
Wastewater Treatment System Operator Minimum Qualifications Guidelines

Version 1.0

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- c) for any results obtained or not obtained from the use of the Wastewater Treatment System Operator Minimum Qualifications Guidelines.

Introduction

In 2016, the ZDHC Foundation set new guidelines in wastewater discharge quality for the global footwear and apparel industries that go beyond regulatory compliance. The ZDHC Wastewater Guidelines ensure that wastewater discharges do not adversely affect the environment and surrounding communities. These guidelines are two-fold:

1. To validate that hazardous chemicals on the ZDHC Manufacturing Restricted Substances List (ZDHC MRSL) are not intentionally used during material production.
2. To preserve the environment by driving for ever-cleaner wastewater via continuous improvement on the treatment of conventional wastewater parameters such as chemical oxygen demand (COD), biological oxygen demand (BOD), ammonia, suspended solids, colour, etc.

Since the adoption of the Guidelines by the ZDHC Signatory Brands and supply chain affiliates, thousands of wastewater test reports have been submitted to the ZDHC Foundation through the ZDHC Gateway. An analysis of these test reports has shown that most facilities are more challenged with meeting the foundational limits of the conventional parameters than they are with the MRSL chemistries.

Further analysis – through on-site reviews of wastewater treatment operations at numerous Supplier facilities around the world – has shown that the training and qualifications of operators and technicians tasked with operating wastewater treatment are not consistent or robust. As a result, facilities may be incurring higher treatment costs than necessary, and wastewater may not be properly treated prior to discharge.

The ZDHC Foundation believes that unless wastewater treatment system operators and technicians have adequate qualifications and are properly trained, some facilities will continue to struggle with meeting the expectations of the ZDHC Wastewater Guidelines, and in some cases, regulatory compliance.

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Minimum Expectations

For the purpose of these guidelines, at a minimum, each Supplier facility is expected to:

- Be recognised by the authorities as a legal enterprise.
- Consistently comply with wastewater discharge permits at all times.
- Apply these guidelines to industrial wastewater, including domestic wastewater that is blended with industrial wastewater.
- Avoid bypasses around wastewater treatment systems that are not permitted by authorities having jurisdiction.
- Follow generally accepted process engineering best practices with respect to wastewater treatment and overall facility water efficiency management.
- Not dilute wastewater discharge with incoming water as a means to achieve compliance to concentration-based discharge permits.
- Properly classify sludge produced from wastewater treatment or zero-liquid discharge operations as either hazardous or non-hazardous as defined by authorities having jurisdiction, and to fully understand the final disposition of sludge wastes by third-party waste haulers.
- Contract sludge hauling and disposal to licensed/permitted and qualified third parties that have appropriate facilities to properly dispose of the sludge wastes to ensure that sludge and leachates from the sludge do not adversely impact the environment.

Scope

This Guideline applies to each facility that owns and/or operates one or more wastewater treatment systems to treat industrial, or a blend of industrial and domestic wastewater, whether or not the treatment system is located on its property. In the event a facility hires an external company to operate and maintain its wastewater treatment plant, the representatives of the external company must demonstrate their level of qualification per these Guidelines.

Exempted from these Guidelines are facilities that implement septic tanks to treat domestic wastewater; and facilities that discharge domestic and/or industrial wastewater into a municipal or centralised sewage collection system without pretreatment in accordance with their legal discharge permit.

Objective

The intent of these Guidelines is to establish standardised minimum expectations for the education, training, and experience for operators and technicians (including external contractors) hired and tasked with operating wastewater treatment systems at manufacturing facilities.

It is expected that each wastewater treatment system operator demonstrates their level of qualification through a ZDHC-administered exam; and has a continuing education plan to maintain or to increase their qualification levels as defined by these Guidelines.

Schedule

These Guidelines will come into effect starting 1 January 2024, to allow time for wastewater treatment plant operators (and those seeking to build a career as a water and wastewater treatment plant operator) to ensure they are adequately prepared to demonstrate they can meet the expectations of these Guidelines.

After 1 January 2024, wastewater treatment operators are expected to be qualified to the level expected of them as per these Guidelines, and be in possession of a certificate from the ZDHC indicating that they are qualified per these Guidelines.

Approach

This Guideline consists of several parts:

1. Characterise the relative complexity of a facility's wastewater treatment system using a points system.
2. Define the minimum qualifications for staffing expected to operate wastewater treatment systems of varying degrees of complexity.
3. Define the minimum education, training, and experience levels for each Operator Qualification Level.
4. Establish the structure for continuing education and validation of the minimum qualifications of wastewater treatment system operators and technicians.

Acknowledgements

This Guideline was inspired by, and is based on, the regulatory frameworks for wastewater treatment operator certification as established by the U.S. states of New York and California; the Water Environment Federation (www.wef.org) and the Oregon State Board of Examiners for Engineering and Land Surveying (OSBEELS).

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1. Assessing Relative Complexity of a Wastewater Treatment System

Because facility-specific wastewater treatment systems are generally designed to meet the requirements of local conditions and prevailing regulations, no two are assumed to be the same and of the same complexity. As a result, the training expectations for wastewater treatment system operators for a very complex system will be different than for a wastewater treatment system with fewer and less-complicated unit operations.

First, use Appendix A to determine the complexity score of the wastewater treatment system. The higher the score, the more complex the wastewater treatment system. The more complex the wastewater treatment system, the greater the qualifications necessary for the most-senior operator or manager of the wastewater treatment system. Second, refer to Table 1 to determine the minimum expected levels of qualification for staff tasked with operating a facility's wastewater treatment system.

Table 1: Minimum qualification level for various roles at wastewater treatment systems with varying levels of complexity.

Minimum Qualification Level for Most-Senior Supervisor Responsible for Wastewater Treatment System					
Position/Role	Wastewater Treatment Plant Complexity Score				
	Under 25	26 to 50	51 to 75	76 to 100	Above 100
Chief Operator	1/1A	2/2A	3/3A	4/4A	5A/Z
Senior Shift Operator	1/1A	1/1A	2/2A	3/3A	4/4A
Maintenance Technician	1/1A	1/1A	2/2A	2/2A	3/3A

2. Operator Qualification Levels

Operator qualification levels are divided into multiple categories, Levels 1 through 5, and Levels 1A, 2A, 3A, 4A, and 5A for those operators who are expected to work on wastewater treatment systems that implement activated sludge technology. The Z-category exists for the most-experienced operators at Level 5 who work on zero liquid discharge systems.

For an operator to qualify at a higher level, they must satisfy all the requirements of the lower qualification levels. For an operator to be qualified at Level 3A, they must satisfy all the requirements for Level 1A and Level 2A. An operator qualified at Level 4 must satisfy all the requirements for Level 1, Level, 2 and Level 3.

In some cases, qualification at Level 5 or Level 5A may not be necessary for the most senior operator working on a wastewater treatment system if the complexity of the wastewater treatment system does not require it. Table 1 defines the expected qualifications of the most-senior supervisor responsible for the operations and maintenance of a wastewater treatment system.

It is expected that only qualified operators will be permitted to operate and maintain wastewater treatment systems. The only exceptions to this are as follows:

1. During initial deployment of these Guidelines when operators are building their credentials to demonstrate their level of qualification.
2. When a new operator is hired to operate and maintain the wastewater treatment system.
3. In each of these cases, each operator that has yet to qualify is expected to have a written development plan with a set schedule and deadline for when they will achieve their targeted qualification level that aligns with their level of responsibility.
4. An operator that has yet to qualify, but is working toward their qualification level, is expected to have a qualified operator as a buddy/mentor to assist with on-the-job training that will count as experience toward operator qualification.

2.1 Experience, Education and Training Expectations for Each Qualification Level

For an operator to consider qualification, they are expected to demonstrate they have:

1. Practical, hands-on experience with wastewater treatment systems
2. Had training specific to wastewater treatment system operations

2.1.1 Formal Education and Hands-On Experience

Operators at each qualification level are expected to possess a minimum amount of continuous hands-on experience working with wastewater treatment systems as outlined in Table 2. A formal education in wastewater treatment is not necessary to be considered a qualified wastewater treatment operator. However, for those with formal education, formal education will count toward years of practical experience:

- a. A four-year bachelor's degree with at least 30 credit hours of science and mathematics courses will be counted as two years of practical experience.
- b. A two-year associate degree with 30 credit hours of science and mathematics courses will be counted as six months of practical experience.
- c. A secondary school diploma will be counted as three months of practical experience.

In addition to formal education and hands-on experience, individuals seeking to be recognised as a qualified operator must demonstrate their knowledge of the topics outlined in Appendix C for the level of qualification the individual is seeking. A summary of the expected job-specific knowledge at each operator qualification level is shown in Table 2.

Table 2: Job-specific knowledge requirements and minimum years of hands-on, practical experience operating a wastewater treatment system for each operator qualification level.

Expected Job-Specific Practical Experience and Knowledge Requirements for Each Operator Qualification Level						
Operator Level	Minimum Years of Practical Wastewater Operations Experience (Years)	I. Basic Physical/Chemical Treatment	II. Basic Biological Treatment	III. Advanced Physical/Chemical Treatment	IV. Advanced Biological Treatment	V. Advanced Treatment Topics
5A/Z	8	X	X	X	X	X
4A	5	X	X	X	X	
4	5	X		X		
3A	3	X	X	X	X	
3	3	X		X		
2A	1	X	X			
2	1	X				
1A	0,5	X	X			
1	0,5	X				

Individuals seeking qualification may use any form of knowledge resources available to them to gain the necessary understanding that will enable them to demonstrate their qualifications at the level they are seeking.

It is possible for an individual with the requisite number of years of experience to become a certified operator without accessing training resources so long as they can successfully complete the knowledge test administered by the ZDHC.

2.2 Demonstration of Qualification

Wastewater treatment operators seeking qualification must demonstrate they possess the knowledge and skills corresponding to the qualification level they are seeking. This is expected to occur in two steps:

1. Complete a written statement of qualification, outlining formal education and previous work experience, which may include diplomas, transcripts, and references from past and current managers and supervisors. A template for the Statement of Qualification is available in Appendix B.
2. Successfully complete a multiple-choice knowledge test administered by the ZDHC, with a score of at least 80 percent. There is no limit to the number of times an individual can take a knowledge test to achieve a given level of qualification.

Upon successfully completing the knowledge test for a given qualification level, the operator will receive a certificate, with a unique identification number, from the ZDHC Foundation stating that the operator has been deemed qualified to that level.

2.2.1 Operator Renewal of Qualification

Operators will be expected to renew their current qualifications every two years from the date they last demonstrated they were qualified, unless they have achieved a new level of qualification before their renewal date. When they achieve a new level by successfully completing a knowledge test and demonstrating years of practical experience, their new renewal date is second, fourth, sixth, eighth, etc. anniversary of successfully completing the knowledge test.

Renewal of qualification consists of the following:

1. A letter of reference from the individual's direct supervisor certifying that the individual has been working continuously as a wastewater treatment system operator since the date of last qualification
2. Earning professional development hours (PDHs) over the two years since qualification or last re-qualification per Table 3. A professional development hour is defined as 60 minutes of instruction, presentation or study in a planned education ex-

perience that is relevant to one's profession or discipline. Refer to Appendix D for more information on what is a professional development hour and how they are earned.

3. If an excess of PDHs is earned within the two years prior to renewal, the operator may roll up to five PDHs into the next renewal period. Once a PDH has been rolled into the next renewal period, it cannot be transferred a second time.

Table 3 – Professional development hours (PDHs) expected for renewal of operator qualification. In addition to PDHs, the operator must have been continuously employed as a wastewater treatment operator throughout the two-year period prior to renewal of qualification.

Operator Level	Number of Professional Development Hours (PDHs) Required for Renewal Every Two Years
5A/Z	15
4A	15
4	15
3A	10
3	10
2A	5
2	5
1A	5
1	5

2.2.2 Records Storage

Facilities are expected to retain statements of qualification and test results for each of their qualified operators for five years from the last qualification or re-qualification date for each operator. Documents are expected to be available for review upon request.

The ZDHC Foundation will retain a global database of qualified wastewater treatment operators, as well as their qualification status, their employer, level of qualification, expiration of qualification, etc. This data will be used to demonstrate the effectiveness of the Wastewater Treatment System Operator Qualification Programme on improving wastewater discharges across the footwear and apparel industries.

Each qualified operator is expected to retain the supporting details of their Professional Development Hours for at least five years. When re-qualifying, operators are expected to submit with their online application a statement outlining the details of their PDHs using the form in Appendix E. A copy of this material is expected to be stored with the operator's employer so it can be available for review upon request.

APPENDIX A

Wastewater Treatment System Complexity Scoring

Wastewater Treatment System Relative Complexity -- Scoring -- Page 1		
Facility Name		
Facility Unique ID #		
Facility Address		
Date Survey Completed		
Facility Wastewater Treatment Plant Manager		
	# Points per Item	Facility Score
Wastewater Treatment System Flowrate	1 point per 1000³/day	

1. Discharge Type (Max 10 points)		
Direct Discharge	10	
Indirect Discharge	5	

2. Preliminary Treatment (Max 8 points)		
Screening (bar, rotary, etc.)	2	
Manual Grit Remover	2	
Mechanical or Aerated Grit Remover	3	
Pre-aeration	2	
Raw wastewater or effluent pumping	3	
Equalization Basin	3	

3. Primary Treatment (Max 5 points)		
Chemical injection with coagulation (Dissolved Air Flotation, inclined plate, etc)	5	
Primary settling tanks	2	

Page 1 Subtotal		



Wastewater Treatment System Relative Complexity -- Scoring -- Page 2		
Facility Name		
Facility Unique ID #		
Facility Address		
Date Survey Completed		
Facility Wastewater Treatment Plant Manager		
	# Points per Item	Facility Score
Wastewater Treatment System Flowrate	1 point per 1000³/day	

4. Secondary Treatment (Max 30 points)		
Unaerated lagoon	3	
Intermittent sand filters without recirculation	3	
Intermittent sand filters with recirculation	5	
Trickling filter, biological filter without recirculation	9	
Trickling filter/biological filter with recirculation	11	
Anaerobic processes	5	
Rotating biological contactors	11	
Activated sludge process (without submerged membrane bioreactor)	20	
Activated sludge process (with submerged membrane bioreactor)	25	
Chemical coagulation with rapid mix, flocculation, clarification	20	
Dissolved air flotation (DAF)		

Page 2 Subtotal		
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Wastewater Treatment System Relative Complexity -- Scoring -- Page 3		
Facility Name		
Facility Unique ID #		
Facility Address		
Date Survey Completed		
Facility Wastewater Treatment Plant Manager		
	# Points per Item	Facility Score
Wastewater Treatment System Flowrate	1 point per 1000³/day	

5. Advanced Water Treatment/Tertiary Treatment (Max 30 points)		
Polishing Pond	2	
Microscreens	3	
Intermittent Sand Filter	3	
Rapid Sand Filter	5	
Activated Carbon Filters	5	
Reverse Osmosis/Nanofiltration	10	
Electrodialysis	6	
Ion Exchange	2	
Antimony Removal	5	
Fenton Oxidation System	8	
Chemical precipitation of metals	6	
Ultrafiltration (cross-flow, not submerged)	5	
Nitrification by Activated Sludge	8	
Nitrification by Other Processes	5	
Nitrification by Activated Sludge and Denitrification	13	
Nitrification by other processes and Denitrification	10	
Phosphorus Removal	8	
Chemical Addition for Neutralization	2	

Page 3 Subtotal		
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Wastewater Treatment System Relative Complexity -- Scoring -- Page 4		
Facility Name		
Facility Unique ID #		
Facility Address		
Date Survey Completed		
Facility Wastewater Treatment Plant Manager		
	# Points per Item	Facility Score
Wastewater Treatment System Flowrate	1 point per 1000³/day	

6. Disinfection (Maximum 8 points)		
Chlorination (gas)	5	
Chlorination (other)	2	
Dechlorination	3	
Ultraviolet	2	
Ozonation	3	

7. Zero Liquid Discharge (Maximum 20 points)		
Facility is a Zero Liquid Discharge (ZLD)	20	
Facility is not a Zero Liquid Discharge (ZLD) facility	0	

Page 4 Subtotal		
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Wastewater Treatment System Relative Complexity -- Scoring -- Page 5		
Facility Name		
Facility Unique ID #		
Facility Address		
Date Survey Completed		
Facility Wastewater Treatment Plant Manager		
	# Points per Item	Facility Score
Wastewater Treatment System Flowrate	1 point per 1000³/day	

8. Solids Handling/Disposal (Max 15 points)		
Gravity Thickener	5	
Dissolved Air Flotation (DAF) Thickener	8	
Centrifugation	5	
Aerobic Digestion	5	
Single Stage Anaerobic Digestion (heated)	8	
Single Stage Anaerobic Digestion (unheated)	5	
Two Stage Anaerobic Digestion	10	
Sludge Drying Beds	3	
Belt Filter Press	8	
Plate and Frame Filter Press	8	
Vacuum Filters	8	
All other dewatering	5	

9. Sludge/Cake Disposal (Max 15 points)		
Land Use	5	
Hazardous Waste Landfill	8	
Non-Hazardous Waste Landfill	5	

Page 5 Subtotal		
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Wastewater Treatment System Relative Complexity -- Scoring -- Page 6		
Facility Name		
Facility Unique ID #		
Facility Address		
Date Survey Completed		
Facility Wastewater Treatment Plant Manager		
	# Points per Item	Facility Score
Wastewater Treatment System Flowrate	1 point per 1000³/day	

10. Cooling or Heat Recovery Systems to Cool Wastewater (Max 10 points)		
Heat Recovery Heat Exchanger(s)	10	
Cooling Tower	5	
None	0	

Page 1 Subtotal	
Page 2 Subtotal	
Page 3 Subtotal	
Page 4 Subtotal	
Page 5 Subtotal	
Page 6 Subtotal	
Total Facility Score (Page 1 + Page 2 + Page 3 + Page 4 + Page 5 + Page 6 Subtotal)	



APPENDIX B

Wastewater Treatment Operator Statement of Experience

Operator Details

Operator Name	
ZDHC Operator ID Number (if applicable)	

Employment (Starting with Most Recent)

Current Employer	
Current Employer's Address	
Employer's ZDHC AID Number	
Employment Start Date (mm/yyyy)	
Employment End Date (mm/yyyy)	
Title/Position:	
Length of Time in Position	
Supervisor Name and Title	
Supervisor Email Address	
Supervisor Telephone Number	
Summary of Job Responsibilities; Type of Wastewater Treatment System	
Wastewater Treatment System Point Score Per Appendix A	

Employer	
Employer's Address	
Employment Start Date (mm/yyyy)	
Employment End Date (mm/yyyy)	
Title/Position	
Length of Time in Position	
Supervisor Name and Title	
Supervisor Email Address	
Supervisor Telephone Number	
Summary of Job Responsibilities; Type of Wastewater Treatment System	
Wastewater Treatment System Point Score Per Appendix A	

Employer	
Employer's Address	
Employment Start Date (mm/yyyy)	
Employment End Date (mm/yyyy)	
Title/Position	
Length of Time in Position	
Supervisor Name and Title	
Supervisor Email Address	
Supervisor Telephone Number	
Summary of Job Responsibilities; Type of Wastewater Treatment System	
Wastewater Treatment System Point Score Per Appendix A	

Formal Education (Starting with Most Recent)

Name of College/University (attach copy of diploma or completion notice)	
School Address	
Graduated? (yes/no)	
Graduation or Completion Date	
Type of Degree	

Name of College/University (attach copy of diploma or completion notice)	
School Address	
Graduated? (yes/no)	
Graduation or Completion Date	
Type of Degree	

Name of College/University (attach copy of diploma or completion notice)	
School Address	
Graduated? (yes/no)	
Graduation or Completion Date	
Type of Degree	



Wastewater Treatment Classes

Wastewater Treatment Class	
Education Provider	
Hours of Study	
Completed? (yes/no, provide copy of diploma or completion notice)	
Graduation or Completion Date	

Wastewater Treatment Class	
Education Provider	
Hours of Study	
Completed? (yes/no, provide copy of diploma or completion notice)	
Graduation or Completion Date	

Wastewater Treatment Class	
Education Provider	
Hours of Study	
Completed? (yes/no, provide copy of diploma or completion notice)	
Graduation or Completion Date	



Wastewater Treatment Class	
Education Provider	
Hours of Study	
Completed? (yes/no, provide copy of diploma or completion notice)	
Graduation or Completion Date	

Wastewater Treatment Class	
Education Provider	
Hours of Study	
Completed? (yes/no, provide copy of diploma or completion notice)	
Graduation or Completion Date	

Previous Qualifications/Certifications

Qualification/Certification	
Approving Organisation	
Date of Qualification/ Certification (provide copy of diploma, certificate, or completion notice)	
Graduation or Completion Date	

Qualification/Certification	
Approving Organisation	
Date of Qualification/ Certification (provide copy of diploma, certificate, or completion notice)	
Graduation or Completion Date	

Qualification/Certification	
Approving Organisation	
Date of Qualification/ Certification (provide copy of diploma, certificate, or completion notice)	
Graduation or Completion Date	

APPENDIX C

Wastewater Treatment System Operator Qualification Training Curriculum

I. Basic Physical/Chemical Treatment

Module 1: Screening

Upon completing Module 1, participants should be able to:

1. Explain the purpose and principles of various screening processes.
2. Safely operate and maintain the screening process.
3. Clean the screens regularly.

Module 2: Coagulation and Flocculation

Upon completing of Module 2, participants should be able to:

1. Explain the purpose of coagulation and flocculation in the wastewater treatment process.
2. Explain the basic principles of coagulation and flocculation.
3. Identify various types of coagulant chemicals and their usage.
4. Assist in the jar test.
5. Safely operate and maintain the process.
6. Recognise factors that indicate the coagulation and flocculation processes are not performing properly and report to supervisor.

Module 3: Filtration

Upon completing of Module 3, participants should be able to:

1. Explain the purpose of filtration.
2. Identify various types of filtration.
3. Measure and control key operational parameters: pressure, turbidity, filter run length, etc.
4. Safely operate, maintain the filtration process.
5. Recognise factors that indicate the filtration process is not performing properly and report to supervisor.

Module 4: Dissolved Air Flotation (DAF)

Upon completing of Module 4, participants should be able to:

1. Explain the purpose of DAF.
2. Understand the key components: air dissolution, air distribution, and air release.
3. Identify and control the desired bubble size.
4. Safely operate, maintain the DAF system.

Module 5: Chemical Precipitation

Upon completing of Module 5, participants should be able to:

1. Understand the theoretical aspects of different types of chemicals that are used for chemical precipitation to improve system performance.
2. Have a fundamental understanding of pre-precipitation, co-precipitation and post-precipitation for ions and heavy metals removal.

Module 6: Sedimentation

Upon completing of Module 6, participants should be able to:

1. Explain the purpose of sedimentation.
2. Understand the principles of the key components: inlet zone, settling zone, sludge zone, outlet zone.
3. Identify the sludge collection and removal frequency.
4. Safely operate, maintain the sedimentation system.
5. Recognise factors that indicate the sedimentation process is not performing properly and report to supervisor.

Module 7: pH Adjustment

Upon completing of Module 7, participants should be able to:

1. Explain the purpose of pH adjustment.
2. Identify the treatment process that pH adjustment is commonly used for.
3. Describe the acidic/neutral/alkaline condition in the pH scale.
4. Demonstrate how to calculate and control the chemical dosage to adjust pH to a desirable range.
5. Safely operate and use chemicals.

Module 8: Disinfection

Upon completing of Module 8, participants should be able to:

1. Describe the purpose and requirements of disinfection (Chlorination, UV, Ozone).
2. Detect chlorine leaks and take appropriate corrective action.
3. Safely operate and maintain the disinfection system.
4. Recognise factors that indicate the UV disinfection process is not performing properly.

Module 9: Sludge treatment and handling

Upon completing of Module 9, participants should be able to:

1. Explain the purpose of sludge treatment and handling.
2. Understand the key components of sludge thickening, sludge dewatering, sludge drying, sludge disposal.
3. Control and record the operational parameters: percent water, temperature, maximum loading, etc.
4. Recognise factors that indicate the processes are not performing properly and report to supervisor.
5. Safely operate and maintain the sludge treatment and handling system.

Module 10: Sampling and Testing

Following topics are discussed in Module 10:

1. Understand different types of sampling (grab/spot vs. composite).
2. How to take a representative sample (e.g. where in a tank, where in a pipe, flushing outlets, effect of overfilling containers, sample hold times, etc.).
3. Use of automatic samplers.
4. Field testing: temperature, pH, chlorine, DO, conductivity, turbidity, settling, perform a solids panel, etc.
5. Flow measurement techniques (open channel, volumetric, dilution, closed pipe).
6. Sample preservation and storage.
7. Understand how to interpret field test and laboratory test results.
8. Instrument calibration: the basic methods for checking the accuracy of the instruments.
9. Principles of safety related to sampling and testing.

Module 11: Piping and Instrumentation

Upon completing of Module 11, participants should be able to:

1. Identify different types of valves, pipes, pumps and their use.
2. Understand how to safely operate and adjust them to the right value.
3. Recognise when processes or equipment are not performing well.

Module 12: Water and Wastewater Quality

Upon completing of Module 12, participants should be able to:

1. Understand the relevance of influent specifications and process water specifications.
2. If influent conditions change, understand what adjustments to the process are necessary to achieve the desired process water specifications and wastewater quality compliance.
3. Understand the applicability and cost/benefits of stream segregation.
4. Appreciate the importance of two-way communication with the production facility to better operate the wastewater treatment system.

II. Basic Biological Treatment

Module 1: Aerobic/Anaerobic Treatment

Upon completing of Module 1, participants should be able to:

1. Explain the functions and details of an aerobic and anaerobic treatment process.
2. Understand the principles of typical aerobic processes, activated sludge process, sequencing batch reactors and oxidation ditches.
3. Understand the principles of typical anaerobic processes: anaerobic contact process, UASB, fixed bed, expanded bed.
4. Understand the concepts of the performance indication data: input parameters, HRT, organic loading, COD removal.
5. Understand the difference between load and concentration for various parameters (BOD, COD, ammonia, etc.).
6. Safely operate and maintain the treatment process.

Module 2: Activated Sludge Process (ASP)

Upon completing of Module 2, participants should be able to:

1. Explain the purpose and principles of ASP, inclusive of waste activated sludge and return activated sludge.
2. Understand the common equipment and parameters used to control the system.
3. Assess the performance of the ASP through typical physical observations.
4. Understand the proper sampling locations and frequencies.
5. Safely operate and maintain the ASP.

Module 3: Clarifier

Upon completing of Module 3, participants should be able to:

1. Describe the basic principles of the clarifier.
2. Identify the difference between primary clarifier and the secondary clarifier.
3. Recognise factors that indicate the clarification processes are not performing properly and report to supervisor.
4. Safely operate and maintain the clarifier.

Module 4: Sludge treatment and handling

Upon completing of Module 4, participants should be able to:

1. Understand the general treatment, reuse and disposal of biosolids.
2. Understand the biological treatment process of sludge for example, sludge digestion and composting.
3. Control and record the operational parameters: temperature, oxygen, maximum loading, etc.
4. Recognise factors that indicate the processes are not performing properly and report to supervisor.
5. Safely operate and maintain the sludge treatment and handling system.

Module 5: Introduction to MBR

Upon completing of Module 5, participants should be able to:

1. Understand the fundamentals and governing principles of membrane separation processes.
2. Understand the key technical constituents of the MBR process treatment.
3. Safely operate and maintain the membrane bioreactor system.

III. Advanced Physical/Chemical Treatment

Module 1: Screening

Upon completing of Module 1, participants should be able to:

1. Explain the purpose of screens.
2. Describe the various types of coarse and fine screens.
3. Describe the types of solids that can be effectively screened.
4. Determine the volume of screening and how long a disposal site will last before it is full.
5. Understand the principle of solids reduction.
6. Safely operate, maintain, and troubleshoot wastewater screens.

Module 2: Coagulation and Flocculation

Following topics are discussed in Module 2:

1. The definition of coagulation and flocculation.
2. The role of coagulation and flocculation processes in removing suspended solids from wastewater.
3. Coagulation process details: flash mixing, types of mixers, use of coagulants, types of coagulants chemicals.
4. Flocculation process details: flocculation basin design, detention time, flocculation aids, incidental flocculation, flocculation quality characteristics.
5. The efficiency of coagulation and flocculation processes: monitoring of water quality, visual observations.
6. Jar tests.
7. Define electrostatic repulsion and coordination sphere formation.
8. Understand the importance of pH in coagulation/flocculation.

Module 3: Dissolved Air Flotation (DAF)

Upon completing of Module 3, participants should be able to:

1. Describe the objective and principles of the DAF processes.
2. Understand the four general methods of flotation.
3. Understand the concept of "white water".
4. Understand the various types of dissolved air systems.
5. Explain the basic design of key components of DAF units.
6. Explain the key processes of air dissolution, air distribution, and air release.

7. Solve the problems with thickening primary sludge.
8. Explain the significance of mass balance and flow.
9. Understand the importance of controlling air bubble size.
10. Understand the importance of controlling pH.
11. Explain what surface tension is and how it can be overcome by the use of surfactants.
12. Define what an air to solids ratio is and explain how it impacts DAF efficiency.
13. Identify the most common troubleshooting situations and solve them.

Module 4: Filtration

Upon completing of Module 4, participants should be able to:

1. Describe the typical filtration techniques.
2. Understand the types of filters: Granular media filters, Gravity/pressure filters, Pre-coat filters, Cartridge filters.
3. Understand the types of filter media and design configurations.
4. Identify and describe the components of inert-media gravity and pressure filters.
5. Explain the filter operation: head loss, turbidity breakthrough, filter production, filtration rate, filter run length.
6. Explain the filter backwashing: process description, surface washing, underdrain systems.
7. Safely operate, maintain and troubleshoot a filtration system.
8. Recognise factors that indicate the filtration process is not performing properly.

Module 5: Sedimentation

Upon completing of Module 5, participants should be able to:

1. Describe various types of sedimentation basins: tube settlers, plate settlers.
2. Explain the principles of the sedimentation process.
3. Describe the water quality characteristics that impact the efficiency of sedimentation: temperature, wind, BOD, TSS, hydraulic stability.
4. Understand sedimentation basin design: basin configuration, inlet zone, settling zone, sludge zone, outlet zone.
5. Understand the sludge collection and removal: types of collection and removal systems, removal frequency.

Module 6: Disinfection

Upon completing of Module 6, participants should be able to:

1. Describe the purpose and requirements of disinfection.
2. Explain the impacts of water quality on disinfection efficiency.
3. Understand the control methods of DBPs.
4. Chlorination
 - a. Explain the principles of wastewater disinfection with chlorine.
 - b. Control the chlorination process to obtain the desired effluent disinfection.
 - c. Conduct chlorination operation and maintenance.
 - d. Recognise factors that indicate the chlorination process is not performing properly, identify the source of the problem, and take corrective action.
 - e. Determine chlorine dosages and define chlorine breakpoint.
 - f. Understand chlorine chemistry.
 - g. Understand contact time (CT).
 - h. Safely operate and maintain a sulfur dioxide dichlorination system.
5. Ultraviolet (UV)
 - a. Describe the principles of wastewater disinfection using ultraviolet (UV) systems.
 - b. Understand the design of UV system.
 - c. Understand the different UV lamps.
 - d. Understand the different types of UV radiation: UV-A, UV-B, UV-C.
 - e. Understand the impact of wastewater constituents on the use of UV radiation for wastewater disinfection.
 - f. Understand the estimated relative effectiveness of UV radiation for the disinfection of representative microorganisms of concern in wastewater.
 - g. Safely operate, maintain, and troubleshoot ultraviolet (UV) systems.
6. Ozone
 - a. Understand the ozone chemistry.
 - b. Calculate the demand of ozone.

Module 7: Sludge treatment and handling

Upon completing of Module 7, participants should be able to:

1. Explain the purpose and principles of sludge treatment and handling.
2. Describe the source of sludge in the wastewater treatment process.
3. Explain the sludge thickening process: gravity and flotation thickening.
4. Explain the sludge dewatering process: sand drying beds, solar drying beds, vacuum filters, belt filter presses, centrifuges, filter press.
5. Understand the sludge disposal process.
 - a. Explain the criteria and requirements of sludge disposal.
 - b. Classify the sludge: hazardous and non-hazardous.
 - c. Understand various disposal techniques.
6. Safely operate, maintain and troubleshoot the sludge treatment and handling process.

Module 8: Phosphorus Removal

Upon completing of Module 8, participants should be able to:

1. Understand the theory and principles of chemical phosphorus removal.
2. Lime precipitation:
 - a. Understand the process and equipment requirements: lime storage and feeding system, mixing chamber, flocculation chamber, clarifier, recarbonation tank, effluent polishing system, pumps, piping and instrumentation.
 - b. Consider the operational parameters: target pH level, the effectiveness of flocculation, recarbonation control, lime handling safety procedures.
3. Alum flocculation:
 - a. Understand the process and equipment requirements: alum storage and feeding system, effluent treatment.
 - b. Consider the operational parameters: alum handling and safety precautions, alum dosage, target pH level, alum feed system pump and pipe plugging, the effectiveness of flocculation, sludge dewatering and disposal.

Module 9: Metal Removal

Upon completing of Module 9, participants should be able to:

1. Explain the need for metal removal in wastewater treatment.
2. Operate and maintain neutralisation, metal precipitation, cyanide destruction, and complexed metal treatment facilities.
3. Explain the addition of chemicals to neutralise the high pH or low pH wastewater condition.
4. Explain high pH precipitation.
5. Explain the chemical reduction process.
6. Explain the precautions must be taken during cyanide destruction.
7. Describe the limitations of the hydroxide precipitation process.
8. Understand the design for antimony removal, for knowledge test the chemistry of precipitation reactions, membrane separation, adsorption and coagulation/flocculation.
9. Collect, treat and dispose of sludge generated by these treatment processes.
10. Safely operate and troubleshoot treatment facilities.

Module 10: Fenton Reaction

Upon completing of Module 10, participants should be able to:

1. Explain the generation and principle of hydroxyl radicals.
2. Understand the various application of Fenton reaction in wastewater treatment.
3. Explain the reaction kinetics, mechanisms and influencing parameters.
4. Describe the reactor design aspects and optimum parameters: dosage of ferrous sulfate and hydrogen peroxide, pH and initial concentration of pollutants.

Module 11: ZDHC Wastewater Guidelines

Upon completing of Module 11, participants should be able to:

1. Explain the purpose of the ZDHC Programme.
2. Describe the Manufacturing Restrictive Substances List (ZDHC MRSL).
3. Understand the characteristics and composition of textile wastewater.
4. Understand the standards for wastewater effluent set by the ZDHC Programme.

IV. Advanced Biological Treatment**Module 1: Sequencing Batch Reactor (SBR)**

Upon completing of Module 1, participants should be able to:

1. Describe each of the process stages used to treat wastewater in SBR: fill, react, settle, decant, idle.
2. Understand the operating parameters that could affect the treatment efficiencies: phase duration, HRT, SRT, organic loading, temperature, mixed liquor suspended solids (MLSS), mixed liquor volatile suspended solids (MLVSS), dissolved oxygen (DO).
3. Collect and analyze samples and make appropriate process adjustments during start-up and normal operation.
4. Describe the advantages and disadvantages of SBR.
5. Safely operate and maintain a sequencing batch reactor.
6. Review plans and specifications for a sequencing batch reactor.

Module 2: Membrane Bioreactor (MBR)

Upon completing of Module 2, participants should be able to:

1. Describe the MBR wastewater treatment process.
2. Describe the advantages and limitations of MBR systems over conventional biological treatment systems.
3. Explain the biological nutrient removal process.
4. Understand and control the operational parameters: HRT, SRT, aeration rate, temperature, organic loading, flowrate.
5. Safely operate, maintain and troubleshoot an MBR treatment system.
6. Perform calculations relating to MBR process design.
7. Monitor the performance of MBR, including COD, N and P removal, etc.
8. Understand the membrane fouling and cleaning process.

Module 3: Moving Bed BioReactor (MBBR)

Upon completing of Module 3, participants should be able to:

1. Describe the MBR wastewater treatment process.
2. Describe the advantages and limitations of MBBR systems over conventional biological treatment systems.
3. Explain the biological nutrient removal process.

4. Understand and control the operational parameters: HRT, SRT, aeration rate, temperature, organic loading, flowrate.
5. Safely operate, maintain and troubleshoot an MBR treatment system.
6. Perform calculations relating to MBBR process design.
7. Monitor the performance of MBBR, including COD, N and P removal, etc.
8. Understand the membrane fouling and cleaning process.

Module 4: Activated Sludge Process

Following topics are discussed in Module 4:

1. Return Activated Sludge (RAS) Flow Control
 - a. The common RAS flow control strategies: constant rate, the percentage of influent, Sludge Blanket Control, Mass Balance.
 - b. The parameters that must be observed with each strategy.
2. Waste Activated Sludge (WAS) Flow Control
 - a. The common WAS flow control strategies: constant mass (MLSS, MLVSS, MCRT, GSA), Constant F/M, Sludge Quality Control.
 - b. Identify the parameters that must be observed with each strategy.
3. Extended Aeration
 - a. The purpose and principles of extended oxidation.
 - b. The difference between the extended aeration system and the conventional system.
 - c. The key process design parameters: F/M ratio, organic loading (maximum), MLSS, aeration retention time (minimum), solids recycle rate.
 - d. The system configuration of the extended aeration modification: aeration and mixing, settling, the return of activated sludge, solids removal.
 - e. Explain the principle and process of intermittent cycle extended aeration system (ICEAS).
 - f. Explain the principle and process of oxidation ditches.
4. Anoxic/Aerobic
 - a. The representative system – Bardenpho process.
 - b. The purpose and principles of the anoxic stage.
 - c. The purpose and principles of the aerobic stage.

- d. Typical design parameters: temperature, pH and alkalinity, DO, mixing, return activated sludge, internal recycle, HRT (anaerobic zone, anoxic zone, aerobic zone), F/M ratio, organic loading, solids retention time, MLSS.
 - e. Discussion of the system configuration.
 - f. Other configurations: Modified Ludzak Ettinger (MLE), A2/O (anaerobic, anoxic and aerobic), etc.
5. Troubleshooting Problems
 - a. The common problems of the activated sludge systems.
 - b. The causes of slow settling sludge and what tests are useful to determine these causes.
 - c. Sludge bulking, the process conditions associated with this and what remedial actions can be taken to control sludge bulking.
 - d. The chemical additives and settling aids used to control bulking.

Module 5: External Nutrient Dosing

Following topics are discussed in Module 5:

1. Explain the purpose of external nutrient dosing.
2. Explain the causes and effects of nutrients: carbon, nitrogen, phosphorous, sulfur, trace elements.
3. Describe the favorable and unfavorable nutrient ratios for biological wastewater treatment – C:N:P ratio ($BOD_5:TKN:P_{tot}$).
4. Identify the typical measurement locations for monitoring of nutrients in wastewater treatment systems.
5. Calculate the external nutrient requirement.

Module 6: Clarifier

Upon completing of Module 6, participants should be able to:

1. Describe the role and principles of operation of primary clarifier: circular and rectangular clarifiers and their components.
2. Describe the role and principles of operation of secondary clarifier.
3. Describe the common physical observation at clarifier.
4. Determine the clarification process: loadings, surface overflow rate, average detention time, the location of a primary unit, the location of a secondary unit, depth, sludge wasting, settling.

5. Discuss the optimisation of primary and secondary clarification process.
6. Discuss the problems occurring in both primary and secondary clarifiers that can affect the quality of effluent.

Module 7: Sludge digestion and handling

Upon completing of Module 7, participants should be able to:

1. Explain the purpose of sludge digestion.
2. Explain the anaerobic sludge digestion process:
 - a. The fundamentals and principles of anaerobic digestion.
 - b. The key parameters of process design: mean cell-residence time, loading factors, volume reduction, gas production, collection and use, digester mixing, digester heating.
3. Explain the aerobic sludge digestion process:
 - a. The fundamentals and principles of aerobic digestion.
 - b. The key parameters of process design: temperature, solids reduction, oxygen requirements, energy requirements for mixing.
4. Recognise factors that indicate the sludge digestion and solids handling processes are not performing properly.
5. Safely operate, maintain, and troubleshoot the sludge digestion system.

Module 8: Phosphorus Removal

Upon completing of Module 8, participants should be able to:

1. Explain the need for phosphorus removal and describe the advanced biological phosphorous removal.
2. Explain the biology of the phosphorous removal: metabolism of PAO.
3. Understand the removal process and equipment requirements: aerobic reactor, sedimentation tank, anaerobic selector/stripper.
4. Consider the operational parameters:
 - a. Anaerobic selector cell residence time.
 - b. Maintenance of anaerobic conditions in the anaerobic selector.
 - c. Maintaining sufficient dissolved oxygen in the aerobic reactor.
 - d. Considerations associated with the chemical phosphorus removal system.
5. Sample influent and effluent, interpret lab results and make appropriate adjustments in the treatment process.

6. Recognise abnormal operating conditions, understand the cause, and take corrective action to ensure proper phosphorus removal.
7. Measure and monitor the system performance.
8. Review plans and specifications for a phosphorus removal system.

Module 9: Nitrogen Removal

Upon completing of Module 9, participants should be able to:

1. Explain the purpose of nitrogen removal in wastewater treatment.
 - a. Identify the types of nitrogen removal systems.
 - b. Explain the purpose and process of nitrification.
 - c. Explain the purpose and process of denitrification.
 - d. Explain the difference between suspended and attached growth reactors.
 - e. Consider the operational parameters: retention time, food to microorganism ratio (F/M), mean cell residence time (MCRT), alkalinity, temperature, pH, etc.

V. Advanced Treatment Topics

Module 1: Bench Testing

Upon completing of Module 1, participants should be able to:

1. Understand the purpose of performing a bench test.
2. Consider the alternatives and technologies, including where they have been used and the performance at those locations.
3. Design data sheets of the actual processes proposed for the bench test.
4. Consider the sampling frequency and Analyze the specific operational and performance characteristics.
5. Estimate costs for all of the alternatives/technologies identified.

Module 2: Membrane Systems (MF, UF, NF, RO)

Following topics are discussed in Module 2:

1. Membrane system overview: historical perspective current and emerging technologies, and applications.
2. Understand how to properly apply MF, UF, NF, and RO in a wastewater treatment system.

3. UF/MF membranes: options, hydrophobicity and hydrophilicity, pore size, diameter, temperature and pressure.
4. Nanofiltration and Reverse Osmosis: the overview of NF and RO, NF/RO units and pre-treatment, typical process flows.
5. Modules: submerged and pressurised, outside-in v inside-out, horizontal v vertical.
6. Operation: dead-end and crossflow, water flux, CIP, CEB, MIT, scouring and fouling.
7. System operation: normal service, CIP and MW, P&ID tracing.
8. Monitoring and Control: TMP, pressure, resistance, permeability.
9. Backwash and Maintenance: procedure, performance trends.
10. Monitoring Performance, operational troubleshooting, and root cause analysis: TMP, sustainable flux, permeability, resistance, testing, calibration, verification.
11. Membrane integrity: air hold test, pinning and repair, loading and unloading.
12. Design and design software.

Module 3: Advanced Oxidation Process

Following topics are discussed in Module 3:

1. Background and fundamentals of advanced oxidation processes.
 - a. The generation and role of hydroxyl.
 - b. Reaction mechanisms and rate law.
 - c. Application of AOPs for water and wastewater treatment.
 - d. Affecting factors: carbonate species, pH, NOM, reduced metal ions.
 - e. Byproducts of AOPs.
 - f. Opportunities and limitations of AOPs.
2. UV irradiation
 - a. UV sources and their characteristics.
 - b. UV light based AOPs for water treatment.
3. Ozonation
 - a. Fundamentals, background, reaction kinetics and mechanisms of ozonation.
 - b. Application of homogeneous and heterogeneous catalytic ozonation in water treatment.
4. Fenton reaction
 - a. Reaction kinetics, mechanisms and influencing parameters.
 - b. Alternative catalysts for Fenton reaction.
5. Combined application: H₂O₂/O₃ process, H₂O₂/UV process, O₃/UV process.

Module 4: Odor Control

Upon completing of Module 4, participants should be able to:

1. Determine the source and cause of odours.
2. Review the different types of odour control (chemical scrubber, biological scrubber, etc.), and the operation of each type.
3. Understand the operational change: aeration rate, overloading, solid inventory, the frequency of pumping of sludge.
4. Understand the control of discharge to the collection system.
5. Understand the control of odour in the liquid phase.
6. Understand the control of odorous gases.

Module 5: Zero Liquid Discharge

Following topics are discussed in Module 5:

1. Overview of ZLD system.
2. The rationale of identifying treatment processes toward ZLD.
3. Unit operations and design of ZLD system.
 - a. Brine concentrate operation: evaporator.
 - b. Crystallizer operation.
 - c. Filter press operation.
4. Choose suitable technologies to achieve ZLD in existing facilities.
5. Understand the opportunity to recover value from ZLD sludges.

Module 6: Wastewater Recycling and Reuse Systems

Upon completing of Module 6, participants should be able to:

1. Describe the scope and demands of wastewater recycling.
 - a. Understand the types and stages of wastewater recycling.
 - b. Understand recycling requirements and designated recycle criteria.
 - c. Understand the centralised v decentralised recycling system.
 - d. Describe the methods of wastewater reuse.
 - e. Develop operational strategies for wastewater reuse facilities.
 - f. Safely operate and maintain a wastewater reuse facility.
 - g. Monitor a wastewater recycle and reuse programme and make appropriate adjustments in treatment processes.

APPENDIX D

Professional Development Hours (PDHs)

A Professional Development Hour (PDH) is defined as one contact hour of instruction, presentation or study in a planned education experience that is relevant to one's profession or discipline. For example, the maximum PDHs for a seminar that starts at 8 am and ends at 5 pm with one hour for lunch is eight (8) since the lunch hour is not considered a contact hour.

The intent of requiring professional development hours is to encourage continuing education to ensure the wastewater treatment operators stay current on latest technologies and approaches. At least 60 percent of an individual's professional development hours must be directly related to a technical topic associated with wastewater treatment. The balance of professional development hours must be directly related to structured problem solving and root cause analysis.

Supporting documentation to verify the PDH units recorded on the Professional Development Hour Tracking Form (Appendix E) must be provided when requested for audit purposes.

Supporting documentation may include, but is not limited to:

- Completion certificate(s)
- Paid receipt(s)
- Attendance log(s)
- Other documents supporting evidence of attendance

The conversion of other units of credit to PDH units is as follows:

- 1 College Semester hour equals 45 PDH;
- 1 College Quarter hour equals 30 PDH;
- 1 Continuing Education unit equals 10 PDH.

Professional development hours may be acquired through many different means and methods, including:

- Successful completion of college courses;
- Successful completion of short courses, tutorials, correspondence, web-based courses, televised and videotaped courses;
- Active participation in seminars, in-house courses, workshops, and professional conventions;

- Teaching or instructing a course, seminar, or workshop one time only. (This does not apply to full-time faculty teaching college courses);
- Authoring or co-authoring published papers, articles, or books. Maximum of 10 PDH units per each renewal period
- Active participation in professional or technical society, committee, or board. Maximum of 8 PDH units per each renewal period
- Self-study. Maximum of 6 PDH units per each renewal period
- Mentoring of wastewater treatment topics to an individual not under your supervision who is not yet a qualified wastewater treatment operator. Maximum of 10 PDH units per each renewal period
- Non-technical educational activities related to the registrant's employment (studies on root cause analysis, structured problem solving, and similar topics)

Activities that are not eligible for PDHs are as follows:

- Regular employment
- Real estate licensing courses
- Personal, estate, or financial planning
- Personal self-improvement
- Service club meetings or activities
- Equipment demonstrations or trade show displays
- Topics not relevant to wastewater treatment
- Enrolment without attendance at courses, seminars, etc.
- Repetitive attendance at the same course
- Repetitive teaching of the same course
- Attending committee meetings or general business meetings of any organisation
- Taking professional or required knowledge tests

APPENDIX E

Tracking of Professional Development Hours (PDHs)

Operator Name	John Smith	Professional Development Hour Tracking Form			
Operator ZDHC ID Number	JJ8675309	Each Operator Is Responsible for Maintaining Records of Training for Future Audits			
Qualification Level	4A				
Date of Activity (mm/dd/yyyy)	Organizer/ Location of Activity	Description/ Topic of Activity	Type of Activity	PDHs Earned	
02/01/2020	Ho Chi Minh University of Technology	Project - Wastewater Treatment Engineering	Intact Class and Laboratory	15	
09/03/2020	Water Environment Federation (WEF)	Wastewater Treatment Fundamentals I (Liquid Treatment)	Self-Study	6	
05/04/2020	Sacramento State University Office of Water Programs	Secondary Treatment	On-Line Class with Exam	36	
Total PDH Units for Renewal Period		Carryover PDHs from Previous Renewal Period		Total Number PDHs for Qualification Renewal	
From (mm/dd/yyyy)	To (mm/dd/yyyy)	From (mm/dd/yyyy)	To (mm/dd/yyyy)		
01/05/2020	01/05/2022	01/05/2018	01/05/2020		
57		0		57	