

Certification Examination

Study Guide

Collection System Maintenance

Grade II

2nd Edition



New 2nd Edition

- * Revised for 2011 tests.
- * New KSA descriptions including KSA weighting.
- * Expanded practice test and solutions.
- * Searchable text optimized for electronic reading.



California
Water
Environment
Association



Collection System Maintenance Grade II Study Guide, 2nd Edition

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Appendix A: You and Wastewater Math

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Cover Photo Courtesy of Orange County Sanitation District

Important Notice: CWEA is pleased that you have purchased this book. We want to remind you that this book is one of many resources available to assist you and encourage you to identify and utilize the other resources in preparing for your next test.

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Grade II Collection System Maintenance Study Guide

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Introduction

What to Expect From This Study Guide

The purpose of this study guide is to help certificate candidates understand what is expected of them on the certification test and to help them identify resources to assist in preparation for the test. It is not a comprehensive text on the wide variety of topics covered on the certification test. Successful candidates should expect to spend significant time reading and reviewing additional materials listed in this study guide along with any other materials available that can help them understand the subject matter of the test. In addition, successful preparation strategies include attending study sessions, participating in study groups, and completing relevant vocational and college courses. Ultimately, the amount of preparation required to pass the test depends on a candidate's education, training, and work experience. After reviewing this study guide, you should be able to determine what you need to do to prepare for the test and how much time you will need (months are often required).

About the CWEA Certification Program

The California Water Environment Association (CWEA) Technical Certification Program (TCP) is either required or encouraged by many wastewater employers. Its purpose is to set a standard of the essential requirements for an individual to perform a given job safely and effectively, and to provide a measure of competency through certification testing. The certification test focuses on the Knowledge, Skills, and Abilities (KSAs) an individual must master to perform their job safely and effectively.

CWEA certifies personnel in six vocations:

- Plant Maintenance Technologist (with two parallel specialties of Electrical/ Instrumentation, and Mechanical Technologist)
- Laboratory Analyst
- Collection System Maintenance Technologist
- Environmental Compliance Inspector
- Industrial Waste Treatment Plant Operator
- Biosolids Land Application Management

Upon qualifying and successfully completing the certification test, an individual becomes certified in that specialty at that grade level. Grade levels within a vocation designate technical knowledge for the entry-level, apprentice, journey, and management levels. More information about minimum qualifications can be found in the Candidate Handbook for your vocation available at www.cwea.org/cert or calling 510-382-7800.

Much of the CWEA mission is dedicated to providing education and training in all aspects of the wastewater industry including the KSAs of each certification vocation. CWEA is careful to separate its education and training activities from its certification activities to ensure that the educational focus is on the KSAs wastewater professional need to know to perform their jobs rather than being narrowly focused on just passing the certification test.



Certification Program and Policies

CWEA's mission is to enhance the education and effectiveness of California wastewater professionals through training, certification, dissemination of technical information, and promotion of sound policies to benefit society through protection and enhancement of the water environment.

CWEA is a California Nonprofit Corporation, a Member Association of the Water Environment Federation (WEF), and a member of the Institute of Credentialing Excellence (ICE).

Technical Certification Program History

TCP was created to offer multilevel technical certification for individuals employed in the water quality field. Tests are written by vocational specialists and administered year round in six different vocations: Collection System Maintenance, Environmental Compliance Inspection, Laboratory Analysis, Plant Maintenance (Electrical/Instrumentation and Mechanical Technologist), Industrial Waste Treatment Plant Operation, and Biosolids Land Application Management.

CWEA first offered a certification program for wastewater treatment plant operators in 1937. The program was administered by CWEA until 1973 when the State of California assumed responsibility. During those 36 years, CWEA awarded 3,915 operator certificates.

CWEA established its Line Maintenance certification program in 1964. Eventually that would become the Collection System Maintenance certification program. In 1974 the first committees were formed to establish a voluntary certification program for water quality professionals specializing in disciplines other than plant operation. The following year the State Water Resources Control Board suggested that CWEA implement an industrial waste pretreatment certification program. TCP, then known as the Voluntary Certification Program or VCP, emerged in 1976 with specialized certificate programs for Plant Maintenance, Environmental Compliance Inspection, and Laboratory Analysis with certifications first issued in April 1976. In the 1980s, two more disciplines were added: Electrical/Instrumentation and Industrial Waste Treatment Plant Operator.

Today, CWEA offers certification in vocational programs with a total of 23 individual certifications. About 2,000 applications are processed annually and currently over 5,500 certificates are held by individuals primarily in California. CWEA also partners with other WEF Member Associations to offer certification in Michigan, Hawaii, and Missouri.

Certification Process

To become certified, *all applicants* must complete the Application for Technical Certification, pay the application fee, meet minimum qualifications regarding professional experience and education, and pass the computer-based test. Application instructions and fee schedules are listed on the application. After applications are received at the CWEA office, applicant information is compiled in a database, and reviewed by CWEA staff and experts in the field. If timing permits, staff will work with the applicant to resolve any incomplete applications. When approved, the applicant will receive an acceptance letter and test registration and scheduling instructions.



Immediately after completion of the computer-based test, a preliminary score and result will be given at the testing center. Occasionally, the official results may be adjusted from the preliminary results to resolve scoring issues. Official results are mailed to candidates. Those who pass the test, are mailed certificates and blue wallet cards (also known simply as “blue cards”).

Test Administration

Test Dates and Sites

Tests are given throughout the year within four quarterly windows (see Application for Technical Certification for test schedule). Applicants who are eligible to take the test are mailed an acceptance letter with instructions on how to schedule their exam.

Test Site Admission

Certificate candidates are required to show at least one valid government issued photo identification (state driver’s license or identification, or passport). Only after positive identification has been made by the testing proctor can a candidate be allowed to take a CWEA cert test. Be sure the name on your acceptance letter matches your identification or you could be turned away at the test center. If your name does not match, contact the CWEA office mediately. Candidates are not require to show their eligibility letters to enter the test site.

Test Security

All tests are computer-based. No reference material, laptop computers, cameras or other personal items are allowed in the test site (see the test site policy at www.cwea.org/cbt). Candidates will have access to an on-screen calculator. However, candidates are welcome to bring their own calculator as long as it is on the list of approved calculators (visit www.cwea.org/cbt). Candidates are not permitted to take any notes from the test site. Candidates who violate test site rules will be asked to leave the site and may be disqualified from that test. All violations of test security will be investigated by CWEA and appropriate action will be taken.

Test Rescheduling and Cancellation

To reschedule your application, you must submit a written request stating that you wish to postpone to the adjacent testing window. You may only reschedule your application to the adjacent window once without a fee. Additional postponement will requires a reschedule fee. There are no exceptions to this policy.

To cancel your application you must submit a written request to CWEA. The written request must be received at the CWEA office no later than 2 weeks after the approved test window begins. Full re-funds, less the administrative fee, will be made within 4 weeks after the scheduled test date. There are no exceptions to this policy.

If you already have a scheduled exam with our testing partner, Pearson VUE, and need to cancel your appointment, you must contact them 24 hours in advance to avoid losing your exam fee

Test Result Notification

Official test results are routinely mailed to certificate candidates approximately two weeks after the test date. Results are never given over the phone, via fax or email. All results are confidential and are only released to the certificate candidate.



Issue of Certificate/ Blue Wallet Card

Certificates and blue wallet cards are issued to all candidates who pass the test. Certificates and blue wallet cards are mailed within three weeks after result notifications are mailed.

Certificate Renewal

All certificates are renewable annually. The first renewal is due one year from the last day of the month in which the certification test was held. Certificate renewals less than one year past due are subject to the renewal fee plus \$25 late fee. Certificates more than two years past due are only renewable through retesting. Renewal notices are mailed to certificate holders two months before the due date. It is the responsibility of certificate holders to ensure the certificate(s) remains valid. Every other year, certificate holders are required to submit 12 contact hours of education or training relevant to the certificate held. Continuing Education is required to help ensure that individuals certified by CWEA continue to be knowledgeable of technological advancements and regulatory requirements in the wastewater fields. Continuing education enhances the operation, maintenance and management skills of the certificate holders, and ensures the quality of wastewater treatment. This ultimately increases the ability and confidence of certificate holders and the credibility of the wastewater professions certified by CWEA.

Accommodations for Physical or Learning Disabilities

In compliance with the Americans with Disabilities Act, special 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 an individual's ability to successfully complete the certification test. Written requests for special accommodations must be made with the test application along with all supporting documents of disability. Applicants requesting accommodations are encouraged to apply as early as possible to ensure sufficient time to process the request.

Test Design and Format

Test Design

All certification tests are designed to test knowledge and abilities required to perform the KSAs listed at the end of the section with minimal acceptable competence.

The KSAs were determined by a job analysis and meta-analysis of job specifications by experts in the field under the guidance of test development specialists. The studies gathered data from on-site visits of over 31 water and wastewater agencies, interviews with 110 water and wastewater professionals, and analysis of more than 300 job specifications. All research was conducted under the guidance of the TCP Committee, vocational subcommittees, and CWEA staff. All test questions are designed to measure at least one area of knowledge or ability that is required to perform an essential duty.



Test Delivery Mechanism

All tests are computer-based format and are available in the English language only. Tests are delivered at Pearson VUE testing centers.

Test Format

All TCP tests are in multiple choice format (see the sample test questions in this booklet for an example). The multiple choice format is considered the most effective for use in standardized tests. This objective format allows a 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.

Test Pass Point

The minimum score required to pass varies depending on the test and possible total points. The score may be adjusted downward depending on test complexity. It should be assumed that if the passing score is 75 percent candidates should try to score as high as possible on their test (in other words, always try for 100 percent). The pass point for each vocation and grade level is set independently. Also, each version, or form of a test will have its own pass point. Different versions are given each time the certification test is administered.

How Pass Points are Set

A modified *Angoff Method* is used to determine the pass point for each version of each test. The modified *Angoff Method* uses expert judgements to determine the test difficulty. The easier the test, the higher the pass point; similarly the more difficult the test, the lower the pass point.

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

1. A group of Subject Matter Experts (SMEs) independently rate each test question within a given test. The ratings are defined as the probability that an acceptably (minimally) competent person with the requisite education and experience will answer the question correctly. An acceptably (minimally) competent person is defined as someone who safely and adequately performs all job functions and requires no further training to do so.
2. The SMEs review each test question as a group. A consensus is reached for the rating of each test question. The SMEs also review comments submitted in writing by test-takers. Any test 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 test. These test questions are then revised for future use, reclassified, or deleted from the test item bank.
3. After the data are refined, the final step is to calculate the mean, or average, of all the test question ratings. This becomes the overall pass point estimation.

Why Use Modified Angoff?

Each version of a given certification test uses questions from a test item bank. Each of these questions vary in difficulty. Because a different mix of questions is used in each test, 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 test to ensure that test results are reliable. Test reliability is concerned with the reproducibility of results for each version of a given test. In other words, for a test to be reliable it must yield the same result (pass or fail) for the same individual under very similar circumstances. For example, imagine taking a certain grade level test and passing it. Immediately after completing this test, a different version of the same grade level test is taken. If the test is reliable, the same result will



be achieved: pass. If a passing grade is not achieved, it is likely that the test is not a reliable measure of acceptable (minimal) competency.

By taking into consideration the difficulty of the test, the modified *Angoff Method* significantly increases the reliability of the test. Also, since each test is adjusted for difficulty level, each test version has the same standard for passing. Thus, test-takers are treated equitably and fairly, even if a different version of the test is taken.

There are other methods for setting pass points. However, for the type of tests administered by CWEA, the modified *Angoff Method* is the best and most widely used.

Test Scoring

All tests are electronically scored by Pearson VUE pending approval by CWEA. Most test items are valued at one point. Some test items requiring calculations are worth multiple points varying from two to five (possibly more). After tests are scored, total points are compiled and an overall score is calculated as the sum of all points earned on the test. If the overall score is equal to, or greater than the established pass point, the candidate has passed the test. Total points possible for each test varies, but the average is 100 points plus or minus 25.

Item Appeals

Candidates who wish to appeal a specific test item must do so during the test by completing the *Candidate Comment Review Section* during the exam. Item appeals will be evaluated and appropriate adjustments will be made to the test content. Candidates submitting comments will not be contacted in regards to the appeal.



Knowledge, Skills, & Abilities (KSAs)

Understanding The KSAs

The key to success on the CWEA certification test is understanding the KSAs and having adequate training, education, and experience in those KSAs. Each KSA describes the competencies required of an individual to successfully perform the essential duties of the job at grade level. Although the KSAs do not correspond precisely to every individual Grade II position description, they do reflect the core competencies and essential duties required of Grade II Collection System Maintenance Technologists employed by any collection system. The KSAs are developed from a job analysis that includes research of the essential duties at a representative cross-section of systems and facilities throughout California and other participating states.

This section outlines each KSA and includes descriptions of the general competencies, math competencies, and suggested reading for that KSA. Candidates are expected to understand the competencies described in this section and seek further educational opportunities to address those KSAs that have not been mastered. Although each candidate is encouraged to find educational opportunities that suits his or her needs best, typical educational opportunities include:

- On the job training
- Print or online training materials
- Manuals of practice, technical documents, regulations, etc.
- Mentoring
- Trade, vocational, or college courses
- Professional education sessions and seminars

Candidates seeking Collection System Maintenance Grade II certification should review the KSAs presented in this section and seek to understand how they apply to everyday duties and responsibilities.

KSA Weight

KSA Weight is the approximate percent of the test content covered by a KSA. For example, a KSA with a weighting of 7% will have about 7% of all questions (or points) dedicated to that KSA, or 7% of the test is about that KSA. The KSA weight is approximate and shows the relative importance of a KSA compared to the other KSAs. The KSA weight on the actual certification test may vary slightly.

General Competencies and Math Competencies

Each KSA includes an expanded description of the competencies, tasks, and duties expected of certificate holders. Math Competencies describe the math, analytical, or calculation knowledge and skills that are expected of certificate holders. There are no specific “math” questions on the test, but questions in some KSAs require computational skills to complete. Like all other questions on the test, questions requiring math or computational skills are randomly distributed throughout the test.

Suggested Reading

The Suggested Reading lists some materials that are representative of each KSA. Each reference includes chapters, sections, or pages that are representative of the KSA. This is not an exhaustive list of sources relevant to the KSA and candidates are strongly encouraged to seek additional material that covers each KSA especially in those KSAs where the candidate is not adequately prepared.



KSA 200**Weight: 11%**

May perform essential duties identified on the Test Content Specifications for Collection Systems Grade I.

KSA200 General Competencies

A Collection System Worker at the Grade II level must be able to perform all elements of wastewater collection system maintenance, as well as provide input on how to improve the Collection System. These duties may include but are not limited to performing collection system maintenance utilizing:

- a high-velocity sewer cleaner.
- a mechanical rodding machine.
- hydraulic winches.
- compressors or construction equipment.

Duties also include:

- performing inspections of wastewater collection system lift/pump stations to ensure the proper operation of such facilities.
- performing maintenance to sewers located on private property, remote canyons or environmentally sensitive areas.
- performing a wide variety of construction activities such as replacing damaged pipes, repairing damaged maintenance structures or raising maintenance structures to grade after paving activities.
- responding to customer service requests and performing other related duties.

As technology has improved so must the computer knowledge of the Collection System Operator. These skills will include but are not limited to Data Entry Input, understanding G.P.S. as well as workflow programs such as C.M.M.S.

This knowledge is gained through a number of sources ranging from basic in-house training to specialized training from outside sources such as vendors or professional trade related agencies. All of the training received is reinforced by on-the job experience and the level of supervision decreases as the worker demonstrates proficiency in the subject area.

KSA200 Math Competencies

Collection System Workers must perform a wide variety of mathematical calculations to:

- determine volume.
- area.
- distances.
- elevation.
- flow rates.
- power usage.



Additionally they must be able to read items such as cut sheets to determine trench slope or benching, trench depth, establishing pipe grade while also determining materials and equipment that may be required.

KSA200 Suggested Reading

- *Operation And Maintenance Of Wastewater Collection Systems*, Volume 1, 6th Edition Chapters 1,3,5,6.
- JAEC Technology Heiroglyphs, <http://www.jaec.info/Automation-Computer-Security/automation-improvement/industrial-control-systems/scada-systems/>.
- *Mathematics For Collection System Operators A Workshop Manual*, Sections 1,2,3,4 10, 13, and 15.
- *Wastewater Collection System Maintenance*, Chapter 12.
- *Safety and Health in Wasewater Systems, WEF Manual of Practice SM-1*, (All).

KSA 201

Weight: 9%

Directs, instructs, oversees and provides feedback to personnel performing Collection System Maintenance Grade I duties.

KSA201 General Competencies

A Collection System Worker at the Grade II level usually acts as a field supervisor or crew leader. Therefore employees at this level must be able to:

- provide clear instructions to others
- provide coaching/training to less skilled employees
- provide feedback to improve performance
- engage others to resolve difficult situations
- take responsibility for the actions of their crew
- be able to manage minor conflicts between crew members.

This knowledge is gained through a number of sources ranging from basic in-house training to specialized training from outside sources such as vendors or professional trade related agencies

KSA201 Math Competencies

There are no specific math competencies for this KSA.



KSA201 Suggested Reading

- *Effective Supervisory Practices*, Chapters 3,4 & 5.
- *Manage for Success*, Chapter 1.

KSA 202

Weight: 9%

Inspects, trouble-shoots, and maintains proper collection system operation using advanced techniques and instruments including but not limited to closed-circuit TV, smoke testing, and related procedures.

KSA202 General Competencies

Collection system workers at the Grade II level is expected to perform more advanced maintenance techniques that are utilized to support condition assessment programs. These duties may include:

- performing Closed Circuit Television (CCTV) equipment to visually inspect sewer pipes.
- smoke testing to determine sources of inflow, infiltration or illegal connections.
- flow monitoring.
- chemical root control.
- odor and corrosion abatement.
- pesticide application to control insects or rodents.
- ultrasonic measurement to determine pipe condition.

Additionally collection system workers must have knowledge of agency specific data management systems such as condition assessment, record keeping and G.I.S. mapping systems. A Grade 2 Collection System Operator should be able understand as well as interpret the NASSCO Rating Standards associated with a C.C.T.V condition assessment.

This knowledge is usually gained through advanced in-house training, vendors and professional trade related agencies.

KSA202 Math Competencies

In order to complete these duties a collection system worker must perform a wide variety of mathematical calculations to determine volume, area, distances, elevation and flow rates.

KSA202 Suggested Reading

- *Wastewater Collection System Maintenance*, Chapter 11.
- *Operations and Maintenance of Wastewater Collection Systems*, Volume 1, 6th Edition, Chapter 5.



- NASSCO: http://www.nassco.org/training_edu/te_pacp.html

KSA 203

Weight: 8%

Supervises and oversees all aspects of confined space entries and completes confined space entry permit.

KSA203 General Competencies

A wastewater crew performing a confined space entry may be faced with many hazards. These may include atmospheric hazards, hazardous conditions inside of maintenance structures or sewers. The Grade II collection system operator must be able to understand how to control a hazardous atmosphere in order to maintain acceptable entry conditions. All workers must have knowledge on how to use a self-contained breathing apparatus and may be required to rescue a crew member by using a tripod, or davit arm retrieval device in conjunction with the associated equipment such as harnesses and winches.

A collection system operator at the Grade II level may be considered a “Confined Space Entry Supervisor” and must complete extensive in-house training including first aid and CPR, which is followed by extensive annual rescue field training and close supervisory oversight before they can lead a confined space entry team.

Extensive knowledge of all confined space entry equipment must be demonstrated. The Grade II collection system operator shall be proficient in entering all required information on the Confined Space Entry Permit as well as being able to identify any associated hazards with the entry space.

KSA203 Math Competencies

There are no specific math competencies for this KSA.

KSA203 Suggested Reading

- *Operation And Maintenance Of Collection Systems*, 6th Edition Volume 1, Chapter 4.
- *Wastewater Collection System Maintenance*, Chapter 1, Utilize references at end of chapter.
- *Confined Space Entry*, (All).
- *Permit-required Confined Spaces*, 1910.146, (All).
- *Confined Spaces*, Health and Safety Topics11, (All).
- *Confined Spaces*, 1910.146 and *Confined Spaces*, Health and Safety Topics, OSHA www.osha.gov.
- *Safety and Health in Wastewater Systems*, *WEF Manual of Practice SM-1*, (All).



KSA 204**Weight: 10%**

Provides detailed oral, written or electronic information on a daily basis on activities including but not limited to timesheets, field activity reports, condition assessment reports, confined space entries permits and crew performance feedback reports.

KSA204 General Competencies

A Collection System Worker at the Grade II level usually acts as a field supervisor or crew leader. An employee at this level must demonstrate good communication skills and competency with agency specific policy, procedures and data management systems. This knowledge is gained through in-house training, which may be supplemented basic software training from vendors.

KSA204 Math Competencies

There are no specific math competencies for this KSA.

KSA204 Suggested Reading

- *Wastewater Collection System Maintenance*, Chapter 12.
- *Operation And Maintenance Of Wastewater Collection Systems*, Volume I, 6th Edition, (index-Records and Record Keeping; appropriate pages).
- *Operation and Maintenance of Wastewater Collection Systems*, Volume II, 7th Edition, Chapter 12, pages 471 - 516.

KSA 205**Weight: 7%**

Provides assistance to agencies and private organizations in locating and identifying utilities and manholes.

KSA205 General Competencies

A collection system worker at the Grade II level may be required to assist others in locating wastewater collection system components and structures. They must be able to read/interpret maps and perform basic mathematical calculations to determine collection system attributes such as flow direction, depth, distances, type of pipe and maintenance structure location. Additionally it is important that they possess some basic map reading skills and have knowledge of agency specific mapping systems. This knowledge is usually gained through basic in-house training and on-the-job experience.



KSA205 Math Competencies

There are no specific math competencies for this KSA.

KSA205 Suggested Reading

- Common Ground Alliance: www.commongroundalliance.com.
- *Operation And Maintenance Of Wastewater Collection Systems*, Volume I, 6th Edition, Chapter 7, pages 428- 429.
- *Operation and Maintenance of Wastewater Collection Systems*, Volume II, 7th Editon,Chapter 12, pages 461 - 470.

KSA 206

Weight: 10%

Plans routine traffic control measures at work sites and performs non-routine traffic control under general supervision.

KSA206 General Competencies

A collection system operator at the Grade II level usually acts as a field supervisor or crew leader over others who perform the vast majority of their required duties while exposed to traffic hazards. At the Grade II level it is essential to have an understanding of the crew's knowledge and abilities.

A Grade II operator must be confident in the fact that the crew has received all the proper training and that the Traffic Control Plan is understood and approved. It is essential that a worker at this level be highly skilled in traffic control measures as outlined in the Work Area Traffic Control Handbook.

This requires in-house training, followed by extensive field training and close supervisory oversight to ensure the safety of both workers and the public. Therefore before becoming a crew leader, a collection system worker must demonstrate an excellent knowledge of traffic control practices and principles.

KSA206 Math Competencies

There are no specific math competencies for this KSA.

KSA206 Suggested Reading

- *Work Area Traffic Control Handbook*, (All).
- *Operation And Maintenance Of Collection Systems*, Volume I; Chapter 4, pages 93 - 114.
- *Manual of Uniform Traffic Control Devices (MUTCD)*, <http://mutcd.fhwa.dot.gov>, (All).



KSA 207**Weight: 9%**

Investigates and directs the resolution of routine complaints and requests for service in a safe, efficient and timely manner, including providing feedback to the customer.

KSA207 General Competencies

In order to respond to a customer request a collection system operator needs to have a good understanding of all areas of collection system maintenance including how to interact with the public. Therefore it is important that they possess knowledge of collection system operation and maintenance principles, basic communication skills, and have knowledge of agency specific procedures.

This knowledge is usually gained through in-house training, basic customer service training and on-the-job experience.

KSA207 Math Competencies

Grade II collection system operators should be able to perform basic mathematical calculations to determine collection system attributes.

KSA207 Suggested Reading

- *Wastewater Collection Systems Management*, 5th edition, Chapters 6 and 7.
- *Manage for Success, Office of Water Programs*, Chapter 13.
- *Utility Management, Office of Water Programs*, Chapter 8.
- *Operation And Maintenance Of Wastewater Collection Systems*, Volume I, 6th Edition, pages 7, 405.

KSA 208**Weight: 11%**

Monitors crew performance to ensure adherence to safe work practices and compliance with all applicable regulations, policies, and procedures.

KSA208 General Competencies

A collection system operator at the Grade II level usually acts as a field supervisor or crew leader. Therefore employees at this level are responsible for the safety of their crewmembers. As such they must be able to provide clear instructions to others, provide coaching and training to less skilled employees and ensure that all employees adhere to safe work practices and procedures.



This knowledge is gained through a number of sources ranging from basic in-house training to specialized training from outside sources such as vendors or professional trade related agencies.

KSA208 Math Competencies

There are no specific math competencies for this KSA.

KSA208 Suggested Reading

- *Operation and Maintenance of Wastewater Collection Systems*, Volume II, 7th Edition, Chapter 11
- *Wastewater Collection System Maintenance*, Chapter 1.
- *Safety and Health in Wastewater Systems*, (All).

KSA 209

Weight: 6%

Participates in the development and propagation of SOPs (standard operating procedures) including safe work practices and procedures..

KSA209 General Competencies

A collection system operator at the Grade II level usually acts as a field supervisor or crew leader and has extensive knowledge and experience in all aspects of wastewater collection system maintenance activities.

Grade 2 collection system operators are expected to participate in the development of SOPs. (standard operating procedures). In order to contribute to an existing S.O.P. or develop a new S.O.P, The Grade 2 Collection System Operator must be familiar with all in house policies, procedures and safety programs as well any state or federal guidelines.

This ability is further developed through knowledge gained from a number of sources ranging from basic in-house training to specialized training from outside sources such as vendors, course related class work or professional trade related agencies.

KSA209 Math Competencies

There are no specific math competencies for this KSA.



KSA209 Suggested Reading

- *Wastewater Collection Systems Management WEF Manual of Practice No. 7*, Chapter 9, Section 3.5, pp. 210-229.
- *Operation and Maintenance of Wastewater Collection Systems*, Volume II, 7th Edition, pages 614-615.
- *Manage for Success*, pages 48, 268, 274.

KSA 210

Weight: 1%

Attends and participates in technical group meetings; stays abreast of new trends and innovations in the field of wastewater collection system operation and maintenance.

KSA210 General Competencies

This activity is generally performed by higher-level personnel, but it is desirable that all workers read trade publications to stay abreast of new trends and innovations in the field of wastewater collection system operation and maintenance.

KSA210 Math Competencies

There are no specific math competencies for this KSA.

KSA210 Suggested Reading

- Attend CWEA conferences and local section lunch or dinner meetings.



KSA 211

Weight: 9%

Direct and oversee the containment and clean-up of sanitary sewer overflows (SSOs) and provides notification and field documentation for the reporting of sanitary sewer overflows.

KSA211 General Competencies

While performing collection system maintenance a collection system crew may need to respond to a Sanitary Sewer Overflow (SSO). It is especially important that a collection system operator at the Grade II level has a good understanding of the State of California Waste Discharge Requirements (WDR) and any agency specific SSO reporting and response requirements. The Grade 2 Collection System Operator must be familiar with the electronic Reporting procedure as well as all associated posting requirements. Additionally they must be able to direct others on the proper containment and cleanup procedures to ensure the protection of public health and safety.

This knowledge is usually gained through basic in-house training followed by close supervisory oversight.

KSA211 Math Competencies

Grade II operators must be able to perform more advanced mathematical calculations to determine flow rates, area and volume.

KSA211 Suggested Reading

- *Sanitary Sewer Overflows What are they and how can we reduce them?*, (All).
- *Best Management Practices for Sanitary Sewer Overflow (SSO) Reduction Strategies*, Sections 12 & 13.



Test Preparation

This section provides tips on how candidates should prepare, information provided with the test, the types of questions likely to be on the test, and solutions to typical math problems.

Basic Study Strategy

To prepare adequately, candidates need to employ discipline and develop good study habits. Ample time to prepare for the test should be allowed. Candidates should establish and maintain a study schedule. One or two nights a week for one or two months should be sufficient in most cases. Spend one or more hours studying in quiet surroundings or in small groups of two or three serious candidates. Efforts should be directed to the test subject areas that are not being performed on a day-to-day basis.

While using this study guide, be sure to understand the KSAs and answers to all questions. Discuss test questions with others. Not only is this a good study technique, it is also an excellent way to learn.

Candidates should study at the certification level being sought after. There is no advantage to spending time studying material that will not be on the test. Refer to Section 3 for a description of the KSAs and reading assignments that cover the topics on the test.

It is not necessary, but certainly helpful, to memorize all formulas and conversion factors. A formula table is provided on the test to assist in this area. Tables 4-1 give the same formulas and conversion factors as those given on the test.

Candidates should obtain the primary reference and training material listed in Section 6. Any material not available at their workplace can be obtained from the sources listed in Section 6.

Multiple Choice Questions

All test questions are written in multiple-choice format. At first glance, the multiple-choice problem may seem easy to solve because so much information is given, but that is where the problem lies. The best answer must be chosen from the information provided. Here are some tips that may help solve multiple-choice questions.

1. Read the question completely and closely to determine what is being asked.
2. Read all the choices before selecting an answer.
3. Look for key words or phrases that often, but not always, tip off correct or incorrect answers:



Table 4-1 Standard Measurements and Formulas	
12 inches = 1 foot	27 cubic feet = 1 cubic yard
36 inches = 3 feet = 1 yard	1 cubic foot of water = 7.48 gallons
5,280 feet = 1 mile	1 cubic foot of water = 62.4 pounds
1,440 minutes = 1 day = 24 hours	1 gallon of water = 8.34 pounds
144 square inches = 1 square foot	1 million gallons per day (MGD) = 694 gallons per minute
9 square feet = 1 square yard	1 million gallons per day (MGD) = 1.55 cubic feet per second (csf)
43,560 square feet = 1 acre	1 horse power = 0.746 kilowatts (kw)
1,728 cubic inches = 1 cubic foot	Slope = $\frac{\text{Rise}}{\text{Run}}$
Flow	
$Q = AV$	Q = Flow A = Area V = Velocity
Area	
Rectangle: $A = L \times W$ Circle: $a = 0.785D^2$	A = Area L = Length W = Width
Volume	
Rectangular Solid: $\text{Vol} = LWd$ Right Regular Cylinder: $\text{Vol} = 0.785D^2L$ or $\text{Vol} = 3.14 R^2L$	Vol = Volume L = Length W = Width d = Depth D = Diameter C = Circumference



Absolute Words

(Suspect as a wrong choice)

All	Never
Always	None
Totally	Completely

Limiting Words

(Often a correct choice)

Few	Occasionally
Some	Generally
Often	Usually
Many	Possible

- Never make a choice based on the frequency of previous answers. If the last ten questions have not had a “b” answer, don’t arbitrarily select “b”. Instead use logic and reasoning to increase the chances of choosing the best answer.
- Reject answers that are obviously incorrect and choose from the remaining answers. For example, in the multiple choice question, “Why are gasoline and volatile solvents objectionable when present in a sewer?”
 - They produce an explosion hazard.
 - They tend to cause solids to vaporize.
 - They will coagulate floatables and cause stoppages.
 - Because they float, the substances flow to plant headworks quicker.”

In reviewing physical and chemical characteristics of gasoline and volatile solvents, the specific gravities of these substances are generally less than water and float to the surface. They are solvents for other similar industrial organic chemicals. Therefore, answer “b”, that proposes gasoline and volatile solvents cause solids such as sand, and grit to vaporize, is obviously an incorrect answer.

- Make an educated guess. Never reconsider a choice that has already been eliminated. That means in the example above, answer “b” is out.

Look for “key” phrases or words that give a clue to the right answer. For the example above, choices “c” and “d” discuss floatables and are potentially good answers. For answer “c”, chemical interaction of gasoline with floatables is not likely unless they are oil and grease. In such case, the solvent may disperse the oil and grease and reduce stoppages.

Answer “a” and “d” remain and are both reasonable choices. However, the best answer must be selected. Answer “d” is true, but without knowing the explosive nature of gasoline and volatile solvents, the answer is only a fact. An explosive material in wastewater creates a condition that endangers the public, a potential loss of expensive facilities, and a hazard to operations and maintenance personnel. The best answer is “a”, they produce an explosion hazard.

- Skip over questions that are troublesome. Mark these questions for later review.



8. When finished with the test, return to the questions skipped. Now think! Make inferences. With a little thought and the information given, the correct answer can be reasoned out.
9. Under no circumstances leave any question unanswered. There is no penalty for an incorrect answer. However, credit is given only for correct answers.

NO ANSWER=WRONG ANSWER

10. Keep a steady pace. Check the time periodically.
11. Remember to read all questions carefully. They are not intended to be “trick questions”; however, the intent is to test a candidates’ knowledge of and ability to understand the written languages of this profession.

Math Problems

Math problems on the certification tests are meant to reflect the type of work encountered in Collection System Maintenance. Although there is no specific math section on the test, many questions will require some calculations such as area, volume, ratios, and conversion of units. Although math is important on the test, do not neglect other parts of the KSAs and focus too much time on the math. Completing the math problems will be greatly simplified by using a calculator and the approach suggested in the following paragraphs.

Calculators

Approved calculators may be used during the test. See the approved calculator list at www.cwea.org/cbt. A screen calculator will also be available on the test similar to the standard calculator found on computers running Windows. The most important factor in effectively using a calculator is the candidates’ familiarity with its use prior to the time of the examination. Confidence in the calculator and a full understanding of how to properly operate it are a must. The best way to gain confidence is to obtain a calculator from the approved calculator list and use it frequently.

Completing the worksheets in this section as well as the sample problems at the various grade levels will improve proficiency. Additional use will also help. For example, calculate the gas mileage when filling a vehicle’s tank each time. Check the sales tax calculation on each purchase. Balance a checkbook, or check a paycheck. The calculator chosen should have large enough keys so that the wrong keys are not accidentally punched. Be certain there are new batteries in the calculator, or use a solar powered calculator with battery back up.

Approach

The solution to any problem requires understanding of the information given, understanding of what is being requested, and proper application of the information along with the appropriate equations to obtain an answer. Any math problem can be organized as follows:

Given or Known. All information provided in the problem statement that will be used to get the correct answer.

Find. A description of the answer that is being requested.

Sketch. If possible, sketch the situation described in the problem statement showing size and shape (dimensions).



Equation. The equation or equations that will be used to generate the listed answers

Assumption(s). Stated assumptions of key information needed to answer a math problem with missing information. This occurs frequently on higher-grade tests.

Answer. This is where the answer is clearly identified.

Advantages to using this approach to organize math problems are that it helps to organize thoughts, breaks the problem solution into a series of smaller steps, reducing chances of making an error.

Solutions

Solutions to math problems are like driving routes from Los Angeles to San Francisco: there are many different routes that can be taken. Some routes are shorter or less complicated than others. Only certain routes end up in San Francisco.

Solutions to sample problems given in this study guide are the most common solutions. If a solution that is different, but arrives at the correct answer is found, then that solution can be used.

Equivalents/Formulas

A sample of the equivalents and formulas sheet from the examination is included in Table 4-1. Familiarity with each of the equivalents (conversion factors) and each of the formulas is important. Pay special attention to the units of measure that are used in the formulas. A correct answer will not be obtained unless the correct units of measure are used.

Check the units, arithmetic, and answer. So that:

1. The units agree.
2. The answer is the same when the arithmetic is repeated.
3. The answer is reasonable and makes sense.

Dimensional Analysis

When setting up an equation to solve a math problem, the trick is to have clearly in mind what units the answer should be in. Once the units have been determined, work backwards using the facts given and the conversion factors known or given. This is known as dimensional analysis, using conversion factors and units to derive the correct answer.

Remember, multiplying conversion factors can be likened to multiplying fractions. The denominator (the number on the bottom of the fraction) and the numerator (the number on the top of the fraction) cancel each other out if they are the same, leaving the units being sought after.

Example:

If a company runs a discharge pump rated at 50 gallons per minute all day, every day for a year, what is the discharge for the year in millions of gallons per year (MGY)?

Given: pump rating = $50 \frac{\text{gal}}{\text{min}}$



Find: discharge = ? MGY

Calculations: Convert gal/min to million gal/yr, convert gallons to million gallons, and minutes to years.

What is known about minutes and years? There are 60 minutes in an hour, 24 hours in a day, and 365 days in a year. Put that into an equation, and multiply each conversion factor so the unneeded units are cancelled out:

$$50 \frac{\text{gal}}{\text{min}} \times 60 \frac{\text{min}}{\text{hr}} \times 24 \frac{\text{hr}}{\text{day}} \times 365 \frac{\text{days}}{\text{yr}} \times$$

$$1 \frac{\text{MG}}{1,000,000 \text{ gal}} = 26.28 \text{ mgy}$$

Sample Questions

The following sample math problems are intended to demonstrate unit conversion techniques. Although they are general wastewater problems, the questions may not be specific to any vocation.

- How many gallons of water will it take to fill a 3 cubic foot container?

$$3 \text{ cubic feet} \times 7.48 \frac{\text{gallons}}{\text{cubic foot}} = 22.4 \text{ gallons}$$

- If a gallon of gasoline weighs 7.0 pounds, what would be the weight of a 350 gallon tank full of gasoline?

$$350 \text{ gallons} \times 7.0 \frac{\text{pounds}}{\text{gallon}} = 2,450 \text{ pounds}$$

- The rated capacity of a pump is 500 gallons per minute (GPM). Convert this capacity to million gallons per day (MGD).

$$500 \text{ gpm} \times 1 \frac{\text{MGD}}{694 \text{ gpm}} = 0.72 \text{ MGD}$$

- A chemical feed pump is calibrated to deliver 50 gallons per day (GPD). What is the calibrated chemical feed in gallons per minute (GPM)?

$$\frac{50 \text{ gal}}{\text{day}} \times \frac{1 \text{ day}}{24 \text{ hr}} \times \frac{1 \text{ hr}}{60 \text{ min}} = 0.035 \text{ GPM}$$

- A chemical feed pump delivers 50 mL per minute (mL/min). Determine the chemical feed in gallons per day (gpd).



$$\frac{50 \cancel{\text{ mL}}}{\cancel{\text{ min}}} \times \frac{1 \cancel{\text{ L}}}{1000 \cancel{\text{ mL}}} \times \frac{1 \text{ gallon}}{3.785 \cancel{\text{ L}}} \times \frac{60 \cancel{\text{ min}}}{\cancel{\text{ hr}}} \times \frac{24 \text{ hr}}{\text{ day}}$$

$$= 19 \frac{\text{gallon}}{\text{day}} = 19 \text{ gpd}$$

6. A cyanide destruction process is designed to treat 30 pounds of cyanide per 24-hour operational day. How many pounds of cyanide can be treated during an 8- hour shift?

$$\frac{30 \text{ lbs CN}}{\cancel{\text{ day}}} \times \frac{8 \cancel{\text{ hr}}}{\text{ shift}} \times \frac{1 \cancel{\text{ day}}}{24 \cancel{\text{ hr}}} = \frac{10 \text{ lbs CN}}{\text{ shift}}$$

Math Skills

Successful candidates must be skilled in arithmetic and geometry. Candidates must be able to apply these skills to make calculations for work-related tasks such as excavation, stationing, pumping, determining flow rate, cost estimation, and any other job related math skill that may fall within the Skill Sets listed in Section 3. A thorough review of the types of mathematics required for the test is beyond the scope of this study guide. Consult an appropriate math text (see Section 6, References) if there is unfamiliarity with any of these specific math skills. Appendix A provides general strategies for approaching math problems, math anxiety, and resources for remedial study.

Arithmetic

Candidates should be able to perform and understand the following calculations either manually or with a calculator:

1. Addition and subtraction of whole numbers and fractions.
2. Multiplication and division of whole numbers and fractions.

Be prepared to apply these basic skills to work-related problems. The following example problem requires application of knowledge and application of basic arithmetic and the ability to convert units.

Example:

Determine the volume of a concrete slab that measure 150 feet long, 200 feet wide, and 3 inches thick. Express your answer in cubic yards.

First convert inches to feet:

$$3 \text{ inches} \times \frac{1 \text{ foot}}{12 \text{ inches}} = 0.25 \text{ feet}$$

Next, using the formula for volume given in Table 4-2, determine the volume of the concrete slab in cubic feet:

$$\text{Vol} = \text{LWd}$$

$$\text{Vol} = 150 \text{ feet} \times 200 \text{ feet} \times 0.25 \text{ Feet}$$

$$\text{Vol} = 7,500 \text{ cubic feet}$$



Finally, calculate the volume of concrete in cubic yards:

$$7,500 \text{ cubic feet} \times \frac{1 \text{ cubic yard}}{27 \text{ cubic feet}}$$

$$= 277.78 \text{ cubic yards}$$

Geometry

Candidates should be able to calculate circumference, find the area of a rectangle, circle, and the volume of a rectangular solid or a right cylinder. This problem requires application of knowledge and application of basic geometry, arithmetic, and the ability to convert units.

Example:

What is the area of a manhole that measures 40 inches in diameter? Express your answer in square feet.

First convert inches into feet.

$$40 \text{ inches} \times \frac{1 \text{ foot}}{12 \text{ inches}} = 3.33 \text{ feet}$$

Then calculate the area of the manhole using the formula for the area of a circle given in Table 4-2.

$$A = 0.785D^2$$

$$A = 0.785 \times 3.33 \text{ feet} \times 3.33 \text{ feet}$$

$$= 1,256 \text{ ft.}^2$$

Area of manhole

$$= 8.71 \text{ square feet}$$



Practice Test

This section provides a practice certification test to help certificate candidates become familiar with the test format and subject matter. The actual certification test is given on a computer at a secure testing site. The computer-based test (CBT) requires test takers to be able to use a computer mouse and some very basic keyboard functions. Candidates who have never taken a computerized test are strongly encouraged to try the online CBT demo to become familiar with the computerized test format before going to a test site. A CBT tutorial is also available to candidates just before they start their test. For more information about CBT and to try the CBT demo go to www.cwea.org/cbt.

The number of test questions on the actual certification test may range from about 90 to 130 questions. The time limit for the test is 3 hours. The computerized certification test can be paused for restroom breaks, but the 3-hour clock will not stop. A formula table very similar to Table 4-1 (Section 4) will be available as a window on the computer screen during the test. The format of the test questions on the computerized certification test is very similar to the multiple choice questions given in this practice test. There are no fill-in or essay type questions given on the test. Most questions on the certification test are worth 1 point, however some can be worth up to 5 or more points depending on the level of difficulty or calculations required. No point values are given for questions on this practice test so the weighting will not precisely reflect that of the actual certification test. If answered correctly, candidates will earn the number of points given for a question. If a question is not answered correctly, then no points are awarded (there is no penalty for "guessing"). At the test site, calculators are limited to a list of approved calculators. A screen calculator, similar to the basic Windows computer calculator, is also available during the test and can be toggled between basic and scientific modes. For the list of allowable calculators see the Calculator Policy at www.cwea.org/cbt, or contact CWEA at 510-382-7800, or tcp@cwea.org.

The practice test includes a key after the end of the test. Some question that require calculations include solutions that are given after the key. These are indicated on the key with "see solutions" to the right of the correct answer. Candidates are encouraged to find the solutions to all of the questions requiring calculations themselves.



Practice Test

Select the best answer for each item below.

1. Why are gasoline and volatile solvents objectionable when present in a sewer?
 - a. They produce an explosion hazard
 - b. They tend to cause the solids to vaporize
 - c. They will coagulate floatables and cause stoppages
 - d. Because they float, these substances flow to the headworks quicker

2. You should never attempt to install, troubleshoot, maintain, repair or replace electrical equipment panels, controls, wiring or circuits unless:
 - a. a manhole is overflowing down a street.
 - b. a pump is plugged.
 - c. you are receiving lots of odor complaints.
 - d. you know what you are doing, are qualified, and are authorized.

3. How many different areas of traffic zones are there when working in roadways?
 - a. Seven
 - b. Two
 - c. Four
 - d. Five

4. Why should hydrogen sulfide be controlled:
 - a. not to protect operators.
 - b. to protect sewers and structures from corrosion.
 - c. to promote odors.
 - d. to promote corrosion of sewers and structures.

5. Personnel entering a Permit Required Confined Space must have the following training:
 - a. traffic control.
 - b. rescue and data entry.
 - c. pipe materials.
 - d. entry and rescue procedures.

6. To find proper protective gear before application of a product, you would:
 - a. never read the product label.
 - b. never ask a co-worker.
 - c. ask someone off the street.
 - d. look at the MSDS.



7. The gas most commonly associated with septic wastewater is:
- carbon dioxide.
 - carbon monoxide.
 - hydrogen sulfide.
 - methane.
8. The lack of an unpleasant odor in a manhole, lift station or other structures does not always mean that dangerous gases are not present because:
- some dangerous gases have no odor.
 - dangerous gases have only pleasant odors.
 - some gases heighten the sense of smell.
 - all gases have an odor.
9. Four conditions are necessary to create an explosion. Three of these conditions are combustible gas, adequate oxygen and sufficient heat. What is the fourth?
- Constant supply of combustible gas
 - Enclosed area that will hold the gases
 - Proper mixing of gas and oxygen
 - Constant ventilation
10. What does “transition area” mean in traffic control?
- Provides protection for traffic and workers
 - Lets traffic resume normal driving path
 - Moves traffic out of its normal path
 - Tells traffic what to expect ahead
11. Which of the following best describes one component of a Traffic Control Zone:
- Curb Face.
 - Underground Service Alert.
 - Transition Area.
 - Rest Area Location.



12. What elements should be considered to improve worker safety in High Speed Temporary Traffic Control Zones?
- Rerouting Traffic around the work site.
 - Positioning of Law Enforcement Officers in the Temporary Traffic Control Zone.
 - Work Zone Training.
 - All of the above.
13. What key factors would you need to address when developing an S.O.P. for a Lift Station failure?
- Traffic Control Plan.
 - By-Pass connections.
 - Spill Containment.
 - All of the above
14. What tools are used with a power rodder?
- Finger grips.
 - Pruning shears.
 - Spring blades.
 - Videotape camera.
15. Tools used for sewer rodding include all but the:
- lag screw.
 - porcupine.
 - root saw.
 - square bar cork screw.
16. What tool would you use to cut VCP pipe?
- Hammer.
 - Grinder.
 - Chain pipe cutter.
 - Chisel.
17. Which conditions should a gas detection device test for?
- Hydrogen sulfide, oxygen, helium.
 - Explosive/flammable gases, helium, oxygen.
 - Oxygen, hydrogen sulfide, helium.
 - Hydrogen sulfide, explosive/flammable gases, oxygen.



18. What does "LEL" mean on a gas detection meter?
- Lower electrical limit
 - Lower explosive limit
 - Lower evaporation limit
 - Lower equipment limit
19. The oxygen level alarm in a gas detection meter is normally set to go off at oxygen levels below:
- 21.5 percent
 - 20.5 percent
 - 19.5 percent
 - 18.5 percent
20. When developing an S.O.P for scheduled maintenance of electrical equipment, what program should be addressed as a primary safety guideline?
- The S.S.M.P.
 - The I.I.P.P.
 - THE L.O.T.O. Program.
 - The Cross Connection prevention Program.
21. What document would you require to be referenced when developing an S.O.P. for hazardous substance spill cleanup as well as spill containment?
- The A.E.D. Log.
 - The D.O.T. Policy.
 - M.S.D.S.
 - THE Confined Space Entry Permit.
22. In developing an S.O.P. for air monitoring in a Permit Required Confined Space you would include which of the following?
- Placement of the Blower
 - Weather forecast
 - P.P.E.
 - Both a and c



23. According to the State Water Resources Control Board Order No. 2006-003-DWQ, each Enrollee must develop and implement a system-specific:
- (SSMP) Sanitary Sewer Maintenance Program
 - (SSMP) Sanitary Sewer Management Plan
 - (SSMP) Sewer System Management Plan
 - (SSMP) Security System Maintenance Plan
24. Category 1 SSO's that discharge to a drainage channel and/or surface water must be reported within:
- 24 hours
 - 2 hours
 - 2 days
 - 2 weeks
25. To report in the Statewide SSO Data-base California Integrated Water Quality System (CIWQS), regarding the location of a Category 2 SSO, you must know:
- the GIS coordinates.
 - the GPS coordinates.
 - the nearest cross streets.
 - the nearest stream or creek.
26. Biological activity in long, sluggish-flow, flat grade sewer lines will likely cause:
- concrete and metal shine.
 - enriched Oxygen in the air in manholes, sewers and wet wells.
 - non-Toxic gas production.
 - odors.
27. Flatter sewer line grades may cause added sewer maintenance expense and odor nuisance. The problem is most likely caused by:
- a decrease in velocity allowing gases to be released from the wastewater.
 - a decrease in velocity allowing organic and inorganic solids to settle out.
 - a decrease in velocity which increases the treatment time of the inorganic solids.
 - an increase in velocity which decreases the treatment time in the lines.



28. Sources of excessive clear water in a collection system include:
- a problem at the wastewater treatment plant.
 - an interceptor sewer leak.
 - exfiltration from a high water table.
 - infiltration from a high water table.
29. What items would you consider when selecting a solution to clear a stoppage in a sewer?
- Adding a solution to the upstream manhole to clear the stoppage
 - Cause of stoppage
 - Time of day
 - Staffing requirements
30. The interior of 300 feet of 12-inch pipe is uniformly coated with one inch of grease. How many gallons will this pipe hold when filled with water?
- 1,230 gallons
 - 1,360 gallons
 - 1,470 gallons
 - 1,630 gallons
31. Infiltration is caused by:
- cracked pipes.
 - improper closed circuit TV operation.
 - poor ventilation.
 - roof drains connected to the sewer.
32. The main reason for adding sodium hypochlorite to sewers is to control:
- BOD.
 - odor.
 - pathogens.
 - suspended solids.
33. Roots can enter collection systems through:
- air gaps.
 - manhole covers.
 - pipe cracks.
 - well maintained lift stations.



34. The lowest point on the inside of a pipeline is called the:
- center line.
 - haunch.
 - channel.
 - invert.
35. How often must an excavation site and adjacent areas be inspected for hazardous conditions?
- Hourly
 - Daily
 - Weekly
 - Monthly
36. Protective shoring systems options include all but:
- proper stopping or benching of the sides of the excavation.
 - working in an un-sloped trench with no shoring.
 - supporting the sides of a trench with shoring.
 - using a shield in the excavation area.
37. Proper operation and maintenance of wastewater collection is:
- allowing stoppages to occur.
 - allowing SSO to occur.
 - keeping wastewater flowing through pipes.
 - collecting fees from public.
38. Minimum design velocity for a sewer should be greater than:
- 2 feet per second.
 - 3 feet per second.
 - 3.5 feet per second.
 - 4 feet per second.
39. Vitrified clay pipe is what type of pipe?
- Soft
 - Rigid
 - Flexible
 - Weak



40. Manholes include all the following except:
- a. barrels.
 - b. lids.
 - c. cones.
 - d. backflow devices.
41. Sewer testing methods do not include:
- a. air.
 - b. water.
 - c. mandrill.
 - d. sewage.
42. Hydraulic sewer cleaning methods include:
- a. high velocity cleaners.
 - b. bucket machines.
 - c. power rodders.
 - d. hand rods.
43. A flow of 650 gpm would be how many mgd?
- a. 0.472
 - b. 0.936
 - c. 1.714
 - d. 1.923
44. One of the advantages of using CCTV is:
- a. ability to see what's happening when camera is underwater.
 - b. to record television shows.
 - c. that the length and severity of defective pipe areas can be recorded.
 - d. visitors are impressed.
45. A hazard that may damage a TV camera going through a sewer is:
- a. camera above the flow.
 - b. clean optical lens.
 - c. offset joints.
 - d. using in a new line.



46. What is the total volume of 1,000 feet of 8-inch line?
- a. 2,201 gallons
 - b. 2,611 gallons
 - c. 3,916 gallons
 - d. 4,217 gallons
47. If an eight-inch force main has a metered flow rate of 400,000 gpd, what is the velocity?
- a. 0.42 fps
 - b. 0.96 fps
 - c. 1.18 fps
 - d. 1.77 fps
48. During the 24-hour operation, a lift station pumped 3,000 gallons per minute for a community of 27,000. What is the per capita pumped in gallons per day?
- a. 100
 - b. 110
 - c. 120
 - d. 160
49. A wet well 20 feet in diameter is filled with water to a depth of 10 feet. How many gallons does the tank contain?
- a. 2,355 gallons
 - b. 3,140 gallons
 - c. 23,500 gallons
 - d. 31,400 gallons
50. How can the members of a balling crew communicate with each other?
- a. Hand signals
 - b. Shouting down the sewer
 - c. Telegraph
 - d. Writing
51. Why must you always know where a cleaning tool is in a sewer?
- a. So the tool can find its way back.
 - b. So you can locate it when resuming work after an interruption.
 - c. So you know where obstructions or difficulties are encountered.
 - d. It is not important to know where the tool is as long as it gets to the end of the sewer.



52. Emergency stoppages in pipelines may be cleared safely by use of:
- balling.
 - high velocity cleaners.
 - bucket machines.
 - kites.
53. Rodents and insects can be controlled by:
- aeration.
 - spraying manholes with an approved pesticide.
 - vacuum filtration.
 - flooding.
54. Sources of excessive clear water in a collection system include:
- a problem at the wastewater treatment plant
 - a water distribution main construction project
 - evaporation
 - infiltration from a high water table
55. How many types of common shoring are there?
- 4
 - 7
 - 9
 - 6
56. If it takes 7 minutes and 30 seconds for dye to travel a distance of 860 feet through an eight inch sewer, what is the velocity in fps?
- 1.91 fps
 - .76 fps
 - 1.02 fps
 - 2.43 fps
57. An upright circular cylinder tank (flat bottom) has a diameter of 12 feet. When filled to a depth of 8 feet, the volume is?
- 226.2 cubic feet
 - 904.3 cubic feet
 - 3619 cubic feet
 - 5000 cubic feet



58. Which item is a critical task in operation and maintenance of wastewater collection?
- Allowing stoppages to occur
 - Allowing SSO to occur
 - Keeping wastewater flowing through pipes
 - Collecting fees from the public
59. Once enrolled in CIWQS, the "Collection System Questionnaire" must be updated at least every:
- 2 years
 - 6 months
 - 18 months
 - 12 months
60. Flow estimation is critical to reporting SSOs. You are dispatched to an SSO coming out of a 24-inch manhole pick hole that was spurting about 3/4 inch, the sewerage was running down the gutter into a storm drain 200' away. You received the call at 1100 hrs, arrived on site at 1115, and your crew relieved the stoppage at 1127. You estimate the spill was running at 6 gallons per minute (6 gpm). How much sewer went un-captured into the storm drain?
- 162 gallons
 - 126 gallons
 - 719 gallons
 - 1,211 gallons
61. Lift station failure can include:
- dip tube failures.
 - electrical circuit failures.
 - invert siphon failures.
 - drip line failures.
62. What would cause a pump to deliver less than its expected rate of discharge?
- Check valves are open.
 - Clogged impeller.
 - Discharge head too low.
 - Pump in primed.



63. Why are wear rings installed in a pump?
- a. To concentrate wear on rings instead of volute and impeller
 - b. To concentrate wear on rings instead of sleeves
 - c. To concentrate wear on rings instead of bearings
 - d. To concentrate wear on rings instead of shaft
64. What control types are used to start or stop pumps?
- a. Dissolved air
 - b. Floats
 - c. Valves
 - d. Rotors
65. What type of pump is used in lift station wet wells?
- a. Piston
 - b. Screw
 - c. Submersible
 - a. Ejector
66. Centrifugal pump parts include:
- a. diaphragm.
 - b. piston.
 - c. rotor.
 - d. volute.



67. You receive a dispatch at 4:30 PM informing you that raw sewage is spewing out of a manhole onto the ground and into a small stream adjacent to a sparsely populated neighborhood. The caller reporting the problem indicated that it had been spilling sewer since 2 PM and that she had noticed it while driving by on the 405 freeway stuck in stop and go traffic. She indicated that she was not able to call right away and report the spill because of the restrictions on using a cell phone when driving a motor vehicle. You immediately dispatch a hydro-vac crew to the site to assist you in taking care of the problem. Upon arrival at the manhole at 5:15 PM, you notice right away that sewage is spilling out from around an unsecured 24-inch bolt down manhole cover. You field measure the height of the sewage from the top of the frame on the manhole casting and determine that the sewage is reaching an elevation 5 inches above the top of the frame. Based on current engineered SSO volume estimation, a sewage spout 5 inches above a manhole rim with the cover still in place tabulates out to 166 gallons per minute. You also notice that the SSO is flowing from the manhole directly down a steep bank and into a waterway. No pooling of sewage is noted between the manhole and the creek. As the creek was flowing rather high that afternoon after an earlier rainstorm, none of the spill would be recoverable. Your crew had setup their equipment and were able to clear the problem causing the mainline stoppage 22 minutes after your arrival. Based on the information supplied, how many reportable unrecoverable gallons of raw sewage had reached the creek.
- 30,622 gallons.
 - 11,122 gallons.
 - 36.022 gallons.
 - 32,370 gallons.
68. Based on new Best Practices of the Common Ground Alliance for marking underground Utilities, the Inquiry Identification Number for an Underground Service Alert (USA) is viable for:
- 21 days.
 - 28 days.
 - 14 days.
 - 30 days.
69. A person who completes a training program in accordance with the requirements of Title 8, Calif. Code of Regulations, Minimum Guidelines of the Common Ground Alliance is considered:
- Competent Person.
 - Concerned Person.
 - Qualified Person.
 - The Excavator.



70. "High priority subsurface installations are high pressure natural gas pipelines with normal operating pressures greater than 415 kPA gauge (60 p.s.i.g.), petroleum pipelines, pressurized sewage pipelines, conductors or cables that have a potential to ground of 60,000 volts or more, or hazardous materials pipelines that are potentially hazardous to employees, or the public, if damaged". This paragraph indicates that before the start date of the excavation the following should occur:
- A phone call
 - An e-mail
 - An agreed upon site visit
 - Nothing
71. Temporary traffic control lanes created as part of a Temporary Traffic Control Zone setup on a street with a 35 MPH maximum speed limit shall be a minimum width of ?
- 8 ft.
 - 10 ft.
 - 11 ft.
 - 12 ft.
72. For a nighttime Short Term Stationary Temporary Traffic Control Zone setup on low speed/low volume street, the minimum height of the traffic cones used shall be ?
- 28" H.
 - 24" H.
 - 18" H.
 - 32" H.
73. After completing a Temporary Traffic Control setup for your work zone it is a good practice to:
- Take a 10 minute rest period so you can eat your breakfast.
 - Leave the job site to go get a cup of coffee at Starbuck's.
 - Immediately get to work on your project.
 - Observe how effective your TTC setup is working to control traffic and make the necessary changes to it if necessary.
74. When a citizen wants information regarding a maintenance operation you should?
- Always refer them to a supervisor.
 - Ignore them.
 - Tell them you are not authorized to give out information.
 - Give them as much factual information as you can, and offer to help them further.



75. Before starting a maintenance operation in a basement located in backyard of a residence you should:
- a. have the police order the resident to allow you access.
 - b. just skip the maintenance operation.
 - c. contact the resident and politely ask permission to enter the backyard.
 - d. just enter the backyard and ignore the resident.
76. Maintenance programs are based on?
- a. A history of emergencies.
 - b. Seasonal requirements.
 - c. A good filing system.
 - d. Preventative and corrective maintenance principles.
77. The goal of preventative maintenance is to?
- a. Avoid doing maintenance.
 - b. Satisfy the city council.
 - c. Avoid breakdowns, severe damage, or harmful depreciation.
 - d. Use the entire budget.

END OF PRACTICE TEST



Practice Test Answer Key

The following tables show the correct answers for the test questions included in this study guide. The tables below show what section the answers are for, the correct answer, and the subsection the question refers to. If you marked a wrong answer to any of the practice test questions, refer to the subsection listed and you will be able to find the correct reference material to study to help you correctly answer the question.

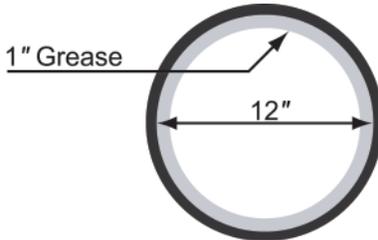
No.	Answer	KSAs			
1	a	200,208	39	b	200,202,205
2	d	200,209	40	d	200,202,203,205
3	d	206	41	d	200,202,207
4	b	202	42	a	200,201,208
5	d	203,204	43	b (see solutions)	200,202,201
6	d	200,204,208	44	c	200,202
7	c	202,203	45	c	200,202,208
8	a	203,205,208	46	b	200,202,201
9	c	203,208	47	d (see solutions)	200,201,202,205
10	c	206,208	48	d (see solutions)	200,201,202
11	c	206	49	c (see solutions)	200,201,202
12	d	206	50	a	200,201,204
13	d	209	51	c	200,202,208
14	c	200	52	b	200,201
15	a	200	53	b	200,202,208
16	c	200	54	d	200,202
17	d	200,202,203,204,208	55	d	200,208
18	b	200,203,208	56	a (see solutions)	200,202
19	c	200,202,203,208	57	b (see solutions)	200,202
20	c	209	58	c	200,201,202
21	c	209	59	d	211
22	d	209	60	a (see solutions)	211
23	c	211	61	b	200,201,208
24	b	211	62	b	200,201,208
25	b	211	63	a	200,201,208
26	d	200,202,207	64	b	200,201,208
27	b	200,202,207	65	c	200,201,208
28	d	200,202	66	d	200,201,208
29	b	201,202,211	67	c	211
30	a (see solutions)	200,202,207	68	b	205
31	a	200,202	69	c	205
32	b	200,202,208	70	c	205
33	c	200,202,207	71	b	206
34	d	200,202	72	a	206
35	b	200,201,203,204,208	73	d	206
36	b	200,203,208,209	74	d	200,207,208
37	c	200,202,211	75	c	200,207,208
38	a	200,202,207	76	d	200,202,204
			77	c	200,202,204



Solutions for Selected Questions

30. The interior of 300 feet of 12-inch pipe is uniformly coated with one inch of grease. How many gallons will this pipe hold when filled with water?

Solution



$$12 \text{ inches} - 2 \text{ inches} = 10 \text{ inches}$$

Convert to feet:

$$10 \text{ inches} \times \frac{1 \text{ foot}}{12 \text{ inches}} = 0.833 \text{ feet}$$

Volume of a right regular cylinder from Table 4-2:

$$\begin{aligned} V &= 0.785D^2H \\ &= 0.785 \times 0.833 \text{ ft} \times 0.833 \text{ ft} \times 300 \text{ ft} \\ &= 163.54 \text{ cu ft} \end{aligned}$$

Convert to gallons:

$$163.54 \text{ cu ft} \times \frac{7.48 \text{ gal}}{\text{cu ft}} = 1,223 \text{ gals}$$

The best answer is 1,230 gals.

43. A flow of 650 GPM would be how many MGD?

Solution

$$650 \text{ GPM} \times \frac{1,440 \text{ min}}{\text{day}} = 936,000 \text{ GPD}$$

$$\frac{936,000 \text{ gal}}{\text{day}} \times \frac{\text{MG}}{1,000,000 \text{ gal}} = 0.936 \text{ MGD}$$



47. If an eight-inch force main has a metered flow rate of 400,000 gpd, what is the velocity?

Solution

Two formulas are needed:

$$\text{Velocity} = \frac{\text{Flow}}{\text{Area}}$$

$$\text{Area} = 0.785 D^2$$

Computing the area, first convert the diameter into feet.

$$8 \text{ inch} = \frac{\text{ft}}{12 \text{ inch}} = 0.667 \text{ ft}$$

$$A = 0.785 (.667 \text{ ft})^2 = 0.349 \text{ ft}^2$$

Convert flow in gallons to ft³ per second.

$$\frac{400,000 \text{ gal}}{\text{day}} \times \frac{\text{ft}^3}{7.48 \text{ gal}} \times \frac{\text{day}}{24 \text{ hrs}}$$

$$\times \frac{\text{hr}}{60 \text{ min}} \times \frac{\text{min}}{60 \text{ sec}} = 0.619 \frac{\text{ft}^3}{\text{sec}}$$

$$V = 0.619 \frac{\text{ft}^3}{\text{sec}} \times \frac{1}{0.349 \text{ ft}^2} = 1.77 \frac{\text{ft}}{\text{sec}}$$

48. During the 24-hour operation, a lift station pumped 3,000 gallons per minute for a community of 27,000. What is the per capita pumped in gallons per day?

Solution

$$\frac{\text{GPD}}{\text{Capita}} = \frac{\text{Volume Pumped Per Day}}{\text{Number of People}}$$

$$\text{Volume} = \frac{3,000 \text{ gal}}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} \times \frac{24 \text{ hr}}{\text{day}}$$

$$= 4,320,000 \text{ gal}$$

$$\frac{\text{GPD}}{\text{Capita}} = \frac{4,320,000 \text{ gal}}{27,000 \text{ People}} = 160 \frac{\text{GPD}}{\text{Capita}}$$



49. A wet well 20 feet in diameter is filled with water to a depth of 10 feet. How many gallons does the tank contain?

Solution

$$V = 0.785 (D)^2 \times H$$

$$V = 0.785 (20 \text{ ft})^2 \times 10 \text{ ft} = 3,140 \text{ ft}^3$$

Convert to gallons:

$$3,140 \text{ ft}^3 \times \frac{7.48 \text{ gal}}{\text{ft}^3} = 23,500 \text{ gallons}$$

56. If it takes 7 minutes and 30 seconds for dye to travel a distance of 860 feet through an eight inch sewer, what is the velocity in fps?

Solution

$$V, \text{ fps} = \frac{(\text{Distance, ft})}{(\text{Time, Sec})}$$

Convert minutes to seconds:

$$7 \text{ min} \times \frac{60 \text{ sec}}{\text{min}} = 420 \text{ seconds}$$

$$= \frac{860 \text{ ft}}{420 \text{ sec} + 30 \text{ sec}}$$

$$= \frac{860 \text{ ft}}{450 \text{ sec}} = 1.91 \text{ fps}$$

57. An upright circular cylinder tank (flat bottom) has a diameter of 12 feet. When filled to a depth of 8 feet, the volume is?

Solution

$$V = 0.785 (D^2) \times H$$

$$= 0.785 (12 \text{ ft})^2 \times 8 \text{ ft}$$

$$= 0.785 (144 \text{ ft}^2) \times 8 \text{ ft} = 904.3 \text{ ft}^3$$



60. Flow estimation is critical to reporting SSOs. You are dispatched to an SSO coming out of a 24-inch manhole pick hole that was spurting about 3/4 inch, the sewerage was running down the gutter into a storm drain 200' away. You received the call at 1100 hrs, arrived on site at 1115, and your crew relieved the stoppage at 1127. You estimate the spill was running at 6 gallons per minute (6 gpm). How much sewer went un-captured into the storm drain?
- a. 162 gallons
 - b. 126 gallons
 - c. 719 gallons
 - d. 1,211 gallons

Solution

Duration X Flow Rate (GPM) = Spill Volume : 27 min x 6 gpm = 162 gallons



S e c t i o n 6

Study Materials

The following section includes the titles and information of primary and secondary references for the Technologist. Because these references contain the majority of the information needed for the CWEA certification test, it is recommended that these references be obtained for personal use. They may also be obtained at a university library or possibly an employer's library.

The Internet is also a valuable resource. However, when searching for material the source should be considered and your search information should be as targeted as possible to obtain the resource requested. If possible, you should target colleges, government agencies, public works agencies and similar trustworthy sources for your requests.

Study Materials Referenced in Section 3

- *Operations and Maintenance of Wastewater Collection Systems, Volume I, 6th Edition*
Office of Water Programs, California State University Sacramento.
6000 J Street, Sacramento, CA 95819-6025, 916-278-6142 www.owp.csus.edu .
- *Operations and Maintenance of Wastewater Collection Systems, Volume II, 7th Edition*
Office of Water Programs, California State University Sacramento.
6000 J Street, Sacramento, CA 95819-6025, 916-278-6142 www.owp.csus.edu .
- *Utility Management*
Office of Water Programs, California State University Sacramento.
6000 J Street, Sacramento, CA 95819-6025, 916/ 278-6142 www.owp.csus.edu.
- *Wastewater Collection System Maintenance*
Michael J. Parcher, CRC Press.
800/272-7737 Fax: 800/374-3401, www.crcpress.com.
- *Mathematics for Collection System Operators, a Workshop Manual*
OCT, Inc.
P.O. Box 332, Gladstone, OR 97027, www.octinc.com
- *Confined Space Entry*
Water Environment Federation
601 Wythe Street, Alexandria, VA. 22314-1994, Phone: 1-800-666-0206, www.wef.org.
- *Safety and Health in Wastewater Systems, WEF Manual of Practice SM-1*
Water Environment Federation
601 Wythe Street, Alexandria, VA 22314-1994, 800-666-0206, www.wef.org



- *Manage For Success: Effective Utility Leadership Practices*
Office of Water Programs, California State University Sacramento.
6000 J Street, Sacramento, CA 95819-6025, 916-278-6142, www.owp.csus.edu
- *Permit-required Confined Spaces*
29 CFR 1910.146, Occupational Safety & Health Administration
www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9797
- Confined Spaces, 1910.146 and Confined Spaces, Health and Safety Topics, OSHA
www.osha.gov.
- *Manual of Uniform Traffic Control Devices (MUTCD)*
US Department of Transportation, Federal Highway Administration
<http://mutcd.fhwa.dot.gov>
- *Wastewater Collection Systems Management, MOP7, 5th edition*
Water Environment Federation
www.wef.org
- *Sanitary Sewer Overflows What are they and how can we reduce them?*
EPA 832-K-96-001 -Summer 1996, EPA Office of Wastewater Management
<http://www.epa.gov/npdes/pubs/ssodesc.pdf>
- *Best Management Practices for Sanitary Sewer Overflow (SSO) Reduction Strategies*
<http://www.bacwa.org/> or <http://www.cvcwa.org/>
- NASSCO: http://www.nassco.org/training_edu/te_pacp.html

Additional Study Materials

- *The Math Text for Water and Wastewater Technology, Second Edition*
Wrights Training
P.O. Box 515, Elmira, CA. 95625-0515, 707-448-3659, www.wrights-trainingsite.com
- *Traffic Manual Chapter 5 Traffic Controls for Construction and Maintenance Work Zones*
State of California, Department of Transportation
1900 Royal Oaks Drive, Sacramento, CA 95815, <http://www.dot.ca.gov/hq/traffops/signtech/signdel/trafficmanual.htm>
- *Statewide General Waste Discharge Requirements for Sanitary Sewer Systems Order No. 2006-0003-DWQ.*
http://www.swrcb.ca.gov/rwqcb9/water_issues/programs/sso/docs/2006_0003.pdf



You and Wastewater Math

By Cheryl Ooten, Santa Ana College email: ooten-cheryl@rsccd.org

Example math problems found in Appendix A are representative of general wastewater math and are designed to illustrate a math problem solving strategy, not specific math skills. Examples given in this appendix may not be like the problems given on the test for your discipline. However, the problems are typical of types of problems you may encounter, including, but not limited to, basic algebra (solving one equation for one unknown), story problems, and geometry, (area and volume problems). For specific kinds of math skills and problems you may encounter on the Collection System Maintenance certification test, please review Sections 3, 4, and 5 of this study guide.

Section 1: Introduction

Now is the time for you to begin preparation for the math portion of your technical certification exam. This Appendix provides suggestions to take charge of:

- Your math skills
- Your attitudes toward math
- Your test-taking skills

By doing this, you can improve your performance in successfully completing the math questions on the certification exam.

Two Facts to Consider

First, since early childhood, you have used math mostly without giving it a second thought. Knowing your age, counting, comparing sizes and shapes, adding your money, and subtracting to get change are math skills.

You drive the streets judging distances, speeds, and times. You estimate if you can afford a vacation or a car and when you can retire. You compare volumes and areas as you build and do jobs around the work site. You even measure volume in putting toothpaste on your toothbrush. You use statistics as you watch sports and consider things like RBIs in baseball or field goal percentages in basketball. All of these are mathematical skills many people take for granted.

Second, if you think math is hard, please know that math becomes hard for *everyone* at some point. You are not alone. There are math problems that have been unsolved for hundreds of years even though they have been attempted by competent, well-informed mathematicians who may work at them for decades. Those are not the problems you need to work unless you are curious. When you work at your appropriate level, you find a combination of easy ideas and hard ideas.

You may get discouraged comparing your speed and understanding in math with others. Those people who appear to do math easily have, most likely, done those specific problems, or ones like them, many, many times.



You will want to study and progress at your “growing edge”—the skill level where you have a bit of discomfort with new material, but where you are not totally overwhelmed. You can expect challenges that trouble you, but that can be overcome. Instead of saying “I cannot do math,” decide now to begin learning enough math to make work and test-taking easier.

Move Beyond the Math You Know

To move beyond your routine skill level in math, consider the following points:

You Have Skills. You already have many math skills and can build on that base. It is best and easiest to build on what you already know.

Basics are Important. Going back over the basics of what you know will build confidence and help you progress and add new math skills to your ability to solve math problems.

Math Progresses Logically. There are many different areas of math and each builds on itself as well as on the others. If you cannot do a particular problem, it may be because you have missed something basic to that one area along the way. Working your way up slowly and cumulatively in math is the fastest way to gain skills.

Words Count. Each and every word and symbol in math means something. You need to find out those meanings and then practice them. If you do not know what “mgd” or “psi” means, or which units measure “flow”, it is harder to do problems involving them. It can seem like a foreign language.

Brains are Unique. Each individual brain is wired differently, causing each person to think and learn differently. The more you know about the way you as a specific individual learn, the more you will permit yourself to do what it takes to learn math. Some people need to do many written repetitions. Some need to walk or move around as they do math. Some need to talk out loud. Others need to draw pictures. Some need to work problems with other people. Some need to use words and some need to use symbols. In order to focus on how to move forward, think about what works for you or where learning has been difficult for you.

If you are an independent learner, you might find a basic math book at your library to work through on your own. You may be able to study with your own children to learn some math together or with your friends and colleagues. You may have an old math book you used a long time ago that could be helpful, and you may come to remember what you learned from it.

Assessment Helps. Assess your skill level honestly. Math placement tests are available at your local college and through private educational agencies to help you determine where your skills are and where you can best get help to make comfortable progress.

You are Not Alone. No one promises that math will always be easy or interesting for you. For most people, working on math is a challenge. Persevering and pushing personal limits allows you to experience the satisfaction of success.

Get help when you get discouraged or experience confusion. Remember this is just a momentary problem in a sequence of ideas that you are confronting. Do not buy into the myth that you have to do math alone. Do not believe it is demeaning for you to admit you do not understand. You can have fun if you lighten up as you progress. Working with others is an outstanding way to improve math



skills.

Questions are Essential. Make a list of people with whom you feel comfortable discussing your math questions. They may be your colleagues, teachers, fellow students, friends, or family members—even your children. Do not ask just anybody; pick people who are helpful and positive or non-judgmental about your questions.

Mistakes Happen. Expect mistakes up front. As you learn anything new, you will make errors. Do not blame your mistakes on math itself! In any new endeavor you need to allow yourself to crawl before you can walk. Successful people in all fields know this. Trial and error is the basis of all learning.

You can learn more from your mistakes than from repeated successes. Making errors gives you feedback by showing you what you do not understand. Learn to value and accept those errors and use them to find out what areas of your learning need more work. Correct them and then move on with new knowledge.

Learning Math is Not a Competitive Game. Physicist Albert Einstein, politician Winston Churchill, and inventor Thomas Edison were all considered slow in school. Musical composer Ludwig Van Beethoven and scientist Louis Pasteur probably had learning disabilities. What all five certainly had was determination and patience to persevere. Only compete with yourself, pushing yourself forward, in learning math.

There is Hope for Those with Learning Disabilities. If you really have a hard time learning, you might ask your local college or a private learning specialist to assess you for a learning disability. Many colleges and universities do free testing and training for their students. You can also purchase this kind of assistance from private consultants. Much is now known about learning disabilities and how to help people who have them. Learning disabilities often become just learning differences as students learn to honor and use their own thinking and learning styles.

Math Success and Test-Taking Success are Not the Same. Many math students understand and can work math problems, but have difficulty in test-taking situations. It is possible to know math and still fail exams. These people may find Section 4 “Test-Taking Strategies” very helpful. Conscious practice of both math skills and test-taking skills can make a big difference in your score.

Resources are Available. Resources exist for all types of math. You will need to decide whether you will work on your math skills independently or with the help of some structure such as a math course or a tutor. Different strategies may work better at different stages in your progress.

Your local community college has inexpensive math courses. Some colleges even have math courses specifically for water and wastewater professionals. Professional organizations sponsor training conferences and seminars which include math courses specific to the field. Many agencies can provide in-house training and many agencies will provide individual help with all aspects of test taking.

Community Colleges. Community colleges offer several types of services including:

- Math Placement Testing
- Math Courses
- Water Utility Science Courses
- Math Anxiety Reduction Courses



- Testing and Training for those with Learning Disabilities

Professional Organizations. Organizations such as the California Water Environment Association (CWEA), American Water Works Association, and American Public Works Association also provide opportunities to practice your math skills and network with others:

- CWEA local section study sessions
- Technical Certification Training Classes and Annual Conferences
- CWEA Northern Regional Training Conferences
- CWEA Study Manuals

At Work. Ask for help and suggestions from others who have taken math courses or are skilled in the work area similar to the one you are trying to prepare or improve. Ask your supervisor for advice on how to prepare and how much time on the job you can have to prepare. Ask your supervisor to provide training classes for the areas that you are wanting to improve. Ask those managing other departments, agencies, or local professional organizations for help in the training you need.

Materials. Any basic math book or instructional manual that you can beg, borrow, or buy, including:

- Courses from Ken Kerri, Office of Waste Programs, California State University, Sacramento, 6000 J Street, Sacramento, CA 95819.
- Price, Joanne Kirkpatrick. *Basic Math Concepts for Water and Wastewater Plant Operators*. Lancaster, Pennsylvania: Technomic, 1991.
- Smith, Richard Manning. *Mastering Mathematics: How to Be a Great Math Student*, 3rd Ed. Pacific Grove, CA: Brooks/Cole, 1998.
- Zaslavsky, Claudia. *Fear of Math*. New Brunswick, NJ: Rutgers University Press, 1994.

Section 2: Practice Problem Solving Strategies

Wastewater math deals with only a handful of basic types of problems that involve moving liquids and semi-solids from place to place, and manipulating, storing, and treating these substances along the way.

So basically, understanding area, volume, slope, rates, concentrations, costs, and time elements that occur in wastewater treatment 24 hours per day, 365 days per year, pretty much covers what you need to know.

Units and Arithmetic

All wastewater math problems can be solved by simple arithmetic—adding, subtracting, multiplying, and dividing. You can become proficient with wastewater math by paying careful attention to the units in the problems as you write down your strategies, and then using a calculator to do the needed arithmetic. Make sure you use only a calculator that you can take into the test site (see www.cwea.org/cbt for a list of approved calculators).

Units. Units such as cubic feet, gallons, gpm, and mgd are important in wastewater math problems. Paying attention to the units will tell you whether to multiply or divide. Also, the units will often help you know what numbers to multiply or divide.



Notice in each example that doing math operations on the units produces the correct units in the answer. Many people do the math on the units first to figure out the correct procedure before they ever do the math on the numbers.

Multiplying. Multiplying is important. There are several symbols for multiplication. They are •, x, and ().

For example,

$$2 \cdot 3 = 2 \times 3 = (2)(3) = 6$$

Dividing. Dividing is important to wastewater math because units often used such as mgd, cfs, ppm, gpm, psi, mg/L, gpd/sq.ft., and % are really division problems.

“Per” stands for “divided by”.

$$\text{mgd} = \frac{\text{million gallons}}{\text{day}}$$

$$\text{cfs} = \frac{\text{cubic feet}}{\text{second}}$$

$$\text{ppm} = \frac{\text{parts}}{\text{million}}$$

$$\text{gpm} = \frac{\text{gallons}}{\text{minute}}$$

$$\text{psi} = \frac{\text{pounds}}{\text{square inch}}$$

$$\text{mg/L} = \frac{\text{milligrams}}{\text{Liter}}$$

$$\text{gpd/square foot} = \frac{\text{gallons/day}}{\text{square foot}}$$

$$10\% = \text{ten percent} = \frac{10}{100}$$

Example Problems

Example 1. Plant No. 1 measured a flow of 3.5 million gallons in half a day. If the peak flow (hydraulic) capacity of the plant is 8 mgd, is there need for concern?

Using the conversion factor:



$$\text{mgd} = \frac{\text{million gallons}}{\text{day}}$$

divide 3.5 million gallons by half a day.

$$\text{mgd} = \frac{3.5 \text{ million gallons}}{0.5 \text{ day}} = 7 \text{ mgd}$$

7 mgd is less than the peak flow capacity, 8 mgd. There is no need for concern yet.

Example 2.

a. Find the number of gallons in 10 cubic feet.

Since we can pour 7.48 gallons into a 1 cubic foot container, that means that 7.48 gallons = 1 cubic foot. We can use either factor:

$$\frac{7.48 \text{ gal}}{1 \text{ cu ft}} \text{ or } \frac{1 \text{ cu ft}}{7.48 \text{ gal}}$$

to convert cubic feet units into gallons or vice versa

$$\frac{10 \text{ cu ft}}{1} \cdot \frac{7.48 \text{ gal}}{1 \text{ cu ft}} = \frac{(10 \text{ cu ft})(7.48 \text{ gal})}{1 \text{ cu ft}}$$

$$= 74.8$$

Notice that using the first factor allows the unit "cu ft" to cancel out leaving the answer in gallons.

b. Find the number of cubic feet in 10 gallons. Notice that using the second factor allows the unit "gal" to cancel out leaving the answer in cubic feet.

$$\frac{10 \text{ gal}}{1} \cdot \frac{1 \text{ cu ft}}{7.48 \text{ gal}} = \frac{(10 \text{ gal})(1 \text{ cu ft})}{7.48 \text{ gal}}$$

$$= 1.34 \text{ cu ft}$$

You will notice how important it was in these examples to consider the units in deciding whether to multiply or divide by 7.48.

Example 3.

a. Find the detention time for a basin with 675,460 gal if the flow is 1,000,000 gal/day.

Flow is always a rate which is division. Units like gpd or cfs are both division.



The formula for the basin detention time is

$$D_t = \frac{\text{volume}}{\text{flow}}$$

$$\begin{aligned} D_t &= \frac{675,460 \text{ gal}}{1,000,000 \text{ gal/day}} \\ &= \frac{675,460 \text{ gal}}{1} \cdot \frac{\text{day}}{1,000,000 \text{ gal}} = 0.675 \text{ days} \end{aligned}$$

b. Find the detention time for a 426 cubic foot basin if the flow is 1,000 cfs.

$$\begin{aligned} D_t &= \frac{426 \text{ ft}^3}{1,000 \text{ cfs}} = \frac{426 \text{ ft}^3}{1,000 \frac{\text{ft}^3}{\text{sec}}} = \frac{426 \text{ ft}^3}{1} \cdot \frac{\text{sec}}{1,000 \text{ ft}^3} \\ &= 0.426 \text{ sec} \end{aligned}$$

Example 4.

Find the number of gallons of an 11% polymer needed to produce 100 gal of a 0.75% solution. Use the formula $C_1V_1 = C_2V_2$ where C = concentration or % and V = volume.

You can let the volume you are looking for (i.e. the number of gal of 11% polymer) be represented by V_1 . Then $C_1 = 11\%$ or 0.11, $C_2 = 0.75\%$ or 0.0075, and $V_2 = 100$ gal.

Using the formula $C_1V_1 = C_2V_2$, you have $(0.11)(V_1) = (0.0075)(100)$

Notice to find V_1 , you do the opposite of multiplying (i.e. dividing) by 0.11 on both sides. You then have

$$\frac{(0.11)(V_1)}{0.11} = \frac{(0.0075)(100)}{0.11}$$

and using a calculator, $V_1 = 6.82$. So, the amount needed is 6.82 gal.

Example 5.

How many hours will it take to empty a 43,000 cubic foot tank if it empties at a rate of 2.7 cubic feet per second?

Notice that dividing 43,000 cubic feet by 2.7 cubic feet per second would make the cubic feet unit cancel out. This would give us the time in seconds. To convert seconds into hours, use the factors



$$\frac{1 \text{ min}}{60 \text{ sec}} \text{ and } \frac{1 \text{ hr}}{60 \text{ min}}$$

The work is given below.

Notice how the units cancel out leaving the answer in hours.

$$\text{Time} = \frac{43,000 \text{ ft}^3}{2.7 \frac{\text{ft}^3}{\text{sec}}} \cdot \frac{1 \text{ min}}{60 \text{ sec}} \cdot \frac{1 \text{ hr}}{60 \text{ min}} = 4.42 \text{ hr}$$

Example 6.

Find the number of gallons of water in a rectangular basin 200 ft long, 50 ft wide, and 12 ft deep.

First, find the volume of the rectangular basin by multiplying length by width by height. Volume = (200 ft)(50 ft)(12 ft) = 120,000 cubic feet or cu ft or ft³.

You now have a problem similar to Example 2. How many gallons are there in 120,000 cubic feet?

Use the factor $\frac{7.48 \text{ gal}}{1 \text{ cu ft}}$ to convert cubic feet into gallons.

$$\text{volume} = \frac{120,000 \text{ cu ft}}{1} \cdot \frac{7.48 \text{ gal}}{1 \text{ cu ft}} = 897,600 \text{ gal}$$

Example 7.

A cylindrical tank is full to 3 feet below the top at 10 a.m. and empty at 4 p.m. If the tank is 50 ft tall with a diameter of 70 ft, find the volume (in gal) of the liquid at 10 a.m. and the rate of flow from the tank in gal per minute.

For a math problem with many words, I recommend always first writing down what you are trying to find:

- First, find the number of gal of water in the tank at 10 a.m.
- Second, find the rate of flow in gal/min.

Drawing a sketch helps some people understand the problem and helps to keep track of the data.

I also like to write down and interpret the details that are given to me like:

Full to 3 ft below the top at 10 a.m.
 Empty at 4 p.m.
 Takes 6 hours to empty

The solution is presented in two parts.

- First, to find the volume in gal at 10 a.m., use the formula for volume of a cylindrical



tank which is $V=(\text{area of the base}) \times (\text{height})$.

To find the area of the base of the tank which is a circle, multiply 0.785 times the diameter squared.

So, the area of the base = $0.785(70^2) = 3,846.5 \text{ sq ft}$.

The height at 10 a.m. is 47 ft because the tank is filled to 3 ft below the top.

Volume = (area of the base)(height) = $(3846.5 \text{ ft}^2)(47 \text{ ft}) = 180,785.5 \text{ ft}^3$

However, you want the volume in gal so use the factor $\frac{7.48 \text{ gal}}{1 \text{ cu ft}}$ to convert.

Volume in gallons =

$$(180,785.5 \text{ ft}^3) \left(\frac{7.48 \text{ gal}}{1 \text{ ft}^3} \right) = 1,352,275.54 \text{ gal}$$

b. Second, to determine the rate of flow in gallons per minute, divide the number of gallons by the number of minutes it took the tank to empty. It took 6 hours to empty. To convert 6 hours to minutes, use $60 \text{ min} = 1 \text{ hour}$ or factors $\frac{60 \text{ min}}{1 \text{ hour}}$ or $\frac{1 \text{ hour}}{60 \text{ min}}$ to convert. You want the hour unit to cancel out, so you will use the first factor. The time becomes:

$$\left(\frac{6 \text{ hrs}}{1} \right) \left(\frac{60 \text{ min}}{1 \text{ hr}} \right) = 360 \text{ min}$$

Rate of flow in gal per minute =

Rate of flow in gallons per minute =

$$\frac{1,352,275.54}{360 \text{ min}} = 3,756.32 \text{ gal per min}$$

Section 3: Take Charge of Your Success

The key to progress with math is to consciously take charge of your thoughts and actions. Then, instead of letting math control you, you control math and you take charge of your success.

Recommendations

Ask Questions. Be active and assertive. Learning is not a spectator sport. You cannot learn well from the sidelines. Get involved. Work problems and keep asking questions until they become clear. In classes and seminars, ask questions on confusing procedures.

Take It Easy. When you get stuck working problems, hang in for a while and then take a break. Go back later, begin at the beginning with a clean sheet of paper and a different point of view. Just because you do not understand at first does not mean understanding will not come. Math learning requires time to settle into your brain. Being able to live with uncertainty for a while is a good math skill to have.



Keep a List. Write down your resources (books, tutors, people to answer questions, people who understand) so that you can consult them when you get discouraged. You are not alone. Find helpful people with whom you are comfortable. Form a network with others working toward the same goals as you.

Find Yourself. Discover your own unique ways of learning. Experiment with new ones. If a method does not work, find others. Ask different people how they learn math or do a problem. They will often feel honored and pleased that you asked them and you might get a breakthrough idea.

Be Positive. Listen to what you say to yourself inside your head. It is difficult to work well if you are saying, “I will never get this” or “I cannot do math.” Change those negative messages to neutral ones like “I have not learned this yet” or “I cannot do this particular problem yet.”

Reward Yourself. Acknowledge your progress—every little bit! Pat yourself on the back for each and every problem you work. Notice what you know now that is new that you did not know two weeks ago. Maybe even write it down to document your growth.

Learn From Mistakes. Remember that errors are part of the learning process. Pay attention to them and figure out where they happened and how to fix them.

Keep It Real. Be realistic with your expectations of yourself—your math level, your life commitments, and your time constraints. Do not beat yourself up for being a human being.

Use Technology. Learn to use a calculator and use it appropriately for calculations with large numbers and decimals. Be sure to use only an approved calculator for the test site (a list is available at www.cwea.org/cbt). Each brand of calculator is different so keep your manual for reference. Take spare batteries to exams.

Start Easy. Practice the easier math problems to warm up each time you begin your math study. This builds confidence and strengthens those math pathways in your brain.

Write Out Problems. You will be given a dry erase sheet to use at the test site. Practice math problems using scratch paper. Use this to think and do calculations.

Promote Emotional Well Being. Patience, self-care, and humor will make your math work so much easier. Your brain will work better too.

Be Healthy. You are making new connections in your brain as you practice math so sufficient sleep and healthy foods are important. Having fresh drinking water available and breathing fresh air also helps you think better.

Section 4: Test-Taking Strategies

There are many actions you can take before, during, and after exams that will improve your test-taking performance and outlook. Remember that math skills and test-taking skills are different from each other. This section will help you become conscious of your thoughts and actions regarding test preparation. Use these suggestions to take charge and approach your test confidently.



If you find yourself thinking negative thoughts about your coming exam, skip to the last section and read “Negative Thinking about Exams” first.

Before the Exam

Work Problems. Diligently prepare and practice. Repeat solving problems to gain speed and confidence. This takes work and time—sometimes many hours, even days. Going in to an exam with the knowledge that you have worked lots of problems boosts confidence. Prep time is invaluable.

Relax. Practice relaxation daily for about at least ten minutes using breathing. Sitting or lying comfortably, breathe slowly in through your nose counting to five and then out through your mouth counting to ten. If you feel dizzy, breathe normally for a while. Deep breathing activates chemicals in your body that help you relax and feel better. Any type of regular meditation, yoga, or slow stretching while breathing deeply can help facilitate your relaxation response. Practicing daily will help you control your adrenaline level during your exam. Using relaxation consciously during an exam frees up the thinking part of your brain. (Do not practice these deep breathing exercises while you are driving.)

Stay Active. Daily walks or biking or whatever aerobic exercise you use consistently prepares your body for your exam by relieving stress and keeping your state of mind positive. Your mind and your body are connected so tightly that they are nearly the same.

Rehearse. Do a dress rehearsal for your exam. Write or have someone assist you in writing a practice test with problems and questions that you think might be on the real exam. Take the practice test in this study guide in an environment as close to your testing situation and schedule as possible. Time it and then correct it to learn from your errors.

Plan Ahead. Plan ahead carefully so that you will get to the exam early—do not be in a rush. Know exactly how to get there and what you will wear so that you are comfortable. You might want to wear your “lucky” shirt or bring a photograph in your wallet of people who care about you and believe in you. WHATEVER you can do to increase your sense of comfort and security, do it. Ahead of time, pack a Testing-Taking Kit with sharp pencils, pens, a ruler, erasers, tissues or handkerchief, a bottle of water, extra calculator batteries, and anything else you think you might need that is allowed at the test.

Care For Your Body. Optimal food and rest are individual preferences. Plan these ahead of time. Some research has shown that a brisk walk before an exam has raised test results. Some research has shown that eating a few candies (not chocolate) right before an exam has raised test results. Protein appears to be essential for clear thinking. Be in charge of what happens to you before the exam. Do not let outside influences take charge of you for this little time before your test.

At the Exam

Do a Data Dump. Bring a short list of formulas or facts you find difficult to remember. Look at them before the test. Visualize them going into a holding tank in your brain. Practice making them subject to recall. You are not allowed to use notes on the exam, so be sure to put the list away so that your honesty is not questioned. When you start your test, quickly write these formulas or facts on your dry erase sheet. Now you do not have to expend any energy trying to recall them later when you need them.

Ignore Others. Ignore all of the other people at the test site—before, during, and maybe even after. Different people have different ways of dealing with their anxiety during tests (and remember, they are



likely to be taking a completely different test than you). Some people get a little hyper and try to rub off their anxiety on everyone else. Do not take on someone else's anxiety. Your test is not a competition so what other people do will not affect your score. Often the first person to leave an exam gets a very low score, while the last person to leave gets a very high score. Take your time. Pay no attention to other people's behavior.

Breathe. When you feel stuck or tense, take a deep breath. Let it all go as you expel the air. (The more you have practiced relaxation and deep breathing before the exam, the more you will relax during the test.)

Take Time Out. Take short breaks during the exam to close your eyes, breathe deeply, and stretch your neck and arms. Massaging your temples, scalp, and the back of your neck will increase blood flow with oxygen to your brain to help you think better. A few isometric exercises can release tension too.

Use Your Subconscious Mind. If a problem makes no sense, read it and go on. Ideas will come to you as the problem sinks into your subconscious mind while you continue with the test.

Trust. Let each question reach into your mind for the answer. Remind yourself that you know everything you need to know for now.

Strategize. Do the easy problems and questions first. Make pencil marks by the questions to which you want to return.

Use Time Wisely. Do not work on one problem for a long time. Often a question further into the exam will act as a "key" to unlock a previous problem. Tell yourself that you have all of the time you need. Let go of the rest of your life during the exam. You can deal with all that later.

After the Exam, Let the Results Go. You have used a lot of energy and may be low and off balance. You may wish to pass up discussing the exam with others so you can take care of yourself. Going to the bathroom, drinking some water, and eating something can help you feel normal again. You may have set much of your life aside to prepare for this exam. Refresh yourself and get your life back. You can deal with the test results later when your priorities are in order again.

Negative Thinking About Exams

Here are negative thoughts math students often think before test-taking. Put a check mark by the examples familiar to you. Recognizing the distorted thinking in each example can help you change negative thoughts to neutral or positive ones. If you need more assistance with overwhelming negative thoughts, I recommend the book *Feeling Good* by David Burns (WholeCare, 1999).

"I Will Fail." Unless you have a crystal ball and can see into the future OR unless you have made a definite plan NOT to prepare for the test OR unless you plan to "freeze up" during the exam, you have no way of knowing whether you will fail or not. Worrying about the future only takes energy from today.

"I Will Panic During the Test." It is not uncommon to be excited. An exam is a process during which you will experience many thoughts, feelings, and body sensations. Actors get nervous, yet they still perform. If you do panic, let panic leave you. It will. No one dies from panicking during an exam.

Preparation by practicing problems, asking questions, and reviewing gives you confidence and skills that you need. Taking a dress rehearsal test and trying to panic can help you practice dealing with out-of-control feelings. Learning some relaxation techniques to use before and during the exam



calms you and aids clear thinking. The more you prepare yourself ahead, the more you are in charge and feel relaxed.

“I Cannot Do Math.” Math is a very broad subject involving many different skills. If you can recognize shapes, tell time, and know where the front and back of a classroom are, you can already do math. There are many more math skills that you have and many that you do not have YET. There are also many that you will never choose to acquire. Instead of thinking so absolutely about math, find areas where you can grow and learn new skills instead of paralyzing yourself with this broad generalization.

“I Am Stupid.” Name calling is seldom productive. Occasionally you may feel stupid because you do not know something or you mess up. What really is happening is that you are being human and humans are not stupid. Educators recognize the need to change how everyone thinks about intelligence. They recognize that there are many different kinds of intelligence including:

- bodily/kinesthetic
- verbal/linguistic
- naturalist
- logical/mathematical
- visual/spatial
- interpersonal
- intrapersonal
- musical/rhythmic

This comes from the work of Howard Gardner [Gardner, Howard. *Multiple Intelligences: The Theory in Practice*. New York: Basic Books, 1993].

You are a wonderful combination of these talents—not just an IQ number. IQ Tests are limited because they only measure a few types of intelligence and ignore the rest. We are not all the same and cannot possibly know all there is to know in every situation. Between now and the exam, there are many questions you can get answered as well as many new skills you can practice and master if you use the skills and intelligence that you have.

“I Will Forget Everything.” Forgetting does not mean something is gone from your mind forever. The right cue will often help you remember what you need to know. Your exam will be filled with cues—words and symbols—that will trigger formulas and ideas you have practiced.

Expecting to forget “everything” is foretelling the future and making a broad generalization. Even most people with amnesia caused by illness or injury do not forget “everything.” If you are extremely worried about your memory, *The Great Memory Book* by Karen Markowitz and Eric Jensen (The Brain Store, 1999) can be of assistance to you.

“Math Tests Are Tricky.” Math students who rely on memorizing the material rather than understanding it are usually the ones who think tests are tricky. You will use your memory to add to your understanding of how to do the math. Your math problems will contain many units such as mgd or ft³ or psi. Learning how to skillfully convert back and forth between units of measure will take a lot of the trickiness away from your test problems. Practicing using your calculator will help too.

“There Is So Much I Do Not Know.” This will always be the case the rest of your life. It is the human condition. Taking a deep breath and finding the level where you can begin to learn will improve your feelings and your confidence.



Technical Terms

Air gap: An open vertical drop, or vertical empty space, between drinking (potable) water supply and the non-potable point of use. This gap prevents back siphonage because there is no way wastewater can reach the drinking water. Air gap devices are used to provide adequate space above the top of a manhole and the end of the hose from the fire hydrant. This gap insures that no wastewater will flow out the top of a manhole, reach the end of the hose from a fire hydrant, and be sucked back up the hose to the water supply.

Asphyxiation: An extreme condition often resulting in death due to lack of oxygen and/or excess of carbon dioxide in the blood from any cause.

Atmospheric: Of or relating to the atmosphere.

Backfill: 1) Materials used to fill in a trench or excavation. 2) The act of filling a trench or excavation usually after a pipe or some type of structure has been placed in the trench or excavation.

Backflow Device: 1) A device that is placed in a sewer lateral to prevent accidental backflow or reverse flow of wastewater into a building. 2) A device used on potable water systems to prevent water from flowing back into a main from a private service line thereby eliminating any possible contamination.

Balling: A method of hydraulically cleaning a sewer or storm drain by using the pressure of a water head to create a high cleansing velocity of water around the ball. Special sewer cleaning balls have an outside tread causing them to spin or rotate resulting in a scrubbing action of the flowing water along the pipe wall.

Bedding: A prepared base or bottom of a trench or excavation on which a pipe or its structure is supported.

Biochemical Oxygen Demand (BOD): The rate at which microorganisms use the oxygen in water or wastewater while stabilizing decomposable organic matter under aerobic conditions.

Bucket machine: A powered winch machine designed for operation over a manhole. The machine controls the travel of buckets used to clean sewers, a mechanical type of cleaning.

Cardiopulmonary Resuscitation (CPR): Reviving the heart and lungs.

Centerline: Center of the width of a public or utility easement or roadway.

Channel: Provides a transition of wastewater from one or more inlet pipes to the outlet line. Located in a manhole.

Clean Water Act (CWA): The federal Clean Water Act sets the framework for the imposition of industrial



wastewater control programs on municipalities and the regulation of industrial users. Sections 307(b) and (c) of the Clean Water Act set forth the authority for U.S. EPA to establish pretreatment standards for existing and new sources discharging industrial wastewater to POTWs.

Coagulate: The use of chemicals that cause very fine particles to clump together in larger particles.

Combination Cleaner: Jet/vacuum trucks that can clean sewers and vacuum up debris simultaneously. A hydraulic type of cleaning.

Compaction: Tamping or rolling of a material to achieve a surface or density that is able to support predicted loads.

Cone: The part of a manhole that tapers up from the barrel to a manhole cover. Can be either of two types, concentric and eccentric.

Confined-Space: A space that is large enough and so configured that an operator can enter and perform assigned work and has limited or restricted means for entry or exit, potentially contains toxic gases, and is not designed for continuous occupancy.

Engulfment: The surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing.

Excavate: To dig a trench, cavity or hole for or with access to install pipe or other structures.

Hydrogen Sulfide Gas (H₂S): A gas with a rotten egg odor. This gas is produced under anaerobic conditions. H₂S is particularly dangerous because it dulls the sense of smell after prolonged exposure and because the odor is not noticeable in high concentrations. The gas is very poisonous to the respiratory system and is very explosive and flammable.

Infiltration: The water entering a sewer pipe including service connections from the ground. Defective pipes, pipe joints, connections or manhole walls are a few of the common location where infiltration can occur.

Invert: The lowest point of the channel inside a pipe or manhole.

Inflow: The water entering a sewer system through above-ground access points such as manhole covers and lift station hatches.

Jetter (High Velocity Cleaner): A machine designed to remove grease and debris from smaller diameter pipe with jets of high velocity water. Also called a “Jet Cleaner”, “Jet Rodder”, “Hydraulic Cleaner”, or “High

Line Cleaning: Collection system pipeline maintenance operations using hydraulic or mechanical cleaning methods.

Material Safety Data Sheets (MSDS): A document which provides pertinent information and a profile of a particular hazardous substance or mixture. The document is provided by the manufacturer of the substance or mixture.



Oxygen Deficiency: An atmosphere containing oxygen at a concentration of less than 19.5% by volume.

Parachute: A device used to catch wastewater flow to pull a float line between manholes.

Pathogen: A bacteria, virus, or cyst found in wastewater that can cause disease in a host.

Penetrator Nozzle: A type of high pressure water nozzle that is designed to penetrate blockages in sewer pipes, usually used with Jet Rodders or Combination Machines.

Porcupine: A type of mechanical tool used with a mechanical rodder. Its function is to scour lines of light build up in conjunction with water flushing of sewer lines.

Root Saw: A type of mechanical tool used with a mechanical rodder. Its function is to cut through, by sawing action, root masses in a pipe.

Sand Nozzle: A type of high pressure water nozzle that is designed to remove large amounts of sand or other light sediment in sewer pipes. Usually used with Jet Rodders or Combination Machines.

Sanitary Sewer Overflow (SSO): A discharge of wastewater from a location that is not authorized by a NPDES permit. A sanitary sewer overflow may be the result of a pipeline blockage, hydraulic overloading of pipelines or pump stations, equipment malfunctions, or damage to conveyance systems.

Shoring: Material such as boards, planks or plates, and hydraulic jacks used to hold back soil around trenches and to protect workers in a trench from cave-ins.

Square Bar Corkscrew: A type of mechanical tool used with a mechanical rodder. Its function is to remove roots and rigid obstructions in a pipe by cutting and tearing action.

Vitrified Clay Pipe (VCP): A type of pipe used in wastewater collection systems. Vitrified clay pipe is rigid and resistant to internal and external attack from acids, alkalies, gases, solvents and other materials found in wastewater.

Volatile Solvents: A solvent that is capable of being evaporated or changed to a vapor at relatively low temperatures.

Wet Well: A compartment or tank in which wastewater is collected. The suction pipe of a pump may be connected to the wet well or a submersible pump may be located in the wet well.

Worker Right-To-Know Law: Federal and State laws governing worker health and safety in the work place.



Common Acronyms and Abbreviations

AC Power: alternating current

AC: acre

AC Pipe: Asbestos Concrete Pipe

ADWF: Average Dry Weather Flow

AF: acre-feet

AF: acre-foot (feet)

AFY: acre-foot per year

AMSA: Association of Metropolitan Sewerage Agencies

ANSI: American National Standard Institute

APHA: American Public Health Association

ASCE: American Society of Civil Engineers

ASME: American Society of Mechanical Engineers

ASTM: American Society for Testing and Materials

AWWA: American Water Works Association

BECP: Business Emergency and Contingency Plan

BOD: Biochemical Oxygen Demand

BTU: British thermal unit

C: Celsius

Cal EMA: California Emergency Management Agency

Cal OSHA: California Occupational Safety and Health Act

CalEPA: California Environmental Protection Administration

CCR: California Code of Regulations

CDPH: California Department of Public Health

cf: cubic feet (foot)

CFR: Code of Federal Regulations

cfs: cubic feet per second

CH₄: Methane

CIU: Categorical Industrial User

CM: common mode

CMOM: Capacity Management, Operations, and Maintenance



CPR: Cardiopulmonary Resuscitation
CPU: central processing Unit
CRWA: California Rural Water Association
CSP: confined-space permit
CT: current transformer
CWA: Clean Water Act
CWEA: California Water Environment Association
DOHS: Department of Homeland Security or Department/Division of Occupational Health & Safety
DV/DT: (DV/DT) The change in voltage per change in time.
DWF: dry weather flow
DWR: Department of Water Resources
EIR: Environmental Impact Report
EIS: Environmental Impact Statement
EMF: electromotive force or voltage
EPA: U.S. Environmental Protection Agency
ERP: Emergency Response Plan
F: Fahrenheit
ft: feet (foot)
ft²: square foot
ft³: cubic feet
gal: gallon
GFI: ground fault interrupter
GIS: Geographical Information System
GPD: gallons per day
GPM: gallons per minute
GTAW: gas tungsten arc welding
H₂S: hydrogen sulfide
HCP&ERP: Hazard Communications Program and Emergency Response Plan
hp: horsepower
Hz: Hertz
IIPP: Injury and Illness Prevention Plan
IML: Interface Management Language
K: Kilo, a prefix meaning 1000
KVA: kilovolt amperes



kw: kilowatt
kwh: kilowatt hour
L: liter
lb: pound
LRO: Legally Responsible Official
M: Mega, a metric prefix meaning 1,000,000
m: meter
MA: millamps
MBO: Management by Objectives
MG: million gallons
mg: milligram
mg/L: milligrams per liter
mgd: million gallons per day
min: minute
MIS: Manufacturing Information System
mL: milliliter
MMI: Man Machine Interface
MOP: Manual of Practice
MPN: most probable number
MSDS: Material Safety Data Sheets
N: normal
NEPA: National Environmental Policy Act
NOCA: National Organization for Competency Assurance
NPDES: National Pollutant Discharge Elimination System
NPSH: net positive suction head
NTU: nephelometric turbidity unit(s)
O&M: operation and maintenance
OCT: Operator Certification Test (State of California)
OMR: operations, maintenance, and replacement
OOC: Office of Operator Certification (SWRCB)
OSHA: Occupational Safety and Health Administration/Act
P: pico, a metric prefix meaning one millionth
PLS: Private Lateral Spill
PC: personal computer



pH: potential of hydrogen

PI&D: piping and instrumentation diagram

PLC: Programmable Logic Controller

POTW: Publicly Owned Treatment Works

PPB: parts per billion

PPE: Personal Protective Equipment

PPM: parts per million

prct: percent

psi: pound per square inch

PSIG: pounds per square inch gage

PVC: polyvinyl chloride (pipe)

QA/QC: quality assurance/quality control

RCP: reinforced concrete pipe

RFI: Radio Frequency Interference

RMS: root mean square

RWQCB: Regional Water Quality Control Board (State of California)

SCADA: supervisory control and data acquisition

SCR: semiconductor, or silicon controlled rectifier

sec: second

SI: System Internationale D'Unites (metric units)

SSO: sanitary sewer overflow

SSMP: Sewer System Mangement Plan

SWRCB: (California) State Water Resources Control Board

TAC: Technical Advisory Committee

TCP: Technical Certification Program

TU: turbidity unit

U: micro, a metric prefix meaning one millionth

UPS: uninterruptible power supply

USA: Underground Service Alert

USEPA: United States Environmental Protection Agency

V: volt

VAC: volts of alternating current

VCP: vitrified clay pipe

VFD: variable frequency drive

VOM: volt Ohm meter



W: watt
WAN: wide area network
WEF: Water Environment Federation
WRP: water reclamation plant
WWF: wet weather flow
WWTF: wastewater treatment facility
WWTP: wastewater treatment plant (same as POTW)
yr: year

