Certification Examination

Study Guide

Collection System Maintenance

Grade III

2nd Edition

New 2nd Edition

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

California Water Environment Association

Collection System Maintenance Grade III Study Guide, 2nd Edition

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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.

Please send comments, questions, and suggestions to:
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Grade III Collection System Maintenance Study Guide

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Section 1

Introduction

What to Expect From This Study Guide

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

About the CWEA Certification Program

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

CWEA certifies personnel in six vocations:

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

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

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

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 Institute of Credentialing Excellence (ICE).

Technical Certification Program History

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

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

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

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

Certification Process

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

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

Test Administration

Test Dates and Sites

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

Test Site Admission

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

Test Security

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

Test Rescheduling and Cancellation

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

To cancel your application you must submit a written request to CWEA. The written request must be received at the CWEA office no later than 2 weeks after the approved test window begins. Full 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 already have a scheduled exam with our testing partner, Pearson VUE, and need to cancel your appointment, you must contact them 24 hours in advance to avoid losing your exam fee

Test Result Notification

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

Issue of Certificate/ Blue Wallet Card

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

Certificate Renewal

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

Accommodations for Physical or Learning Disabilities

In compliance with the Americans with Disabilities Act, special accommodations will be provided for those individuals who provide CWEA with a physician's certificate, or its equivalent, documenting a physical or psychological disability that may affect an individual's ability to successfully complete the certification test. Written requests for special accommodations must be made with the test application along with all supporting documents of disability. Applicants requesting accommodations are encouraged to apply as early as possible to ensure sufficient time to process the request.

Test Design and Format

Test Design

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

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

Test Delivery Mechanism

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

Test Format

All TCP tests are in multiple choice format (see the sample test questions in this booklet for an example). The multiple choice format is considered the most effective for use in standardized tests. This objective format allows a greater content coverage for a given amount of testing time and improves competency measurement reliability. Multiple choice questions range in complexity from simple recall of knowledge to the synthesis and evaluation of the subject matter.

Test Pass Point

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

How Pass Points are Set

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

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

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

Why Use Modified Angoff?

Each version of a given certification test uses questions from a test item bank. Each of these questions vary in difficulty. Because a different mix of questions is used in each test, the overall difficulty level is not fixed. Thus, it is important to make sure that the varying difficulty level is reflected in the pass point of each test to ensure that test results are reliable. Test reliability is concerned with the

reproducibility of results for each version of a given test. In other words, for a test to be reliable it must yield the same result (pass or fail) for the same individual under very similar circumstances. For example, imagine taking a certain grade level test and passing it. Immediately after completing this test, a different version of the same grade level test is taken. If the test is reliable, the same result will be achieved: pass. If a passing grade is not achieved, it is likely that the test is not a reliable measure of acceptable (minimal) competency.

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

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

Test Scoring

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

Item Appeals

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

Section 3

Knowledge, Skills, & Abilities (KSAs)

Understanding The KSAs

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

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

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

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

KSA Weight

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

General Competencies and Math Competencies

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

Suggested Reading

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

KSA 300

Weight: 10%

Have a working knowledge and understanding of the essential duties identified on the Test Content Specifications for Collection Systems Grades I and II.

KSA300 General Competencies

Evidence that this knowledge domain has been met would be demonstrated by understanding the knowledge domains described for the Collection Systems Grades I and II Collection System worker. This knowledge includes but is not limited to:

- operation and maintenance of Hydraulic-flusher trucks.
- mechanical rodding machines.
- closed circuit television equipment.
- emergency generators.
- compressors.
- construction tools and equipment used to perform collection system maintenance.
- operating, maintaining, and troubleshooting problems with wastewater collection system lift/pump stations to ensure reliable operation of critical facilities.
- performing maintenance on sewers located in difficult to access locations and easements.
- performing a wide variety of construction activities such as repairing damaged pipe.
- maintenance structures or raising maintenance structures to grade using hand and powered.
- responding to customer service requests.
- asphalt repair.
- training, and certification in trenching and excavation practices.
- performing other related duties.

Additionally Grade III Collection System Workers must be able to read items such as cut sheets and blue prints to determine trench slope or benching, trench depth, setting pipe grade while also determining materials and equipment that may be required.

This knowledge is gained through in-house training, technical seminars, workshops, college level course work, and 6 years on the job experience. This grade level exhibits a high level of proficiency for all collection system duties and tasks and works with minimum supervisory oversight.

KSA300 Math Competencies

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

- volume.
- area.
- distances.

- elevation.
- flow rates.
- head (or pressure).
- power usage.

KSA300 Suggested Reading

- *Operations and Maintenance of Wastewater Collection Systems,* Volume I, and Volume II.
- *Wastewater Collection System Maintenance.*
- *Work Area Traffic Control Handbook*, (All).
- *Mathematics for Collection System Operators*, *a Workshop Manual*, Sections 1-6, Section 9-16.
- *The Math Text for Water and Wastewater Technology*, Pages 1-60, 87-94, 230-255.

KSA 301

Weight: 6%

Plans, coordinates, and evaluates the performance of Collection System Maintenance Grades I and II personnel.

KSA301 General Competencies

A Collection System Grade III worker is expected to operate as a supervisor level employee. The knowledge to perform this function includes but is not limited to:

- effectively planning and scheduling daily work loads for themselves and multiple crews.
- communicating clearly verbally and in writing.
- coordinating staff to effectively perform required maintenance tasks.
- assisting in solving difficult or unusual problems or situations.
- providing feed back and guidance.
- training Collection System grades I and II crew.
- evaluating individual and crew performance.
- possessing good interpersonal.
- leadership, and goal setting skills.

This knowledge is gained through in-house training, technical seminars, workshops, college level course work, and on the job experience.

KSA301 Math Competencies

There are no specific math competencies for this KSA.

KSA301 Suggested Reading

- *Manage for Success*.
- *Utility Management*.
- *Effective Supervisory Practices: Better Results Through Teamwork.*
- *Supervision Concepts and Practices of Management*.

KSA 302

Weight: 4%

Coordinates wastewater collection system with other utilities, agencies, private organizations, government entities and the general public to address complex or non-routine issues.

KSA302 General Competencies

A Collection System Grade III worker is expected to coordinate wastewater collection system operations, maintenance, and service with other utilities, agencies, private organizations, and the general public to address complex or non-routine issues. This function requires knowledge in but not limited to:

- good verbal and written communication skills
- interpersonal skills
- record keeping
- problem solving ability
- flexibility
- local collection system characteristics and layout.

This knowledge is gained through in-house training, technical seminars, workshops, college level course work, and on the job experience.

KSA302 Math Competencies

There are no specific math competencies for this KSA.

KSA302 Suggested Reading

- *Manage for Success*.

- *Utility Management*, Sections 6,8,10,13.
- *Effective Supervisory Practices: Better Results Through Teamwork*, Chapter 17.
- *Supervision Concepts and Practices of Management*.

KSA 303

Weight: 6%

Participates in the evaluation of the performances of the wastewater collection system such as but not limited to energy efficiency, material costs, sanitary sewer overflows (SSOs) and preventive and predictive maintenance programs.

KSA303 General Competencies

A Collection System Grade III worker must be able to assess collection system performance, interpret raw data, draw conclusions from that data to effectively and proactively manage maintenance operations, and prevent sanitary sewer overflows. The knowledge to perform this function includes but is not limited to:

- record keeping
- mapping systems
- agency specific computerized maintenance management programs
- spreadsheet programs
- advanced mathematical calculations
- interpretation of Closed Circuit video inspection and flow monitoring reports
- oral and written communication skills
- federal, state, and regional rules and regulations pertaining to sanitary sewer overflows and mandated reporting requirements.

This knowledge is gained through in-house training, technical seminars, workshops, college level course work, and on the job experience.

KSA303 Math Competencies

There are no specific math competencies for this KSA.

KSA303 Suggested Reading

- *Manage for Success.*
- *Utility Management.*
- *Effective Supervisory Practices: Better Results Through Teamwork.*
- *Supervision Concepts and Practices of Management.*

KSA 304

Weight: 6%

Participates in the development and implementation of training programs for Collection System Maintenance Grade I and II personnel.

KSA304 General Competencies

A Collection System Grade III worker is expected to possess a complete and detailed understanding of the equipment and operational techniques used to operate and maintain a wastewater collection system. The knowledge needed to develop and implement training programs for Collection System Maintenance Grades I and II personnel includes but is not limited to:

- operation and maintenance of Hydraulic-flusher trucks.
- mechanical rodding machines.
- closed circuit television equipment.
- emergency generators.
- compressors.
- pipeline repair
- construction equipment used to perform collection system maintenance.
- operating, maintaining, and troubleshooting problems with wastewater collection system lift/pump stations.
- map reading.
- computerized maintenance management systems.
- good planning and organizational skills.
- oral and written communication skills.
- experience with presentation and spreadsheet programs.

This knowledge is gained through in-house training, technical seminars, workshops, college level course work, and on the job experience.

KSA304 Math Competencies

There are no specific math competencies for this KSA.

KSA304 Suggested Reading

- *Manage for Success.*
- *Utility Management.*
- *Effective Supervisory Practices: Better Results Through Teamwork*, Chapter 15.
- *Supervision Concepts and Practices of Management.*

KSA 305

Weight: 7%

Verifies the work of Collection System Maintenance Grade I and II personnel for accuracy, proper work methods, complaints, and compliance with applicable standards and specifications.

KSA305 General Competencies

A Collection System Grade III worker monitors and oversees Collection System Maintenance Grade I and II personnel performance. The knowledge needed to perform this function includes but is not limited to:

- good oral and written communication skills.
- record keeping.
- agency specific computerized maintenance management programs.
- customer service protocols.
- federal, state, and regional rules and regulations pertaining to sanitary sewer overflows and mandated reporting requirements.
- Agency construction standards.
- Agency standard operating procedures pertaining to operations and maintenance.
- Confined space entry procedures and SOP's.
- Trench safety procedures and SOP's.
- Hot Work procedures.
- Injury and Illness Prevention Program.
- traffic control measures as outlined in the Work Area Traffic Control Handbook.

This knowledge is gained through in-house training, technical seminars, workshops, college level course work, and on the job experience.

KSA305 Math Competencies

There are no specific math competencies for this KSA.

KSA305 Suggested Reading

- *Manage for Success.*
- *Utility Management.*
- *Effective Supervisory Practices: Better Results Through Teamwork.*
- *Supervision Concepts and Practices of Management.*

KSA 306

Weight: 6%

May work with contractors performing a variety of construction, inspection and maintenance projects.

KSA306 General Competencies

A Collection System Grade III worker interfaces with contractors, monitors, oversees, and/or coordinates Collection System activities relating to or in support of construction, inspection, and maintenance projects affecting the wastewater collection system for which he or she is responsible. The knowledge needed to perform this function includes but is not limited to:

- good oral and written communication skills.
- record keeping.
- good planning and organizational skills.
- agency construction standards.
- local construction ordinances and regulations.
- federal and state OSHA rules and regulations.
- multi-employer work site guidelines.
- agency policies regarding contractor operations.
- agency contract language, terms, and interpretation.
- traffic control measures as outlined in the *Work Area Traffic Control Handbook.*
- trench safety and confined space entry procedures and SOP's.
- hot work procedures.

This knowledge is gained through in-house training, technical seminars, workshops, college level course work, and on the job experience.

KSA306 Math Competencies

Advanced mathematical calculations.

KSA306 Suggested Reading

- *Manage for Success*.
- *Utility Management*,Sections 6,10,13.

KSA 307

Weight: 6%

Analyze and review system data to recommend priorities, schedules, and workload performance measures.

KSA307 General Competencies

A Collection System Grade III worker is expected to possess the ability to analyze and interpret data from collection system maintenance activities such as:

- cleaning operations.
- lift station records.
- CCTV inspections.
- flow monitoring data.

A Collection System Grade III worker is also expected to use the above data to effectively prioritize and implement collection system operations activities and set production goals and expectations for field crews.

The knowledge needed to perform this function includes but is not limited to:

- record keeping.
- mapping systems.
- agency specific computerized maintenance management systems.
- spreadsheet programs.
- interpretation of Closed Circuit video inspection and flow monitoring reports.
- oral and written communication skills.
- good planning and organizational skills
- good interpersonal leadership.
- goal setting skills.

This knowledge is gained through in-house training, technical seminars, workshops, college level course work, and on the job experience.

KSA307 Math Competencies

Advanced mathematical calculations.

KSA307 Suggested Reading

- *Manage for Success*.
- *Utility Management*,Sections 6,10,13.

KSA 308

Weight: 6%

Develops and directs the execution of complex or non-routine traffic safety plans under the Manual on Uniform Traffic Control Devices for Streets & Highways (MUTCD)*.*

KSA308 General Competencies

A Collection System Grade III worker is expected to exhibit a high level of competence in planning and setting up complex traffic control plans. The knowledge needed to perform this function includes but is not limited to:

- good planning and organizational skills
- good oral and written communication skills
- interpersonal and leadership skills
- the ability to safely install traffic control safety measures as outlined in the Work Area Traffic Control Handbook.

This knowledge is gained through in-house training, technical seminars, workshops, college level course work, and on the job experience.

KSA308 Math Competencies

There are no specific math competencies for this KSA.

KSA308 Suggested Reading

- *Work Area Traffic Control Handbook*, All chapters.

KSA 309

Weight: 6%

Responds to exceptional and/or non-routine inquiries in a professional, courteous and timely manner.

KSA309 General Competencies

A Collection System Grade III worker is expected to provide a high level of customer service when responding to any requests or inquiries from contractors, outside agencies, agency staff, or the general public. The knowledge needed to perform this function includes but is not limited to:

- public relations training.
- good planning and organizational skills.
- good oral and written communication skills.
- interpersonal skills.
- knowledge of agency customer service protocols and the Public Information Act.
- mapping systems.
- agency specific computerized maintenance management programs.
- spreadsheet programs.

This knowledge is gained through in-house training, technical seminars, workshops, college level course work, and on the job experience.

KSA309 Math Competencies

There are no specific math competencies for this KSA.

KSA309 Suggested Reading

- *Manage for Success*.
- *Utility Management*, Sections 6,7,8,13.
- *Effective Supervisory Practices: Better Results Through Teamwork*, Chapter 17.

KSA 310

Weight: 9%

Assists and participates in the development, and ensures adherence to the wastewater collection safety program.

KSA310 General Competencies

A Collection System Grade III worker is expected to assist in ensuring that all employees and affected individuals follow the mandates of the Agency safety program. This individual would assist in the development of the program and act as a conduit for safety concerns to be brought forward so they could be addressed at a higher level if necessary.

The knowledge needed to perform this function includes but is not limited to:

- good oral and written communication skills.
- record keeping.
- good planning and organizational skills.
- knowledge of the Injury and Illness Prevention Program.
- federal and state OSHA rules and regulations, traffic control measures as outlined in the *Work Area Traffic Control Handbook*.
- confined Space entry procedures and SOPs.
- personal protective equipment rules.
- trenching and excavation safety.
- fall protection.
- competent person requirements 8 CCR Construction Safety orders, Subchapter 4.
- hot work procedures.

This knowledge is gained through in-house training, leading and/or participating in local safety meetings and staff level safety committee meetings.

KSA310 Math Competencies

There are no specific math competencies for this KSA.

KSA310 Suggested Reading

- *California Code of Regulations, Title 8, Subchapter 4, Construction Safety Orders*.
- *Work Area Traffic Control Handbook.*
- *Manage for Success*.
- *Utility Management*, Sections 6,12,13.

- *Effective Supervisory Practices: Better Results Through Teamwork*, Chapter 15.
- *Safety and Health in Wastewater Systems.*
- *Confined Space Entry.*
- *Operations and Maintenance of Wastewater Collection Systems,* Volume I, Chapters 4, 11.

KSA 311

Weight: 6%

Participates in fact gathering to respond to liability claims.

KSA311 General Competencies

A Collection System Grade III worker is expected to assist in collecting information relating to liability claims. The knowledge needed to perform this function includes but is not limited to:

- good oral and written communication skills.
- record keeping.
- organizational skills.
- interpersonal skills.
- interpretation of Closed Circuit video inspection reports.
- computerized maintenance management system.
- accident investigation training.

This knowledge is gained through in-house training, technical seminars, workshops, college level course work, and on the job experience.

KSA311 Math Competencies

There are no specific math competencies for this KSA.

KSA311 Suggested Reading

- *Manage for Success.*
- *Utility Management*.

KSA 312

Weight: 5%

Participates in the investigation of violations of employer policies or agency ordinances.

KSA312 General Competencies

A Collection System Grade III worker is expected to assist in the investigation of failures to follow agency policies and ordinances. The knowledge needed to perform this function includes but is not limited to:

- good oral and written communication skills.
- record keeping.
- organizational skills.
- interpersonal skills.
- knowledge of the Injury and Illness Prevention Program.
- Federal and State OSHA regulations.
- traffic control measures as outlined in the Manual on Uniform Traffic Control Devices.
- Confined Space entry procedures and Agency SOPs.
- personal protective equipment policy or guidelines and hot work procedures.
- local sewer ordinances.
- agency construction standards, and local construction ordinances and regulations.

This knowledge is gained through Human Resource in-house departmental training, technical seminars, workshops, college level course work, and on the job experience.

KSA312 Math Competencies

There are no specific math competencies for this KSA.

KSA312 Suggested Reading

- *Effective Supervisory Practices: Better Results Through Teamwork*
- *Manage For Success: Effective Utility Leadership Practices*

KSA 313

Weight: 6%

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

KSA313 General Competencies

A Collection System Grade III worker is expected to stay current in wastewater collection industry philosophy, innovations, trends, equipment, and new operational techniques relating to collection system operation and maintenance. Means or methods for acquiring the knowledge needed to meet this Knowledge Domain includes but is not limited to:

- attending technical seminars and workshops.
- college level course work.
- professional conferences.
- membership in wastewater related professional organizations and groups.
- vendor trainings and demonstrations.

KSA313 Math Competencies

There are no specific math competencies for this KSA.

KSA313 Suggested Reading

- *Manage For Success: Effective Utility Leadership Practices.*
- *Supervision Concepts and Practices of Management* Parts 2-3.
- *Utility Management*, Section 6-7.

KSA 314

Weight: 8%

Direct and oversees the containment and clean-up of sanitary sewer overflows (SSOs) as well as reports sanitary sewer overflows.

KSA314 General Competencies

A Collection System Grade III worker is expected to quickly and effectively respond to collection system overflows and discharges and follow mandated reporting guidelines. The knowledge needed to perform this function includes but is not limited to:

- good oral and written communication skills.
- interpersonal skills.
- record keeping.
- organizational and leadership skills.
- operation of Hydraulic-flusher trucks.
- mechanical rodding machines.
- closed circuit video inspection equipment.
- interpret multiple mapping systems.
- agency Sanitary Sewer Maintenance Plan (SSMP).
- sewer overflow containment techniques.
- federal, state, and regional rules and regulations pertaining to sanitary sewer overflows and mandated reporting requirements.
- media training, and customer service skills.

This knowledge is gained through in-house training, technical seminars, professional workshops, college level course work, and on the job experience.

KSA314 Math Competencies

There are no specific math competencies for this KSA.

KSA314 Suggested Reading

- *Manage For Success: Effective Utility Leadership Practices.*
- *Supervision Concepts and Practices of Management.*
- *Utility Management*, Section 11.

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 KSAs and answers to all questions. Discuss test questions with others. Not only is this a good study technique, it is also an excellent way to learn.

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

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

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

Multiple Choice Questions

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

1. Read the question completely and closely to determine what is being asked.

2. Read all the choices before selecting an answer.

3. Look for key words or phrases that often, but not always, tip off correct or incorrect answers:

Table 4-1 Standard Measurements and Formulas	
12 inches = 1 foot	27 cubic feet = 1 cubic yard
36 inches = 3 feet = 1 yard	1 cubic foot of water = 7.48 gallons
5,280 feet = 1 mile	1 cubic foot of water = 62.4 pounds
1,440 minutes = 1 day = 24 hours	1 gallon of water = 8.34 pounds
144 square inches = 1 square foot	1 million gallons per day (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

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 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. Although math is important on the test, do not neglect other parts of the KSAs and focus too much time on the math. Completing the math problems will be greatly simplified by using a calculator and the approach suggested in the following paragraphs.

Calculators

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

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

Approach

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

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

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

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

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

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

Answer. This is where the answer is clearly identified.

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

Solutions

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

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

Equivalents/Formulas

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

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

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

Dimensional Analysis

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

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

Example:

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

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

Find: discharge =___?___MGY

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

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

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

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

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 gallons per minute (GPM). Convert this capacity to million gallons per day (MGD).

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

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)?

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

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?

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

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 estimation, and any other job related math skill that may fall within the Skill Sets listed in Section 3. A thorough review of the types of mathematics required for the test is beyond the scope of this study guide. Consult an appropriate math text (see Section 6, References) if there is unfamiliarity with any of these specific math skills. Appendix A provides general strategies for approaching math problems, math anxiety, and resources for remedial study.

Arithmetic

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

1. Addition and subtraction of whole numbers and fractions.

2. Multiplication and division of whole numbers and fractions.

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

Example:

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

First convert inches to feet:

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

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

Practice Test

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

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

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

Practice Test

Select the best answer for each item below.

1. A flagger should stand:

   a. on the shoulder adjacent traffic being controlled
   b. in the closed lane before stopping vehicle traffic.
   c. in the traffic lane.
   d. as stated in "a" or "b" above.

2. Legally responsible officials are required to report category 1 sanitary sewer overflows:

   a. Within 30 days
   b. Before the end of the day
   c. As soon as possible
   d. Within 2 hours

3. When working in confined spaces or sewers, what form of lighting would you use?

   a. Mirrors to direct the sunlight into the manhole on a sunny day or explosion-proof electric lights.
   b. Ordinary electric lights operated on line current, portable generator, or battery; and regular flashlights.
   c. Propane, gasoline, or kerosene lanterns.
   d. Special matches used by the underground mining industry.

4. When testing a manhole for explosive gases when should the first tests be made?

   a. After removing the manhole cover
   b. Before removing the manhole cover
   c. At any time
   d. After ventilation

5. What can happen if water-based substances are used to extinguish electrical fires?

   a. Nothing but extinguish the fire
   b. The fumes are not harmful
   c. Receive an electrical shock
   d. They will corrode the electrical contacts

6. Atmospheric hazards encountered in manholes can include:

   a. non-explosive atmospheres.
   b. non-toxic atmosphere.
   c. lack of oxygen.
   d. non-flammable atmospheres.

7. When setting up to ventilate a manhole, the air inlet should be how many feet above street level?

   a. 4.0
   b. 3.0
   c. 2.0
   d. 1.0

8. Which chemical may be used for odor control in a sewer system?

   a. Calcium chloride
   b. Hydrogen peroxide
   c. Oxidized aluminum
   d. Sodium chloride

9. What information must be on a warning tag attached to a switch that has been locked out?

   a. Directions for removing tag.
   b. Name of nearest physician to call in case of emergency.
   c. Signature of person who locked out switch and who is the only person authorized to remove tag.
   d. Time to unlock switch.

10. Under what conditions must each member of the rescue service practice permit space rescues?

    a. At least once a year in a simulated situation or by the satisfactory performance of an actual rescue.
    b. At least twice a year in simulated situations.
    c. At least once a year in simulated situation using non-representative space conditions
    d. At least four times a year.

11. How is a permit-required space described?

    a. Has or may contain atmospheric, engulfment, design, or other serious health/safety hazard.
    b. Is large enough to enter and work in and is meant for continuous occupancy.
    c. Is large enough to enter and work in and has an unrestricted entry/exit.
    d. Never contains an atmospheric or engulfment hazard.

12. What are the three duties of personnel in a Confined Space entry?

    a. Authorized entrants, parking attendants, entry supervisors.
    b. Unauthorized entrants, attendants, entry supervisors.
    c. Authorized entrants, attendants, entry supervisors.
    d. Authorized entrants, attendants, evening supervisors.

13. What is an important element of hydrogen sulfide production?

    a. Flow velocity.
    b. Pipe materials.
    c. Amount of odor present.
    d. Amount of inorganic materials.

14. Which of the following is the most common factor leading to the generation of hydrogen sulfide in sewers?

    a. Anaerobic conditions.
    b. Constantly high velocity of flow in sewers.
    c. Low concentrations of ferrous sulfide.
    d. Presence of highly soluble fats and oils.

15. A category 2 SSO is:

    a. any SSO which does not reach surface waters.
    b. not reportable.
    c. preventable.
    d. any SSO which is not category 1.

16. Which tool would you use for cleaning under a pipe, or hard dirt near a pipe?

    a. Miner's pick.
    b. Wrench.
    c. Drill.
    d. Hammer.

17. A torque wrench is used to tighten which device?

    a. Pipe clamp.
    b. Drill chuck.
    c. Light bulb.
    d. Sheet metal screw.

18. Which unit uses high water pressure and a vacuum to clean sewer lines?

    a. Jetter
    b. Mechanical rodder
    c. Combination unit
    d. Bucket machine

19. In sewer maintenance, what is a pig?

    a. A ball forced through a sewer line.
    b. A power rod.
    c. Any foul smelling equipment.
    d. The hydraulic rodding truck.

20. When pouring a concrete slab, which of the following tools is used to finish the concrete?

    a. Grasshopper.
    b. Tamper.
    c. Trowel.
    d. Vibrator.

21. What tool is used to snare a broken section of sewer rod?

    a. Square stock corkscrew.
    b. Auger.
    c. Pickup tool.
    d. Pull out tool.

22. A wet well is 12 ft long and 10 ft wide. With no flow entering the wet well the pump lowers the water level 2 feet 6 inches in 5 minutes. What is the pump rate of the pump in gpm?

    a. 60 gpm.
    b. 467 gpm.
    c. 449 gpm.
    d. 2,244 gpm.

23. A 6-inch pipe has a flow with a velocity of 2.6 fps. What is the gpm flow rate through the pipeline? Assume the pipe is flowing full.

    a. 125 gpm.
    b. 220 gpm.
    c. 225 gpm.
    d. 229 gpm.

24. A 10-inch pipe has a flow with a velocity of 3.2 fps. What is the flow rate in gpm if the depth of 5 inches?

a. 330 gpm.
b. 388 gpm.
c. 225 gpm.
d. 488 gpm.

25. Why is the replacement of wastewater collection systems in some downtown streets difficult?

a. Crowding of other underground utilities.
b. Records have not been maintained properly and the collection system is lost.
c. Some people have landscaped their backyards over the collection system and do not want their yards dug up.
d. The streets will have to be paved again.

26. How can the velocity of water flowing in a sewer be estimated?

a. Driving between manholes and reading the speedometer.
b. Measuring the Manning's roughness coefficient for the sewer.
c. Measuring the time it takes for the dye to be carried by the wastewater between the two manholes.
d. Measuring the time it takes to run between the two manholes.

.

27. Drawings which are considered "As Built" would be?

a. Construction drawings issued to the contractor.
b. Corrected construction drawings showing changes made in the field installation.
c. Detailed drawings of proposed construction.
d. Sectional maps on file.

28. In lieu of a shorting system, the sides or the walls of an excavation, or trench, may be:

a. sloped 3:1.
b. sloped 1:3.
c. sloped 2:1.
d. sloped 1:1.

29. Hydrogen peroxide controls odors in sewers by:

a. decreasing the dissolved oxygen.
b. neutralizing the pH.
c. oxidizing sulfide compounds.
d. providing a source of hydrogen ions.

30. When a water main must be laid under a sewer main, the sewer pipe must be:

a. lined with epoxy.
b. cleaned carefully.
c. replaced with water type pipe with pressure tight joints.
d. taken out while the water main is being installed.

31. Construction of a wastewater pipeline under a highway or railway without disrupting the traffic is done by?

a. Drag lining.
b. Dredging.
c. Embankment excavation.
d. Boring and jacking.

32. When a grade conflict exists between a water main and a sewer main, which of the following is the best solution?

a. Build a manhole around the sewer main and continue the water main through the manhole.
b. Drop the sewer service under the water main and let it work like a siphon.
c. Have the water main adjusted and hold the grade on the sewer main.
d. Raise the sewer over the water main and install a sewer pump station.

33. The reason newly constructed collection system sewers should be inspected is to:

a. determine if the contractor has complied with plans and specifications.
b. determine if smoke tests will be successful.
c. determine if dye tests will be successful.
d. determine if the streets are paved.

34. A source of infiltration in a collection is:

a. new pipes.
b. proper joint pipes.
c. pipe liners
d. broken pipe joints

35. What are the advantages of a video tape recording system?

a. Cheaper than a Polaroid camera.
b. Record and play private video tapes.
c. The ability to see what's happening when the camera is underwater.
d. The length and severity of defective areas that can be recorded for later study.

36. Before conducting smoke testing you should:

a. warn the public after smoke testing is completed.
b. notify local police and fire departments only if a fire is started.
c. notify local animal control departments in advance of testing.
d. notify public, local police, and fire departments in advance of testing.

37. Manholes are installed in sewer line for the access of:

a. backflow devices.
b. personnel and materials
c. traffic control devices.
d. survey equipment.

38. Anaerobic wastewater is frequently corrosive to materials it contacts, especially:

a. coal tar enamel.
b. concrete.
c. stainless Steel.
d. plastic.

38. Pipe materials that are the least susceptible to corrosion by acids formed from gases generated in sewers is:

a. ACP.
b. CIP.
c. RCP.
d. VCP.

39. Repairs to manholes include:

a. adjusting the alignment.
b. correcting cavitation damages.
c. raising frame and cover to grade.
d. tightening packing.

40. How many gallons of wastewater are contained in 100 feet of 10-inch force main?

a. 40,800 gallons.
b. 4,080 gallons
c. 408.0 gallons
d. 40.8 gallons

42. Wastewater is pumped through an 8-inch force main at the rate of 448 gallons per minute. Calculate the velocity of the flow in the line.

a. 2.85 ft/sec.
b. 42.95 ft/sec.
c. 66.40 ft/sec.
d. 100.00 ft/sec.

43. A rectangular wet well is 6 feet 6-inches wide by 8 feet long. When no pumps were running, the level of the wet well was rising 2 feet 9-inches in 4 minutes. What was the rate of flow of wastewater into the wet well?

a. 267.4 GPM.
b. 297.4 GPM.
c. 1070 GPM.
d. 2,230 GPM.

44. Liners are installed in sewers to correct problems caused by:

a. grade alignment.
b. grease.
c. grit.
d. infiltration.

45. Using a labor cost of $3.40 per man-hour, what is the labor cost of a job that requires 2 people 10 hours to complete?

a. $8.50.
b. $13.60.
c. $17.00.
d. $68.00.

46. Which one of the following would not be considered a natural event?

a. Explosion.
b. Flood.
c. Lightning.
d. Tornado.

47. Find the invert grade at station 0+ 50 for a sewer laid on a 0.5% grade.

Station	Stake Elev.	Invert Elev.	Cut
0+00	105.60	100.00	5.60
0+50	106.12	_____	___

a. 99.25.
b. 99.75.
c. 100.25.
d. 100.75.

48. Find the stake elevation at station 5+88 for a sewer laid at 0.0081 ft/ft grade.

Station	Stake Elev.	Invert Elev.	Cut
0+00	91.11	85.33	5.78
3+18	102.71	87.91	14.80
5+88	_____	90.09	7.23

a. 97.25.
b. 97.29.
c. 97.32.
d. 97.36.

49. Find the invert elevation and the cut at station 2+30 for a sewer laid at 1.58% grade.

Station	Stake Elev.	Invert Elev.	Cut
0+00	128.11	121.36	6.75
0+73	126.70	122.51	4.19
1+81	126.88	124.22	2.66
2+30	132.20	_____	___
3+00	135.43	126.10	9.33

a. 124.99 & 7.21.
b. 124.65 & 6.46.
c. 125.00 & 7.56.
d. 124.88 & 7.20.

50. What does not need to be done prior to excavation?

a. Determine exact location of underground utilities in the area
b. Remove or support objects that could create a hazard to workers
c. Properly classify the type of soil and rock deposits at the site
d. Notify the local OSHA office

51. A kilowatt is the equivalent of:

a. 0.67 amperes at a voltage of 120.
b. 1.34 horsepower.
c. 746 watts.
d. 1,000 megacycles.

52. "Schedule 40" refers to:

a. flow capacity.
b. friction loss.
c. tubing strength.
d. wall thickness.

53. What factors should be considered when providing trench shoring?

a. Grade of sewer.
b. Pipe material.
c. Structures or sources of vibration near trenches.
d. Cost of shoring.

54. When sewer line grades are too flat, an odor problem is likely to result. The most likely cause of the odor problem is decreased velocity which:

a. allows decomposable solids to settle.
b. decreases the treatment time in the lines.
c. increases the treatment time of inorganic solids.
d. allow decomposable solids to be suspended.

55. After a collection system problem has been solved, you should:

a. wait until next week to fill out the report forms.
b. take a break.
c. go home.
d. evaluate the effectiveness of the results.

56. Improper connections can be detected through:

a. DO tests.
b. soundings.
c. TV inspection.
d. radar.

57. The static pressure in a pipeline is 120psi. How much head, in feet, creates that much pressure?

a. 51.9
b. 60.0
c. 277.2
d. 900.0

58. Which of these pH readings indicates an acidic wastewater?

a. 3
b. 12
c. 7
d. 9

59. The record log of hydraulic cleaning operation should include:

a. type and amount of material removed from downstream manhole.
b. feet of rod used.
c. camera malfunctions.
d. feet of cable used.

60. What items would you consider when selecting a solution to clear a stoppage in a sewer?

a. Adding a chemical to the upstream manhole.
b. Cause of the stoppage.
c. Time of day.
d. Staffing requirements.

61. To test for pipe deflection and joint offset, you would conduct which of the following tests?

a. Smoke.
b. Air.
c. Mandrill.
d. Water.

62. While the CCTC is being pulled through the line, the:

a. camera must never stop.
b. camera should be forced through any obstruction.
c. operator must never stop looking at the monitor.
d. operator must never use a tag line.

63. What is the slope in percent (%) of a pipe 7,000 feet long with a drop of 12 feet?

a. 0.12%
b. 0.17%
c. 0.21%
d. 0.30%

64. What is the difference in elevation of two manholes 500 feet apart if the slope is 0.4%?

a. 3.0 feet
b. 4.0 feet
c. 2.0 feet
d. 5.0 feet

65. What is the flow in a full 12-inch sewer pipe when the velocity is 4 feet per second (fps) in gallons per minute (gpm)?

a. 850 GPM
b. 1,400 GPM
c. 1,000 GPM
d. 1,650 GPM

66. A full 8-inch sewer has a flow of 550 gpm. What is the velocity if fps?

a. 24.1 fps
b. 4.5 fps
c. 12.1 fps
d. 3.5 fps

67. If the camera becomes wedged during a video inspection, which of the following would be your first step in solving the problem?

a. Dig up the area where the camera is wedged.
b. Attempt to free the camera with the tag line.
c. Attach pull cable to a backhoe and pull is out.
d. Wait awhile to see if it will free itself.

68. A new sewer line is installed using a bubble level and a quarter inch (¼") of fall for every foot measured. The slope is equal to what percent?

a. 4%
b. 1.4%
c. 2%
d. 0.002%

69. A Category 1 SSO is:

a. any volume reaching surface waters.
b. any volume entering a storm drain and not recovered .
c. any spill greater than 1000 gallons.
d. all of the above.

70. In a 25 MPH zone, Distance of Flagger Station in Advance of the Work Space should be:

a. 155 feet
b. 15 feet
c. 25 feet
d. Unimportant

71. A condition which can cause cavitation in a pump is:

a. an air leak on suction side.
b. clear water being pumped.
c. a fully opened suction valve.
d. operating within design curve.

72. Where is a check valve for a lift station pump installed?

a. Between the discharge isolation valve and the discharge port of the pump.
b. Between the suction isolation valve and the line through the wet well wall.
c. Between the suction port of the pump and the suction isolation valve for the pump.
d. Downstream, just beyond the discharge isolation valve for the pump.

73. Upon inspection of a lift station, an operator observes that the pump is not running and the circuit breakers will not reset. Which of the following is most likely the cause?

a. A misaligned belt drive.
b. An improper wet well sensor adjustment.
c. A clogged pump.
d. A blown fuse.

74. The electrical disconnect for a pumping station motor can trip out under which condition?

a. Pump cavitation.
b. Low temperature.
c. Strike by lightning.
d. Worn packing.

75. “enclosed”, “open”, and “semi-closed” are terms used to describe what pump part?

a. Stuffing box
b. Lantern ring
c. Impeller
d. Bearings

76. What is a typical bubbler type controller failure?

a. Air compressor failed
b. Broken float line
c. Short in electrode leads
d. Electrode coated with grease

77. What is the most common type of pump used in lift stations?

a. Piston
b. Ejector
c. Centrifugal
d. Diaphragm

78. Vibrations in pumps may be caused by improper motor-pump:

a. alignment.
b. curves.
c. piping.
d. power factor.

79. What type of pump is not seriously damaged if the discharge valve is closed for a short time while the pump is running?

a. Centrifugal pump.
b. Diaphragm pump.
c. Piston pump.
d. Plunger pump.

80. A mechanical ventilation system in a lift station wet well should be able to exchange the air in the wet well how many times an hour?

a. 10
b. 20
c. 30
d. 60

81. A pump is pumping less than its expected rate of discharge. What could be the cause?

a. Speed of motor too high.
b. Pump is primed.
c. Impeller clogged.
d. Discharge head too low.

82. A maintenance budget:

a. is not concerned with capitol replacement.
b. does not consider equipment-operating conditions.
c. must be justifiable.
d. does not relate to future needs.

83. Which of the following governs employee behavior?

a. Unions
b. Rules prepared by the manager
c. The grapevine
d. The buddy system

84. A good manager:

a. sets goals.
b. waits for an emergency to happen.
c. resists changes.
d. blames others for his mistakes.

85. Planning which covers a period of five to fifteen years is called:

a. scheduling.
b. long range.
c. updating.
d. future modeling.

86. The main purpose of a policy is to:

a. explain how higher management wants work done.
b. excuse managers from making decisions.
c. provide guidelines for not making decisions.
d. provide coverage against loss.

87. Performance appraisal forms:

a. should not be discussed with the employee.
b. make the employee evaluation process consistent.
c. should not contain a rating scale.
d. must be limited to three judging factors.

88. Who develops Material Safety Data sheets?

a. Management
b. Manufacturer
c. Salesman
d. Safety officer

89. Responsibilities of supervisors and managers for a safety program include:

a. not providing a written safety policy.
b. never provide safety training.
c. identify and correct unsafe work practices.
d. never investigate accidents.

90. What is the intent of the OSHA regulations?

a. To provide adequate staffing.
b. To put managers in jail.
c. To provide a safe work environment.
d. To provide a safe home environment.

91. What are the four major types of records a utility must maintain?

a. Equipment/maintenance, operations, procurement/inventory, personal.
b. Equipment/maintenance, operations, procurement/inventory, personnel.
c. Equipment/maintenance, operations, credit, personal.
d. Equipment/maintenance, sales, procurement/inventory, personal.

92. Behavior that is considered sexual harassment is:

a. invited, annoying, offensive, humiliating, hostile.
b. non-hostile, invited, annoying, offensive, humiliating.
c. uninvited, hostile, annoying, offensive, humiliating.
d. uninvited, hostile, annoying, defensive, non-humiliating.

93. What is the best approach for field personnel to handle complaints from citizens?

a. Be trained to handle the more common ones and report the others to supervisors
b. Refer all complaints to the manager's office
c. Handle only if the time permits
d. Ignore them

94. Public relations are important because we:

a. like our jobs.
b. need lots of training.
c. want to finish our work in a hurry.
d. work for the public.

95. Staffing a new system should be viewed primarily as the function of:

a. every operator.
b. personnel department.
c. the employee.
d. the supervisory management.

96. Decentralization of organization refers to?

a. Nominating new supervisors.
b. Looking at all positions, and possibly redelegating authority.
c. Firing all employees and hiring new ones.
d. Eliminating some departments.

97. What do organization charts represent?

a. How the collection system structures are organized.
b. How to locate sewers.
c. The structure of an agency.
d. The way to select solutions to problems.

98. While evaluating an applicant for employment, which one of the following may enter into your decision?

a. Age
b. Education level
c. Minority classification
d. Gender

99. The best way to record all work is done through a:

a. closed circuit TV.
b. Polaroid system.
c. tape recorder.
d. work order system.

100. The most important function of record keeping is:

a. record how much money was budgeted and how much was spent.
b. record the past and provide a sound basis on which to plan the future.
c. record what was done and when it was done.
d. record where the company has been, and how they got where they are today.

101. What should financial management provide for a collection system?

a. Capital improvement funds, careful budgeting, financial stability.
b. Careful budgeting, financial stability, prudent investment of financial reserves.
c. Careful budgeting, financial stability, lowest possible bond rates.
d. Lowest possible bond rates, financial stability, capital improvement funds.

102. An organization chart for a utility can be helpful for several reasons. Which of the following is the least valid objective of an organization chart?

a. To establish proper chain of command authority.
b. To help develop a budget.
c. To help in making up project schedules.
d. To help in scheduling emergencies.

END OF PRACTICE TEST

Practice Test Answer Key

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

No.	Answer	KSAs
1	d	308
2	d	314
3	a	300,304,305
4	b	304,310,312
5	c	304,305,310,312
6	c	304,305,310
7	c	304,305,310
8	b	303,304,305,309
9	c	301,305,311,312
10	a	304,305,310
11	a	310,311,312
10	c	305,310,311,312
13	a	301,304,309
14	a	303,304,309
15	d	314
16	a	300,304,305
17	a	300,304
18	c	300,314
19	a	300,314
20	c	300
21	c	300,314
22	c *(see solutions)*	301,307,309
23	d *(see solutions)*	301,307
24	b	301,306,307
25	a	302,303,306,309
26	c	300,306,307
27	b	302,303,306,309
28	a	300,306,310
29	c	302,303,305,309
30	c	306,309,312
31	d	302,306,309
32	c	302,306,309
33	a	302,303,306,312
34	d	300,307
35	d	300,307
36	d	302,303,309,311
37	b	300,306
38	b	302,303,306
39	d	300,306,312
40	c	300,305
41	c	301,306,307,309
42	a	303,306,307
43	a	301,302,303
44	d	302,303,307
45	d	301,305,307
46	a	302,309,311
47	c	302,306,306
48	c	305
49	a	301,302,306
50	d	301,306,311
51	b	301,306,312
52	d	302,306
53	c	301,306,312
54	a	303,307,309
55	d	303,305,315
56	c	303,307,312
57	c *(see solutions)*	302,303,306
58	a	303
59	a	301,302,305,307
60	b	303,305,314
61	c	303,311
62	c	310,305
63	b	302,303,306
64	c	303,306
65	b	305,306,307
66	d	303,307,309
67	b	305,314
68	c *(see solutions)*	302,303,305,306
69	d	314
70	a	308
71	a	303,305
72	a	303,305,312
73	c	303,305
74	c	303,305
75	c	303,305
76	a	303,305,314

No.	Answer	KSAs	No.	Answer	KSAs
77	c	310,303	90	c	310
78	a	303,305	91	b	301,302,305,311,312
79	a	303,305	92	c	301,305,311
80	a	305,310	93	a	301,302,305
81	c	303,305	94	d	301,302,305
82	c	301	95	d	301
83	b	301,305	96	b	301
84	a	301,305	97	c	301
85	b	301	98	b	301
86	a	301,305,312	99	d	301,302,307,311
87	b	301,305	100	b	301,302,303,311
88	b	300,311,312	101	a	301,302
89	c	310	102	d	301

Solutions for Selected Questions

22. A wet well is 12 feet long and 10 feet wide. With no flow entering the wet well the pump lowers the water level 2 feet 6 inches in 5 minutes. What is the pump rate of the pump in GPM?

Solution

This problem involves calculating a volume pumped over a specified time period and then conversion to the proper units. First, determine the volume pumped as a rectangular solid.

Convert inches to feet:

$$6'' \times \frac{ft}{12''} = 0.5\ ft$$

$V = L \times W \times H$
$= 12' \times 10' \times 2.5'$

$V = 300\ ft^3$

The volume was pumped in 5 minutes or:

$$\frac{60\ ft^3}{min} \times \frac{7.48\ gal}{ft^3} = 448.8\ GPM$$

23. A 6 inch pipe has a flow with a velocity of 2.6 fps. What is the GPM flow ate through the pipeline? Assume the pipe is flowing full.

Solution

The solution uses the common formula of Q = AV where Q is flow, A is area, and V is velocity. Once found, the units must be converted.

For a circular pipe:

$A = 0.785\ D^2$

Convert the diameter to feet:

$$6'' \times \frac{ft}{12''} = 0.5\ ft$$

$A = 0.785 \times (0.5\ ft)^2$

$= 0.19625\ ft^2$

$Q = AV$

$$= 0.19625\ ft^2 \times \frac{2.5\ ft}{sec}$$

$$= \frac{0.49\ ft^3}{sec}$$

Convert to gallons per minute:

$$\frac{0.49\ ft^3}{sec} \times \frac{60\ sec}{min} \times \frac{7.48\ gal}{ft^3}$$

= 220 GPM

24. A 10-inch pipe has a flow with a velocity of 3.2 fps. What is the flow rate in GPM if the pipe has a flow depth of 5 inches?

Solution.

Similar to the problem above, the solution uses the formula Q = VA. The pipe is half full (5 inches full in a 10-inch pipe). Therefore, the area is computed as follows:

$$A_{flow} = \frac{0.785\ D^2}{2}$$

$$D = 10" \times \frac{ft}{12''} = 0.833\ ft$$

$$A = \frac{0.785 \times (0.833\ ft)^2}{2}$$

$$= 0.2726\ ft^2$$

$$= 0.2726\ ft\ 2 \times \frac{3.2\ ft}{sec}$$

$$= \frac{0.872\ ft^3}{sec}$$

Convert to gallons per minute:

$$\frac{0.872\ ft^3}{sec} \times \frac{60\ sec}{min} \times \frac{7.48\ gal}{ft^3}$$

= 391 GPM

The closest answer is 388.

41. How many gallons of wastewater is con tained in 100 feet of 10-inch force main?

Solution

The problem is one of calculating the volume of a right rectangular cylinder. First, convert the diameter to feet.

$$D = 10" \times \frac{ft}{12"} = 0.833\ ft$$

$V = 0.785\ D^2\ L$
$= 0.785 \times (0.833\ ft)^2 \times 100\ ft$
$= 54.47\ ft^3$

Convert to gallons:

$$54.47\ ft^3 \times \frac{7.48\ gal}{ft^3} = 407\ gal$$

42. Wastewater is pumped through an 8-inch force main at the rate of 448 gallons per minute. Calculate the velocity of the flow in the line.

Solution.

Using the formula Q = AV, solve for velocity by dividing both sides by A.

$$\frac{Q}{V} = V$$

Convert flow to $\frac{ft^3}{sec}$

$$\frac{448\ gal}{min} \times \frac{min}{60\ sec} \times \frac{ft^3}{7.48\ gal}$$

$$= 0.998\ \frac{ft^3}{sec}$$

Calculate the area of a full pipe since the pipe is a force main. First, convert the diameter to feet.

$$8'' \times \frac{ft}{12''} = 0.667\ ft$$

$A = 0.785\ D^2$
$= 0.785 \times (0.667\ ft)^2$
$= 0.349\ ft^2$

Substitute the values into the equation and calculate the velocity.

$$0.998\ \frac{ft^3}{sec} \times \frac{1}{0.349\ ft^2} = 2.86\ \frac{ft}{sec}$$

45. Using a labor cost of $3.40 per man-hour, wh is the labor cost of a job that requires 2 people 10 hours to complete?

Solution

This is a straight multiplication problem.

$$2 \times 10\ hrs \times \frac{\$3.40}{hr} = \$68.00$$

49. Find the invert elevation and the cut at station 2+30 for a sewer laid at 1.58% grade.

Station	Stake Elev.	Invert Elev.	Cut
0+00	128.11	121.36	6.75
0+73	126.70	122.51	4.19
1+81	126.88	124.22	2.66
2+30	132.20	_____	___
3+00	135.43	126.10	9.33

This problem is similar to the one reviewed in Section 4. To calculate the invert elevation at 2+30, first calculate the distance between the two stations.

2+30 = 2.30

$$1+81 = \frac{1.81}{0.49}$$

The difference in elevation is the slope of the sewer over the distance.

1.58 x 0.49 = 0.77 ft

Adding this to the invert elevation at station 1+81:

124.22 + 0.77 = 124.99

Checking to confirm that answer a is correct, calculate the cut by subtracting the invert elevation from the stake (ground) elevation:

132.20 – 124.99 = 7.21

57. The static pressure in a pipeline is 120psi. How much head, in feet, creates that much pressure?

Solution

Convert pressure in pounds per square inch (psi) to feet of head.

$$120 \text{ psi} \times \frac{2.31 \text{ ft}}{\text{psi}} = 277.2 \text{ ft}$$

64. What is the difference in elevation of two manholes 500 feet apart if the slope is 0.4%?

Solution

This problem requires an understanding of percent as it relates to slope.

$$0.4\% = \frac{0.4 \text{ ft}}{100 \text{ ft}}$$

Therefore, the difference in elevation over the specified distance is:

0.4 ft x 500 ft = 2.0 ft

68. A new sewer line is installed using a bubble level and a quarter inch (¼") of fall for every foot measured. The slope is equal to what percent?

Solution

Convert inces to feet

$$1/4'' \times \frac{ft}{12''} = 0.0208 \text{ ft}$$

Convert ft/ft to percent.

$$\frac{0.0208 \text{ ft}}{\text{ft}} \times \frac{100}{100} = \frac{2.08 \text{ ft}}{100 \text{ ft}} = 2.08\%$$

Section 6

Study Materials

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

Study Materials Referenced in Section 3

- *Operations and Maintenance of Wastewater Collection Systems,* Volume I 6th Edition, and Volume II, 7th Edition.
  Office of Water Programs, California State University Sacramento.
  6000 J Street, Sacramento, CA 95819-6025, 916-278-6142 www.owp.csus.edu .

- *Manage For Success: Effective Utility Leadership Practices*
  Office of Water Programs, California State University Sacramento.
  6000 J Street, Sacramento, CA 95819-6025, 916-278-6142, www.owp.csus.edu

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

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

- *Wastewater Collection System Maintenance*
  Michael J. Parcher, CRC Press.
  800/272-7737 Fax: 800/374-3401, www.crcpress.com.

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

- *Confined Space Entry*
  Water Environment Federation
  601 Wythe Street, Alexandria, VA. 22314-1994, Phone: 1-800-666-0206, www.wef.org.

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

- *The Math Text for Water and Wastewater Technology*, Second Edition
  Wrights Training
  P.O. Box 515, Elmira, CA. 95625-0515, 707-448-3659, www.wrights-trainingsite.com

- *Supervision Concepts and Practices of Management*
  Raymond L. Hilgert and Edwin C. Leonard, Thomson Learning
  www.thomsonedu.com

- *Effective Supervisory Practices: Better Results Through Teamwork*
  ICM International, City/Council Management Association
  1-800-745-8780, www.icma.org

- *Work Area Traffic Control Handbook*, 2009
  BNi Building News, http://www.bnibooks.com

- *California Code of Regulations, Title 8, Subchapter 4, Construction Safety Orders*.
  http://www.dir.ca.gov/title8/sub4.html

Additional Study Materials

- *Wastewater Collection Systems Management WEF Manual of Practice No. 7*
  Water Environment Federation
  601 Wythe Street, Alexandria, VA 22314-1994, 800-666-0206, www.wef.org

- *What Every Supervisor Should Know*
  Lester R. Bittel and John W. Newstrom, McGraw-Hill, Inc.
  800-262-4729, www.mcgraw-hill.com

- *Applied Math for Wastewater Operators*
  Joan Kirkpatrick Price, CRC Press
  1-800-374-3401, www.crcpress.com

- *Traffic Manual Chapter 5 Traffic Controls for Construction and Maintenance Work Zones*
  State of California, Department of Transportation
  1900 Royal Oaks Drive, Sacramento, CA 95815, http://www.dot.ca.gov/hq/traffops/signtech/signdel/trafficmanual.htm

- *California Manual on Uniform Traffic Control Devices for Streets & Highways*
  State Of California Business, Transportation And Housing Agency Department Of Transportation
  www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/pdf/camutcd/CAMUTCD-Part9.pdf

- *Statewide General Waste Discharge Requirements for Sanitary Sewer Systems Order No. 2006-0003-DWQ*.
  http://www.swrcb.ca.gov/rwqcb9/water_issues/programs/sso/docs/2006_0003.pdf

- *Trenching and Excavation Practices for Water Line Installation and Repairs*
  ACWA/JPIA-2007
  5620 Birdcage St., Suite 200, Citus Heights, CA 95610-7632.

- *Flagging Instruction Handbook*
  California Department of Transportation, Division of Construction
  http://www.dot.ca.gov/hq/construc/flagging/flaggerhandbook2007.pdf

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 Collection System Maintenance certification test, please review Sections 3, 4, and 5 of this study guide.

Section 1: Introduction

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

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

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

Two Facts to Consider

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

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

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

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

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

Move Beyond the Math You Know

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

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

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

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

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

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

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

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

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

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

skills.

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

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

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

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

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

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

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

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

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

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

- ❑ Testing and Training for those with Learning Disabilities

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

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

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

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

- ❑ Courses from Ken Kerri, Office of Waste Programs, California State University, Sacramento, 6000 J Street, Sacramento, CA 95819.
- ❑ Price, Joanne Kirkpatrick. *Basic Math Concepts for Water and Wastewater Plant Operators*. Lancaster, Pennsylvania: Technomic, 1991.
- ❑ Smith, Richard Manning. *Mastering Mathematics: How to Be a Great Math Student*, 3rd Ed. Pacific Grove, CA: Brooks/Cole, 1998.
- ❑ Zaslavsky, Claudia. *Fear of Math*. New Brunswick, NJ: 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. Make sure you use only a calculator that you can take into the test site (see www.cwea.org/cbt for a list of approved calculators).

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

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

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

For example,

2•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.

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

$$= 0.426 \text{ sec}$$

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

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

The work is given below.

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

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

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.

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

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 understand the problem and helps to keep track of the data.

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

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

The solution is presented in two parts.

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 diameter 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. Be sure to use only an approved calculator for the test site (a list is available at www.cwea.org/cbt). Each brand of calculator is different so keep your manual for reference. Take spare batteries to exams.

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

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

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

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

Section 4: Test-Taking Strategies

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

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

Before the Exam

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

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

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

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

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

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

At the Exam

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

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

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

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

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

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

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

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

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

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

Negative Thinking About Exams

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

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

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

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

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

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

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

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

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

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

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

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

"Math Tests Are Tricky." Math students who rely on memorizing the material rather than understanding it are usually the ones who think tests are tricky. You will use your memory to add to your understanding of how to do the math. Your math problems will contain many units such as mgd or 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

Technical Terms

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

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

Atmospheric: Of or relating to the atmosphere.

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

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

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

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

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

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

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

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

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

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

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

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

Combination Cleaner: Jet/vacuum trucks 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.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Management and Supervision Terms

Ability: The quality of being able to perform; a natural or acquired skill or talent.

Accident: Unplanned or uncontrolled event in which action or reaction of an object, material, or person results in personal injury.

Accountability: Non-assigned liability for the manner in which an organizational obligation held by a supervisor is discharged, either personally or by subordinates.

Active listening: Conscious process of securing information through full attention, intent listening, and alert observation.

Affirmative Action: In-company program designed to remedy current and future employment inequities.

Americans with Disabilities Act (ADA): Prohibits employment discrimination based on a person's mental or physical disability.

Appraisal interview: Meeting held between a supervisor and an employee to review performance rating and, using the evaluation as a basis, to discuss overall quality of work performed, and methods of improvement, if necessary.

Arbitration: Labor dispute or employee grievance settlement by an impartial umpire selected through mutual agreement by organization and worker's union.

Attrition – Gradual reduction in a work force due to natural events and causes, e.g. - retirement, death, resignation, as opposed to planned reductions, e.g.- discharges, layoffs, early retirement.

Authority: The power needed to do a specific job or to carry out one's responsibilities usually handed down from immediate bosses or superior.

Body language: Nonverbal body movements, facial expressions and/or gestures that project or reveal underlying attitudes and sentiments.

Budget: Plan, or forecast, especially of allowable expenses in operation of a department.

Budgetary control: Planning and reporting system incorporating standards for operating conditions and results as well as costs and expenses, within a single document.

Certification Exam: An examination administered by a state or professional association that candidates take to indicate a level of professional competence.

Chain-of-Command: Formal channels in an organization that distributes authority from top down.

Code of Federal Regulations (CFR): A publication of the United States Government that contains all of the proposed and finalized federal regulations, including environmental.

Collective bargaining: Process of give-and-take engaged in by management and collective employees representatives to reach formal, written agreement about wages, hours, and working conditions.

Communication process: Giving and receiving information and understanding such as between a supervisor and an employee, leading to a desired action or attitude.

Computerized Maintenance Management System (CMMS): A computerized system to assist with the effective and efficient management of maintenance activities through application of computerized elements including: work orders, routine standard jobs, bills of materials, application parts, and lists of all numerous other features.

Competition: Relatively healthy struggle among individuals or organizational groups to excel in striving to meet mutually beneficial goals.

Conflict: Disruptive clash of interests, objectives, or personalities between individuals or groups within an organization.

Control: To exercise authoritative influence over; the authority or ability to manage and/or direct.

Cost-benefit analysis: Technique for weighing pros and cons of alternative actions, in which both intangible benefits as well as costs are assigned dollar values.

Cost variance report: Listing of allowable expenses compared with actual expenses incurred.

Decision-making: Part of the problem-solving process that entails evaluation of alternative solutions and a choice of an effective action.

Delegation: The act in which power is given to another person in the organization to accomplish a specific job.

Differential treatment: Act of treating a minority or protected group member differently from other applicants or employees.

Discipline: Imposition of a penalty by management on an employee for infraction of a rule, regulation, or standard in such a manner as to encourage more constructive behavior.

Discrimination: Managerial action or decision based on favoring or disfavoring one person or group member over another on the basis of race, color, ethnic or national origin, sex, age, handicap, or Vietnam era war service, or union membership.

Division of work: Principle that performance is more efficient when a large job is broken down into smaller, specialized tasks.

Due process: Employee's legal entitlement to a fair hearing, usually before an impartial party and with appropriate representation, before discipline can be metered out.

Employee turnover: Measure of how many people come to work for an organization and do not remain employed by that organization, for whatever reason.

Ergonomics: Study of how workers react to their physical environment; used in design of more comfortable and productive workstations.

Equal Employment Opportunity (EEO): System of organizational justice, stipulated by law, that applies to all aspects of employment; intended to provide equal opportunity for all members of the labor force.

Feedback: Process of relaying measurement of actual performance back to an individual or unit so that action can be taken to correct, or narrow, the variance.

Geographical Information System (GIS): An integrated system of computer hardware, software, and trained personnel linking topographic, demographic, utility, facility, images, and other resource data that are geographically referenced.

Gantt chart: Chart that enables a planner to schedule tasks in the most productive sequence that also provides a visual means for observing and controlling progress.

Grievance: Job-related complaint stemming from an injury or injustice, real or imaginary, suffered by an employee for which relief or redress from management is sought.

Grievance procedure: Formalized, systematic channel for employees to follow in bringing complaints to the attention of management.

Hazard: Potentially dangerous object, material, condition, or practice present in the workplace, to which employees must be alert and from which they must be protected.

Hostile Work Environment: As applied to harassment, offensive speech or unwelcomed conduct that is severe or persuasive enough to create an abusive, antagonistic, or inhospitable work place.

Information Management System (IMS): System comprised of data processing devices, programs, and people, that collects, analyzes, exchanges, and delivers information to an organization in such a manner as to aid managers in making best possible decisions.

Information: Dates past or present facts, observation or conclusions collected in numbers and words that have been selected, arranged, and analyzed (processed) to make it useful for a specific human (managerial) activity.

Injury Illness Prevention Plan: Plan required by California Senate Bill (SB) 198 to establish, implement, and maintain an effective program helping assure employee safety while on the job. It includes eight elements: management assignments and responsibilities, safety communications system with the employees, system assuring employee compliance with safe working practices, scheduled inspections and compliance system, accident investigation, health and safety training and instruction, and record-keeping and documentation.

Job breakdown analysis: Segmentation of a job into key elements, or steps, of which an employee must perform, induce, or supervise an action that advances work toward completion.

Job evaluation: Systematic technique for determining job worth, compared with other jobs in an organization.

Just cause: Reason for a disciplinary action that is accurate, appropriate, well founded, deserved and meets the test of prior notification of unacceptable behavior and its penalty.

Knowledge: Information that can be learned from reading, listening to an expert, or keenly observ-

ing a situation; often a prerequisite to skill development.

Management: Process of obtaining, deploying, and utilizing a variety of essential resources in support of an organization's objectives.

Management by objectives (MBO): Planning and control technique where a supervisor and their immediate superior agree on goals to be attained and/or standards to be maintained.

Management development: Systematic program for improving knowledge, attitudes, and skills of supervisors and managers.

Management principles: Set of guidelines established for carrying out the management process.

Management process: General sequence of five unique functions; planning, organizing, staffing, directing or activating, and controlling, provided by managers for any organization.

Manager: Individual who plans, organizes, directs, and controls work of others in an organization.

Material Safety Data Sheets (MSDS): Provides information about manufactured chemicals as required by the Hazard Communication Rule (HCR).

Mentor: Knowledgeable, often influential, individual who takes an interest in, and advises, another person concerning that person's career.

Morale: Measure of extent of voluntary cooperation demonstrated by an individual or work group and of the intensity of desire to meet common work goals.

Motivation: Process that impels someone to behave in a certain manner in order to satisfy highly individual needs.

Networking: Informal process of getting to know, and create confidence among others who, through mutual exchange, help advance one's career.

Non-managerial employees: Workers who receive direction from managers, who perform specific, designated tasks, and who are responsible only for their own performance.

Operator: (As related the Underground Service Alert System) Also known as the Facility Owner/ Operator – Any person, utility, municipality, authority, political subdivision or other person or entity who owns, operates or controls the operation of an underground line/facility.

Organizing: Deciding who does what work and delegating authority to the appropriate person.

Organization: Structure derived from systematically grouping tasks to be performed and from prescribing formal relationships that strengthen the ability of people to work together more effectively.

Performance appraisal: Formal and systematic evaluation of how well a person is performing their work and fills an appropriate role in the organization.

Penalty: Punishment or forfeiture imposed by management on an employee as discipline.

Personality – An individual's unique way of behaving and interpreting events and actions of others.

PERT Chart: Graphic technique for planning a project in which a large number of tasks must be coordinated by showing the relationship between tasks and critical bottlenecks that may delay progress towards completion.

Policies: Broad guidelines, philosophy, or principles which management establishes, then follows, in support of organizational goals.

Procedures: Methods, prescribed by management, for the proper and consistent forms, sequences, and channels to be followed by individuals and units of an organization.

Productivity – Measure of efficiency that compares operational output value with cost of resources used.

Progressive Discipline: Providing increasingly harsh penalties for substandard performance or broken rules as the condition continues or the infraction is repeated.

Quid pro quo: an equal exchange or substitution; as applied to harassment- when a supervisor threatens to fire or not promote an employee if they do not provide sexual favors in return.

Regulations: Special rules, orders, and controls set forth by management restricting the conduct of units and or individuals within an organization.

Reprimand: Severe expression of disapproval or censure by management of an employee, usually written as well as oral, and retained in an employee's personal file.

Responsibilities: Those duties one is held accountable for.

Responsibility: Duty or obligation to perform a prescribed task or service or attain an objective.

Reverse discrimination: Notion that implementation of affirmative action deprives qualified members of non-protected groups their rightful opportunities.

Satisfaction: State that exists when motivating factors - such as interesting and challenging work, full use of one's capabilities, or recognition for achievement - are provided.

Schedules: Detailed assignments dictating how facilities, equipment, and/or individuals are used, according to times and dates, in accomplishment of organizational objectives.

Sexual Harassment: Unwanted sexual advances, requests for sexual favors or other visual, verbal, or physical conduct of a sexual nature which is conditioned upon an employment benefit, unreasonably interferes with an individuals work performance or creates an offensive work environment.

Skill: The capacity to perform a job related action by blending relevant knowledge and physical or perceptual ability.

Specification: Collection of standardized dimensions and characteristics pertaining to a product, process, or service.

Stereotype: Characterization of an individual on the basis of a standardized, oversimplified view of characteristics believed to be held in common by a group to which the individual is assumed to

belong.

Supervisor: Manager who is in charge of, and coordinates, activities of a group of employees engaged in related activities within a department, section, or unit of an organization.

Suspension: Temporary removal by management of an employee privilege (such as the right to report to work and receive pay for it) until proper actions have been determined and imposed.

Time budget – Charting technique for planning the systematic distribution of a supervisor's time.

Theory X: Negative approach to human relations in which a supervisor presumes most people don't like to work and thus need to be pushed or threatened.

Theory Y: Positive approach to human relations whereby a supervisor presumes that, given meaningful work, most people will try hard to achieve, especially when there is an opportunity to improve their self-regard.

Tolerance: Permissible deviation, or variance, from a standard.

Type A individual: Person characterized by high standards of achievement and an urgency to attain them, who is especially susceptible to stress.

Underground Service Alert (USA): The entity in California that administers the system through which a person can notify owner/operators of lines or facilities of proposed excavations.

Unfair labor practices: Practices engaged in by management or labor unions that are judged by federal labor law to be improper, especially when they interfere with the right to organize or discriminate against labor union activities.

Unity of Command: Principle that each individual should report to only one boss.

Unity of Direction: Principle that there should be a single set of goals and objectives that unites the activities of everyone in an organization.

Variance: Gap, or deviation, between actual performance, condition, or result and a standard or expected performance, condition, or result.

Warning: A reprimand so worded as to give formal notice to an employee that repetition of a particular form of unacceptable behavior will draw a penalty.

Worker's compensation: Financial reparations or awards granted by an employer to an employee who has suffered an on-the-job injury or illness that is judged to have permanently restricted the employee's earning capacity.

Acknowledgment/Credit: Many of the terms found in the Management and Supervision Termssection of this glossary are taken from the 6th Edition of What Every Supervisor Should Know by L. Bittle and J. Newstrom. The explanations are in part or whole reproduced with permission of The McGraw-Hill Companies. Most of the remaining terms have been extracted from the 1st Edition of Utility Management - A Field Study Training Program prepared by L. Lindsay for the California State University, Sacramento Foundation.

Appendix C

Common Acronyms and Abbreviations

AC Power: alternating current

AC: acre

AC Pipe: Asbestos Concrete Pipe

ADWF: Average Dry Weather Flow

AF: acre-feet

AF: acre-foot (feet)

AFY: acre-foot per year

AMSA: Association of Metropolitan Sewerage Agencies

ANSI: American National Standard Institute

APHA: American Public Health Association

ASCE: American Society of Civil Engineers

ASME: American Society of Mechanical Engineers

ASTM: American Society for Testing and Materials

AWWA: American Water Works Association

BECP: Business Emergency and Contingency Plan

BOD: Biochemical Oxygen Demand

BTU: British thermal unit

C: Celsius

Cal EMA: California Emergency Managment Agency

Cal OSHA: California Occupational Safety and Health Act

CalEPA: California Environmental Protection Administration

CCR: California Code of Regulations

CDPH: California Department of Public Health

cf: cubic feet (foot)

CFR: Code of Federal Regulations

cfs: cubic feet per second

CH_4: Methane

CIU: Categorical Industrial User

CM: common mode

CMOM: Capacity Management, Operations, and Maintenance

CPR: Cardiopulminary Resuscitation

CPU: central processing Unit

CRWA: California Rural Water Association

CSP: confined-space permit

CT: current transformer

CWA: Clean Water Act

CWEA: California Water Environment Association

DOHS: Department of Homeland Security or Department/Division of Occupational Health & Safety

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

DWF: dry weather flow

DWR: Department of Water Resources

EIR: Environmental Impact Rerport

EIS: Environmental Impact Statement

EMF: electromotive force or voltage

EPA: U.S. Environmental Protection Agency

ERP: Emergency Response Plan

F: Fahrenheit

ft: feet (foot)

ft^2: square foot

ft^3: cubic feet

gal: gallon

GFI: ground fault interrupter

GIS: Geographical Information System

GPD: gallons per day

GPM: gallons per minute

GTAW: gas tungsten arc welding

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

LRO: Legally Responsible Official

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

m: meter

MA: millamps

MBO: Management by Objectives

MG: million gallons

mg: milligram

mg/L: milligrams per liter

mgd: million gallons per day

min: minute

MIS: Manufacturing Information System

mL: milliliter

MMI: Man Machine Interface

MOP: Manual of Practice

MPN: most probable number

MSDS: Material Safety Data Sheets

N: normal

NEPA: National Environmental Policy Act

NOCA: National Organization for Competency Assurance

NPDES: National Pollutant Discharge Elimination System

NPSH: net positive suction head

NTU: nephelometric turbidity unit(s)

O&M: operation and maintenance

OCT: Operator Certification Test (State of California)

OMR: operations, maintenance, and replacement

OOC: Office of Operator Certification (SWRCB)

OSHA: Occupational Safety and Health Administration/Act

P: pico, a metric prefix meaning on million millionth

PLS: Private Lateral Spill

PC: personal computer

pH: potential of hydrogen

PI&D: piping and instrumentation diagram

PLC: Programmable Logic Controller

POTW: Publicly Owned Treatment Works

PPB: parts per billion

PPE: Personal Protective Equipment

PPM: parts per million

prct: percent

psi: pound per square inch

PSIG: pounds per square inch gage

PVC: polyvinyl chloride (pipe)

QA/QC: quality assurance/quality control

RCP: reinforced concrete pipe

RFI: Radio Frequency Interference

RMS: root mean square

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

SCADA: supervisory control and data acquisition

SCR: semiconductor, or silicon controlled rectifier

sec: second

SI: System Internationale D'Unites (metric units)

SSO: sanitary sewer overflow

SSMP: Sewer System Mangement Plan

SWRCB: (California) State Water Resources Control Board

TAC: Technical Advisory Committee

TCP: Technical Certification Program

TU: turbidity unit

U: micro, a metric prefix meaning one millionth

UPS: uninterruptible power supply

USA: Underground Service Alert

USEPA: United States Environmental Protection Agency

V: volt

VAC: volts of alternating current

VCP: vitrified clay pipe

VFD: variable frequency drive

VOM: volt Ohm meter

W: watt

WAN: wide area network

WEF: Water Environment Federation

WRP: water reclamation plant

WWF: wet weather flow

WWTF: wastewater treatment facility

WWTP: wastewater treatment plant (same as POTW)

yr: year