

ABC Need-to-Know Criteria for Wastewater Treatment Operators



ABC

Association of
Boards of Certification

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Introduction

As part of the development of its certification exams, the Association of Boards of Certification (ABC) conducted a job analysis of wastewater treatment operators in 2002 and 2003. As part of this process, ABC conducted a national survey of wastewater treatment operators. In 2004, ABC's Wastewater Treatment Validation and Examination (V&E) Committee evaluated the results of the job analysis. This Need-to-Know Criteria was developed from the results of the evaluation of ABC's wastewater treatment operator job analysis.

How the Need-to-Know Criteria was Developed

The results of the task survey were provided to the ABC Wastewater Treatment V&E Committee. In the task survey, operators rated job tasks and capabilities for frequency of performance and seriousness of inadequate or incorrect performance. These two rating scales were used because they provide useful information (i.e., how critical each task is and how frequently each task is performed) pertaining to certification. Of the 138 operators who completed the survey, 20% were class I operators, 27% were class II operators, 28% were class III operators, and 25% were class IV operators.

The Wastewater Treatment V&E Committee met in April 2004 to develop the new Need-to-Know Criteria. During this meeting, the committee evaluated the operator survey ratings and identified the level of knowledge (i.e., comprehension, application, analysis) required by operators for each task.

Core Competencies

The essential tasks and capabilities that were identified through this process are called the core competencies. The following pages list the core competencies for wastewater treatment operators. The core competencies are clustered into the following job duties:

- Evaluate Incoming Wastestream/Sidestream Characteristics
- Monitor, Evaluate and Adjust Treatment Processes
- Evaluate and Maintain Equipment
- Operate Equipment
- Collect Samples and Interpret Laboratory Analyses
- Perform Laboratory Analyses
- Perform Security, Safety and Administrative Procedures

The level of knowledge (i.e., comprehension, application, analysis) required for each task is also identified in the following pages.

- **Comprehension** is the most basic level of understanding and remembering. Items written at the comprehension level require examinees to recognize, remember, or identify important ideas.
- Items written at the **application** level require examinees to interpret, calculate, predict, use or apply information and solve problems.
- Items written at the **analysis** level require examinees to compare, contrast, diagnose, examine, analyze, and relate important concepts.

The level of knowledge is a hierarchy from basic comprehension to analysis. The level of knowledge tested is cumulative. Therefore, tasks identified as application may include questions written at both the application and comprehension levels. Tasks identified as analysis may include questions written at the comprehension, application and analysis levels.

Core Competencies for Wastewater Treatment Operators

Evaluate Incoming Wastestream/Sidestream Characteristics	Class I	Class II	Class III	Class IV
Biological/Chemical	Analysis	Analysis	Analysis	Analysis
Color	Analysis	Analysis	Analysis	Analysis
Flow pattern	Analysis	Analysis	Analysis	Analysis
Mixing pattern	Analysis	Analysis	Analysis	Analysis
Odor/Off-gas	Analysis	Analysis	Analysis	Analysis
Solids concentration	Analysis	Analysis	Analysis	Analysis
Temperature	Analysis	Analysis	Analysis	Analysis
Volume	Analysis	Analysis	Analysis	Analysis

Required Capabilities for Evaluate Wastestream Characteristics:

- Ability to communicate observations verbally and in writing
- Ability to discriminate between normal and abnormal conditions
- Knowledge of industrial sources and characteristics
- Knowledge of normal characteristics of wastewater

Monitor, Evaluate and Adjust Treatment Processes	Class I	Class II	Class III	Class IV
Preliminary Treatment				
Screening	Analysis	Analysis	Analysis	Analysis
Grit removal	Comprehension	Comprehension	Analysis	Analysis
Flow equalization	Comprehension	Application	Analysis	Analysis
Primary Treatment				
Clarifiers	Analysis	Analysis	Analysis	Analysis
Secondary Treatment				
Fixed-film reactors (trickling filters, RBCs)	Comprehension	Analysis	Analysis	Analysis
Activated sludge	Comprehension	Analysis	Analysis	Analysis
Stabilization ponds without aeration	Analysis	Analysis	Analysis	Analysis
Stabilization ponds with aeration	Analysis	Analysis	Analysis	Analysis
Advanced (Tertiary) Treatment				
Chemical/physical advanced waste treatment without secondary (carbon adsorption, air stripping, chemical coagulation, precipitation, etc.)			Comprehension	Comprehension
Chemical/physical advanced waste treatment following secondary (carbon adsorption, air stripping, chemical coagulation, precipitation, etc.)	Comprehension	Application	Analysis	Analysis
Biological or chemical/biological advanced waste treatment (nitrification, denitrification, phosphorus removal, etc.)	Comprehension	Application	Analysis	Analysis
Nitrification by designed extended aeration only		Application	Analysis	Analysis
Ion exchange for advanced waste treatment		Comprehension	Application	Analysis
Reverse osmosis, electrodialysis and other membrane filtration			Analysis	Analysis
Media filtration		Comprehension	Analysis	Analysis

(continued)

Core Competencies (continued)

Monitor, Evaluate and Adjust Treatment Processes <i>(continued)</i>	Class I	Class II	Class III	Class IV
Additional Treatment				
Dissolved air flotation (for other than sludge thickening)		Application	Analysis	Analysis
Septage	Application	Analysis	Analysis	Analysis
Fats, oils, and grease	Application	Analysis	Analysis	Analysis
Odor control	Application	Analysis	Analysis	Analysis
Microscreens		Application	Application	Application
Chemical Addition				
Add dry chemicals	Comprehension	Application	Application	Analysis
Add gaseous chemicals	Application	Application	Analysis	Analysis
Add liquid chemicals	Application	Analysis	Analysis	Analysis
Disinfection				
Chlorination	Analysis	Analysis	Analysis	Analysis
Dechlorination	Analysis	Analysis	Analysis	Analysis
Ultraviolet irradiation	Comprehension	Analysis	Analysis	Analysis
Ozonation	Comprehension	Application	Analysis	Analysis
Effluent discharge and reuse	Comprehension	Analysis	Analysis	Analysis
Solids Handling				
Conditioning (chemical, thermal, elutriation)	Comprehension	Application	Analysis	Analysis
Dewatering (filtration, centrifugation, drying beds)	Comprehension	Application	Analysis	Analysis
Stabilization (digestion, thermal, chemical)	Comprehension	Application	Analysis	Analysis
Thickening (gravity, flotation, centrifugation, filtration)	Comprehension	Comprehension	Comprehension	Analysis
Volume reduction (drying, incineration, composting)	Comprehension	Application	Analysis	Analysis

Required Capabilities for Monitor, Evaluate, and Adjust Treatment Processes:

- Ability to adjust chemical feed rates, flow patterns, and process units
- Ability to calculate dosage rates
- Ability to confirm chemical strength
- Ability to evaluate, diagnose, and troubleshoot process units
- Ability to interpret Material Safety Data Sheets
- Ability to maintain processes in normal operating conditions
- Ability to measure and prepare chemicals
- Ability to perform basic math and process control calculations
- Knowledge of biological science
- Knowledge of biosolids policies and regulations
- Knowledge of flow measurement principles
- Knowledge of general chemistry
- Knowledge of general electrical and mechanical principles
- Knowledge of normal chemical range
- Knowledge of personal protective equipment
- Knowledge of physical science
- Knowledge of principles of measurement
- Knowledge of proper application, handling, and storage of chemicals
- Knowledge of proper lifting procedures
- Knowledge of regulations
- Knowledge of sludge management practices
- Knowledge of urban water reuse
- Knowledge of wastewater treatment concepts and treatment processes

Core Competencies (continued)

Evaluate and Maintain Equipment	Class I	Class II	Class III	Class IV
Evaluate Equipment				
Check and evaluate capacity of equipment	Analysis	Analysis	Analysis	Analysis
Inspect equipment for abnormal conditions	Analysis	Analysis	Analysis	Analysis
Measure and evaluate head loss	Comprehension	Application	Analysis	Analysis
Read and evaluate chart and meter results	Analysis	Analysis	Analysis	Analysis
Read and evaluate gauges	Analysis	Analysis	Analysis	Analysis
Perform Maintenance				
Backflow prevention devices	Comprehension	Comprehension	Comprehension	Comprehension
Blowers and compressors	Analysis	Analysis	Analysis	Analysis
Boilers	Comprehension	Comprehension	Comprehension	Comprehension
Cathodic and lightning protection systems	Comprehension	Comprehension	Comprehension	Comprehension
Chemical feeders	Analysis	Analysis	Analysis	Analysis
Digesters		Application	Analysis	Analysis
Drives	Comprehension	Application	Analysis	Analysis
Engines (gas, diesel)	Analysis	Analysis	Analysis	Analysis
Fittings/Piping	Comprehension	Application	Application	Application
Gates	Analysis	Analysis	Analysis	Analysis
Generators	Analysis	Analysis	Analysis	Analysis
Heat exchangers			Comprehension	Comprehension
HVAC equipment	Analysis	Analysis	Analysis	Analysis
Hydrants	Comprehension	Comprehension	Comprehension	Comprehension
Hydraulic equipment	Comprehension	Comprehension	Comprehension	Comprehension
Instrumentation	Analysis	Analysis	Analysis	Analysis
Motors	Application	Application	Application	Application
Off-gas equipment		Application	Application	Application
Pneumatic equipment	Application	Application	Application	Application
Pumps	Analysis	Analysis	Analysis	Analysis
Safety equipment	Analysis	Analysis	Analysis	Analysis
Traps and drains	Comprehension	Application	Analysis	Analysis
Valves	Analysis	Analysis	Analysis	Analysis

Required Capabilities for Evaluate and Maintain Equipment:

- Ability to assign work to proper trade
- Ability to calibrate equipment
- Ability to diagnose and troubleshoot equipment
- Ability to differentiate between preventive and corrective maintenance
- Ability to discriminate between normal and abnormal conditions
- Ability to monitor and adjust equipment
- Ability to order necessary spare parts
- Ability to perform basic math
- Ability to perform general maintenance
- Knowledge of facility operation and maintenance
- Knowledge of general electrical and mechanical principles
- Knowledge of hydraulic and pneumatic principles
- Knowledge of internal combustion engines
- Knowledge of lubricant and fluid characteristics
- Knowledge of process control instrumentation
- Knowledge of safety regulations
- Knowledge of start-up and shut-down procedures

Core Competencies (continued)

Operate Equipment	Class I	Class II	Class III	Class IV
Backflow prevention devices	Comprehension	Comprehension	Comprehension	Comprehension
Blowers and compressors	Application	Application	Analysis	Analysis
Boilers	Comprehension	Comprehension	Application	Application
Cathodic and lightning protection systems	Comprehension	Comprehension	Comprehension	Comprehension
Chemical feeders	Application	Analysis	Analysis	Analysis
Computers	Analysis	Analysis	Analysis	Analysis
Digesters and gas collection		Application	Analysis	Analysis
Drives	Application	Analysis	Analysis	Analysis
Electronic testing equipment	Analysis	Analysis	Analysis	Analysis
Engines	Analysis	Analysis	Analysis	Analysis
Fittings/Piping	Comprehension	Comprehension	Comprehension	Comprehension
Flow meters	Analysis	Analysis	Analysis	Analysis
Gates	Analysis	Analysis	Analysis	Analysis
Generators	Analysis	Analysis	Analysis	Analysis
Hand and power tools	Analysis	Analysis	Analysis	Analysis
Heat exchangers		Application	Analysis	Analysis
Heavy vehicles	Analysis	Analysis	Analysis	Analysis
HVAC equipment	Application	Application	Analysis	Analysis
Hydrants	Comprehension	Comprehension	Comprehension	Comprehension
Hydraulic equipment	Comprehension	Comprehension	Application	Application
Incinerators			Application	Analysis
Instrumentation	Analysis	Analysis	Analysis	Analysis
Motors	Analysis	Analysis	Analysis	Analysis
Off-gas/odor control equipment	Comprehension	Comprehension	Analysis	Analysis
Pneumatic equipment	Comprehension	Application	Analysis	Analysis
Pumps	Analysis	Analysis	Analysis	Analysis
Pure oxygen			Application	Analysis
SCADA	Analysis	Analysis	Analysis	Analysis
Traps and drains	Comprehension	Application	Analysis	Analysis
Valves	Analysis	Analysis	Analysis	Analysis

Required Capabilities for Operate Equipment:

- Ability to monitor, evaluate and adjust equipment
- Knowledge of function of tools
- Knowledge of general electrical and mechanical principles
- Knowledge of hydraulic and pneumatic principles
- Knowledge of regulations
- Knowledge of safety procedures
- Knowledge of start-up and shut-down procedures
- Knowledge of wastewater treatment concepts

Core Competencies (continued)

Collect Samples and Interpret Laboratory Analyses	Class I	Class II	Class III	Class IV
Collect Samples				
Alkalinity	Application	Application	Application	Application
Ammonia (nitrate/nitrite)	Application	Application	Application	Application
Bacteriological	Application	Application	Application	Application
Biochemical oxygen demand	Application	Application	Application	Application
Carbon dioxide			Application	Application
Chemical oxygen demand		Application	Application	Application
Chlorine residual	Application	Application	Application	Application
Conductivity		Application	Application	Application
Dissolved oxygen	Application	Application	Application	Application
Effluent toxicity			Application	Application
Metal analysis			Application	Application
Oxidation reduction potential		Application	Application	Application
Oxygen uptake/Respiration rate		Application	Application	Application
pH	Application	Application	Application	Application
Phosphorus	Application	Application	Application	Application
Settleability testing	Application	Application	Application	Application
Solids	Application	Application	Application	Application
Temperature	Application	Application	Application	Application
Turbidity	Application	Application	Application	Application
Volatile acids			Application	Application
Interpret Laboratory Analyses				
Alkalinity	Analysis	Analysis	Analysis	Analysis
Ammonia (nitrate/nitrite)	Analysis	Analysis	Analysis	Analysis
Bacteriological	Analysis	Analysis	Analysis	Analysis
Biochemical oxygen demand	Analysis	Analysis	Analysis	Analysis
Carbon dioxide			Analysis	Analysis
Chemical oxygen demand		Analysis	Analysis	Analysis
Chlorine residual	Analysis	Analysis	Analysis	Analysis
Conductivity		Analysis	Analysis	Analysis
Dissolved oxygen	Analysis	Analysis	Analysis	Analysis
Effluent toxicity			Analysis	Analysis
Metal analysis			Analysis	Analysis
Oxidation reduction potential		Analysis	Analysis	Analysis
Oxygen uptake/Respiration rate		Analysis	Analysis	Analysis
pH	Analysis	Analysis	Analysis	Analysis
Phosphorus	Analysis	Analysis	Analysis	Analysis
Settleability testing	Analysis	Analysis	Analysis	Analysis
Solids	Analysis	Analysis	Analysis	Analysis
Temperature	Analysis	Analysis	Analysis	Analysis
Turbidity	Analysis	Analysis	Analysis	Analysis
Volatile acids			Analysis	Analysis

Core Competencies (continued)

Perform Laboratory Analyses	Class I	Class II	Class III	Class IV
Alkalinity	Analysis	Analysis	Analysis	Analysis
Ammonia (nitrate/nitrite)			Analysis	Analysis
Bacteriological			Analysis	Analysis
Biochemical oxygen demand		Analysis	Analysis	Analysis
Carbon dioxide				Analysis
Chemical oxygen demand			Analysis	Analysis
Chlorine residual	Analysis	Analysis	Analysis	Analysis
Conductivity		Analysis	Analysis	Analysis
Dissolved oxygen	Analysis	Analysis	Analysis	Analysis
Oxidation reduction potential		Analysis	Analysis	Analysis
Oxygen uptake/Respiration rate		Analysis	Analysis	Analysis
pH	Analysis	Analysis	Analysis	Analysis
Phosphorus			Analysis	Analysis
Settleability testing	Analysis	Analysis	Analysis	Analysis
Solids	Analysis	Analysis	Analysis	Analysis
Temperature	Analysis	Analysis	Analysis	Analysis
Turbidity	Analysis	Analysis	Analysis	Analysis
Volatile acids			Analysis	Analysis

Required Capabilities for Collect Samples and Interpret Laboratory Analyses, and Perform Laboratory Analyses:

- Ability to calibrate instruments
- Ability to follow written procedures
- Ability to interpret Material Safety Data Sheets
- Ability to perform laboratory calculations
- Ability to recognize abnormal analytical results
- Knowledge of approved analytical procedures
- Knowledge of biological science
- Knowledge of chain of custody
- Knowledge of general chemistry
- Knowledge of laboratory equipment and procedures
- Knowledge of normal characteristics of wastewater
- Knowledge of physical science
- Knowledge of principles of measurement
- Knowledge of proper chemical handling and storage
- Knowledge of quality control and assurance practices
- Knowledge of safety regulations
- Knowledge of sampling and preservation procedures

Core Competencies (continued)

Perform Security, Safety and Administrative Procedures	Class I	Class II	Class III	Class IV
Perform Security and Safety Procedures				
Bloodborne pathogens	Analysis	Analysis	Analysis	Analysis
Chemical handling	Analysis	Analysis	Analysis	Analysis
Confined space entry	Analysis	Analysis	Analysis	Analysis
Electrical hazards	Analysis	Analysis	Analysis	Analysis
Facility upset	Analysis	Analysis	Analysis	Analysis
Fire safety	Analysis	Analysis	Analysis	Analysis
Hazardous environment	Analysis	Analysis	Analysis	Analysis
Lock-out/tag-out	Analysis	Analysis	Analysis	Analysis
Natural and manmade disasters	Analysis	Analysis	Analysis	Analysis
Personal protective equipment	Analysis	Analysis	Analysis	Analysis
Respiratory protection	Analysis	Analysis	Analysis	Analysis
Spill response	Analysis	Analysis	Analysis	Analysis
Traffic control	Analysis	Analysis	Analysis	Analysis
Transportation	Analysis	Analysis	Analysis	Analysis
Trenching and shoring	Analysis	Analysis	Analysis	Analysis
Perform Administrative Procedures				
Administer compliance, emergency preparedness and safety program	Analysis	Analysis	Analysis	Analysis
Develop budget	Analysis	Analysis	Analysis	Analysis
Develop operation and maintenance plan	Analysis	Analysis	Analysis	Analysis
Plan and organize work activities	Analysis	Analysis	Analysis	Analysis
Record and evaluate data	Analysis	Analysis	Analysis	Analysis
Respond to complaints	Analysis	Analysis	Analysis	Analysis
Write regulatory authority reports	Analysis	Analysis	Analysis	Analysis

Required Capabilities for Perform Security, Safety and Administrative Procedures:

- Ability to assess likelihood of disaster occurring
- Ability to communicate safety hazards verbally and in writing
- Ability to conduct meetings and training programs
- Ability to coordinate emergency response with other organizations
- Ability to develop a public relations program
- Ability to evaluate facility performance
- Ability to interpret and transcribe data
- Ability to organize information and review reports
- Ability to perform basic math
- Ability to perform impact assessment of change
- Ability to prepare and evaluate proposals
- Ability to recognize unsafe work conditions
- Ability to select and operate safety equipment
- Ability to translate technical language into common terminology
- Ability to write plans, policies and procedures
- Knowledge of emergency plans
- Knowledge of facility operation and maintenance
- Knowledge of local codes and ordinances
- Knowledge of monitoring and reporting requirements
- Knowledge of potential causes and impact of disasters on facility
- Knowledge of principles of finance
- Knowledge of principles of management
- Knowledge of principles of public relations
- Knowledge of public administration practices
- Knowledge of public participation process
- Knowledge of recordkeeping functions & policies
- Knowledge of regulations

ABC Wastewater Treatment Certification Exams

The ABC wastewater treatment certification exams evaluate an operator's knowledge of tasks related to the operation of wastewater treatment plants. The Wastewater Treatment V&E Committee determined the content of each exam based on the results of the national job analysis. To successfully take an ABC exam, an operator must demonstrate knowledge of the core competencies in this document. Because certificates may be used to work in various treatment plants, the exams may include technologies that are not used in each treatment plant but are commonly used in many treatment plants.

Four levels of certification exams are offered by ABC, with class I being the lowest level and class IV the highest level. The specifications for the exams are based on a weighting of the job analysis results so that they reflect the criticality of tasks performed on the job. The specifications list the percentage of questions on the exam that fall under each job duty. For example, 5% of the questions on the ABC class I exam relate to the job duty "Evaluate Incoming Wastestream/Sidestream Characteristics." For a list of tasks and capabilities associated with each job duty, please refer to the list of core competencies on the previous pages.

ABC Wastewater Treatment Exam Specifications

	Exam Level			
	Class I	Class II	Class III	Class IV
Evaluate Incoming Wastestream/Sidestream Characteristics	5%	5%	5%	5%
Monitor, Evaluate and Adjust Treatment Processes	34%	34%	34%	34%
Evaluate and Maintain Equipment	16%	15%	15%	15%
Operate Equipment	17%	16%	16%	16%
Collect Samples and Interpret Analyses	8%	9%	10%	10%
Perform Laboratory Analyses	5%	7%	9%	9%
Perform Security, Safety and Administrative Procedures	15%	14%	11%	11%

Suggested Wastewater Treatment Exam References

The following are approved as reference sources for the ABC wastewater treatment examinations. Operators should use the latest edition of these reference sources to prepare for the exam.

California State University, Sacramento (CSUS) Foundation, Office of Water Programs

- *Operation of Wastewater Treatment Plants, Volume I and II*
- *Advanced Waste Treatment*
- *Manage for Success*

To order, contact: Office of Water Programs
California State University, Sacramento
6000 J Street
Sacramento, CA 95819-6025

Web site: www.owp.csus.edu
Phone: (916) 278-6142
Fax: (916) 278-5959
E-mail: wateroffice@owp.csus.edu

(continued)

Suggested Wastewater Treatment Exam References *(continued)*

National Environmental Training Center for Small Communities (NETCSC)

- *Protecting Your Community's Assets: A Guide for Small Wastewater Systems*

A PDF version of this guide is available from: www.nesc.wvu.edu/training.cfm

You may also request a printed and bound hard copy of the guide by calling NETCSC at (800) 624-8301, and asking for product TRBKMG03 (shipping and handling charges may apply).

Water Environment Federation

- *Operation of Municipal Wastewater Treatment Plants - Manual of Practice No. 11*
- *Activated Sludge - Manual of Practice OM-9*

To order, contact: Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1994

Web site: www.wef.org
Phone: (800) 666-0206
Fax: (703) 684-2492
E-mail: pubs@wef.org

Regulations

For United States exams:

- *Code of Federal Regulations*, Title 40 (www.gpo.gov)
- State regulations (contact information for state certification programs is available on the Certification Contacts page of ABC's web site, www.abccert.org)
- American Public Health Association (APHA), American Water Works Association, and Water Environment Federation. *Standard Methods for the Examination of Water and Wastewater* (latest EPA-approved edition). Washington, DC: APHA. (www.apha.org)

For Canadian exams:

- Provincial and territorial regulations (contact information for provincial/territorial certification programs is available on the Certification Contacts page of ABC's web site, www.abccert.org)

Study Guides

- Price, Joanne. 2000. *Applied Math for Wastewater Plant Operators*. Boca Raton, FL: CRC Press. (www.crcpress.com)
- Water Environment Federation, *WEF/ABC Wastewater Operators' Guide to Preparing for the Certification Examination* (www.wef.org; complete contact information is listed above)

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Introduction

As part of the development of its certification exams, the Association of Boards of Certification (ABC) conducted a job analysis of wastewater laboratory analysts during 2001 and 2002. The purpose of the job analysis was to identify the essential job tasks performed by wastewater laboratory analysts and the capabilities required to competently perform these job tasks. The results of this job analysis provide ABC with the foundation for the development of new wastewater laboratory analyst certification exams.

The *Need-to-Know Criteria* was developed from the results of ABC's wastewater laboratory job analysis. The information in this document reflects the essential job tasks performed by analysts and their requisite capabilities. This document is intended to be used by certification programs and trainers to help prepare analysts for certification.

How the Job Analysis was Conducted

Subject Matter Expert Committee

The ABC Wastewater Laboratory Validation and Examination Committee provided technical assistance in the development of the job analysis. This committee developed the list of the important job tasks performed by wastewater laboratory analysts. The committee verified the technical accuracy, clarity, and comprehensiveness of the job tasks. The committee then identified the capabilities (i.e., knowledge, skills, and abilities) required to perform the identified job tasks. Identification of capabilities was done on a task-by-task basis, so that a link was established between each task statement and requisite capability.

Task Survey

A task survey was developed from the data collected by the committee. The survey included 8-point rating scales for frequency of performance and seriousness of inadequate or incorrect performance. These two rating scales were used because they provide useful information (i.e., how critical each task is and how frequently each task is performed) pertaining to certification.

The task inventory also included a background information section where demographic data such as gender, age, ethnic origin, educational level attained, work experience, and certification level were collected. Space was provided at the end of the survey for analysts to list any important tasks performed on their job which were not included on the survey, and to make general comments.

The task inventory was sent to 490 wastewater laboratory analysts throughout the United States and Canada. 243 out of the 490 inventories mailed were returned for a response rate of 49.6%. Class levels were created based on lab tests run as follows:

- Class I: Non-supervisors running the following lab tests: pH, DO, Chlorine residual, Temperature, TSS/TS, BOD and Settleability
- Class II: Non-supervisors running the following lab tests: all Class I tests plus COD, Nitrogen, Phosphorus, and Coliform
- Class III: Non-supervisors running the following lab tests: all Class I and II tests plus Metals, Inorganics, Organics, Oil and Grease, and Bioassay
- Class IV: Supervisors running any of the tests listed above in Class I through III

Results

The mean, standard deviation, and the percentage of respondents performing each task statement at each class level were computed. The mean was used to determine the importance of items and the standard deviation was used to identify items with a wide variation in responses. The percentage of respondents performing each task statement was used to identify tasks and capabilities commonly performed by analysts throughout the United States and Canada.

A criticality value of 2(mean seriousness rating) + mean frequency rating was calculated for each item on the inventory. This formula gives extra weight to the seriousness rating in determining critical items and was appropriate because it emphasized the purpose of certification — to provide competent analysts.

Core Competencies

The ABC Wastewater Laboratory Validation and Examination Committee reviewed the results of the task survey to identify the most important and commonly performed job tasks and capabilities for wastewater laboratory analysts. The essential tasks and capabilities that were identified through this process are called the core competencies.

The following pages list the core competencies for wastewater laboratory analysts. The core competencies are clustered into the following job duties:

- Collect and preserve samples
- Prepare samples for analysis
- Analyze samples and interpret results
- Operate and maintain equipment and instruments
- Handle chemicals and wastes
- Quality assurance/quality control
- Manage laboratory
- Laboratory safety

Core Competencies for Wastewater Laboratory Analysts

Collect and Preserve Samples	Class I	Class II	Class III	Class IV
Alkalinity	X	X	X	X
Ammonia	X	X	X	X
Bioassay		X	X	X
Biochemical oxygen demand (BOD)	X	X	X	X
Chemical oxygen demand (COD)		X	X	X
Chlorine residual	X	X	X	X
Coliform	X	X	X	X
Conductivity		X	X	X
Dissolved oxygen	X	X	X	X
Hardness			X	X
Jar test	X	X	X	X
Metals		X	X	X
Microbiology of activated sludge	X	X	X	X
Nitrate/Nitrite		X	X	X
Oil and grease		X	X	X
Organics		X	X	X
pH	X	X	X	X
Phosphorus	X	X	X	X
Solids	X	X	X	X
Temperature	X	X	X	X
Test on biosolids	X	X	X	X

Required capabilities:

- Ability to determine appropriate sample location
- Be familiar with chain of custody procedures
- Be familiar with holding times, preservatives, and storage conditions
- Be familiar with permit requirements
- Be familiar with personal protective equipment
- Be familiar with safety procedures for sample collection and preservation
- Be familiar with sample identification and labeling procedures
- Be familiar with the sterilization process
- Knowledge of biology and chemistry
- Knowledge of contamination sources
- Knowledge of duplicates and splits
- Knowledge of sample types
- Knowledge of sampler setup
- Knowledge of sampling techniques and equipment
- Knowledge of wastewater treatment processes

Core Competencies (continued)

Prepare Samples for Analysis	Class I	Class II	Class III	Class IV
Digestion		X	X	X
Dilution	X	X	X	X
Distillation		X	X	X
Extraction			X	X
Filtration	X	X	X	X
Laboratory pure water	X	X	X	X
Mixing	X	X	X	X
pH adjustment	X	X	X	X
Reagent addition and preparation	X	X	X	X
Sample concentration	X	X	X	X
Temperature adjustment	X	X	X	X

Required capabilities:

- Ability to identify common laboratory apparatus and glassware
- Ability to maintain and operate equipment/instruments
- Ability to perform calculations
- Ability to prepare reagents
- Ability to store and handle chemicals
- Ability to weigh/measure accurately
- Be familiar with dilution techniques
- Be familiar with documentation requirements
- Be familiar with laboratory pure water standards
- Be familiar with Material Safety Data Sheets
- Be familiar with personal protective equipment
- Be familiar with QA/QC practices
- Be familiar with safety procedures
- Knowledge of apparatus preparation
- Knowledge of contamination sources
- Knowledge of holding times
- Knowledge of interferences
- Knowledge of method limitations
- Knowledge of reagent purity
- Knowledge of sample preparation techniques
- Knowledge of laboratory pure water classification (types I, II, III)

Core Competencies (continued)

Analyze Samples and Interpret Results	Class I	Class II	Class III	Class IV
Alkalinity		X	X	X
Ammonia		X	X	X
Bioassay			X	X
Biochemical oxygen demand (BOD)	X	X	X	X
Chemical oxygen demand (COD)		X	X	X
Chlorine residual	X	X	X	X
Coliform	X	X	X	X
Conductivity		X	X	X
Dissolved oxygen	X	X	X	X
Hardness			X	X
Jar test	X	X	X	X
Metals			X	X
Microbiology of activated sludge		X	X	X
Nitrate/Nitrite		X	X	X
Oil and grease			X	X
Organics			X	X
Oxidation reduction potential (ORP)	X	X	X	X
pH	X	X	X	X
Phosphorus		X	X	X
Solids	X	X	X	X
Temperature	X	X	X	X
Test on biosolids	X	X	X	X
Tasks Performed	Class I	Class II	Class III	Class IV
Calibrate and check instruments	X	X	X	X
Flow and loading calculations	X	X	X	X
Optimize equipment and instruments	X	X	X	X
Perform titrations	X	X	X	X
Prepare standards	X	X	X	X
Prepare standard curve		X	X	X
Reduce data and perform calculations	X	X	X	X
Record results	X	X	X	X
Review data	X	X	X	X
Interpret results	X	X	X	X

Core Competencies (continued)

Analyze Samples and Interpret Results (continued)

Required capabilities:

- Ability to calibrate instruments
- Ability to determine appropriate sample volume
- Ability to evaluate and interpret data
- Ability to follow written procedures
- Ability to recognize abnormal analytical results and determine appropriate corrective action
- Ability to select proper test method
- Ability to summarize results of analysis
- Be familiar with common acid and alkali solutions
- Be familiar with normal characteristics of wastewater
- Be familiar with QA/QC practices
- Be familiar with reporting requirements
- Knowledge of additive volumes
- Knowledge of analytical procedures
- Knowledge of basic math and statistics
- Knowledge of biology and chemistry
- Knowledge of interferences
- Knowledge of method limitations
- Knowledge of wastewater treatment processes

Core Competencies (continued)

Operate and Maintain Equipment and Instruments	Class I	Class II	Class III	Class IV
Operate equipment:				
Apparatus and glassware	X	X	X	X
Atomic absorption spectrophotometer (flame and furnace)			X	X
Autoclave	X	X	X	X
Balances	X	X	X	X
Computer	X	X	X	X
Desiccators	X	X	X	X
Digestion apparatus		X	X	X
Distillation apparatus		X	X	X
DO meter	X	X	X	X
Gas chromatograph (GC) and GC/MS			X	X
ICP/ and ICP/MS			X	X
Incubator	X	X	X	X
Ion specific electrodes (ammonia)		X	X	X
Microscope	X	X	X	X
Oven and muffle furnace	X	X	X	X
Oxidation reduction potential instruments	X	X	X	X
pH and conductivity meters	X	X	X	X
UV/Vis spectrophotometer/color/turbidimeter	X	X	X	X
Water purification equipment	X	X	X	X
Maintain equipment and instruments:				
Calibrate equipment/instruments	X	X	X	X
Clean equipment/instruments	X	X	X	X
Retain maintenance contracts		X	X	X
Store equipment/instruments	X	X	X	X
Troubleshoot equipment/instruments	X	X	X	X
Retain maintenance logs	X	X	X	X

Required capabilities:

- Ability to determine appropriate corrective action
- Ability to follow written procedures
- Ability to identify common laboratory apparatus and glassware
- Ability to interpret manuals
- Be familiar with EPA approved procedures
- Be familiar with labware cleaning procedures
- Be familiar with proper installation procedures
- Be familiar with recordkeeping requirements
- Knowledge of basic math
- Knowledge of biology and chemistry
- Knowledge of computers
- Knowledge of electronic equipment
- Knowledge of instrumental techniques

Core Competencies (continued)

Handle Chemicals and Wastes	Class I	Class II	Class III	Class IV
Dispose of laboratory wastes:				
Biohazard	X	X	X	X
Expired and excess reagents	X	X	X	X
Glassware	X	X	X	X
Waste minimization and pollution prevention		X	X	X
Store and handle containers:				
Label containers	X	X	X	X
Maintain inventory	X	X	X	X
Maintain security	X	X	X	X
Maintain current Material Safety Data Sheet files	X	X	X	X
Segregate chemicals	X	X	X	X

Required capabilities:

- Ability to store and handle chemicals safely
- Be familiar with labeling requirements
- Be familiar with Material Safety Data Sheets
- Be familiar with personal protective equipment
- Be familiar with regulations
- Be familiar with waste storage requirements
- Knowledge of chemical compatibility, storage limitations and expiration dates
- Knowledge of chemical hygiene plan
- Knowledge of chemical spill cleanup procedures and hazard management plan
- Knowledge of holding times
- Knowledge of pollution prevention methods
- Knowledge of safety procedures
- Knowledge of wastewater pathogens

Quality Assurance/Quality Control	Class I	Class II	Class III	Class IV
Conduct internal audits				X
Develop, maintain and interpret control charts	X	X	X	X
Establish method detection/reporting limits		X	X	X
Establish quality assurance plans		X	X	X
Maintain method detection/reporting limits	X	X	X	X
Maintain training records				X
Perform corrective actions	X	X	X	X
Conduct proficiency tests	X	X	X	X
Validate data	X	X	X	X

Required capabilities:

- Ability to determine appropriate corrective action
- Be familiar with approved analytical methods
- Be familiar with permit and recordkeeping requirements
- Be familiar with regulations
- Knowledge of auditing procedures
- Knowledge of basic statistics
- Knowledge of chemistry
- Knowledge of computer spreadsheets and databases

Core Competencies (continued)

Manage Laboratory	Class I	Class II	Class III	Class IV
Develop and maintain standard operating procedures		x	x	x
Ensure staff is trained		x	x	x
Maintain analyst certification	x	x	x	x
Maintain laboratory certification				x
Maintain records	x	x	x	x
Maintain regulatory compliance/ethics	x	x	x	x
Order supplies		x	x	x
Organize and plan work activities	x	x	x	x
Promote public relations				x
Respond to complaints				x
Supervise operation of laboratory				x
Write reports (federal, state, internal)	x	x	x	x
Establish Recordkeeping System:				
Analytical				x
Documentation				x
Maintenance				x
Personnel				x
Record Information:				
Analytical	x	x	x	x
Documentation	x	x	x	x
Financial				x
Maintenance	x	x	x	x
Personnel				x

Required capabilities:

- Ability to accurately transcribe data
- Ability to determine what information needs to be recorded
- Ability to evaluate laboratory performance
- Ability to evaluate and interpret data
- Ability to generate plans
- Ability to summarize results of analysis
- Be familiar with documentation requirements
- Be familiar with permit requirements
- Be familiar with regulations
- Be familiar with reporting requirements
- Knowledge of approved analytical methods
- Knowledge of basic math
- Knowledge of computer spreadsheets and databases
- Knowledge of customer service principles
- Knowledge of principles of communication
- Knowledge of principles of management
- Knowledge of principles of project management
- Knowledge of principles of public relations
- Knowledge of recordkeeping policies
- Knowledge of wastewater treatment processes

Core Competencies (continued)

Laboratory Safety	Class I	Class II	Class III	Class IV
Establish safety programs for:				
Burns		X	X	X
Chemicals	X	X	X	X
Compressed gases				X
Confined space				X
Electrical shock				X
Fire				X
General safety and health		X	X	X
Housekeeping		X	X	X
Infectious materials		X	X	X
Personal hygiene	X	X	X	X
Personal protective equipment	X	X	X	X
Showers and eyewash stations		X	X	X
Spill response and cleanup			X	X
Toxic fumes		X	X	X
Perform safety procedures for:				
Burns	X	X	X	X
Chemicals	X	X	X	X
Compressed gases			X	X
Confined space	X	X	X	X
Electrical shock	X	X	X	X
Fire	X	X	X	X
General safety and health	X	X	X	X
Housekeeping	X	X	X	X
Infectious materials	X	X	X	X
Personal hygiene	X	X	X	X
Personal protective equipment	X	X	X	X
Showers and eyewash stations	X	X	X	X
Spill response and cleanup	X	X	X	X
Toxic fumes	X	X	X	X

Required capabilities:

- Ability to communicate verbally and in writing
- Ability to operate equipment
- Ability to recognize unsafe work conditions
- Ability to select safety equipment
- Be familiar with Material Safety Data Sheets
- Be familiar with personal protective equipment
- Be familiar with regulations
- Knowledge of chemical hygiene plan
- Knowledge of compressed gas cylinder handling hazards
- Knowledge of confined space characteristics
- Knowledge of fume hood operation
- Knowledge of safety procedures and emergency plan

Wastewater Laboratory Analyst Certification Exams

The ABC wastewater laboratory analyst certification exams evaluate an analyst's knowledge of tasks related to the operation of wastewater laboratories. Each exam is based on the core competencies listed in this Need-to-Know Criteria. To successfully take an ABC exam, an analyst must demonstrate knowledge of these core competencies.

Four levels of certification are offered by ABC, with class I being the lowest level and class IV the highest level. The specifications for the exams are based on a weighting of the job analysis results so that they reflect the criticality of tasks performed on the job. The specifications list the percentage of questions on the exam that fall under each job duty. For example, 17% of the class I exam consists of questions relating to the job duty "collect and preserve samples" and its associated tasks and capabilities. For a list of tasks and capabilities associated with each job duty, please refer to the list of core competencies on the previous pages.

ABC Wastewater Laboratory Exam Specifications

	Exam Level			
	I	II	III	IV
Collect and Preserve Samples	17%	12%	5%	5%
Prepare Samples for Analysis	12%	19%	14%	5%
Analyze Samples and Interpret Results	24%	19%	21%	7%
Operate and Maintain Equipment/Instruments	14%	11%	14%	7%
Handle Chemicals and Wastes	5%	8%	8%	5%
Quality Assurance/Quality Control	9%	9%	15%	18%
Manage Laboratory	5%	8%	9%	34%
Laboratory Safety	9%	9%	9%	14%
General Science	5%	5%	5%	5%

Suggested Exam References

The following are approved as reference sources for the ABC examinations. Analysts should use the latest edition of these reference sources to prepare for the exam.

- American Public Health Association (APHA), American Water Works Association, and Water Environment Federation. *Standard Methods for the Examination of Water and Wastewater* (latest EPA-approved edition). Washington, DC: APHA. (www.apha.org)
- California State University, Sacramento (CSUS) Foundation, Office of Water Programs. 2001. *Operation of Wastewater Treatment Plants*, Vol. I and II. Sacramento, CA: CSUS Foundation. (www.owp.csus.edu)
- California State University, Sacramento (CSUS) Foundation, Office of Water Programs. 2001. *Utility Management*. Sacramento, CA: CSUS Foundation. (www.owp.csus.edu)
- California State University, Sacramento (CSUS) Foundation, Office of Water Programs. 2005. *Manage for Success*. Sacramento, CA: CSUS Foundation. (www.owp.csus.edu)
- *Code of Federal Regulations*. "Occupational Safety and Health Standards." Title 29 (Labor), Chapter XVII, Part 1910. (www.gpo.gov)

(continued)

Suggested Exam References *(continued)*

- *Code of Federal Regulations*. Title 40 (Protection of Environment), Chapter I, Parts 136, 261, 433, 501, and 503. (www.gpo.gov)
- Csuros, Maria. 1994. *Environmental Sampling and Analysis for Technicians*. Boca Raton, FL: CRC Press. (www.crcpress.com)
- Csuros, Maria. 1997. *Environmental Sampling and Analysis Lab Manual*. Boca Raton, FL: CRC Press. (www.crcpress.com)
- Csuros, Maria, and Csaba Csuros. 1999. *Microbiological Examination of Water and Wastewater*. Boca Raton, FL: CRC Press. (www.crcpress.com)
- Smith, Roy-Keith. 1995. *Water and Wastewater Laboratory Techniques*. Alexandria, VA: Water Environment Federation. (www.wef.org)
- U.S. Environmental Protection Agency (US EPA). 1979. *Handbook for Analytical Quality Control in Water and Wastewater Laboratories*. EPA Number 600/479019. Cincinnati, OH: US EPA. (www.epa.gov/nepis/)
- U.S. Environmental Protection Agency (US EPA). 1983. *Methods for Chemical Analysis of Water and Wastes*. EPA Number 600/479020. Cincinnati, OH: US EPA. (www.epa.gov/nepis/)
- Water Pollution Control Federation and Michael Richard. 1989. *Activated Sludge Microbiology*. Alexandria, VA: Water Environment Federation. (www.wef.org)