Water Systems: One-Year Program: Scope & Sequence

Semester 1

ENS101- Water Systems I
(90 days)

District Pre-Assessment

Unit 1 3 Days (3 Class/0 Lab)

Basic Safety:

- Demonstrate knowledge of safety, health, and environmental rules and regulations to avoid workplace injury and maximize machine productivity.
- Demonstrate knowledge of electrical safety standards.
- Select appropriate Personal Protective Equipment (PPE) for various industrial safety situations.
- Describe how to appropriately use Personal Protective Equipment (PPE) for various industrial safety situations.

CTSO Integration (Leadership Skills): SkillsUSA Officer Elections and Training
Professional Skills: 1.A-D, 4.A-F, 7.A-C
Academic Standards: ELA.11-12.W.4, ELA.11-12.W.5, ELA.11-12.SL.4, ELA.11-12.L.4, 5.NF.B.3, 5.NF.B.6, 5.NF.B.7
Work-based Learning: Industry Guest Speaker, Mock Interview, Job Application
Technical Standards: 101.01-.06

Unit 2 30 Days (15 Class/15 Laab)

Water Treatment

Introduction to Water Treatment

- Purpose & Operator Role: Water treatment ensures safe, clean drinking water through processes managed by certified operators who uphold safety and ethical standards.
- Source Water Knowledge: Operators identify and evaluate surface and groundwater sources, monitoring for biological, chemical, and physical contaminants.
- Source Protection: Effective watershed management and well inspections prevent contamination from runoff, waste, and industrial sources.
- Pretreatment & Aeration: Initial processes remove large debris and introduce oxygen to improve water quality before chemical treatment.
- Coagulation, Flocculation & Sedimentation: Chemicals like alum or ferric chloride help particles clump and settle out, clarifying the water.
- Filtration & Disinfection: Water passes through filters and is disinfected using chlorine, UV light, ozone, or chloramines to kill harmful microorganisms.
- Chemical Control & Monitoring: Operators calculate and adjust chemical dosages, flow rates, and contact time to ensure efficiency and compliance.
- Laboratory Analysis: Regular testing of pH, turbidity, chlorine residuals, and other parameters ensures the plant meets regulatory standards.
- Equipment & System Maintenance: Operators maintain pumps, valves, filters, and SCADA systems through preventive and corrective maintenance programs.
- Safety & Compliance: Adherence to safety practices, regulatory reporting, and ethical conduct ensures protection of public health and the environment.

CTSO Integration (Leadership Skills): SkillsUSA Chapter Meetings, Leadership lessons, Regionals prep and State Competition

Professional Skills: 5.A-E, 6.A-C

Academic Standards: ELA.11-12.W.4, ELA.11-12.W.5, ELA.11-12.L.4, ELA.11-12.S, 5.NF.B.3 - 7, 6.RP.A.3, 7.RP.A.3, 7.G.B.4, G-GMD.A.3, HS.P1U1.1, Essential HS.P1U1.2
Work-Based Learning: Industry Guest Speaker, Resume and Cover Letter

Technical Standard: AZ-ES-W-WWT-1.1-1.5, 2.1, 3.1 ,4.2, 5.1, 6.1, 7.1, 8.1, 9.1, 10.1, 11.1, 12.1, 13.1, 14.1, 15.1, 16.1, 17.1, 18.1, 19.1, 20.1, 21.1

Unit 3 (30 Days (8 Class/22 Lab)

Water Distribution

Introduction to Water Distribution Systems

- Overview of water distribution system purpose and components
- Roles and responsibilities of water distribution operators
- Overview of regulatory agencies (EPA, ADEQ, AWWA)
- Introduction to SCADA system functions and data interpretation
- Basic hydraulics principles (pressure, flow, head loss)
- Professional ethics, safety culture, and customer service expectations

Distribution System Components

- Identify and describe key distribution system parts:
  - Pumps, mains, hydrants, valves, meters, and storage facilities
- Understand backflow prevention and cross-connection control
- Measure static and pumping water levels
- Calculate water flow rates and volumes
- Monitor system parameters (pressure, flow, water age, velocity, and tank levels)
- Analyze operational data to identify system trends and abnormalities

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- Understand how water demand impacts flow and storage operations

Equipment Installation, Operation, Maintenance & Repair
- Perform installation of service lines and mains
    - Proper tapping, curb stops, and corporation stops
- Inspect and disinfect new construction before service connection
- Conduct system flushing and disinfection of components after repairs
- Perform routine and preventive maintenance on:
    - Pumps, valves, hydrants, meters, storage tanks, and well components
- Maintain pump stations and control systems
- Maintain sanitary conditions in wells and finished water storage facilities
- Complete and maintain accurate repair and maintenance records

Water Quality Monitoring & Laboratory Analysis
- Collect regulatory and operational water samples
- Perform routine tests for:
    - Chlorine residuals, pH, turbidity, and microbiological indicators
- Interpret lab results to verify compliance with standards
- Adjust chemical feed systems and maintain appropriate dosages
- Maintain and store chemicals safely (chlorine, coagulants, disinfectants)
- Ensure safety and regulatory compliance during sampling and handling

Safety, Security & Emergency Procedures
- Implement safety practices for confined space entry, traffic control, lockout/tagout, excavation, and hazardous materials handling
- Identify and mitigate potential risks or vulnerabilities (e.g., contamination or tampering)

Administrative Procedures & Public Interaction
- Maintain accurate records (maintenance, sampling, repairs, consumption)
- Develop and maintain Standard Operating Procedures (SOPs)
- Communicate effectively with customers about pressure issues, outages, or water quality concerns
- Conduct customer notifications for planned repairs or disruptions
- Demonstrate professionalism and customer service during field interactions

Applied Operations & Troubleshooting
- Analyze SCADA and system data to diagnose issues
- Balance water production and demand efficiently
- Troubleshoot and resolve low-pressure, leakage, and flow irregularities
- Implement corrective actions in distribution systems and pump operations
- Evaluate system performance for efficiency and reliability

CTSO Integration (Leadership Skills): SkillsUSA Chapter Meetings, Fundraiser, Fall Leadership Conference, Regionals Prep
Professional Skills: 3.A-E, 4.A-F
Academic Standards: ELA.11-12.W.4, ELA.11-12.SL.4, ELA.11-12.L.4, 5.NF.B.3 - 7, 6.RP.A.3, 7.RP.A.3, 7.G.B.4, G-GMD.A.3, HS.P1U1.1, Essential HS.P1U1.2
Work-based Learning: Resume and Cover Letter
Technical Standard: 101.01-06, AZ-ES-W-WD-1.1-3, 2.1-2.8, 3.1-3.5, 4.1-4.6, 5.1-5.5, 6.1-6.4, 7.1-5, 106.01-07, 107.01-07, 108.01-07, 109.01-07

<u>Unit 4 27 Days (13 Class/14 Lab)</u>

Wastewater Treatment

Introduction to Wastewater Treatment
- Purpose and importance of wastewater treatment
- Overview of wastewater collection and treatment systems
- Roles and Responsibilities of a Wastewater Treatment Operator I
- Major treatment stages: preliminary, primary, secondary, tertiary, and disinfection
- Flow of wastewater through the treatment plant Regulatory framework and environmental compliance (EPA, ADEQ, Clean Water Act)
- Introduction to SCADA and process monitoring systems
- Safety culture and professional conduct in wastewater operations

Equipment Evaluation, Maintenance, and Operation
- Identify and describe wastewater treatment plant equipment:
    - Preliminary Treatment: bar screens, grinders, grit removal, flow equalization
    - Primary Treatment: clarifiers and sedimentation basins
    - Secondary Treatment: aeration basins, lagoons, trickling filters, rotating biological contactors (RBCs)
    - Tertiary Treatment: filtration systems (sand, anthracite, disc filters)
    - Disinfection Systems: chlorination, dechlorination, UV systems
    - Solids Handling: digesters, dewatering equipment (belt press, drying beds)
- Operate and maintain pumps, blowers, mixers, compressors, and chemical dosing systems
- Perform preventative, predictive, and corrective maintenance
- Operate standby and auxiliary systems (generators, cranes, valves)

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- Record and interpret operational data to evaluate equipment efficiency

Treatment Process Evaluation and Adjustment
- Evaluate and optimize preliminary and primary processes (screening, grit removal, sedimentation)
- Operate and adjust secondary treatment processes:
    - Suspended growth (activated sludge, extended aeration, oxidation ditches)
    - Attached growth (trickling filters, RBCs)
    - Nutrient removal systems (anoxic/anaerobic/aerobic)
- Understand biological treatment principles and microbial growth processes
- Operate tertiary treatment systems for polishing and filtration
- Manage disinfection and dechlorination for effluent quality control
- Adjust chemical dosing for pH correction, coagulation, and nutrient control
- Calculate flows, detention times, and chemical dosages
- Evaluate solids handling and disposal: digesters, sludge thickening, dewatering, and land application
- Manage effluent disposal (surface discharge, infiltration basins)
- Analyze trends in process data and apply corrective actions

Laboratory Analysis and Data Interpretation
- Follow laboratory Standard Operating Procedures (SOPs)
- Collect representative wastewater samples using proper methods and preservation
- Conduct and interpret laboratory tests for:
    - Biological: BOD, CBOD, WET
    - Chemical: COD, nutrients, metals
    - Physical: pH, temperature, dissolved oxygen, settleable solids
    - Bacteriological: total coliforms, E. coli
- Operate and maintain lab instruments (DO meters, pH meters, ORP sensors, spectrophotometers)
- Record, analyze, and interpret lab results for process control and compliance reporting
- Identify trends and anomalies in laboratory data
- Correlate lab findings with process adjustments for optimal treatment performance

Safety and Security Procedures
- Implement and maintain plant safety programs:
    - Confined space entry, lockout/tagout, hazard communication, spill response, fall protection
- Conduct vulnerability assessments and develop risk mitigation strategies
- Maintain and inspect safety equipment (PPE, eyewash stations, respirators, gas detectors)
- Respond to chemical spills, process upsets, and emergencies safely and effectively
- Conduct and document security checks of plant facilities
- Maintain compliance with all OSHA, EPA, and local safety standards
- Participate in ongoing safety training and drills

Administrative and Reporting Responsibilities
- Prepare and maintain operational logs, maintenance records, and daily plant reports
- Complete regulatory reporting requirements (monthly/annual discharge monitoring reports)
- Develop and update Standard Operating Procedures (SOPs)
- Assist in budgeting and inventory management for plant supplies and chemicals
- Ensure proper documentation of sampling, calibration, and lab results
- Respond to public inquiries and customer service complaints professionally
- Collaborate with supervisors and engineers on system improvements

Process Optimization and Troubleshooting
- Analyze SCADA and plant data to identify performance trends
- Troubleshoot low dissolved oxygen, high BOD, or abnormal sludge conditions
- Implement corrective actions in aeration, clarification, and disinfection systems
- Optimize chemical usage and energy efficiency
- Conduct process control testing to maintain effluent compliance
- Adjust plant operations to respond to load changes, seasonal variations, or emergencies

Certification: OSHA 10

Semester Exam

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Semester 2

ENS102- Water Systems II

(90 days)

Unit 5 90 Days (45 Class/45 Lab)

Water Treatment Operator

Introduction to Water Treatment

- Overview of the water treatment process and operator responsibilities
- Importance of clean drinking water and regulatory compliance
- Understanding the role of a Water Treatment Operator I
- Introduction to SCADA systems, safety procedures, and plant operations
- Professional standards and ethics in water treatment

Source Water Characteristics

- Identify types of source water (surface vs. groundwater)
- Evaluate biological, chemical, and physical characteristics
  Identify potential contamination sources (runoff, industrial waste, septic systems)
- Measure static and pumping water levels of wells
- Inspect wells and groundwater systems for contamination or flooding issues
- Review source water protection and watershed management plans

Treatment Process Fundamentals

- Overview of pretreatment and aeration
- Coagulation and flocculation: purpose, chemicals used (alum, ferric chloride)
- Sedimentation and clarification: types and operation (inclined plate, tube settlers)
- Filtration processes: conventional, direct, and membrane filtration methods
- Disinfection methods: chlorine, UV, ozone, chloramines
- Chemical feed systems and operator control procedures
- Determine and adjust chemical dosages and flow rates
- Calculate dosage, flow, and contact time
- Interpret process data (gauges, meters, charts, graphs)
- Monitor and adjust plant operations for efficiency and compliance

Laboratory Analysis

- Proper sample collection, labeling, and preservation
- Operate and maintain laboratory equipment (calibration, verification, maintenance)
- Conduct and interpret tests for key parameters:
  - Color, taste, and odor
  - pH, turbidity, and hardness
  - Alkalinity, iron, and manganese
  - Chlorine residuals (free and total)
  - Temperature and disinfection byproducts
  - Total suspended solids (TSS) and bacterial counts
- Record and interpret lab data for operational decisions

Equipment Operation and Maintenance

- Operate and maintain:
  - Raw water intake and pumping systems
  - Chemical feed and mixing equipment
  - Filters and chlorination systems
    Valves, compressors, motors, and backup generators
  - PLC/SCADA control systems
- Conduct preventive, corrective, and predictive maintenance
  Calibrate and verify online instrumentation (pH, turbidity, Cl analyzers)
- Maintain and document maintenance and repair records
- Implement asset management and equipment life-cycle practices

Security, Safety, and Administrative Procedures

- Implement workplace safety practices:
  - PPE, confined space entry, lockout/tagout
  - Chemical safety and SDS compliance
- Conduct emergency response for spills, contamination, and equipment failure
- Maintain physical and cybersecurity of the facility
- Ensure regulatory compliance (monitoring, reporting, notifications)
- Manage SOPs, safety training, and facility inspections
- Maintain operating records, logs, and inventory
- Optimize energy and chemical usage
- Respond to consumer complaints professionally

Professional and Regulatory Compliance

- Understand federal, state, and local drinking water regulations
- Review EPA and state certification requirements
- Recognize and report water quality violations
- Understand reporting standards and documentation protocols
- Apply ethical decision-making and accountability in plant operations

CTSO Integration (Leadership Skills): SkillsUSA Chapter Meetings, Leadership lessons, Regionals prep and State Competition

Professional Skills: 5.A-E, 6.A-C

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Academic Standards: ELA.11-12.W.4, ELA.11-12.W.5, ELA.11-12.L.4, ELA.11-12.S, 5.NF.B.3 - 7, 6.RP.A.3, 7.RP.A.3, 7.G.B.4, G-GMD.A.3, HS.P1U1.1, Essential HS.P1U1.2
Work-Based Learning: Industry Guest Speaker, Resume and Cover Letter
Technical Standard: AZ-ES-W-WWT-1.1-1.5, 2.1, 3.1 ,4.2, 5.1, 6.1, 7.1, 8.1, 9.1, 10.1, 11.1, 12.1, 13.1, 14.1, 15.1, 16.1, 17.1, 18.1, 19.1, 20.1, 21.1

Certification: ADEQ Water Treatment Operator Level 1

District Post Assessment

Arizona Department of Environmental Quality (ADEQ)
Common AZCCR Math Standards (CAMS)
English Language Art Standards (ELAS)
Safety and Health Administration (OSHA)

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