

State Water Resources Control Board

## Drinking Water Treatment Exams Expected Range of Knowledge

Exam Content	Number of questions			
	T1	T2	T3	T4
Grade				
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

Watershed Protection, Wells / Groundwater, Surface Water / Reservoirs, Raw Water Storage, Clear Well Storage

### Water Treatment Processes

Coagulation/Flocculation/ Sedimentation, Filtration, Disinfection, Corrosion Control, Taste and Odor, Iron and Manganese removal, Fluoridation, BAT (Best Available Technology)

### Operation / Maintenance

Chemical feeders, Pumps and Motors, Blowers and Compressors, Water meters, Pressure gauges, Instrumentation, Electrical generators

### 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

### Regulations/Administrative Duties

Safety, Planning, Organizing, Directing, Controlling, Implementing Regulations, Record keeping, California Waterworks Standards, Safe Drinking Water Act and amendments, Surface Water Treatment Rule and amendments, Primary Contaminants, Secondary Contaminants, Lead and Copper Rule, Total Coliform Rule, Operator Certification Regulations

## EXPECTED RANGE OF KNOWLEDGE WATER TREATMENT EXAMS

(Items marked "T1-T4" may be on the T1 – T4 exams)

(Items marked "T2-T4" may be on the T2 – T4 exams but not on the T1 exam)

### *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, (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 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
- 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/shut down 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
- 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 MCL's and MRDL's of disinfectants
- T2 - T4** Ability to calculate a CT value
- T2 - T4** Ability to choose an appropriate disinfectant for a particular 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
- 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

- 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 BAT, (Best Available Technology) 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
- 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 an on-line analyzers
- T3 - T4** Knowledge of the operation of on-line analyzers

#### 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 end-point
- 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 effect the pH of water
- T1 - T4** Knowledge of the effects of pH on water quality
- T1 - T4** Knowledge of the pH scale
- 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 NTU scale, (Nephelometric Turbidity Unit)
- 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

- T4** Ability to operate an ISE, (Ion Specific Electrode)
- 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

- 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

## 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 HPC, (Heterotrophic Plate Count)
- 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**

- 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 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

### ***Administrative Duties / Regulations***

- 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
- 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, (MCL's)
- 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
- 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