Job Analysis Report

California-Nevada Section
of the
American Water Works Association

Advanced Water Treatment Operator (AWT)

August 2017

Developed by PSI Services LLC

Authors and Correspondence

This Item Analysis Study was conducted on behalf of the California-Nevada Section of the American Water Works Association, by PSI Services LLC.

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Table of Contents

EXECUTIVE SUMMARY

In 2016 and 2017, Comira (now PSI) conducted a job analysis study for the California-Nevada Section of the American Water Works Association (CA-NV AWWA) in support of an Advanced Water Treatment Certification Program, expected to begin operation in 2017. The primary intent of the certification program is to assure public safety, particularly where Direct Potable Reuse (DPR) is implemented; therefore, upon the recommendation of the California State Water Resources Control Board, the operators to be certified are those in more autonomous or supervisory roles, who are responsible for more complex and critical tasks in ensuring safety. The purpose of the job analysis study was to identify the critical job tasks and knowledge required to perform the duties of an Advanced Water Treatment Operator (AWT), Grades 3 through 5. The job analysis results to date are a content outline, task and knowledge statements. The content outline is the list of task statements and knowledge statements falling within each content domain.

The process began with review of job descriptions and training documents from a variety of water and wastewater operations across California and Nevada. An in-person workshop was held on October 13-16, 2016, in Ontario, California. Eleven AWTs attended the workshop in the role of subject matter experts (SMEs) for the job analysis panel; an additional four observers were present, representing stakeholder organizations. A Comira psychometrician led the SMEs in a series of group discussions in order to reach a consensus on a) definitions of an AWT, Grades 3, 4, and 5 for the purposes of the AWT Certification Examination, b) a set of content domains, c) a set of task statements for each grade, and d) a set of knowledge statements for each grade.

The content outline, with its associated task and knowledge statements, were produced for the purpose of guiding AWT Certification Examination item writing and form construction, in that they define the breadth and level of work and knowledge needed for each grade of Advanced Water Treatment Operator.

In consideration of the small size of the AWT population in California and Nevada, estimated at under 200 AWTs, the present AWT job analysis study was completed using a a focus group approach to generate a test blueprint. A second in-person workshop was held on May 22-23, 2017, also in Ontario, California. Sixteen AWTs attended the workshop in the role of SMEs for the job analysis panel; an additional three observers were present, representing the stakeholder organizations. A PSI psychometrician facilitated a group working session to a) refine the task statements at each grade, b) lay out guidelines for the revision of the knowledge statements at each grade, to be completed by committee, c) to establish the mandate for examination design and examination development projects, and d) to come to a group consensus upon the frequency, applicability and risk of each task at each AWT grade, in support of an appropriately linked and balanced test blueprint at each grade.

The entire validation process incorporates the 2014 Joint Standards for Educational and Psychological Testing (AERA/APA/NCME, 2014) and the National Commission for Certifying Agencies (NCCA) 2016 Standards for the Accreditation of Certification Programs (Institute for Credentialing Excellence, 2014).

The results from the job analysis establish the content-related validity of the certification program by identifying the important tasks performed and the requisite knowledge and skills to perform the tasks safely and competently. The results of the job analysis are the foundation for all aspects of the examination development process including item writing, item review, and test assembly and publication.

INTRODUCTION

In 2016, Comira (now PSI) conducted a job analysis study for the California-Nevada Section of the American Water Works Association (CA-NV AWWA) in support of an Advanced Water Treatment Certification Program, expected to begin operation in 2017. The purpose of the job analysis study was to identify the critical job tasks and knowledge required to perform the duties of an Advanced Water Treatment Operator (AWT), Grades 3 through 5. Comira team members employed a content validation strategy to establish the link between the tasks performed by AWTs and the content to be assessed on the AWT certification examination. To that end, AWTs were utilized as subject matter experts (SMEs) to assist in identifying the essential tasks and knowledge performed by AWTs.

The AWT job analysis study was initiated as a four-day in-person workshop, held October 13th through 16th, 2016 in Ontario, California. In consideration of the small size of the AWT population in California and Nevada, estimated at under 200 AWTs, the present AWT job analysis study was completed using a a focus group approach to generate a test blueprint.

The methodology used for the practice analysis study is consistent with the validation processes recommended in the 2014 Joint Standards for Educational and Psychological Testing (AERA/APA/NCME, 2014) and the National Commission for Certifying Agencies (NCCA) 2016 Standards for the Accreditation of Certification Programs (Institute for Credentialing Excellence, 2014).

The following 2014 Joint Standards apply to job analysis studies:

- **Standard 4.12** "Test developers should document the extent to which the content domain of a test represents the domain defined in the test specifications."
- **Standard 11.03** "When test content is a primary source of validity evidence in support of the interpretation for the use of a test for employment decisions or credentialing, a close link between test content and the job or professional/occupational requirements should be demonstrated."
- **Standard 11.13** "The content domain to be covered by a credentialing test should be defined clearly and justified in terms of the importance of the content for credential-worthy performance in an occupation or profession. A rationale and evidence should be provided to support the claim that the knowledge or skills being assessed are required for credential- worthy performance in that occupation and are consistent with the purpose for which the credentialing program was instituted."

The following 2016 NCCA Standards apply to job analysis studies:

- **Standard 13** "The certification program must use panels of qualified subject-matter experts (SMEs) to provide insight and guidance and to participate in Practice analysis, standard setting, and other examination development activities."
- **Standard 14** "The certification program must have a Practice analysis that defines and analyzes domains and tasks related to the purpose of the credential, and a summary of the study must be published."
- **Standard 15** "The certification program must establish specifications that describe what the examination is intended to measure as well as the design of the examination and requirements for its standardization and use, consistent with the stated objectives of the certification program."

Appendix C. ROLE DEFINITIONS

AWT Grade 3

The AWT 3 understands AWT processes and the impact of feed water quality on production and finished water quality. The AWT 3 operates, monitors, and maintains AWT processes, such as membrane systems and advanced oxidation. The AWT 3 has a basic understanding of AWT-related terminology, process-related calculations (e.g., membrane flux, membrane TMP, and UVT), and chemicals used in individual AWT processes. The AWT 3 understands and executes operational and safety procedures and chemical handling practices. The AWT 3 maintains and follows regulations pertinent to the end uses of treated water, such as recycled water, potable water, and potable water reuse. The AWT 3 understands instrumentation and analyzers, as well as basic maintenance calibration and verification. The AWT 3 has a basic understanding of the control strategy of plant systems. The AWT 3 has a basic understanding of SCADA systems and data trending. The AWT 3 has a basic understanding of incident response and investigation. The AWT 3 follows a HACCP (Hazard Analysis Critical Control Point) systems approach (including critical control point barriers, critical monitoring, key health risks, and operational response procedures). The AWT 3 has a general understanding of engineering plans and specifications, and important sampling and analysis procedures.

AWT Grade 4

The AWT 4 has an advanced understanding of the AWT processes, the impacts of feed water quality on production, and methods for optimizing production and finished water quality. The AWT 4 operates, monitors, maintains, troubleshoots, and optimizes the AWT processes, such as membrane systems and advanced oxidation. The AWT 4 has an advanced understanding of AWT-related terminology, process-related calculations (e.g., membrane normalization and sensor calibration parameters), and chemicals used in individual AWT processes. The AWT 4 develops and executes operational and safety procedures and chemical handling practices. The AWT 4 maintains and follows regulations pertinent to the end uses of treated water, such as recycled water, potable water, and potable water reuse. The AWT 4 assists with the preparation of regulatory reports. The AWT 4 understands instrumentation and analyzers, as well as maintenance calibration and verification. The AWT 4 has an advanced understanding of the control strategy of plant systems. The AWT 4 has an advanced understanding of the use of SCADA systems, data trending, and analysis for performance monitoring and optimization. The AWT 4 has an advanced understanding of incident response and investigation, and assists with the implementation of corrective actions. The AWT 4 helps to develop and maintain a HACCP (Hazard Analysis Critical Control Point) systems approach (including critical control point barriers, critical monitoring, key health risks, and operational response procedures). The AWT 4 has a general understanding of engineering plans and specifications, and important sampling and analysis procedures. The AWT 4 assists with the tracking and development of plant operations and maintenance budget.

AWT Grade 5

The AWT 5 has an advanced understanding of the regulations pertinent to the end uses of treated water, such as recycled water, potable water, and potable water reuse. The AWT 5 maintains regular communication with regulatory agencies. The AWT 5 ensures permit compliance. The AWT 5 has responsible charge for preparing and submitting regulatory reports. The AWT 5 has an advanced

understanding of the AWT processes, the impacts of feed water quality on production, and methods for optimizing production and finished water quality. The AWT 5 oversees and may also operate, monitor, maintain, troubleshoot, and optimize the AWT processes, such as membrane systems and advanced oxidation. The AWT 5 has an advanced understanding of AWT-related terminology, process-related calculations (e.g., membrane normalization and sensor calibration parameters), and chemicals used in individual AWT processes. The AWT 5 develops and executes operational and safety procedures and chemical handling practices. The AWT 5 has an advanced understanding of instrumentation and analyzers, as well as maintenance calibration and verification. The AWT 5 has an advanced understanding of the control strategy of plant systems. The AWT 5 has an advanced understanding of the use of SCADA systems, data trending, and analysis for performance monitoring and optimization. The AWT 5 has an advanced understanding of incident management and leads the implementation of corrective actions. The AWT 5 develops and maintains a HACCP (Hazard Analysis Critical Control Point) systems approach (including critical control point barriers, critical monitoring, key health risks, and operational response procedures). The AWT 5 has a general understanding of engineering plans and specifications, and important sampling and analysis procedures. The AWT 5 leads the development and tracking of plant operations and maintenance budget.

Appendix I. REVISED TASK STATEMENTS AND RATINGS

AWT Grade 3	Task Statements	Freq.	Applic.	Risk
1 Source Water				
a Wells and Groundwater (Brackish and Fresh)				
	Analyze well water and groundwater quality	D	30	Moderate
	Determine drawdown level	M	30	Moderate
	Calculate a disinfectant dosage in a well	Y	30	Minor
	Recognize the influence of surface water on a groundwater source	Y	30	Moderate
b Surface water (Fresh, Saline, and Seawater)				
	Recognize potential sources of contamination in surface water	D	30	Major
	Discriminate between normal and abnormal conditions in surface water	D	30	Major
	Calculate the volume of surface water contained in a surface water storage facility	M	30	Moderate
	Collect a water sample from a surface water source	D	30	Moderate
	Recognize abnormal odors or colors in surface water	D	30	Moderate
c Wastewater				
	Recognize water resource recovery facility upsets/operations that will impact AWT processes	D	40	Moderate
	Collect a water sample from a secondary/tertiary source	D	40	Moderate
	Interpret secondary/tertiary effluent water quality data and reports	D	40	Moderate
2 Advanced Water Treatment Processes				
a Membrane Filtration				
	Recognize and correct problems in membrane systems	D	75	Moderate
	Calculate membrane surface area	Y	75	Minor
	Monitor membrane water production	D	75	Minor
	Monitor recovery rate and rejection rate	W	75	Minor
	Monitor a flux rate	W	75	Minor
	Measure turbidity	D	75	Major

AWT Grade 3	Task Statements	Freq.	Applic.	Risk
	Identify membrane fouling characteristics	W	75	Moderate
	Interpret turbidity information	D	75	Major
	Monitor chemical conditioning dosage (including pH, chloramines)	D	75	Major
	Monitor membrane backwash rate	D	75	Moderate
	Perform integrity testing on membranes	D	75	Major
	Identify and repair/replace compromised membranes	D	75	Major
	Repair/replace ancillary membrane components (e.g., o-rings, valves, couplings)	D	75	Major
b Membrane Desalination				
	Recognize and correct problems in membrane systems	D	75	Moderate
	Calculate membrane surface area	Y	75	Minor
	Monitor membrane water production	D	75	Minor
	Monitor recovery rate and rejection rate	W	75	Minor
	Monitor flux rate	W	75	Minor
	Measure turbidity	D	75	Moderate
	Identify membrane scaling characteristics	M	75	Major
	Identify membrane fouling characteristics	M	75	Major
	Interpret turbidity information	D	75	Moderate
	Monitor chemical conditioning dosage (including pH, anti-scalant, chloramines)	D	75	Moderate
	Perform conductivity profiles	M	75	Moderate
	Identify and repair/replace compromised membranes	M	75	Major
	Repair/replace ancillary membrane components (e.g., o-rings, valves, couplings)	M	75	Major
	Calculate a TDS value from a specific conductance reading	D	75	Minor
	Monitor oxidant presence in RO feed systems (e.g., chlorine, chloramines)	D	75	Major
	Perform SDI tests	W	75	Moderate
c Biological Filtration				
	Recognize and correct problems in media biofilters	Y	20	Moderate
	Calculate filter media volume and capacity	Y	20	Moderate

AWT Grade 3	Task Statements	Freq.	Applic.	Risk
	Monitor daily filter production	D	20	Moderate
	Monitor filtration rate	D	20	Moderate
	Measure turbidity	D	20	Major
	Monitor chemical dosage (e.g, supplemental carbon, oxidant quenching, nutrients, etc.)	D	20	Moderate
	Monitor filter backwash rate	D	20	Moderate
	Identify underdrain failure	Y	20	Major
d Adsorption/Exchange				
	Regenerate ion exchange resin	W	25	Major
	Replace ion exchange resin	Y	25	Minor
	Replace GAC media	Y	10	Moderate
	Measure chemical breakthrough	D	35	Major
e Finished Water Chemical Stabilization				
	Measure alkalinity, pH, TDS, temperature, hardness	D	100	Major
	Adjust chemical doses based upon measurements and target stability indices	D	100	Major
f Iron and Manganese Removal				
	Recognize an iron and manganese problem	D	10	Minor
	Calculate a chemical dosage (including Potassium Permanganate (KMnO4), Sodium Permanganate (NaMnO4), chlorine, ozone)	D	10	Minor
	Calculate chemical solution concentration	D	10	Minor
	Monitor backwash frequency	W	10	Minor
	Monitor chemical residuals	D	10	Minor
	Regenerate greensand	M	10	Moderate
g Advanced Oxidation				
	Monitor oxidant dosing	D	50	Major
	Measure oxidant residual	D	50	Major
	Track major process control inputs (e.g., power, UVT, chloramine, oxidant residual)	D	50	Major
	Track major maintenance items (e.g., lamps and lamp hours, ballasts and ballast hours)	W	50	Moderate
	Calculate chemical feed rates	D	50	Moderate
	Repair/replace major components (e.g., lamps, ballasts, wipers, diffusers)	Y	50	Major

AWT Grade 3	Task Statements	Freq.	Applic.	Risk
	Repair/replace ancillary components (e.g., valves, flow meters, gaskets, electronics)	Y	50	Moderate
h Disinfection				
	Monitor de-chlorination dosage	D	50	Major
	Analyze a water sample for disinfectant residual (e.g. free and total chlorine and ozone)	D	100	Critical
	Monitor and adjust a chemical feeder pump	D	100	Critical
	Calibrate a chemical feeder pump	M	100	Critical
	Monitor a disinfectant dosage	D	100	Critical
	Monitor an ammonia/chlorine ratio	D	100	Critical
	Monitor a CT (oxidant residual multiplied by contact time) value	D	100	Critical
	Monitor liquid and gas feed rates, volumes, dilution factors, and chemical concentrations	D	100	Critical
	Track major process control inputs (e.g., power, UVT, sensor intensity)	D	100	Critical
	Track major maintenance items (e.g., lamps and lamp hours, ballasts and ballast hours)	D	100	Critical
	Repair/replace major components (e.g., lamps, ballasts, wipers, diffusers)	Y	100	Critical
	Repair/replace ancillary components (e.g., valves, flow meters, gaskets, electronics, solenoids, o-rings, probes)	Y	100	Critical
i Membrane Bioreactors (MBR)				
	Recognize and correct problems in membrane systems	D	30	Major
	Calculate membrane surface area	Y	30	Minor
	Monitor daily membrane water production	D	30	Minor
	Monitor flux rate	D	30	Minor
	Measure and interpret turbidity	D	30	Major
	Monitor membrane fouling	D	30	Moderate
	Monitor chemical conditioning dosage	D	30	Moderate
	Monitor membrane backwash rate	D	30	Minor
	Monitor biological monitoring parameters (e.g., SRT, HRT, MLSS)	D	30	Major
	Identify and repair/replace compromised membranes	M	10	Major

AWT Grade 3	Task Statements	Freq.	Applic.	Risk
	Repair/replace ancillary membrane components (e.g., o-rings, valves, couplings, diffusers)	M	10	Major
3 Advanced Water Treatment Support Processes				
a Pre-Screening				
	Monitor head loss and clogging rates	D	100	Moderate
	Perform backwash operations	D	100	Moderate
	Replace cartridge filters	M	75	Moderate
	Inspect screen integrity	Y	75	Major
b Chemical Cleaning				
	Select cleaning chemicals	M	100	Moderate
	Prepare chemicals	M	100	Moderate
	Calculate chemical doses	M	100	Moderate
	Monitor feed flow rates and cleaning duration	M	100	Moderate
	Operate or support equipment for cleaning	M	100	Moderate
	Perform different chemical cleanings	M	100	Moderate
	Replace mechanical wiping systems	Y	15	Moderate
	Perform membrane filtration maintenance clean	D	75	Moderate
	Maintain target chemical cleaning temperature, pH	D	100	Moderate
c Residuals Management				
	Operate residuals management systems	D	100	Major
d Coagulation/Flocculation				
	Monitor chemical solution concentration	D	75	Moderate
	Analyze a water sample for turbidity	D	75	Moderate
	Analyze a water sample for pH	D	75	Moderate
	Analyze a water sample for temperature	D	75	Moderate
	Measure sludge depth	D	75	Minor
	Recognize normal and abnormal floc formation	D	75	Moderate
	Analyze a water sample for alkalinity	D	75	Minor
	Recognize and correct abnormal conditions in the sedimentation basin	D	75	Moderate
	Calculate coagulant dosage	W	75	Moderate
	Perform a jar test	W	75	Moderate

AWT Grade 3	Task Statements	Freq.	Applic.	Risk
	Operate different types of clarifiers (e.g., DAF, solids contact, sedimentation, ballasted flocculation)	D	75	Moderate
4 Advanced treated water management				
a Communication				
	Communicate system status to supervisor	D	100	Major
	Communicate system status to affected parties downstream	W	100	Moderate
b Operations				
	Adjust delivery to meet downstream requirements	D	100	Major
5 Operations and Maintenance				
a SCADA systems				
	Interpret and respond to alarms	D	100	Critical
b Chemical Feed Systems				
	Discriminate between normal and abnormal operation	D	100	Critical
	Monitor a chemical feed solution concentration	D	100	Major
	Replace components of a chemical feeder system	Y	100	Moderate
	Adjust chemical feed dose	D	100	Moderate
	Calibrate and verify feed system rate	W	100	Moderate
	Rotate feed pump between standby and duty	M	100	Moderate
	Adjust backpressure valves	Y	100	Moderate
c Ancillary Equipment				
	Discriminate between normal and abnormal operation of pumps and motors	D	100	Moderate
	Discriminate between normal and abnormal operation of blowers and compressors	D	100	Moderate
	Monitor air pressure regulating devices	D	100	Moderate
	Maintain and verify flow meters	D	100	Moderate
	Discriminate between normal and abnormal operation of valves and actuators	D	100	Moderate
	Monitor valve operation/sequencing in membrane systems	D	100	Moderate
	Troubleshoot valve operation/sequencing in membrane systems	M	50	Moderate
d Maintenance Management Systems				

AWT Grade 3	Task Statements	Freq.	Applic.	Risk
	Generate work orders	D	75	Moderate
	Document preventative maintenance, corrective maintenance, and equipment calibrations	D	75	Minor
	Perform inventory inspections	Y	100	Minor
	Maintain and manage critical spare parts inventory	M	100	Moderate
e Analyzer Calibration, Verification, and Maintenance				
	Discriminate between normal and abnormal operation of online analyzers	D	100	Critical
	Maintain and clean online analyzers	W	100	Major
	Calibrate and verify online analyzers	W	100	Major
6 Controls and Monitoring				
a SCADA Controls				
	Adjust control set points	D	100	Major
	Trend and interpret data	D	100	Major
b Critical Control Points				
	Operate within critical limits	D	100	Critical
	Test automated response procedures	Y	100	Critical
c Performance Reporting				
	Generate and interpret performance trends and reports	D	100	Major
7 Laboratory				
a Sampling				
	Follow chain-of-custody	D	100	Major
	Determine an appropriate sampling site	M	100	Moderate
	Collect a representative sample	D	100	Major
b General Laboratory Practices				
	Follow chain-of-custody	D	100	Major
	Perform dilutions	D	100	Moderate
	Calculate a dilution factor	D	100	Moderate
c Laboratory Analyses				
	Read, calibrate, and verify accuracy of benchtop analyzers (inc. turbidity, ORP, UVT, UV intensity, pH, oxidant residual, EC)	D	100	Major
	Perform water quality analysis (e.g., ATP, iron, manganese, chlorite, chlorine dioxide)	D	100	Major

AWT Grade 3	Task Statements	Freq.	Applic.	Risk
	Perform bacterial analysis	D	100	Major
	Evaluate laboratory data for questionable results	D	100	Major
8 Regulations and Reporting				
	Verify chemical certificate of analysis in accordance with regulatory requirements	W	100	Major
	Research and interpret MCLs	Y	100	Major
	Contribute to development of an operations plan	Y	50	Minor
	Contribute to development of an operational site sampling plan	Y	50	Minor
	Contribute to a comprehensive performance evaluation	Y	50	Minor
	Comply with permit conditions	D	100	Critical
9 Safety				
	Demonstrate safe work habits	D	100	Critical
	Recognize unsafe working conditions	D	100	Critical
	Select and operate safety equipment	D	100	Critical
	Interpret SDS and act accordingly	M	100	Major
	Manage SDS library	M	100	Minor

AWT Grade 4		Task Statements	Freq.	Applic.	Risk
1	Source Water				
	a	Wells and Groundwater (Brackish and Fresh)			
		Analyze well water and groundwater quality	D	30	Moderate
		Determine drawdown level	M	30	Moderate
		Recognize hydrological changes	M	30	Moderate
		Calculate a disinfectant dosage in a well	Y	30	Minor
		Recognize the influence of surface water on a groundwater source	Y	30	Moderate
	b	Surface water (Fresh, Saline, and Seawater)			
		Recognize potential sources of contamination in surface water	D	30	Major
		Discriminate between normal and abnormal conditions in surface water	D	30	Major
		Calculate the volume of surface water contained in a surface water storage facility	M	30	Moderate
		Collect a water sample from a surface water source	D	30	Moderate
		Recognize abnormal odors or colors in surface water	D	30	Moderate
		Interpret surface water quality reports	M	30	Moderate
		Manage water source selection and flow rate	D	30	Moderate
	c	Wastewater			
		Recognize water resource recovery facility upsets/operations that will impact AWT processes	D	40	Moderate
		Collect a water sample from a secondary/tertiary source	D	40	Moderate
		Interpret secondary/tertiary effluent water quality data and reports	D	40	Moderate
		Update a risk assessment for a facility	Y	40	Minor
	d	Raw Wastewater and Industrial Source Control			
		Recognize the impact of industrial source discharges on final water quality	D	40	Major
		Communicate with the water resource recovery facility pre-treatment coordinator	M	40	Major
2	Advanced Water Treatment Processes				
	a	Membrane Filtration			
		Recognize and correct problems in membrane systems	D	75	Moderate
		Calculate membrane surface area	Y	75	Minor

AWT Grade 4	Task Statements	Freq.	Applic.	Risk
	Monitor membrane water production	D	75	Minor
	Monitor recovery rate and rejection rate	W	75	Minor
	Monitor flux rate	W	75	Minor
	Measure turbidity	D	75	Major
	Identify membrane fouling characteristics	W	75	Moderate
	Monitor transmembrane pressure (TMP) and permeability	D	75	Moderate
	Interpret turbidity information	D	75	Major
	Monitor chemical conditioning dosage (including pH, chloramines)	D	75	Moderate
	Monitor membrane backwash rate	D	75	Moderate
	Identify and repair/replace compromised membranes	M	75	Major
	Repair/replace ancillary membrane components (e.g., o-rings, valves, couplings)	M	75	Major
b	Membrane Desalination			
	Recognize and correct problems in membrane systems	D	75	Moderate
	Calculate membrane surface area	Y	75	Minor
	Monitor membrane water production	D	75	Minor
	Monitor recovery rate and rejection rate	W	75	Minor
	Monitor flux rate	W	75	Minor
	Measure turbidity	D	75	Moderate
	Identify membrane scaling characteristics	M	75	Major
	Identify membrane fouling characteristics	M	75	Major
	Monitor transmembrane pressure (TMP) and permeability	D	75	Moderate
	Interpret turbidity information	D	75	Moderate
	Monitor chemical conditioning dosage (including pH, anti-scalant, chloramines)	D	75	Moderate
	Perform conductivity profiles	M	75	Moderate
	Identify and repair/replace compromised membranes	M	75	Major
	Repair/replace ancillary membrane components (e.g., o-rings, valves, couplings)	M	75	Major
	Calculate a TDS value from a specific conductance reading	D	75	Minor
	Monitor oxidant presence in RO feed systems (e.g., chlorine, chloramines)	D	75	Major

AWT Grade 4	Task Statements	Freq.	Applic.	Risk
	Perform SDI tests	W	75	Moderate
c	Biological Filtration			
	Recognize and correct problems in media biofilters	Y	20	Moderate
	Calculate filter media volume and capacity	Y	20	Moderate
	Monitor daily filter production	D	20	Minor
	Calculate empty bed contact times (EBCT) for biofiltration	D	20	Minor
	Monitor filtration rate	D	20	Moderate
	Measure turbidity	D	20	Major
	Interpret turbidity, BDOC, ATP, HPC, TOC, EBCT information	D	20	Major
	Monitor chemical dosage (e.g, supplemental carbon, oxidant quenching, nutrients, etc.)	D	20	Moderate
	Monitor filter backwash rate	D	20	Moderate
	Identify underdrain failure	Y	20	Major
d	Adsorption/Exchange			
	Regenerate ion exchange resin	W	25	Major
	Replace ion exchange resin	Y	25	Minor
	Replace GAC media	Y	10	Moderate
	Calculate empty bed contact time (EBCT) for Adsorption and Exchange Processes	D	35	Moderate
	Measure chemical breakthrough	D	35	Major
	Interpret process data (TOC, EBCT, process surrogates, residuals)	D	35	Moderate
e	Finished Water Chemical Stabilization			
	Calculate stability indices	W	100	Moderate
	Calculate chloride indices	W	100	Moderate
	Measure alkalinity, pH, TDS, temperature, hardness	D	100	Major
	Adjust chemical doses based upon measurements and target stability indices	D	100	Major
f	Iron and Manganese Removal			
	Recognize an iron and manganese problem	D	10	Minor
	Calculate a chemical dosage (including Potassium Permanganate (KMnO4), Sodium Permanganate (NaMnO4), chlorine, ozone)	D	10	Minor
	Calculate chemical solution concentration	D	10	Minor

AWT Grade 4	Task Statements	Freq.	Applic.	Risk
	Monitor backwash frequency	W	10	Minor
	Monitor chemical residuals	D	10	Minor
	Regenerate greensand	M	10	Moderate
g	Advanced Oxidation			
	Monitor oxidant dosing	D	50	Major
	Measure oxidant residual	D	50	Major
	Track major process control inputs (e.g., power, UVT, chloramine, oxidant residual, UV intensity)	D	50	Major
	Track major maintenance items (e.g., lamps and lamp hours, ballasts and ballast hours)	W	50	Moderate
	Calculate chemical feed rates	D	50	Moderate
	Repair/replace major components (e.g., lamps, ballasts, wipers, diffusers)	Y	50	Major
	Repair/replace ancillary components (e.g., valves, flow meters, gaskets, electronics)	Y	50	Moderate
h	Disinfection			
	Monitor de-chlorination dosage	D	50	Major
	Analyze a water sample for disinfectant residual (e.g. free and total chlorine and ozone)	D	100	Critical
	Monitor and adjust a chemical feeder pump	D	100	Critical
	Calibrate a chemical feeder pump	M	100	Critical
	Monitor a disinfectant dosage	D	100	Critical
	Monitor an ammonia/chlorine ratio	D	100	Critical
	Choose an appropriate disinfectant for a particular bacterial problem	Y	100	Critical
	Monitor a CT (oxidant residual multiplied by contact time) value	D	100	Critical
	Monitor liquid and gas feed rates, volumes, dilution factors, and chemical concentrations	D	100	Critical
	Track major process control inputs (e.g., power, UVT, sensor intensity)	D	100	Critical
	Track major maintenance items (e.g., lamps and lamp hours, ballasts and ballast hours)	D	100	Critical
	Repair/replace major components (e.g., lamps, ballasts, wipers, diffusers)	Y	100	Critical

AWT Grade 4	Task Statements	Freq.	Applic.	Risk
	Repair/replace ancillary components (e.g., valves, flow meters, gaskets, electronics, solenoids, o-rings, probes)	Y	100	Critical
i Membrane Bioreactors (MBR)				
	Recognize and correct problems in membrane systems	D	30	Major
	Calculate membrane surface area	Y	30	Minor
	Monitor daily membrane water production	D	30	Minor
	Monitor flux rate	D	30	Minor
	Measure and interpret turbidity	D	30	Major
	Monitor membrane fouling	D	30	Moderate
	Calculate transmembrane pressure (TMP) and permeability	D	30	Moderate
	Monitor chemical conditioning dosage	D	30	Moderate
	Monitor membrane backwash rate	W	30	Minor
	Monitor biological monitoring parameters (e.g., SRT, HRT, MLSS)	D	30	Major
	Identify and repair/replace compromised membranes	M	10	Major
	Repair/replace ancillary membrane components (e.g., o-rings, valves, couplings, diffusers)	M	10	Major
3 Advanced Water Treatment Support Processes				
a Pre-Screening				
	Monitor head loss and clogging rates	D	100	Moderate
	Perform backwash operations	D	100	Moderate
	Replace cartridge filters	M	75	Moderate
	Inspect screen integrity	Y	75	Major
b Chemical Cleaning				
	Select cleaning chemicals	M	100	Moderate
	Prepare chemicals	M	100	Moderate
	Calculate chemical doses	M	100	Moderate
	Monitor feed flow rates and cleaning duration	M	100	Moderate
	Operate or support equipment for cleaning	M	100	Moderate
	Perform different chemical cleanings	M	100	Moderate
	Replace mechanical wiping systems	Y	15	Moderate
	Perform membrane filtration maintenance clean	D	75	Moderate
	Maintain target chemical cleaning temperature, pH	D	100	Moderate

AWT Grade 4	Task Statements	Freq.	Applic.	Risk
c	Residuals Management			
	Operate residuals management systems	D	100	Major
	Ensure compliance with discharge or disposal requirements	D	100	Major
	Recognize impact of residuals return on water resource recovery facility operations	D	100	Moderate
d	Coagulation/Flocculation			
	Monitor chemical solution concentration	D	75	Moderate
	Analyze a water sample for turbidity	D	75	Moderate
	Analyze a water sample for pH	D	75	Moderate
	Analyze a water sample for temperature	D	75	Moderate
	Measure sludge depth	D	75	Minor
	Recognize normal and abnormal floc formation	D	75	Moderate
	Analyze a water sample for alkalinity	D	75	Minor
	Recognize and correct abnormal conditions in the sedimentation basin	D	75	Moderate
	Calculate coagulant dosage	W	75	Moderate
	Perform a jar test	W	75	Moderate
	Operate different types of clarifiers (e.g., DAF, solids contact, sedimentation, ballasted flocculation)	D	75	Moderate
4	Advanced Treated Water Management			
a	Communication			
	Communicate system status to supervisor	D	100	Major
	Communicate system status to affected parties downstream	D	100	Major
b	Operations			
	Adjust delivery to meet downstream requirements	D	100	Major
5	Operations and Maintenance			
a	SCADA systems			
	Adjust alarm and deviation setpoints based upon water quality and process performance results	W	100	Major
	Trouble-shoot hardware failures	Y	100	Major
	Calculate monitoring values ordinarily produced by SCADA, for verification or in case of SCADA unavailability	M	100	Moderate
	Ensure preservation of SCADA data	W	100	Major

AWT Grade 4	Task Statements	Freq.	Applic.	Risk
	Ensure availability and integrity of SCADA system	D	100	Major
	Interpret and respond to alarms	D	100	Critical
b	Chemical Feed Systems			
	Discriminate between normal and abnormal operation	D	100	Critical
	Monitor a chemical feed solution concentration	D	100	Major
	Replace components of a chemical feeder system	Y	100	Moderate
	Adjust chemical feed dose	D	100	Moderate
	Calibrate and verify feed system rate	W	100	Moderate
	Rotate feed pump between standby and duty	M	100	Moderate
	Adjust backpressure valves	Y	100	Moderate
	Monitor and manage chemical budget	M	50	Moderate
c	Ancillary Equipment			
	Discriminate between normal and abnormal operation of pumps and motors	D	100	Moderate
	Discriminate between normal and abnormal operation of blowers and compressors	D	100	Moderate
	Monitor air pressure regulating devices	D	100	Moderate
	Maintain and verify flow meters	D	100	Moderate
	Discriminate between normal and abnormal operation of valves and actuators	D	100	Moderate
	Adjust limit stops for actuators	Y	50	Minor
	Monitor valve operation/sequencing in membrane systems	D	75	Moderate
	Troubleshoot valve operation/sequencing in membrane systems	M	75	Moderate
d	Maintenance Management Systems			
	Generate work orders	D	100	Moderate
	Schedule and document preventative maintenance, corrective maintenance, and equipment calibrations	W	100	Moderate
	Perform inventory inspections	Y	75	Minor
	Maintain and manage critical spare parts inventory	M	75	Moderate
	Trend repair history and predict future repair for various equipment	M	75	Moderate
	Monitor and manage maintenance budget	M	50	Moderate
e	Analyzer Calibration, Verification, and Maintenance			

AWT Grade 4	Task Statements	Freq.	Applic.	Risk
	Discriminate between normal and abnormal operation of online analyzers	D	100	Critical
	Maintain and clean online analyzers	M	100	Major
	Calibrate and verify online analyzers	M	100	Major
6	Controls and Monitoring			
a	SCADA Controls			
	Adjust control set points	D	100	Major
	Recommend changes to SCADA controls and screen configuration	Y	100	Minor
	Trend and interpret data	D	100	Major
	Extract and transform data from SCADA historical record for analysis	M	50	Moderate
b	Critical Control Points			
	Operate within critical limits and anticipate corrective action	D	100	Critical
	Recommend or implement corrective action when critical limits are exceeded	W	100	Critical
	Test automated response procedures	Y	100	Critical
	Update and maintain automated response procedures and plans	Y	90	Moderate
c	Performance Reporting			
	Generate and interpret performance trends and reports	W	100	Moderate
	Recommend changes based on performance trends and reports	W	100	Moderate
7	Laboratory			
a	Sampling			
	Follow chain-of-custody	D	75	Major
	Determine an appropriate sampling site	M	75	Moderate
	Collect a representative sample	M	75	Major
	Develop and update a sampling plan	Y	75	Major
b	General Laboratory Practices			
	Follow chain-of-custody	D	75	Major
	Perform dilutions	W	75	Moderate
	Calculate a dilution factor	W	75	Moderate
	Implement a quality assurance program	D	100	Major

AWT Grade 4	Task Statements	Freq.	Applic.	Risk
	Manage hazardous waste generated by the laboratory under ordinary and emergency circumstances	D	75	Moderate
	Review laboratory budget and recommend changes	M	75	Moderate
c Laboratory Analyses				
	Read, calibrate, and verify accuracy of benchtop analyzers (inc. turbidity, ORP, UVT, UV intensity, pH, oxidant residual, EC)	W	75	Major
	Perform water quality analysis (e.g., ATP, iron, manganese, chlorite, chlorine dioxide)	W	75	Major
	Perform bacterial analysis	W	75	Major
	Evaluate laboratory data for questionable results	D	90	Major
	Recommend contract laboratory services when appropriate	Y	25	Moderate
8 Regulations and Reporting				
	Verify chemical certificate of analysis in accordance with regulatory requirements	M	100	Major
	Research and interpret MCLs	Y	100	Major
	Develop and review an operations plan	Y	50	Moderate
	Develop and review an operational site sampling plan	Y	50	Moderate
	Contribute to a comprehensive performance evaluation	Y	90	Moderate
	Comply with permit conditions	D	100	Critical
	Formulate strategies to respond to pending regulatory changes	Y	50	Moderate
	Review and assist with preparation of regulatory reports	M	75	Major
9 Safety				
	Demonstrate safe work habits	D	100	Critical
	Recognize unsafe working conditions	D	100	Critical
	Select and operate safety equipment	D	100	Critical
	Develop, review and apply safety plan	Y	100	Moderate
	Interpret SDS and act accordingly	M	100	Major
	Manage SDS library	M	100	Minor

AWT Grade 5		Task Statements	Freq.	Applic.	Risk
1	Source Water				
	a	Wells and Groundwater (Brackish and Fresh)			
		Analyze well water and groundwater quality	M	30	Moderate
		Adjust well operations based on hydrological conditions	Y	30	Major
		Approve a disinfectant dosage in a well	Y	30	Moderate
		Recognize the influence of surface water on a groundwater source	Y	30	Moderate
		Review ground water quality data and determine treatment changes	Y	30	Moderate
	b	Surface water (Fresh, Saline, and Seawater)			
		Evaluate and address potential sources of contamination in surface water	W	30	Major
		Discriminate between normal and abnormal conditions in surface water	W	30	Major
		Manage a surface water storage facility	W	30	Moderate
		Collect a water sample from a surface water source	M	30	Moderate
		Recognize abnormal odors or colors in surface water and determine a course of action	W	30	Moderate
		Interpret surface water quality reports	M	30	Moderate
		Review surface water quality data and determine treatment changes	W	30	Moderate
		Manage water source selection and flow rate	W	30	Moderate
	c	Wastewater			
		Recommend changes to water resource recovery facility operations based on upset conditions	M	40	Moderate
		Collect a water sample from a secondary/tertiary source	Y	40	Moderate
		Interpret secondary/tertiary effluent water quality data and reports	W	40	Moderate
		Develop or update a risk assessment for a facility	Y	40	Moderate
	d	Raw Wastewater and Industrial Source Control			
		Recognize the impact of industrial source discharges on final water quality	M	40	Major
		Investigate, or recommend investigation of, industrial source discharges affecting final water quality	M	40	Major

AWT Grade 5		Task Statements	Freq.	Applic.	Risk
		Review and support implementation of an upstream agency's source control plan	Y	40	Moderate
		Communicate with the water resource recovery facility pre-treatment coordinator	M	40	Major
	e	Interagency Communication			
		Communicate with other agencies drawing from and feeding into water sources	W	100	Moderate
		Communicate with regulators in response to source water contamination	Y	100	Major
2		Advanced Water Treatment Processes			
	a	Membrane Filtration			
		Recognize and correct problems in membrane systems	W	75	Moderate
		Calculate membrane surface area	Y	75	Minor
		Manage membrane water production	W	75	Minor
		Manage recovery rate and rejection rate	W	75	Minor
		Manage flux rate	W	75	Minor
		Measure turbidity	W	75	Major
		Identify membrane fouling characteristics	M	75	Moderate
		Make changes based on transmembrane pressure (TMP) and permeability	M	50	Moderate
		Interpret turbidity information	D	75	Major
		Manage chemical conditioning dosage (including pH, chloramines)	W	75	Moderate
		Manage membrane backwash rate	W	75	Moderate
		Identify and repair/replace compromised membranes	Y	75	Major
		Repair/replace ancillary membrane components (e.g., o-rings, valves, couplings)	Y	75	Major
	b	Membrane Desalination			
		Recognize and correct problems in membrane systems	W	75	Moderate
		Calculate membrane surface area	Y	75	Minor
		Manage membrane water production	W	75	Minor
		Manage recovery rate and rejection rate	W	75	Minor
		Manage flux rate	W	75	Minor
		Measure turbidity	M	75	Moderate

AWT Grade 5	Task Statements	Freq.	Applic.	Risk
	Identify and remedy membrane scaling characteristics	M	75	Major
	Identify and remedy membrane fouling characteristics	M	75	Major
	Make changes based on transmembrane pressure (TMP) and permeability	W	75	Moderate
	Manage chemical conditioning dosage (including pH, anti-scalant, chloramines)	W	75	Moderate
	Review conductivity profiles for abnormalities and adjust operations accordingly	M	75	Moderate
	Identify and repair/replace compromised membranes	Y	75	Moderate
	Repair/replace ancillary membrane components (e.g., o-rings, valves, couplings)	Y	75	Moderate
	Review a TDS value and adjust operations accordingly	M	75	Moderate
	Manage oxidant presence in RO feed systems (e.g., chlorine, chloramines)	W	75	Moderate
	Review SDI test results for abnormalities and adjust operations accordingly	W	75	Moderate
c	Biological Filtration			
	Recognize and correct problems in media biofilters	Y	20	Moderate
	Calculate filter media volume and capacity	Y	20	Moderate
	Manage filter production	W	20	Moderate
	Calculate empty bed contact times (EBCT) for biofiltration	W	20	Moderate
	Manage filtration rate	W	20	Moderate
	Review and act upon turbidity information	W	20	Major
	Make adjustments based on turbidity, BDOC, ATP, HPC, TOC, EBCT information	W	20	Major
	Manage chemical dosage (e.g, supplemental carbon, oxidant quenching, nutrients, etc.)	W	20	Moderate
	Manage filter backwash rate	W	20	Moderate
	Identify underdrain failure and determine corrective action	Y	20	Major
d	Adsorption/Exchange			
	Determine regeneration schedule for ion exchange resin	M	25	Moderate

AWT Grade 5	Task Statements	Freq.	Applic.	Risk
	Determine replacement schedule for ion exchange resin	Y	25	Moderate
	Determine replacement schedule for GAC media	Y	10	Moderate
	Manage empty bed contact time (EBCT) for adsorption and exchange processes	W	35	Moderate
	Determine corrective action in case of chemical breakthrough	Y	35	Major
	Make decisions based on process data (TOC, EBCT, process surrogates, residuals)	W	35	Moderate
e	Finished Water Chemical Stabilization			
	Update operational strategies based on stability indices	Y	100	Moderate
	Update operational strategies based on chloride indices	Y	100	Moderate
	Update operational strategies based on alkalinity, pH, TDS, temperature, hardness	Y	100	Major
	Oversee adjustment of chemical doses based upon measurements and target stability indices	W	100	Major
f	Iron and Manganese Removal			
	Determine a course of action to resolve an iron and manganese problem	Y	10	Minor
	Oversee calculation of a chemical dosage (including Potassium Permanganate (KMnO4), Sodium Permanganate (NaMnO4), chlorine, ozone)	M	10	Minor
	Oversee calculation of a chemical solution concentration	M	10	Minor
	Manage backwash frequency	M	10	Moderate
	Manage chemical residuals	M	10	Minor
	Determine regeneration schedule for greensand	Y	10	Moderate
g	Advanced Oxidation			
	Manage oxidant dosing and residuals	W	50	Major
	Manage major process control inputs (e.g., power, UVT, chloramine, oxidant residual, UV sensor intensity)	W	50	Major
	Oversee calculation of chemical feed rates	W	50	Moderate
	Schedule repair/replacement of major components (e.g., lamps, ballasts, wipers, diffusers)	M	50	Moderate

AWT Grade 5	Task Statements	Freq.	Applic.	Risk
	Schedule repair/replacement of ancillary components (e.g., valves, flow meters, gaskets, electronics)	M	50	Moderate
h	Disinfection			
	Manage de-chlorination dosage	W	50	Major
	Oversee analysis of a water sample for disinfectant residual (e.g. free and total chlorine and ozone) and adjust operations accordingly	W	100	Critical
	Manage chemical dosages and chemical feeder pump operations	W	100	Critical
	Choose an appropriate disinfectant for a particular bacterial problem	Y	100	Critical
	Adjust treatment based on a CT (oxidant residual multiplied by contact time) value	M	100	Critical
	Manage liquid and gas feed rates, volumes, dilution factors, and chemical concentrations	M	100	Critical
	Adjust operations based on major process control inputs (e.g., power, UVT, sensor intensity)	W	100	Critical
	Schedule repair/replacement of major components (e.g., lamps, ballasts, wipers, diffusers)	M	100	Critical
	Schedule repair/replacement of ancillary components (e.g., valves, flow meters, gaskets, electronics, solenoids, o-rings, probes)	M	100	Critical
i	Membrane Bioreactors (MBR)			
	Recognize and correct problems in membrane systems	W	30	Major
	Manage membrane water production	W	30	Minor
	Manage flux rate	W	30	Minor
	Determine a course of action based on turbidity	W	30	Major
	Manage membrane fouling	M	30	Moderate
	Determine a course of action based on transmembrane pressure (TMP) and permeability	M	30	Moderate
	Manage chemical conditioning dosage	M	30	Moderate
	Manage membrane backwash rate	M	30	Moderate
	Manage biological process (e.g., SRT, HRT, MLSS)	W	30	Moderate
	Schedule repair/replacement of compromised membranes	M	30	Moderate

AWT Grade 5		Task Statements	Freq.	Applic.	Risk
		Schedule repair/replacement of ancillary membrane components (e.g., o-rings, valves, couplings, diffusers)	M	30	Moderate
3	Advanced Water Treatment Support Processes				
	a	Pre-Screening			
		Manage head loss and clogging rates	W	100	Moderate
		Oversee backwash operations	W	100	Moderate
		Schedule cartridge filter replacement	M	75	Moderate
		Schedule inspections of screen integrity and determine corrective actions	Y	75	Moderate
	b	Chemical Cleaning			
		Authorize selection and acquisition of cleaning chemicals	M	100	Moderate
		Oversee preparation of chemicals	M	100	Moderate
		Manage chemical concentrations	M	100	Moderate
		Manage feed flow rates and cleaning duration	M	100	Moderate
		Oversee operation of equipment for cleaning	M	100	Moderate
		Schedule replacement of mechanical wiping systems	Y	15	Moderate
		Oversee membrane filtration maintenance clean	W	75	Moderate
		Manage target chemical cleaning temperature, pH	W	75	Moderate
		Analyze chemical cleaning results and determine a course of action	Y	75	Moderate
	c	Residuals Management			
		Manage residuals management systems	M	100	Major
		Ensure compliance with discharge or disposal requirements	M	100	Major
		Manage or coordinate residuals return	M	100	Moderate
	d	Coagulation/Flocculation			
		Manage chemical solution concentration	M	75	Moderate
		Manage coagulation and flocculation processes based on water quality analysis results, jar test and visual observation	M	75	Moderate
		Oversee operation of different types of clarifiers (e.g., DAF, solids contact, sedimentation, ballasted flocculation)	M	75	Moderate
4	Advanced Treated Water Management				
	a	Communication			

AWT Grade 5		Task Statements	Freq.	Applic.	Risk
		Communicate system status to management	W	100	Moderate
		Communicate system status to affected parties downstream	M	100	Moderate
		Communicate system status and process control changes to supporting staff	W	100	Moderate
	b	Operations			
		Manage delivery to meet downstream requirements	W	100	Major
5		Operations and Maintenance			
	a	SCADA systems			
		Oversee adjustment of alarm and deviation setpoints based upon water quality and process performance results	M	100	Major
		Trouble-shoot hardware failures	Y	100	Major
		Calculate monitoring values ordinarily produced by SCADA, for verification or in case of SCADA unavailability	Y	100	Moderate
		Ensure preservation of SCADA data	M	100	Major
		Ensure availability and integrity of SCADA system	M	100	Major
		Interpret and respond to alarms	D	100	Critical
	b	Chemical Feed Systems			
		Discriminate between normal and abnormal operation	M	100	Critical
		Manage a chemical feed solution concentration	M	100	Major
		Schedule replacement of components of a chemical feeder system	Y	100	Moderate
		Oversee adjustment of chemical feed dose and feed system rate	M	100	Moderate
		Set schedule of feed pump rotation for standby and duty	M	100	Moderate
		Oversee adjustment of backpressure valves	Y	100	Moderate
		Oversee chemical budget	M	100	Moderate
	c	Ancillary Equipment			
		Discriminate between normal and abnormal operation of pumps and motors	M	100	Moderate
		Discriminate between normal and abnormal operation of blowers and compressors	M	100	Moderate
		Manage air pressure regulating devices	Y	100	Moderate

AWT Grade 5		Task Statements	Freq.	Applic.	Risk
		Schedule maintenance of ancillary equipment	Y	100	Moderate
		Discriminate between normal and abnormal operation of valves and actuators	M	100	Moderate
		Oversee adjustment of limit stops for actuators	Y	50	Minor
		Manage valve operation/sequencing in membrane systems	Y	75	Moderate
		Troubleshoot valve operation/sequencing in membrane systems	Y	75	Moderate
		Identify a need and budget for new ancillary equipment	M	100	Moderate
	d	Maintenance Management Systems			
		Generate and monitor work orders	M	100	Moderate
		Schedule and document preventative maintenance, corrective maintenance, and equipment calibrations	M	100	Moderate
		Oversee inventory inspections	Y	100	Moderate
		Maintain and manage critical spare parts inventory	Y	100	Moderate
		Trend repair history and predict future repair for various equipment	Y	100	Moderate
		Oversee maintenance and new equipment budget	M	100	Moderate
	e	Analyzer Calibration, Verification, and Maintenance			
		Discriminate between normal and abnormal operation of online analyzers	W	100	Critical
		Oversee maintenance and cleaning of online analyzers	Y	100	Major
		Oversee calibration and verification of online analyzers	Y	100	Major
		Manage service contracts for online analyzers	Y	100	Moderate
6		Controls and Monitoring			
	a	SCADA Controls			
		Manage SCADA roles	Y	100	Moderate
		Manage adjustment of control set points	W	100	Major
		Approve changes to SCADA controls and screen configuration	Y	100	Moderate
		Trend and interpret data	M	100	Moderate
		Extract and transform data from SCADA historical record for analysis	M	100	Moderate
	b	Critical Control Points			

AWT Grade 5		Task Statements	Freq.	Applic.	Risk
		Operate within critical limits and anticipate corrective action	D	100	Critical
		Recommend or implement corrective action when critical limits are exceeded	W	100	Critical
		Schedule testing of automated response procedures	Y	100	Moderate
		Update and maintain automated response procedures and plans	Y	100	Moderate
	c	Performance Reporting			
		Generate and interpret performance trends and reports	W	100	Moderate
		Approve changes based on performance trends and reports	W	100	Moderate
7	Laboratory				
	a	Sampling			
		Follow chain-of-custody	Y	75	Major
		Determine an appropriate sampling site	Y	75	Moderate
		Collect a representative sample	Y	75	Major
		Develop and update a sampling plan	Y	75	Major
	b	General Laboratory Practices			
		Follow chain-of-custody	Y	75	Major
		Implement a quality assurance program	Y	100	Major
		Manage hazardous waste generated by the laboratory under ordinary and emergency circumstances	Y	100	Moderate
		Oversee laboratory budget	M	100	Moderate
	c	Laboratory Analyses			
		Manage benchtop analyzer program (inc. turbidity, ORP, UVT, UV intensity, pH, oxidant residual, EC)	Y	100	Major
		Oversee water quality analysis (e.g., ATP, iron, manganese, chlorite, chlorine dioxide)	M	100	Major
		Oversee bacterial analysis	M	100	Major
		Oversee quality assurance program	M	100	Major
		Manage contract laboratory services	Y	100	Moderate
8	Regulations and Reporting				
		Verify chemical certificate of analysis in accordance with regulatory requirements	Y	100	Major

AWT Grade 5	Task Statements	Freq.	Applic.	Risk
	Research and interpret MCLs	Y	100	Major
	Develop an operations plan	Y	100	Major
	Develop an operational site sampling plan	Y	100	Major
	Oversee a comprehensive performance evaluation	Y	100	Major
	Ensure compliance with permit conditions and regulations	D	100	Critical
	Formulate strategies to respond to pending regulatory changes	Y	100	Moderate
	Prepare, sign and submit regulatory reports	M	100	Major
	Negotiate permit conditions and renewal	Y	100	Major
	Participate in design projects	Y	100	Major
9 Safety				
	Ensure safe work habits	D	100	Critical
	Remedy unsafe working conditions	D	100	Critical
	Select and operate safety equipment	D	100	Critical
	Manage a mandatory safety training program	M	100	Critical
	Develop, review and apply a comprehensive safety plan	Y	100	Major
	Interpret SDS and act accordingly	Y	100	Moderate
	Manage SDS library	Y	100	Moderate

Appendix J. PROVISIONAL BLUEPRINT

Content Domain	AWT 3	AWT 4	AWT 5
Source Water	3%	4%	3%
Advanced Water Treatment Processes	40%	40%	24%
Advanced Water Treatment Support Processes	11%	14%	4%
Advanced Treated Water Management	3%	4%	3%
Operations and Maintenance	16%	18%	14%
Controls and Monitoring	6%	6%	13%
Laboratory	12%	7%	1%
Regulations and Reporting	2%	2%	10%
Safety	6%	6%	29%

Appendix L. REVISED KNOWLEDGE STATEMENTS

AWT Grade 3		Knowledge Statements
1	Source Water	
a	Wells and Groundwater (Brackish and Fresh)	
		Basic knowledge of groundwater quality and potential contamination in groundwater
		Basic knowledge of hydrogeology
		Basic knowledge of well sampling techniques
		Basic knowledge of microbial contamination, well capacity, and well maintenance
		Basic knowledge of surface water connectivity to groundwater
b	Surface water (Fresh, Saline, and Seawater)	
		Basic knowledge of microbial contamination
		Basic knowledge of water quality impacts on health and treatment efficiacy and efficienty
		Basic knowledge of flow measurement devices
		Basic knowledge of proper surface water sampling procedures
		Basic knowledge of the effects of reservoir stratification
		Basic knowledge of the effects of seasonal water quality changes
c	Wastewater	
		Basic knowledge of microbial contamination
		Basic knowledge of flow measurement devices
		Basic knowledge of the physical and chemical characteristics of secondary/tertiary effluent
		Basic knowledge of conventional primary, secondary, and tertiary treatment processes
		Basic knowledge of the effects of seasonal and diurnal changes on water resource recovery facility water quality
		Basic knowledge of proper secondary/tertiary sampling procedures
		Basic knowledge of flow equalization impact on AWT process control and maintenance
2	Advanced Water Treatment Processes	
a	Membrane Filtration	
		Basic knowledge of turbidity causing matter

AWT Grade 3		Knowledge Statements
		Basic knowledge of membrane operational sequences
		Basic knowledge of membrane replacement considerations, requirements, and techniques
		Basic knowledge of data normalization
		Basic knowledge of membrane integrity tests (MIT, PDT)
		Basic knowledge of membrane system components
		Basic knowledge of different membrane systems (e.g., MF, UF) and their characteristics
		Basic knowledge of critical monitoring parameters
		Basic knowledge of chemical conditioning to minimize biological fouling (e.g., chloramines)
b	Membrane Desalination	
		Basic knowledge of membrane operational sequences
		Basic knowledge of membrane replacement considerations, requirements, and techniques
		Basic knowledge of data normalization
		Basic knowledge of membrane system components
		Basic knowledge of different membrane systems (including NF, RO, EDR) and their characteristics
		Basic knowledge of critical monitoring parameters and online monitoring systems
		Basic knowledge of chemical conditioning to minimize biological fouling (e.g., chloramines)
		Basic knowledge of dissolved minerals in water
		Basic knowledge of specific conductance/TDS ratio
		Basic knowledge of chemical conditioning for scale minimization (e.g., pH, anti-scalant)
c	Biological Filtration	
		Basic knowledge of turbidity causing matter
		Basic knowledge of filtration mechanisms (absorption, adsorption, biodegradation)
		Basic knowledge of head loss effects on filters
		Basic knowledge of filter media types and uses
		Basic knowledge of filtration rates
		Basic knowledge of oxidant dose impacts on biology
		Basic knowledge of backwashing techniques
d	Adsorption/Exchange	

AWT Grade 3		Knowledge Statements
		Basic knowledge of ion exchange processes and GAC systems
		Basic knowledge of resin and media types and purpose (for both granular activated carbon and ion exchange)
		Basic knowledge of regeneration systems
		Basic knowledge of critical monitoring parameters for adsorption and exchange processes
		Basic knowledge of waste stream impacts
e	Finished Water Chemical Stabilization	
		Basic knowledge of water quality stability, targets, and indices (including langlier, ryznars, etc.)
		Basic knowledge of water chemistry specific to stabilization chemicals
f	Iron and Manganese Removal	
		Basic knowledge of iron and manganese removal processes
		Basic knowledge of iron and manganese oxidation chemistry
		Basic knowledge of greensand regeneration
		Basic knowledge of backwash and regeneration systems
g	Advanced Oxidation	
		Basic knowledge of advanced oxidation principles
		Basic knowledge of advanced oxidation technologies (including UV with hydrogen peroxide, UV with sodium hypochlorite, Ozone with hydrogen peroxide)
		Basic knowledge of disinfection byproduct formation (e.g., NDMA)
		Basic knowledge of performance set points for disinfection and advanced oxidation
		Basic knowledge of multiple treatment targets for advanced oxidation
		Basic knowledge of online water quality measurements as they impact performance (e.g., UV intensity, UV transmittance, oxidant residuals)
		Basic knowledge of chlorine chemistry and hydroxyl radical scavenging
		Basic knowledge of hydrogen peroxide impact on ozone disinfection credit
h	Disinfection	
		Basic knowledge of chlorine chemistry

AWT Grade 3		Knowledge Statements
		Basic knowledge of breakpoint chlorination chemistry
		Basic knowledge of chlorine analysis procedures
		Basic knowledge of quenching practices
		Basic knowledge of chloramines chemistry
		Basic knowledge of ammonia feed systems
		Basic knowledge of disinfectant properties and uses (chlorine, chlorine dioxide, chlorine gas, chloramines, ozone)
		Basic knowledge of ozonation system operation
		Basic knowledge of disinfection byproduct formation
		Basic knowledge of oxidant (chlorine, ozone) decay
		Basic knowledge of background oxidant demand (inc. nitrite, ammonia, sulfate, iron, manganese, total organic carbon)
		Basic knowledge of pH and temperature impacts on disinfection efficacy
		Basic knowledge of on-site ozone, chlorine dioxide and hypochlorite generation systems
		Basic knowledge of UV disinfection principles and systems (e.g., dose calculation, lamp technologies, disinfection mechanisms)
		Basic knowledge of performance set points for different systems
		Basic knowledge of online water quality measurements as they impact performance (e.g., UV intensity, UV transmittance)
i	Membrane Bioreactors (MBR)	
		Basic knowledge of prescreening and pretreatment
		Basic knowledge of turbidity causing matter
		Basic knowledge of membrane operational sequences
		Basic knowledge of membrane replacement considerations, requirements, and techniques
		Basic knowledge of data normalization
		Basic knowledge of membrane integrity tests (MIT, PDT)
		Basic knowledge of membrane system components
		Basic knowledge of different MBR systems (e.g., flat sheet, hollow fiber, tubular, ceramic)
		Basic knowledge of critical monitoring parameters

AWT Grade 3		Knowledge Statements
		Basic knowledge of biologial secondary treatment processes (e.g., aeration, wasting, recirculation, aerobic/anaerobic/anoxic zones)
		Basic knowledge of membrane aeration
		Basic knowledge of critical component maintenance
		Basic knowledge of air quality impacts for membrane use
3	Advanced Water Treatment Support Processes	
	a Pre-Screening	
		Basic knowledge of screening sizes and uses as pretreatment for different processes (e.g. MF feed strainers, MBR feed strainers, cartridge filtration ahead of RO) and different feed water types (e.g., seawater, secondary effluent)
		Basic knowledge of screen/filter replacement
		Basic knowledge of backwash frequency and impacts on feed water to downstream processes, including flow loss and shutdown
	b Chemical Cleaning	
		Basic knowledge of chemicals used for cleaning
		Basic knowledge of cleaning system triggers, limits, needs for key processes (including MF, UF, RO, UV, MBR, cartridge filters)
		Basic knowledge of scaling characteristics
		Basic knowledge of permeability and anticipated recovery of membrane systems
		Basic knowledge of chemical cleaning sequences, cleaning procedures, and water quality
		Basic knowledge of chemical compatibility with process components
		Basic knowledge of handling methods for chemical waste streams
		Basic knowledge of chemical neutralization systems
	c Residuals Management	
		Basic knowledge of chemical compatibility with infrastructure components (e.g., pipes, tanks, valves)
		Basic knowledge of different waste streams (including MF/UF backwash, RO concentrate, chemical wastes, regenerant wastes, analyzer wastes)
		Basic knowledge of backwash waste treatment (e.g., DAF, plate settling, belt press and centrifuge, gravity thickeners)

AWT Grade 3		Knowledge Statements
d	Coagulation/Flocculation	
		Basic knowledge of safe chemical handling
		Basic knowledge of chemical compatibilities
		Basic knowledge of maximum dose levels
		Basic knowledge of the coagulation/flocculation process
		Basic knowledge of chemical coagulants and coagulant aids
		Basic knowledge of coagulation/flocculation start-up/shut-down procedures
		Basic knowledge of coagulation/flocculation adjustment procedures
		Basic knowledge of chemical feeder calibration and adjustment
		Basic knowledge of the mixing process
		Basic knowledge of zeta potential
		Basic knowledge of TOC/Disinfection by-product correlation
		Basic knowledge of enhanced coagulation
		Basic knowledge of different types of clarifiers (e.g., DAF, solids contact, sedimentation, ballasted flocculation)
4	Advanced treated water management	
a	Communication	
		Basic knowledge of high priority process and water quality alarms and the need to escalate to a supervisory level
		Basis knowledge of the impact of monitored water quality parameters on downstream processes
b	Operations	
		Knowledge of standard operating procedures and best practices
5	Operations and Maintenance	
a	SCADA systems	
		Basic knowledge of SCADA components
		Basic knowledge of alarm settings and trigger values, and alarm deviation setpoints
		Basic knowledge of data historian and data backup
b	Chemical Feed Systems	
		Basic knowledge of the operation of chemical feeder systems
		Basic knowledge of the components of chemical feeder systems

AWT Grade 3		Knowledge Statements
		Basic knowledge of backpressure retention valves
		Basic knowledge of chemical drawdown calculations
		Basic knowledge of chemical and material compatibility
		Basic knowledge of chemical viscocity impacts on pumping and dosing rates
		Basic knowledge of off-gas impacts (e.g., sodium hypochlorite vapor lock)
c	Ancillary Equipment	
		Basic knowledge of the operation of a water pump
		Basic knowledge of the components of a water pump
		Basic knowledge of pump types
		Basic knowledge of the operation of blowers and compressors
		Basic knowledge of the components of blowers and compressors
		Basic knowledge of flow meter types and applications
		Basic knowledge of valve and actuator types, application, and maintenance
		Basic knowledge of solenoid control systems
d	Maintenance Management Systems	
		Basic knowledge of asset management principles
		Basic knowledge of asset management inventory management
		Basic knowledge of maintenance management tools
e	Analyzer Calibration, Verification, and Maintenance	
		Basic knowledge of online analyzers and applications (e.g., TOC, pH, EC, UVT, turbidity, ORP)
		Basic knowledge of the components of on-line analyzers
		Basic knowledge of required reagents for online analyzers
		Basic knowledge of flow rates for low range and high range turbidimeters
6	Controls and Monitoring	
a	SCADA Controls	
		Basic knowledge of process and system control strategies and setpoints
		Basic knowledge of trending systems
b	Critical Control Points	

AWT Grade 3		Knowledge Statements
		Basic knowledge of critical control points and monitoring parameters
		Basic knowledge of key process performance parameters
c	Performance Reporting	
		Basic knowledge of performance metrics and reporting requirements
7	Laboratory	
a	Sampling	
		Basic knowledge of proper sampling techniques and sample management
		Basic knowledge of writing and developing sampling plans
b	General Laboratory Practices	
		Basic knowledge of Standard Methods
		Basic knowledge of proper reagant use and disposal
		Basic knowledge of laboratory QA/QC procedures
c	Laboratory Analyses	
		Basic knowledge of abnormal chlorine levels
		Basic knowledge of chlorine analysis techniques (DPD, amperometric)
		Basic knowledge of chlorine chemistry
		Basic knowledge of ozone chemistry
		Basic knowledge of de-chlorination chemistry
		Basic knowledge of chemicals that contribute alkalinity to water
		Basic knowledge of abnormal alkalinity levels
		Basic knowledge of the pH scale
		Basic knowledge of acids and bases
		Basic knowledge of temperature effects on pH
		Basic knowledge of EC/TDS
		Basic knowledge of chemicals that contribute hardness to water
		Basic knowledge of bacteriological analysis methods
		Basic knowledge of the presence/absence test method
		Basic knowledge of Heterotrophic Plate Count (HPC)
		Basic knowledge of the membrane filtration method
		Basic knowledge of bacteriological testing controls
8	Regulations and Reporting	

AWT Grade 3	Knowledge Statements
	Basic knowledge of chemical certificate of analysis for chemicals used in the process
	Basic knowledge of sampling requirements
	Basic knowledge of pathogen inactivation requirements
	Basic knowledge of MCLs and and secondary MCLs
	Basic knowledge of notification protocol and procedures
	Basic knowledge of record keeping requirements
9 Safety	
	Basic knowledge of safe working practices (e.g., forklift, cranes, fall protection)
	Basic knowledge of the use of safety equipment
	Basic knowledge of compressed fluid safety procedures
	Basic knowledge of hazardous chemical handling
	Basic knowledge of personal protective equipment (PPE)
	Basic knowledge of lock-out/tag-out procedures
	Basic knowledge of electrical safety
	Basic knowledge of HAZWOPER guidelines (including exposures to oxidants)
	Basic knowledge of confined space requirements
	Basic knowledge of UV exposure risks and safe working practices
	Basic knowledge of high pressure sysetms and safe working practices

AWT Grade 4		Knowledge Statements
1	Source Water	
a	Wells and Groundwater (Brackish and Fresh)	
		Advanced knowledge of groundwater quality and potential contamination in groundwater
		Advanced knowledge of hydrogeology
		Advanced knowledge of well sampling techniques
		Advanced knowledge of microbial contamination, well capacity, and well maintenance
		Advanced knowledge of surface water connectivity to groundwater
		Basic knowledge of source water assessment
b	Surface water (Fresh, Saline, and Seawater)	
		Advanced knowledge of microbial contamination
		Advanced knowledge of water quality impacts on health and treatment efficiacy and efficienty
		Advanced knowledge of flow measurement devices
		Advanced knowledge of proper surface water sampling procedures
		Basic knowledge of the effects of reservoir stratification
		Basic knowledge of the effects of seasonal water quality changes
c	Wastewater	
		Advanced knowledge of microbial contamination
		Advanced knowledge of flow measurement devices
		Advanced knowledge of the physical and chemical characteristics of secondary/tertiary effluent
		Advanced knowledge of conventional primary, secondary, and tertiary treatment processes
		Advanced knowledge of the effects of seasonal and diurnal changes on water resource recovery facility water quality
		Advanced knowledge of proper secondary/tertiary sampling procedures
		Advanced knowledge of flow equalization impact on AWT process control and maintenance
		Basic knowledge of water quality impacts on risk profile
d	Raw Wastewater and Industrial Source Control	
		Basic knowledge of characteristics of industrial wastewater dischargers in the collection system
		Basic knowledge of industrial source control procedures
2	Advanced Water Treatment Processes	

AWT Grade 4		Knowledge Statements
a	Membrane Filtration	
		Advanced knowledge of turbidity causing matter
		Advanced knowledge of membrane operational sequences
		Advanced knowledge of membrane replacement considerations, requirements, and techniques
		Advanced knowledge of data normalization
		Advanced knowledge of membrane integrity tests (MIT, PDT)
		Advanced knowledge of membrane system components
		Advanced knowledge of different membrane systems (e.g., MF, UF) and their characteristics
		Advanced knowledge of critical monitoring parameters
		Advanced knowledge of chemical conditioning to minimize biological fouling (e.g., chloramines)
b	Membrane Desalination	
		Advanced knowledge of membrane operational sequences
		Advanced knowledge of membrane replacement considerations, requirements, and techniques
		Advanced knowledge of data normalization
		Advanced knowledge of membrane system components
		Advanced knowledge of different membrane systems (including NF, RO, EDR) and their characteristics
		Advanced knowledge of critical monitoring parameters and online monitoring systems
		Advanced knowledge of chemical conditioning to minimize biological fouling (e.g., chloramines)
		Advanced knowledge of dissolved minerals in water
		Advanced knowledge of specific conductance/TDS ratio
		Advanced knowledge of chemical conditioning for scale minimization (e.g., pH, anti-scalant)
c	Biological Filtration	
		Advanced knowledge of turbidity causing matter
		Advanced knowledge of filtration mechanisms (absorption, adsorption, biodegradation)
		Advanced knowledge of head loss effects on filters
		Advanced knowledge of filter media types and uses

AWT Grade 4		Knowledge Statements
		Advanced knowledge of filtration rates
		Advanced knowledge of oxidant dose impacts on biology
		Advanced knowledge of backwashing techniques
		Basic knowledge of filter media replacement considerations, requirements, and techniques
		Basic knowledge of filter porosity
d	Adsorption/Exchange	
		Advanced knowledge of ion exchange processes and GAC systems
		Advanced knowledge of resin and media types and purpose (for both granular activated carbon and ion exchange)
		Advanced knowledge of regeneration systems
		Advanced knowledge of ion exchange processes and GAC systems
		Advanced knowledge of critical monitoring parameters for adsorption and exchange processes
		Advanced knowledge of waste stream impacts
		Basic knowledge of process data (TOC, EBCT, process surrogates, residuals) on performance
		Basic knowledge of chemical removal isotherms and regeneration frequency
e	Finished Water Chemical Stabilization	
		Advanced knowledge of water quality stability targets and corrosion indices (including langlier, ryznars, etc.)
		Advanced knowledge of water chemistry specific to stabilization chemicals
f	Iron and Manganese Removal	
		Advanced knowledge of iron and manganese removal processes
		Advanced knowledge of iron and manganese oxidation chemistry
		Advanced knowledge of greensand regeneration
		Advanced knowledge of backwash and regeneration systems
		Basic knowledge of sequestering methods for Iron and Manganese management
g	Advanced Oxidation	
		Advanced knowledge of advanced oxidation principles
		Advanced knowledge of advanced oxidation technologies (including UV with hydrogen peroxide, UV with sodium hypochlorite, Ozone with hydrogen peroxide)

AWT Grade 4		Knowledge Statements
		Advanced knowledge of disinfection byproduct formation (e.g., NDMA)
		Advanced knowledge of performance set points for disinfection and advanced oxidation
		Advanced knowledge of multiple treatment targets for advanced oxidation
		Advanced knowledge of online water quality measurements as they impact performance (e.g., UV intensity, UV transmittance, oxidant residuals)
		Advanced knowledge of chlorine chemistry and hydroxyl radical scavenging
		Advanced knowledge of hydrogen peroxide impact on ozone disinfection credit
h	Disinfection	
		Advanced knowledge of chlorine chemistry
		Advanced knowledge of breakpoint chlorination chemistry
		Advanced knowledge of chlorine analysis procedures
		Advanced knowledge of quenching practices
		Advanced knowledge of chloramines chemistry
		Advanced knowledge of ammonia feed systems
		Advanced knowledge of disinfectant properties and uses (chlorine, chlorine dioxide, chlorine gas, chloramines, ozone)
		Advanced knowledge of ozonation system operation
		Advanced knowledge of disinfection byproduct formation
		Advanced knowledge of oxidant (chlorine, ozone) decay
		Advanced knowledge of background oxidant demand (inc. nitrite, ammonia, sulfate, iron, manganese, total organic carbon)
		Advanced knowledge of pH and temperature impacts on disinfection efficacy
		Advanced knowledge of on-site ozone, chlorine dioxide and hypochlorite generation systems
		Advanced knowledge of UV disinfection principles and systems (e.g., dose calculation, lamp technologies, disinfection mechanisms)
		Advanced knowledge of performance set points for different systems
		Advanced knowledge of online water quality measurements as they impact performance (e.g., UV intensity, UV transmittance)
i	Membrane Bioreactors (MBR)	
		Advanced knowledge of prescreening and pretreatment
		Advanced knowledge of turbidity causing matter

AWT Grade 4		Knowledge Statements
		Advanced knowledge of membrane operational sequences
		Advanced knowledge of membrane replacement considerations, requirements, and techniques
		Advanced knowledge of data normalization
		Advanced knowledge of membrane integrity tests (MIT, PDT)
		Advanced knowledge of membrane system components
		Advanced knowledge of different MBR systems (e.g., flat sheet, hollow fiber, tubular, ceramic)
		Advanced knowledge of critical monitoring parameters
		Advanced knowledge of biologial secondary treatment processes (e.g., aeration, wasting, recirculation, aerobic/anaerobic/anoxic zones)
		Advanced knowledge of membrane aeration
		Advanced knowledge of critical component maintenance
		Advanced knowledge of air quality impacts for membrane use
3	Advanced Water Treatment Support Processes	
	a Pre-Screening	
		Advanced knowledge of screening sizes and uses as pretreatment for different processes (e.g. MF feed strainers, MBR feed strainers, cartridge filtration ahead of RO) and different feed water types (e.g., seawater, secondary effluent)
		Advanced knowledge of screen/filter replacement
		Advanced knowledge of backwash frequency and impacts on feed water to downstream processes, including flow loss and shutdown
	b Chemical Cleaning	
		Advanced knowledge of chemicals used for cleaning
		Advanced knowledge of cleaning system triggers, limits, needs for key processes (including MF, UF, RO, UV, MBR, cartridge filters)
		Advanced knowledge of scaling characteristics
		Advanced knowledge of permeability and anticipated recovery of membrane systems
		Advanced knowledge of chemical cleaning sequences, cleaning procedures, and water quality
		Advanced knowledge of chemical compatibility with process components
		Advanced knowledge of handling methods for chemical waste streams

AWT Grade 4		Knowledge Statements
		Advanced knowledge of chemical neutralization systems
		Basic knowledge of membrane autopsies
c	Residuals Management	
		Advanced knowledge of chemical compatibility with infrastructure components (e.g., pipes, tanks, valves)
		Advanced knowledge of different waste streams (including MF/UF backwash, RO concentrate, chemical wastes, regenerant wastes, analyzer wastes)
		Advanced knowledge of backwash waste treatment (e.g., DAF, plate settling, belt press and centrifuge, gravity thickeners)
		Basic knowledge of return streams to permit (e.g., discharge permit) and to process performance (toxic impacts on biological processes)
		Basic knowledge of concentrate treatment options (e.g., evaporation, brine concentration, crystalization, high recovery systems, lime softening)
d	Coagulation/Flocculation	
		Advanced knowledge of safe chemical handling
		Advanced knowledge of chemical compatibilities
		Advanced knowledge of maximum dose levels
		Advanced knowledge of the coagulation/flocculation process
		Advanced knowledge of chemical coagulants and coagulant aids
		Advanced knowledge of coagulation/flocculation start-up/shut-down procedures
		Advanced knowledge of coagulation/flocculation adjustment procedures
		Advanced knowledge of chemical feeder calibration and adjustment
		Advanced knowledge of the mixing process
		Advanced knowledge of zeta potential
		Advanced knowledge of TOC/Disinfection by-product correlation
		Advanced knowledge of enhanced coagulation
		Advanced knowledge of different types of clarifiers (e.g., DAF, solids contact, sedimentation, ballasted flocculation)
4	Advanced treated water management	
a	Communication	
		Advanced knowledge of high priority process and water quality alarms
		Advanced knowledge of the significance of water quality impacts on downstream processes

AWT Grade 4		Knowledge Statements
		Basic knowledge of downstream permit requirements, legal authorities, and chain of command.
b	Operations	
		Knowledge of standard operating procedures and best practices
5	Operations and Maintenance	
a	SCADA systems	
		Advanced knowledge of SCADA components
		Advanced knowledge of alarm settings and trigger values, and alarm deviation setpoints
		Advanced knowledge of data historian and data backup
		Basic knowledge of data integration and system control strategy changes/reactions
b	Chemical Feed Systems	
		Advanced knowledge of the operation of chemical feeder systems
		Advanced knowledge of the components of chemical feeder systems
		Advanced knowledge of backpressure retention valves
		Advanced knowledge of chemical drawdown calculations
		Advanced knowledge of chemical and material compatibility
		Advanced knowledge of chemical viscocity impacts on pumping and dosing rates
		Advanced knowledge of off-gas impacts (e.g., sodium hypochlorite vapor lock)
c	Ancillary Equipment	
		Advanced knowledge of the operation of a water pump
		Advanced knowledge of the components of a water pump
		Advanced knowledge of pump types
		Advanced knowledge of the operation of blowers and compressors
		Advanced knowledge of the components of blowers and compressors
		Advanced knowledge of flow meter types and applications
		Advanced knowledge of valve and actuator types, application, and maintenance
		Advanced knowledge of solenoid control systems
d	Maintenance Management Systems	
		Advanced knowledge of asset management principles
		Advanced knowledge of asset management inventory management
		Advanced knowledge of maintenance management tools

AWT Grade 4		Knowledge Statements
e	Analyzer Calibration, Verification, and Maintenance	
		Advanced knowledge of online analyzers and applications (e.g., TOC, pH, EC, UVT, turbidity, ORP)
		Advanced knowledge of the components of on-line analyzers
		Advanced knowledge of required reagents for online analyzers
		Advanced knowledge of flow rates for low range and high range turbidimeters
		Basic knowledge of Maintenance and Warranty Contracts and Requirements
6	Controls and Monitoring	
a	SCADA Controls	
		Advanced knowledge of process and system control strategies and setpoints
		Advanced knowledge of trending systems
b	Critical Control Points	
		Advanced knowledge of critical control points and monitoring parameters
		Advanced knowledge of key process performance parameters
		Knowledge of critical control point response procedures
c	Performance Reporting	
		Knowledge of performance metrics and reporting requirements
7	Laboratory	
a	Sampling	
		Advanced knowledge of proper sampling techniques and sample management
		Advanced knowledge of writing and developing sampling plans
b	General Laboratory Practices	
		Advanced knowledge of Standard Methods
		Advanced knowledge of proper reagant use and disposal
		Advanced knowledge of laboratory QA/QC procedures
c	Laboratory Analyses	
		Advanced knowledge of abnormal chlorine levels
		Advanced knowledge of chlorine analysis techniques (DPD, amperometric)
		Advanced knowledge of chlorine chemistry
		Advanced knowledge of ozone chemistry
		Advanced knowledge of de-chlorination chemistry

AWT Grade 4	Knowledge Statements
	Advanced knowledge of chemicals that contribute alkalinity to water
	Advanced knowledge of abnormal alkalinity levels
	Advanced knowledge of the pH scale
	Advanced knowledge of acids and bases
	Advanced knowledge of temperature effects on pH
	Advanced knowledge of EC/TDS
	Advanced knowledge of chemicals that contribute hardness to water
	Advanced knowledge of bacteriological analysis methods
	Advanced knowledge of the presence/absence test method
	Advanced knowledge of Heterotrophic Plate Count (HPC)
	Advanced knowledge of the membrane filtration method
	Advanced knowledge of bacteriological testing controls
8 Regulations and Reporting	
	Advanced knowledge of chemical certificate of analysis for chemicals used in the process
	Advanced knowledge of sampling requirements
	Advanced knowledge of pathogen inactivation requirements
	Advanced knowledge of MCLs and and secondary MCLs
	Advanced knowledge of record keeping requirements
	Basic knowledge of public notification procedures
	Basic knowledge of corrective actions to take when regulations are violated
	Basic knowledge of regulatory reporting procedures (e.g., Engineering Reports)
	Basic knowledge of the Consumer Confidence Report (CCR)
	Basic knowledge of regulatory primacy issues
	Basic knowledge of performance standards and removal requirements governing regulations (water, non-potable water reuse, potable water reuse)
	Basic knowledge of the source water survey process
	Basic knowledge of pending regulations
	Basic knowledge of commissioning requirements for water reuse
9 Safety	
	Advanced knowledge of safe working practices (e.g., forklift, cranes, fall protection)
	Advanced knowledge of the use of safety equipment

AWT Grade 4	Knowledge Statements
	Advanced knowledge of compressed fluid safety procedures
	Advanced knowledge of hazardous chemical handling
	Advanced knowledge of personal protective equipment (PPE)
	Advanced knowledge of lock-out/tag-out procedures
	Advanced knowledge of electrical safety
	Advanced knowledge of HAZWOPER guidelines (including exposures to oxidants)
	Advanced knowledge of confined space requirements
	Advanced knowledge of UV exposure risks and safe working practices
	Advanced knowledge of high pressure sysetms and safe working practices
	Advanced knowledge of Comprehensive Safety Plans

AWT Grade 5	Knowledge Statements
1 Source Water	
a Wells and Groundwater (Brackish and Fresh)	
	Advanced Knowledge of groundwater quality and potential contamination in groundwater
	Advanced Knowledge of hydrogeology
	Advanced Knowledge of well sampling techniques
	Advanced Knowledge of microbial contamination, well capacity, and well maintenance
	Advanced knowledge of surface water connectivity to groundwater
	Advanced knowledge of source water assessment
b Surface water (Fresh, Saline, and Seawater)	
	Advanced Knowledge of microbial contamination
	Advanced knowledge of water quality impacts on health and treatment efficiacy and efficienty
	Advanced Knowledge of flow measurement devices
	Advanced Knowledge of proper surface water sampling procedures
	Advanced Knowledge of the effects of reservoir stratification
	Advanced Knowledge of the effects of seasonal water quality changes
c Wastewater	
	Advanced Knowledge of microbial contamination
	Advanced Knowledge of flow measurement devices
	Advanced Knowledge of the physical and chemical characteristics of secondary/tertiary effluent
	Advanced Knowledge of conventional primary, secondary, and tertiary treatment processes
	Advanced Knowledge of the effects of seasonal and diurnal changes on water resource recovery facility water quality
	Advanced Knowledge of proper secondary/tertiary sampling procedures
	Advanced Knowledge of flow equalization impact on AWT process control and maintenance
	Advanced Knowledge of water quality impacts on risk profile
d Raw Wastewater and Industrial Source Control	
	Advanced knowledge of characteristics of industrial wastewater dischargers in the collection system
	Advanced knowledge of industrial source control procedures
2 Advanced Water Treatment Processes	

AWT Grade 5		Knowledge Statements
a	Membrane Filtration	
		Advanced Knowledge of turbidity causing matter
		Advanced Knowledge of membrane operational sequences
		Advanced Knowledge of membrane replacement considerations, requirements, and techniques
		Advanced Knowledge of data normalization
		Advanced Knowledge of membrane integrity tests (MIT, PDT)
		Advanced Knowledge of membrane system components
		Advanced Knowledge of different membrane systems (e.g., MF, UF) and their characteristics
		Advanced Knowledge of critical monitoring parameters
		Advanced Knowledge of chemical conditioning to minimize biological fouling (e.g., chloramines)
b	Membrane Desalination	
		Advanced Knowledge of membrane operational sequences
		Advanced Knowledge of membrane replacement considerations, requirements, and techniques
		Advanced Knowledge of data normalization
		Advanced Knowledge of membrane system components
		Advanced Knowledge of different membrane systems (including NF, RO, EDR) and their characteristics
		Advanced Knowledge of critical monitoring parameters and online monitoring systems
		Advanced Knowledge of chemical conditioning to minimize biological fouling (e.g., chloramines)
		Advanced Knowledge of dissolved minerals in water
		Advanced Knowledge of specific conductance/TDS ratio
		Advanced Knowledge of chemical conditioning for scale minimization (e.g., pH, anti-scalant)
c	Biological Filtration	
		Advanced Knowledge of turbidity causing matter
		Advanced Knowledge of filtration mechanisms (absorption, adsorption, biodegradation)
		Advanced Knowledge of head loss effects on filters
		Advanced Knowledge of filter media types and uses

AWT Grade 5		Knowledge Statements
		Advanced Knowledge of filtration rates
		Advanced Knowledge of oxidant dose impacts on biology
		Advanced Knowledge of backwashing techniques
		Advanced Knowledge of filter media replacement considerations, requirements, and techniques
		Advanced Knowledge of filter porosity
d	Adsorption/Exchange	
		Advanced Knowledge of ion exchange processes and GAC systems
		Advanced Knowledge of resin and media types and purpose (for both granular activated carbon and ion exchange)
		Advanced Knowledge of regeneration systems
		Advanced Knowledge of ion exchange processes and GAC systems
		Advanced Knowledge of critical monitoring parameters for adsorption and exchange processes
		Advanced Knowledge of waste stream impacts
		Advanced knowledge of process data (TOC, EBCT, process surrogates, residuals) on performance
		Advanced knowledge of chemical removal isotherms and regeneration frequency
e	Finished Water Chemical Stabilization	
		Advanced Knowledge of water quality stability targets and corrosion indices (including langlier, ryznars, etc.)
		Advanced Knowledge of water chemistry specific to stabilization chemicals
f	Iron and Manganese Removal	
		Advanced Knowledge of iron and manganese removal processes
		Advanced Knowledge of iron and manganese oxidation chemistry
		Advanced Knowledge of oxidation techniques
		Advanced Knowledge of greensand regeneration
		Advanced Knowledge of backwash and regeneration systems
		Advanced knowledge of sequestering methods for Iron and Manganese management
g	Advanced Oxidation	
		Advanced Knowledge of advanced oxidation principles

AWT Grade 5	Knowledge Statements
	Advanced Knowledge of advanced oxidation technologies (including UV with hydrogen peroxide, UV with sodium hypochlorite, Ozone with hydrogen peroxide)
	Advanced Knowledge of disinfection byproduct formation (e.g., NDMA)
	Advanced Knowledge of performance set points for disinfection and advanced oxidation
	Advanced Knowledge of multiple treatment targets for advanced oxidation
	Advanced Knowledge of online water quality measurements as they impact performance (e.g., UV intensity, UV transmittance, oxidant residuals)
	Advanced Knowledge of chlorine chemistry and hydroxyl radical scavenging
	Advanced Knowledge of hydrogen peroxide impact on ozone disinfection credit
h Disinfection	
	Advanced Knowledge of chlorine chemistry
	Advanced Knowledge of breakpoint chlorination chemistry
	Advanced Knowledge of chlorine analysis procedures
	Advanced Knowledge of quenching practices
	Advanced Knowledge of chloramines chemistry
	Advanced Knowledge of ammonia feed systems
	Advanced Knowledge of disinfectant properties and uses (chlorine, chlorine dioxide, chlorine gas, chloramines, ozone)
	Advanced Knowledge of ozonation system operation
	Advanced Knowledge of disinfection byproduct formation
	Advanced Knowledge of oxidant (chlorine, ozone) decay
	Advanced Knowledge of background oxidant demand (inc. nitrite, ammonia, sulfate, iron, manganese, total organic carbon)
	Advanced Knowledge of pH and temperature impacts on disinfection efficacy
	Advanced Knowledge of on-site ozone, chlorine dioxide and hypochlorite generation systems
	Advanced Knowledge of UV disinfection principles and systems (e.g., dose calculation, lamp technologies, disinfection mechanisms)
	Advanced Knowledge of performance set points for different systems
	Advanced Knowledge of online water quality measurements as they impact performance (e.g., UV intensity, UV transmittance)
i Membrane Bioreactors (MBR)	

AWT Grade 5	Knowledge Statements
	Advanced Knowledge of prescreening and pretreatment
	Advanced Knowledge of turbidity causing matter
	Advanced Knowledge of membrane operational sequences
	Advanced Knowledge of membrane replacement considerations, requirements, and techniques
	Advanced Knowledge of data normalization
	Advanced Knowledge of membrane integrity tests (MIT, PDT)
	Advanced Knowledge of membrane system components
	Advanced Knowledge of different MBR systems (e.g., flat sheet, hollow fiber, tubular, ceramic)
	Advanced Knowledge of critical monitoring parameters
	Advanced Knowledge of biologial secondary treatment processes (e.g., aeration, wasting, recirculation, aerobic/anaerobic/anoxic zones)
	Advanced Knowledge of membrane aeration
	Advanced Knowledge of critical component maintenance
	Advanced Knowledge of air quality impacts for membrane use
3 Advanced Water Treatment Support Processes	
a Pre-Screening	
	Advanced Knowledge of screening sizes and uses as pretreatment for different processes (e.g. MF feed strainers, MBR feed strainers, cartridge filtration ahead of RO) and different feed water types (e.g., seawater, secondary effluent)
	Advanced Knowledge of screen/filter replacement
	Advanced Knowledge of backwash frequency and impacts on feed water to downstream processes, including flow loss and shutdown
b Chemical Cleaning	
	Advanced Knowledge of chemicals used for cleaning
	Advanced Knowledge of cleaning system triggers, limits, needs for key processes (including MF, UF, RO, UV, MBR, cartridge filters)
	Advanced Knowledge of scaling characteristics
	Advanced Knowledge of permeability and anticipated recovery of membrane systems
	Advanced Knowledge of chemical cleaning sequences, cleaning procedures, and water quality
	Advanced Knowledge of chemical compatibility with process components

AWT Grade 5		Knowledge Statements
		Advanced Knowledge of handling methods for chemical waste streams
		Advanced Knowledge of chemical neutralization systems
		Advanced Knowledge of membrane autopsies
c	Residuals Management	
		Advanced Knowledge of chemical compatibility with infrastructure components (e.g., pipes, tanks, valves)
		Advanced Knowledge of different waste streams (including MF/UF backwash, RO concentrate, chemical wastes, regenerant wastes, analyzer wastes)
		Advanced Knowledge of backwash waste treatment (e.g., DAF, plate settling, belt press and centrifuge, gravity thickeners)
		Advanced knowledge of return streams to permit (e.g., discharge permit) and to process performance (toxic impacts on biological processes)
		Advanced knowledge of concentrate treatment options (e.g., evaporation, brine concentration, crystalization, high recovery systems, lime softening)
d	Coagulation/Flocculation	
		Advanced Knowledge of safe chemical handling
		Advanced Knowledge of chemical compatibilities
		Advanced Knowledge of maximum dose levels
		Advanced Knowledge of the coagulation/flocculation process
		Advanced Knowledge of chemical coagulants and coagulant aids
		Advanced Knowledge of coagulation/flocculation start-up/shut-down procedures
		Advanced Knowledge of coagulation/flocculation adjustment procedures
		Advanced Knowledge of chemical feeder calibration and adjustment
		Advanced Knowledge of the mixing process
		Advanced Knowledge of zeta potential
		Advanced Knowledge of TOC/Disinfection by-product correlation
		Advanced Knowledge of enhanced coagulation
		Advanced Knowledge of different types of clarifiers (e.g., DAF, solids contact, sedimentation, ballasted flocculation)
4	Advanced treated water management	
a	Communication	
		Advanced knowledge of process and water quality alarms and appropriate response procedures

AWT Grade 5		Knowledge Statements
		Advanced knowledge of the significance of water quality impacts on downstream processes
		Advanced Knowledge of communication principles with governing boards, public and media
		Advanced Knowledge of operating permit requirements and legal authorities
		Advanced knowledge of high priority processes and water quality alarms
		Advanced knowledge of the significance of water quality impacts on downstream processes
		Advanced knowledge of key contacts and communication plans.
		Advanced Knowledge of downstream permit requirements, legal authorities, and chaing of command.
	b Operations	
		Advanced knowledge of performance metrics and reporting requirements
5	Operations and Maintenance	
	a SCADA systems	
		Advanced Knowledge of SCADA components
		Advanced Knowledge of alarm settings and trigger values, and alarm deviation setpoints
		Advanced Knowledge of data historian and data backup
		Advanced Knowledge of data integration and system control strategy changes/reactions
	b Chemical Feed Systems	
		Advanced Knowledge of the operation of chemical feeder systems
		Advanced Knowledge of the components of chemical feeder systems
		Advanced Knowledge of backpressure retention valves
		Advanced Knowledge of chemical drawdown calculations
		Advanced Knowledge of chemical and material compatibility
		Advanced Knowledge of chemical viscocity impacts on pumping and dosing rates
		Advanced Knowledge of off-gas impacts (e.g., sodium hypochlorite vapor lock)
	c Ancillary Equipment	
		Advanced Knowledge of the operation of a water pump
		Advanced Knowledge of the components of a water pump
		Advanced Knowledge of pump types
		Advanced Knowledge of the operation of blowers and compressors

AWT Grade 5	Knowledge Statements
	Advanced Knowledge of the components of blowers and compressors
	Advanced Knowledge of flow meter types and applications
	Advanced Knowledge of valve and actuator types, application, and maintenance
	Advanced Knowledge of solenoid control systems
d Maintenance Management Systems	
	Advanced Knowledge of asset management principles
	Advanced Knowledge of asset management inventory management
	Advanced Knowledge of maintenance management tools
e Analyzer Calibration, Verification, and Maintenance	
	Advanced Knowledge of online analyzers and applications (e.g., TOC, pH, EC, UVT, turbidity, ORP)
	Advanced Knowledge of the components of on-line analyzers
	Advanced Knowledge of required reagents for online analyzers
	Advanced Knowledge of flow rates for low range and high range turbidimeters
	Advanced Knowledge of Maintenance and Warranty Contracts and Requirements
6 Controls and Monitoring	
a SCADA Controls	
	Advanced Knowledge of process and system control strategies and setpoints
	Advanced Knowledge of trending systems
	Advanced Knowledge of historical data management and report generation
b Critical Control Points	
	Advanced Knowledge of critical control points and monitoring parameters
	Advanced Knowledge of key process performance parameters
	Advanced Knowledge of critical control point response procedures
c Performance Reporting	
	Advanced knowledge of performance metrics and reporting requirements
7 Laboratory	
a Sampling	
	Advanced Knowledge of proper sampling techniques and sample management
	Advanced knowledge of writing and developing sampling plans

AWT Grade 5	Knowledge Statements
b General Laboratory Practices	
	Advanced Knowledge of Standard Methods
	Advanced Knowledge of proper reagant use and disposal
	Advanced knowledge of laboratory QA/QC procedures
c Laboratory Analyses	
	Advanced Knowledge of abnormal chlorine levels
	Advanced Knowledge of chlorine analysis techniques (DPD, amperometric)
	Advanced Knowledge of chlorine chemistry
	Advanced Knowledge of ozone chemistry
	Advanced Knowledge of de-chlorination chemistry
	Advanced Knowledge of chemicals that contribute alkalinity to water
	Advanced Knowledge of abnormal alkalinity levels
	Advanced Knowledge of the pH scale
	Advanced Knowledge of acids and bases
	Advanced Knowledge of temperature effects on pH
	Advanced Knowledge of EC/TDS
	Advanced Knowledge of chemicals that contribute hardness to water
	Advanced Knowledge of bacteriological analysis methods
	Advanced Knowledge of the presence/absence test method
	Advanced Knowledge of Heterotrophic Plate Count (HPC)
	Advanced Knowledge of the membrane filtration method
	Advanced Knowledge of bacteriological testing controls
8 Regulations and Reporting	
	Advanced Knowledge of chemical certificate of analysis for chemicals used in the process
	Advanced Knowledge of sampling requirements
	Advanced Knowledge of pathogen inactivation requirements
	Advanced Knowledge of MCLs and and secondary MCLs
	Advanced knowledge of record keeping requirements
	Advanced knowledge of public notification procedures
	Advanced knowledge of corrective actions to take when regulations are violated
	Advanced knowledge of regulatory reporting procedures (e.g., Engineering Reports)
	Advanced knowledge of the Consumer Confidence Report (CCR)

AWT Grade 5	Knowledge Statements
	Advanced knowledge of regulatory primacy issues
	Advanced knowledge of performance standards and removal requirements governing regulations (water, non-potable water reuse, potable water reuse)
	Advanced knowledge of the source water survey process
	Advanced knowledge of pending regulations
	Advanced knowledge of commissioning requirements for water reuse
9 Safety	
	Advanced Knowledge of safe working practices (e.g., forklift, cranes, fall protection)
	Advanced Knowledge of the use of safety equipment
	Advanced Knowledge of compressed fluid safety procedures
	Advanced Knowledge of hazardous chemical handling
	Advanced Knowledge of personal protective equipment (PPE)
	Advanced Knowledge of lock-out/tag-out procedures
	Advanced Knowledge of electrical safety
	Advanced Knowledge of HAZWOPER guidelines (including exposures to oxidants)
	Advanced Knowledge of confined space requirements
	Advanced Knowledge of UV exposure risks and safe working practices
	Advanced Knowledge of high pressure sysetms and safe working practices
	Advanced Knowledge of Comprehensive Safety Plans