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CWEA TECHNICAL CERTIFICATION PROGRAM

Laboratory Analyst **Candidate Handbook**

LAB CERTIFICATION

v05.01.23.02

Laboratory Analyst **Candidate Handbook**

Version 05.01.23.02

Congratulations on pursuing certification. Certification is a great way to demonstrate competency, show commitment to the profession, and help with job advancement.

This handbook contains information about California Water Environment Association's Technical Certification Program for certification candidates. Please read this entire handbook to become familiar with CWEA's certification policies and procedures. Certification candidates are responsible for knowing the contents of this handbook. Please contact the CWEA office at (510) 382-7800 with any questions.

All policies are subject to change. The most recent edition of this handbook can be downloaded for free on Cert.CWEA.org. Candidates should ensure that they have the most current version as indicated by the date in the title above.

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INTRODUCTION TO THE TECHNICAL CERTIFICATION PROGRAM

CWEA's Technical Certification Program (TCP) develops and administers competency-based certification exams for wastewater professionals in a number of different vocations. The certification program was founded in 1937. The first certification offered was the Wastewater Treatment Plant Operator certification, which was later adopted by the State Water Board. The exams are developed and revised by CWEA Subject Matter Experts under the guidance of exam development professionals. The certifications continue to grow and be refined in accordance with water sector and certification professional practices. Exams are offered throughout the year and are experience based, ranging from entry level to upper management.

CWEA currently certifies over 7,000 individuals. Certification is a great way to demonstrate competency, show commitment to the water profession, and help with job advancement.

TECHNICAL CERTIFICATION PROGRAM

Executive Committee

The Technical Certification Program Executive Committee is the governing body of CWEA's certification program. It was created to develop and implement a multilevel technical certification program for individuals employed in the wastewater field. They are responsible for the development and administration of the Technical Certification Program, including the application, examination development, examination administration, and certification renewal process. They develop the guidelines, criteria, and testing procedures that are responsive to the needs of the water quality industry and allow participants to demonstrate technical competence. They are also responsible for maintaining the quality of the examinations through continuous upgrading and review.

For current Committee members, contact the CWEA office.

Overview of the Certification Process

To become certified all applicants must complete the following requirements:

1. Submit an application
2. Pay the application fee
3. Meet the minimum qualifications regarding professional experience
4. Pass the exam

Once an applicant successfully completes the requirements, they will be mailed their certificate. In order to maintain the certification once earned, certified individuals must continue to meet the following recertification requirements:

1. Submit 12 contact hours of continuing education every two years
2. Pay the annual renewal fee

Certifications Offered by CWEA

- Collection Systems Maintenance, Grades 1-4
- Mechanical Technologist, Grades 1-4
- Electrical & Instrumentation, Grades 1-4
- Laboratory Analyst, Grades 1-4
- Environmental Compliance Inspector, Grades 1-4
- Advanced Water Treatment Operator, Grades 3-5
    - Offered in partnership with California-Nevada Section of the American Water Works Association. For more information visit www.AWTOperator.org.

Please note that the **Wastewater Treatment Plant Operator Certification** and **Drinking Water Treatment Plant Operator Certification** are administered by the State of California. To work on a drinking water treatment system, distribution system or in a wastewater treatment plant, an individual must have a valid operator certificate or an operator-in-training certificate from the State Water Board. For information about these programs, please contact the State Water Board Office of Operator Certification.

APPLICATION PROCESS

Submitting an Application

Candidates must submit an application and be approved before they can schedule an exam. Applications can be faxed, emailed or mailed to the CWEA office at any time throughout the year. Applications are reviewed by CWEA TCP Staff and/or Subject Matter Experts. Once the application is processed, candidates are notified of their approval status via email. Please follow all instructions on the application carefully. Incomplete applications may delay approval. The application is available on the Cert.CWEA.org website.

Application Deadlines and Exam Windows

The year is divided into four exam windows, each with an application deadline. Applications are valid for one year from the first date of the applicant's original exam window. Applicants may transfer exam windows throughout the year, for details see *Transferring Exam Windows* (p. 17).

Exam Windows	Exam Dates	Application Deadlines
FALL	October 1st – December 31st	August 31st
WINTER	January 1st – March 31st	November 30th
SPRING	April 1st – June 30th	February 28th
SUMMER	July 1st – September 30th	May 31st

CWEA Application Fees

Current fees are listed on the application. Valid CWEA members qualify for a discounted member rate. The non-member rate includes a one-year CWEA membership. If an applicant does not wish to take advantage of the membership, they must note it on the application.

Minimum Qualifications: Qualifying Education and Experience

Applicants must meet the minimum qualifications for the exam at the time the application is submitted. The table below gives the combinations of education and/or experience that will satisfy the requirements. There is no education or experience requirement to take any Grade 1 exam, however, the Grade 1 exams test at the level of one year of experience in the field. Education and experience should be relevant to the vocation and reflect the job knowledge for that grade level. Relevancy is at the sole discretion of CWEA. Applicant's experience must be indicated on the application under "Job Duties." Applicants should provide sufficient detail to demonstrate they possess the relevant experience. The best way to provide this information is to include the official job description for the position. Applicants consent to a thorough investigation of employment records and other qualifications in related activities for the purpose of verification of qualifications. CWEA may verify job history by contacting employers.

LAB Certification Minimum Qualifications Chart

GRADE 1	▪ No experience required ▪ (1 year of experience in the vocation is recommended)
GRADE 2	▪ 2 years of experience in the vocation
GRADE 3	▪ LAB Grade 2 certification in good standing ▪ 4 years of experience in the vocation OR 3 years with any of the following: – bachelor's degree in a related field – associate degree in a related field
GRADE 4	▪ LAB Grade 3 certification in good standing ▪ 6 years of experience in the vocation OR 5 years with any of the following: – bachelor's degree in a related field – associate degree in a related field ▪ 1 year of experience supervising others in a related field

***Laboratory Analyst experience in the wastewater or water treatment industry are both considered acceptable forms of experience.**

***Related laboratory experience from Environmental Laboratories or TNI-accredited laboratories may count for up to 100% of experience. Related experience from non-Environmental laboratories may count for up to 50% of experience.**

Acceptable Degrees for LAB Certification Application

Bachelor's Degrees

- Chemistry
- Biology
- Environmental Science (with laboratory coursework)
- Agriculture
- Microbiology
- Zoology
- Biotechnology
- Biochemistry
- Chemical Engineering
- Environmental Engineering (with laboratory coursework)
- Oceanography
- Marine Biology
- Forensic Science
- Geology
- Hydrology
- Environmental Toxicology

Associate Degrees

- Chemistry
- Biology
- Microbiology
- Forensic Science
- Water / Wastewater (with laboratory coursework)

***Related degrees that are not listed may be submitted for consideration.**

Application Approval

Once an application has been approved, the applicant will receive a Certification Application Approval Notification via email. It is very important that applicants use a current email address when filling out the application. CWEA will only contact applicants in regard to their application status via email. The Certification Application Approval Notification will contain the certification exam the applicant has been approved for, the exam window and CWEA ID number. This ID number is needed when contacting Pearson VUE to schedule an exam appointment.

Rejected Application

Applications will be rejected if applicants do not meet all requirements at the time they apply. CWEA will refund the application fee minus a $50 admin fee. Refunds are automatically issued within two weeks of rejection to the original form of payment. Candidates may request that their rejected application be reviewed by the Technical Certification Program Executive Committee by submitting a request in writing to tcpcommittee@cwea.org.

Code of Ethics

All CWEA certification holders and applicants are expected to meet the following standards of professional conduct and ethics:

1. To protect public health, themselves, their co-workers, property, and the environment by performing the essential duties of the CWEA certified vocation safely and effectively, and complying with all applicable federal, state and local regulations.
2. To represent themselves truthfully and honestly throughout the entire certification process.
3. To adhere to all test site rules and make no attempt to complete the test dishonestly or to assist any other person in doing so.
4. To refrain from activities that may jeopardize the integrity of the Technical Certification Program.

The CWEA Code of Ethics establishes basic values and standards of conduct for certification applicants and certification holders. Any action of a certification holder or applicant that compromises the reliability of the certification process may be subject to the process described by the Ethics Procedures.

The Ethics Procedures provide a fair process for dealing with ethics complaints. The procedures define the participants in an ethics case and how each case will be handled. Individuals going through the process will be given opportunities to defend themselves and appeal any decisions made. The Ethics Officer handles all official ethics complaints and determines if there is enough merit in each case to follow through with the procedures. If appropriate, the Ethics Officer may suggest mediation to resolve ethics disputes without the formality of going through the entire procedural process. This information is paraphrased for clarity from the 05-01 CWEA Code of Ethics and Ethics Procedures.

A full copy of the policy can be requested by contacting the TCP department.

Some examples of violations would be:

- Providing false work history on an application
- Using prohibited reference materials during a test
- Taking test materials from a test site
- Falsifying documentation of continuing education contact hours

Any action that might undermine CWEA's process of certifying basic minimal competency will be investigated.

Non-Discrimination Policy

CWEA does not discriminate among applicants on the basis of age, gender, race, religion, national origin, disability, sexual orientation or marital status.

Accommodations

In compliance with the Americans with Disabilities Act, reasonable accommodations will be provided for those individuals who provide CWEA with a physician's certificate, or its equivalent, documenting a physical or psychological disability that may affect the individual's ability to successfully complete the certification examination. Written requests for reasonable accommodations must be submitted with the application.

Language barriers and lack of familiarity with computers are not covered under ADA laws.

Privacy

CWEA is committed to protecting privacy. Exam results and any other information regarding an application are confidential and will only be released to the applicant. Basic certification information is available on our Certification Registry. Employers can use the registry to verify an individual's certification status.

Out-of-State Programs

Anyone anywhere in the United States can apply for CWEA certification. Our certifications are specific to the state of California.

CWEA partners with the following water environment associations to administer certification exams for their members:

- Hawaii Water Environment Association
- Michigan Water Environment Association

Candidates wishing to earn certification through one of those associations should be sure to use the correct application that is specific to that association.

Reciprocity

CWEA does not grant certification by reciprocity. For other certification programs that do offer reciprocity, CWEA will provide any information necessary for verification upon request.

SCHEDULING AN EXAM

Scheduling an Exam Appointment

Once an applicant receives the approval notification email, they will be eligible to schedule an exam appointment. Applicants can schedule an exam appointment through Pearson VUE's website by creating an account or by logging into an existing account. The applicant's CWEA ID number is needed when creating an account. The CWEA ID number can be found in the approval notification email. To schedule an appointment over the phone, call Pearson VUE at

888-749-3881. Test centers are conveniently located throughout the U.S. Locations can be found on Pearson VUE's Test Center Search.

Online Proctored Exams

Online proctoring is available for CWEA exams. If available, candidates will be notified in their approval email of the option to schedule their exam online versus at an in-person test center. Candidates should examine both options before making the choice that is best for them. Candidates will make their selection at the time when they schedule their exam.

Online proctored exams are a convenient way to take an exam at home or at work. Candidates will complete a check in process and are monitored online by a live proctor. **An onscreen calculator and white board are provided, no physical calculators or scratch paper are allowed.**

For more information about the online proctored experience, please see: https://home.pearsonvue.com/cwea/onvue. Please review the system requirements and Pearson Vue policies and procedures for online proctored exams before you schedule your appointment. You will be required to accept and comply with these policies.

To take an online proctored exam, candidates must meet the system requirements. If a candidate is testing at work, they should check with their Network Administrator or IT Professional that their system meets the requirements.

It is the candidate's responsibility to ensure they meet the system requirements prior to their appointment time. If a candidate does not meet the system requirements, they will not be able to complete their exam and will need to reschedule.

Canceling an Existing Appointment

To cancel an appointment, applicants must notify Pearson VUE 24 hours before their scheduled appointment time. Failure to notify Pearson VUE at least 24 hours before the existing appointment will result in an $85 No Show fee. Pearson VUE will send applicants a Cancellation Confirmation to the email on file in their Pearson VUE account.

The following are considered No Shows and will result in an $85 No Show fee:

- Failing to appear at a scheduled test appointment
- Failing to check-in for an online appointment
- Arriving at the test center without a current, government-issued photo ID
- Arriving at the test center 15 minutes or later to a scheduled test appointment

Applicants must pay the No Show fee to schedule a new test appointment. Applicants should contact the CWEA office to reschedule.

Rescheduling an Exam Appointment

To reschedule an existing appointment within the same exam window, applicants must call Pearson VUE directly at least 24 hours before their existing exam appointment, for details see *Canceling an Existing Appointment* (p. 16).

Applicants must contact the CWEA office to reschedule (transfer) an existing exam appointment to a different exam window. Before contacting CWEA, the applicant must cancel their existing appointment.

Transferring Exam Windows

Applications are valid for one year from the first date of the applicant's original test window. Applicants may transfer exam windows throughout the year. The first transfer is complimentary, subsequent transfers are $50.

Applicants can request a transfer at any time. If an applicant does not test by the last date of their original exam window, CWEA will automatically initiate a transfer and the applicant will be notified via email.

PREPARING FOR THE EXAM

Laboratory Analyst Certification Scope

Specifications	Grade 1	Grade 2	Grade 3	Grade 4
Brief description of the Grade Level in relation to the job family.	Entry and basic working level.	Skilled or journey level.	Lead/advanced technical level.	Program manager level.
Level of knowledge, skill and ability within the job family, in relation to job tasks, including the taxonomic level of knowledge applied on the job.	Basic knowledge and ability, as needed to safely and effectively perform basic tasks. This includes: recall and recognition, comprehension, and application.	Knowledge and ability to safely and effectively accomplish most technical tasks in the job family. This includes: comprehension, application, and analysis.	Knowledge, skill and ability to safely and effectively accomplish and coordinate complex tasks. This includes: application, analysis and synthesis.	Knowledge, skill and ability to administer, coordinate and manage complex programs across vocations. This includes: analysis, synthesis, and evaluation.
Level of supervision received.	Receives direct supervision.	Receives limited supervision.	Receives general direction.	May receive broad direction.
Level of supervision exercised.	None.	May provide technical direction over other staff.	Will oversee and direct complex tasks performed by others.	Will coordinate program activities within or across vocations.
Level of training provided to other personnel.	None.	May train lower level personnel.	May oversee a training program.	Designs and administers training programs within the job family.
Use of tools.	Will recognize the basic tools of the job family.	Will be able to apply most of the tools used by those in the job family.	Will select tools for individuals and teams in relation to specific problems.	Manages and evaluates systems and facilities.

Specifications	Grade 1	Grade 2	Grade 3	Grade 4
Problem solving and troubleshooting responsibilities.	Follows directions.	Troubleshoots and solves common problems without supervision.	Troubleshoots and solves complex problems.	Evaluates program effectiveness and takes corrective actions as needed.
Actions in relation to safety problems.	Recognizes unsafe conditions.	Recognizes and corrects unsafe conditions.	Anticipates and prevents unsafe conditions.	Designs and administers safety programs.
Actions in relation to standard operating procedures (S.O.P.s), laws and regulations.	Has the ability to follow S.O.P.s.	May assist in formulating and revising S.O.P.s.	May oversee and formulates new S.O.P.s and ensure regulatory compliance.	Assures program compliance with laws and regulations.
Actions in relation to documentation of work activities.	Accurately completes records of work processes.	Accurately completes records of work processes and performs peer review of records.	Conducts audits of records of work processes for completeness, accuracy, and compliance, and recommends or takes necessary corrective action.	Responsible for quality assurance of program documentation, including management review and internal audits.

Exam Content

CWEA's Technical Certification Program Laboratory Analyst exams are based on exam blueprints that outline the exam content and are periodically reviewed by CWEA Subject Matter Experts. An exam blueprint is based on a job task analysis that includes research of the essential duties of a Laboratory Analyst at a representative cross-section of systems and facilities in California. The Laboratory Analyst Certifications were last reviewed by Subject Matter Experts in 2023.

The exam content outlines that follows presents content covered on the Laboratory Analyst exams and shows the amount of the exam devoted to each Domain in the column labeled weighting.

LAB GRADE 1 EXAM CONTENT OUTLINE

Content Domain	Weighting
Domain 1 – Sample Collection, Testing, and Analysis	34%
Domain 2 – Documentation, Quality Assurance/Control, and Ethics	24%
Domain 3 – Laboratory Equipment, Supplies, and Facilities	18%
Domain 4 – Safety	12%
Domain 5 – Math	12%
Total	100%

Domain 1: Sample Collection, Testing, and Analysis

Sub-Domain 1.1:

Basic Water and Wastewater Laboratory Knowledge

1. Basic knowledge of organic and inorganic chemistry and microbiology as applied in a water or wastewater treatment laboratory
2. Understand the basic physical properties of water and wastewater, and analytical methods to determine: color, turbidity, odor, alkalinity, hardness, conductivity, solids, temperature, pH, ammonia, anions
3. Understand the basic chemical properties of water and wastewater and analytical methods to determine: dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, chlorine residual (total and free)
4. Understand the microbiological properties and methods for analysis of water and wastewater, such as: Coliform by multiple tube fermentation, Colilert knowledge for drinking water, Heterotrophic plate count (HPC), Enterococcus analysis
5. Understand general microbiological concepts such as sterilization or aseptic technique, media preparation, different types of microorganisms
6. Understand basic water and wastewater treatment processes

7. Understand sample collection procedures
8. Understand quality control terms and procedures, such as: method blanks, laboratory control samples, matrix spikes, sample replicates and duplicates, positive and negative controls, and count verifications

Sub-Domain 1.2:

Testing

1. Perform a variety of routine chemical, physical, and biological/microbiological tests of water, wastewater, solids, and soils in order to optimize treatment processes and ensure that plant processes meet regulatory requirements and process control requirements (e.g., National Pollutant Discharge Elimination System (NPDES) discharge permit standards, State and Federal health requirements for drinking water)
2. Perform analytical tests and observations necessary to monitor the treatment process, including relating data to the plant operation
3. Perform testing required for regulatory compliance and process control in accordance with laboratory standard operating procedures (SOPs), and produce work with precision and accuracy within SOP acceptance criteria

Sub-Domain 1.3:

Analysis and Interpretation of Test Results and Data

1. Analyze wastewater and drinking water samples using a variety of chemistry wastewater and drinking water methodologies and instrumentation, such as:
   - Basic wet chemistry methods
   - Solids analysis
   - Chemical Oxygen Demand (COD)
   - Ammonia
   - Anions
   - Selective ion electrodes
   - pH
   - Alkalinity
   - Chlorine residual
   - Turbidity
   - Volatile acids
2. Demonstrate basic knowledge of biological, microbiological, and bioassay wastewater and drinking water analytical methodologies, including:
   - Chronic and Acute Bioassays using live organisms (e.g., Ceriodaphnia dubia, various vertebrates)
   - Total and Fecal Coliform tests
   - Microbiological tests
   - Identification of microbial organisms

3. Determine dissolved oxygen using a dissolved oxygen probe to determine biochemical oxygen demand
4. Determine chlorine residual using a colorimeter and titration
5. Knowledge of sound analytical techniques and principles of analytical chemistry and microbiology

Sub-Domain 1.4:

Sample Collection

1. Knowledge of water and wastewater sample collection and disposal procedures
2. Collect water and wastewater samples from various locations in accordance with established laboratory procedures, including:
   - Chain of custody
   - Sample type (grab and composite)
   - Container type and preparation
   - Preservation
   - Hold time
   - Sampling techniques
   - Proper labeling
   - Storage condition
3. Understand 24-hour sampling and operation of an autosampler
4. Knowledge of appropriate use of glass and plastic containers, including preservation and washing methods

Domain 2: Documentation, Quality Assurance/Control, and Ethics

Sub-Domain 2.1:

Records, Reporting, and Documentation

1. Review and follow standard operating procedures (SOPs) and recommend modifications when appropriate
2. Enter, maintain, and review data in the Laboratory Information Management System (LIMS)/electronic database to ensure accuracy
3. Enter, review, and maintain bench records of all work performed, including for sampling, analysis procedures, and results
4. Conduct and maintain records of results for quality control performed on media, standardized solutions, and reagents for microbiological, toxicity, and chemical analyses
5. Provide technical support to lab management in the development of sampling programs and analytical techniques, and contribute feedback and suggestions to lab management as appropriate
6. Prepare accurate reports of test results and statistical analyses

7. Document and maintain accurate and complete laboratory records such as: routine documentation including worksheet/log sheet entries, sample documentation, and chain-of-custody
8. Demonstrate basic knowledge of state and federal laws and regulations applicable to the work (e.g., Safe Drinking Water Act, National Pollutant Discharge Elimination System requirements, 40 CFR 136)

Sub-Domain 2.2:

Quality Assurance and Quality Control

1. Review and follow the Laboratory Quality Assurance Manual (QAM) and any quality assurance/quality control program criteria that the quality assurance program may require
2. Conduct regular Method Detection Limit (MDL) Studies, Initial Demonstration of Capability (IDOC), and Ongoing Demonstration of Capability (ODOC) as required
3. Communicate quality assurance concerns and exceedances, and document required corrective and preventive action steps taken
4. Understand measurement traceability

Sub-Domain 2.3:

Ethics

1. Understand and practice proper laboratory ethics
2. Report unethical behavior/practices such as improper data manipulations, adjustments of instrument time clocks, and inappropriate changes in concentrations of standards
3. Understand direct chain of command
4. Knowledge of the consequences of unethical behavior
5. Knowledge of data integrity and legal defensibility

Domain 3: Laboratory Equipment, Supplies, and Facilities

Sub-Domain 3.1:

Operation, Maintenance, and Repair of Laboratory Equipment and Facilities

1. Perform routine and preventative maintenance and cleaning of lab equipment, fixtures, samplers, and glassware according to laboratory procedures
2. Prepare, calibrate, standardize, and operate a variety of laboratory and operations equipment and instruments, such as:
   - Turbidity meters/turbidimeters
   - Dissolved oxygen meters
   - pH meters
   - Balances (analytical and top-loading)

- Conductivity meters
- UV-VIS spectrophotometers
- Gravimetrics equipment
- Columetric equipment
- Sterilization equipment
- Colorimeters
- Thermometers

3. Perform general laboratory housekeeping including cleaning

Sub-Domain 3.2:

Preparing Solutions and Performing Dilution

1. Prepare standard chemical solutions, reagents, stains, and media
2. Understand how to make a dilution series and perform dilution of concentrated solutions
3. Prepare filters and dishes for residue testing
4. Knowledge of glass fiber filters, crucibles, sterilizations, and buffering solutions

Sub-Domain 3.3:

Inventory and Ordering Supplies

1. Assist in inventory control of supplies and chemicals
2. Order laboratory supplies and document receipt
3. Properly store chemicals and supplies, and track their expiration dates

Domain 4: Safety

Sub-Domain 4.1:

Laboratory Safety

1. Recognize, correct, and report laboratory hazards and ensure work is performed in a safe manner consistent with safety policies and procedures
2. Understand chemical handling and hygiene, storage, disposal, and spill response
3. Understand engineering controls (fume hoods, etc.)
4. Understand physical hazards (burns, sharps, compressed gas, electrical safety, fire, etc.)
5. Knowledge of safety regarding handling and disposal of acids, bases, and solvents
6. Knowledge of safety regarding inhalation hazards
7. Knowledge of the purpose and use of Personal Protective Equipment (PPE) and safety measures such as face shields, gloves, and emergency showers
8. Review and follow the Laboratory Chemical Hygiene Plan (CHP)

9. Assist in maintaining the laboratory safety data sheet (SDS) records; understand each section of SDSs and their relation to lab safety and right-to-know law
10. Demonstrate safe practices when collecting field samples

Domain 5: Math

Sub-Domain 5.1:

Math

1. Calculate test results (e.g., alkalinity, hardness, solids) according to industry standards and method requirements
2. Perform unit conversions utilizing dimensional analysis
3. Perform basic algebra (e.g., solve for an unknown)
4. Demonstrate a basic understanding of statistics, including standard deviations, mean, median, and mode
5. Calculate concentrations from a dilution series
6. Demonstrate knowledge of scientific notation
7. Demonstrate a basic understanding of how to calculate solution concentrations using concepts such as molarity and normality
8. Understand significant figures and proper rounding
9. Calculate percent recovery, relative percent difference (RPD), expected recoveries, and geometric mean

Suggested References

CWEA's exam is based on a job task analysis that includes research of the essential duties of a Laboratory Analyst at a representative cross-section of systems and facilities in California. CWEA's exams do not correspond directly to any specific textbook, educational course, or program; instead, the exams are based on an analysis of the duties commonly performed in actual practice. In developing the exam, CWEA Subject Matter Experts used their years of experience in the field along with the key textbooks and reference materials listed below. Candidates should understand that the references listed do not necessarily cover all exam content. Candidates who meet the minimum qualifications for this exam may find these suggested references useful when preparing for this exam; however, these suggested references are not required reading and should not be interpreted as constituting the sole source of all exam questions.

This list does not include all the available textbooks and materials for studying for this exam. Candidates are strongly encouraged to seek additional material, training, and experience, especially in content areas for which the candidate is not adequately prepared. Candidates are encouraged to prepare for CWEA certification exams using as many different study materials as possible plus education events and on-the-job training. Candidates are encouraged to develop their own personal study plan based on individual needs and knowledge.

Domain 1 – Sample Collection, Testing, & Analysis	
Sub-Domain 1.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-550, 557-629 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 759-935 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Sections 1020, 1030, 2130, 2150, 2160, 2320, 4500, 4500-CL, 4500-H+, 4500 NH3, 5210, 5220, 5310, 5520, 9010, 9020, 9030, 9040, 9050, 9060, 9215, 9221, 9223.
Sub-Domain 1.2	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 557-629 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-935 NPDES Permit Basics
Sub-Domain 1.3	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 557-629, 691-719

	Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-935, 1001-1031
Sub-Domain 1.4	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 619-629 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 814-828
Domain 2 – Documentation, Quality Assurance/Control, and Ethics	
Sub-Domain 2.1	Water Treatment Plant Operation Volume 1, 7th Edition. Pages 43, 534-628, 548 Operation of Water Treatment Plants, Volume 2, 8th Edition. Pages 717-721 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 454-458 Utility Management, 3rd Edition. Pages 36-40 Manage for Success, 1st Edition. Pages 253-279 Contaminants in Drinking Water
Sub-Domain 2.2	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-538, 549 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 760-762
Sub-Domain 2.3	
Domain 3 – Laboratory Equipment, Supplies, & Facilities	
Sub-Domain 3.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-550, 538-544 Operation of Wastewater Treatment Plants Volume 1, 8th Edition. Pages 775-814 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 716-721 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 458-477 Utility Management, 3rd Edition. Pages 95-115 Manage for Success, 1st Edition. Pages 253-279, 307-357

Sub-Domain 3.2	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 557-629, 634-752, 545-548 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-814, 944-1030
Sub-Domain 3.3	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-538, Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 718-720 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-814 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 456-457 Utility Management, 3rd Edition. Pages 36-40, 95-113 Manage for Success, 1st Edition. Pages 307-357
Domain 4 – Safety	
Sub-Domain 4.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 550-557 Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 690-718 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 762-775 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 488-499 Utility Management, 3rd Edition. Pages 50-61 Manage for Success, 1st Edition. Pages 357-385 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Sections 1090, 1090 J, 1100C
Domain 5 – Math	
Sub-Domain 5.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 634-752, 691-720 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 944-1030, 1001-1030 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Sections 1010, 1020, 1050, 2320, 2340, 2540,

Suggested References List

- Contaminants in Drinking Water
- Manage for Success, Effective Utility Leadership Practices, 1st Edition. Office of Water Programs
- NPDES Permit Basics
- Operation of Wastewater Treatment Plants, Volume 1, 8th Edition, Office of Water Programs
- Operation of Wastewater Treatment Plants, Volume 2, 8th Edition, Office of Water Programs
- Operation of Wastewater Treatment Plants, Volume 3, 1st Edition, Office of Water Programs
- Standard Methods for the Examination of Water and Wastewater, 23rd Edition.
- Utility Management, A Field Study Training Program, 3rd Edition. Office of Water Programs
- Water Treatment Plant Operations, Volume 1, 7th Edition, Office of Water Programs
- Water Treatment Plant Operations, Volume 2, 7th Edition, Office of Water Programs

Sample Questions

This section provides sample questions to help applicants become familiar with the exam format and subject matter.

1. Sampling protocol for chloride includes:
    a. glass or plastic container preserved with sodium thiosulfate.
    b. plastic container preserved with sulfuric acid.
    c. glass or plastic container with no preservative.
    d. glass or plastic container preserved at 4°C.
2. Precision is measured by:
    a. analyzing replicate samples.
    b. analyzing matrix spiked samples.
    c. calculating standard error.
    d. calculating percent recovery.
3. Laboratory data mistakes may be corrected by:
    a. covering the mistake with white correction fluid, writing over the fluid after it.
    b. erasing the mistake and writing the correct answer again in pencil.
    c. lining out the mistake with pen and writing the correct answer to the side of the first.
    d. lining out the mistake with pen and writing the correct answer to the side of the first, with analyst's initials and date.
4. Laboratory test results for an individual environmental sample within an analytical batch may be rejected when:
    a. extremely high or low concentrations of the analyte are achieved.
    b. the recovery of the laboratory control standard falls outside of the control limits.
    c. the relative standard deviation between the duplicates falls outside the control limits.
    d. a known error has occurred.
5. EPA acceptable primary standards for the turbidity determination include:
    a. formazine and synthetic styrene-divinylbenzene.
    b. formazine only.
    c. synthetic styrene-divinylbenzene only.
    d. formazine, and manufactured gel-filled vials.
6. A pH measurement requires the following:
    a. a voltmeter, glass pH electrode, reference electrode, and a temperature compensating device.
    b. a voltmeter, glass pH electrode, combination electrode, and a temperature compensating device.

c. a voltmeter, combination electrode, reference electrode and a temperature compensating device.
d. a voltmeter, glass pH electrode, reference electrode, and a combination electrode.

7. Standard phenylarsine oxide solution (PAO):
   a. requires only routine lab safety considerations.
   b. should be handled with caution because it is highly corrosive.
   c. should be handled with caution because it is highly acidic.
   d. should be handled with caution because it is a severe poison.
8. Hood flow should be monitored and documented at:
   a. 100 milligrams per liter.
   b. 100 parts per million.
   c. 100 linear feet per minute.
   d. 100 cubic feet per minute.
9. Given the following, find the percent solids and the percent volatile solids of the sample:

   Dish tare weight = 1.38 g
   Dish and wet sample weight = 32.40
   Dish and dry sample weight = 1.86 g
   Dish and ashed weight = 1.56 g

   a. 0.96 percent solids and 62.5 percent volatile solids
   b. 0.96 percent solids and 83.9 percent volatile solids
   c. 1.55 percent solids and 62.5 percent volatile solids
   d. 1.55 percent solids and 83.9 percent volatile solids
10. Given the following data, calculate the BOD for the sample if the initial DO is 8.5 mg/L.

Sample size, mL	DO Final, mg/L
Blank	8.5
3.0	7.0
5.0	5.8
7.0	4.8
9.0	3.4
11	2.7
15	0.5

   a. 159 mg/L
   b. 159.7 mg/L
   c. 160 mg/L
   d. 162.2 mg/L

Answer Key and Solutions

1. C – Domain 1
2. A – Domain 1
3. D – Domain 2
4. D – Domain 2
5. B – Domain 3
6. A – Domain 3
7. D – Domain 4
8. C – Domain 4
9. C – Domain 5

   Solution:

   Wet sample weight = 32.40 g -1.38 g = 31.02 g
   Dry sample weight = 1.86 g - 1.38 g = 0.48 g
   Ash sample weight = 1.56 g- 1.38 g = 0.18 g
   % solis = (dry sample weight X100)/ wet sample weight
   = (0.48 g X100)/31.02 g = 1.55 % solids
   % volatile solids ={ (dry weight- ash weight) X100}/dry weight
   = {(0.48 g - 0.18 g) X 100}/0.48 g + 62.5 % volatile

10. C – Domain 5

    Solution:

    BOD ={(DOinitial mg/L - DO final mg/L) X 300 mL}/ sample size mL
    Average values obtained for volumes 5,7,9 and 11 sample volumes, round final results to 3 signicant figures

LAB GRADE 2 EXAM CONTENT OUTLINE

Content Domain	Weighting
Domain 1 – Sample Collection, Testing, and Analysis	32%
Domain 2 – Documentation, Quality Assurance/Control, Regulatory Compliance, and Ethics	26%
Domain 3 – Laboratory Equipment, Supplies, and Facilities	20%
Domain 4 – Safety	10%
Domain 5 – Math	12%
Total	100%

Domain 1: Sample Collection, Testing, and Analysis

Sub-Domain 1.1:

Water and Wastewater Laboratory Knowledge

1. Proficient knowledge of organic and inorganic chemistry, biology, microbiology, and toxicity, as applied in a water or wastewater testing and treatment laboratory
2. Understand general microbiological concepts such as sterilization or aseptic technique, media preparation, and good laboratory practices for minimizing cross-contamination
3. Understand basic water and wastewater treatment processes

Sub-Domain 1.2:

Testing, Analysis, and Interpretation of Results and Data

1. Perform testing and analysis of samples using a variety of chemistry wastewater and drinking water methodologies and instrumentation, including:
   - Basic wet chemistry methods
   - Methods using Specific Ion Electrode Technologies (ammonia, pH)
   - Titrimetric Methods (alkalinity, hardness)
   - Acute and chronic toxicity
   - Colorimetric Methods (phosphorous, NO3/NO2)
   - Solids Methods (TSS, TS)

- Dissolved oxygen
- Chemical Oxygen Demand (COD)
- Biochemical Oxygen Demand (BOD) Methods
- Carbonaceous Biochemical Oxygen Demand (cBOD) Methods
- TOC
- Anions
- Cyanide
- Selective ion electrodes
- Flow analyzers
- Discrete analyzers
- Ion Chromatography
- Chlorine residual (total and free)
- Turbidity
- Volatile acids

2. Perform testing and analysis of samples using a variety of biological, microbiological, and bioassay wastewater and drinking water methodologies, including:
   - Chronic and Acute Bioassays using live organisms (e.g., Ceriodaphnia dubia, various vertebrae)
   - Total and Fecal Coliform tests
   - Coliform by multiple tube fermentation
   - Coliform by enzyme substrate test
   - Coliform by membrane filtration
   - Enterococcus enzyme substrate
   - Enterococcus by membrane filtration
   - Heterotrophic plate count (HPC)
   - Microbiological tests (MTF, MF)
   - Membrane filtration methods
   - Identification of microbial organisms
3. Perform testing required for regulatory compliance and process control in accordance with laboratory standard operating procedures (SOPs), and produce work with precision and accuracy within SOP acceptance criteria
4. Assist in the development of new or modified test procedures using standard reference materials
5. Troubleshoot analytical procedures and instrumentation
6. Recognize atypical data and apply appropriate corrections and notifications
7. Set up and adjust testing schedules to meet changing conditions and emergencies

8. Recognize when process control and regulatory compliance testing results are outside normal trending, and may indicate a change in the treatment process
9. Communicate test results to internal clients and outside consultants or other parties as required

Sub-Domain 1.3:

Sample Collection

1. Knowledge of water and wastewater sample collection and disposal procedures
2. Collect water and wastewater samples from various locations in accordance with established laboratory procedures, including:
   - Chain of custody
   - Sample type (grab and composite)
   - Container type and preparation
   - Preservation (pH adjustment)
   - Hold time
   - Sampling techniques
   - Proper labeling
   - Storage condition
   - Quality Control (sample validation/invalidation)
   - Ultra clean sampling methods
   - Autosampler maintenance and programming (flow-based or time based)

Domain 2: Documentation, Quality Assurance/Control, Regulatory Compliance, and Ethics

Sub-Domain 2.1:

Records, Reporting, and Documentation

1. Participate in the development, revision, and recommendation of modifications to policies and procedures
2. Complete and maintain accurate physical and electronic records for all work performed, including sampling, analysis, equipment maintenance, and quality assurance/quality control tasks
3. Enter, maintain, and review data in the Laboratory Information Management System (LIMS)/electronic database to ensure accuracy
4. Conduct and maintain records of results for quality control performed on media, standardized solutions, and reagents for microbiological, toxicity, and chemical analyses
5. Provide technical support for assessing and developing sampling programs and analytical techniques
6. Prepare accurate reports of test results and statistical analyses

7. Document and maintain accurate and complete laboratory records such as: routine documentation including worksheet/log sheet entries, sample documentation, chain-of-custody

Sub-Domain 2.2:

Quality Assurance and Quality Control

1. Conduct regular Method Detection Limit (MDL) Studies, and perform Initial and Ongoing Demonstration of Capability (IDOC & ODOC)
2. Communicate quality assurance concerns and exceedances, and initiate required corrective and preventive action requirements
3. Provide oversight and review of quality control data for the laboratory's operations, and report any quality control issues

Sub-Domain 2.3:

Ethics

1. Understand and practice proper laboratory ethics
2. Report unethical behavior/practices such as improper data manipulations, adjustments of instrument time clocks, and inappropriate changes in concentrations of standards
3. Understand direct chain of command
4. Knowledge of the consequences of unethical behavior
5. Knowledge of data integrity and legal defensibility

Sub-Domain 2.4:

Regulatory Compliance

1. Knowledge of regulatory compliance requirements for water and wastewater contained in NPDES permits, 40 CFR 136 and 141, and other regional, state and federal laws and regulations (e.g., Safe Water Drinking Act, OSHA (IIPP, ERP, CHP), etc.)
2. Knowledge of reference method sources, such as Standard Methods and EPA
3. Knowledge of CA ELAP regulations and the TNI laboratory accreditation standard
4. Participate in EPA and Environmental Laboratory Accreditation Program (ELAP) audits of the laboratory to maintain the laboratory's certification

Domain 3: Laboratory Equipment, Supplies, and Facilities

Sub-Domain 3.1:

Operation, Maintenance, and Repair of Laboratory Equipment and Facilities

1. Perform routine and preventative maintenance and cleaning of lab equipment, fixtures, samplers, and glassware according to laboratory procedures

2. Prepare, calibrate, standardize, operate, troubleshoot, and maintain a variety of laboratory and operations equipment and instruments, such as:
   - Turbidity meters/turbidimeters
   - Dissolved oxygen meters
   - pH meters
   - Balances (analytical and top-loading)
   - Conductivity meters
   - UV-VIS spectrophotometers
   - Microscopes
   - Autoclaves
   - Ovens
   - Incubators
   - Refrigerators
   - Water baths
   - Titrators
   - TOC
   - Continuous flow and discrete analyzers
   - Ion-specific electrodes
3. Perform general laboratory housekeeping, including cleaning
4. Utilize techniques and equipment used in laboratory analysis including:
   - Gravimetric (balance weighting)
   - Titrimetric/volumetric (burette, pipette, graduated cylinder, titrator)
   - Sterilization (autoclave, Bunsen burner, oven)
   - Colorimetric (visual observation, spectrophotometer/colorimeter)
   - Electrometric (meters, probes/electrodes, LDO, ISE)
   - Thermometers (ranges and max temp)
   - Sample preparation (digestion, extraction, filtration, distillation)

Sub-Domain 3.2:

Preparing Solutions and Performing Dilution

1. Prepare standard chemical solutions, reagents, stains, and media for various chemical and microbiological analyses
2. Understand how to make a dilution series and perform dilution of concentrated solutions
3. Prepare filters and dishes for residue testing
4. Prepare bacteriological culture media
5. Knowledge of glass fiber filters, crucibles, sterilizations, and buffering solutions
6. Verify prepared reagent quality (standardization)

Sub-Domain 3.3:
Inventory and Ordering Supplies

1. Assist in maintaining the supply inventory
2. Assist laboratory staff in ordering supplies and document them upon receipt
3. Assist laboratory staff in estimating laboratory supply and equipment needs
4. Determine acceptability of reagents based on established policies and procedures and supplies
5. Assist with vendor evaluations

Domain 4: Safety

Sub-Domain 4.1:
Laboratory Safety

1. Recognize, correct, and report laboratory hazards and ensure work is performed in a safe manner consistent with safety policies and procedures
2. Understand chemical handling and hygiene, storage, disposal, and spill response
3. Understand biological hazards and hygiene, handling, storage, and disposal
4. Understand engineering controls (fume hoods, etc.)
5. Understand physical hazards (burns, sharps, compressed gas, electrical safety, fire, etc.)
6. Knowledge of safety regarding handling and disposal of acids, bases, and solvents
7. Knowledge of safety regarding inhalation hazards
8. Familiarity with the purpose and use of Personal Protective Equipment (PPE) and safety measures such as face shields, gloves, and emergency showers
9. Maintain laboratory safety data sheet (SDS) records and understand each section of SDSs and their relation to laboratory safety and right-to-know law

Domain 5: Math

Sub-Domain 5.1:
Math

1. Calculate test results (e.g., alkalinity, hardness, solids) according to industry standards and method requirements
2. Perform unit conversions utilizing dimensional analysis
3. Perform algebraic and statistical calculations
4. Calculate concentrations from a dilution series
5. Demonstrate knowledge of scientific notation

6. Perform accurate calculations for solution preparation utilizing concepts such as dilution factors, molarity, normality, and standardization
7. Understand significant figures and proper rounding
8. Graph/generate standard curves and linear regressions
9. Calculate percent recovery, relative percent difference (RPD), expected recoveries, and geometric mean

Suggested References

CWEA's exam is based on a job task analysis that includes research of the essential duties of a Laboratory Analyst at a representative cross-section of systems and facilities in California. CWEA's exams do not correspond directly to any specific textbook, educational course, or program; instead, the exams are based on an analysis of the duties commonly performed in actual practice. In developing the exam, CWEA Subject Matter Experts used their years of experience in the field along with the key textbooks and reference materials listed below. Candidates should understand that the references listed do not necessarily cover all exam content. Candidates who meet the minimum qualifications for this exam may find these suggested references useful when preparing for this exam; however, these suggested references are not required reading and should not be interpreted as constituting the sole source of all exam questions.

This list does not include all the available textbooks and materials for studying for this exam. Candidates are strongly encouraged to seek additional material, training, and experience, especially in content areas for which the candidate is not adequately prepared. Candidates are encouraged to prepare for CWEA certification exams using as many different study materials as possible plus education events and on-the-job training. Recommended reading from the Office of Water Programs (which is a third-party) was provided by their team based on their expertise and review of CWEA's content outlines. Candidates are encouraged to develop their own personal study plan based on individual needs and knowledge.

Domain 1 – Sample Collection, Testing, & Analysis	
Sub-Domain 1.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-629 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-935 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Sections 1020, 1030, 2130, 2150, 2160, 2320, 4500, 4500-CL, 4500-H+,4500 NH3, 5210, 5220, 5310, 5520, 9010, 9020, 9030, 9040, 9050, 9060, 9215, 9221, 9223
Sub-Domain 1.2	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-629, 691-719 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 760-935, 1001-1031
Sub-Domain 1.3	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 619-629

	Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 814-828 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Sections 1030, 1060
Domain 2 – Documentation, Quality Assurance/Control, Regulatory Compliance, & Ethics	
Sub-Domain 2.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 43, 534-628, 548 Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 717-721 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 454-458 Manage for Success, 1st Edition. Pages 253-279 Utility Management, 3rd Edition. Pages 95-115 Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Edition
Sub-Domain 2.2	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-538, 549 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 760-762, 812-814, Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Edition
Sub-Domain 2.3	Supplement 1 to the Fifth Edition of the Manual for the Certification of Laboratories Analyzing Drinking Water
Sub-Domain 2.4	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-538 Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 459-464, 690-716 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 42-45, 56-60, 74, 89-100, 113-120 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 454-458 Utility Management, 3rd Edition. Pages 36-41 Manage for Success, 1st Edition. Pages 253-279 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Section 1090

	ELAP Laws and Regulations Title 40 CFR 136 Title 40 CFR 141
Domain 3 – Laboratory Equipment, Supplies, & Facilities	
Sub-Domain 3.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-550, 538-544 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-814 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 716-721 Utility Management, 3rd Edition. Pages 95-115 Manage for Success, 1st Edition. Pages 253-279, 307-357
Sub-Domain 3.2	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 557-629, 634-752, 545-548 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-814, 944-1030
Sub-Domain 3.3	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-538 Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 718-720 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-814 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 456-457 Utility Management, 3rd Edition. Pages 36-40 Manage for Success, 1st Edition. Pages 253-337
Domain 4 – Safety	
Sub-Domain 4.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 550-557 Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 690-716 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 762-775 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 488-499 Utility Management, 3rd Edition. Pages 50-61

	Manage for Success, 1st Edition. Pages 357-385 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Section 1090
Domain 5 – Math	
Sub-Domain 5.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 634-752, 691-719 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 944-1030, 1001-1030

Suggested References List

- ELAP Laws and Regulations

- Manage for Success, Effective Utility Leadership Practices, 1st Edition. Office of Water Programs
- Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Edition. United States Environmental Protection Agency
- Operation of Wastewater Treatment Plants, Volume 1, 8th Edition, Office of Water Programs
- Operation of Wastewater Treatment Plants, Volume 2, 8th Edition, Office of Water Programs
- Operation of Wastewater Treatment Plants, Volume 3, 1st Edition, Office of Water Programs
- Standard Methods for the Examination of Water and Wastewater, 23rd Edition
- Supplement 1 to the Fifth Edition of the Manual for the Certification of Laboratories Analyzing Drinking Water. United States Environmental Protection Agency.
- Title 40 CFR
  - 136
  - 141
- Utility Management, A Field Study Training Program, 3rd Edition. Office of Water Programs
- Water Treatment Plant Operations, Volume 1, 7th Edition, Office of Water Programs
- Water Treatment Plant Operations, Volume 2, 7th Edition, Office of Water Programs

Sample Questions

This section provides sample questions to help applicants become familiar with the exam format and subject matter.

1. Sample protocol for residual chlorine includes:
   a. preserving the sample with sodium thiosulfate for a 7-day holding time.
   b. preserving the sample at 4°C for a 7-day holding time.

c. preserving the sample at 4°C for a 2-hour holding time.
d. no preservation and immediate analysis.

2. Chain-of-custody:
   a. replaces the need for sample container labels.
   b. must include field notes regarding sampling conditions.
   c. is the ability to trace sample possession and handling from collection through analysis and final disposition.
   d. is the ability to trace sample handling techniques from preservation through extraction or digestion to analysis.
3. Of the four possible outcomes of bias and precision:
   a. only the condition of low bias and high precision is accurate.
   b. only the condition of low bias and low precision is accurate.
   c. only the condition of high bias and high precision is accurate.
   d. only the condition of high bias and low precision is accurate.
4. A wastewater discharge (NPDES) permit is issued under the authority of the:
   a. Office of Drinking Water (ODW).
   b. Environmental Laboratory Accreditation Program.
   c. State Water Resources Control Board.
   d. Department of Toxic Substances Control.
5. Sample containers typically are made of plastic or glass, but one material may be preferred over the other. Which of the following statements is correct?
   a. Silica and sodium may be leached from plastic but not from glass, and trace levels of metals may adsorb onto the walls of glass containers.
   b. Silica and sodium may be leached from plastic but not from glass, and trace levels of metals may adsorb onto the walls of plastic containers.
   c. Silica and sodium may be leached from glass but not from plastic, and trace levels of metals may adsorb onto the walls of glass containers.
   d. Silica and sodium may be leached from glass but not from plastic, and trace levels of metals may adsorb onto the walls of plastic containers.
6. Turbidity analysis is an optical measurement of scattered light. Here the scattered light is measured by the detector at an angle of
   a. 45°
   b. 75°
   c. 180°
   d. 90°
7. Standard phenylarsine oxide solution (PAO):
   a. should be handled with caution because it is a severe poison.
   b. should be handled with caution because it is highly corrosive.
   c. should be handled with caution because it is highly acidic.

   d. requires only routine laboratory safety considerations.

8. Which of the following practices is important in storing and handling flammable liquids?
   a. Flammable liquids must only be used in a low oxygen environment.
   b. All nonworking quantities of flammable liquids should be removed from the bench top and stored under the counter or in a laboratory storage cabinet.
   c. Flammable liquids need to stored separate from other flammable organic solvents.
   d. Segregate flammable liquids from other hazardous materials and minimize ignition sources whenever flammable liquids are being stored or handled.
9. If the anticipated BOD (unseeded) of a wastewater sample is 120 mg/L, what is the sample volume giving nearest to 50% oxygen depletion in a 300 mL bottle? (initial DO = 8 mg/L)
   a. 1 mL
   b. 3 mL
   c. 10 mL
   d. 15 mL
10. 24-hour composite samples from the inlet and outlet of a primary clarifier had an influent TSS of 220 mg/L and an effluent TSS of 90 mg/L. How many pounds of solids were removed if the flow was 12.5 MGD, and what was the percent removal?
   a. 13,600 pounds removed, 41% removal
   b. 13,600 pounds removed, 59% removal
   c. 22,900 pounds removed, 41% removal
   d. 22,900 pounds removed, 59% removal

Answer Key and Solutions

1. D – Domain 1
2. C – Domain 1
3. A – Domain 2
4. C – Domain 2
5. C – Domain 3
6. D – Domain 3

7. A – Domain 4
8. D – Domain 4
9. C – Domain 5

   Solution:

   Desired final oxygen concentration = 8 mg/L x 50% = 4 mg/L.

   Dilution needed for original sample to exert 4 mg/L of BOD = 120 mg/L / 4 mg/L = 30.

   Sample volume needed to provide 30 dilution = 300 mL/30 = 10 mL
10. B – Domain 5

    Solution:

    lbs/day = 8.34 x mg/L x flow in MGD
    = 8.34 x (220 – 90) x 12.5
    = 13,553 lbs/day removed
    Round to 13,600.

    *% removal = TSS removed/Influent TSS * 100 = 130 mg/L / 220 mg/L * 100 = 59%*

    Alternatively:

    Conversion factors:
    mg to kg = 1,000,000
    kg to lbs = 2.20462
    gallons to liters = 3.78541

    TSS removal/liter = 220 mg/L - 90 mg/L = 130 mg/L

    *TSS removed / day (lbs/day) = 130 mg/L * 12,500,000 G/D * 3.78541 L/G * kg/1,000,000 mg * 2.20462 lbs/kg = 13,561 lbs/day*
    Round to 13,600 lbs/day

LAB GRADE 3 EXAM CONTENT OUTLINE

Content Domain	Weighting
Domain 1 – Sample Collection, Testing, and Analysis	30%

Domain 2 – Documentation, Compliance, Ethics, and Administration	32%
Domain 3 – Laboratory Equipment, Supplies, and Facilities	17%
Domain 4 – Safety	8%
Domain 5 – Math	13%
Total	100%

Domain 1: Sample Collection, Testing, and Analysis

Sub-Domain 1.1:

Water and Wastewater Laboratory Knowledge

1. Advanced knowledge of organic and inorganic chemistry, biology, microbiology, and toxicity as applied in water or wastewater testing and treatment
2. Functional knowledge of acute and chronic toxicity methods in water or wastewater
3. Basic understanding of wastewater treatment processes and phases of the treatment process including effluent discharge and efficiency, activated sludge monitoring, treatment chemical doses
4. Proficiency in wastewater treatment process control analyses including process control topics (MLSS/SVI, MCRT, F/M, chlorination (free and total), dechlorination, volatile acids/alkalinity ratio), microorganism speciation and counting, and digester sludge analysis
5. Knowledge of which pollutants can be removed at each stage of treatment and which pollutants will remain in the final effluent
6. Understand the chemical principles of methods/analysis, why some methods work better for certain matrices, and how and why interferences can be controlled (e.g., chlorine residual and cyanide)
7. Understand how results are qualified and the relationships between various analytical techniques (BOD/COD/TOC, anion-cation balance)

Sub-Domain 1.2:

Testing, Analysis, and Interpretation of Results and Data

1. Oversee and perform testing and analysis of samples using a variety of chemistry wastewater and drinking water methodologies and instrumentation, including:
   - Basic wet chemistry methods
   - Methods using Specific Ion Electrode Technologies (ammonia, pH)
   - Titrimetric Methods (alkalinity, hardness)
   - Acute and chronic toxicity
   - Colorimetric Methods (NO3/NO2)
   - Solids Methods (TSS, TS)
   - Dissolved oxygen
   - Chemical Oxygen Demand (COD)
   - Biochemical Oxygen Demand (BOD) Methods
   - Carbonaceous Biochemical Oxygen Demand (cBOD) Methods
   - Sulfide
   - Phosphorous methods (orthophosphate, total phosphorous)
   - Nitrogen methods (ammonia, nitrate, nitrite, Total Kjeldahl Nitrogen)
   - Major cations (Sodium, Calcium, Magnesium, Potassium)
   - Major anions (Sulfate, Chloride, Fluoride, Nitrate, Bicarbonate)
   - Cyanide
   - Selective ion electrodes
   - Flow analyzers
   - Discrete analyzers
   - Ion Chromatography
   - Chlorine residual (total and free)
   - Turbidity
   - Volatile acids
2. Oversee and perform testing and analysis of samples using a variety of biological, microbiological, and bioassay wastewater and drinking water methodologies, including:
   - Chronic and Acute Bioassays using live organisms (e.g., Ceriodaphnia dubia, various vertebrae)
   - Total and Fecal Coliform tests
   - Coliform by multiple tube fermentation
   - Coliform by enzyme substrate test
   - Coliform by membrane filtration
   - Enterococcus enzyme substrate
   - Enterococcus by membrane filtration
   - Heterotrophic plate count (HPC)
   - Microbiological tests (MTF, MF)

- Membrane filtration methods
- Identification of microbial organisms

3. Interpret and evaluate data related to the physical properties, methods, and interferences for the analysis of water and wastewater:
   - Color
   - Turbidity
   - Odor
   - Alkalinity
   - Hardness
   - Conductivity
   - Solids
   - Temperature
   - pH
   - Acidity
   - Salinity
   - Oil and grease
4. Possess proficient knowledge of:
   - Trace metals
   - Volatile Organic Compounds (VOC)
   - Semi-Volatile Organic Compounds (SVOC)
   - Pesticides
   - Organics
   - Total organic carbon (TOC)
   - Surfactants (MBAS)
   - Priority pollutants
5. Oversee and perform National Pollutant Discharge Elimination System (NPDES) required methods, including advanced instrumental methods, and process control tests within acceptable precision and accuracy standards
6. Assist in the development of new test procedures using standard reference materials
7. Recognize when process control and regulatory compliance testing results are outside normal trending, and may indicate a change in the treatment process
8. Communicate test results to internal clients and outside consultants or other parties as required
9. Understand how to interpret inhibitory residue and water suitability tests results to verify water quality
10. Recognize atypical data and apply appropriate corrections and notifications
11. Establish, adjust, and troubleshoot testing schedules and analytical procedures to meet changing conditions and emergencies

Sub-Domain 1.3:

Sample Collection

1. Knowledge of water and wastewater sample collection and disposal procedures
2. Coordinate collection of water and wastewater samples from various locations in accordance with established laboratory procedures, including:
   - Chain of custody
   - Sample type (grab and composite)
   - Container type and preparation
   - Preservation (pH adjustment)
   - Holding time
   - Sampling techniques
   - Proper labeling
   - Storage condition
   - Sample location
   - Quality Control (sample validation/invalidation)
   - Ultra clean sampling methods
   - Autosampler maintenance and programming (flow-based or time based)

Domain 2: Documentation, Compliance, Ethics, and Administration

Sub-Domain 2.1:

Records, Reporting, and Documentation

1. Document and maintain existing analytical standard operating procedures; develop, write, and review new analytical standard operating procedures, and recommend modifications as appropriate
2. Manage, validate, and maintain accurate data in the Laboratory Information Management System (LIMS)/electronic database
3. Complete and maintain accurate physical and electronic records for all work performed, including sampling, analysis, results, equipment maintenance, and quality assurance/quality control tasks
4. Prepare and maintain accurate laboratory reports including, but not limited to, work performed, test results, special statistical analyses, chain-of-custody
5. Knowledge of the reporting requirements of applicable regulatory permits for influent, effluent, biosolids, and receiving waters
6. General awareness of SCADA

Sub-Domain 2.2:

Laboratory Technical Support and Administration

1. Provide technical support for assessing and developing sampling programs and analytical techniques

2. Assist in implementation of regulations concerning water quality testing programs and ensure compliance
3. Ability to conduct research projects
4. Supervise, train, and evaluate the activities of staff and implement corrective actions as necessary
5. Basic knowledge of pretreatment programs
6. Participate in the development and validation of methodology and reconfigure the Laboratory Information Management System (LIMS)/electronic database with the addition of new methods and/or changes to Quality Control
7. Assist with the preparation of the laboratory budget and suggest capital improvements
8. Monitor and track expenditures
9. Identify resource needs and prepare detailed cost estimates with appropriate justifications
10. Participate in vendor evaluations and contracting process

Sub-Domain 2.3:

Quality Assurance and Quality Control

1. Plan, implement, schedule, oversee, coordinate, and monitor the laboratory quality assurance program including quality assurance related activities
2. Oversee regular QA/QC testing and studies, such as:
   – Method Detection Limit (MDL) Studies
   – Monitoring Initial and Continuing Demonstration of Capability (IDOC & CDOC)
   – Quality Control on media, standardized solutions, and reagents
3. Communicate quality assurance concerns and exceedances, and initiate required corrective and preventive action requirements
4. Regularly review Laboratory Information Management System (LIMS) data/electronic database, and document and communicate trends or exceedances
5. Develop, maintain and interpret quality assurance/quality control program criteria
6. Develop and review documents with regard to :
   - Control charts
   - Standards and reagents quality
   - Reagent water quality (inhibitory residue and water suitability),
   - Demonstration of Capability (DOC),
   - Instrument maintenance records
   - Documentation of corrective action
   - Analytical and microbiological data quality
   - Internal/external audits

- Concept of equivalency testing/Alternative Test Protocol (ATP)
- Correctness of analysis
- Quality assurance plan
- Equipment calibration and verification
- Analytical and microbiological data quality

7. Understand the use of laboratory control samples, method blanks, matrix spikes, and duplicates
8. Schedule, implement, and report annual proficiency testing requirements for laboratory accreditation; address noncompliance issues with corrective action requirements

Sub-Domain 2.4:

Ethics

1. Avoid and report ethics violations such as improper data manipulations, adjustments of instrument time clocks, and inappropriate changes in concentrations of standards
2. Understand direct chain of command
3. Understand the consequences of violations
4. Knowledge of data integrity and legal defensibility
5. Knowledge of the root causes of fraud and techniques to avoid or discourage fraud

Sub-Domain 2.5:

Regulatory Compliance

1. Participate in EPA and Environmental Laboratory Accreditation Program (ELAP) audits and activities to obtain and maintain accreditation
2. Understand and comply with State and federal laws and regulations applicable to the work, including the Clean Water Act, Safe Drinking Water Act, National Pollutant Discharge Elimination System permit compliance and regulatory authority, OSHA (IIPP, ERP, CHP), NFPA, Method Update Rule, Hazardous waste program, 40 CFR 136 for analytical procedures
3. Understand and participate in Discharge Monitoring Report - Quality Assurance (DMR-QA) reporting
4. Understand TNI requirements to achieve ELAP Accreditation for the laboratory

Domain 3: Laboratory Equipment, Supplies, and Facilities

Sub-Domain 3.1:

Operation, Maintenance, and Repair of Laboratory Equipment and Facilities

1. Oversee routine and preventative maintenance, repairs, and cleaning of lab equipment, fixtures, samplers, and glassware according to laboratory procedures

2. Prepare, calibrate, standardize, operate, troubleshoot, and maintain a variety of laboratory and operations equipment and instruments, such as:
   - Turbidity meters/turbidimeters
   - Dissolved oxygen meters
   - pH meters
   - Balances (analytical and top-loading)
   - Conductivity meters
   - UV-VIS spectrophotometers
   - Ion chromatographs
   - Microscopes
   - Autoclaves
   - Ovens
   - Incubators
   - Refrigerators
   - Water baths
   - Titrators
   - TOC
   - Continuous flow and discrete analyzers
   - Ion-specific electrodes
3. Oversee general laboratory housekeeping, including cleaning
4. Implement and evaluate techniques and equipment used in laboratory analysis including:
   - Gravimetric (balance weighting)
   - Titrimetric/volumetric (burette, pipette, graduated cylinder, titrator)
   - Sterilization (autoclave, Bunsen burner, oven)
   - Colorimetric (visual observation, spectrophotometer/colorimeter)
   - Electrometric (meters, probes/electrodes, LDO, ISE)
   - Turbidimetric (Nephelometer)
   - Thermometers (ranges and max temp)
   - Sample preparation (digestion, extraction, filtration, distillation)
   - Basic understanding of Ion chromatographs (GC, GC/MS, ICP-OES/MS, cold vapor AAS, HPLC)
5. Knowledge of method detection limits (MDLs) and when they need to be updated

Sub-Domain 3.2:

Preparing Solutions and Performing Dilution

1. Prepare standard chemical solutions, reagents, stains, media, and samples for various chemical and microbiological analyses

2. Understand how to make a dilution series and perform dilution of concentrated solutions
3. Prepare filters and dishes for residue testing
4. Knowledge of glass fiber filters, crucibles, sterilizations, and buffering solutions
5. Create working standards from concentrated standards
6. Verify prepared reagent quality (standardization)
7. Understand the concepts of molarity/normality and equivalence/valences
8. Knowledge of atomic and molecular weights
9. Standardize solutions using chemicals of known concentrations

Sub-Domain 3.3:

Inventory and Ordering Supplies

1. Maintain chemical inventory and assist in inventory control of supplies and chemicals
2. Oversee the order, receipt, and documentation of laboratory supplies
3. Estimate laboratory supply and equipment needs
4. Per TNI, verify that supplies are acceptable to use in the lab by keeping track of approved vendors and the quality of product that has to be used

Domain 4: Safety

Sub-Domain 4.1:

Laboratory Safety

1. Ensure work is performed in a safe manner consistent with safety policies and procedures; follow proper safety procedures, and recognize, correct, and report safety hazards
2. Understand chemical handling and hygiene, storage, disposal, and spill response
3. Understand biological hazards and hygiene, handling, storage, and disposal
4. Understand engineering controls (fume hoods, etc.)
5. Understand physical hazards (burns, sharps, compressed gas, electrical safety, fire, etc.)
6. Understand inhalation hazards
7. Select and use appropriate Personal Protective Equipment (PPE) and safety measures such as face shields, gloves, and emergency showers
8. Develop, review, edit, and maintain the Laboratory Chemical Hygiene Plan (CHP)
9. Maintain laboratory safety data sheet (SDS) records and understand each section of SDSs and their relation to laboratory safety and right-to-know law
10. Understand confined space entry, including hazardous atmospheres and PPE necessary for entry

Domain 5: Math

Sub-Domain 5.1:

Math

1. Calculate test results (e.g., alkalinity, hardness, solids) according to industry standards and method requirements
2. Perform unit conversions utilizing dimensional analysis
3. Perform algebraic and statistical calculations, and be able to extrapolate data for a concentration-response relationship
4. Calculate concentrations from a dilution series
5. Familiarity with scientific notation
6. Perform accurate calculations for solution preparation utilizing concepts such as dilution factors, molarity, and normality
7. Perform temperature conversions between different temperature scales
8. Calculate Biochemical Oxygen Demand (BOD)
9. Graph/generate linear regressions, weighted linear regressions, quadratic regressions, and standard curves
10. Calculate percent recoveries and expected recoveries

Suggested References

CWEA's exam is based on a job task analysis that includes research of the essential duties of a Laboratory Analyst at a representative cross-section of systems and facilities in California. CWEA's exams do not correspond directly to any specific textbook, educational course, or program; instead, the exams are based on an analysis of the duties commonly performed in actual practice. In developing the exam, CWEA Subject Matter Experts used their years of experience in the field along with the key textbooks and reference materials listed below. Candidates should understand that the references listed do not necessarily cover all exam

content. Candidates who meet the minimum qualifications for this exam may find these suggested references useful when preparing for this exam; however, these suggested references are not required reading and should not be interpreted as constituting the sole source of all exam questions.

This list does not include all the available textbooks and materials for studying for this exam. Candidates are strongly encouraged to seek additional material, training, and experience, especially in content areas for which the candidate is not adequately prepared. Candidates are encouraged to prepare for CWEA certification exams using as many different study materials as possible plus education events and on-the-job training. Recommended reading from the Office of Water Programs (which is a third-party) was provided by their team based on their expertise and review of CWEA's content outlines. Candidates are encouraged to develop their own personal study plan based on individual needs and knowledge.

Domain 1 – Sample Collection, Testing, & Analysis	
Sub-Domain 1.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-629 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-935 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Section 2710 Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, 5th Edition.
Sub-Domain 1.2	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-629, 691-719 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 760-935, 1001-1031 Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, 5th Edition. Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Section 2120, 2130, 2150, 2310, 2320, 2340, 2410, 2520, 2540, 2550, 3500-Ca, 3500-Na, 3500-Mg, 3500-K, 4130, 4120, 4110, 4500-Cl, 4500-CN, 4500-F, 4500-SO4^2-, 4500-H+, 4500-NH3, 4500-NO2, 4500-NO3, 4500-N org, 4500-O, 4500-P, 4500-PO4, 4500-S^2-, 5210, 5220, 5520, 5560, 9221, 9222, 9223, 9215, SM 3110, 3111, 3112, 3113, 3114, 3120, 3125, 5310, 5540, SM 1020, 2020, 3020, 4020, 5020, 9020, 1080, 1030 Title 40 CFR Part 136

Sub-Domain 1.3	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 619-629 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 814-828 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Section 1020, 1100, 1060 Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Edition
Domain 2 – Documentation, Quality Assurance/Control, Regulatory Compliance, & Ethics	
Sub-Domain 2.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 43, 534-628, 548 Water Treatment Plant Operation, Volume 2, 7th Edition, Pages 717-721 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 454-458 Manage for Success, 1st Edition. Pages 253-279 Utility Management, 3rd Edition. Pages 95-115 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Section 1020, 1030 Title 40 CFR Part 136 Title 40 CFR Part 503
Sub-Domain 2.2	Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 707-728 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 454-478 Pretreatment Facility Inspection, 4th Edition. Pages 2-157 Manage for Success, 1st Edition, Pages 7-71 Utility Management, 3rd Edition. Pages 2-36
Sub-Domain 2.3	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-538, 549 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 760-762, 812-814 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Section 9020, 1020, 2020, 3020, 4020, 5020
Sub-Domain 2.4	

Sub-Domain 2.5	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-538 Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 85-97, 459-464, 690-716 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition, Pages 42-45, 56-60, 74, 89-100, 113-120 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 454-458 Utility Management, 3rd Edition. Pages 36-41 Manage for Success, 1st Edition. Pages 253-279
Domain 3 – Laboratory Equipment, Supplies, & Facilities	
Sub-Domain 3.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-550, 538-544 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-814 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 716-721 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 458-478 Utility Management, 3rd Edition. Pages 95-115 Manage for Success, 1st Edition. Pages 253-279, 307-357 Title 40 CFR Part 136
Sub-Domain 3.2	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 557-629, 634-752, 545-548 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-814, 944-1030 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Sections Before the preface, 1010C
Sub-Domain 3.3	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-538 Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 718-720 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-814 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 456-457

	Utility Management, 3rd Edition. Pages 36-40 Manage for Success, 1st Edition. Pages 253-337
Domain 4 – Safety	
Sub-Domain 4.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 550-557 Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 690-716 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 762-775 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 488-499 Utility Management, 2nd Edition. Pages 50-61 Manage for Success, 1st Edition. Pages 357-385 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Sections 1090, 1100
Domain 5 – Math	
Sub-Domain 5.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 634-752, 691-719 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 944-1030

Suggested References List

- Manual for the Certification of Laboratories Analyzing Drinking Water, 5th Edition. United States Environmental Protection Agency
- Manage for Success, Effective Utility Leadership Practices, 1st Edition. Office of Water Programs

- Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, 5th Edition, October 2002, United States Environmental Protection Agency
- Operation of Wastewater Treatment Plants, Volume 1, 8th Edition, Office of Water Programs
- Operation of Wastewater Treatment Plants, Volume 2, 8th Edition, Office of Water Programs
- Operation of Wastewater Treatment Plants, Volume 3, 1st Edition, Office of Water Programs
- Pretreatment Facility Inspection, 4th Edition, Office of Water Programs
- Standard Methods for the Examination of Water and Wastewater, 23rd Edition
- Title 40 CFR
  - 136
  - 503
- Utility Management, A Field Study Training Program, 3rd Edition. Office of Water Programs
- Water Treatment Plant Operations, Volume 1, 7th Edition, Office of Water Programs
- Water Treatment Plant Operations, Volume 2, 7th Edition, Office of Water Programs.
- 2016 TNI Laboratory Accreditation Standard, The NELAC Institute

Sample Questions

This section provides sample questions to help applicants become familiar with the exam format and subject matter.

1. In the cyanide determination, which one of the following is not an interference?
   a. Carbonates

   b. Halogenated aromatics
   c. Fatty acids
   d. Sulfides
2. What analysis uses the purge and trap technique?
   a. Polyaromatic hydrocarbon analysis
   b. Volatile organic compound analysis
   c. Pesticide analysis
   d. Organic acid analysis
3. Which of the following types of control samples may be used to determine accuracy?
   a. Method blank
   b. Calibration standard
   c. Certified reference material
   d. Duplicate
4. The lower warning limit (LWL) on an LCS control chart indicates:
   a. The recovery which is two standard deviations below the average recovery.
   b. The standard is out of control and must be reanalyzed.
   c. The recovery is one standard deviation (95%) below the average recovery.
   d. The standard is one standard deviation (105%) above the average recovery.
5. What does an ICP source consist of?
   a. An electrically heated atomizer with programmable temperature ramping Capability.
   b. A cavity-type microwave with programmable temperature ramping capability.
   c. A flowing stream of argon gas ionized by an applied radio frequency.
   d. A hydride reactor cell purged with a flowing stream of argon gas.
6. In gas chromatography, electron capture detectors (ECD) are used to detect which of the following compounds?
   a. Polynuclear aromatic hydrocarbons
   b. Aldehyde and ketone derived pesticides
   c. Chlorinated hydrocarbon pesticides
   d. Polynuclear phenols
7. A waste is considered hazardous if it has at least one of the following properties:
   a. Ignitability, reactivity, toxicity, and is carcinogenic.
   b. Ignitability, corrosivity, acidity, and toxicity.
   c. Ignitability, corrosivity, reactivity, and toxicity.
   d. Ignitability, corrosivity, reactivity, and conductivity.
8. The HAZWOPER Standard, 29 CFR 1910.120 addresses which of the following situations?

a. Regulates shipments of hazardous waste
b. Regulates the disposal of radioisotopes
c. Characterizes toxicity and lists organic compounds, metals, and herbicides considered to be hazardous waste
d. Requires documentation of training for the handling of major spills and acutely hazardous materials

9. You are asked to determine the cost per test of the COD analysis. Use the following information:

   The base salary of an analyst is $30,000; employer paid benefits add 35% to the base salary; administrative overhead adds another 45% to the base salary; there are 10 paid holidays, 15 days paid vacation leave, and 12 days paid sick leave per year; the hourly salary is determined by dividing the monthly salary by 174. Each COD test requires an average of 20 minutes of labor from sample preparation to cleanup. Costs for chemicals, glassware, and equipment use average $1.00 per test. Disposal costs average $2000/year for reagents from 1,000 tests.

   What is the total cost per test?
   a. $ 8.62/test
   b. $ 9.62/test
   c. $10.62/test
   d. $11.62 /test

10. A freshly prepared sodium hydroxide (NaOH) solution is standardized against primary standard potassium acid phthalate (KHC8H4O4). 0.8000 grams of potassium acid phthalate was dissolved into 50 mL CO2-free water. 2-3 drops of phenolphthalein were added. The sample was titrated to a faint pink endpoint with 22 mLs sodium hydroxide. What is the normality of the sodium hydroxide?
    Molecular weights: K=39, H=1, C=12, O=16, Na=23
    a. 3.580 N
    b. 1.156 N
    c. 1.980 N
    d. 0.178 N

Answer Key and Solutions

1. B – Domain 1
2. B – Domain 1
3. C – Domain 2
4. A – Domain 2
5. C – Domain 3

6. C – Domain 3
7. C – Domain 4
8. D – Domain 4
9. D – Domain 5

    Solution:

    Determine the total cost of the analyst's time:

    $$\frac{\$30{,}000 + (\$30{,}000 \times 0.35) + (\$30{,}000 \times 0.45)}{1 \text{ year}}$$

    = $54,000/year

    $54,000 x 1 year x 1 month = $25.86/hr
    year 12 mos 174 hrs

    At 20 minutes analyst time per test:

    $25.86 x 1 hour x 20 mins = $8.62/test
    hr 60 mins test(analytical labor cost)

    Disposal costs:

    $2,000 = $2.00/test
    1,000 tests

    Reagent costs = $1.00/test

    Total costs per COD test:

    $8.62 + $2.00 + $1.00 = $11.62

10. D – Domain 5

    Solution:

    Molecular weights: K=39, H=1, C=12, O=16, Na=23

    Molecular weight of KHC8H4O4 =

    (39) + (1) + (12 x 8) + (1 x 4) + (16 x 4) = 204 g

    eq/L KHP = 0.8000 g KHP x 1.000 mL x
    50 mL 1 L

    1 mole KHP x 1 eq H+ = 0.078 eq/L
    204 g. 1 mole KHP

    Using the formula C1V1 = C2V2

    0.078 eq/L x 50 mL = N NaOH x 22 mL

    N NaOH = 0.078 eq/L x 50 mL = 0.086 eq/L
    22 mL

LAB GRADE 4 EXAM CONTENT OUTLINE

Content Domain	Weighting

Domain 1 – Management and Administration	26%
Domain 2 – Testing and Analysis	25%
Domain 3 – Documentation, Compliance, and Ethics	25%
Domain 4 – Safety	12%
Domain 5 – Math	12%
Total	100%

Domain 1: Management and Administration

Sub-Domain 1.1:

Management

1. Manage, direct, control, and implement laboratory services conducting analysis of potable water, recycled water, and/or wastewater
2. Develop laboratory goals, objectives, policies, and administrative systems of wastewater, drinking water, or recycled water testing and/or treatment facilities
3. Represent agency and/or treatment plant in public and private meetings, seminars/workshops on matters relating to analytical procedures
4. Act as liaison between laboratory and regulatory agencies
5. Evaluate laboratory operations and activities and recommend improvements and modifications
6. Coordinate laboratory services with other departments and agencies

Sub-Domain 1.2:

Budgeting

1. Oversee laboratory budget preparation, development, and administration
2. Monitor and control laboratory budget and expenditures
3. Assist with budget forecasts and justifications for capital improvements
4. Develop budget forecasts and cost justifications for laboratory staffing needs
5. Develop budget forecasts and cost justifications for laboratory equipment, materials, and supplies
6. Establish and oversee contracts or agreements with contract laboratories and vendors

Sub-Domain 1.3:

Supervision

1. Supervise, plan, organize, direct, coordinate and review the work and activities of laboratory personnel
2. Establish performance standards for laboratory personnel, conduct performance evaluations, implement discipline procedures and incentives
3. Oversee, coordinate, and document staff professional development and training
4. Participate in the recruitment, selection, and recommendation of the appointment of new staff
5. Monitor staff and address actions that may be improper, illegal or in violation of ethics policies or procedures
6. Participate in employee development and advancement initiatives and succession planning

Domain 2: Testing and Analysis

Sub-Domain 2.1:

Interpretation and Evaluation

1. Interpret and evaluate data related to the physical properties, methods, and interferences for the analysis of water and wastewater, such as:
   - Color
   - Turbidity
   - Odor
   - Alkalinity
   - Hardness
   - Conductivity
   - Solids
   - Temperature
   - pH
   - Acidity
   - Salinity
   - Oil and grease
2. Apply advanced knowledge of the chemical properties, methods and interferences for the analysis of water and wastewater, such as:
   - Dissolved oxygen
   - Biochemical oxygen demand
   - Chemical oxygen demand
   - Chlorine residual (total and free)
   - Sulfide
   - Phosphorus methods (orthophosphate, total phosphorus)
   - Nitrogen methods (ammonia, nitrate, nitrite, Total Kjeldahl Nitrogen)

- Major cations (Sodium, Calcium, Magnesium, Potassium)
- Major anions (Sulfate, Chloride, Fluoride, Nitrate, Bicarbonate)
- Cyanide

3. Possess proficient knowledge of:
   - Trace metals
   - Volatile
   - Semi-volatile
   - Pesticides
   - Organics
   - Total organic carbon (TOC)
   - Surfactants (MBAS)
   - Priority pollutants
   - Radiochemistry
   - Emerging contaminants
4. Interpret and evaluate data related to the microbiological properties, methods, and interferences for the analysis of water and wastewater, such as:
   - Coliform by multiple tube fermentation
   - Coliform by enzyme substrate test
   - Coliform by membrane filtration
   - Heterotrophic plate count (HPC)
   - Enterococcus analysis
   - Iterative methods
5. Interpret evaluate and report acute and chronic toxicity data results including Toxicity Reduction Evaluation (TRE) and Toxicity Identification Evaluation (TIE)
6. Knowledge of Whole Effluent Toxicity testing, including facilities and equipment, dilution water, effluent sampling methods, holding times, temperature, organism culturing and handling, data analysis, report preparation
7. Interpret and evaluate laboratory data from contract laboratories

Sub-Domain 2.2:

Procedures and Equipment

1. Oversee and implement lab procedures and direct the collection of samples including:
   - Chain of custody
   - Sample type (grab and composite)
   - Container type and preparation
   - Preservation (pH adjustment)
   - Hold time
   - Sampling techniques
   - Proper labeling

- Storage condition
- Sample location
- Quality Control (sample validation/invalidation)
- Ultra clean sampling methods
- Autosampler maintenance and programming (flow-based or time-based)

2. Oversee and direct operation and maintenance of test equipment including:
   - Turbidimeters
   - Dissolved oxygen meter
   - pH meters
   - Balances (analytical and top-loading)
   - Ion chromatographs
   - Conductivity meters
   - Microscopes, autoclaves
   - Ovens
   - Incubators
   - Refrigerators
   - Water baths
   - Titrators
   - Spectrophotometers
   - Gas Chromatography (GC) or Mass Spectrometry (GC/MS) analysis
   - Inductively coupled plasma mass spectrometry (ICP-MS)
   - Inductively coupled plasma - optical emission spectrometry (ICP-OES) analysis
   - Cold Vapor Atomic Absorption Spectroscopy (CVAAS)
   - HPLC
   - Reagent water purification system
3. Oversee, maintain, calibrate, and monitor laboratory equipment used to ensure standardized chemical solutions and filtrates

Sub-Domain 2.3:

Preparing Solutions and Performing Dilution

1. Oversee the preparation of reagents, calibration and quality control standards and essential laboratory supplies
2. Oversee the correct dilution of concentrated solutions
3. Oversee the preparation of filters and dishes for residue testing
4. Oversee the preparation of bacteriological culture media
5. Advanced knowledge of glass fiber filters, crucibles, sterilizations, and buffering solutions
6. Oversee the creation of working standards from concentrated standards
7. Oversee the verification of prepared reagent quality (standardization)

8. Understand the concepts of molarity/normality and equivalence/valences
9. Advanced knowledge of atomic and molecular weights
10. Direct the use of internal, external and second source QC standards

Sub-Domain 2.4:

Analysis

1. Advanced knowledge of treatment process control analyses:
   - Process control topics (MLSS/SVI, MCRT, F/M, chlorination, dichlorination, volatile acids/alkalinity ratio)
   - Microorganism speciation and counting
   - Digester sludge analysis
   - Phases of the treatment process
   - Plant process efficiency
2. Advanced knowledge of treatment processes including effluent discharge monitoring and process efficiency, activated sludge monitoring and chemicals used in treatment
3. Apply lab results to plant processes and interpret plant performance
4. Knowledge of drinking water disinfection and treatment processes in order to assist with troubleshooting water quality issues in drinking water (i.e., nitrification, blending calculations, positive coliform detections, surface water treatment, filtration technologies, etc.)

Sub-Domain 2.5:

Research and New Method Development

1. Investigate, plan, develop, and evaluate new laboratory techniques, analytical procedures, and instrumentation
2. Evaluate and revise existing chemical test procedures
3. Develop test methods

Domain 3: Documentation, Compliance, and Ethics

Sub-Domain 3.1:

Laboratory Records

1. Manage, review, maintain, and archive accurate and complete laboratory records and reports, including:
   - Routine documentation, including worksheet/log sheet entries
   - Sample documentation
   - Chain-of-custody forms
   - Record data accurately
   - Report non-conforming data
   - Management of laboratory computerized database

- Standard Operating Procedures (SOPs)
- Method development and validation
- Awareness of Process Operations SCADA
- Data integrity and legal defensibility
- Ethics training
- Corrective actions
- Equipment/Inventory list
- Controlled documents list

2. Expert knowledge in SOP development, including evaluating and revising SOPs to adhere to 2016 TNI Standard
3. Awareness of SCADA

Sub-Domain 3.2:

Quality Assurance and Quality Control

1. Direct, implement, and maintain the laboratory accreditation and quality assurance programs
2. Read, analyze and interpret laboratory data effectively and correctly as applicable to regulations
3. Review and update quality manual annually
4. Oversee Initial and Continuing Demonstration of Capability (IDOC & CDOC) documentation
5. Ensure internal audits are performed
6. Conduct management review every 12 months

Sub-Domain 3.3:

Regulatory Compliance

1. Ensure adherence to government regulations, including:
   - EPA regulations as applied to laboratories (Clean Water Act, 40 CFR Part 136)
   - California Drinking Water Regulations (Title 22)
   - Safe Water Drinking Act
   - NPDES permit compliance and regulatory authority
   - OSHA (IIPP, ERP, HCP)
   - NFPA (chemical storage and labeling)
   - Method Update Rule
   - Laboratory accreditation (ELAP/TNI)
   - Hazardous waste program
   - CUPA
   - 503 Regulations Compliance
   - Indirect Potable Reuse Order Compliance
2. Prepare and approve technical reports and correspondence on various matters as required by the National Pollution Discharge Elimination Systems (NPDES),

Discharge Monitoring Report (DMR) permits, Division of Drinking Water (DDW) and Regional Water Quality Control Board (RWQCB), and Title 22 (California Laboratory Intake Portal Reports)

3. Knowledge of Drinking Water regulations, such as MCLs, DLRs, notification limits, chlorine and chloramine disinfection, nitrate, treatment technologies (GAC, ion exchange, reverse osmosis), blending calculations, arsenic, PFAS, well operations, water quality issues specific to groundwater, surface water, and recycled water, lead and copper rule, water quality issues related to storage tanks
4. Provide or ensure laboratory staff provide the required notifications for any analyzed constituent that exceeds regulatory standards within the required timeframe
5. Knowledge of and ability to upload laboratory data into required electronic data portals

Sub-Domain 3.4:

Ethics

1. Oversee laboratory ethics training program
2. Oversee the avoidance, reporting, and corrective action of ethics violations such as improper data manipulations, adjustments of instrument time clocks, and inappropriate changes in concentrations of standards
3. Understand the consequences of ethics violations
4. Understand data integrity and legal defensibility
5. Understand the root causes of fraud and techniques to avoid or discourage fraud
6. Oversee, schedule, implement, and report annual performance testing monitoring requirements for laboratory accreditation; address noncompliance issues with corrective action requirements

Domain 4: Safety

Sub-Domain 4.1:

Hazards and Hygiene

1. Understand biological and chemical hazards and hygiene (handling, storage, and disposal)
2. Understand engineering controls (fume hoods, etc.)
3. Understand physical hazards (burns, sharps, compressed gas, electrical safety, fire, ladder use, slip/trips/falls, etc.)
4. Advanced knowledge of safety regarding inhalation hazards, including how to test and use a respirator

5. Oversee and ensure the appropriate use of Personal Protective Equipment (PPE) and safety measures such as face shields, gloves, and emergency showers

Sub-Domain 4.2:

Safety Management

6. Direct implementation of corrective action for laboratory hazards
7. Develop, review, revise, implement, and enforce the Laboratory Chemical Hygiene Plan (CHP)
8. Oversee the maintenance of laboratory safety data sheet (SDS) records
9. Ensure work is performed in a safe manner consistent with safety policies and procedures
10. Understand field sampling hazards, including vehicle (driving) hazards, the recognition of confined-space entry hazards, manhole sampling and safety, etc.
11. Knowledge of accident notification procedures and ability to deal with on-the-job injuries
12. Oversee, coordinate, and document staff safety trainings

Domain 5: Math

Sub-Domain 5.1:

Statistics and Sampling

1. Apply statistical methods used to analyze acute and chronic toxicity test data
2. Analyze a variety of statistical data and/or information and make recommendations based on findings
3. Program a flow-based sampling schedule
4. Calculate running annual averages (RAA), operational evaluation levels (OELs), and 90th percentiles

Sub-Domain 5.2:

Calculations

1. Ensure accurate calculations when preparing solutions (dilution factors, normality, molarity) and performing sample dilution
2. Ensure accurate calculations were used when assessing the results from different parameters of a sample correlate
3. Ensure accurate calculations were used when assessing quality control (recoveries, RPD) and control charting
4. Ensure that method detection limit (MDL) calculations are accurate

Suggested References

CWEA's exam is based on a job task analysis that includes research of the essential duties of a Laboratory Analyst at a representative cross-section of systems and facilities in California. CWEA's exams do not correspond directly to any specific textbook, educational course, or

program; instead, the exams are based on an analysis of the duties commonly performed in actual practice. In developing the exam, CWEA Subject Matter Experts used their years of experience in the field along with the key textbooks and reference materials listed below. Candidates should understand that the references listed do not necessarily cover all exam content. Candidates who meet the minimum qualifications for this exam may find these suggested references useful when preparing for this exam; however, these suggested references are not required reading and should not be interpreted as constituting the sole source of all exam questions.

This list does not include all the available textbooks and materials for studying for this exam. Candidates are strongly encouraged to seek additional material, training, and experience, especially in content areas for which the candidate is not adequately prepared. Candidates are encouraged to prepare for CWEA certification exams using as many different study materials as possible plus education events and on-the-job training. Recommended reading from the Office of Water Programs (which is a third-party) was provided by their team based on their expertise and review of CWEA's content outlines. Candidates are encouraged to develop their own personal study plan based on individual needs and knowledge.

Domain 1 – Management & Administration	
Sub-Domain 1.1	Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 624-694 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 403-441 Utility Management, 3rd Edition. Pages 1-40 Manage for Success, 1st Edition. Pages 1-169
Sub-Domain 1.2	Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 624-694 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 441-454 Utility Management, 3rd Edition. Pages 82-95 Manage for Success, 1st Edition. Pages 279-307
Sub-Domain 1.3	Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 624-656 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 400-454 Utility Management, 3rd Edition. Pages 2-36 Manage for Success, 1st Edition. Pages 7-71

Domain 2 – Testing & Analysis	
Sub-Domain 2.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 557-629, 691-719 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-935, 1001-1031 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Sections 2120B; 2130A,B; 2310 A,B; 2320 A,B; 2340 A,C; 2350B; 2510A,B; 2520 A,B; 2540; 2710 B,C,F; 3110, 3112, 3114, 3120, 3125; 3500Ca B; 3500 B; 4110 A,B ,C; 4500 CN B,C,D,E,F,N; 4500 A,B,C,D,G; 4500-H+; 4500-NH3 A,B,D,E; 4500-NO2- B; 4500 NO3- E; 4500 B,C; 4500-O A,B,C,D,E,G,H; 4500 A, E; 4500A,B,C; 5010, 5210 A,B; 5220 A,C,D; 5310 A,C ;5520 A,B,D; 6200A,B; 6232 A,B,C; 6410 A,B; 6431A,C; 6440 A,C; 6630A,D; 6640A,B; 5540, 7010,7020; 8010, 8020, 8712, 8910, 8921; 9010, 9030, 9040, 9050, 9060, 9211, 9215, 9221, 9222, 9223, 9225, 9230.
Sub-Domain 2.2	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-550; 538-544 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-814 Operation of Wastewater Treatment Plants, Volume 2, 8th Edition. Pages 716-721 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 458-477 Utility Management, 3rd Edition. Pages 95-115 Manage for Success, 1st Edition. Pages 253-279, 307-357 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Sections 1080, 1060
Sub-Domain 2.3	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-629, 634-752, 545-548 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 775-935, 944-1030 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Sections Before the preface, 1010C
Sub-Domain 2.4	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 557-629, 691-719 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 760-762; 775-935, 1001-1031

	Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Section 1040
Sub-Domain 2.5	
Domain 3 – Documentation, Compliance, and Ethics	
Sub-Domain 3.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 534-628, 548 Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 717-721 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 42-45 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 454-458 Manage for Success, 1st Edition. Pages 253-279, 307-357 Utility Management, 3rd Edition. Pages 95-115 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Section 1030, 1050
Sub-Domain 3.2	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 538-544, 549 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 760-762 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Sections 1020, 2020, 3020, 4020, 5020, 6020, 8020, 9020, 1030, 1040
Sub-Domain 3.3	Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 716-721 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 454-478 Utility Management, 3rd Edition. Pages 36-40 Manage for Success, 1st Edition. Pages 253-279
Sub-Domain 3.4	
Domain 4 – Safety	
Sub-Domain 4.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 550-557 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 762-775

	Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 690-718 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 488-498 Utility Management, 3rd Edition. Pages 50-61 Manage for Success, 1st Edition. Pages 357-385 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Sections 1090, 1100
Sub-Domain 4.2	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 550-557 Water Treatment Plant Operation, Volume 2, 7th Edition. Pages 690-718 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 762-775 Operation of Wastewater Treatment Plants, Volume 3, 1st Edition. Pages 488-498 Utility Management, 3rd Edition. Pages 50-61 Manage for Success, 1st Edition. Pages 357-385 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Sections 1090, 1100
Domain 5 – Math	
Sub-Domain 5.1	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 619-629, 691-720 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 814-818, 1001-1031 Standard Methods for the Examination of Water and Wastewater, 23rd Edition. Sections 1010B, 1010C, 1020B,C, 1030
Sub-Domain 5.2	Water Treatment Plant Operation, Volume 1, 7th Edition. Pages 634-752, 691-720 Operation of Wastewater Treatment Plants, Volume 1, 8th Edition. Pages 944-1030, 1001-1031

Suggested References List

- Manage for Success, Effective Utility Leadership Practices, 1st Edition. Office of Water Programs
- Operation of Wastewater Treatment Plants, Volume 1, 8th Edition, Office of Water Programs
- Operation of Wastewater Treatment Plants, Volume 2, 8th Edition, Office of Water Programs

- Operation of Wastewater Treatment Plants, Volume 3, 1st Edition, Office of Water Programs
- Pretreatment Facility Inspection, 4th Edition, Office of Water Programs
- Standard Methods for the Examination of Water and Wastewater, 23rd Edition
- Utility Management, A Field Study Training Program, 3rd Edition. Office of Water Programs
- Water Treatment Plant Operations, Volume 1, 7th Edition, Office of Water Programs
- Water Treatment Plant Operations, Volume 2, 7th Edition, Office of Water Programs
- 2016 TNI Laboratory Accreditation Standard, The NELAC Institute

Sample Questions

This section provides sample questions to help applicants become familiar with the exam format and subject matter.

1. How can the supervisor be certain that scheduled maintenance is completed?
    a. Ask the workers
    b. Hire someone to inspect completed work
    c. Use a form that compares work assigned with work completed
    d. Wait and see if there are any failures

2. Word has just come down from the upper management that operating funds are being cut. How should this be handled?
    a. Cut the supplies and repairs in order to balance the budget
    b. Fire some of the less productive old employees
    c. Keep it quiet and do what you have to do—the less said the better
    d. Let the other personnel know what the situation is and ask for their help
3. In the cyanide determination, which one of the following is not an interference?
    a. Sulfides
    b. Hydrogen cyanide
    c. Fatty acids
    d. Carbonates
4. A mass spectrometer is an instrument:
    a. containing a hollow graphite rod that can be heated electrically to about 2500°K to decompose and atomize a sample for analysis.
    b. which measures a sample that has been bombarded with electrons to produce charged molecular fragments that are separated according to their mass in a magnetic field.
    c. in which an electric potential exists at the junction between two different electrolyte solutions or substances.
    d. in which the analytes are immediately accelerated by a powerful radiofrequency field that oscillates about a load coil at a frequency of 27 MHz.
5. An application for laboratory accreditation (ELAP or NELAP) includes:
    a. laboratory information; personnel qualifications for the lab director and the quality assurance officer; fields of testing; invoice for fees; and the submission of a quality assurance manual.
    b. laboratory information; personnel qualifications for the lab director, the emergency response team leader, and the quality assurance officer; fields of testing; and the submission of a quality assurance manual.
    c. laboratory information; personnel qualifications for the lab director and the quality assurance officer; fields of testing; and the submission of a quality assurance manual and the standard operating procedures manual.
    d. laboratory information; personnel qualifications for the lab director, the quality assurance officer, and the safety officer; fields of testing; and the submission of a standard operating procedures manual.
6. Why are good records important?
    a. To demonstrate a pattern of lawful behavior over time
    b. To demonstrate your good report-writing skills
    c. To provide a journal record all uncritical events
    d. To prepare for facility audits

7. As a laboratory supervisor, you must see that someone is primarily responsible for safety supervision. The most appropriate method of assigning this duty would be:
    a. to rotate the responsibility to someone new each month so everyone will feel involved in laboratory safety issues.
    b. to assign a permanent safety officer so that the individual can provide planning continuity and follow-up attention to reported hazards.
    c. to ask for a volunteer because volunteers tend to be more conscientious and capable because they have expressed an interest in the job.
    d. as a laboratory supervisor, you are ultimately responsible for laboratory safety and are unable to delegate this important responsibility.
8. When developing an Emergency Response Plan, the first step is to:
    a. inventory all chemicals in the laboratory.
    b. identify the tasks assigned to each group responding to emergency situations.
    c. identify the line of authority in an emergency.
    d. identify the hazards and dangers faced by the plant.
9. Calculate the method detection limit given the following information.
    A standard solution was analyzed 7 times with the following results in mg/L:
    0.0356 0.0380
    0.0352 0.0360
    0.0371 0.0374
    0.0346
    Calculated mean = 0.0362
    Calculated standard deviation = 0.00125 T Scores

    Level of Certainty

N	90%	95%	99%	99.5%
1	3.078	6.314	31.821	63.657
2	1.886	2.920	6.965	9.925
3	1.638	2.353	4.541	5.841
4	1.533	2.132	3.747	4.604
5	1.476	2.015	3.365	4.032
6	1.440	1.943	3.143	3.707
7	1.415	1.865	2.998	3.499
8	1.397	1.860	2.896	3.355

    a. 0.00393 mg/L
    b. 0.00375 mg/L
    c. 0.109 mg/L
    d. 0.114 mg/L
10. You must select one of two approved methods for performing an analysis. Method A

requires 30 minutes of analyst time per test and uses no special instruments. Method B requires 15 minutes of analyst time per test and uses an instrument costing $30,000. The Base salary for the analyst is $2,600 per month, employer paid benefits add 35% to the base salary, and administrative overhead adds another 45%. Assume there are 2,080 working hours per year. The instrument has a one-year full warranty; maintenance and repair costs for subsequent years are estimated to be $1,000 per year. The instrument has an eight-year service life. The test is now run on one sample at each of three locations, five days per week. Regulatory requirements may add one or two more sampling locations to the present requirements. The justification for expenditure for an instrument must show at least a 20% cost saving. (Assume there is no inflation in the salary for this example.) The recommendation you make is to:

a. remain with Method A.
b. purchase the equipment with the present requirements.
c. purchase the equipment if one more sample location is added.
d. purchase the equipment if two more sample locations are added.

Answer Key and Solutions

1. C – Domain 1
2. D – Domain 1
3. B – Domain 2
4. B – Domain 2
5. A – Domain 3
6. A – Domain 3
7. B – Domain 4
8. D – Domain 4

9. A – Domain 5

Solution:

Standard Methods states: Analyze seven portions of this solution and calculate the standard deviation. Compute MDL from replicate measurements one to five times the actual MDL. From a table of the one-sided t distribution, select the value of t for 7 - 1 = 6 degrees of freedom at the 99% level; this value is 3.14. The product 3.14 times the standard deviation is the desired MDL.

3.14 x 0.001252 = 0.00393

10. D – Domain 5

Solution:

Determine total cost of analyst's time:

$$\frac{\$2{,}600 + (\$2{,}600 \times 0.35) + (\$2{,}600 \times 0.45)}{\text{month}}$$

= $4,680/month

$$\frac{\$4{,}680}{\text{Month}} \times \frac{12 \text{ months}}{1 \text{ year}} \times \frac{1 \text{ year}}{2{,}080 \text{ hrs}} = \$27.00/\text{hr}$$

Method A:

Cost/sample (Analyst's time) =

$$\frac{\$27.00}{\text{hr}} \times \frac{1 \text{ hr}}{60 \text{ mins}} \times \frac{30 \text{ mins}}{\text{sample}}$$

= $13.50/sample

Present workload = 15 samples/week

15 samples/week x $13.50/sample

= $202.50/week

With 1 additional sample point

= 20 samples/week

20 samples/week x $13.50/sample

= $270.00/week

With 2 additional sample points

= 25 samples/week

25 samples/week x $13.50/sample

= $337.50/week

Method B:

Cost/sample (Analyst's time) =

$$\frac{\$27.00}{\text{hr}} \times \frac{1 \text{ hr}}{60 \text{ mins}} \times \frac{15 \text{ mins}}{\text{sample}} = \$6.75/\text{sample}$$

Present workload = 15 samples/week

15 samples/week x $6.75/sample
= $101.25/week
With 1 additional sample point
= 20 samples/week
20 samples/week x $6.75/sample
= $135.00/week
With 2 additional sample points
= 25 samples/week
25 samples/week x $6.75/sample
= $168.75/week
Instrument costs:
$30,000 + (7 years x $1,000/year maintenance) = $37,000 over 8 years
$37,000 x 1 year = $88.94/week
8 years 52 weeks
Method B present workload
= $101.25 + $88.94 = $190.19/week
Method B with 1 additional sample point
= 20 samples/week = $135.00 + $88.94
= $223.94/week
Method B with 2 additional sample points
= 25 samples/week = $168.75 + $88.94
= $257.69/week
Method A / Method B relative costs:
Present workload = $190.19 = 0.94
$202.50
With 1 additional sample point =
$223.94 = 0.83
$270.00
With 2 additional sample points =
$257.69 = 0.76
$337.50
The addition of two sample points would justify the expenditure due to a cost savings of
>20%.

LAB FORMULA SHEET

This formula sheet is available onscreen during the exam.

Element Name, Symbols and Standard Atomic Weights:*

Aluminum	Al	26.981
Arsenic	As	74.921
Calcium	Ca	40.078
Carbon	C	12.010
Chlorine	Cl	35.446
Chromium	Cr	51.996

Conversion Factors:

1 gal = 8.34 lbs
1 cu ft = 7.48 gal
1 lb = 454 grams

Copper	Cu	63.546
Hydrogen	H	1.007
Iodine	I	126.904
Iron	Fe	55.845
Magnesium	Mg	24.305
Nickel	Ni	59.693
Nitrogen	N	14.006
Oxygen	O	15.999
Phosphorus	P	30.973
Potassium	K	39.098
Silver	Ag	107.868
Sodium	Na	22.989
Sulfur	S	32.059

Abbreviations

AA = atomic absorption
AE = atomic emission
mL = milliliter
mg = milligram
L = liter
g = gram
GC = gas chromatography
M = molar
N = normal
MGD = million gallons per day

MPN Index (10 mL, 1.0 mL, 0.1 mL)

5 - 3 - 0	80 MPN/100mL
5 - 5 - 3	900 MPN/100mL
5 - 5 - 4	1600 MPN/100mL
5 - 5 - 5	> 1600 MPN/100mL

*Source: Standard Methods for the Examination of Water and Wastewater, 22nd Edition

CREATING A STUDY PLAN

Completing a Gap Analysis

CWEA certification exams are experience based. The Gap Analysis Tool is designed to help candidates identify which grade level is best suited to their current level of experience, and where they may be lacking sufficient experience.

This free self-evaluation is available on the CWEA website for all vocations.

Candidates are encouraged to develop their own personal study plan based on individual needs, experience and knowledge. Candidates should seek as many different study materials as possible as well as attend educational events and on-the-job training. This is especially important for areas in which the candidate is not adequately prepared.

CWEA's exams do not correspond directly to any specific textbook, educational course, or program. Instead, the exams are based on an analysis of the duties commonly performed in actual practice.

CWEA Local Section Training

It is the goal of CWEA's Technical Certification Program to operate in line with established best practices for certification programs. As such, CWEA is careful to separate its education and training activities from its certification program to ensure that no conflict of interest exists. Any educational materials or trainings that are designed to prepare candidates for an exam are developed and conducted by individuals that do not have access to the exams.

CWEA Local Sections host education and training events throughout the year that focus on the job duties tested by our certifications. These trainings are limited based on demand and volunteer availability.

Local Section trainings can be found on the CWEA Events Website. For questions about a Local Section training, please contact the Local Section directly. Contact information for individual Local Sections can be found in our Directory.

EXAM DAY INFORMATION

Test Site Admission and Exam Information

Applicants are required to show at least one current, valid, government-issued photo identification, such as a state driver's license or ID, or passport. A temporary license is acceptable if there is an expiration date, or if it is accompanied by paperwork explaining an expiration date.

Candidates have three (3) hours to complete the exam.

The formula sheet from this Handbook will be available on the exam screen.

For more information about the number of questions on each exam, see *Exam Scoring* (p. 96).

Calculators Allowed

An onscreen calculator with basic and scientific capability is available on all CWEA exams. Applicants may bring a handheld calculator to a test center as long as it is from the CWEA approved calculator list:

Casio	All FX-115 models (any Casio calculator with FX-115 in its name)
Texas Instruments	All TI-30x and TI-36x models
Sharp	EL models *except* EL-W516B and EL-W535B

Pearson VUE's Candidate Rules Agreement

Pearson VUE maintains its own rules regarding professional examinations. All applicants are required to sign the Candidate Rules Agreement at the test center prior to sitting the exam. Applicants are responsible for knowing and complying with these rules. CWEA recommends all applicants familiarize themselves with this agreement prior to testing.

AFTER THE EXAM

Exam Result Notification

Applicants will see their result on the screen immediately after the exam is submitted. An Official Score Report will be printed out and given to the applicant before they leave the test center. Additional copies can be obtained by logging into the Pearson VUE user account. All results are confidential and will only be released to the applicant. No results will be given over the phone, by fax or email.

Exam Appeal Policy

All appeals must be submitted within two weeks of the exam date. Appeals will be reviewed by CWEA staff and/or Subject Matter Experts. Candidates' personal information will remain confidential and will not be accessible to Subject Matter Experts. Candidates will be updated on the status of their appeal within 4-6 weeks, and they will be notified in writing when a decision has been made. Once an appeal has been processed, candidates cannot submit a new appeal for the same exam.

Candidates cannot submit an appeal simply because they did not pass the exam.

Candidates can appeal under the following justifications:

Exam Delivery Appeal

Candidates may appeal testing conditions severe enough to have caused a major disruption of the examination process. CWEA staff will review the appeal and consult our exam administrator, Pearson VUE, to investigate the appeal if necessary. Please note, under Pearson VUE's candidate agreement, candidates must notify the proctor immediately during the exam of any issues to open a claim documenting the incident. If candidates did not notify the proctor during the exam, an appeal may still be submitted but may be dismissed if CWEA cannot verify the validity of the complaint.

Exam Question Appeal

If the candidate wishes to comment on specific exam questions, they may flag the question during the exam using the Flag to Enter a Comment function. Candidates are allowed to add comments about any question as long as there is time remaining. All comments will be reviewed and considered by the Technical Certification Program as part of the ongoing exam review and development process. Candidates that wish to submit an appeal of their exam results, must complete the form below within two weeks of their exam date. Candidates that wish to have specific comments considered in support of their appeal should indicate so on the appeal form.

Non-substantive appeals or appeals without just cause will be automatically rejected. If candidates are not satisfied with the outcome of their appeal, they may submit a request for review by the Technical Certification Program Executive Committee at tcpcommittee@cwea.org. The committee's decision will be final.

All communication related to certification decisions and appeal results with the Technical Certification Program Executive Committee must be sent in writing to tcpcommittee@cwea.org. We ask that candidates do not contact committee members directly.

The appeal form can be accessed here: CWEA Exam Appeal Form.

Retest Application

If the candidate does not pass the exam the first time, they can submit a retest application along with the appropriate fees. The candidate will be required to skip at least one exam window before they are eligible to retest. If the candidate tested within the first 15 days of a window, they are not required to skip an exam window. Under no circumstances are candidates allowed to sit for the same exam twice in the same window. There are no exceptions to this policy.

To be eligible to use the retest application form, candidates must submit the application within one year of their original exam date. Candidates must meet the minimum qualifications of the exam for which they are applying. CWEA may require candidates to fill out a full application with job history to verify candidates meet the minimum requirements. Use of a retest application does not guarantee approval for any exam.

Receiving the Certificate and Blue Card

Certificates and Blue Cards will be issued to all candidates who pass their exam. The certificate contains the certification number and expiration date. The Blue Card contains the expiration date, contact hour due date and contact hour period. These documents are mailed along with the Score Report within 4 weeks to the address on file with CWEA. Candidates are responsible for making sure this address is current.

MAINTAINING CERTIFICATION

How to Renew

All certifications must be renewed annually. Certifications expire one year from the last day of the month in which the certification was earned. Renewal notices are mailed to certification holders three months before the expiration date. Certification holders can pay their renewal

online by logging into their mycwea.org account or by mailing their renewal notice with a check or credit card information to the CWEA office. Renewal certificates and blue cards will be mailed within 4 weeks to the address on file with CWEA.

Certification holders are required to meet Continuing Education (CE) requirements. This requirement is met by completing 12 contact hours (1.2 CEUs) of vocation-related education or training every two years. For more information about earning contact hours, for details see *Earning Contact Hours* (p. 91).

Not meeting these requirements by the expiration date will cause the certification to expire. Certifications that have been expired for more than three months are subject to a $35 late fee. If a certification holder does not meet the renewal requirements within two years of their expiration date their certification will permanently expire. To become certified once again, the individual must re-apply for certification and pass the exam. It is the certification holder's responsibility to ensure that his or her certification remains valid. There are no exceptions to these policies.

Renewal Fees

Current fees are listed on the CWEA website. Valid CWEA members qualify for a discounted member rate. The non-member rate includes a one-year CWEA membership. If an applicant does not wish to take advantage of the membership, please inform CWEA.

Continuing Education (CE) Requirement

Certification holders are required to meet Continuing Education (CE) requirements. This requirement is met by completing 12 contact hours (1.2 CEUs) of vocation-related education or training every two years. Certification holders may submit up to 50% (6 contact hours) of the required contact hours in safety related training. One contact hour is defined as 50 minutes of participation in an organized continuing education experience under responsible sponsorship, capable direction, and qualified instruction.

Contact hours must be earned within the contact hour period. Hours are earned on the date of completion of the educational or training program. The program may begin before, but must be completed during the contact hour period. If a certification holder will not earn the required hours within their contact hour period, they must notify CWEA before the period ends if they wish to remain certified, for details see *Temporary Deactivation* (p. 93).

Individuals holding more than one CWEA certification can apply the same contact hours to each certification as long as the training is relevant to each vocation. Training is acceptable as long as it is related to the vocations in which certification is held. CWEA may send contact hour certificates to Subject Matter Experts to determine relevancy.

In-house training can be used to meet this requirement as long as standard Safety Tailgate meetings do not exceed 50% (6 contact hours). In-house training includes any training that is conducted by an employer, or a trainer contracted by an employer.

Earning Contact Hours

Contact hours may be earned by any of the following activities:

- Attendance at educational/training programs, including in-house training
- Teaching, instructing or presenting educational/training material (1 hour per 25 min)
- Developing and reviewing CWEA certification exam content as a Subject Matter Expert (1 hour per 25 minutes)
- Authorship of published books or articles (2 hours per book or article)
- Retesting and passing the relevant CWEA certification exam (12 hours)
- Membership in professional membership organizations (.5 hours per year, per membership, with a maximum of 6 hours per contact hour period)

CWEA may require and request additional documentation to assess the authenticity and/or relevance of these activities.

This information is paraphrased for clarity from the 02-03 TCP Re-Certification Policy; a full copy of the policy can be requested by contacting the TCP department.

Contact Hour Documentation

Proof of contact hour completion for an educational/training program must meet these following guidelines:

- The name of the training organization
- The training title
- The name of the attendee who completed the program
- The number of contact hours earned
- The date of completion

- An official signature or stamp from the training organization, instructor's signature is acceptable

For other continuing education activities, CWEA may request additional information. Any documentation that does not meet these guidelines will not be accepted. It is the certification holder's responsibility to retain verification of records documenting earned contact hours and submit proof to CWEA.

Contact Hour Audit

Audits are conducted on a regular basis by CWEA to ensure that certification holders are complying with the continuing education requirement and that the documentation meets the guidelines. Certification holders are randomly selected for an audit of contact hours. The audit reviews the relevancy of the trainings to the vocation, and the dates in which the contact hours were earned to ensure that they fall within the appropriate contact hour period.

Selected participants will be notified via email that they have either successfully passed the audit, or that CWEA requires further information.

Temporary Deactivation

The Temporary Deactivation program is for certification holders that will not meet the continuing education requirement for recertification by their expiration date. Under this program, certification holders can request that CWEA temporarily deactivate their certification for up to two years from their expiration date. This grants the individual extra time to earn the required contact hours. During the time of temporary deactivation, the CWEA certification is invalid and may not be used. Certification holders can apply for reactivation once they fulfill all requirements. Certification must be in good standing to qualify for this program. For more information including current fees, or to request an application for temporary deactivation, contact the CWEA office.

The application must be submitted before the certification expiration date. There is no exception to this policy.

Reinstating Certification

If a certification expires, it is invalid until all recertification requirements are met. There is a three-month grace period before a certification is considered lapsed. Once a certification becomes lapsed, the certification holder will need to pay a $35 late fee in addition to meeting the renewal requirements. Certification will remain lapsed for up to two years from the expiration date. If a lapsed certification is not renewed within the two-year period, the certification becomes permanently expired.

Expired Certification

Certificates expired for two years, or longer, cannot be reinstated under any circumstances. To become certified once again, the individual must re-apply for certification and pass the exam. It is the certification holder's responsibility to ensure that his or her certification remains valid. There are no exceptions to these policies.

Retiring Certification

Certification holders can request that CWEA retire their certification at the time it expires if they no longer wish to hold it. Once a certification has been retired, the certification will no longer be valid and CWEA will cease all communications regarding the certification. A retired certification can be reactivated only if the certification holder has met all renewal requirements within the appropriate timeframe and the certification has not permanently expired.

EXAM DESIGN AND FORMAT

Exam Design

All certification exams are designed to test knowledge required to perform the essential duties of a job at a given grade level with minimum acceptable competence. Exams are created by Subject Matter Experts under the guidance of exam development professionals.

Exam content is developed from a job task analysis that includes research of the essential duties at a representative cross-section of systems and facilities throughout California. All exam items are written by subject matter experts based on the content outline established by the job task analysis. These items are used to create the exam forms. The pass point for each exam is based on difficulty, using the Modified Angoff Method, for details see *Pass Point* and *How Pass Points are Set* (p. 95).

Exam Delivery Mechanism

All exams are computer-based format and are available in the English language only. Exams are delivered at Pearson VUE testing centers or via Pearson VUE's online testing platform On Vue.

Exam Format

All certification exams are in multiple-choice format. Multiple-choice is considered the most effective format for use in standardized tests as it allows for greater content coverage for a given amount of testing time and improves competency measurement reliability. Multiple choice questions range in complexity from simple recall of knowledge to the synthesis and evaluation of the subject matter.

Weighting

The percentage of the exam that covers a particular content area is referred to as its weighting. Weightings are established through a Job Task Analysis and are based on the frequency and criticality of the task. A weighting is approximate and shows the relative importance of a particular area compared to the other portions of the exam. Weightings are indicated on the content outline for each exam and can be found in the preparation materials. Each weighting on the actual certification exam may vary slightly.

Pass Points

An exam pass point is the minimum score required to pass a certification exam. The pass point is also known as a cut score or passing score. Candidates should try to score as high as

possible on their exam. Pass points for CWEA certification exam vary with each exam form. The pass point for each vocation, grade level and exam form is set independently.

How Pass Points are Set

A modified Angoff Method is used to determine the pass point for each version of each exam. The modified Angoff Method uses expert judgments to determine the difficulty level of the exam. The easier the exam, the higher the pass point. Likewise, the more difficult the exam, the lower the pass point.

The following is a basic outline of the modified Angoff Method (some details have been omitted):

1. A group of Subject Matter Experts (SMEs) independently rate each exam question within a given exam. The ratings are defined as the probability, or likelihood, that a minimally competent person with the requisite education and experience will answer the question correctly. A minimally competent person is defined as someone who adequately performs all job functions safely and requires no further training to do so.
2. The SMEs review each exam question as group. A consensus is reached for the rating of each exam question. During this time the SMEs review comments submitted in writing by exam-takers. Any exam question that is judged to be ambiguous, has more than one correct answer, or has no correct answers is eliminated from the scoring process for that exam. These exam questions are then revised for future use, re-classified, or deleted from the exam item bank.
3. After the data are refined, the final step is to calculate the mean, or average, of all the exam question ratings. This becomes the overall pass point estimation.

Why Use Modified Angoff?

Each version of a given certification exam pulls questions from an exam item bank. Each of these questions varies in difficulty. Because a different mix of questions is used in each exam form, the overall difficulty level is not fixed. Thus, it is important to make sure that the varying difficulty level is reflected in the pass point of each exam to ensure that results are reliable. Exam reliability is concerned with the reproducibility of results for each version of a given exam. In other words, for an exam to be reliable it must yield the same result (pass or fail) for the same individual under very similar circumstances. For example, imagine a candidate takes an exam at a certain grade level and passes it. Immediately after completing the exam, the candidate takes the same grade level exam, but a different version. If the exam is reliable they

will achieve the same result: pass. If they do not, it is likely that the exam is not a reliable measure of minimal competency.

By taking into consideration the difficulty level of an exam, the modified Angoff Method significantly increases the reliability of the exams. Also, since each exam is adjusted for difficulty level, each exam version has the same standard for passing. Thus, exam-takers are treated equitably and fairly, even if they take different versions of the exam.

There are other methods for setting pass points. However, for the type of exams administered by CWEA, the modified Angoff Method is the best.

Exam Scoring

All exams are electronically scored by Pearson VUE. Most exam items are valued at one point unless otherwise stated on the exam. After exams are scored, total points are compiled, and an overall score is calculated as the sum of all points earned on the exam. If the overall score is equal to, or greater than the established pass point, the candidate has passed the exam. Each question is worth 1 point. Total points possible for each exam are as follows:

- Grade 1 – 100 points
- Grade 2 – 100 points
- Grade 3 – 100 points
- Grade 4 – 85 points

Summary of Certification Activities

A summary of certification activities for each vocation is available upon request. The summary includes pass/fail statistics, and the number of individuals currently certified. To request this information, please visit the CWEA website.