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**Water Treatment Exams 2008  
Expected Range of Knowledge  
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Exam Content Grade	Number of questions			
	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**

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

**Water Treatment Processes**

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

**Operation / Maintenance**

Chemical feeders, Pumps and Motors, Blowers and Compressors, Water meters, Pressure gauges, Electrical generators, Safety, SCADA systems

**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, Dissolved Oxygen analysis, Algae Count, Bacteriological analysis

**Regulations/Administrative Duties**

Planning, Organizing, Directing, Controlling, Staffing, Implementing Regulations, Record keeping, Safe Drinking Water Act and amendments, Surface Water Treatment Rule and amendments, Primary Contaminants, Secondary Contaminants, Lead and Copper Rule, Fluoride Regulations, Operator Certification Regulations

## EXPECTED RANGE OF KNOWLEDGE 2008 WATER TREATMENT EXAMS

\*(Items marked "1-4" may be on the T1 – T4 exams)

\*\* (Items marked "2-4" may be on the T2 – T4 exams but not on the T1 exam)

### *Source Water*

#### Wells/Groundwater

- 1-4\* Knowledge of the characteristics of aquifers
- 1-4 Knowledge of the chemical components of groundwater
- 1-4 Knowledge of potential contamination in groundwater
- 1-4 Knowledge of well sampling techniques
- 1-4 Knowledge of groundwater characteristics
- 1-4 Ability to analyze water quality characteristics
- 1-4 Ability to calculate well drawdown
- 2-4\*\* Ability to recognize hydrological changes
- 2-4 Ability to calculate a disinfectant dosage in a well
- 2-4 Ability to recognize the influence of surface water on a Groundwater source
- 2-4 Ability to calculate well specific capacity
- 3-4 Knowledge of the source water assessment process
- 3-4 Ability to recognize abnormal chemical characteristics of water
- 3-4 Ability to calculate well head pressure

#### Surface Water/Reservoirs

- 1-4 Knowledge of microbial contamination
- 1-4 Knowledge of flow measurement devices
- 1-4 Ability to recognize potential sources of contamination in surface water
- 1-4 Ability to calculate flow rates
- 1-4 Ability to discriminate between normal and abnormal conditions
- 1-4 Ability to collect a water sample from a surface water source
- 1-4 Ability to calculate the volume of water contained in a storage facility
- 1-4 Ability to recognize abnormal odors or colors
- 2-4 Knowledge of the characteristics of surface waters
- 2-4 Knowledge of the chemical characteristics of surface water
- 2-4 Knowledge of the physical characteristics of surface water
- 2-4 Knowledge of reservoir stratification
- 2-4 Knowledge of the effects of seasonal changes
- 2-4 Knowledge of proper surface water sampling procedures
- 3-4 Ability to interpret water quality reports

### Raw Water Storage

- 1-4 Knowledge of water quality characteristics
- 1-4 Knowledge of bacterial contaminants
- 1-4 Knowledge of potential contamination sources
- 1-4 Ability to discriminate between normal and abnormal conditions
- 1-4 Ability to calculate a chemical dosage
- 1-4 Ability to collect a water sample
- 2-4 Knowledge of proper sampling procedures
- 2-4 Ability to measure temperature
- 2-4 Ability to determine water level
- 2-4 Ability to measure turbidity
- 2-4 Ability to calculate detention time

### Clear Well Storage

- 1-4 Knowledge of water quality characteristics
- 1-4 Knowledge of bacterial contaminants
- 1-4 Knowledge of proper sampling procedures
- 1-4 Ability to calculate a chemical dosage
- 1-4 Ability to measure temperature
- 1-4 Ability to measure pH
- 1-4 Ability to determine water level
- 1-4 Ability to measure turbidity
- 2-4 Knowledge of potential contamination sources
- 2-4 Ability to discriminate between normal and abnormal conditions
- 4 Ability to calculate a CT value

## ***Water Treatment Processes***

### Coagulation/Flocculation/Sedimentation

- 2-4 Knowledge of safe chemical handling
- 2-4 Knowledge of chemical compatibilities
- 2-4 Knowledge of maximum dose levels
- 2-4 Ability to calculate chemical solution concentration
- 2-4 Ability to analyze a water sample for turbidity
- 2-4 Ability to analyze a water sample for pH
- 2-4 Ability to analyze a water sample for temperature
- 2-4 Ability to measure sludge depth
- 3-4 Knowledge of the coagulation/flocculation process
- 3-4 Knowledge of chemical coagulants and coagulant aids
- 3-4 Knowledge of coagulation/flocculation start-up/shut-down procedures
- 3-4 Knowledge of coagulation/flocculation adjustment procedures
- 3-4 Knowledge of chemical feeder calibration and adjustment
- 3-4 Knowledge of the mixing process

- 3-4 Knowledge of zeta potential
- 3-4 Knowledge of TOC/Disinfection by-product correlation
- 3-4 Knowledge of enhanced coagulation
- 3-4 Ability to recognize normal and abnormal floc formation
- 3-4 Ability to measure turbidity
- 3-4 Ability to analyze a water sample for alkalinity
- 3-4 Knowledge of the sedimentation process
- 3-4 Knowledge of sedimentation basins
- 3-4 Ability to recognize and correct abnormal conditions in the sedimentation basin
- 3-4 Ability to operate a sedimentation basin
- 3-4 Ability to calculate the correct coagulant dosage
- 3-4 Ability to perform a jar test
- 4 Ability to determine sludge-depth in solids-contact unit
- 4 Ability to operate a solids-contact unit
- 4 Ability to operate an upflow clarifier

#### Filtration

- 1-4 Ability to interpret turbidity information
- 1-4 Knowledge of turbidity causing matter
- 2-4 Knowledge of filtration mechanisms (absorption, adsorption)
- 2-4 Knowledge of head loss effects on filters
- 2-4 Ability to calculate filter-aid dosage
- 2-4 Ability to calculate filtration rate ratio
- 2-4 Ability to calculate filter backwash rate
- 3-4 Knowledge of filter porosity
- 3-4 Knowledge of filter media types and uses
- 3-4 Ability to recognize and correct problems in gravity filters
- 3-4 Knowledge of the diatomaceous earth process
- 3-4 Knowledge of filtration rates
- 3-4 Ability to recognize and correct problems in granular activated carbon filters
- 3-4 Ability to recognize and correct problems in multimedia filters
- 3-4 Ability to calculate filter media volume and capacity
- 3-4 Ability to calculate a filtration rate
- 3-4 Ability to calculate daily filter production
- 3-4 Ability to measure turbidity
- 4 Knowledge of filter media replacement considerations, requirements, and techniques

## Disinfection

- 1-4 Knowledge of chlorine chemistry
- 1-4 Knowledge of breakpoint chlorination chemistry
- 1-4 Knowledge of proper sampling techniques
- 1-4 Knowledge of safe chemical handling practices
- 1-4 Knowledge of chlorine analysis procedures
- 1-4 Ability to calculate flow rates, volumes, dilution factors, feed rates, and chemical concentrations
- 1-4 Ability to calculate a dechlorination dosage
- 1-4 Ability to analyze a water sample for free and total chlorine
- 1-4 Knowledge of dechlorination practices
- 2-4 Knowledge of chloramines chemistry
- 2-4 Knowledge of ammonia feed systems
- 2-4 Ability to calibrate and adjust a chemical feeder pump
- 2-4 Ability to calculate a disinfectant dosage
- 2-4 Ability to calculate an ammonia/chlorine ratio
- 3-4 Knowledge of disinfectant properties and uses (chlorine, chlorine dioxide, chlorine gas, chloramines, ozone)
- 3-4 Knowledge of ozonator system operation
- 4 Ability to choose an appropriate disinfectant for a particular bacterial problem
- 4 Ability to calculate a CT value

## Demineralization

- 3-4 Knowledge of dissolved minerals in water
- 3-4 Ability to analyze a sample for specific conductance
- 4 Knowledge of ion exchange processes
- 4 Ability to regenerate ion exchange system
- 4 Knowledge of specific conductance/TDS ratio
- 4 Ability to calculate a TDS value from a specific conductance reading

## Corrosion Control

- 1-4 Knowledge of health effects of Pb and Cu
- 2-4 Knowledge of pH adjustment
- 2-4 Knowledge of corrosion causes
- 2-4 Knowledge of C-factor
- 2-4 Ability to recognize corrosion problems
- 2-4 Ability to calculate a chemical feed rate (dose)
- 2-4 Ability to set the proper chemical feed rate
- 3-4 Knowledge of corrosion control inhibitors
- 3-4 Knowledge of corrosion control chemical reactions
- 3-4 Knowledge of the cathodic protection process
- 3-4 Ability to calculate chemical solution concentration
- 3-4 Ability to analyze a water sample for pH

- 4 Ability to choose the proper corrosion control chemical for a specific problem

#### Iron and Manganese

- 2-4 Knowledge of iron and manganese removal processes
- 2-4 Knowledge of proper sampling and preservation techniques
- 2-4 Ability to recognize an iron and manganese problem
- 2-4 Ability to calculate a chemical dosage
- 3-4 Knowledge of iron and manganese oxidation chemistry
- 3-4 Knowledge of oxidation techniques
- 3-4 Ability to calculate chemical solution concentration
- 4 Knowledge of ion exchange chemistry

#### Fluoridation

- 1-4 Knowledge of the health effects of fluoride
- 2-4 Knowledge of back siphoning prevention measures
- 2-4 Knowledge of incompatible chemicals
- 2-4 Ability to calculate a chemical dosage
- 3-4 Knowledge of fluoridation chemicals
- 3-4 Ability to calculate chemical solution concentration
- 3-4 Ability to operate a chemical feeder system
- 4 Knowledge of fluoride chemistry

#### Water Softening

- 1-4 Knowledge of hard water causing chemicals
- 2-4 Knowledge of the water softening processes
- 2-4 Knowledge of acceptable water hardness range
- 2-4 Ability to convert units
- 2-4 Ability to calculate a chemical dosage
- 3-4 Knowledge of hardness removal chemicals
- 3-4 Ability to analyze a sample for water hardness
- 3-4 Ability to calculate blended water concentrations
- 4 Ability to calculate a the hardness removal capacity of resin

#### Best Available Technology

- 1-4 Knowledge of waterborne pathogens
- 4 Knowledge of BAT (Best Available Technology) for each contaminant
- 4 Knowledge of effective removal techniques other than BAT
- 4 Knowledge of adverse health effects caused by contaminants
- 4 Knowledge of contaminant source or formation chemistry
- 4 Knowledge of pharmaceutical contaminants

### Chemical Feeders

- 1-4 Ability to discriminate between normal and abnormal operation
- 2-4 Knowledge of the operation of chemical feeder systems
- 2-4 Knowledge of the components of a chemical feeder systems
- 2-4 Knowledge of backpressure retention valves
- 2-4 Ability to calculate a dosage
- 2-4 Ability to replace components of a chemical feeder system
- 2-4 Ability to set speed and stroke

### Pumps and Motors

- 1-4 Knowledge of the operation of a water pump
- 1-4 Knowledge of the components of a water pump
- 1-4 Knowledge of pump types
- 1-4 Ability to calculate a flow rate
- 3-4 Ability to discriminate between normal and abnormal operation

### Blowers and Compressors

- 2-4 Knowledge of the operation of blowers and compressors
- 2-4 Ability to discriminate between normal and abnormal operation
- 4 Knowledge of the components of blowers and compressors

### Water Meters

- 1-4 Knowledge of the operation of water meters
- 1-4 Knowledge of water meter types
- 1-4 Ability to discriminate between normal and abnormal operation
- 2-4 Knowledge of the components of water meters

### Pressure Gauges

- 1-4 Knowledge of the operation of pressure gauges
- 1-4 Knowledge of head pressure
- 1-4 Ability to discriminate between normal and abnormal operation
- 1-4 Ability to replace pressure gauges

### Electrical Generators

- 1-4 Ability to discriminate between normal and abnormal operation
- 2-4 Knowledge of the operation of an electrical generator

## ***Intrumentation***

- 2-4 Knowledge of basic SCADA system components
- 2-4 Knowledge of SCADA system capabilities
- 2-4 Ability to determine normal operation of a SCADA system
- 2-4 Knowledge of the operation of on-line analyzers
- 2-4 Knowledge of the components of on-line analyzers
- 2-4 Ability to discriminate between normal and abnormal operation of on-line analyzers
- 2-4 Ability to repair or replace EXPENDABLE parts of on-line analyzers
- 2-4 Knowledge of the various types of water flow meters
- 2-4 Knowledge of required reagents for free or total chlorine analysis, and preparation of KI solution
- 3-4 Knowledge of flow rates for low range and high range turbidimeters
- 3-4 Knowledge of cleaning and adjusting the flow (i.e., 100 mL/min) for a particle counter
- 4 Ability to prepare and calibrate turbidimeters with Primary standard (Formazin)
- 4 Ability to adjust STREAMING CURRENT DETECTOR to "zero" using gain knob and knowledge of what this "zero" represents
- 4 Ability to prepare and calibrate turbidimeters with Primary standard (Formazin)
- 4 Knowledge of what an STREAMING CURRENT DETECTOR reading dropping below or above "zero" represents with regard to coagulation dosage and raw water condition
- 4 Ability to standardize a dissolved ozone residual analyzer
- 4 Knowledge of the transfer efficiency derived from the relationship between gas phase ozone product gas and off gas analyzers
- 4 Ability to calculate U.V. dosages

## ***Laboratory Procedures:***

### Sampling

- 1-4 Knowledge of proper sampling and preservation techniques
- 1-4 Knowledge of appropriate sample containers and required sample sizes
- 1-4 Ability to follow chain-of-custody
- 2-4 Knowledge of maximum holding times
- 3-4 Ability to determine a proper sampling site
- 4 Knowledge of giardia and cryptosporidia sampling techniques
- 4 Ability to write a sampling plan

### General Laboratory Practices

- 1-4 Knowledge of proper chemical handling techniques
- 2-4 Knowledge of quality control procedures
- 3-4 Knowledge of approved analytical procedures
- 3-4 Ability to follow chain-of-custody
- 3-4 Ability to perform dilutions
- 3-4 Ability to calculate a dilution factor

### Disinfectant Analysis

- 1-4 Knowledge of abnormal chlorine levels
- 1-4 Knowledge of chlorine analysis techniques (DPD, amperometric)
- 3-4 Knowledge of chlorine chemistry
- 3-4 Knowledge of ozone chemistry
- 3-4 Knowledge of dechlorination chemistry

### Alkalinity Analysis

- 1-4 Knowledge of chemicals that contribute alkalinity to water
- 2-4 Ability to read a pH meter
- 3-4 Knowledge of abnormal alkalinity levels
- 3-4 Ability to use a titrator
- 3-4 Ability to recognize a titration end-point

### pH

- 1-4 Knowledge of the pH scale
- 1-4 Knowledge of acids and bases
- 1-4 Ability to read a pH meter
- 2-4 Knowledge of temperature effects on pH
- 2-4 Ability to calibrate a turbidimeter

### Specific Conductance

- 4 Knowledge of EC/TDS
- 4 Ability to read a specific conductance meter

### Hardness

- 1-4 Knowledge of chemicals that contribute hardness to water
- 2-4 Knowledge of abnormal hardness levels
- 3-4 Ability to use a titrator
- 3-4 Ability to read a pH meter
- 3-4 Ability to recognize a titration end-point

### Fluoride

- 2-4 Knowledge of abnormal levels of fluoride
- 3-4 Knowledge of optimal fluoride level control range

### Color Analysis

- 3-4 Knowledge of color analysis scale
- 3-4 Knowledge of abnormal color levels
- 3-4 Knowledge of true and apparent color
- 4 Ability to determine small variations in color

### Taste and Odor

- 2-4 Knowledge of chemicals that contribute taste and odor
- 2-4 Knowledge of abnormal taste and odors
- 3-4 Knowledge of odor analysis protocol
- 3-4 Ability to identify an objectionable taste or odor

### Dissolved Oxygen

- 3-4 Knowledge of normal and abnormal dissolved oxygen levels
- 3-4 Knowledge of the adverse effects of abnormal dissolved oxygen levels
- 3-4 Knowledge of dissolved oxygen measuring devices

### Algae Count

- 3-4 Knowledge of algae treatment techniques
- 4 Ability to identify algal organisms that impact the water treatment process (filter clogging, Taste and Odor)

### Bacteriological Analysis

- 2-4 Knowledge of bacteriological analysis methods
- 2-4 Knowledge of the presence/absence test method
- 2-4 Knowledge of the multiple tube fermentation method
- 2-4 Knowledge of Heterotrophic Plate Count (HPC)
- 2-4 Knowledge of the membrane filtration method
- 2-4 Knowledge of bacteriological testing controls
- 2-4 Ability to distinguish between presumptive and confirmed results

## **Safety**

- 1-4 Knowledge of safe working practices
- 1-4 Knowledge of the use of safety equipment
- 1-4 Knowledge of compressed gas safety procedures
- 1-4 Knowledge of hazardous chemical handling
- 1-4 Knowledge of personal protective equipment (PPE)
- 1-4 Knowledge of lock-out/tag-out procedures

- 1-4 Ability to demonstrate safe work habits
- 1-4 Ability to recognize unsafe working conditions
- 2-4 Knowledge of electrical safety
- 2-4 Ability to select and operate safety equipment
- 3-4 Knowledge of HAZWOPER guidelines
- 3-4 Ability to administer first aid
- 3-4 Ability to administer CPR

### ***Administrative Duties***

- 1-4 Knowledge of drinking water regulations
- 1-4 Ability to communicate verbally and in writing
- 1-4 Ability to demonstrate safe work habits
- 1-4 Ability to identify potential safety hazards
- 1-4 Ability to organize information and follow written procedures
- 1-4 Ability to recognize unsafe work conditions
- 2-4 Knowledge of facility operation and maintenance
- 2-4 Knowledge of monitoring and reporting requirements
- 2-4 Ability to determine what information needs to be recorded
- 2-4 Ability to interpret and transcribe data
- 3-4 Knowledge of record keeping requirements
- 3-4 Knowledge of NSF Standards
- 3-4 Ability to evaluate facility performance
- 3-4 Ability to review reports
- 3-4 Ability to translate technical language into common terminology
- 4 Ability to calculate the cost of operations
- 4 Knowledge of management principles
- 4 Knowledge of public relations principles
- 4 Knowledge of principles of supervision

### ***Regulations***

- 1-4 Knowledge of sampling requirements
- 1-4 Knowledge of turbidity level requirements
- 1-4 Knowledge of disinfection residual requirements
- 1-4 Knowledge of MCLs and MRDLs of disinfectants
- 1-4 Ability to research and interpret MCLs
- 2-4 Knowledge of notification protocol and procedures
- 2-4 Knowledge of public notification procedures
- 2-4 Knowledge of record keeping requirements
- 2-4 Knowledge of corrective actions to take when regulations are violated
- 3-4 Knowledge of reporting procedures
- 3-4 Knowledge of the Consumer Confidence Report (CCR)

- 3-4 Knowledge of regulatory primacy issues
- 3-4 Knowledge of performance standards and removal requirements for the SWTR and IESWTR
- 4 Knowledge of the sanitary survey process
- 4 Knowledge of the watershed survey process
- 4 Knowledge of pending regulations
- 4 Knowledge of cryptosporidia action plan
- 4 Ability to develop an operations plan
- 4 Ability to develop an operational site sampling plan
- 4 Ability to conduct a Sanitary Survey
- 4 Ability to conduct a Watershed Survey
- 4 Ability to perform a filter profile analysis
- 4 Ability to perform a filter assessment surveillance program
- 4 Ability to conduct a comprehensive performance evaluation

## Water Treatment Exam Math 2008

### Draft 12/17/2007

- 1-4 Ability to calculate well drawdown
- 1-4 Ability to calculate flow rates, water velocity
- 1-4 Ability to calculate the volume of water contained in a storage facility
- 1-4 Ability to calculate a chemical, disinfectant dosage
- 1-4 Ability to determine water level
- 1-4 Ability to calculate volumes, dilution factors, feed rates, and chemical concentrations
- 1-4 Ability to calculate a dechlorination dosage
- 1-4 Ability to calculate chlorine residual
- 1-4 Ability to convert a head pressure to water elevation
  
- 2-4 Ability to calculate well specific capacity
- 2-4 Ability to calculate detention time
- 2-4 Ability to calculate chemical solution concentration
- 2-4 Ability to calculate filter-aid dosage
- 2-4 Ability to calculate filter backwash rate
- 2-4 Ability to calculate an ammonia/chlorine ratio
- 2-4 Ability to calculate a chemical feed rate (dose) for corrosion control
- 2-4 Ability to calculate a chemical dosage for Fe/Mn removal, fluoridation
- 2-4 Ability to calculate a dosage on a chemical feeder
  
- 3-4 Ability to calculate well head pressure
- 3-4 Ability to calculate a coagulant dosage
- 3-4 Ability to perform a jar test
- 3-5 Ability to calculate filter media volume and capacity
- 3-4 Ability to calculate a filtration rate
- 3-4 Ability to calculate filter loading rate
- 3-4 Ability to calculate daily filter production
- 3-4 Ability to calculate a chemical solution concentration for Fe/Mn, fluoridation
- 3-4 Ability to calculate blended water chemical concentrations
- 3-4 Ability to calculate % removal of chemical contaminants
  
- 4 Ability to calculate a CT value
- 4 Ability to calculate a TDS value from a specific conductance reading
- 4 Ability to calculate the hardness removal capacity of resin
- 4 Ability to calculate the cost of operations