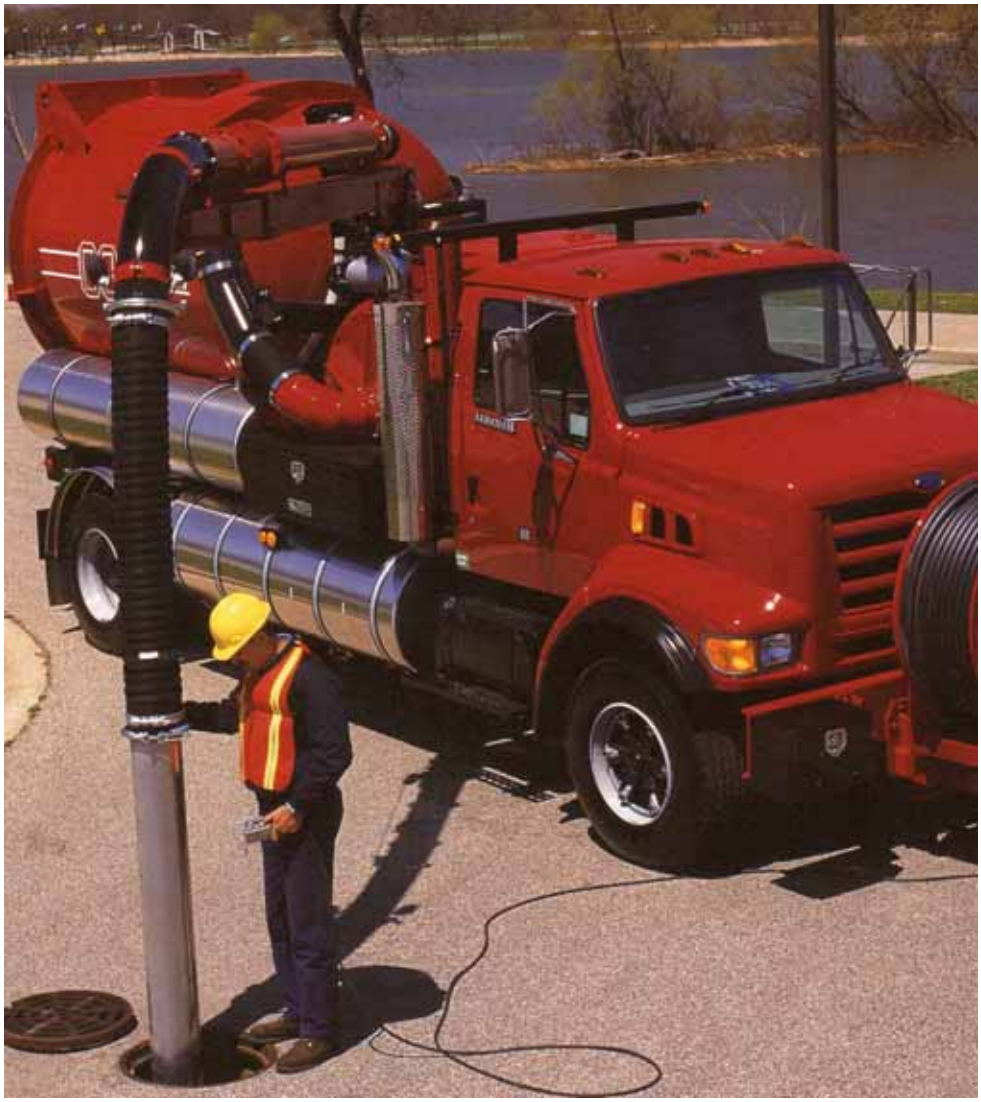
Certification Examination

Study Guide

Collection System Maintenance

Grade I



CALIFORNIA WATER ENVIRONMENT ASSOCIATION

Collection System Maintenance Grade I Study Guide

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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 I Collection System Maintenance Study Guide

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Section 1

Introduction

The California Water Environment Association (CWEA) Technical Certification Program (TCP) is voluntary; its purpose is to educate, prepare, and test an individual's knowledge within six vocations.

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

CWEA also assists in educating and training wastewater treatment plant operators for the State of California Operator Certification Tests. Upon qualifying and successfully completing a test, an individual is certified in that specialty at one of the grade levels. Levels within a specialty designate technical knowledge for the apprentice, journey, and management levels. Tests are designed to demonstrate minimum competence for a particular grade.

The purpose of this study guide is to provide a description of the knowledge, skills, and abilities (KSA) needed to pass the test. Also included are questions designed to assess a candidate's strengths and weaknesses relative to their present KSA. Finally, the study guide provides references used to refresh subject knowledge, or to learn more about particular subject areas not completely understood.

Typically there are two to five primary references for each specialty area which need to be read and understood. Test questions are generally based on information contained in these references. Secondary references give more information and often provide a different approach to a subject making it easier to understand.

This study guide is not a compendium of all that may be on the test, so successfully answering questions contained in this guide does not guarantee passing. To successfully pass the Grade I Collection System Maintenance test, the reference materials presented in this study guide should be thoroughly understood.

This study guide can be best used to help identify strengths and weaknesses and to identify material that may need further study. Comments and suggestions to improve the study guide are always welcome and appreciated. Good luck on the test!

Section 2

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 National Organization for Competency Assurance (NOCA).

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 twice yearly in six different disciplines: 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.

The first committees were formed in 1975 to establish a voluntary certification program for water quality professionals specializing in disciplines other than plant operation. The Voluntary Certification Program (VCP) emerged with specialized certificate programs for Collection System Maintenance, 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 six vocational programs with a total of 22 individual certifications. About 2,000 applications are processed annually and currently over 5,500 certificates are held by individuals in California and neighboring states.

Certification Process

To become certified, *all applicants* must complete the Application for Technical Certification, pay the application fee, have suitable 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 subject matter experts for the respective vocation applied for. If approved, the applicant will receive an eligibility letter. If the application is rejected, the applicant will be notified and asked if warranted to supply more information.

After completion of the computer-based test and grading, applicants are mailed official test results. Those who pass the exam, are mailed certificates and wallet cards.

Test Administration

Test Dates and Sites

Tests are given throughout the year in California, Michigan, and Alaska (see Application for Technical Certification for test schedule. Applicants who are eligible to take the test will be 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 may a candidate begin the exam. Candidates do not require to show their eligibility letters to enter the test site.

Test Security

All tests are computer-based. No reference material, laptop computers, or cameras are allowed in the test site. Candidates will have access to an on-screen calculator, however, candidates are welcome to bring their own pre-approved calculator (visit www.cwea.org/cert). Candidates are not allowed to take any notes from the test site. Candidates who violate test site rules may 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 (a letter stating that you wish to postpone), to postpone to the adjacent testing window. You may only reschedule your application once without a fee. Additional postponent will require a $40 reschedule fee. There are no exceptions to this policy.

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

If you have a scheduled exam with our testing administrator, Pearson Vue, you must contact them 24 hours in advance to avoid losing your exam fee.

Test Result Notification

Test results are routinely mailed to certificate candidates approximately two weeks after the test date. Results are never given over the phone. All results are confidential and are only released to the certificate candidate.

Issue of Certificate/Wallet Card

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

Certificate Renewal

All certificates are renewed 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 a penalty fee of 100 percent of the renewal fee. Certificate holders more than one year past due will need to retest to regain certification. Renewal notices are mailed to certificate holder's two months before the due date. It is the responsibility of certificate holders to ensure the certificate(s) remains valid. Continuing education will be required for renewal after 2001.

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.

Test Design and Format

Test Design

All certification tests are designed to test knowledge and abilities required to perform the Es-

sential Duties listed at the end of the section with minimal acceptable competence.

The Essential Duties and Test Content Areas for each certification were determined by a job analysis and meta-analysis of job specifications by two independent psychometric consulting firms. 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 sub-committees, 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 written in the English language only.

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 basic minimum score required to pass all tests is 75 percent of possible total points. However, the score may be adjusted downward depending on test complexity. It should be assumed that the passing score is 75 percent and 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, re-classified, 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 re-

sults 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 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

Item Appeals

Candidates who wish to appeal a specific test item must do so during the test by completing the candidate feedback review screen during the exam. Item appeals will be evaluated and appropriate adjustments will be made to the test content. Candidates submitting feedback will not be contacted in regards to the appeal.

Section 3

Skill Sets

This section gives a concise description of each of the practical skills that a Grade I Collection Technologist must possess to successfully pass the certification exam. Table 3-1, presented at the end of this section, cross-references each skill set with a specific chapter, section, or page of applicable references to assist the candidate better understands the subject matter.

To assist the candidate to better understand the subject matter, Table 3-1, presented at the end of this section, cross-references each skill set with a specific chapter, section, or page of applicable references.

1.1 General

To successfully achieve a Grade I classification, Technologists should have the ability to recognize and identify hazards and hazardous situations encountered above and below ground in collection system maintenance and operations. A full knowledge of safety procedures and prevention techniques is also needed.

Additionally, it is necessary to be familiar with and understand safety laws, rules, and regulations as they apply to Technologists, their co-workers and the public. The ability to interpret and understand the worker right-to-know law is also necessary.

1.2 Traffic

It is necessary to be familiar with and understand the elements of traffic control. Awareness and comprehension of the hazards of working in roadways as they pertain to Technologists, co-workers, drivers, and pedestrians is imperative. A general understanding and identification of traffic safety equipment and its proper use is needed. The ability to identify basic flagging equipment, and understand proper procedures is also necessary.

1.3 Vehicles and Equipment

Technologists are expected to understand how to perform appropriate safety checks on vehicles, and possess a thorough knowledge and understanding of traffic laws and defensive driving techniques. For safety purposes, the proper application and operation of the various vehicles, tools and equipment used in collection system maintenance and operations must be understood.

1.4 Confined Space

It is important to define what confined space is and understand the definition. There are different classifications of confined space and it is important to know the differences between classes. A working knowledge of the confined space permit process, entry procedures and rescue operations, as well as terminology, is necessary.

Knowledge and understanding of confined space safety rules, requirements, and regulations, as well as accident/injury prevention techniques is important. It is necessary to be aware of and understand the hazards and effects of working in confined spaces and the responsibilities in these situations. Technologists need to be able to recognize confined space safety equipment and its components, and understand its proper function and operation.

1.5 Chemical and Biological Hazards

There are numerous chemical and biological hazards within the wastewater collection field that may be encountered on a daily basis. A basic knowledge of these substances, and understanding their potential for hazard should be obtained. Technologists should be knowledgeable of the policies and procedures for prevention of, and protection from these hazards. The ability to understand and identify the types of proper use of personal protection equipment is important.

1.6 Hazardous Atmospheres

It is important for Technologists to understand what hydrogen sulfide (H_2S) is and its impacts in wastewater collection systems. In addition, Technologists should understand its causes, as well as hazards and effects to both operators and the collection system. It will also be necessary to identify the methods used for control of this substance.

Technologists should also know the purposes of air or atmosphere safety monitoring, including monitoring for specific gases or indicators such as carbon dioxide (CO_2), oxygen (O_2), H_2S, and the lower explosive limit (LEL).

1.7 Material Safety Data Sheets (MSDS)

Any hazardous chemical product used within the wastewater collection field has an MSDS. These MSDSs will provide valuable information about potentially hazardous chemicals used on the job. Technologists should know what MSDSs are and understand their use.

Skill Set 2 Tools and Equipment

2.1 Hand Tools and Equipment

Technologists should be able to correctly identify the various hand tools and small equipment used in collection system maintenance and operations. It is important to understand the characteristics and operation of various tools and equipment as they apply to the collection field. Technologists must have the ability to recognize and understand inherent hazards and exercise caution, and know the proper use of hand tools.

2.2 Power Tools and Light Equipment

It is important to correctly identify the various power tools and light equipment used in collection system maintenance and operations, and to know how to properly operate them. Technologists should have a full understanding of the characteristics and proper application of the various power tools and light equipment used in the collection field. Technologists should also have the ability to recognize and understand inherent hazards and exercise caution and proper use of power tools.

2.3 Heavy Equipment

It is important to correctly identify the various types of heavy equipment used in collection system maintenance and operations. There should be an understanding of the unique function and application of the heavy equipment used. Comprehension of the hazards associated with operation of heavy equipment is important.

2.4 Vehicles

It is important for Technologists to correctly identify and properly operate the various vehicles used in wastewater collection system maintenance and operations.

Technologists should understand the characteristics and functions of vehicles used in the collection field.

2.5 Line Cleaning Tools and Equipment

Technologists should be able to correctly identify the basic equipment and tools used in line cleaning operations. It is important to understand the characteristics and functions of these tools and equipment, and be able to perform basic setup and operation. The ability to recognize inherent hazards of line cleaning equipment operations is essential.

2.6 Detection and Measurement Devices

It is necessary to have the ability to recognize various types of detection, measurement and safety devices. Knowledge of the basic principles and techniques of detection, measurement and safety devices used in the collection field is beneficial as is understanding the basic procedures of recording readings from detection, measurement, and safety devices.

Skill Set 3 Maintenance, Repair, Construction, and Inspection

3.1 Wastewater Collection Fundamentals

Technologists should understand the basic principles and purposes of wastewater collection systems (i.e. its components and appurtenant facilities). Also necessary is the ability to understand the basic characteristics of wastewater, and wastewater flow. It is useful to understand the principles and reasoning behind flow measurement.

Technologists should be able to identify the sources and effects of sanitary sewer overflows (SSO). An understanding of the basic principles of containment, cleanup, assessment and reporting of an SSO is useful.

3.2 Cleaning and Maintenance

Technologists should be able to define the purpose of a collection system maintenance program, and understand the implementation of such a program. It is essential to possess basic knowledge of sewer line cleaning methods and terminology. The ability to identify maintenance problems and understand their effects within a collection system as well as the knowledge of the characteristics and functions of cleaning equipment is necessary. Understanding its components, proper operating procedures and terminology associated with this equipment is also important.

3.3 Pipe Repair and Construction (Service and Main Lines)

It is important to understand the characteristics of pipe materials, sources of pipe failure, and basic techniques of underground repairs. A working knowledge of the basics of pipe repair methods and procedures is important. Also, knowledge of pipe laying methods and procedures is helpful. It will be useful to have a basic understanding of excavation methods, bedding, backfill and compaction procedures, and terminology. A working knowledge of manhole repair components and terminology is helpful.

3.4 Trenching and Shoring

Technologists should possess an elemental knowledge of shoring requirements, installation, removal, and the equipment used. It is important to be knowledgeable of safety procedures and regulations associated with shoring operations, as well as soil classification as it relates to shoring. Additionally, Technologists should be able to identify and report or prevent hazardous situations.

3.5 Inspection and Testing

It is important to be able to understand the need for inspecting and testing as they relate to the wastewater collection field. Technologists should possess a basic understanding of these inspection duties and responsibilities. A working knowledge of basic inspection and testing methods, procedures, and equipment is useful.

3.6 Mathematics in Wastewater Collection

Basic mathematical functions are used on a regular basis in the wastewater collection field. Basic mathematical formulas must be used to measure area and volume, and conversion units.

Skill Set 4 Lift Stations and Pumps

4.1 General

Technologists will need to know what a wastewater lift station is and understand its function and purpose within the wastewater collection system.

Skill Set 5 Communications, Customer Service, and Interpersonal Relationships

5.1 General

It is important to maintain effective communications with customers, co-workers, and supervisors. The ability to follow written and verbal instructions from supervisor(s) is necessary. Technologists should know when to provide answers to questions or refer certain questions to a supervisor and should be able to read, speak, and write in the English language at a high school education level.

Technologists are representatives of their agency or city when dealing with the public. Therefore, it is necessary to wear a clean uniform to create a favorable first impression.

Table 3-1 Grade I Collection System Maintenance

		Primary References[a]				
No.	Skill Set	Operations and Maintenance of Colection Systems Volume I	Wastewater Collection System Maintenance	Safety and Health in Wastewater Systems	Confined Space Entry	Manual of Traffic Controls for Construction and Maintenance Work Zones
1	Safety					
1.1	**General**	Chapter 4	Chapter 1	All		
1.2	**Traffic**	Chapter 4	Chapter 1	All		All
1.3	**Vehicle and Equipment**	Chapter 4 Sections 4-4.3	Chapter 1 Pages 12-13	Chapter 7 Pages 80-88		
1.4	**Confined Space**	Chapter 4 Sections 4.4-4.7	Chapter 1 Pages 9-12	Chapter 7	All	
1.5	**Chemical and Biological Hazards**	Chapter 4 Section 4.43 Chapter 6 Section 6.5	Chapter 1 Pages 7, 14-17	Chapter 7 Pages 80-88		
1.6	**Hydrogen Sulfide**	Chapter 4 Section 4.43 Chapter 6 Section 6.5	Chapter 1 Pages 7, 14-17	Chapter 7 Pages 80-88		
1.7	**Material Safety Data Sheet**	Chapter 4 Section 4.11	Chapter 1 Section 7			
2	Tools and Equipment					
2.1	**Hand Tools**		Chapter 7 Section 7.33 and 7.43	Chapter 8 Page 104		
2.2	**Power Tools and Light Equipment**	Chapters 3 and 6 Chapter 7 Section 7.37, 7.43 7.45, 7.62 Supplemental Section 3.700	Chapter 4 Chapter 8			
2.3	**Heavy Equipment**	Chapter 3,4 Chapter 7 Section 7.43 Supplemental Section 3.700				
2.4	**Vehicles**	Chapter 6 Section 6.13 Lessons 2,3, and 4	Chapter 6	Chapter 6		

[a] Complete reference information is provided in Section 6
[b] *Operations and Maintenance of Collection Systems, Volume II* (see Section 6)
[c] *Utility Management* (see Section 6)

Table 3-1 Grade I Collection System Maintenance

		Primary References[a]				
No.	Skill Set	Operations and Maintenance of Colection Systems Volume I	Wastewater Collection System Maintenance	Safety and Health in Wastewater Systems	Confined Space Entry	Manual of Traffic Controls for Construction and Maintenance Work Zones
2	Tools and Equipment (continued)					
2.5	Line Cleaning Tools and Equipment	Chapter 6	Chapter 4			
2.6	Detection and Measurement Devices	Chapter 3 Section 3.23 Chapter 4 Section 4.52		Chapter 8 Page 98		
3	Maintenance, Repair, Construction, and Inspection					
3.1	Wastewater Collection Fundamentals	Chapter 1-3	Chapter 2			
3.2	Cleaning and Maintenance	Chapter 6	Chapters 4-6, 8-1			
3.3	Pipe Repair and Construction	Chapter 3 Supplemental Section 3.7 Chapter 7	Chapters 13-16			
3.4	Trenching and Shoring	Chapter 7 Section 7.2				
3.5	Inspection and Testing					
3.6	Mathematics in wastewater	Appendix, Applications of Arithmetic to Collection Systems Section A.0-A.4, A.7, A.9-A.12 D				
4	Lift Stations and Pumps					
4.1	General	Chapter 3, Volume II Chapter 8[b]	Pages 27-28			
5	Communications, Customer Service, and Interpersonal Relationships					
5.1	General	Chapters 6-8[c]				

a Complete reference information is provided in Section 6
b *Operations and Maintenance of Collections Systems, Volume II* (see Section 6)
c *Utility Management* (see Section 6)

Section 4

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 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 the previous section for topics that will be covered.

It is not necessary, but certainly helpful, to memorize all formulas and conversion factors. A sheet is provided with the test to assist in this area. Tables 4-1 and 4-2 give many of these formulas and conversion factors.

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:

   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**

4. 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.

5. Reject answers that are obviously incorrect

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 (MDG) = 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 = LxW Circle: a = $0.785D^2$	A = Area L = Length W = Width
Volume	
Rectangular Solid: Vol = LWd Right Regular Cylinder: Vol = $0.785D^2L$ *or* Vol = $3.14R^2L$	Vol = Volume L = Length W = Width d = Depth D = Diameter C = Circumference

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?

a. They produce an explosion hazard.
b. They tend to cause solids to vaporize.
c. They will coagulate floatables and cause stoppages.
d. 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.

6. 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.

7. 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. By far, the greatest number of applicants that fail the certification examinations do so by failing to complete the math problems. Completing the math problems will be greatly simplified by using a calculator and the approach suggested in the following paragraphs.

Calculators

A scientific calculator may be used during the test; however, a four-function (add, subtract, multiply and divide) calculator is adequate for completing any of the certification tests. Additional functions (i.e. square root) are not necessary, but may be helpful in some situations. The most important factor in effectively using a calculator is the candidates' familiarity with its use prior to the time of the examination. Confi-

dence 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 the calculator early 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 = $50 \frac{gal}{min}$

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:

$$50 \frac{\cancel{gal}}{\cancel{min}} \times 60 \frac{\cancel{min}}{\cancel{hr}} \times 24 \frac{\cancel{hr}}{\cancel{day}} \times 365 \frac{\cancel{days}}{yr} \times 1 \frac{MG}{1{,}000{,}000\ \cancel{gal}} = 26.28 \text{ mgy}$$

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.

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

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

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

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

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

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

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

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

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

$$\frac{50\ \cancel{mL}}{\cancel{min}} \times \frac{1\cancel{L}}{1000\ \cancel{mL}} \times \frac{1 \text{ gallon}}{3.785\cancel{L}} \times \frac{60\ \cancel{min}}{\cancel{hr}} \times \frac{24\ \cancel{hr}}{\text{day}} = 19 \frac{\text{gallon}}{\text{day}} = 19 \text{ gpd}$$

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?

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

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 esti-

mation, 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:

Vol = LWd
Vol = 150 feet x 200 feet x 0.25 Feet
Vol = 7,500 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 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 square feet

Section 5

Diagnostic Test

This section provides a diagnostic test for individuals studying for a Grade I Technologist Certification to help determine their current knowledge level of safety, tools and equipment, maintenance, repair construction and inspection, lift stations and pumps, and communication, customer service and interpersonal relationships.

These questions represent the type of knowledge that may be required to successfully pass the CWEA Collections System Maintenance certification test. Test questions are generally based on the information contained in the references (See Section 6 for a list of references). However, passing the example questions is not a guarantee of passing the test, as test writers did not prepare these questions. Answers for this practice test and tips on where to find the answers in this text are located at the end of test.

Skill Set 1 Safety

1. At low concentrations, hydrogen sulfide gas smells like:

   a. dead fish.
   b. fuel gas.
   c. rotten cabbage.
   d. rotten eggs.

2. Which safety hazard in collection system operation can be detected by an instrument?

   a. Pathogenic organisms
   b. Physical injuries
   c. Slips and falls
   d. Toxic gases

3. What must be checked first before entering a manhole?

   a. Atmosphere in manhole
   b. Gas monitoring equipment
   c. Proper barricades or warning devices around manhole
   d. Harnesses and tripod

4. When should field crews use signs and cones?

   a. When field calibrating gas detection equipment
   b. When over half the street is blocked
   c. When performing maintenance work on a lift station
   d. To reduce the number of sanitary sewer overflows (SSOs)

5. The different zones of traffic control include:

   a. buffer.
   b. bumper.
   c. rest.
   d. lane.

6. Elements of defensive driving include:

   a. being aware of what is going on in front of you.
   b. having your vehicle under control.
   c. driving above the speed limit.
   d. frequently changing lanes.

7. Sewer maintenance vehicles are:

   a. easy to drive with power steering.
   b. can be driven without training.
   c. hard to see on city streets.
   d. difficult to maneuver.

8. The primary function of an entry supervisor is to:

    a. maintain overall safety of permited confined-space operations.
    b. provide non-entry rescue when needed.
    c. monitor and protect authorized entrants.
    d. issue and verify entry permits.

9. What should be the alarm set point for oxygen in an atmospheric monitoring/testing device?

    a. 17.5%
    b. 19.5%
    c. 20.9%
    d. 22.0%

10. WARNING, CAUTION, DANGER on a label means the product is:

    a. non-hazardous.
    b. toxic if ingested.
    c. flammable.
    d. hazardous.

11. “MSDS” is an acronym for:

    a. Men Safely Delivering Sulfur Dioxide
    b. Material Safety Data Sheet
    c. Maintaining Safe Departmental Standards
    d. Maintaining Sewers to District’s Standards

12. What is the purpose of the OSHA Hazard Communication Standard?

    a. To make all employees aware of the need to prevent hazardous substances from entering sewers
    b. To make each employee a chemical safety expert
    c. To make employees effective communicators with the public
    d. To make sure employees know about any hazardous chemical that they may contact

13. How can traffic be warned of your presence in the street?

    a. Signs, cones, chairs
    b. Billboards, cones, flagmen
    c. Signs, cones, flagmen
    d. Banners, signs, cones

14. What check should be performed before driving a vehicle?

    a. Mechanical/color
    b. Mechanical/safety
    c. Mechanical/air
    d. Mechanical/chemical

15. Where will collection system operators most likely find black widow spiders and scorpions?

    a. Manholes
    b. Lunch room
    c. Office
    d. Restroom

16. Typical safety hazards in collection system operations include:

    a. non-noxious or non-toxic gases.
    b. oxygen deficiency.
    c. non-physical injuries.
    d. radiation burns.

Skill Set 2 Tools and Equipment

1. You have an air compressor and you have been instructed to compact the backfill in a trench. Which of the following is the best tool to use?

    a. Jack Hammer
    b. Tamper
    c. Clay Spade
    d. Splitter

2. Which type of shovel do collection system technologists use?

   a. Diamond
   b. Grit
   c. Round
   d. Sludge

3. What type of saw is used to cut asphalt?

   a. Diamond bladed or toothed power saw
   b. Hand saw
   c. Skil saw
   d. Hack saw

4. Goggles, earplugs, and gloves are needed gear when using:

   a. a welding torch.
   b. a sledgehammer.
   c. a shovel.
   d. a power grinder.

5. What type of equipment should be used to excavate a broken sewer pipe?

   a. Front end loader
   b. Bull dozer
   c. Backhoe
   d. Grader

6. What is a mechanical means to dislodge material from a sewer?

   a. High water pressure
   b. Pumping
   c. Scraping
   d. Vacuuming

Skill Set 3 — Maintenance, Repair, Construction, and Inspection

1. The formula for calculating the volume of a wet well is:

   a. V = L x W x C.
   b. V = W x A x P.
   c. V = W x L x H.
   d. V = W x H x D.

2. Tasks performed by a collection system operator include:

   a. cleaning local treatment plants.
   b. maintaining collection system equipment.
   c. making water connections.
   d. Cleaning on-site industrial sewers.

3. One cubic foot per second flow is equal to:

   a. 2,794 gallons per hour.
   b. 3,600 gallons per hour.
   c. 6,000 gallons per hour.
   d. 26,928 gallons per hour.

4. To properly operate a power rodder:
   a. jam rodding tool into an obstruction.
   b. rotate the rod in one position for extended periods.
   c. make sure all the torque is out of it before handling it if a rod should break.
   d. for difficult obstructions, rotate the rod in the same position until it is free.

5. The diameter of a wet well is 10 feet. If filled to a depth of 10 feet, it will contain approximately:

   a. 2,987 gallons.
   b. 5,872 gallons.
   c. 6,020 gallons.
   d. 10,602 gallons.

6. How does an emergency service crew try to remove a stoppage?

   a. Balling
   b. Flushing
   c. Hand rods
   d. Parachutes

7. Determine the volume in cubic yards of a concrete slab that measures 150 feet long, 200 feet wide, and 3 inches thick.

   a. 278
   b. 287
   c. 265
   d. 295

8. How many cubic yards of backfill will be needed to fill a 200 cubic foot trench (Do not allow for compaction)?

   a. 6.9 cubic yards
   b. 7.1 cubic yards
   c. 7.4 cubic yards
   d. 7.8 cubic yards

9. If a gallon of water weighs 8.34 pounds what would 450 gallons of water weigh?

   a. 200 pounds
   b. 3,753 pounds
   c. 3,750 pounds
   d. 4,000 pounds

10. Wastewater collection systems are built to:

    a. carry away wastewater from homes and industries.
    b. carry potential disease producing materials to our homes.
    c. to drain swamps.
    d. to put people to work.

11. Manholes are used for:

    a. access to sewers.
    b. prevention of inflow.
    c. to hold solids after cleaning.
    d. to give operators a place to rest.

12. Which are the following types of shores?

    a. Bar
    b. Hydraulic
    c. Truss
    d. Flat

13. To convert cubic yards into cubic feet:

    a. divide cubic yards by 27
    b. divide cubic yards by 9
    c. multiply cubic yards by 27
    d. multiply cubic yards by 9

Skill Set 4 Lift Stations and Pumps

1. Lift stations:

   a. float wastewater to a different elevation.
   b. lift wastewater to a different elevation.
   c. suck wastewater to a different elevation.
   d. siphon wastewater to a different elevation.

2. What are important lift station components?

   a. Data loggers
   b. Pumps
   c. SCADA system
   e. Water wells

3. Lift stations are sometimes referred to as:

   a. pump stations.
   b. injections stations.
   c. suctions stations.
   d. infiltration stations.

4. Wastewater is moved through a lift station by:

   a. propellers.
   b. paddles.
   c. buckets.
   d. pumps.

Skill Set 5 Communications, Customer Service, and Interpersonal Relationships

1. Which of the following is inappropriate when communicating with the public by telephone?

   a. Courtesy
   b. Understanding
   c. Rudeness
   d. Decisiveness

2. Of the following, which would be most important when communicating with the public in person:

   a. appearance and attitude.
   b. disheveled appearance.
   c. aggressiveness.
   d. answering the question even if you do not know the answer.

3. What is an important aspect of your customer service relationships?

   a. Relationship with financial institutions
   b. Relationship with general public
   c. Relationship with HMOs
   d. Relationships with out-of-service area collection system operators

4. One of your most delicate problems of community relations is:

   a. lost dog.
   b. properly functioning sewer system.
   c. sewer overflow into a home or business.
   d. increases in sewer rates.

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 diagnostic 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.

Skill Set 1 Safety

No.	Answer	Skill Set
1	d	1.5
2	d	1.2
3	c	1.4
4	b	1.2
5	a	1.2
6	b	1.3
7	d	1.3
8	a	1.4
9	b	1.4
10	d	1.7
11	b	1.7
12	d	1.7
13	c	1.2
14	b	1.3
15	a	1.5
16	b	1.4

Skill Set 2 Tools and Equipment

No.	Answer	Skill Set
1	b	2.2
2	c	2.1
3	a	2.2
4	d	2.2
5	c	2.3
6	c	2.5

Skill Set 3 Maintenance, Repair, Construction, and Inspection

No.	Answer	Skill Set
1	c	3.6
2	b	3.1
3	d	3.6
4	c	3.3
5	b	3.6
6	c	3.1
7	a	3.6
8	c	3.6
9	b	3.6

10	a	3.1
11	a	3.5
12	b	3.4
13	c	3.7

Skill Set 4 Lift Stations and Pumps

No.	Answer	Skill Set
1	b	4.1
2	b	4.1
3	a	4.1
4	d	4.1

Skill Set 5 Communications, Customer Service, and Interpersonal Relationships

No.	Answer	Skill Set
1	c	5.1
2	a	5.1
3	b	5.1
4	c	5.1

Selected Problem Solutions

Skill Set 3 Maintenance, Repair, Construction, and Inspection

2. One cubic foot per second flow is equal to how many gallons per hour?

Solution.

$$\frac{1 \text{ cu ft}}{\text{sec}} \times \frac{60 \text{ sec}}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} \times \frac{7.48 \text{ gal}}{\text{cu ft}}$$

$$= 26{,}928 \ \frac{\text{gal}}{\text{hr}}$$

6. The diameter of a wet well is 10 feet. If filled to a depth of 10 feet, it will contain approximately:

Solution.

Volume of a right regular cylinder:

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

Substituting in the values:

$V = 0.785 \times (10 \text{ ft})^2 \times 10 \text{ ft}$

$= 785 \text{ ft}^3$

Converting to gallons:

$$785 \text{ ft}^3 \times \frac{748 \text{ gals}}{\text{ft}^3} = 5{,}872 \text{ gals}$$

7. Determine the volume in cubic yards of a concrete slab that measures 150' long, 200' wide, and 3" thick.

Solution.

$V = L \times W \times H$

First, convert the thickness to feet:

$$3 \text{ inch} \times \frac{\text{ft}}{12 \text{ inch}} = 0.25 \text{ ft}$$

$V = 150 \text{ ft} \times 200 \text{ ft} \times 0.25 \text{ ft} = 7{,}500 \text{ cu ft}$

Convert cu ft to cu yd:

$$7500 \text{ cu ft} \times \frac{\text{cu yd}}{27 \text{ cu ft}} = 278 \text{ cu yds}$$

8. How many cubic yards of backfill will be needed to fill a 200 cubic foot trench (do not allow for compaction)?

Solution.

Convert cubic feet to cubic yards

$$200 \text{ cu ft} \times \frac{\text{cu yd}}{27 \text{ cu ft}} = 7.4 \text{ cu yd}$$

10. If a gallon of water weighs 8.34 pounds, what would 450 gallons of water weigh?

Solution.

$450 \text{ gal} \times 8.34 \text{ lb/gal} = 3{,}753 \text{ lbs}$

Section 6

References

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 TCP 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.

Primary References

Operations and Maintenance of Wastewater Collection Systems, Volume I
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

Safety and Health in Wastewater Systems, Water Environment Federation (WEF) Manual of Practice SM-1
Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1994
800/666-0206
www.wef.org

Confined Space Entry, WEF
Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1994
800/666-0206
www.wef.org

Manual of Traffic Controls for Construction & Maintenance Work Zones – 1996
State of California
Department of Transportation
1900 Royal Oaks Drive
Sacramento, CA 95815
916/445-3520
http://svhqsgi4.dot.ca.gov/hq/traffops/signtech/signdel/pdffiles.htm

Secondary References

Mathematics for Collection System Operators, a Workshop Manual
OCT, Inc.
P.O. Box 332
Gladstone, OR 97027
www.octinc.com

Sewer Rehabilitation Handbook
NASSCO
140 Circle Drive, Suite 103
Maitland, FL 32751
www.nassco.org

Trench Safety Shoring Manual, Red Cass
Cruse Publications
www.biblio.com

Operation and Maintenance of Wastewater Collection Systems, WEF Manual of Practice No. 7 – 1985
Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1994
800/666-0206
www.wef.org

Operations and Maintenance of Wastewater Collection Systems, Volume II
Office of Water Programs
California State University Sacramento
J Street, Sacramento, CA 95819-6025

916/278-6142 www.owp.csus.edu

Utility Management
Office of Water Programs
California State University Sacramento
6000J Street
Sacramento, CA 95819-6025
916/278-6142
www.owp.csus.edu

Appendix A

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 Grade I 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 your-

self, 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:

- ❑ Technical Certification Training Classes and Annual Conferences
- ❑ CWEA Northern and Southern 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: Rutger 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.

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,

$2 \bullet 3 = 2x3 = (2)(3) = 6$

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

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

$$= 74.8$$

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.

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

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

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

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

$$D_t = \frac{675{,}460\ \text{gal}}{1{,}000{,}000\ \text{gal/day}}$$

$$= \frac{675{,}460\ \text{gal}}{1} \bullet \frac{\text{day}}{1{,}000{,}000\ \text{gal}} = 0.675\ \text{days}$$

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

$$D_t = \frac{426\ \text{ft}^3}{1{,}000\ \text{cfs}} = \frac{426\ \cancel{\text{ft}^3}}{1{,}000\ \frac{\cancel{\text{ft}^3}}{\text{sec}}} = \frac{426\ \cancel{\text{ft}^3}}{1} \bullet \frac{\text{sec}}{1{,}000\ \cancel{\text{ft}^3}}$$

$$= 0.426\ \text{sec}$$

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 ft^3.

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:

a. First, find the number of gal of water in the tank at 10 a.m.

b. Second, find the rate of flow in gal/min.

   Drawing a sketch helps some people un derstand 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.

a. First, to find the volume in gal at 10 a.m., use the formula for volume of a cylindrical tank which is V=(area of the base) times (height).

   To find the area of the base of the tank which is a circle, multiply 0.785 times the diam eter squared.
   So, the area of the base = $0.785(70^2)$ = 3,846.5 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 min = 1 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:

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

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. 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.

Use Paper. Keep scratch paper available and

expect to use it for your math work. You need empty space on paper 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. Use questions from the prep materials listed on page A-5 and A-6. Give yourself this practice test 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. If you are not allowed to use notes on the exam, be sure to put the list away so that your honesty is not questioned. When you receive your test, quickly write these formulas or facts on your exam paper. 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 exam—before, during, and maybe even after. Different people have different ways of dealing with their anxiety during tests. 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 pan-

icking 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 ft^3 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.

Appendix B

Glossary

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: 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 than 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 (H_2S): A gas with a rotten egg odor. This gas is produced under anaerobic conditions. H_2S 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.

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 Pressure Cleaner".

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 (SOS): 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.

Appendix C

Common Acronyms and Abbreviations

AC Power: alternating current

AC: acre

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

BTU: British thermal unit

C: Celsius

Cal OSHA: California Occupational Safety and Health Act

CalEPA: California Environmental Protection Administration

CCR: California Code of Regulations

cf: cubic feet (foot)

CFR: Code of Federal Regulations

cfs: cubic feet per second

CH_4: Methane

CIU: Categorical Industrial User

CM: common mode

CMOM: Capacity Management, Operations, and Maintenance

CPU: central processing

CRWA: California Rural Water Association

CSP: confined-space permit

CT: current transformer

CWA: Clean Water Act

CWEA: California Water Environment Association

DOHS: California Department of Health Services

DV/DT: (DV/DT) The change in voltage per change in time.

DWF: dry weather flow

DWR: Department of Water Resources

EIS: Environmental Impact Statement

EMF: electromotive force or voltage

EPA: U.S. Environmental Protection Agency

F: Fahrenheit

ft: feet (foot)

ft^2: square foot

ft^3: cubic feet

gal: gallon

GFI: ground fault interrupter

GPD: gallons per day

GPM: gallons per minute

GTAW: gas tungsten arc welding

H_2S: 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

M: Mega, a metric prefix meaning 1,000,000

m: meter

MA: millamps

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 probably 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 on million millionth

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: adio 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

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

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

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 we encourage you to identify and utilize the other resources in preparing for your next test.

Your comments, questions, and suggestions are welcome.

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