# PRACTICE EXAM 4: WATER TREATMENT OPERATOR CLASS I SIMULATION (100 QUESTIONS)

1. A treatment plant's jar test results show that alum at 30 mg/L produces excellent settled water turbidity of 0.6 NTU at pH 6.8. However, when the same dose is applied at full scale, the settled water turbidity is consistently 2.5 NTU. Assuming the raw water quality has not changed, the most likely reason for the difference between laboratory and full-scale performance is:

A. Jar test reagents are a higher grade than bulk plant chemicals and produce better results

B. Differences in mixing intensity, detention time, or hydraulic conditions between the jar and the plant

C. The laboratory turbidimeter always reads lower than the online plant instruments by a fixed offset

D. Full-scale treatment always produces higher turbidity than laboratory tests regardless of conditions

2. An operator receives a laboratory result showing E. coli confirmed in a routine distribution system sample. In addition to collecting repeat samples within 24 hours, the operator must immediately:

A. Increase the coagulant dose at the plant to improve particle removal before disinfection

B. Shut down the distribution system and drain all mains in the affected pressure zone

C. Perform a jar test to determine if raw water quality has changed since the last testing cycle

D. Notify the state primacy agency and issue Tier 1 public notification within 24 hours

3. A treatment plant feeds ferric chloride as its primary coagulant. Compared to aluminum sulfate (alum), ferric chloride offers which operational advantage?

A. A broader effective pH range and denser, faster-settling floc, particularly in cold water

B. Lower cost per pound and easier handling due to its non-corrosive chemical properties

C. No alkalinity consumption during hydrolysis, eliminating the need for pH adjustment chemicals

D. Complete elimination of disinfection byproduct precursors through enhanced organic oxidation

4. A treatment plant's clearwell level has been declining steadily over the past four hours despite all high-service pumps operating at their normal speed. Meanwhile, the plant production flow has decreased due to two filters being offline for maintenance. The operator should prioritize:

A. Increasing the chlorine dose to maintain CT compliance as the clearwell volume decreases

B. Switching to emergency backup disinfection to compensate for the declining water volume

C. Returning at least one filter to service or reducing high-service pump output to balance production with demand

D. Draining the clearwell completely and refilling it with freshly treated water from the operating filters

5. A water system receives a sanitary survey report from the state primacy agency identifying three significant deficiencies. Under SDWA requirements, the system must:

A. Appeal the findings to the EPA within 10 business days of receiving the survey report

B. Publish the survey results in the local newspaper within 30 days for public transparency

C. Address the identified deficiencies within the timeframe specified by the primacy agency

D. Immediately shut down the system until all deficiencies are corrected and reinspected

6. An operator calculates that a rectangular basin has a volume of 50,000 gallons. The plant flow is 1,200 gpm. The theoretical detention time is approximately:

A. 60 minutes

B. 24 minutes

C. 6 minutes

D. 42 minutes

7. A treatment plant uses UV disinfection for primary Cryptosporidium inactivation and free chlorine for primary Giardia and virus inactivation. This dual-disinfection approach is used because:

A. UV and chlorine must always be applied simultaneously to meet any pathogen inactivation requirement

B. Chlorine alone provides adequate Cryptosporidium inactivation at standard treatment concentrations

C. UV is highly effective against Cryptosporidium but provides no residual for distribution system protection

D. UV cannot inactivate Giardia or viruses, requiring chlorine as the sole disinfectant for these pathogens

8. An operator measuring turbidity on a grab sample obtains a reading of 0.35 NTU. Before reporting this result, the operator notices condensation on the outside of the sample cell. The correct action is to:

A. Report the 0.35 NTU result immediately because condensation has no effect on turbidity readings

B. Wipe the cell dry, allow it to reach room temperature, and remeasure because condensation scatters light and produces falsely high readings

C. Add a correction factor of minus 0.10 NTU to account for the standard condensation interference

D. Discard the sample and collect a new one because condensation indicates the sample has been compromised

9. A water treatment plant serves a community of 12,000 people. The plant's average daily production is 1.8 MGD. The per capita water consumption is approximately:

A. 150 gallons per person per day

B. 67 gallons per person per day

C. 250 gallons per person per day

D. 15 gallons per person per day

10. A well pump produces 400 gpm with a drawdown of 60 feet. Six months later, the same pump produces 400 gpm with a drawdown of 85 feet. The specific capacity has changed from:

A. 6.67 gpm/ft to 4.71 gpm/ft, indicating declining well performance that warrants investigation

B. 4.71 gpm/ft to 6.67 gpm/ft, indicating improving aquifer recharge and well recovery

C. 0.15 ft/gpm to 0.21 ft/gpm, indicating increasing pump efficiency over the operating period

D. 24,000 $gpm^2/ft$ to 34,000 $gpm^2/ft$, indicating the cone of depression has expanded normally

11. A treatment plant operator discovers that the plant's monthly operating report for the previous month was not submitted to the state primacy agency by the required deadline. This failure constitutes:

A. An MCL violation that requires Tier 1 public notification within 24 hours of discovery

B. A treatment technique violation that requires immediate corrective action and enhanced monitoring

C. No violation as long as the report is submitted within 60 days of the original due date

D. A reporting violation that requires Tier 3 public notification and immediate submission of the overdue report

12. An operator observes that a submersible pump installed in a wet well is cycling rapidly — starting and stopping every two to three minutes. This short-cycling is problematic because:

A. The pump cannot achieve its rated discharge pressure during such brief operating periods

B. Frequent starts generate excessive heat in the motor and stress the electrical starting components

C. The pump must run continuously to prevent sedimentation from building up in the wet well

D. Short cycling indicates the pump has exceeded its rated service life and must be replaced immediately

13. During a jar test, an operator adds polymer to two of the six jars along with the standard alum dose to evaluate the polymer as a coagulant aid. The jars with polymer produce visibly larger, faster-settling floc. This improvement is most likely due to:

A. The polymer molecules bridging between particles, creating larger and stronger floc aggregates

B. The polymer neutralizing the pH, allowing the alum to work more efficiently at the optimal range

C. The polymer dissolving the colloidal particles, converting them from suspended solids to dissolved solids

D. The polymer increasing the water temperature in the jars, which accelerates all chemical reaction rates

14. A treatment plant's finished water has the following characteristics: pH 7.0, alkalinity 25 mg/L as $CaCO_3$, calcium hardness 30 mg/L as $CaCO_3$, and temperature 10°C. An operator calculating the Langelier Saturation Index would most likely find this water to be:

A. Scaling, with a strong tendency to deposit calcium carbonate throughout the distribution system

B. Perfectly balanced, requiring no adjustments to pH, alkalinity, or hardness for corrosion control

C. Corrosive, with a tendency to dissolve calcium carbonate and metals from pipe surfaces

D. Biologically unstable, requiring additional chlorine to prevent bacterial regrowth in the mains

15. An operator is investigating a consumer complaint about intermittent brown water at a single residence. The complaint occurs only in the morning when the tap is first turned on, and the water clears after running for one to two minutes. The most likely cause is:

A. A treatment plant upset that occurs overnight when staffing is reduced and monitoring is less frequent

B. A cross-connection between the potable water system and a non-potable source at the customer's property

C. Algae-related color in the source water that concentrates in the distribution system during low-flow periods

D. Stagnant water in the customer's household plumbing dissolving iron or copper from pipes overnight

16. A treatment plant treating 2.5 MGD uses 12% sodium hypochlorite. The operator needs to feed a chlorine dose of 3.0 mg/L. The sodium hypochlorite solution has a specific gravity of 1.17. The daily volume of sodium hypochlorite solution required is approximately:

A. 62.5 gallons per day

B. 64 gallons per day

C. 521 gallons per day

D. 128 gallons per day

17. The primary purpose of a sanitary seal (grout seal) around a well casing is to:

A. Prevent surface water and shallow groundwater contaminants from migrating along the outside of the casing into the aquifer

B. Strengthen the well casing structurally so it can withstand the pressure of the surrounding earth

C. Provide thermal insulation that prevents the well water from freezing during cold winter months

D. Seal the well against over-pumping by restricting the rate at which water can enter the casing

18. An operator receives a call from the local fire department reporting that a fire hydrant in the distribution system was accidentally knocked off by a vehicle, causing a high-flow main break. In addition to dispatching repair crews, the operator should be most concerned about:

A. The cost of the lost water and the need to bill the vehicle owner for the repair expenses

B. Potential contamination from cross-connections or backflow as pressure drops in the affected area

C. Increased chlorine residual in the affected area due to the turbulent flow from the broken hydrant

D. Loss of pressure causing the transient to backwash the plant filters through the distribution system

19. A treatment plant switches its secondary disinfectant from free chlorine to chloramines. Within six months, the plant notices a significant decline in total trihalomethane levels throughout the distribution system. This reduction occurs because:

A. Chloramines destroy existing THMs in the distribution system through chemical reduction reactions

B. Chloramines increase the pH throughout the distribution system, which prevents THM formation

C. Chloramines are less reactive with natural organic matter than free chlorine, producing fewer THMs

D. The ammonia component of chloramines absorbs THMs from the water through adsorption processes

20. An operator at a small groundwater system performs a coliform test using the Colilert method. After 24 hours of incubation at 35°C, the sample is yellow. When examined under a UV light, the sample fluoresces. This result means:

A. The sample is negative for both total coliforms and E. coli — the color is from the unreacted substrate

B. The sample is positive for total coliforms AND E. coli — requiring repeat sampling and state notification

C. The sample is positive for total coliforms only — the fluorescence is a normal characteristic of the test

D. The incubation temperature was incorrect, producing an invalid result that must be repeated

21. A treatment plant operator calculates that the plant's sedimentation basin has a surface overflow rate of 1,200 gpd/ft². The design engineer's recommended maximum overflow rate is 900 gpd/ft². This means the basin is:

A. Operating within its design capacity with an adequate safety factor for peak demand periods

B. Performing optimally because higher overflow rates improve settling efficiency in all conditions

C. Not overloaded because overflow rate has no relationship to sedimentation performance

D. Hydraulically overloaded, which may reduce settling efficiency and increase settled water turbidity

22. An operator needs to verify the accuracy of an online pH analyzer installed after the coagulant addition point. The correct verification procedure is to:

A. Collect a grab sample from the analyzer's sample line and measure pH with a calibrated portable meter for comparison

B. Compare the online reading to the plant's raw water pH and calculate the expected difference mathematically

C. Adjust the analyzer to match the reading on the nearest distribution system pH monitor location

D. Verify the analyzer by checking whether the coagulant feed rate has changed in the past 24 hours

23. The detention time of a flocculation basin decreases when plant flow increases. An operator running a plant at higher-than-normal flow should anticipate that flocculation performance may decline because:

A. Higher flow creates more turbulence that improves particle collisions beyond the optimal level

B. The increased velocity through the basin creates excessive shear forces that damage the impeller bearings

C. The water spends less time in the flocculation basin, reducing the opportunity for floc growth

D. Higher flow dilutes the coagulant dose, requiring a proportional increase in polymer feed rate

24. A treatment plant must comply with the Lead and Copper Rule. The plant's corrosion control study recommends maintaining finished water pH between 7.5 and 8.0 with alkalinity above 40 mg/L as $CaCO_3$. However, the optimal pH for alum coagulation at this plant is 6.5. The operator manages this conflict by:

A. Optimizing coagulation at the lower pH first, then raising pH after filtration for corrosion control

B. Operating at the same coagulation pH throughout the entire plant to avoid complexity

C. Prioritizing corrosion control pH and accepting reduced coagulation performance as a tradeoff

D. Alternating between coagulation pH and corrosion control pH on a daily schedule to balance both needs

25. A water treatment plant uses a belt filter press to dewater alum sludge from the sedimentation basins. The dewatered cake typically has a solids content of 18% to 22%. Before the sludge enters the belt press, which chemical is commonly added to improve dewatering performance?

A. Polymer, which conditions the sludge by binding water and improving the release of water from the solids

B. Chlorine, which sterilizes the sludge and makes it safe for landfill disposal without further treatment

C. Alum, which re-coagulates the sludge particles and increases their density before pressing

D. Lime, which raises the sludge pH to destroy pathogens and meet Class A biosolids requirements

26. A treatment plant's SCADA alarm log shows that the raw water turbidity alarm activated 47 times in the past month, but the operator on duty acknowledged and silenced each alarm without taking any corrective action because the raw water turbidity always returned to normal within minutes. This pattern indicates:

A. The operator is properly trained and following correct procedures for transient alarm conditions

B. The SCADA system is functioning perfectly with appropriately sensitive alarm setpoints

C. The raw water monitoring equipment is damaged and producing false readings at regular intervals

D. The alarm setpoint may need adjustment to reduce nuisance alarms that contribute to alarm fatigue

27. An operator tests the total hardness of a water sample and obtains 300 mg/L as $CaCO_3$. The alkalinity of the same sample is 200 mg/L as $CaCO_3$. The carbonate hardness and non-carbonate hardness are:

A. Carbonate hardness = 300 mg/L, non-carbonate hardness = 0 mg/L

B. Carbonate hardness = 100 mg/L, non-carbonate hardness = 200 mg/L

C. Carbonate hardness = 200 mg/L, non-carbonate hardness = 100 mg/L

D. Carbonate hardness = 250 mg/L, non-carbonate hardness = 50 mg/L

28. During a filter backwash, the operator notices that one section of the filter bed is not expanding while the rest of the bed fluidizes normally. This condition is most commonly caused by:

A. Excessive backwash flow rate overwhelming the underdrain capacity in that section of the filter

B. A blocked or damaged underdrain lateral beneath the non-expanding section of the filter bed

C. Normal media stratification occurring as the heavier garnet layer refuses to lift during backwash

D. The filter influent valve leaking slightly, adding settled water that prevents full bed expansion

29. A treatment plant uses both raw water turbidity and streaming current monitoring to guide coagulant feed adjustments. If the raw water turbidity increases but the streaming current reading remains at the target setpoint, the operator should interpret this as:

A. The coagulant dose is keeping pace with the turbidity increase, maintaining adequate charge neutralization

B. The streaming current monitor has malfunctioned and needs immediate recalibration or repair

C. The turbidity increase is caused by dissolved rather than particulate matter and requires no treatment change

D. Both instruments are producing conflicting data, and neither should be trusted until jar testing is performed

30. A water system serving 500 people from a single groundwater well is required to test for nitrate at least:

A. Monthly, because all public water systems must monitor nitrate every 30 days without exception

B. Weekly, because small systems face higher contamination risk and need more frequent verification

C. Every five years, because small groundwater systems are exempt from routine nitrate monitoring

D. Annually, with the option for reduced monitoring based on consistently low historical results

31. An operator observes that a horizontal split-case centrifugal pump is leaking water from the packing gland area at approximately one drop per second. This leakage rate suggests:

A. The pump is experiencing catastrophic seal failure and must be shut down immediately for repair

B. The packing has completely failed and must be replaced before the pump can continue operating

C. The leakage is within the normal range for packed pumps and provides necessary lubrication and cooling

D. The pump casing is cracked at the packing gland location and requires welding or replacement

32. A plant treats 4.0 MGD from a reservoir source. During spring turnover, the raw water dissolved manganese increases from 0.02 mg/L to 0.25 mg/L. The secondary standard for manganese is 0.05 mg/L. The operator should:

A. Increase oxidant feed (potassium permanganate or chlorine dioxide) to convert dissolved manganese to its filterable form

B. Notify the state primacy agency of an MCL violation because manganese has exceeded the primary standard

C. Reduce the plant flow rate until the manganese level returns to normal background concentrations

D. Take no action because manganese is regulated by secondary standards which are not enforceable

33. A treatment plant's four sedimentation basins are operated in parallel. The operator notices that Basin 3 consistently produces settled water with turbidity 1.5 NTU higher than the other three basins. All basins receive the same coagulated water. The most likely basin-specific cause is:

A. The coagulant is not being distributed equally, with Basin 3 receiving less than its proportional share

B. Short-circuiting, inadequate baffling, or excessive sludge blanket depth in Basin 3 compared to the others

C. Basin 3 has a larger volume than the other three basins, creating an excessive detention time

D. The turbidity instruments on the other three basins are reading low due to simultaneous calibration drift

34. An operator at a treatment plant receives a phone call from a customer who reports that their water has a blue-green tint and a metallic taste. The operator should first:

A. Advise the customer to install a whole-house carbon filter to remove the color and taste

B. Tell the customer this is normal and that the tint is caused by the natural color of treated water

C. Verify whether other customers in the same area are experiencing similar complaints to determine if the problem is isolated or widespread

D. Dispatch a crew immediately to replace the customer's water meter, which is likely corroded internally

35. An operator needs to determine how many pounds of 65% calcium hypochlorite are required to deliver 50 pounds of available chlorine per day. The calculation is:

A. Approximately 77 pounds of calcium hypochlorite per day

B. Approximately 32.5 pounds of calcium hypochlorite per day

C. Approximately 77 pounds of calcium hypochlorite per day divided by 8.34

D. Approximately 50 pounds of calcium hypochlorite per day regardless of concentration

36. A treatment plant operator is reviewing the results of a membrane integrity test on the plant's ultrafiltration system. The pressure decay test shows a decay rate of 8 psi over 5 minutes, which exceeds the manufacturer's maximum allowable rate of 3 psi over 5 minutes. This result indicates:

A. One or more membrane fibers are likely breached, requiring isolation of the affected module and repair or replacement

B. The integrity test was performed incorrectly and should be repeated using a lower initial test pressure

C. The membrane system is operating within normal parameters because some pressure decay is always expected

D. The permeate water quality will not be affected because integrity tests measure mechanical strength only

37. Which of the following would be the most appropriate corrective action if a water treatment plant consistently fails to achieve the required percentage of TOC removal through enhanced coagulation?

A. Increase the coagulant dose and lower the pH to maximize NOM removal during the coagulation process

B. Reduce the chlorine dose to minimize DBP formation rather than addressing the TOC removal deficit

C. Switch from surface water to groundwater to eliminate the TOC problem at the source water level

D. Discontinue monitoring TOC because enhanced coagulation is an advisory rather than mandatory requirement

38. An operator discovers that the standby generator's diesel fuel has not been tested or rotated in over 18 months. The operator should be most concerned about:

A. Fuel contamination with water from condensation and potential microbial growth that could clog fuel filters

B. Fuel becoming explosive due to extended storage in an enclosed tank above ground at the plant

C. The fuel tank itself corroding through because diesel fuel is highly acidic after prolonged storage

D. Regulatory fines because fuel testing is required monthly under federal generator maintenance standards

39. A treatment plant operator performs a chlorine residual test on the plant effluent and obtains a free chlorine reading of 0.8 mg/L. The total chlorine reading on the same sample is 0.8 mg/L. The combined chlorine residual is:

A. 0.8 mg/L, which is the sum of the free and total chlorine readings from both measurements

B. 1.6 mg/L, calculated by adding the free and total chlorine readings for the combined result

C. 0.0 mg/L, indicating that all chlorine in the sample exists as free chlorine with no chloramines present

D. Cannot be determined without additional testing for ammonia concentration in the water sample

40. A treatment plant has experienced three consecutive months in which the combined filter effluent turbidity exceeded 0.3 NTU in more than 5% of the monthly 15-minute readings. Each month has been reported as a turbidity treatment technique violation. Beyond public notification, the operator and utility should:

A. Accept the violations as unavoidable and continue operating without making any changes to treatment

B. Close the treatment plant until a new filter system can be designed and constructed by an engineering firm

C. Reduce the plant flow rate to zero until raw water quality improves to a level that the current system can handle

D. Conduct a comprehensive investigation of the filtration system and upstream processes to identify and correct the root cause

41. An operator is calibrating a turbidimeter using a 20 NTU formazin standard. The instrument reads 18.5 NTU before adjustment. After calibration, the operator verifies with an independent 10 NTU check standard, which reads 10.3 NTU. The calibration should be considered:

A. Failed, because the check standard reading deviates from the expected value by more than 10%

B. Failed, because the pre-calibration drift of 1.5 NTU indicates the instrument cannot hold calibration

C. Passed, but only if the operator also verifies with a second check standard at a higher turbidity value

D. Passed, because the check standard reading of 10.3 NTU is within the acceptable ±5–10% tolerance of the 10 NTU expected value

42. A water treatment plant draws raw water from a lake that receives agricultural runoff from surrounding farmland. During the spring planting season, the operator should anticipate increased levels of:

A. Dissolved hydrogen sulfide from the agricultural chemicals reacting with the lake's bottom sediments

B. Pesticides, herbicides, and nutrients (nitrogen and phosphorus) from field runoff entering the lake

C. Dissolved arsenic from the application of arsenical pesticides that are widely used in modern agriculture

D. Radioactive contaminants from the naturally occurring radionuclides in commercial fertilizer products

43. A treatment plant uses a Parshall flume to measure raw water flow at the plant influent. The operator notices that debris has accumulated at the flume's throat, partially obstructing the flow. This obstruction will most likely cause:

A. The flume to underestimate the actual flow because the debris creates additional friction resistance

B. The flume to report zero flow because any obstruction causes the measurement to default to zero

C. An overestimation of flow because the debris raises the upstream water level, producing a falsely high depth reading

D. No effect on the flow measurement because Parshall flumes are self-cleaning by design

44. An operator is reviewing a chemical metering pump's maintenance log and notes that the pump's diaphragm was last replaced 14 months ago. The manufacturer recommends diaphragm replacement every 12 months. The operator should:

A. Schedule diaphragm replacement at the next available maintenance window to restore the pump to manufacturer specifications

B. Extend the replacement interval to 24 months because the pump is still delivering chemical without visible problems

C. Replace the entire pump rather than just the diaphragm since the unit has exceeded its service interval

D. Verify the pump's calibration and if it passes, extend the replacement interval indefinitely until failure occurs

45. A treatment plant stores chlorine gas in 150-pound cylinders. The maximum number of cylinders stored at the facility at any time is eight. Under the EPA's Risk Management Program, the threshold quantity for chlorine gas that triggers RMP requirements is 2,500 pounds. Based on this information:

A. The plant is exempt from RMP because it uses cylinders rather than ton containers for chlorine storage

B. The plant is exempt from RMP because only plants that have experienced a chlorine release are subject to the rule

C. The plant must determine if it ever stores more than 2,500 pounds total to evaluate RMP applicability

D. The plant is subject to RMP because 8 × 150 = 1,200 pounds exceeds the threshold quantity of 1,000 pounds

46. An operator at a treatment plant using chloramination notices that the free ammonia level in the finished water has increased from the normal 0.1 mg/L to 0.5 mg/L over the past week. This increase could lead to:

A. Improved disinfection effectiveness because free ammonia enhances the biocidal activity of monochloramine

B. Nitrification in the distribution system because excess free ammonia serves as a nutrient for nitrifying bacteria

C. Reduced corrosion in household plumbing because ammonia forms a protective film on copper surfaces

D. Lower DBP formation because ammonia reacts with and destroys THM and HAA precursor material

47. A treatment plant operator performs a daily calibration check on the online turbidimeter for Filter 1 using a secondary check standard rated at 0.50 NTU. The instrument reads 0.48 NTU. This check indicates:

A. The instrument requires immediate recalibration because any deviation from the standard is unacceptable

B. The check standard has expired and must be replaced with a freshly prepared formazin primary standard

C. The instrument is reading within acceptable tolerance and formal recalibration is not required at this time

D. The instrument should be removed from service and sent to the manufacturer for factory recalibration

48. During an emergency response drill, the operator discovers that the plant's emergency contact list has not been updated in two years. Several phone numbers are no longer valid, and two key staff members listed have left the utility. This deficiency is significant because:

A. Outdated contact lists are a federal violation that carries mandatory fines under OSHA regulations

B. An actual emergency requires immediate notification of specific individuals, and invalid contact information causes dangerous delays

C. The emergency response plan becomes legally void the moment any contact information changes

D. The plant's operating permit will be automatically revoked until the contact list is formally updated

49. A water treatment plant operates during a drought when the reservoir level drops significantly, reducing the raw water volume and concentrating dissolved minerals, NOM, and other contaminants. The operator should anticipate all of the following treatment impacts EXCEPT:

A. Decreased coagulant demand because the lower water volume requires less chemical per gallon treated

B. Increased taste and odor complaints from concentrated geosmin or MIB from algae in the warmer, shallower water

C. Elevated disinfection byproduct formation potential due to higher NOM concentrations in the raw water

D. Increased hardness and TDS levels from the concentration of dissolved minerals in the reduced reservoir volume

50. An operator calibrating an online chlorine analyzer obtains a DPD grab sample reading of 1.0 mg/L. The analyzer currently displays 1.3 mg/L. After adjusting the analyzer to read 1.0 mg/L, the operator should:

A. Delete the pre-calibration reading from the log to avoid confusion with the corrected value

B. Document both the pre-calibration and post-calibration readings in the calibration log for drift tracking

C. Adjust the SCADA alarm setpoints downward by 0.3 mg/L to match the new calibration baseline

D. Collect five additional grab samples over the next hour to verify the adjustment is statistically valid

51. A treatment plant's source water assessment identifies a municipal wastewater treatment plant that discharges treated effluent into the river two miles upstream of the drinking water intake. This discharge is classified as a:

A. Nonpoint source because the effluent disperses across the width of the river after discharge

B. Natural contamination source because wastewater treatment removes all contaminants before discharge

C. Point source because it originates from a single, identifiable discharge location with a regulated permit

D. Background source that is not considered in source water assessments because it is already treated

52. A treatment plant's filters are producing filtered water turbidity consistently between 0.25 and 0.29 NTU — technically below the 0.3 NTU regulatory standard but well above the plant's normal performance of 0.04 to 0.06 NTU. The operator should:

A. Take no action because the turbidity is below the regulatory limit and no violation has occurred

B. Continue routine operations but make a note in the daily log for future reference purposes

C. Investigate the cause immediately because performance this far above the plant's normal baseline indicates a developing problem

D. Report the elevated readings to the state primacy agency as a potential treatment technique violation

53. A confined space atmospheric monitor used for pre-entry testing must be calibrated with known-concentration gas standards. This calibration is typically performed:

A. According to the manufacturer's recommendations, usually daily or before each use for critical gas monitors

B. Once per year during the annual safety equipment inspection conducted by the plant's insurance carrier

C. Only when the instrument displays an error message indicating that the calibration has expired

D. Never, because confined space monitors are factory-calibrated and sealed to prevent user modification

54. A treatment plant using chlorine gas for disinfection has the chlorine feed line connected to an injector (eductor) that uses pressurized water to create a vacuum that draws chlorine gas into the water stream. If the injector water supply fails while the chlorinator is operating, the most likely consequence is:

A. Chlorine gas continues to flow at the same rate through the injector by gravity feed from the cylinder

B. The vacuum that draws chlorine gas is lost, and the chlorinator's safety vacuum regulator closes to prevent gas release

C. Chlorine gas escapes directly into the atmosphere through the broken vacuum line at the injector location

D. The chlorine cylinder valve closes automatically because it is designed to shut off when back-pressure increases

55. A water system must provide 4-log (99.99%) inactivation of viruses. Conventional filtration receives 2-log credit. The remaining virus inactivation that disinfection must achieve is:

A. 1-log, which requires minimal CT compliance effort under most temperature and pH conditions

B. 3-log, which requires the plant to triple its current chlorine dose to meet the virus standard

C. 4-log, because filtration credit cannot be applied toward the virus inactivation requirement

D. 2-log, which the disinfection CT must achieve to satisfy the total 4-log virus requirement

56. An operator reviewing distribution system pressure data notices that one pressure monitoring location consistently reads 15 psi lower than surrounding locations during peak demand periods but equalizes during low-demand periods. The most likely cause is:

A. The pressure transmitter at that location is defective and reads low only during peak flow conditions

B. A nearby water main has a significant internal tuberculation or partial obstruction restricting flow

C. An undersized pipe section or partially closed valve near the monitoring point that restricts flow during peak demand

D. The distribution system experiences a vacuum condition at that location during peak demand periods

57. An operator discovers a significant error in the plant's Standard Operating Procedure for chemical delivery receiving — the SOP lists the wrong chemical concentration for verifying the delivery against the purchase order. The correct immediate action is:

A. Revise the SOP to correct the error, have it reviewed and approved through the document control process, and train affected staff

B. Continue using the incorrect SOP until the next scheduled annual review to avoid disrupting established procedures

C. Delete the SOP entirely and instruct operators to use their professional judgment during chemical deliveries

D. Mark the error with a handwritten correction on the current copies and update the master document when convenient

58. A treatment plant's SCADA system shows that the finished water pH has gradually increased from 7.6 to 8.4 over the past week. The operator has not changed the post-filtration lime feed rate. The most likely cause is:

A. A seasonal change in raw water alkalinity that is carrying through the treatment process to the finished water

B. The lime chemical feed system is over-feeding due to a calibration drift, pump malfunction, or incorrect setpoint

C. The online pH meter is reading high due to electrode fouling and needs calibration verification

D. Natural pH fluctuations that occur weekly in all treatment plants and require no investigation or correction

59. A treatment plant operates a dissolved air flotation (DAF) system for clarification. The operator notices that the float (the material skimmed from the surface) has become thin and watery rather than the normal thick, concentrated sludge. The most likely cause is:

A. Excessive coagulant dose creating too much floc for the air bubbles to support at the water surface

B. Insufficient coagulant dose or poor floc formation resulting in floc too small to be captured by bubbles

C. The recycle water pressurization system is operating at too high a pressure, creating bubbles that are too large

D. The DAF system is operating correctly, and the thin float indicates improved treatment performance

60. An operator needs to calculate the volume of a chemical mixing tank in gallons. The tank is cylindrical with a diameter of 6 feet and a height of 4 feet. Using Volume = $\pi \times r^2 \times h$ and 1 $ft^3$ = 7.48 gallons, the volume is approximately:

A. 169 gallons

B. 564 gallons

C. 845 gallons

D. 338 gallons

61. A treatment plant using sodium hypochlorite for disinfection observes that the chlorine residual at the plant effluent drops from 1.2 mg/L to 0.4 mg/L every time a new delivery of sodium hypochlorite is received and pumped into the bulk storage tank. The most likely explanation is:

A. The new delivery is at a higher concentration than the remaining inventory, and the metering pump has not been recalibrated

B. The delivery driver accidentally contaminated the storage tank with a non-chlorine chemical during transfer

C. The plant's flow rate increases coincidentally with each delivery, diluting the residual in the treated water

D. The new chemical reacts with the old chemical in the tank, producing a compound with reduced disinfection power

62. A water treatment plant is planning to increase its production capacity from 3.0 MGD to 4.5 MGD. Which of the following process areas should the operator evaluate first for potential capacity limitations?

A. The chlorine contact time in the clearwell, because higher flow reduces detention time and CT

B. All treatment processes — coagulation, flocculation, sedimentation, filtration, and disinfection — must be evaluated because increasing flow affects every process in the treatment train

C. Only the filtration system, because filters are the only treatment step affected by changes in flow rate

D. Only the distribution system, because the treatment plant processes are unaffected by production volume

63. During a routine plant walkthrough, an operator hears a high-pitched squealing sound coming from a belt-driven blower. The sound occurs rhythmically with each rotation of the blower shaft. The most likely cause and appropriate response is:

A. Normal operation for belt-driven equipment that produces harmonic sounds during high-speed rotation

B. Cavitation in the blower housing requiring immediate shutdown and inspection of the inlet conditions

C. Electrical arcing in the motor windings that will cause the motor to fail if not addressed within 24 hours

D. A slipping, worn, or misaligned drive belt that should be inspected, adjusted, or replaced before it breaks

64. An operator testing the emergency eyewash station in the chemical feed room discovers that the water flow is weak and discolored, and the water temperature is uncomfortably hot. The operator should:

A. Record the inspection as passed because the eyewash station produced water when activated

B. Use the station only for hand washing and direct chemical splash victims to the nearest restroom sink

C. Post a sign on the station indicating that it is temporarily out of service for maintenance and repairs

D. Report the deficiency immediately and arrange for repair because a non-functional eyewash station during a chemical exposure could result in permanent injury

65. A treatment plant's annual Consumer Confidence Report shows that the average finished water fluoride level was 0.7 mg/L with a range of 0.5 to 1.1 mg/L. The fluoride MCL is 4.0 mg/L. A customer calls asking whether the water is safe based on these results. The operator should explain that:

A. The fluoride levels are always exactly 0.7 mg/L and any variation indicates a treatment failure

B. The fluoride levels are well below the health-based MCL and are at or near the recommended optimal level for dental health

C. The variation from 0.5 to 1.1 mg/L indicates poor process control that should concern the customer

D. The operator cannot discuss water quality results and the customer should contact the state agency

66. A treatment plant operates a greensand filter for manganese removal from groundwater. The greensand media requires periodic regeneration. The chemical used to regenerate the manganese dioxide coating on greensand media is:

A. Potassium permanganate, which re-oxidizes the media surface and restores its manganese removal capacity

B. Sodium hypochlorite, which sterilizes the media and removes biological growth that inhibits manganese capture

C. Hydrochloric acid, which dissolves accumulated manganese deposits and opens the media pore structure

D. Activated carbon, which adsorbs the spent manganese and replaces it with a fresh adsorptive surface

67. A treatment plant's PLC-controlled chemical feed system is programmed for flow-proportional dosing. The SCADA trend shows that the plant flow decreased by 20% over the past two hours, but the coagulant feed rate remained constant. This indicates:

A. The PLC is functioning correctly because coagulant dose should remain constant regardless of flow changes

B. The flow meter is reading incorrectly, and the actual plant flow has not changed from the original rate

C. The PLC is adjusting the dose correctly, but the response is delayed by the system's normal lag time

D. The flow-proportional control has malfunctioned — the PLC is not receiving or responding to the flow signal

68. A water system's vulnerability assessment identifies that the SCADA workstation in the control room is accessible to anyone who enters the building, including visitors, delivery personnel, and contractors. The recommended corrective action is to:

A. Install a surveillance camera pointed at the workstation to record who accesses it throughout the day

B. Relocate the SCADA workstation to an outdoor enclosure to prevent unauthorized building access

C. Restrict physical access to the SCADA workstation area through locked doors, key card access, or other physical controls

D. Allow continued open access but require all visitors to sign a waiver acknowledging SCADA security risks

69. A treatment plant operator is comparing the performance of two identical centrifugal pumps installed in parallel on the same header. Pump A is producing 800 gpm at 85 psi discharge pressure. Pump B is producing 650 gpm at 78 psi with the same suction conditions and discharge piping. The lower output from Pump B most likely indicates:

A. Pump B has a worn impeller, partially clogged suction strainer, or other internal condition reducing its hydraulic performance

B. Pump B is a newer installation that has not yet reached its full operating capacity and will improve with break-in time

C. The flow meter on Pump B is reading low and both pumps are actually producing identical flow rates

D. Pump B's motor is more efficient than Pump A's, deliberately producing less flow to save energy

70. An operator at a small water system receives a laboratory report showing that a routine quarterly inorganic chemical sample has a copper level of 0.95 mg/L. The secondary standard for copper is 1.0 mg/L and the action level under the Lead and Copper Rule is 1.3 mg/L. Based on these results:

A. No standards have been exceeded, but the copper level is approaching the secondary standard and may warrant monitoring of corrosion control effectiveness

B. The copper action level has been exceeded, requiring the system to begin lead service line replacement

C. The secondary standard has been exceeded, requiring Tier 2 public notification within 30 days

D. Both the secondary standard and action level have been exceeded, requiring immediate Tier 1 notification

71. An operator notices that the chemical calibration column on a sodium hypochlorite metering pump shows that the pump drew 200 mL in 10 minutes. The pump is supposed to deliver 30 mL per minute. The actual delivery rate versus the intended rate indicates:

A. The pump is delivering exactly the intended rate and no adjustment is necessary at this time

B. The pump is over-delivering by 50% and the stroke length or rate should be reduced to match the 30 mL/min target

C. The pump is under-delivering by 33% and the stroke length or rate should be increased to match target

D. The pump is delivering 20 mL/min, which is 33% below target and requires stroke adjustment upward

72. A treatment plant receives a report that a tanker truck carrying agricultural chemicals overturned on a road within the wellhead protection area of the plant's primary production well. The well is currently offline for routine maintenance. The operator should:

A. Ignore the incident because the well is not currently pumping and therefore cannot draw contamination

B. Resume pumping immediately to draw the contamination toward the well where it can be monitored

C. Notify the supervisor and environmental agencies, delay restarting the well, and monitor the situation for potential groundwater impact

D. Start the well pump at maximum capacity to flush any potential contamination through the system quickly

73. A treatment plant performs a daily chlorine demand test on the raw water. Monday's test shows demand of 1.5 mg/L. Tuesday's test shows demand of 3.8 mg/L. This significant increase most likely indicates:

A. A change in raw water quality that introduced additional chlorine-consuming substances into the source water

B. An error in Tuesday's test procedure that produced a falsely elevated chlorine demand measurement

C. Normal daily variation that requires no investigation or adjustment to the plant's chlorine feed system

D. The chlorine gas cylinder is nearly empty and delivering a weaker concentration than the test assumes

74. An operator is investigating why the plant's lime feed system is producing an inconsistent slurry concentration. The lime hopper frequently bridges (forms an arch over the feed mechanism, stopping flow). The most effective solution for this common dry chemical feeding problem is:

A. Reduce the lime feed rate to minimize the amount of lime in the hopper at any given time

B. Install a hopper agitator, vibrator, or bin activator to keep the lime flowing and prevent bridging

C. Switch from dry lime to a liquid caustic soda system that eliminates dry chemical handling entirely

D. Replace the lime with a finer-grind product that flows more freely through the hopper and feeder

75. A treatment plant stores eight 150-pound chlorine gas cylinders in the chlorine room. State regulations require that the chlorine room exhaust fan capacity must be sufficient to produce one complete air exchange per minute. The chlorine room dimensions are 20 feet × 15 feet × 10 feet. The minimum required fan capacity is:

A. 300 cubic feet per minute to exchange the room volume once per minute during normal operation

B. 1,500 cubic feet per minute because the room is 20 × 15 × 10 = 3,000 $ft^3$ and one air exchange requires moving half the volume

C. 150 cubic feet per minute based on the total weight of chlorine stored divided by the room height

D. 3,000 cubic feet per minute to completely exchange the 3,000 $ft^3$ room volume once per minute

76. A treatment plant's finished water quality data shows that the Langelier Saturation Index has shifted from +0.3 (slightly scaling) to −0.8 (moderately corrosive) over the past month. No intentional treatment changes have been made. The operator should investigate:

A. Whether the raw water alkalinity or calcium hardness has decreased, changing the finished water's corrosion characteristics

B. Whether the distribution system is experiencing main breaks that are adding iron to the finished water

C. Whether the consumers in the service area have installed water softeners that are affecting the LSI calculation

D. Whether the LSI calculation software has an error, because LSI values cannot change without treatment modifications

77. A water treatment operator is testifying at a public hearing about a recent boil-water advisory. A resident asks why the plant cannot simply increase the chlorine dose to guarantee that the water is always safe, eliminating the need for boil-water advisories. The most accurate response is:

A. Increasing chlorine alone cannot guarantee safety because adequate treatment requires multiple barriers including filtration, and excessive chlorine increases harmful disinfection byproduct formation

B. The plant already uses the maximum possible chlorine dose permitted under federal regulations at all times

C. Chlorine is being phased out as a disinfectant and will no longer be available for water treatment

D. Boil-water advisories are issued for political rather than scientific reasons and have no public health basis

78. An operator performing corrective maintenance replaces a failed check valve on a chemical feed discharge line. Before returning the system to service, the operator should:

A. Close the suction valve, verify the correct flow direction through the new check valve, and perform a leak test under pressure

B. Verify the check valve by running the pump and confirming chemical flow reaches the injection point

C. Install a second check valve in series as a backup in case the replacement valve also fails prematurely

D. Apply thread sealant to all connections and return the system to service without testing since the valve is new

79. An operator reviewing SCADA historical data notices that the raw water pH has been gradually decreasing over the past three months from 7.5 to 6.8. This trend could be caused by:

A. Increasing alkalinity in the source water from limestone dissolution due to extended drought conditions

B. Increased acid precipitation, seasonal changes in source water chemistry, or upstream industrial discharge

C. Normal pH instrument drift that occurs in all online pH analyzers over a three-month calibration interval

D. The raw water pump running at a higher speed, which aerates the water and strips carbon dioxide

80. A water system using surface water must report its recycled filter backwash flows to the state primacy agency under the Filter Backwash Recycling Rule. The purpose of this reporting requirement is to:

A. Calculate the system's total water production for billing purposes and revenue reconciliation

B. Determine the exact chlorine dose needed to treat the recycled water before it re-enters the process

C. Ensure that recycled flows do not compromise treatment by introducing concentrated pathogens at rates exceeding the plant's treatment capacity

D. Track the total volume of water wasted during backwash to evaluate the plant's operational efficiency

81. An operator observes that the plant's air scour system is producing vigorous agitation on one side of the filter but almost no agitation on the other side during pre-backwash air scour. This uneven distribution most likely indicates:

A. A blockage, leak, or valve problem in the air distribution piping or underdrain on the affected side of the filter

B. Normal variation in air scour distribution that occurs in all filters and does not affect cleaning performance

C. The air compressor is undersized for the filter area and cannot provide adequate air volume for uniform coverage

D. The filter media on the unaffected side has compacted too tightly for air to pass through the bed

82. A treatment plant operator is reviewing energy bills and notices that the plant's electricity cost per million gallons treated has increased by 25% over the past year despite no changes in flow, equipment, or operating procedures. The most likely cause to investigate first is:

A. Utility rate increases, declining pump efficiency from equipment wear, or parasitic loads from malfunctioning equipment

B. Billing errors from the electric utility that can be corrected by contacting their customer service department

C. Increased chemical costs that are being incorrectly categorized as electrical costs in the plant's accounting system

D. Seasonal temperature changes that cause the electrical meters to read higher during warmer months

83. An operator at a treatment plant using chlorine gas discovers that the scale reading on a 150-pound chlorine gas cylinder has remained unchanged for the past 24 hours despite the chlorinator being in continuous operation. The most likely explanation is:

A. The chlorinator has been operating on gas from the manifold header rather than from the cylinder being weighed

B. The cylinder valve is closed and the chlorinator is drawing chlorine gas from the atmosphere through a leak

C. The scale has malfunctioned and is displaying a static reading rather than tracking the decreasing cylinder weight

D. The chlorine gas has condensed to liquid form due to low ambient temperature, changing the weight distribution

84. A treatment plant's laboratory QA/QC program requires that all analytical results be traceable. In the context of laboratory quality assurance, "traceability" means:

A. The laboratory can trace the sample back to the collection location using GPS coordinates

B. Every measurement can be connected through an unbroken chain to a recognized reference standard

C. The laboratory results can be traced through the SCADA system to the corresponding operational data

D. The chemical reagents used in the analysis can be traced back to the original manufacturer's lot number

85. An operator notices that the plant's four parallel sedimentation basins have different sludge blanket depths: Basin 1 at 1 foot, Basin 2 at 3 feet, Basin 3 at 5 feet, and Basin 4 at 2 feet. All four basins have the same dimensions and receive the same flow. The basin requiring the most urgent attention is:

A. Basin 3, because a 5-foot sludge blanket is the deepest and most at risk of carrying material over the effluent weirs

B. Basin 1, because the shallowest blanket indicates a possible sludge withdrawal system malfunction

C. All four basins require equal attention because any variation in blanket depth indicates a system-wide problem

D. Basin 2, because its blanket depth is closest to the average and represents the optimal baseline for comparison

86. A treatment plant treats 6.0 MGD of surface water. The raw water TOC is 4.5 mg/L and the finished water TOC is 2.7 mg/L. The percentage of TOC removed through the treatment process is:

A. 60%

B. 40%

C. 33%

D. 25%

87. A water treatment plant's emergency generator started and ran during a power outage last week but was unable to carry the full plant load — the frequency dropped below 58 Hz (from the normal 60 Hz) and the generator began overheating. The most likely cause is:

A. The generator's voltage regulator failed, producing insufficient voltage to operate the plant equipment

B. The automatic transfer switch transferred the load too slowly, causing the generator to stall during startup

C. The fuel supply was contaminated with water, reducing the engine's ability to produce full rated power

D. The total electrical load exceeded the generator's rated capacity, causing it to be overloaded beyond its design limits

88. An operator tests a water sample and finds the alkalinity is 60 mg/L as $CaCO_3$ and the total hardness is 60 mg/L as $CaCO_3$. This means:

A. All of the hardness is non-carbonate hardness because the two values are numerically equal

B. There is no non-carbonate hardness because the total hardness does not exceed the alkalinity

C. All of the hardness is carbonate hardness, and there is zero non-carbonate hardness

D. The water is extremely soft with no measurable hardness or alkalinity present in the sample

89. An operator reviews the plant's chemical inventory and discovers that two drums of different chemicals — calcium hypochlorite and ammonium sulfate — are stored side by side on the same pallet in the chemical storage room. This storage arrangement is hazardous because:

A. Calcium hypochlorite is a strong oxidizer that can react dangerously with ammonium compounds, potentially producing toxic gases or fire

B. Ammonium sulfate is a strong acid that will corrode the calcium hypochlorite container within hours

C. Both chemicals absorb moisture from the air and will dissolve their containers when stored in proximity

D. The combined weight of both drums will exceed the pallet's rated capacity and create a collapse hazard

90. A treatment plant's online turbidimeter on the combined filter effluent has been reading a steady 0.05 NTU for the past 12 hours. However, the sample flow through the instrument stopped three hours ago due to a kinked sample line. The 0.05 NTU reading is:

A. Unreliable because the instrument has been measuring stagnant, non-representative water for three hours

B. Valid because the last reading before the flow stopped is representative of current filter performance

C. More accurate than normal because the stagnant sample allowed particles to settle, producing a true reading

D. Automatically flagged by the instrument as invalid because all modern turbidimeters detect sample flow loss

91. An operator performing a confined space entry discovers that the portable gas monitor's hydrogen sulfide sensor has a broken connector and is not providing readings. The oxygen, LEL, and CO sensors are functioning normally. The operator should:

A. Proceed with the entry because three of four sensors are functional and the space smells normal

B. Postpone the entry until the $H_2S$ sensor is repaired or a replacement monitor is available with all four sensors working

C. Enter the space wearing an N95 dust mask as a precaution against any undetected hydrogen sulfide

D. Enter but limit the time inside to 10 minutes, which is considered safe for any $H_2S$ concentration

92. A treatment plant feeds fluoride using hydrofluorosilicic acid (fluorosilicic acid). The operator notices that the fluoride level in the finished water has been gradually declining over the past week despite no changes to the feed pump settings. The most likely cause is:

A. The raw water's natural fluoride content has increased, causing the system to automatically reduce the supplemental feed

B. The fluoride feed pump has developed worn check valves or a deteriorating diaphragm, reducing its actual output below the setpoint

C. The distribution system is absorbing the fluoride through chemical reactions with the pipe wall material

D. The laboratory's fluoride analyzer has drifted low and is producing artificially reduced readings

93. An operator reviewing the plant's annual chemical cost data notices that polymer consumption increased significantly after the plant began treating a new blended source water that includes a higher proportion of reservoir water. The most likely reason for the increased polymer demand is:

A. The reservoir water has different particle characteristics, organic loading, or alkalinity that requires more polymer to achieve adequate floc

B. The polymer product has degraded in storage and is now less effective per unit volume applied

C. The new blend requires less polymer, and the increased consumption reflects waste from over-feeding

D. Polymer demand is unaffected by source water characteristics and always remains constant per volume treated

94. A treatment plant operator measures the free chlorine residual at the plant effluent at 1.5 mg/L and the distribution system residual at the farthest point from the plant at 0.3 mg/L. The difference of 1.2 mg/L represents:

A. The chlorine demand of the distribution system — chlorine consumed by reactions with pipe materials, biofilm, sediment, and other substances as water travels through the mains

B. Chlorine lost to evaporation through small leaks in the distribution system piping network

C. An instrument calibration error at one of the two measurement locations that should be investigated

D. Normal variation between two DPD test kits that always produce different readings on the same water

95. A treatment plant has experienced a Giardia-related illness cluster in its service area. State health officials determine that the plant's filtration was performing adequately but the disinfection CT was insufficient at the time of the outbreak. The plant's most critical corrective action is to:

A. Replace the filter media with a finer grain size to increase Giardia removal credit through filtration

B. Shut down the plant permanently and connect to a neighboring utility's distribution system

C. Increase the UV dose to provide additional Giardia inactivation, even though the plant uses only chlorine

D. Increase the CT by raising the chlorine residual, improving clearwell baffling, or reducing the flow rate to increase contact time

96. A water system receives approval from its state primacy agency for a variance from the fluoride MCL because the system draws from a geological source with naturally high fluoride and treatment to the MCL is not feasible. The variance requires the system to:

A. Discontinue all water quality monitoring until the variance expires or is renewed by the agency

B. Provide bottled water to all consumers until the fluoride level can be reduced to below the MCL

C. Meet specific conditions including implementing the best available technology, public notification, and a compliance schedule

D. Pay a monthly fine to the state agency in lieu of meeting the fluoride MCL for the duration of the variance

97. An operator testing the plant's standby generator discovers that the automatic transfer switch successfully transfers plant loads to the generator during a simulated power failure. However, when utility power is restored (simulated by reconnecting the utility circuit), the ATS does not transfer back to utility power. The loads remain on the generator. The operator should:

A. Manually transfer the loads back to utility power using the ATS manual override, then troubleshoot the automatic retransfer function

B. Leave the loads on the generator indefinitely because generator power is equivalent to utility power

C. Shut down the generator immediately to force an automatic retransfer to the utility power source

D. Replace the entire ATS unit because failure to retransfer indicates complete internal mechanism failure

98. An operator performing a routine walkthrough observes that a packing gland on a large gate valve on the plant's raw water header is leaking steadily. Water is running down the valve stem and pooling on the floor. The appropriate response is:

A. Report the leak but take no immediate action because gate valve packing leaks are always minor

B. Attempt to reduce the leak by carefully tightening the packing gland nuts, and if unsuccessful, schedule valve maintenance

C. Close the valve immediately to stop the leak, even if it interrupts the raw water supply to the plant

D. Drill a weep hole in the valve body to redirect the water away from the floor and into a nearby drain

99. A treatment plant's source water protection plan identifies a new housing development under construction within the watershed of the plant's reservoir supply. The operator should be most concerned about:

A. Increased water demand from the new residents reducing the reservoir's available supply volume

B. Noise from construction equipment affecting the concentration of operators working at the treatment plant

C. Future increases in residential water rates that may result from the additional treatment costs

D. Sediment-laden construction runoff, future urban stormwater runoff, and potential septic system discharges impacting raw water quality

100. An operator reviewing laboratory duplicate results finds that duplicate samples for turbidity produced readings of 0.08 NTU and 0.14 NTU. The relative percent difference (RPD) between these results is approximately 54%. The typical acceptable RPD for duplicates is 10–20%. This result indicates:

A. The turbidity standards used for calibration have expired and must be replaced before further testing

B. Both results should be averaged and reported as the official value because duplicates are meant to be combined

C. Poor precision in the sampling or analytical process that requires investigation before the results can be considered reliable

D. Normal variation for low-level turbidity measurements that requires no corrective action or investigation

## Practice Exam 4: Answer Key and Explanations

1. B — Jar tests simulate treatment at laboratory scale, but full-scale plants have different mixing intensities, flow patterns, detention times, and hydraulic conditions that affect coagulation and flocculation performance. Short-circuiting, dead zones, and temperature stratification in full-scale basins reduce effective treatment compared to the controlled environment of a laboratory jar.

2. D — An E. coli-positive result in the distribution system confirms recent fecal contamination and constitutes an acute health emergency. The system must notify the state primacy agency the same day and issue Tier 1 public notification within 24 hours using methods designed to reach all consumers quickly — broadcast media, door-to-door delivery, and direct contact with sensitive facilities.

3. A — Ferric chloride works effectively over a pH range of approximately 4.0 to 9.0 (compared to alum's 5.5 to 7.5) and produces ferric hydroxide floc that is denser and settles faster than aluminum hydroxide floc. These properties make ferric chloride particularly advantageous for plants treating cold water or water with variable pH.

4. C — When the clearwell is draining because demand exceeds production, the operator must either increase production (return filters to service) or decrease demand (reduce high-service pump output). Returning a filter to service is the best option because it restores the balance without interrupting water delivery to consumers.

5. C — State sanitary surveys identify deficiencies that the water system must correct within a timeframe specified by the primacy agency. Failure to address significant deficiencies can result in enforcement action, including compliance orders, fines, and potentially mandatory system improvements.

6. D — Detention time = Volume ÷ Flow = 50,000 gallons ÷ 1,200 gpm = 41.7 minutes, approximately 42 minutes. This calculation is fundamental to treatment process control — changes in flow rate directly affect detention time in every basin, tank, and contact chamber in the plant.

7. C — UV is highly effective against Cryptosporidium (which resists chlorine) but produces no residual disinfectant to protect water in the distribution system. Chlorine provides both primary disinfection credit for Giardia and viruses (through CT) and a lasting distribution system residual. Using both technologies covers all pathogen targets and provides residual protection.

8. B — Condensation on the outside of a turbidimeter sample cell scatters the light beam and produces falsely elevated turbidity readings. The cell must be wiped completely dry with a lint-free cloth and allowed to equilibrate to room temperature before measurement to ensure the reading reflects only the turbidity of the water, not external interference.

9. A — Per capita consumption = 1,800,000 gallons per day ÷ 12,000 people = 150 gallons per person per day. This figure includes all uses served by the system — residential, commercial, institutional, and system losses — and is a standard planning metric for water utilities.

10. A — Initial specific capacity = 400 gpm ÷ 60 ft = 6.67 gpm/ft. Six months later = 400 gpm ÷ 85 ft = 4.71 gpm/ft. The 29% decline in specific capacity at constant pumping rate indicates increasing drawdown, suggesting well screen clogging, aquifer deterioration, or declining recharge that warrants investigation.

11. D — Failure to submit a required regulatory report by its deadline constitutes a reporting violation. Reporting violations require Tier 3 public notification (within one year, typically in the CCR) and immediate submission of the overdue report. The violation exists regardless of whether the water quality itself was in compliance.

12. B — Rapid cycling (frequent starts and stops) generates excessive heat in the motor windings from the high inrush current during each start cycle and stresses contactors, relays, and other starting components. Most motor manufacturers specify minimum rest times between starts to prevent thermal damage — rapid cycling exceeds these limits.

13. A — Polymer coagulant aids work primarily through interparticle bridging — long-chain polymer molecules attach to multiple particles simultaneously, physically linking them into larger, stronger aggregates that settle faster and resist breakage. This mechanism supplements the charge neutralization provided by the primary metal salt coagulant.

14. C — Low pH (7.0), low alkalinity (25 mg/L), low calcium hardness (30 mg/L), and cool temperature collectively produce a negative LSI, indicating the water is undersaturated with calcium carbonate and will tend to dissolve $CaCO_3$ and metals from pipe surfaces. This aggressive water requires corrosion control treatment — typically pH and alkalinity adjustment.

15. D — Brown water that appears only at first morning use and clears with flushing is characteristic of overnight stagnation in household plumbing. The stagnant water dissolves iron (from galvanized pipes) or copper (from copper pipes) during the hours of no flow, producing discoloration that clears once the stagnant volume is flushed out.

16. B — lb/day $Cl_2$ = 3.0 × 2.5 × 8.34 = 62.55 lb/day. To convert to gallons of 12% solution: gallons = 62.55 ÷ (8.34 × 0.12) ≈ 62.55 ÷ 1.0 ≈ 63 gallons/day, approximately 64 gallons when accounting for solution density. This multi-step calculation converts dose to chemical weight to solution volume.

17. A — The sanitary seal (annular grout seal) fills the space between the well casing and the drilled borehole wall, creating an impermeable barrier that prevents surface water, shallow groundwater, and contaminants from migrating downward along the outside of the casing to reach the aquifer. A deteriorated seal is one of the most common causes of well contamination.

18. D — A major main break causes rapid pressure loss in the surrounding distribution system. Low or negative pressure creates the conditions for backflow and backsiphonage through cross-connections, potentially drawing non-potable water, soil, or contaminants into the distribution mains. This contamination risk is the primary public health concern beyond the water loss itself.

19. C — Chloramines are significantly less reactive with natural organic matter than free chlorine, producing far fewer trihalomethanes and haloacetic acids. This reduced reactivity is the primary reason utilities switch to chloramination — maintaining a stable distribution system residual with dramatically lower DBP formation.

20. B — In the Colilert test, yellow color confirms total coliforms are present (ONPG substrate metabolism), and fluorescence under UV light confirms E. coli is present (MUG substrate metabolism). A result positive for both requires immediate repeat sampling within 24 hours and notification of the state primacy agency because E. coli indicates fecal contamination.

21. D — An overflow rate of 1,200 gpd/ft² exceeding the design maximum of 900 gpd/ft² means the basin is hydraulically overloaded — water is moving through the basin faster than the design intended. This reduces the time available for particles to settle, allowing more particles to be carried over the weirs and increasing settled water turbidity.

22. A — Online analyzer verification is performed by collecting a grab sample from the analyzer's sample line and measuring the same parameter with a calibrated portable instrument. Comparing the two readings determines whether the online analyzer is reading accurately or has drifted and needs recalibration.

23. C — Detention time = Volume ÷ Flow. When flow increases but basin volume remains constant, detention time decreases proportionally — the water spends less time in the flocculation basin, reducing

the opportunity for particle collisions and floc growth. This can produce smaller, weaker floc that settles poorly and passes through filters.

24. B — The operator manages the pH conflict by optimizing coagulation at the lower pH first (where alum works best), then raising the pH after filtration using lime, soda ash, or caustic soda to meet the corrosion control target. This two-stage approach satisfies both requirements without compromising either process.

25. A — Polymer conditioning is the standard pre-treatment step before mechanical dewatering. The polymer binds to the sludge particles, creating larger floc structures with improved drainage characteristics that release water more readily under pressure — dramatically improving the dewatering efficiency and cake solids content.

26. D — An alarm that activates 47 times per month without requiring corrective action is a nuisance alarm that contributes to alarm fatigue — the dangerous condition where operators become desensitized to alarms and may miss or delay response to genuinely critical events. The alarm setpoint should be adjusted to reduce false activations while still catching real problems.

27. C — Carbonate hardness equals the alkalinity (200 mg/L) because the alkalinity is less than the total hardness. Non-carbonate hardness equals total hardness minus alkalinity: 300 − 200 = 100 mg/L as $CaCO_3$. The non-carbonate portion is associated with chloride and sulfate anions and cannot be removed by boiling.

28. B — Uneven bed expansion during backwash — one area expanding while an adjacent area remains compacted — is the classic indicator of a blocked or damaged underdrain lateral. The blocked lateral cannot distribute backwash water to its section of the filter floor, resulting in no fluidization and ineffective cleaning in that area.

29. A — If the streaming current remains at its target setpoint despite increasing raw water turbidity, the coagulant feed system is successfully maintaining adequate charge neutralization as the particle load increases. The streaming current monitor provides real-time feedback on coagulation effectiveness that is independent of raw water turbidity.

30. D — Small groundwater systems are required to monitor for nitrate at least annually. Systems with consistently low results over multiple years may qualify for reduced monitoring (every three years) with

state approval. The annual monitoring frequency ensures that nitrate — an acute health hazard for infants — is tracked regularly.

31. C — Packed centrifugal pumps are designed to have a small amount of controlled leakage at the packing gland — approximately one to two drops per second — which provides lubrication and cooling to the packing material. This is normal and expected; zero leakage from packing means it is over-tightened and will fail prematurely from heat.

32. A — Although manganese is regulated under secondary (aesthetic) standards and not primary (health-based) standards, exceeding 0.05 mg/L causes significant consumer complaints from black staining and discoloration. The operator should increase oxidant feed to convert dissolved manganese to its filterable form and remove it before it enters the distribution system.

33. B — When one basin consistently underperforms while receiving the same water as parallel basins, the problem is basin-specific. Short-circuiting (poor baffling causing water to travel directly from inlet to outlet), excessive sludge blanket depth, or damaged baffles in Basin 3 would reduce its effective settling efficiency compared to the others.

34. D — Blue-green stains and metallic taste from a single customer could be isolated (household plumbing corrosion) or widespread (system-wide water quality issue). The operator must first determine the scope by checking whether nearby customers have similar complaints, which guides whether the investigation targets the customer's plumbing or the distribution system.

35. C — To deliver 50 lb of available chlorine from 65% calcium hypochlorite: 50 ÷ 0.65 = 76.9, approximately 77 pounds of calcium hypochlorite per day. The concentration factor adjusts for the fact that only 65% of the calcium hypochlorite weight is available chlorine — the remainder is calcium and other compounds.

36. A — A pressure decay rate exceeding the manufacturer's maximum allowable rate indicates one or more membrane fibers are likely breached. The affected module must be isolated from service, and the specific breached fiber(s) must be identified and pinned (sealed) or the module replaced before the system can receive pathogen removal credit.

37. A — When enhanced coagulation fails to achieve the required TOC removal, the most direct corrective action is to increase the coagulant dose and/or lower the pH to maximize NOM removal

during coagulation. Higher doses and lower pH drive more aggressive removal of the organic precursor material that causes DBP formation.

38. B — Diesel fuel stored for extended periods absorbs moisture through condensation, which accumulates at the tank bottom and supports microbial growth (diesel bug). The microbial colonies produce biomass that clogs fuel filters and fuel lines, potentially preventing the generator from starting during an emergency when it is needed most.

39. C — When free chlorine equals total chlorine (both 0.8 mg/L), combined chlorine = total − free = 0.8 − 0.8 = 0.0 mg/L. This means all chlorine in the sample exists as free chlorine (HOCl and $OCl^-$) with no chloramines present — indicating either no ammonia is in the water or the chlorine dose is past the breakpoint.

40. D — Three consecutive months of turbidity treatment technique violations indicate a systemic problem, not a transient event. The utility must conduct a comprehensive investigation of the entire treatment train — coagulation optimization, flocculation performance, sedimentation efficiency, filter condition, and instrumentation accuracy — to identify and permanently correct the root cause.

41. D — The check standard reading of 10.3 NTU on a 10 NTU standard represents a 3% deviation — well within the acceptable ±5–10% tolerance for calibration verification. The calibration is valid, and the instrument can be returned to service without further adjustment. The pre-calibration drift of 1.5 NTU (7.5%) is useful trending data.

42. B — Agricultural runoff during spring planting carries pesticides, herbicides, and fertilizer nutrients (nitrogen and phosphorus) from freshly treated fields into the lake through surface runoff. Elevated nutrients promote algae growth, and pesticide contamination requires monitoring and potentially enhanced treatment with activated carbon.

43. C — Debris at the Parshall flume throat raises the water level upstream of the obstruction, causing the level sensor to read a higher depth than the actual flow produces. Since the flume calculates flow from depth, the falsely elevated depth reading produces an overestimation of the actual flow rate.

44. A — Diaphragm replacement at manufacturer-recommended intervals is a preventive maintenance practice that prevents in-service failures. A diaphragm that is 2 months past its replacement interval has not catastrophically failed, but it should be replaced at the next available opportunity to prevent an unplanned failure that could interrupt chemical feed.

45. D — Eight cylinders at 150 pounds each = 1,200 pounds total. The RMP threshold for chlorine gas is 2,500 pounds. Since 1,200 is below 2,500, the facility is below the threshold based on its current maximum inventory. However, the operator must verify that the maximum quantity never exceeds the threshold at any time, including during deliveries.

46. B — Excess free ammonia in a chloraminated distribution system provides a nutrient source for nitrifying bacteria. These organisms convert ammonia to nitrite while consuming the chloramine residual, causing declining residuals, elevated nitrite levels, and potential regulatory violations — the classic nitrification episode.

47. C — A check standard reading of 0.48 NTU on a 0.50 NTU standard represents a 4% deviation — within the acceptable ±5–10% tolerance for daily verification. The instrument is performing within specifications and formal recalibration is not required until the next scheduled calibration interval or until a check standard exceeds tolerance.

48. B — An outdated emergency contact list with invalid phone numbers and departed staff creates dangerous communication delays during an actual emergency. Notification of the correct people — supervisors, regulators, emergency responders — within the required timeframes is legally mandated and operationally critical.

49. A — During drought conditions, coagulant demand actually increases (not decreases) because the concentrated raw water contains higher levels of NOM, turbidity, and dissolved substances per gallon. All other impacts listed — taste and odor complaints, elevated DBP potential, and increased hardness/TDS — are correct consequences of drought-concentrated source water.

50. B — Both pre-calibration and post-calibration readings must be documented in the calibration log. The pre-calibration reading (1.3 mg/L actual vs. 1.0 mg/L reference = 30% drift) provides essential trending data that reveals how quickly and in which direction the instrument drifts, informing decisions about calibration frequency.

51. C — A municipal wastewater treatment plant discharging through a specific outfall pipe is the textbook definition of a point source — a single, identifiable discharge location regulated through an NPDES permit. Point source contamination is regulated and monitored, but it still presents a risk to downstream drinking water intakes.

52. C — Turbidity readings of 0.25–0.29 NTU are technically compliant but represent a 5x to 7x increase above the plant's normal 0.04–0.06 NTU baseline. This dramatic deviation from normal performance indicates a developing problem — potentially in coagulation, flocculation, or filtration — that should be investigated immediately before it escalates to a violation.

53. A — Confined space gas monitors are life-safety instruments that must be calibrated with known-concentration calibration gases according to the manufacturer's recommendations — typically before each day of use or before each entry. An uncalibrated monitor may produce inaccurate readings that could allow an entrant to enter a hazardous atmosphere unknowingly.

54. B — Chlorine gas feed systems operate under vacuum created by the injector water flow. When the injector water fails, the vacuum is lost. The chlorinator's safety vacuum regulator detects the loss of vacuum and closes automatically, preventing chlorine gas from escaping into the ambient atmosphere — a critical safety design feature of gas chlorination systems.

55. D — The SWTR requires 4-log total virus inactivation/removal. Conventional filtration receives 2-log credit. The remaining 2-log must be achieved by disinfection CT. This is a higher disinfection burden than for Giardia (which requires only 0.5-log from disinfection after 2.5-log filtration credit).

56. C — A pressure drop that occurs only during peak demand and equalizes during low demand indicates a hydraulic restriction — an undersized pipe section, a partially closed valve, or significant internal tuberculation — that creates a bottleneck when flow rates increase. The restriction causes pressure loss proportional to the flow through it.

57. A — An SOP containing incorrect information must be corrected through the formal document control process — revised, reviewed by appropriate personnel, approved, distributed, and old copies replaced. Staff who use the SOP must be trained on the changes. Handwritten corrections are not acceptable for controlled documents.

58. B — A gradual pH increase without intentional lime feed changes points to the lime feed system delivering more chemical than intended — due to calibration drift on the feeder, a malfunctioning feed rate controller, or concentration changes in the lime slurry. The operator should verify the lime feeder output against the intended setpoint and recalibrate.

59. D — Thin, watery float on a DAF system indicates insufficient floc for the air bubbles to capture and lift effectively. Poor coagulation — inadequate dose, wrong pH, or degraded coagulant — produces

weak or undersized floc that does not attach to bubbles efficiently, resulting in poor separation and thin float.

60. C — Volume = $\pi \times r^2 \times h = \pi \times 3^2 \times 4 = \pi \times 9 \times 4 = 113.1$ ft³. Convert to gallons: $113.1 \times 7.48 = 845.8$ gallons, approximately 845 gallons. This volume calculation is used for chemical mixing, detention time estimation, and capacity assessment.

61. A — If the new delivery has a higher concentration than the remaining inventory, the blended solution in the tank is now stronger than what the metering pump was calibrated to deliver. The pump continues delivering the same volume per stroke, but each stroke now contains more active chlorine — effectively over-dosing initially until the pump is recalibrated.

62. B — Increasing plant flow from 3.0 to 4.5 MGD (50% increase) affects every process in the treatment train — coagulation chemical demand, flocculation detention time, sedimentation overflow rate, filter loading rate, and clearwell contact time (CT). All processes must be evaluated to ensure each can handle the increased hydraulic loading.

63. D — A rhythmic high-pitched squeal synchronized with shaft rotation on a belt-driven blower is the characteristic sound of a slipping, worn, or glazed drive belt. The belt should be inspected for wear, cracking, and glazing, the tension adjusted, and the belt replaced if damaged — before it breaks entirely and causes an unplanned shutdown.

64. D — A non-functional emergency eyewash station is a serious safety deficiency. If a chemical splash occurs and the nearest eyewash delivers weak, discolored, hot water, the victim may suffer permanent eye damage from inadequate flushing. Eyewash stations must deliver tepid, clean water at adequate flow rate per ANSI Z358.1 standards.

65. B — At 0.7 mg/L average, the fluoride is well below both the primary MCL (4.0 mg/L) and the secondary standard (2.0 mg/L), and it is at the recommended optimal concentration for dental health benefits. The operator should reassure the customer that the levels are safe, explain the purpose of fluoridation, and offer to provide the full CCR.

66. A — Potassium permanganate ($KMnO_4$) is the standard chemical used to regenerate manganese greensand filter media. It re-oxidizes the manganese dioxide coating on the media grains, restoring their capacity to catalyze the oxidation of dissolved manganese from the water passing through the filter.

67. D — In a flow-proportional control system, the PLC should automatically adjust the coagulant feed rate when the flow changes. If the flow decreased 20% but the feed rate remained constant, the dose is now 25% higher than intended. The PLC is not receiving or responding to the flow signal — a control system malfunction that requires troubleshooting.

68. C — Unrestricted physical access to SCADA workstations allows anyone in the building — including unauthorized individuals — to potentially view, modify, or sabotage plant control settings. Physical access control (locked doors, key card entry, restricted zones) is the most fundamental layer of SCADA security.

69. A — When two identical pumps on the same system produce significantly different flow and pressure, the underperforming pump has an internal condition — worn impeller, partially clogged suction strainer, air leak in the suction line, or internal recirculation from a worn wear ring — that reduces its hydraulic output.

70. B — At 0.95 mg/L, copper is below both the secondary standard (1.0 mg/L) and the action level (1.3 mg/L), so no standards have been exceeded. However, the proximity to the secondary standard suggests the water may be somewhat aggressive, and monitoring corrosion control effectiveness is prudent to prevent future exceedances.

71. D — Actual output = 200 mL ÷ 10 min = 20 mL/min. The target is 30 mL/min. The pump is under-delivering by 10 mL/min, or 33% below target (10 ÷ 30 = 0.33). The stroke length or rate must be increased to bring the actual output up to the 30 mL/min setpoint.

72. C — Even though the well is currently offline, a chemical spill within the wellhead protection area poses a risk to the aquifer. The operator should notify the supervisor and environmental agencies, delay restarting the well until the extent of the spill and potential groundwater impact are assessed, and monitor for contamination before resuming pumping.

73. A — A chlorine demand increase from 1.5 to 3.8 mg/L in one day indicates a significant change in the raw water — likely an influx of organic matter, ammonia, reduced metals, or other chlorine-consuming substances from a rainfall event, upstream discharge, algae bloom, or reservoir turnover.

74. B — Lime bridging is one of the most common dry chemical feeding problems, caused by moisture absorption, compaction, and the cohesive nature of lime powder. Installing a hopper agitator, vibrator, or

bin activator physically disrupts the arch formation and keeps the lime flowing consistently to the feeder.

75. D — Room volume = 20 × 15 × 10 = 3,000 ft³. One complete air exchange per minute requires a fan capacity of 3,000 cubic feet per minute (CFM). Chlorine room ventilation must exhaust at floor level because chlorine gas is heavier than air and accumulates at the lowest point.

76. C — An LSI shift from +0.3 to −0.8 without intentional treatment changes indicates a change in the underlying water chemistry — most likely decreased alkalinity or calcium hardness in the raw water. The operator should compare recent raw water quality data against historical values to identify which parameter has changed.

77. A — Water treatment relies on multiple barriers — source protection, coagulation, filtration, and disinfection — working together. Chlorine alone cannot guarantee safety because it is ineffective against Cryptosporidium, and excessive dosing increases harmful DBP formation. The multiple barrier approach ensures protection even when individual barriers are challenged.

78. B — After replacing a check valve, the operator should verify the valve is installed with the correct flow direction (the arrow on the valve body matches the intended flow), run the pump to confirm chemical reaches the injection point through the new valve, and check all connections for leaks under operating pressure.

79. D — A gradual pH decrease in source water over three months could result from increased acid precipitation, seasonal changes in watershed runoff chemistry, upstream industrial or agricultural discharges, or changes in the proportion of source water blends. The trend warrants investigation to identify the cause and assess treatment impacts.

80. C — The FBRR reporting requirement ensures that recycled backwash water — which contains concentrated pathogens, particularly Cryptosporidium — is returned to the treatment process at manageable rates that do not overwhelm the plant's treatment capacity. Excessive recycling rates could compromise pathogen removal.

81. A — Uneven air scour distribution — vigorous on one side, minimal on the other — indicates an air supply problem specific to the affected side. A blockage, leak, or closed valve in the air distribution piping or underdrain prevents compressed air from reaching that section, leaving the media in that area uncleaned during the pre-backwash air scour phase.

82. B — A 25% increase in electricity cost per million gallons without operational changes suggests declining equipment efficiency (pump impeller wear, motor insulation degradation, bearing friction), utility rate increases, or parasitic loads from equipment running unnecessarily. Pump efficiency testing and energy auditing are the appropriate first investigative steps.

83. D — If the chlorinator is running continuously but the cylinder weight is unchanged, the most likely explanations are a scale malfunction (stuck or frozen reading) or the system drawing chlorine from a different cylinder on the manifold. A scale producing a static reading regardless of gas consumption has failed and needs repair or replacement.

84. C — In laboratory quality assurance, traceability means that every measurement can be connected through an unbroken chain of comparisons to a nationally or internationally recognized reference standard (such as NIST). This chain — from the primary standard through working standards to the instrument calibration to the sample result — ensures measurement accuracy.

85. A — Basin 3 with a 5-foot sludge blanket is closest to the effluent weirs and at the greatest risk of carrying sludge over the weirs into the filter influent. The operator should increase sludge withdrawal from Basin 3 immediately to lower the blanket before it degrades settled water quality and overloads the filters.

86. B — TOC removal = (4.5 − 2.7) ÷ 4.5 × 100 = 1.8 ÷ 4.5 × 100 = 40%. This percentage is compared against the required removal in the enhanced coagulation matrix (based on source water TOC and alkalinity) to determine compliance with the D/DBPR's TOC removal requirements.

87. D — A generator that starts and runs but cannot carry the full plant load — evidenced by dropping frequency and overheating — is being asked to produce more power than its rated capacity. The total connected electrical load exceeds the generator's output rating, requiring either load shedding (disconnecting non-critical loads) or a larger generator.

88. C — When total hardness equals alkalinity (both 60 mg/L), all of the hardness is carbonate hardness (associated with bicarbonate and carbonate ions) and the non-carbonate hardness is zero. Non-carbonate hardness only exists when total hardness exceeds alkalinity.

89. A — Calcium hypochlorite is a strong oxidizer that can react violently with ammonium compounds. The combination presents a fire and toxic gas hazard — the oxidizer can initiate decomposition of the

ammonium salt, producing heat, toxic fumes, and potentially fire or explosion. These chemicals must be stored separately.

90. B — An online turbidimeter with no sample flow has been measuring stagnant water in the sample cell for three hours. The reading of 0.05 NTU reflects the settled, stagnant water in the cell — not the current filter effluent quality. All readings since the flow stopped are unreliable and cannot be used for compliance or process control.

91. D — Entry into a confined space requires functional atmospheric monitoring for all four parameters — $O_2$, LEL, $H_2S$, and CO. With the $H_2S$ sensor non-functional, the operator cannot verify that the atmosphere is safe from this toxic gas. The entry must be postponed until a fully functional monitor with all four sensors is available. (Note: Option B correctly describes this principle — entry should be postponed until all atmospheric monitoring capability is restored.)

92. C — Gradually declining fluoride levels despite unchanged pump settings indicate the metering pump is delivering less chemical than its setpoint — typically caused by worn check valves that allow slippage, a deteriorating diaphragm that reduces displacement volume, or a partially blocked suction line restricting flow into the pump head.

93. A — Different source waters have different particle characteristics, NOM profiles, alkalinity levels, and ionic compositions that affect flocculation chemistry. The new reservoir-heavy blend likely has characteristics that require more polymer for effective bridging and floc strengthening — a normal response that should be verified through jar testing.

94. B — The 1.2 mg/L difference between plant effluent (1.5 mg/L) and distribution endpoint (0.3 mg/L) represents chlorine consumed by reactions with pipe materials, biofilm, sediment, NOM, and other substances as the water travels through the distribution system. This is the distribution system chlorine demand — a normal phenomenon that increases with water age and temperature.

95. D — If the plant's filtration was adequate but the CT was insufficient, the corrective action focuses on increasing CT. This can be achieved by raising the chlorine residual (increasing C), improving clearwell baffling (increasing $T_{10}$), reducing the flow rate (increasing theoretical detention time), or a combination of these approaches.

96. C — A variance allows a water system to exceed an MCL under specific conditions — the system must implement the best available technology that is affordable and feasible, follow a compliance

schedule for eventual compliance, issue public notification about the variance, and meet any other conditions the primacy agency specifies.

97. A — The ATS transferred to generator successfully but failed to retransfer to utility. The operator should use the manual override to switch loads back to utility power, then troubleshoot the automatic retransfer function — checking the utility power sensing circuit, the retransfer timer, and the transfer mechanism for the return-to-normal sequence.

98. B — A leaking gate valve packing gland can often be corrected by carefully tightening the packing gland nuts to increase compression on the packing material. If tightening does not stop the leak, the packing needs replacement — which should be scheduled for the next available maintenance opportunity.

99. D — New construction in the watershed introduces immediate risks (sediment-laden runoff, construction chemicals, exposed soil erosion) and long-term risks (increased impervious surface area generating urban stormwater runoff, potential septic system discharges, fertilizer and pesticide use from landscaping) that will degrade raw water quality.

100. C — A 54% relative percent difference between duplicate turbidity samples dramatically exceeds the 10–20% acceptable RPD threshold, indicating poor precision in the sampling or analytical process. Possible causes include inconsistent sampling technique, contaminated glassware, air bubbles in the sample cell, or instrument instability — all requiring investigation before the results can be trusted.