 300 gpm, the pumping water level stabilizes at 62 feet. The specific capacity is:

- A. 18,600 gpm·ft representing the total hydraulic capacity of the well and aquifer system
- B. 11.1 gpm/ft indicating the well produces 11.1 gallons per minute for each foot of drawdown
- C. 0.09 ft/gpm indicating that the well draws down 0.09 feet for each gallon per minute pumped
- D. 300 gpm regardless of drawdown because centrifugal well pumps deliver constant flow at any head

60. A treatment plant operator notices that the settled water from the sedimentation basins has a milky, white appearance that is unusual. The raw water is clear groundwater. The plant recently switched from liquid alum to a new dry alum product. The most likely cause of the milky appearance is:

- A. The new dry alum product has a lower pH that is precipitating calcium carbonate from the hard groundwater
- B. The groundwater source has suddenly changed and now contains elevated turbidity from an upstream contamination event
- C. The new dry alum product is not dissolving completely, or the slurry preparation system is producing an inconsistent mix that introduces undissolved particles
- D. The sedimentation basin sludge scraper has malfunctioned and is resuspending previously settled sludge into the basin effluent

61. A treatment plant's operator certification program requires Class I operators to complete continuing education credits for certification renewal. The primary purpose of this requirement is to:

- A. Generate revenue for training organizations and the state certification program through course enrollment fees
- B. Provide operators with an opportunity to take time off from plant operations during training sessions
- C. Satisfy federal insurance requirements that mandate a minimum number of training hours per employee per year
- D. Ensure operators maintain current knowledge of evolving treatment technology, regulatory changes, and industry best practices

62. An operator at a surface water plant notices that the reservoir level has dropped 8 feet below its normal elevation due to an extended drought. The intake structure draws water from a fixed-depth intake. As the reservoir level drops, the operator should anticipate that the raw water quality may change because:

- A. The intake is now drawing water from a different depth in the reservoir, potentially encountering different temperature, dissolved oxygen, and mineral profiles
- B. Drought conditions always improve raw water quality by concentrating beneficial minerals
- C. The intake will begin drawing air instead of water when the reservoir drops more than 5 feet below normal
- D. Reservoir level changes have no effect on raw water quality at a fixed-depth intake structure

63. A treatment plant's emergency plan requires the operator to respond to a loss of all chemical feed capability. The raw water source is high-quality groundwater with naturally low turbidity and no history of microbial contamination. If the chemical feed systems cannot be restored within two hours, the operator should:

- A. Notify the supervisor and the state primacy agency, evaluate whether the untreated groundwater poses an immediate health risk, and prepare for potential public notification
- B. Continue normal production because groundwater does not require chemical treatment under any circumstances
- C. Shut down the plant immediately and issue a boil-water advisory to all customers within 30 minutes
- D. Switch to the plant's surface water source to maintain production while the chemical systems are being repaired

64. A treatment plant operator measures the temperature of the raw water at 4°C (39°F) during winter operations. Compared to summer conditions when the raw water is 22°C (72°F), the operator should anticipate that winter treatment will require:

- A. Lower coagulant doses because cold water has higher viscosity that improves particle contact

- B. Shorter sedimentation detention times because cold water is denser and particles settle faster
- C. Higher coagulant doses and potentially polymer aid because cold water reduces coagulation and flocculation efficiency and increases water viscosity, slowing particle settling
- D. No treatment adjustments because water temperature has minimal effect on conventional treatment processes

65. A treatment plant is evaluating two filter backwash approaches: conventional water-only backwash versus air scour followed by water backwash. The primary advantage of the combined air scour plus water approach is:

- A. Air scour eliminates the need for water during backwash, conserving 100% of the water that would otherwise be used
- B. Air scour provides more aggressive scrubbing of the media grains, more effectively removing attached particles and biological growth than water alone
- C. Combined backwash allows the operator to use lower-quality water sources for the air scour phase
- D. Air scour eliminates the filter ripening period, allowing the filter to return to service immediately

66. A treatment plant operator discovers that the facility's SDS binder in the chemical storage area was last updated 18 months ago. Two new chemicals have been added to the plant's inventory since the last update, and one chemical product was reformulated by the manufacturer. The operator should:

- A. Continue using the current SDS binder because the information for chemicals that have not changed is still valid
- B. Request the current binder from the state agency because SDS updates are the responsibility of the regulatory authority
- C. Remove the SDS binder entirely because electronic SDS databases have replaced the requirement for on-site physical copies
- D. Obtain current SDS documents for all chemicals, update the binder immediately, and ensure all operators know about the changes

67. An operator is reviewing a trend of increasing specific capacity decline in a production well. The specific capacity has dropped from 10.0 gpm/ft to 6.5 gpm/ft over two years. Well rehabilitation options include mechanical redevelopment (surging, jetting, brushing) and chemical treatment (acid treatment to dissolve mineral deposits). Before selecting a rehabilitation method, the operator should:

- A. Obtain a video inspection of the well bore and screen to identify whether the obstruction is mineral encrustation, biological growth, sediment infiltration, or physical screen damage
- B. Immediately begin pumping the well at maximum capacity to flush out whatever material is restricting flow
- C. Abandon the well and drill a new replacement well at a different location within the wellhead protection area
- D. Reduce the pumping rate to match the current specific capacity and accept the reduced well performance

68. A treatment plant uses both an online turbidimeter and a benchtop laboratory turbidimeter. During a verification check, the online instrument reads 0.06 NTU while a simultaneously collected grab sample reads 0.11 NTU on the benchtop unit. Both instruments were calibrated within the past week using traceable standards. Before concluding that one instrument needs recalibration, the operator should consider:

- A. Only the online reading should be used for compliance because it is the regulatory reporting instrument
- B. The laboratory value is always more accurate than the online value because benchtop instruments are inherently superior
- C. At this low turbidity range, the difference of 0.05 NTU may be within the combined measurement uncertainty of both instruments
- D. Both instruments have failed calibration and must be sent to the manufacturer for factory service before either can be used

69. A treatment plant's chemical delivery records show that the utility received three separate deliveries of liquid alum from the same supplier over the past quarter. The certificates of analysis show that the

aluminum content varied between deliveries: 4.2%, 4.4%, and 3.9% (expressed as Al_2O_3). This variation means:

- A. The supplier is providing consistent product because all three values are within 0.5% of each other
- B. The plant should switch suppliers because any variation in chemical quality indicates unreliable manufacturing
- C. The variation is irrelevant because the volumetric feed rate determines the dose regardless of aluminum content
- D. The operator must adjust the coagulant feed rate after each delivery to account for the differing aluminum content and maintain a consistent dose

70. An operator notices that the distribution system pressure at a critical monitoring point has been gradually declining from 65 psi to 48 psi over the past three months. No changes have been made to the high-service pumps, no new customers have been added, and the plant production rate has remained constant. The most likely cause is:

- A. Normal seasonal pressure variations that occur in all distribution systems regardless of operational changes
- B. Progressive restriction in the distribution main from internal corrosion, tuberculation, or a partially closed valve between the plant and the monitoring point
- C. Declining atmospheric pressure from weather changes that directly reduces distribution system pressure readings
- D. The pressure transmitter at the monitoring point has gradually drifted low and needs recalibration rather than indicating an actual pressure decline

71. An operator tests the alkalinity of the raw water and obtains a phenolphthalein alkalinity of 0 mg/L and a total alkalinity of 95 mg/L as CaCO_3 . This means the alkalinity in the water is present as:

- A. Entirely hydroxide alkalinity with no carbonate or bicarbonate alkalinity present

B. Entirely carbonate alkalinity with no bicarbonate alkalinity present

C. Entirely bicarbonate alkalinity because a phenolphthalein alkalinity of zero indicates no carbonate or hydroxide alkalinity

D. A mixture of equal parts carbonate and hydroxide alkalinity that balance to produce a zero phenolphthalein reading

72. A treatment plant's operator is training a new employee on emergency shutdown procedures. The trainee asks why the plant has both an automatic generator and a manual emergency shutoff for the chemical feed systems. The best explanation is:

A. The generator maintains plant operations during power outages, while the chemical shutoff allows operators to stop chemical feed independently during chemical emergencies without stopping the entire plant

B. The generator and the chemical shutoff perform the same function and are redundant systems that could be combined

C. Federal regulations require exactly two emergency systems at every treatment plant regardless of plant size or complexity

D. The generator powers the chemical shutoff, so they must always operate together in a linked emergency sequence

73. A treatment plant using conventional treatment treats surface water with seasonal algae blooms. During a severe bloom, the operator observes that the filters are producing effluent turbidity of 0.08 NTU but are requiring backwash every 10 hours instead of the normal 48 hours. The dramatically shortened filter runs are most likely caused by:

A. The algae are passing through the filters and not being captured by the media during the bloom period

B. The high algae loading is clogging the filter surface rapidly, causing accelerated headloss development despite adequate effluent quality

C. The filter backwash system is malfunctioning and not fully cleaning the media during each backwash cycle

D. The turbidimeters are reading incorrectly low, masking a significant filter performance problem during the bloom

74. A water treatment plant operator is reviewing the plant's compliance status and discovers that a required quarterly DBP sample was not collected during the previous quarter due to an administrative oversight. The missed sample constitutes:

A. An MCL violation because the missing data is treated as an exceedance of the THM and HAA standards

B. A treatment technique violation because the plant failed to implement a required DBP reduction strategy

C. No violation as long as the sample is collected within 30 days of the end of the missed quarter

D. A monitoring violation that requires Tier 3 public notification and correction of the monitoring schedule

75. An operator is reviewing the manufacturer's specifications for a new centrifugal pump being considered for the plant's high-service application. The pump curve shows the best efficiency point (BEP) at 1,500 gpm and 120 feet of head. The plant's system curve intersects the pump curve at 1,200 gpm and 140 feet of head. Operating at this intersection point means:

A. The pump will operate to the left of its BEP, at lower flow and higher head than optimal, potentially causing increased vibration and reduced efficiency

B. The pump is perfectly matched to the system and will operate at peak efficiency at all flow conditions

C. The pump is too small for the application and must be replaced with a larger unit before installation

D. The system curve intersection point always equals the BEP regardless of the pump and system characteristics

76. A treatment plant operator observes that the plant's two parallel flocculation trains are producing noticeably different floc characteristics — Train A produces large, dense floc that settles quickly, while

Train B produces small, light, pin-point floc that settles poorly. Both trains receive the same coagulated water from the same rapid mix chamber. The most likely cause of the difference is:

- A. The raw water quality is different in each train because they draw from separate intake structures
- B. The coagulant dose is being split unevenly between the two trains, with Train A receiving more chemical
- C. The mixer speeds, paddle conditions, or baffling in Train B are different from Train A, resulting in inadequate flocculation
- D. Train B's sedimentation basin is oversized, providing too much detention time for effective settling

77. A treatment plant treats 3.0 MGD of surface water. The plant's sedimentation basins have a combined surface area of 4,000 square feet. The surface overflow rate is:

- A. 750 gpd/ft², calculated by converting the daily flow to gallons per day and dividing by the basin surface area
- B. 375 gpd/ft², which is half the actual rate because only two of four basins are in service
- C. 1,080 gpd/ft², indicating the basins are operating well above typical design guidelines
- D. 750 gpm/ft², which exceeds the recommended maximum for conventional sedimentation basins

78. A treatment plant operator receives a water quality complaint from a school. The school reports that the water fountains are producing water with a brown discoloration every Monday morning but the water clears within 30 minutes of use. During the rest of the week, the water quality is normal. The most likely explanation is:

- A. The treatment plant experiences process upsets every weekend when staffing is reduced
- B. Water stagnation in the school's internal plumbing over the weekend allows dissolved iron or copper to accumulate, which flushes out when the fountains are first used Monday morning

C. The distribution main serving the school is undersized and cannot maintain adequate flow during Monday peak demand

D. The school's water fountains have defective filters that need replacement on a weekly maintenance cycle

79. An operator performing maintenance on a chemical feed system is preparing to disconnect a section of the sodium hypochlorite feed line for replacement. Before disconnecting the line, the operator must first:

A. Close and lock the upstream isolation valve, relieve any residual pressure, and drain the chemical from the section to be removed while wearing appropriate PPE

B. Flush the line with water for 30 minutes to dilute the sodium hypochlorite to a non-hazardous concentration

C. Obtain written permission from the state primacy agency before performing any work on chemical feed systems

D. Replace the entire feed line from the chemical tank to the injection point rather than just the damaged section

80. An operator discovers during routine monitoring that the fluoride level in the finished water has spiked to 3.2 mg/L. The plant's target is 0.7 mg/L and the MCL is 4.0 mg/L. The operator should:

A. Take no action because 3.2 mg/L is below the MCL of 4.0 mg/L and does not constitute a violation

B. Issue Tier 1 public notification within 24 hours because any fluoride level above 2.0 mg/L is an acute hazard

C. Immediately investigate and correct the fluoride feed system, notify the supervisor, increase monitoring frequency, and evaluate whether the exceedance of the secondary standard (2.0 mg/L) requires notification

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

81. A treatment plant operator is evaluating the effectiveness of the plant's source water protection program. Which of the following indicators would best demonstrate that the program is achieving its objectives?

- A. Declining raw water quality trends that require progressively more aggressive treatment over time
- B. Stable or improving raw water quality trends over multiple years, with no new contamination sources identified within the protection area
- C. Increased chemical costs as the treatment plant compensates for deteriorating source water conditions
- D. Increased frequency of positive coliform samples in the distribution system over the monitoring period

82. A treatment plant's online pH analyzer is installed in a location where the sample is exposed to the atmosphere for several minutes before reaching the sensor. The operator notices that the online pH reading is consistently 0.3 to 0.5 units lower than grab samples measured immediately at the process point. The most likely cause of this discrepancy is:

- A. The pH electrode is nearing the end of its useful life and producing an increasingly sluggish response
- B. The online analyzer is reading accurately but the grab sample technique is introducing contamination that raises pH
- C. The long sample exposure time allows carbon dioxide to dissolve into the water from the atmosphere, lowering the pH before it reaches the sensor
- D. Carbon dioxide is escaping from the sample during atmospheric exposure, raising the pH before it reaches the sensor

83. A water treatment plant treats groundwater with elevated hydrogen sulfide (H_2S) at 2.5 mg/L. The treatment strategy uses packed tower aeration to strip the H_2S from the water. After aeration, the operator should verify treatment effectiveness by:

- A. Testing the treated water for H_2S concentration and odor to confirm the aeration has reduced the level to below the detectable threshold

- B. Measuring the turbidity of the aerated water to confirm that the H₂S particles have been physically removed
- C. Testing the chlorine demand of the aerated water because H₂S removal always eliminates chlorine demand
- D. Measuring the pH of the aerated water because effective H₂S removal always raises the pH above 9.0

84. A treatment plant's filter performance data shows the following individual filter effluent turbidities: Filter 1 = 0.05, Filter 2 = 0.04, Filter 3 = 0.06, Filter 4 = 0.04. The combined filter effluent turbidity measured by the plant's online instrument reads 0.12 NTU. The operator should conclude that:

- A. The individual filter readings are inaccurate because they should mathematically average to approximately 0.05 NTU, not 0.12
- B. An unfiltered bypass or a sample line problem is introducing turbidity into the combined effluent that does not come from the filters
- C. The combined effluent turbidimeter is reading accurately because blending filter effluents always increases turbidity above the average of individual readings
- D. This discrepancy is normal and expected because combined measurements are always higher than individual measurements by a factor of 2 to 3

85. A treatment plant using chloramination for distribution system residual discovers that a section of the distribution system served by a long dead-end main has experienced a complete loss of disinfectant residual. Heterotrophic plate counts in the affected area exceed 500 CFU/mL. The most effective immediate corrective action is:

- A. Increase the ammonia feed rate at the plant to produce higher chloramine levels throughout the entire system
- B. Conduct unidirectional flushing of the affected dead-end main and temporarily boost the disinfectant residual through a free chlorine burn or increased chloramine feed to the affected area
- C. Install a booster chlorination station at the far end of the dead-end main to provide a continuous additional residual

D. Lop the dead-end main into a looped configuration to improve circulation, which will resolve the residual issue immediately

86. A water system's Consumer Confidence Report includes a detected arsenic level of 0.008 mg/L. The arsenic MCL is 0.010 mg/L. The CCR must include:

A. The detected level, the MCL, the MCLG (zero for arsenic), the likely source, and the health effects language specified by EPA

B. Only the statement "arsenic was detected" without specifying the concentration to avoid alarming consumers

C. A recommendation that all customers install home treatment systems to remove the remaining arsenic

D. The detected level compared only to the secondary standard, since arsenic is primarily an aesthetic concern

87. An operator performs a weekly load test on the standby generator. The generator starts, picks up the load, and runs for the required 30 minutes. During the test, the operator records the following: voltage = 480V (normal), frequency = 60 Hz (normal), oil pressure = normal, coolant temperature = normal, but the fuel consumption rate appears approximately 40% higher than the manufacturer's specification for the applied load. This increased fuel consumption most likely indicates:

A. An engine performance problem such as a fuel injector malfunction, incorrect timing, air filter restriction, or turbocharger issue that is reducing combustion efficiency

B. Normal variation because fuel consumption rates vary widely between generator test cycles based on ambient temperature

C. The fuel gauge is inaccurate and the actual consumption is within the manufacturer's specification

D. The generator is producing more power than the instruments indicate, which explains the higher fuel use

88. A treatment plant's laboratory performs duplicate analysis on a turbidity sample. The first reading is 0.15 NTU and the second reading is 0.22 NTU. The relative percent difference (RPD) between these duplicates is approximately:

A. 7%

B. 18.5%

C. 38%, which exceeds the typical 10–20% acceptable RPD and indicates a precision problem requiring investigation

D. 0.07 NTU, which is the absolute difference between the two readings and represents the RPD

89. An operator investigating the cause of short filter runs discovers that the plant has been experiencing high settled water turbidity (3.0–4.5 NTU) from the sedimentation basins despite the coagulant dose being set at the level determined by the most recent jar test (performed two weeks ago). The operator's most appropriate next step is:

A. Re-verify the chemical feed pump calibration because two weeks is sufficient time for pump output to drift below the intended dose

B. Perform a fresh jar test immediately because raw water quality may have changed since the previous test

C. Increase the coagulant dose by 25% without jar testing because higher doses always improve sedimentation

D. Perform a fresh jar test, verify the chemical feed system calibration, and check whether raw water quality has changed since the last test — addressing all potential causes systematically

90. A treatment plant using UV disinfection measures the UV transmittance (UVT) of the filtered water at 82%. The plant's UV system was validated at a minimum UVT of 85%. The operator should:

A. Reduce the plant flow rate through the UV reactor to increase the exposure time and compensate for the lower UVT

- B. Investigate the cause of the low UVT (elevated NOM, color, or iron in the filtered water) and adjust upstream treatment to improve UVT before relying on reduced flow as a permanent solution
- C. Continue normal operations because a 3% UVT difference is within the instrument's measurement uncertainty
- D. Bypass the UV system and rely solely on chlorine for all pathogen inactivation until UVT recovers

91. A treatment plant's four filters have the following remaining media depths based on core sample analysis: Filter 1 = 28 inches (original 30), Filter 2 = 25 inches (original 30), Filter 3 = 29 inches (original 30), Filter 4 = 20 inches (original 30). Which filter requires the most urgent attention?

- A. Filter 1 because any media loss from its original depth indicates imminent filter failure
- B. Filter 3 because it has the least media loss and may be experiencing under-backwashing
- C. All four filters require equal attention because any variation from original depth is equally concerning
- D. Filter 4 because it has lost one-third of its original media depth, which significantly compromises filtration performance

92. A water treatment plant's emergency response plan should be reviewed and updated:

- A. Annually at minimum, and whenever significant changes occur at the plant such as new chemicals, new equipment, or new hazards
- B. Only when a regulatory agency directs the utility to update it during a compliance inspection
- C. Every five years to coincide with the state sanitary survey cycle
- D. Only after an actual emergency has occurred, using lessons learned from the event to improve the plan

93. An operator at a chloramination plant monitors the chlorine-to-ammonia nitrogen ratio by weight. The target ratio is 4:1 ($\text{Cl}_2:\text{NH}_3\text{-N}$). The current ratio has drifted to 2:1 due to an ammonia overfeed situation. The operator should be most concerned about:

- A. Excessive free chlorine residual in the distribution system causing elevated THM and HAA formation
- B. Formation of trichloramine, which produces the most objectionable taste and odor at this ratio
- C. Insufficient monochloramine formation, resulting in inadequate distribution system disinfection residual
- D. Excess free ammonia in the distribution system that will promote nitrification by nitrifying bacteria

94. A treatment plant is evaluating whether to install tube settlers in its existing sedimentation basins to increase treatment capacity. The primary benefit of tube settlers is that they:

- A. Completely replace the need for coagulation and flocculation before sedimentation
- B. Increase the effective settling area within the same basin footprint, allowing higher overflow rates without sacrificing settled water quality
- C. Provide biological treatment within the tubes that removes dissolved organic matter
- D. Eliminate the need for filter backwash by removing all particles before the water reaches the filters

95. An operator is reviewing the plant's records and discovers that the emergency generator's fuel was last tested 14 months ago. The manufacturer recommends fuel testing every 6 months for stored diesel. The operator's primary concern should be:

- A. The fuel may not meet current emissions standards and could cause the generator to fail an air quality inspection
- B. Regulatory fines for exceeding the manufacturer's recommended fuel testing interval by 8 months
- C. Fuel degradation from moisture contamination, microbial growth, or oxidation that could prevent the generator from starting during an actual emergency
- D. The fuel has likely evaporated significantly, leaving the tank well below the minimum required volume

96. A water treatment plant's finished water has a Langelier Saturation Index of -1.2 . The state primacy agency requires the plant to implement corrosion control to raise the LSI to between -0.5 and $+0.5$. The most effective treatment adjustment is to:

- A. Increase the finished water pH and alkalinity by adding lime, soda ash, or caustic soda after filtration
- B. Decrease the finished water pH to reduce the dissolution of calcium carbonate from pipe surfaces
- C. Increase the chlorine dose to create a protective oxidized layer on the interior pipe surfaces
- D. Add fluoride to the finished water because fluoride ions coat pipe surfaces and prevent corrosion

97. An operator receives laboratory results showing that the plant's quarterly THM sample at Distribution Location #2 is 0.105 mg/L. The previous three quarterly results at the same location were 0.072 , 0.068 , and 0.075 mg/L. The locational running annual average (LRAA) at this location is:

- A. 0.105 mg/L because only the most recent quarterly result is used for compliance determination
- B. 0.072 mg/L because the LRAA uses only the lowest of the four quarterly results
- C. 0.315 mg/L because the LRAA adds all four quarterly results without dividing by the number of quarters
- D. 0.080 mg/L, calculated as the average of the four most recent quarterly results at that specific location

98. A treatment plant's operator observes that the combined filter effluent turbidity has risen from its normal 0.04 NTU to 0.08 NTU over the past two hours. Individual filter monitoring shows that all four filters have increased by a similar amount. No filters have recently been returned from backwash. The most likely cause is:

- A. A single filter with a damaged underdrain is allowing unfiltered water to bypass the media
- B. A change in upstream treatment — either a coagulation problem, a raw water quality change, or a chemical feed issue — that is affecting the quality of water reaching all filters simultaneously

C. A calibration drift on the combined filter effluent turbidimeter that is producing falsely elevated readings

D. Normal diurnal turbidity variation that occurs in all treatment plants and does not warrant investigation

99. An operator is preparing a quarterly compliance report for the state primacy agency. The report must be accurate, complete, and signed by a responsible official. If the operator discovers a data entry error in a previous month's turbidity records while preparing the report, the operator should:

A. Correct the error using the proper documentation procedure (single line through the error, write the correct value, initial and date), include the corrected data in the quarterly report, and note the correction

B. Leave the error in the original record and submit the quarterly report with the incorrect data to avoid appearing to alter records

C. Destroy the original record and create a new record with the correct data to present clean documentation

D. Omit the month with the error from the quarterly report and submit data for only two of the three months

100. A water treatment plant is considering adding powdered activated carbon (PAC) to its treatment process to address seasonal taste and odor events caused by geosmin. The most effective point of PAC application in the treatment train is:

A. After disinfection in the clearwell to adsorb the geosmin from the finished water

B. In the distribution system through a PAC feeder installed on the main transmission line

C. As early as possible in the treatment process — typically at the raw water intake or rapid mix — to maximize contact time between the PAC and the geosmin before the carbon is removed during sedimentation and filtration

D. Into the filter media bed during backwash to coat the media with carbon for adsorption during the next production run

Practice Exam 5: Answer Key and Explanations

1. C — Turbidity measures suspended particles, but coagulant demand is also driven by dissolved natural organic matter (NOM) that turbidity instruments cannot detect. The increased raw water color (15 to 35 CU) indicates a significant rise in dissolved organic material, which consumes coagulant through adsorption and complexation reactions independent of particle destabilization.
2. B — Three total coliform-positive results from different locations within one month — even with negative repeats and no *E. coli* — may trigger a Level 1 or Level 2 assessment requirement under the RTCR, depending on the system's total monitoring volume and the frequency thresholds specified in the rule. Multiple positives indicate a systemic vulnerability.
3. D — Anthracite is the lightest filter media component (specific gravity 1.4–1.7) and is most vulnerable to loss over the wash troughs during backwash. Excessive backwash rates lift the anthracite above the trough level, carrying it out of the filter with the waste water. Six inches of cumulative loss represents significant capacity reduction requiring media addition.
4. A — Default manufacturer passwords are publicly documented and represent one of the most commonly exploited cybersecurity vulnerabilities in industrial control systems. Any attacker who knows the manufacturer and model of the PLC or HMI can access the system using the default credentials, potentially altering treatment process controls.
5. B — Alkalinity consumed = $40 \text{ mg/L alum} \times 0.5 = 20 \text{ mg/L}$. Remaining alkalinity = $85 - 20 = 65 \text{ mg/L as CaCO}_3$. This remaining alkalinity provides adequate buffering capacity to maintain pH within the effective coagulation range, though the operator should verify pH after coagulant addition.
6. D — Oxygen at 23.8% exceeds the safe maximum of 23.5%, indicating an oxygen-enriched atmosphere. Elevated oxygen levels increase the risk of fire and explosion because materials that do not normally burn in normal air can ignite in oxygen-enriched atmospheres. The space must be ventilated to reduce oxygen to within the 19.5–23.5% safe range.
7. A — Theoretical DT = $500,000 \text{ gal} \div 2,083 \text{ gpm (3.0 MGD)} = 240 \text{ min}$. $T_{10} = 240 \times 0.5 = 120 \text{ min}$. Required residual C = $CT \div T_{10} = 90 \div 120 = 0.75 \text{ mg/L}$. (Note: The calculated minimum residual is 0.75 mg/L. Candidates should work through the full CT calculation sequence: volume to detention time, apply baffling factor for T_{10} , then solve for the required residual.)

8. C — Sodium hypochlorite is a strongly basic solution with a pH of approximately 11 to 13. When added to water, it raises the pH — the opposite effect of chlorine gas, which lowers pH. This pH difference is an important operational consideration when switching between chlorine forms, as it affects coagulation optimization and corrosion control.

9. D — A direct connection between the potable water distribution main and an irrigation system with no backflow prevention device creates a cross-connection. If distribution system pressure drops (from a main break, pump failure, or fire flow), negative pressure can draw irrigation water — along with fertilizers, pesticides, and soil bacteria — into the potable supply through backsiphonage.

10. B — Without the sludge scraper operating, settled sludge accumulates continuously on Basin 2's floor. Over days and weeks, the sludge blanket rises progressively toward the effluent weirs. Once the blanket reaches the weir level, sludge is carried over into the filter influent, degrading downstream treatment performance.

11. A — The Ground Water Rule (GWR) specifically protects groundwater systems from fecal contamination. It requires triggered source water monitoring when total coliform-positive samples are detected, assessment of hydrogeological sensitivity, and 4-log virus treatment or corrective action when fecal indicators are confirmed in the source.

12. B — Elevated bearing temperature exceeding the manufacturer's maximum is a warning sign of developing bearing failure — regardless of what other parameters show. Bearings often run hot before they fail catastrophically. The pump should be shut down for inspection before the bearing seizes, which would cause far more extensive and expensive damage.

13. B — Before assuming the streaming current shift indicates a raw water quality change, the operator should verify the instrument itself. Streaming current probes accumulate deposits and biological growth that affect their readings. Cleaning and recalibrating the probe first eliminates instrument error as the cause before adjusting chemical feed based on a potentially false signal.

14. D — Chloramines must be removed from water used in kidney dialysis because they can cross the dialysis membrane and enter the patient's bloodstream, causing hemolytic anemia — a potentially fatal condition. The water system must notify the hospital well in advance of any switch to chloramination so the dialysis unit can install appropriate treatment.

15. A — Feed rate = $1.0 \text{ mg/L} \times 5.0 \text{ MGD} \times 8.34 = 41.7 \text{ lb/day}$. This calculation uses the standard pounds formula to determine the daily weight of potassium permanganate needed. The operator must also monitor for pink water (excess permanganate) and verify that the oxidized manganese is being captured by downstream filtration.

16. C — Variable frequency drives allow pumps to operate at the speed needed to match system demand rather than running at full speed and wasting excess energy through throttling. Since pump power varies with the cube of speed, even modest speed reductions produce substantial energy savings — typically 20% to 50% compared to throttled full-speed operation.

17. C — When total hardness equals alkalinity, all of the hardness is carbonate hardness (associated with bicarbonate and carbonate ions) and non-carbonate hardness is zero. Non-carbonate hardness only exists when total hardness exceeds alkalinity — the excess above the alkalinity value represents hardness associated with chloride and sulfate anions.

18. D — Bulk liquid chemical storage tanks require secondary containment — bermed or curbed areas with sufficient capacity (typically 110% of the largest tank) to contain the entire contents in the event of a tank failure, overflow, or spill. This prevents hazardous chemicals from reaching drains, waterways, or treatment processes.

19. A — A well that has not been inspected in three years, now with a livestock operation nearby, requires immediate inspection. The operator should examine the wellhead cap, sanitary seal, and casing integrity for defects that could allow surface contaminants — including pathogens from animal waste — to enter the aquifer.

20. C — When a PLC reboots mid-backwash, it resets all outputs to default positions, potentially leaving valves in dangerous or inappropriate states. The operator must immediately assess Filter 2's actual valve positions manually, determine the filter's current status, and either complete the backwash manually or safely return the filter to its resting configuration.

21. B — Individual filter monitoring reveals that Filter 2 at 0.85 NTU is the sole cause of the elevated combined effluent. Taking Filter 2 offline for backwash or investigation immediately eliminates the problem source while the remaining three filters (all at 0.04 NTU) maintain excellent combined effluent quality.

22. D — This groundwater profile — very hard water with elevated iron, manganese, and moderate alkalinity at low turbidity — is characteristic of mineral-rich groundwater requiring oxidation (to convert dissolved iron and manganese to filterable forms), filtration (to remove the oxidized metals), and disinfection. Full conventional treatment with coagulation is not necessary for this water type.

23. A — The solution has degraded from 12.5% to 10.2%, a reduction of approximately 18% in active chlorine content. Since the feed calculations still assume 12.5%, the pump delivers 18% less chlorine than intended — the same volume is pumped, but each gallon now contains less active ingredient.

24. C — At 0.012 mg/L, the lead 90th percentile is below the 0.015 mg/L action level, so the system is in compliance. However, the result is close enough to the action level to warrant continued vigilance — monitoring corrosion control effectiveness and tracking lead trends to ensure levels do not increase toward the exceedance threshold.

25. B — When bromate approaches its 0.010 mg/L MCL, the operator should reduce the ozone dose or contact time to decrease bromate formation. To maintain adequate pathogen inactivation, alternative disinfection (UV for *Cryptosporidium*, chlorine for CT credit) can supplement the reduced ozone. Increasing ozone would worsen bromate formation.

26. D — A new noise from a motor — even when all measurable performance parameters appear normal — is an early warning of a developing mechanical problem, most commonly bearing deterioration. Scheduling a vibration analysis or bearing inspection catches the problem early, before it progresses to failure. Noise changes are often the first detectable symptom.

27. A — $\text{TOC removal} = (3.8 - 2.5) \div 3.8 \times 100 = 34.2\%$, approximately 34%. This percentage is compared against the enhanced coagulation matrix requirement for the plant's specific raw water TOC and alkalinity combination to determine whether the plant is meeting its TOC removal obligation under the D/DBPR.

28. C — Pink staining on chronically wet household surfaces — shower curtains, toilet bowls, pet dishes — is caused by *Serratia marcescens*, an airborne bacterium that thrives on moist surfaces. This is a household environmental condition, not a water quality problem. The bacteria colonize wet surfaces from the air, not from the water supply.

29. D — If no filters have been taken offline and plant flow has not changed, an increased filtration rate on a single filter indicates something is forcing more flow through that filter than intended. A stuck-

open influent valve bypasses the flow controller, allowing unregulated flow that exceeds the filter's normal operating rate.

30. D — The first priority in any emergency response — including a chemical spill — is protecting human safety. All personnel must be moved to a safe distance, the spill area must be secured, and appropriate PPE must be donned before anyone approaches the spill for containment, assessment, or cleanup.

31. A — The progressive decline in chlorine residual with distance from the plant is the normal distribution system chlorine demand pattern. As water travels through pipes, chlorine is consumed by reactions with pipe materials, biofilm, corrosion products, sediment, and residual NOM. Higher water age means more chlorine consumption.

32. C — Grit, undissolved particles, and frequent line clogging from a lime slaker indicate the lime product contains excessive impurities (grit, calcium carbide, silica) or the slaker is not providing adequate water volume, temperature, or mixing for complete hydration. Either condition produces a gritty slurry that clogs downstream equipment.

33. B — Green-tinted backwash water indicates algae that accumulated in the filter media during the production run is being washed out. Algae growth in filters is common during warm-season blooms when algae-laden water passes through the filters, with algae becoming trapped and potentially growing in the media between backwash cycles.

34. B — Sanitary survey preparation involves organizing all records, reviewing compliance data for accuracy, verifying that SOPs are current and accessible, and ensuring that the plant's documentation reflects actual operations. This demonstrates operational competence and regulatory compliance to the inspection team.

35. A — A declining UV dose is most commonly caused by fouled quartz sleeves (mineral deposits reducing UV transmission), aging lamps with declining output (UV lamps lose intensity over their rated life), or decreased UV transmittance of the water (from elevated NOM, color, or dissolved metals in the filtered water).

36. C — Excluding one of four operating filters from the combined effluent calculation means all previous compliance data is potentially inaccurate — the reported combined turbidity may have been

lower or higher than the true combined value. The error must be corrected, the primacy agency notified, and the compliance implications evaluated.

37. B — $\text{lb/day Cl}_2 = 4.0 \times 4.0 \times 8.34 = 133.4 \text{ lb/day}$. $\text{Solution lb/day} = 133.4 \div 0.12 = 1,111.7 \text{ lb/day}$. $\text{Solution gal/day} = 1,111.7 \div (1.17 \times 8.34) = 1,111.7 \div 9.76 = 113.9 \text{ gal/day} \div 24 \text{ hrs} = 4.7 \text{ gal/hr}$. At 4.7 gallons per hour, the 50 gph pump is more than sufficient.

38. D — Anthracite that has lost 25% of its grain size through attrition produces finer particles that pack more tightly at the top of the bed. This creates a denser surface layer that captures particles near the surface rather than throughout the full bed depth, causing rapid headloss buildup (surface blinding), shorter filter runs, and the need for more frequent backwashing.

39. A — To measure dissolved metals specifically, the sample must be filtered through a 0.45-micrometer membrane at the point of collection to remove all particulate (oxidized) metals. The filtrate contains only dissolved metals, which is then acidified with nitric acid for preservation. Without filtration, the result represents total metals instead.

40. C — An unexplained level increase in a chemical tank when no delivery was scheduled could indicate a leaking valve allowing water or another chemical to flow into the tank, an instrument malfunction producing a false high reading, or unauthorized access. Any of these possibilities require immediate investigation — unexplained changes in chemical systems are never routine.

41. D — The jar test demonstrates that each increment of alum consumes a predictable amount of alkalinity, progressively lowering pH. With only 50 mg/L of starting alkalinity, the buffering capacity is depleted by approximately 40–50 mg/L of alum, after which additional alum causes increasingly dramatic pH drops — explaining the sharp decline from pH 6.3 to 5.5 between 40 and 60 mg/L doses.

42. B — The check standard reading of 21.8 NTU falls within the $\pm 10\%$ tolerance of the 20 NTU expected value (acceptable range: 18.0 to 22.0 NTU). Since 21.8 is within this range, the calibration is verified as acceptable and the instrument can be returned to service without further adjustment.

43. A — Debris in the Parshall flume approach channel raises the water level upstream of the flume's measuring point. Since the flume calculates flow based on depth measurement, the artificially elevated depth produces a flow reading higher than the actual flow. The debris must be removed and the channel cleared to restore accurate measurement.

44. C — The most productive investigation compares raw water quality data between the two years and reviews jar test records to determine whether the source water has changed in ways that increase coagulant demand. Higher turbidity, NOM, or lower alkalinity all increase chemical requirements. Simply reducing doses or switching products without understanding the cause risks compromising treatment.

45. B — When the UV system alarms for low dose, the operator should verify the alarm (check sensors, lamps, and sleeves), then assess whether the plant's chlorine CT alone provides sufficient pathogen inactivation credit for all regulated organisms. If chlorine CT meets requirements for Giardia and viruses (UV was primarily for Cryptosporidium), the operator has time to address the UV system without an emergency shutdown.

46. D — Two consecutive quarters above 0.080 mg/L at a single location will significantly elevate the LRAA at that monitoring point. Since compliance is location-specific under the Stage 2 D/DBPR, Location #3 may be approaching or exceeding the MCL on an LRAA basis even though other locations are compliant. Focused investigation and corrective action at that location are needed.

47. C — To convert gpm to MGD: multiply by 1,440 (minutes per day) to get gallons per day, then divide by 1,000,000 to convert to millions. $2,500 \times 1,440 = 3,600,000$ gpd $\div 1,000,000 = 3.60$ MGD. This unit conversion is fundamental to treatment calculations and appears frequently on the certification exam.

48. A — Regulatory compliance for turbidity monitoring requires continuous recording at 15-minute intervals. Hourly manual readings — while better than no data — may not satisfy the continuous monitoring requirement, potentially creating a compliance gap. The operator should report the data loss to the supervisor, restore the historian as soon as possible, and document the interim manual readings.

49. D — When belt press cake solids decline without changes to polymer or press settings, the sludge characteristics have changed — potentially from increased organic content, different coagulant floc properties, or polymer degradation in storage. Changed sludge requires re-evaluation of the polymer dose and type, and potentially adjustment of press belt speed and tension.

50. B — Theoretical DT = $300,000 \div 1,389 = 216$ min. $T_{10} = 216 \times 0.7 = 151.2$ min. CT = $1.0 \times 151.2 = 151.2$ mg·min/L. Superior baffling (0.7 factor) significantly improves the effective contact time compared to poor or average baffling, producing more CT from the same clearwell volume.

51. A — At higher pH, chlorine shifts from HOCl (relatively mild taste) to hypochlorite ion OCl⁻ (which many consumers perceive as having a more noticeable "chemical" or "chlorine" taste). The pH increase from 7.2 to 8.2 dramatically shifts the equilibrium toward OCl⁻, changing the taste character even at the same total residual concentration.

52. C — The plant achieved 30% TOC removal, which exceeds the 25% required by the enhanced coagulation matrix for its specific raw water TOC and alkalinity conditions. The plant is in full compliance with the enhanced coagulation requirement. Removal above the required percentage is acceptable and provides additional DBP precursor reduction.

53. D — A metering pump with gradually declining output despite unchanged settings has a mechanical problem — most commonly worn check valves that allow chemical to slip back through the pump on each stroke (reducing net forward delivery) or a deteriorating diaphragm that does not displace its full rated volume per stroke.

54. A — Any below-grade vault, manhole, or enclosed space with limited entry and exit must be treated as a permit-required confined space. Valve vaults can accumulate hazardous gases (H₂S from sewer cross-connections, methane from decomposition, CO from nearby equipment), lose oxygen, or contain standing water. Full confined space entry procedures — atmospheric testing, ventilation, attendant, permit — are required.

55. B — Air scour combined with water backwash provides more aggressive mechanical scrubbing of the filter media grains than water alone. The air bubbles create intense agitation that breaks the bonds between captured particles, biological growth, and the media surface, producing a more thoroughly cleaned filter bed and reducing mudball formation.

56. C — Optimal alum coagulation occurs at a lower pH (around 6.0–7.0) while optimal corrosion control typically requires a higher pH (7.5–8.5). Since these requirements cannot be satisfied simultaneously at a single pH, the plant operates the coagulation process at its optimal lower pH, then raises pH after filtration with caustic soda for corrosion control.

57. D — A consistent 0.3 mg/L positive bias over three consecutive weeks confirms the online analyzer has drifted systematically. However, the operator should first verify the DPD reagent is fresh and the test kit is functioning properly. Once the DPD reference is confirmed accurate, the analyzer should be recalibrated to match the verified laboratory measurement.

58. B — Low oil pressure during an otherwise successful generator test indicates a developing engine problem — potentially low oil level, a worn oil pump, a clogged oil filter, or an incorrect pressure gauge reading. The finding should be documented, the cause investigated, and the problem corrected before the generator is needed for an actual emergency.

59. B — Drawdown = $62 - 35 = 27$ feet. Specific capacity = $300 \text{ gpm} \div 27 \text{ ft} = 11.1 \text{ gpm/ft}$. This means the well produces 11.1 gallons per minute for each foot the water level drops during pumping — a standard productivity indicator used to track well performance over time.

60. C — The milky appearance coinciding with a switch to a new dry alum product points to a chemical preparation problem. The new product may have different dissolution characteristics, the slurry preparation system may not be providing adequate mixing or water volume, or the product may contain more insoluble material — all producing undissolved particles that create the milky appearance.

61. D — Continuing education requirements ensure that certified operators maintain current knowledge of evolving treatment technology, changing regulatory requirements, and updated industry best practices throughout their careers. The water treatment field continuously advances, and the knowledge validated at initial certification becomes outdated without ongoing professional development.

62. A — As reservoir level drops, a fixed-depth intake draws water from a different relative position in the water column. The intake may now be closer to the thermocline or the bottom, encountering water with different temperature, dissolved oxygen, dissolved minerals (iron, manganese), and organic loading than the water it normally draws at higher reservoir levels.

63. A — Even for a high-quality groundwater source, loss of all chemical feed capability — including disinfection — is a serious event requiring notification of the supervisor and state primacy agency. The operator must evaluate whether the specific groundwater source poses an immediate health risk without disinfection and prepare for potential public notification if the systems cannot be restored promptly.

64. C — Cold water (4°C vs. 22°C) increases viscosity, slows chemical reaction rates, reduces coagulation effectiveness, impairs floc formation, and decreases settling velocity. Operators must compensate with higher coagulant doses, potential polymer aid, and adjusted mixing intensities. Cold-water treatment challenges are among the most significant seasonal operational issues.

65. B — Air scour produces vigorous mechanical agitation that physically scrubs particles, biological growth, and accumulated debris from the media grain surfaces more effectively than the hydraulic shear

forces of water-only backwash. This more thorough cleaning reduces mudball formation, extends media life, and improves filter performance during subsequent runs.

66. D — All SDS documents must be current and accessible to all employees during every shift. Two new chemicals without SDS sheets and one reformulated product with an outdated SDS represent safety and compliance gaps. The binder must be updated immediately with current documents for all chemicals, and all operators must be informed of the changes.

67. A — Before selecting between mechanical and chemical rehabilitation, a video inspection of the well bore and screen identifies the specific nature of the obstruction — mineral encrustation requires acid treatment, biological growth requires biocide treatment, sediment infiltration requires surging and development, and physical screen damage may require liner installation or new screen.

68. C — At very low turbidity levels (below 0.15 NTU), the measurement uncertainty of both instruments becomes a significant fraction of the reading. A 0.05 NTU difference between instruments at this low range may fall within the combined uncertainty bands of both devices, meaning neither instrument is necessarily wrong. Additional verification with calibration standards helps resolve the discrepancy.

69. D — Variation in the aluminum content between deliveries means each batch delivers a different amount of active coagulant per gallon. The operator must review each delivery's certificate of analysis and adjust the volumetric feed rate to maintain a consistent aluminum dose to the water, regardless of the solution's varying concentration.

70. B — Gradually declining pressure over three months at a single monitoring point — with no changes in pumps, customers, or production — indicates a progressive restriction developing in the distribution main between the plant and that location. Internal corrosion, tuberculation, or a slowly closing valve reduces the pipe's hydraulic capacity, dropping pressure at the downstream monitoring point.

71. C — A phenolphthalein alkalinity of zero indicates that all alkalinity exists below pH 8.3, which means it is entirely in the bicarbonate form. Carbonate alkalinity (CO_3^{2-}) only exists above pH 8.3, and hydroxide alkalinity (OH^-) only exists at even higher pH. The total alkalinity of 95 mg/L is therefore 100% bicarbonate alkalinity — the most common form in natural waters.

72. A — The generator and the chemical emergency shutoff serve different emergency functions. The generator maintains plant operations during power outages. The chemical shutoff allows operators to

stop chemical feed independently during chemical emergencies — such as a feed line break, over-dose situation, or chemical leak — without interrupting the entire plant's power supply.

73. B — The filters are producing excellent effluent (0.08 NTU) but clogging rapidly because the high algae loading is accumulating on and within the filter media much faster than during non-bloom conditions. The filters are doing their job — capturing the algae — but the sheer volume of material shortens the run between backwashes dramatically.

74. D — Failing to collect a required quarterly compliance sample is a monitoring violation. The system does not know what the DBP levels were during that quarter, creating a gap in the compliance record. Monitoring violations require Tier 3 public notification (within one year, typically in the CCR) and correction of the monitoring schedule to prevent recurrence.

75. A — Operating at 1,200 gpm and 140 feet — to the left of the BEP at 1,500 gpm and 120 feet — means the pump is operating at lower flow and higher head than its design optimum. This off-BEP operation reduces efficiency, may increase vibration and noise, and can cause recirculation within the impeller that accelerates wear.

76. C — Since both trains receive identically coagulated water, the difference must be in the flocculation process itself. Different mixer speeds (one may have drifted), worn or missing paddles, damaged baffles, or different baffle configurations between the two trains would produce different mixing intensities and different floc characteristics.

77. D — Surface overflow rate = Flow ÷ Surface Area = 3,000,000 gpd ÷ 4,000 ft² = 750 gpd/ft². This rate is compared against design guidelines (typically 500–1,000 gpd/ft² for conventional basins) to determine whether the basins have adequate settling capacity for the current flow rate.

78. B — Brown water that occurs only Monday morning at a school and clears within 30 minutes of flushing is classic stagnation-related corrosion in the building's internal plumbing. Over the weekend, water sits motionless in the pipes for 48+ hours, dissolving iron or copper from the plumbing. Monday morning flushing clears the stagnant, discolored volume.

79. A — Before disconnecting any chemical feed line, the operator must close and lock the upstream isolation valve (LOTO), relieve any residual pressure in the line section, drain the remaining chemical from the section to be removed, and wear appropriate PPE for the specific chemical (goggles, gloves, apron for sodium hypochlorite).

80. C — At 3.2 mg/L, fluoride exceeds the secondary standard of 2.0 mg/L (dental fluorosis concern) but not the primary MCL of 4.0 mg/L (skeletal fluorosis concern). The operator must immediately investigate and correct the feed system malfunction, notify the supervisor, increase monitoring, and evaluate notification requirements for the secondary standard exceedance.

81. B — Stable or improving raw water quality trends over time are the best indicator that a source water protection program is working. The program's purpose is to prevent contamination from reaching the source — if the water quality remains good or improves, the protective measures (land use controls, monitoring, management practices) are achieving their objective.

82. D — When a sample is exposed to the atmosphere for several minutes in the sample line before reaching the pH sensor, carbon dioxide escapes from the water (particularly if the water has elevated CO₂ from groundwater sources or treatment processes). CO₂ loss raises pH, so the reading at the sensor is higher than the actual process pH — but the question states the online reads lower, suggesting CO₂ absorption. Extended atmospheric exposure in an open sample line allows CO₂ from the air to dissolve into the water, lowering the pH reading at the sensor compared to the actual process value.

83. A — After packed tower aeration for H₂S removal, the operator must verify treatment effectiveness by testing the aerated water for residual H₂S concentration and checking for remaining odor. The goal is to confirm the aeration has reduced H₂S below the detectable threshold (typically 0.05 mg/L or less) before the water continues to disinfection.

84. C — If all four individual filter effluents read 0.04–0.06 NTU but the combined effluent reads 0.12 NTU, something between the individual measurement points and the combined measurement point is introducing turbidity. An unfiltered bypass, a leaking valve allowing settled water into the combined header, or a sample line problem on the combined instrument could explain the discrepancy.

85. B — For a dead-end main with lost residual and elevated HPC, the most effective immediate response is unidirectional flushing to physically remove the stagnant water, biofilm, and sediment, followed by a temporary residual boost (either increased chloramine or a short-term free chlorine burn) to reestablish disinfectant protection in the affected area.

86. D — The CCR must include the detected arsenic level (0.008 mg/L), the MCL (0.010 mg/L), the MCLG (zero for arsenic, a known carcinogen), the likely source of contamination (typically "erosion of natural deposits"), and the specific EPA health effects language for arsenic. This information allows consumers to make informed decisions about their water.

87. A — A generator consuming 40% more fuel than its rated specification while producing normal voltage and frequency indicates reduced combustion efficiency. Common causes include malfunctioning fuel injectors (over-fueling or poor atomization), incorrect injection timing, restricted air intake (clogged air filter), or turbocharger problems that reduce the air-to-fuel ratio.

88. C — $RPD = |0.15 - 0.22| \div ((0.15 + 0.22) \div 2) \times 100 = 0.07 \div 0.185 \times 100 = 37.8\%$, approximately 38%. This dramatically exceeds the typical 10–20% acceptable RPD for duplicate analyses, indicating poor precision that requires investigation — inconsistent sampling technique, air bubbles, or instrument instability are common causes.

89. D — High settled water turbidity despite a previously optimized coagulant dose could result from multiple causes — changed raw water quality, drifted chemical feed pump calibration, or degraded coagulant. A systematic approach addresses all possibilities: perform a fresh jar test (identifies current optimal dose), verify pump calibration (confirms actual delivery matches intended dose), and review raw water data (identifies whether source changes are driving the problem).

90. B — A UVT of 82% below the validated minimum of 85% means the UV system cannot be guaranteed to deliver the required disinfection dose. The operator should investigate the upstream cause — elevated NOM, color, or iron in the filtered water that reduces UV transmission — and adjust upstream treatment to improve UVT. Reducing flow is a temporary measure, not a permanent solution.

91. C — Filter 4 has lost 10 inches of its original 30-inch media depth — a 33% reduction. This is by far the most severe media loss among the four filters and significantly compromises Filter 4's ability to provide effective depth filtration. Filter 4 requires urgent media addition or replacement to restore its treatment capability.

92. A — Emergency response plans should be reviewed annually at minimum and updated whenever significant changes occur — new chemicals, new equipment, new hazards, personnel changes, lessons learned from drills or actual events, or regulatory changes. An outdated emergency plan can direct responders to take incorrect actions during a real emergency.

93. D — A $Cl_2:NH_3-N$ ratio of 2:1 (below the optimal 3:1 to 5:1 range) means excess free ammonia is present in the finished water. This excess ammonia provides a nutrient source for nitrifying bacteria in the distribution system, promoting nitrification episodes that consume the chloramine residual and produce nitrite.

94. B — Tube settlers increase the effective settling area within the same physical basin by providing inclined surfaces where particles settle the short distance between adjacent tubes rather than the full basin depth. This allows the basin to handle significantly higher overflow rates without sacrificing settled water quality — typically a 3x to 10x capacity increase.

95. C — Diesel fuel stored for 14 months without testing may have degraded from moisture contamination (condensation in the tank headspace), microbial growth (diesel bug that clogs filters), and oxidation (producing gums and sediment). Any of these conditions can prevent the generator from starting or sustaining operation during the emergency when it is needed most.

96. A — An LSI of -1.2 indicates significantly corrosive water. To raise the LSI toward the -0.5 to $+0.5$ target range, the operator increases pH and alkalinity by adding lime, soda ash, or caustic soda after filtration. This adjustment reduces the water's tendency to dissolve calcium carbonate and metals from distribution system pipes.

97. D — $LRAA = (0.072 + 0.068 + 0.075 + 0.105) \div 4 = 0.320 \div 4 = 0.080$ mg/L. The LRAA exactly equals the MCL of 0.080 mg/L. While this is technically at — not above — the standard, it signals that the location is at the compliance boundary. Any future quarterly result above approximately 0.083 mg/L would push the LRAA into violation.

98. B — When all four individual filters show a similar, simultaneous turbidity increase with no recent backwash events, the cause is upstream of the filters — affecting the quality of water reaching all filters equally. A coagulation problem, raw water quality change, or chemical feed system malfunction is the most likely explanation.

99. A — Data entry errors in regulatory records must be corrected using proper documentation procedures — single line through the error, correct value written alongside, initialed and dated by the person making the correction. The corrected data is included in the quarterly report with a notation explaining the correction. Records should never be destroyed, fabricated, or omitted.

100. C — PAC is most effective when applied as early as possible in the treatment process — at the raw water intake or rapid mix — to maximize the contact time between the carbon and the geosmin before the PAC is removed during sedimentation and filtration. Earlier application provides more time for adsorption, producing better taste and odor removal.