



**State Water Resources Control Board**

**Expected Range of Knowledge for Drinking Water Treatment Exam**

Content Category	Number of questions by Exam Grade			
	T1	T2	T3	T4
Source Water	25	25	20	15
Water Treatment Processes	25	25	35	20
Operation / Maintenance	20	20	15	15
Laboratory Procedures	15	15	15	15
Regulations / Administrative Duties	15	15	15	35

**Source Water**

Clear Well Storage Raw Water Storage	Surface Water/Reservoirs Watershed Protection	Wells/Groundwater
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**Water Treatment Processes**

Coagulation Sedimentation Filtration Disinfection	Corrosion Control Taste and Odor Iron and Manganese Removal Fluoridation	Flocculation Best Available Technology
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**Operation / Maintenance**

Chemical Feeders Pumps, Motors, and Gearboxes Blowers and Compressors	Water Meters Pressure Gauges Instrumentation	Electrical Generators
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**Laboratory Procedures**

Sampling General Lab Practices Disinfectant Analysis Alkalinity Analysis	pH Analysis Turbidity Analysis Specific Conductance Hardness	Fluoride Analysis Color Analysis Taste and Odor Analysis Microbiological Analysis
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**Safety / Regulations / Administrative Duties**

Controlling Directing Implementing Regulations Lead and Copper Rule California Waterworks Standards Operator Certification Regulations Safe Drinking Water Act & Amendments Surface Water Treatment Rule and Amendments	Organizing Planning Primary Contaminants Recordkeeping	Safety Secondary Contaminants Total Coliform Rule
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# Expected Range of Knowledge for Drinking Water Treatment Exam

The tables below list specific objectives in each content category. The specific exam grades where these objectives are included are also provided below.

## Source Water

T1 - T4	Ability to calculate flow rates and water velocity
T1 - T4	Ability to calculate the volume of water in a storage facility
T1 - T4	Ability to calculate well drawdown
T1 - T4	Ability to calculate detention time
T1 - T4	Ability to calculate well specific capacity
T1 - T4	Ability to calculate well head pressure
T1 - T4	Ability to convert common water units (e.g. gallons per minute to MGD)
T1 - T4	Ability to convert head pressure to water elevation
T1 - T4	Ability to convert units of length, volume, flow and pressure
T1 - T4	Ability to determine water level in a storage tank, reservoir, or well
T1 - T4	Ability to recognize abnormal chemical characteristics of water
T1 - T4	Ability to recognize abnormal odors or colors
T1 - T4	Ability to recognize abnormal well operations
T1 - T4	Ability to recognize potential security risks
T1 - T4	Ability to recognize potential sources of contamination in surface water
T1 - T4	Ability to recognize the influence of surface water on a groundwater source
T1 - T4	Knowledge of chemicals that contribute alkalinity and hardness to water
T1 - T4	Knowledge of common chemical and microbial contaminants in raw water
T1 - T4	Knowledge of flow measurement devices
T1 - T4	Knowledge of potential microbial and chemical contamination sources in groundwater and surface water
T1 - T4	Knowledge of problems caused by hard water
T1 - T4	Knowledge of storage tank disinfection procedures
T1 - T4	Knowledge of the characteristics of aquifers
T1 - T4	Knowledge of the chemical components of groundwater and surface water
T1 - T4	Knowledge of the hydrologic cycle
T1 - T4	Knowledge of visual signs of contamination in a surface water reservoir
T1 - T4	Knowledge of well components
T1 - T4	Knowledge of well depth measurement procedures
T1 - T4	Knowledge of well disinfection procedures
T1 - T4	Knowledge of well drawdown measurement techniques
T2 - T4	Ability to discriminate between normal and abnormal conditions of a surface water reservoir
T2 - T4	Ability to recognize hydrological changes
T2 - T4	Knowledge of how reservoir intake level effects water quality
T2 - T4	Knowledge of the effects of seasonal changes on water reservoirs

# Expected Range of Knowledge for Drinking Water Treatment Exam

- T2 - T4 Knowledge of pretreatment procedures
- T3 - T4 Knowledge of surface water reservoir stratification
- T3 - T4 Ability to recognize head loss across an intake screen
- T3 - T4 Knowledge of groundwater treatment procedures

## Water Treatment Processes

### Coagulation/Flocculation/Sedimentation

- T3 - T4 Ability to calculate a coagulant dose from a jar test
- T3 - T4 Ability to perform a jar test
- T3 - T4 Ability to recognize and correct abnormal conditions in a sedimentation basin
- T3 - T4 Ability to recognize normal and abnormal floc formation
- T3 - T4 Knowledge of flocculation tanks
- T3 - T4 Knowledge of chemical coagulants and coagulant aids
- T3 - T4 Knowledge of coagulation/flocculation start-up/shutdown and adjustment procedures
- T3 - T4 Knowledge of enhanced coagulation
- T3 - T4 Knowledge of sedimentation basins
- T3 - T4 Knowledge of the coagulation/flocculation process
- T3 - T4 Knowledge of the effects of temperature, alkalinity, and pH on flocculation
- T3 - T4 Knowledge of the flash mixing process
- T3 - T4 Knowledge of the jar testing procedure
- T3 - T4 Knowledge of the sedimentation process
- T3 - T4 Knowledge of tube settlers
  - T4 Knowledge of water gradient velocities
  - T4 Knowledge of the zeta potential
  - T4 Knowledge of Van Der Waals forces
  - T4 Knowledge of ballasted flocculation procedures

### Filtration

- T1 - T4 Ability to interpret turbidity information
- T1 - T4 Knowledge of turbidity causing matter
- T2 - T4 Ability to calculate daily filter production
- T2 - T4 Ability to calculate filter backwash rate
- T2 - T4 Knowledge of head loss effects on filters
- T2 - T4 Knowledge of filter surface washing methods
- T2 - T4 Knowledge of filtration mechanisms (absorption, adsorption)
- T3 - T4 Ability to calculate a filter-aid dosage
- T3 - T4 Ability to calculate a filtration rate
- T3 - T4 Ability to calculate filter loading rate
- T3 - T4 Ability to recognize and correct problems in gravity filters

## Expected Range of Knowledge for Drinking Water Treatment Exam

T3 - T4	Ability to recognize and correct problems in multimedia filters
T3 - T4	Knowledge of backwash sequencing
T3 - T4	Knowledge of filter media types and uses
T3 - T4	Knowledge of maximum filtration rates
T3 - T4	Knowledge of normal and abnormal filter media conditions
T3 - T4	Ability to calculate filter media volume and capacity
T4	Ability to conduct a comprehensive performance evaluation of a filter
T4	Ability to operate an air scour system
T4	Ability to perform a filter assessment surveillance program
T4	Ability to perform a filter profile analysis
T4	Ability to recognize and correct problems in granular activated carbon filters
T4	Knowledge of air scouring systems
T4	Knowledge of filter media replacement requirements and techniques
T4	Knowledge of filter porosity

### Disinfection

T1 - T4	Ability to calculate a chemical dosage
T1 - T4	Ability to calculate a chemical solution concentration
T1 - T4	Ability to calculate chlorine demand and chlorine residual
T1 - T4	Knowledge of acceptable chlorine residual levels
T1 - T4	Knowledge of breakpoint chlorination chemistry
T1 - T4	Knowledge of chlorine chemistry
T1 - T4	Knowledge of common chlorine compounds used for disinfection
T1 - T4	Knowledge of disinfectant byproduct formation
T1 - T4	Knowledge of disinfectant properties and uses
T1 - T4	Knowledge of disinfection residual requirements
T1 - T4	Knowledge of MCLs and MRDLs of disinfectants
T2 - T4	Ability to calculate a CT value
T2 - T4	Ability to choose an appropriate disinfectant for a specific microbial problem
T2 - T4	Knowledge of chloramine chemistry
T2 - T4	Knowledge of disinfectant byproduct reduction procedures
T2 - T4	Knowledge of TOC/Disinfection byproduct correlation

### Corrosion Control

T1 - T4	Ability to recognize corrosion problems
T1 - T4	Knowledge of pH adjustment procedures
T1 - T4	Knowledge of corrosion causes
T2 - T4	Knowledge of corrosion reduction methods
T3 - T4	Knowledge of C-factor
T3 - T4	Knowledge of the cathodic protection process

# Expected Range of Knowledge for Drinking Water Treatment Exam

- T3 - T4 Knowledge of corrosion control inhibitors
- T3 - T4 Knowledge of the Langelier Index
- T3 - T4 Knowledge of corrosion control chemical reactions
- T4 Ability to choose the proper corrosion control chemical for a specific problem

## Taste and Odor

- T1 - T4 Knowledge of abnormal taste and odors
- T1 - T4 Knowledge of chemicals that contribute taste and odor
- T1 - T4 Knowledge of taste and odor treatment processes

## Iron and Manganese

- T1 - T4 Ability to recognize an iron and manganese problem
- T3 - T4 Knowledge of iron and manganese oxidation chemistry
- T3 - T4 Knowledge of iron and manganese removal techniques

## Fluoridation

- T4 Knowledge fluoridation chemicals
- T4 Knowledge of fluoride chemistry
- T4 Knowledge of optimal fluoride level range
- T4 Knowledge of the health effects of fluoride

## Best Available Technology (BAT)

- T1 - T4 Knowledge of health effects of lead and copper
- T1 - T4 Knowledge of adverse health effects caused by common contaminants
- T2 - T4 Knowledge of Best Available Technology (BAT) for common water contaminants
- T2 - T4 Knowledge of effective removal techniques for common contaminants
- T3 - T4 Ability to perform blending calculations
- T3 - T4 Knowledge of the aeration process
- T4 Knowledge of chemical oxidation techniques and uses
- T4 Knowledge of granular activated carbon (GAC)
- T4 Knowledge of nitrate removal processes

## Operation / Maintenance

### Chemical Feeders

- T1 - T4 Ability to calculate a dosage for a chemical feeder
- T1 - T4 Ability to calibrate and adjust a chemical feeder pump
- T1 - T4 Ability to operate a chemical feeder system
- T1 - T4 Ability to replace components of a chemical feeder system
- T1 - T4 Ability to set proper chemical feed rate
- T1 - T4 Knowledge of chemical feeder calibration and adjustment

# Expected Range of Knowledge for Drinking Water Treatment Exam

- T1 - T4 Knowledge of the components of chemical feeder systems
- T1 - T4 Knowledge of the operation of chemical feeder systems

## Pumps, Motors, and Gearboxes

- T1 - T4 Ability to discriminate between normal and abnormal operation of a water pump
- T1 - T4 Knowledge of pump types and uses
- T1 - T4 Knowledge of the components of a water pump
- T1 - T4 Knowledge of the operation of a water pump
- T1 - T4 Knowledge of valve types and uses
- T1 - T4 Ability to replace components of a water pump
- T2 - T4 Knowledge of pump installation procedures

## Blowers and Compressors

- T3 - T4 Knowledge of the operation of blowers and compressors
- T3 - T4 Ability to discriminate between normal and abnormal operation of blowers and compressors
- T4 Ability to replace components of blowers and compressors
- T4 Knowledge of the components of blowers and compressors

## Water Meters

- T1 - T4 Ability to read and interpret water meter readings
- T1 - T4 Knowledge of the components of water meters
- T1 - T4 Knowledge of the operation of water meters
- T1 - T4 Knowledge of water meter types and uses
- T2 - T4 Ability to calibrate a water meter

## Pressure Gauges

- T1 - T4 Knowledge of head pressure
- T1 - T4 Knowledge of the operation of pressure gauges
- T2 - T4 Ability to replace pressure gauges
- T3 - T4 Knowledge of the components of pressure gauges

## Instrumentation

- T1 - T4 Knowledge of basic SCADA system components
- T2 - T4 Ability to determine normal operation of a SCADA system
- T2 - T4 Knowledge of the components of on-line analyzers
- T3 - T4 Ability to recognize analytical interferences in on-line analyzers
- T3 - T4 Ability to repair or replace defective parts of on-line analyzers
- T3 - T4 Knowledge of the operation of on-line analyzers

# Expected Range of Knowledge for Drinking Water Treatment Exam

## Electrical Generators

- T3 - T4 Knowledge of the operation of an electrical generator
- T3 - T4 Knowledge of the components of an electrical generator

## Laboratory Procedures

### Sampling

- T1 - T4 Ability to collect a water sample
- T1 - T4 Ability to determine a proper sampling site
- T1 - T4 Ability to follow chain of custody
- T1 - T4 Knowledge of appropriate sample containers and sample sizes
- T1 - T4 Knowledge of maximum holding times
- T1 - T4 Knowledge of proper sampling and preservation techniques
- T1 - T4 Knowledge of well sampling techniques

### General Laboratory Practices

- T1 - T4 Ability to calculate a chemical solution concentration
- T1 - T4 Knowledge of chemical hazards
- T2 - T4 Ability to calculate a dilution factor
- T2 - T4 Ability to mix chemicals and prepare reagents
- T2 - T4 Ability to perform dilutions

### Disinfectant Analysis

- T1 - T4 Ability to analyze a water sample for free and total chlorine
- T1 - T4 Ability to read and interpret a colorimeter
- T1 - T4 Knowledge of approved analytical procedures for chlorine analysis
- T1 - T4 Knowledge of chlorine chemistry

### Alkalinity Analysis

- T2 - T4 Knowledge of chemicals that contribute alkalinity to water
- T3 - T4 Ability to use a titrator
- T3 - T4 Ability to recognize a titration endpoint
- T3 - T4 Knowledge of abnormal alkalinity levels

### pH Analysis

- T1 - T4 Ability to read and interpret a pH meter
- T1 - T4 Knowledge of acids and bases
- T1 - T4 Knowledge of acceptable water pH range
- T1 - T4 Knowledge of chemicals that affect the pH of water
- T1 - T4 Knowledge of the effects of pH on water quality
- T1 - T4 Knowledge of the pH scale

# Expected Range of Knowledge for Drinking Water Treatment Exam

- T1 - T4 Ability to analyze a water sample for pH
- T2 - T4 Ability to calibrate a pH meter

## Turbidity Analysis

- T1 - T4 Ability to analyze a water sample for turbidity
- T1 - T4 Ability to read and interpret a turbidimeter
- T1 - T4 Knowledge of the Nephelometric Turbidity Unit (NTU) scale
- T1 - T4 Knowledge of turbidimeter instrumentation
- T1 - T4 Knowledge of turbidity causing matter
- T1 - T4 Knowledge of turbidity level requirements
- T2 - T4 Ability to prepare and calibrate turbidimeter with Primary Standard (Formazin)

## Specific Conductance

- T3 - T4 Ability to analyze a water sample for specific conductance
- T3 - T4 Ability to read and interpret a specific conductance meter
- T4 Ability to calculate a TDS value from a specific conductance reading
- T4 Knowledge of EC/TDS ratio
- T4 Ability to calibrate a specific conductance meter

## Hardness

- T1 - T4 Knowledge of chemicals that contribute hardness to water
- T2 - T4 Ability to analyze a water sample for water hardness
- T2 - T4 Knowledge of hardness removal processes

## Fluoride Analysis

- T4 Ability to operate an Ion Specific Electrode (ISE)
- T4 Knowledge of optimal fluoride level range

## Color Analysis

- T2 - T4 Ability to recognize abnormal colors in water
- T3 - T4 Knowledge of abnormal color levels
- T4 Knowledge of color analysis scale
- T4 Knowledge of true and apparent color

## Taste and Odor Analysis

- T1 - T4 Ability to identify an objectionable taste or odor in water
- T1 - T4 Knowledge of chemicals that contribute taste and odor to water
- T4 Knowledge of odor analysis protocol



# Expected Range of Knowledge for Drinking Water Treatment Exam

## Microbiological Analysis

- T1 - T4 Knowledge of the presence/absence test method
- T1 - T4 Knowledge of approved analytical procedures for coliform analysis
- T1 - T4 Knowledge of common microbial contaminants in raw water
- T2 - T4 Knowledge of Heterotrophic Plate Count (HPC)
- T3 - T4 Ability to distinguish between presumptive and confirmed coliform results
- T3 - T4 Knowledge of the multiple tube fermentation method
- T3 - T4 Knowledge of the membrane filtration method

## Safety / Regulations / Administrative Duties

### Safety

- T1 - T4 Ability to demonstrate safe work habits
- T1 - T4 Ability to identify potential safety hazards
- T1 - T4 Ability to recognize unsafe working conditions
- T1 - T4 Ability to select and utilize safety equipment
- T1 - T4 Knowledge of chemical hazards
- T1 - T4 Knowledge of compressed gas safety procedures
- T1 - T4 Knowledge of confined space safety procedures
- T1 - T4 Knowledge of electrical safety
- T1 - T4 Knowledge of hazardous chemical handling
- T1 - T4 Knowledge of incompatible chemicals
- T1 - T4 Knowledge of lock-out/tag-out procedures
- T1 - T4 Knowledge of Material Safety Data (MSD) sheets
- T1 - T4 Knowledge of personal protective equipment (PPE)
- T1 - T4 Knowledge of proper chemical handling techniques
- T1 - T4 Knowledge of safe working practices
- T1 - T4 Knowledge of the use of safety equipment
- T2 - T4 Knowledge of HAZWOPER guidelines
- T3 - T4 Ability to administer a safety plan
- T3 - T4 Ability to generate a written safety plan

### Regulations / Administrative Duties

- T1 - T4 Ability to interpret water quality characteristics (hardness, turbidity, pH)
- T1 - T4 Knowledge of basic unit processes used in treating drinking water
- T1 - T4 Knowledge of corrective actions to take when regulations are violated
- T1 - T4 Knowledge of drinking water monitoring and reporting requirements
- T1 - T4 Knowledge of drinking water regulations
- T1 - T4 Knowledge of notification protocol and procedures
- T1 - T4 Knowledge of NSF Standards

## Expected Range of Knowledge for Drinking Water Treatment Exam

T1 - T4	Knowledge of operator certification requirements
T1 - T4	Knowledge of Primary and Secondary Drinking Water Standards
T1 - T4	Knowledge of public notification procedures
T1 - T4	Knowledge of record keeping requirements
T1 - T4	Knowledge of California Waterworks Standards
T1 - T4	Knowledge of the Consumer Confidence Report (CCR)
T1 - T4	Knowledge of the Disinfectants and Disinfection Byproduct Rule and amendments
T1 - T4	Knowledge of the Groundwater Rule
T1 - T4	Knowledge of the Lead and Copper Rule
T1 - T4	Knowledge of the Surface Water Treatment Rule and amendments
T1 - T4	Knowledge of the Total Coliform Rule and amendments
T1 - T4	Knowledge of waterborne pathogens
T1 - T4	Ability to interpret water quality reports
T1 - T4	Ability to research and interpret Maximum Contaminant Levels (MCLs)
T2 - T4	Ability to administer a maintenance program
T2 - T4	Knowledge of cryptosporidium action plan
T2 - T4	Knowledge of pending regulations
T2 - T4	Knowledge of performance standards and removal requirements for surface water treatment
T2 - T4	Knowledge of the Filter Backwash Rule
T2 - T4	Knowledge of routine sampling requirements
T3 - T4	Ability to administer a regulatory compliance program
T3 - T4	Ability to calculate percent or log removal of contaminants from water
T3 - T4	Ability to calculate the cost of water treatment operations
T3 - T4	Ability to develop an operational site sampling plan
T3 - T4	Ability to develop an operations plan
T3 - T4	Ability to evaluate treatment facility performance
T3 - T4	Knowledge of facility operation and maintenance
T3 - T4	Knowledge of management principles
T3 - T4	Knowledge of permit requirements for water operations
T3 - T4	Knowledge of principles of supervision
T3 - T4	Knowledge of public relations principles
T3 - T4	Knowledge of pump to waste discharge environmental regulations
T3 - T4	Knowledge of regulatory primacy issues
T3 - T4	Knowledge of source water replenishment processes
T3 - T4	Knowledge of the Sanitary Survey process
T4	Ability to interpret historical water use data
T4	Knowledge of the role of Regional Boards in managing contamination sources
T4	Knowledge of the Source Water Assessment Program
T4	Knowledge of the Watershed Survey process

# Expected Range of Knowledge for Drinking Water Treatment Exam

T4 Knowledge of the vulnerability assessment process

## Water Treatment Exam Math

- T1 - T4 Ability to calculate flow rates and water velocity
- T1 - T4 Ability to calculate the volume of water in a storage facility
- T1 - T4 Ability to calculate well drawdown
- T1 - T4 Ability to calculate detention time
- T1 - T4 Ability to calculate well specific capacity
- T1 - T4 Ability to calculate well head pressure
- T1 - T4 Ability to convert common water units, (gallons per minute to MGD, etc...)
- T1 - T4 Ability to convert head pressure to water elevation
- T1 - T4 Ability to convert units of length, volume, flow and pressure
- T1 - T4 Ability to determine water level in a storage tank, reservoir or well
- T1 - T4 Ability to calculate a chemical dosage
- T1 - T4 Ability to calculate a chemical solution concentration
- T1 - T4 Ability to calculate chlorine demand and chlorine residual
- T1 - T4 Ability to calculate a dosage for a chemical feeder
- T1 - T4 Ability to calculate a chemical solution concentration
- T2 - T4 Ability to calculate daily filter production
- T2 - T4 Ability to calculate filter backwash rate
- T2 - T4 Ability to calculate a CT value
- T2 - T4 Ability to calculate a dilution factor
- T2 - T4 Ability to perform dilutions
- T3 - T4 Ability to calculate a coagulant dose from a jar test
- T3 - T4 Ability to calculate a filter-aid dosage
- T3 - T4 Ability to calculate a filtration rate
- T3 - T4 Ability to calculate filter loading rate
- T3 - T4 Ability to calculate percent or log removal of contaminants from water
- T3 - T4 Ability to calculate the cost of water treatment operations