

## DOCUMENT RESUME

ED 480 388

CE 085 380

AUTHOR Kershaw, Isaac; Mazak, Sara A.; Spence, Janet G.  
TITLE Environmental/Natural Resources Technologies. State Competency Profile.  
INSTITUTION Ohio State Univ., Columbus. Tech Prep Curriculum Services.  
SPONS AGENCY Ohio Board of Regents, Columbus.; Ohio State Dept. of Education, Columbus.  
PUB DATE 2000-00-00  
NOTE 407p.  
AVAILABLE FROM For full text: <http://www.ohtpcs.org/cp/environmental.asp>.  
PUB TYPE Guides - Non-Classroom (055)  
EDRS PRICE EDRS Price MF01/PC17 Plus Postage.  
DESCRIPTORS Academic Standards; Administration; Basic Skills; College School Cooperation; \*Competency Based Education; Data Processing; Education Work Relationship; \*Employment Qualifications; \*Environmental Education; Job Skills; \*Natural Resources; Outcome Based Education; Pollution; Postsecondary Education; Secondary Education; State Standards; Statistical Analysis; \*Tech Prep; \*Technical Occupations; Wastes  
IDENTIFIERS Geographic Information Systems; \*Ohio

## ABSTRACT

This document, which lists the environmental and natural resources technology competencies identified by representatives from businesses and industries as well as secondary and postsecondary educators throughout Ohio, is intended to assist individuals and organizations in developing college tech prep programs that will prepare students from secondary through postsecondary associate degree programs for employment in these eight occupational clusters: pollution prevention and control, environmental sampling and analysis, health and safety, environmental compliance assurance, hazardous materials handling, water environment management, fishery and wildlife habitat management, and geographic information management systems. The competencies, which are separated into essential competencies needed to ensure a minimal level of employability and recommended competencies, are organized by instructional units and include suggestions as to when students should be introduced to, reinforced, and proficient at them. The Tech Prep Competency Profile(TCP) matrix includes a list of 39 technical competencies that are essential or recommended for employment in the occupational clusters listed above. Some of the common competencies are as follows: technical documentation; statistical analysis; management and supervision; environmental science; environmental assessment; soil science; hydrology; chemical technology; equipment operation and maintenance; surveying and mapping; waste management; hazardous materials management; database administration; and communication. The document includes a profile review of panel participants and occupational area definitions.  
(MO)



# ENVIRONMENTAL/NATURAL RESOURCES TECHNOLOGIES

## State Competency Profile

PERMISSION TO REPRODUCE AND  
DISSEMINATE THIS MATERIAL HAS  
BEEN GRANTED BY

*M. Aring*

TO THE EDUCATIONAL RESOURCES  
INFORMATION CENTER (ERIC)

U.S. DEPARTMENT OF EDUCATION  
Office of Educational Research and Improvement  
EDUCATIONAL RESOURCES INFORMATION  
CENTER (ERIC)

This document has been reproduced as  
received from the person or organization  
originating it.

Minor changes have been made to  
improve reproduction quality.

Points of view or opinions stated in this  
document do not necessarily represent  
official OERI position or policy.

**Tech Prep Curriculum Services  
In conjunction with  
The Ohio Department of Education  
And  
The Ohio Board of Regents**

1  
CE 480 388

## INTRODUCTION

The Ohio Environmental/Natural Resources Technology Competency Profile was developed under the auspices of the Joint Council of the Ohio Board of Regents and the State Board of Education. It provides the framework for a broad-based educational response to Ohio's need for a skilled Environmental/Natural Resources workforce.

The profile includes a comprehensive set of Environmental/Natural Resources competencies that are grounded in core academic subject areas and built around eight occupational clusters: Pollution Prevention and Control, Environmental Sampling and Analysis, Health and Safety, Environmental Compliance Assurance, Hazardous Materials Handling, Water Environment Management, Fishery and Wildlife Habitat Management, and Geographic Information Management Systems. Generated using the Ohio Tech Prep model of curriculum development, the profile reflects the job opportunities and skills required for Ohio's Environmental/Natural Resources technology workers.

Ohio business/industry representatives and educators worked together to create the Environmental/Natural Resources Technology Competency Profile. Representatives from a broad cross-section of Ohio businesses and industries played a critical role in this effort. Business/industry representatives defined the vision and scope of Environmental/Natural Resources technology. They also identified the essential and recommended skills for current and future Environmental/Natural Resources technology professionals. Secondary and post-secondary educators representing schools and colleges throughout Ohio identified when in the educational process and to what depth those skills identified by business should be addressed.

The Ohio Environmental/Natural Resources Technology Profile will be used as the basis for the development of an integrated delivery system that provides opportunities for new and challenging Environmental/Natural Resources technology programs and courses in Ohio's secondary schools, colleges, and universities. Career-Technical Education, Tech Prep, and adult education will be enhanced and expanded through the use of the Environmental/Natural Resources Profile.

This profile is available on the Internet at: [www.ohtpcs.org](http://www.ohtpcs.org). At this location, users can download copies of the entire profile or conduct searches on a number of key variables. Additional information on academic connections and certification crosswalks is available at this site.

For additional information contact:

Tech Prep Curriculum Services  
The Ohio State University  
1900 Kenny Road  
Columbus, Ohio 43210  
(614) 247-7426  
[spence.16@osu.edu](mailto:spence.16@osu.edu)

## ACKNOWLEDGEMENTS

The Ohio Environmental/Natural Resources Technology Competency Profile is a project of the Joint Council of the Ohio Board of Regents and the State Board of Education. In addition to the business/industry representatives and educators listed on the following pages, a number of individuals contributed their time and expertise to this initiative. Special thanks is due to Jonathan L. Tafel, Associate Vice-Chancellor, Ohio Board of Regents; Joanna Kister, Director, Career-Technical and Adult Education, Ohio Department of Education; Julie Novel, Supervisor, Tech Prep, Career-Technical and Adult Education, Ohio Department of Education; and Richard Arndt, Director, K-16 Initiatives, Ohio Board of Regents. Their vision, support, and encouragement made this project possible.

Thanks are also due to the following:

- Project Managers:** Isaac Kershaw, Assistant Director, Career-Technical and Adult Education, Environmental and Agricultural Education, Ohio Department of Education  
Sara A. Mazak, Senior Program Associate, Tech Prep Curriculum Services, The Ohio State University  
Janet G. Spence, Senior Program Associate, Tech Prep Curriculum Services, The Ohio State University
- Draft Document Development and Panel Facilitation:** Linda Fauber, Consultant, Tech Prep Curriculum Services
- Panel Facilitation:** Beverly Smith, Tech Prep Coordinator, Edison State Community College  
John Miley, Supervisor, Career-Technical and Adult Education, Environmental and Agricultural Education, Ohio Department of Education  
William Waidelich, Vocational Education Consultant, The Ohio State University
- Research and Editorial Assistance:** Steven D. Chambers, Librarian, Tech Prep Curriculum Services, The Ohio State University
- Information Services:** Christopher Dickman, Systems Specialist, Tech Prep Curriculum Services, The Ohio State University  
Gregory D. Lyle, Systems Specialist, Tech Prep Curriculum Services, The Ohio State University
- Administrative Support:** Janet I. Ray, Administrative Assistant, Tech Prep Curriculum Services, The Ohio State University

# TABLE OF CONTENTS

<b>Profile Review Panel Participants .....</b>	<b>iii</b>
<b>Occupational Area Definitions.....</b>	<b>xiii</b>
<b>Key to Profile Codes .....</b>	<b>xvii</b>
<b>Ohio Environmental/Natural Resources Technology Competency Profile Matrix .....</b>	<b>xix</b>
<b>Environmental/Natural Resources Technology Competency Profile Units, Competencies, and Competency Builders .....</b>	<b>1-408</b>

# ENVIRONMENTAL/NATURAL RESOURCES TECHNOLOGY CURRICULUM DEVELOPMENT PROFILE REVIEW PANELS

---

## FUTURING PANEL

March 3, 2000

---

**Purpose:** To define the vision and scope of Environmental/Natural Resources and identify critical occupational areas

**Participants:** **Laurie Chase**, I/I Program Manager (Engineer)  
City of Columbus

**D. Gary Cox**, Assistant Attorney General  
Environmental Enforcement Section

**Mark Glasgow**, Assistant Attorney General  
Environmental Enforcement Section

**John Hollback**, Environmental Affairs Manager  
American Electric Power

**Tom Jenkins**, Senior Hydrogeologist  
Burgess and Niple, Ltd.

**Lewis Jones**, Dairy Division Chief  
Ohio Department of Agriculture

**Ron Kolbash**, Deputy Director, Resource Conservation  
Ohio Department of Natural Resources

**David Landis**, Research/Director of Educational Programming,  
Division of Recycling  
Ohio Department of Natural Resources

**Joseph F Lorenz**, CEO  
Pro-Terra Environmental Contracting Company

**John Marks**, Professor, Environmental Resource Management, Parks  
Recreation and Wildlife  
Muskingum Area Technical College

**Timothy J Murphy**, Manager, Training Services  
Environmental Resource Training Center, The University of Findlay

**Mike Parkes**, Communication and Employee Relations Manager  
Von Roll WTI

**John Sadzewicz**, Manager, Division for the Water/Waste Water  
R. D. Zande and Associates, Inc.

**Lee Schoen**, Vice President  
Floyd Browne Associates

**Mark Shanahan**, Executive Director  
Air Quality Development Authority

**Jeff Steers**, Assistant Chief of Northwest District Office  
Ohio Environmental Protection Agency

**Larry Vance**, Chief of Division of Soil and Water Conservation  
Ohio Department of Natural Resources

**Jerry Wager**, Administrator of Pollution Abatement and Land  
Treatment Section  
Ohio Department of Natural Resources

**Tony Wisbith**, Principle Research Scientist  
Battelle Memorial Institute

**Barb Wooldridge**, Environmental Specialist  
Ohio Environmental Protection Agency

**Steve Wordelman**, Partner  
Jones and Henry Engineering

---

**BUSINESS AND INDUSTRY REVIEW PANEL**

March 30, 2000

---

**Purpose:** To identify essential and recommended skills for Environmental/  
Natural Resources professionals

**Participants:** **Daniel Adams**, Senior Geologist/Vice President  
Foppy Technical Group

**Mohammad I. Alam**, Director  
Cincinnati Health Department

**John Bates**, Wastewater Superintendent  
Village of Caldwell

**Joe Carvitti**, Manager, Ohio Operations  
TRC Environmental Corporation

**Chris Clark**, Utilities Director  
City of Sidney

**Duane R. Day**, Environmental Manager  
Bayer Corporation

**Jeannette T. Durkalski**, Chemist, Natural Resources  
OARDC/Ohio State University

**Ed Folk**, Woodberry Wildlife Management  
Retired

**Tami Galliher**, Research Assistant  
OARDC/Ohio State University

**Melissa Griffith**, Stillwater Forester  
Ohio Department of Natural Resources, Division of Forestry/MWCD

**Bryon L. Holbrook**, HES Technician  
Marathon Ashland Petroleum LLC

**Charles Kane**, Supervisor, Treatment  
Metropolitan Sewer District of Greater Cincinnati, Hamilton County

**John Kirwin**, Air Pollution Control, Central District  
Ohio Environmental Protection Agency

**Fred Klingelhaver**, Unit Supervisor, Air Pollution Control  
Ohio Environmental Protection Agency, Southeast District Office

**Ronald Kolbash**, Deputy Director, Resource Conservation  
Ohio Department of Natural Resources

**Kent E. Kroonemeyer**, Supervisor, Ecological Services  
U.S. Fish & Wildlife Service

**David Landis**, Researcher  
Ohio Department of Natural Resources

**Lola Lewis**, Regional Urban Forester  
Ohio Department of Natural Resources, Division of Forestry

**Paul Logsdon**, Environmental Health & Safety Manager  
Clark Lima Refinery

**Kenneth Maly**, Crime Analyst, GIS Technician  
Akron Police Department



**Noah McManus**, Health & Safety Coordinator/Project Coordinator  
Rader Environmental Services, Inc.

**Walter Olszewski**, Environment Manager, Foil Division  
Gould Electronics

**Aaron Otto**, Law Enforcement Planner  
Akron Police Department

**Cathy Pickrel**, Toxicologist  
Ashland, Inc.

**John Rauch**, Technical Assistance Provider  
Great Lakes RCAP

**Gordon Rudloff**, Agriculture Inspection Manager  
Ohio Department of Agriculture

**John Sadzewicz**, Division Manager, Water/Waste Water  
R. D. Zande and Associates, Inc.

**Nicholas A. Scambilis**, Chair Environmental Engineering Technology  
Sinclair Community College

**Lee Schoon**, Vice President  
Floyd Browne Associates, Inc.

**Jeff Steers**, Assistant District Chief  
Ohio Environmental Protection Agency, Northwest District Office

**Robert A. Stonerock**, Investigator  
Ohio Department of Natural Resources, Division of Oil & Gas

**Andy Toppel**, Naturalist  
Blue Rock-Muskingum River State Parks

**Leslie M Van Kuren**, Environmental Chemist  
Quanterra, Inc.

**Jeffery J. Wander**, Environmental Specialist III, Site Investigation  
Field Unit  
Ohio Environmental Protection Agency

**Carolyn Watkins**, Chief, Office of Environmental Education  
Ohio Environmental Protection Agency

---

**EDUCATOR REVIEW PANEL**

April 20, 2000

---

**Purpose:** To identify when and to what depth essential and recommended skills should be addressed in the educational process

**Participants:**

**David Apsley**, Forestry  
Hocking College

**Richard Bennett**, Assistant Professor  
The University of Akron

**Gary Bergstrand**, College Instructor  
Hocking College

**Joe Beringer**, Environmental Tech Instructors  
Miamisburg High School

**Greg Bush**, Environmental Tech Instructors  
Miamisburg High School

**Joe R. Cahill**, Instructor  
Hocking College

**William S. Carter**, Associate Professor of Environmental  
Management  
University of Findlay

**Jeff Cramer**, Dept Head/Assoc Prof, Science  
Stark State College of Technology

**Bob Daniels**, Agricultural Education Teacher  
West Muskingum High School

**Diane D. DeYonker**, Natural Resource Teacher  
Natural Science Technology Center

**Diane Dudzinski**, Professor of Biology  
Washington State Community College

**Daniel Durfee**, Professor  
Muskingum Area Technical College

**Michael D. Erbaugh**, Environmental Management Instructor  
Greene County Career Center

**Robert Erwin**, Environmental Management Instructor  
Centerville City Schools

**Susan Everett**, Associate Professor, Agribusiness/Horticulture  
Clark State Community College

**David Gardner**, Chairman  
Owens Community College

**William Garnett**, Professor of Biology  
Raymond Walters College

**Louise M. Gerl**, Science Teacher  
Western Hills High School

**David Landis**, Researcher  
Ohio Department of Natural Resources

**Daniel Leininger**, Instructor  
Hocking College

**Jim Lorz**, Instructor  
Laurel Oaks Career Development Campus

**John R. Marks**, Professor, Environmental Resource Management/  
Parks Recreation & Wildlife  
Muskingum Area Technical College

**Julie Maurer**, Administrator  
Columbus State Community College

**David Miller**, Instructor  
Clark State Community College

**John Oliver**, Natural Resources Teacher  
Marlington High School

**William Peneston**, Wildlife Biologist/Professor  
Hocking College

**Robert Scott Placier**, Instructor  
Hocking College

**Susan Roseum**, Tech Prep Science Instructor  
Auburn Career Center

**David A. Sagan**, Instructor  
Hocking College

**Nick Scambilis**, Chair, Environmental Engineering Technology  
Department  
Sinclair Community College

**Tom Steckel**, Professor of Chemistry  
Washington State Community College

**Dana R. White**, Ag Science/Natural Resources Teacher  
Miller High School

**Ruth Willey**, Dept Head/Teacher  
Fremont Ross High School

**Rebecca J. Wood**, Instructor  
Hocking Technical College

**Tom L. Zimmerman**, Associate Professor  
The Ohio State University ATI

**Jennifer Zylko**, Instructor, Environmental Technology  
Stark State College of Technology

---

**STAKEHOLDER REVIEW PANEL**

November 15, 2000

---

**Purpose:** To refine the Ohio Environmental/Natural Resources State Competency Profile through dialogue among all key stakeholders

**Business & Industry Participants:** **Mohammad I Alam**, Environmental Director  
Cincinnati Health Department

**John Bates**, Wastewater Superintendent  
Village of Caldwell

**Jeannette T Durkalski**, Chemist, Natural Resources  
OARDC/Ohio State University

**Bryon L Holbrook**, HES Technician  
Marathon Ashland Petroleum LLC

**Charles Kane**, Treatment Supervisor  
Metropolitan Sewer District of Greater Cincinnati, Hamilton County

**Fred Klingelhaver**, Unit Supervisor, Air Pollution Control  
Ohio Environmental Protection Agency, Southeast District Office

**Walter Olszewski**, Environment Manager, Foil Division  
Gould Electronics

**Cathy Pickrel**, Project Manager, Toxicologist  
Ashland, Inc.

**John Rauch**, Southern District Manager  
Great Lakes Rural Community Assistance Programs (RCAP)

**John Sadzewicz**, Division Manager, Water/Waste Water  
R. D. Zande and Associates, Inc.

**Lee Schoon**, Vice President  
Floyd Browne Associates, Inc.

**Jeff Steers**, Assistant District Chief  
Ohio Environmental Protection Agency, Northwest District Office

**Robert A Stonerock**, Investigator  
Ohio Department of Natural Resources, Division of Mineral Resource  
Management

**Carolyn Watkins**, Chief, Office of Environmental Education  
Ohio Environmental Protection Agency

**Educator  
Participants:**

**Richard Bennett**, Assistant Professor  
The University of Akron

**Joe Beringer**, Environmental Technology Instructors  
Miamisburg High School

**William S Carter**, Associate Professor, Environmental Management  
University of Findlay

**Robert Daniels**, Agricultural Education Instructor  
West Muskingum High School

**Karen Dearbaugh**, Director, Support Services  
Eastland Career Center

**Diane D DeYonker**, Natural Resource Teacher  
Natural Science Technology Center

**Diane Dudzinski**, Professor of Biology  
Washington State Community College

**Daniel Durfee**, Professor  
Muskingum Area Technical College

**David Gardner**, Chairman, Industrial Operations  
Owens Community College

**William Garnett**, Professor of Biology  
Raymond Walters College, University of Cincinnati

**Louise M Gerl**, Science Teacher  
Western Hills High School

**John R Marks**, Professor, Environmental Resource Management/  
Parks, Recreation, & Wildlife  
Muskingum Area Technical College

**Julie Maurer**, Administrator  
Columbus State Community College

**David W Miller**, Assistant Professor  
Clark State Community College

**Nick Scambilis**, Chair, Environmental Engineering Technology  
Sinclair Community College

**Bill Somerlot**, Teacher  
Eastland/New Albany School

**Tom Steckel**, Chemistry Professor  
Washington State Community College

**Dana R White**, Ag Science/Natural Resources Teacher  
Miller High School

**Tom L Zimmerman**, Associate Professor  
The Ohio State University/ATI

# ENVIRONMENTAL OCCUPATIONAL AREA DEFINITIONS

**Pollution Prevention and Control** - Individuals employed in pollution control ensure the prevention of pollution and safe and effective collection, treatment, disposal and documentation of agricultural and industrial by-products, air emissions, waste, hazardous waste, water treatment and waste water products in compliance with local, state and federal regulations. Skill areas should include, but are not limited to:

*compliance with laws, regulations, policies and contracts*  
*safe working conditions*  
*data recording and analysis*  
*preparation of summaries and charts for review*  
*creative solutions for preventing pollution and reducing the use of toxic materials*  
*extent, sources, and clean-up of pollution*  
*certification for various positions*  
*quality control practices*  
*operation, calibration, and maintenance of equipment and pollution control devices*  
*data and sample collection*  
*operation and calibration of field and laboratory instruments*  
*watershed pollution prevention and control*

**Environmental Sampling and Analysis** - Individuals employed in environmental instrumentation and monitoring determine presence, sources, intensity and constituents or components in air, water, soil and waste through field and laboratory techniques utilizing principles of agriculture, chemistry, meteorology, engineering and applied technologies in accordance with government regulations and methodologies. Skill areas should include, but are not limited to:

*safe working conditions*  
*installation, operation and calibration of field and laboratory equipment and instruments*  
*data recording and analysis*  
*basic chemical, physical, and biological analyses*  
*hazards recognition*  
*flow monitoring*  
*bio-monitoring*  
*process monitoring*  
*sampling and tracking*

**Health and Safety - Individuals employed in health and safety evaluate and minimize the risk to human health in relationship to the industrial/commercial/municipal workplace, hazardous and infectious waste sites, air pollution, water supply, and sanitation processes. Skill areas should include, but are not limited to:**

*safety training programs*  
*job hazard analyses*  
*workplace hazards*  
*Materials Safety Data Sheets (MSDS)*  
*corrective action plans*  
*cost and cost benefit statements for specific corrective actions*  
*accident incidence statistics/accident investigation*  
*certification for various positions*  
*OSHA Workplace Standards 29CFR 1910.120*

**Environmental Compliance Assurance - Individuals employed in environmental compliance assurance ensure that environmental permits are complied with or assistance is provided to ensure compliance. They may also assist in developing standard operating procedures. Skill areas should include, but are not limited to:**

*safe working conditions*  
*complaint response*  
*stress response*  
*violations identification and reporting*  
*citations and warnings*  
*compliance inspections*  
*risk assessments*  
*application, modification, or termination of permits*  
*implications of the regulatory development process*  
*certification for various positions*  
*training program assistance*



**Hazardous Materials Handling** - Individuals employed in hazardous materials handle, process, sample and store hazardous materials and respond to hazardous materials situations in accordance with regulatory requirements. Skill areas should include, but are **not** limited to (*Under Revision*):

*collection, preparation, documentation, and shipping of samples for analysis*  
*sample data analysis*  
*equipment related to hazardous materials operations*  
*hazardous materials identification and labeling*  
*calibration, operation, and maintenance of required instrumentation*  
*documentation of hazardous materials management activities*  
*hazardous materials handling, transporting, and storing in accordance with regulations*  
*hazardous materials treatment and disposal systems*  
*toxic effects of hazardous materials on people*  
*certification for various positions (e.g., HAZWOPER)*  
*construction techniques and equipment*  
*mechanical skills*

**Water Environment Management** - Individuals employed in water resource management help solve fresh water resource related problems via conservation agencies and environmental businesses and industries. Skill areas should include, but are **not** limited to:

*water resource utilization*  
*water pollution control and design*  
*water conservation*  
*wetlands management*  
*watershed protection and planning*  
*data collection and analysis*  
*compliance with laws, regulations, policies and contracts*  
*extent, sources and clean-up of water pollution*  
*point and non-point source pollutants*  
*contamination pathways*  
*water ecology*  
*basic toxicology*  
*biological/chemical and ecological effects*  
*test result analysis*  
*drinking water treatment control and design*  
*drinking water treatment equipment*  
*wastewater treatment equipment*  
*basic economics and finance*  
*human health issues*

**Fishery and Wildlife Habitat Management** - Individuals employed in fishery and wildlife habitat management maintain or manage natural resources, including soil, water, plants, animals and fish for recreational purposes and the best interests of the environment. Skill areas should include, but are not limited to:

*hatchery fish propagation*  
*fish and wildlife disease control*  
*data compilation*  
*wildlife conservation*  
*wildlife habitats*  
*migratory and native species of birds, mammals, fish, endangered species, and other wildlife*  
*federal, state, and local regulations*  
*wetlands management*  
*animal damage control*  
*human-animal conflicts*  
*bio-monitoring*  
*stream, lake, and pond management*

**Geographic Information Management Systems** - Individuals employed in cartography/Geographic Information Systems (GIS) compile, refine, and map data on selected environmental, economic, natural, infrastructure, and cultural resources for a variety of uses such as habitat rehabilitation, wildlife tracking, resource management, floodplain management, phase mapping, trending analysis, benchmarking, and water quality. Skill areas should include, but are not limited to:

*computer skills*  
*digital maps*  
*data collection*  
*database management*  
*database and Geographic Information Systems integration*  
*GIS analysis including GPS/remote sensing concepts, map projections, scale, resolution, accuracy and precision*  
*statistical theory/analysis*  
*resource management principles*  
*surveying*

#### **Possible GIS Specialty Areas**

Waste Management  
Fishery and Wildlife Management  
Watershed Management  
Soil Science  
Forest Science

Environmental Recreational Planning  
City and Community Planning  
Ecosystem Management  
Marine/Oceanography Studies

\*\*\*\*\*  
**KEY TO PROFILE CODES**  
 \*\*\*\*\*

**GRADE LEVEL**

**12** = by the end of grade 12

**AD** = by the end of the Associate Degree

**DEPTH**

**I = Introduce** (applies to 25% of the competency builders. In competencies with 3 or less builders, all builders should be introduced before this code can be used.)

**R = Reinforce** or add depth (after introducing or proficiency)

**P = Proficient** (achievement of the competency without supervision)

**OTHER (Determined by Business, Industry and Labor Panel)**

**Essential Competency:** Competency is needed to ensure **minimal** level of employability. Entry level employees should be able to perform this competency without supervision at the end of the associate degree. Competencies required for certification, licensure, and/or national skills standards should be tagged as essential.

**Recommended Competency:** Competency should be included but is not essential for minimal level of employability.

**Delete:** Competency should not be included.

**Example:**

**BIL:** Essential – PC, ECA, HS  
 Recommended - FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	P	I
ESA		
HS		P
ECA	P	R
HM		
WEM		
FWM	I	P
GIS		

**Competency1.1:** Analyze . . . .

**Competency Builders:**

Explain . . . .

Identify . . . .

# ENVIRONMENTAL/NATURAL RESOURCES TECHNOLOGIES TECH PREP COMPETENCY PROFILE

## Matrix

Page #	Unit #	Unit	PC	ESA	HS	ECA	HM	WEM	FWM	GIS
PC =		Pollution Prevention and Control								
ESA =		Environmental Sampling and Analysis								
HS =		Health and Safety								
ECA =		Environmental Compliance Assurance								
HM =		Hazardous Materials Handling								
WEM =		Water Environment Management								
FWM =		Fishery and Wildlife Habitat Management								
GIS =		Geographic Information Management System								
Page #	Unit #	Unit	PC	ESA	HS	ECA	HM	WEM	FWM	GIS
1	1	Technical Documentation	E	E	E	E	E	E	E	E
5	2	Statistical Analysis	E	E	E	E	E			E
15	3	Management & Supervision	E	E	E	E	E	E	E	R
31	4	Psychology of Stress	R	R	E	R				
35	5	Emergency Response	R		E	E	E			
37	6	Environmental Safety	E	E	E	E	E	E		
49	7	Environmental Laws and Regulations	E	E	E	E	E	E		
61	8	Environmental Science	E	E	E	E	E	E	E	E
77	9	Energy Sources	R			R		R		
79	10	Environmental Assessment	E	E	E	R	E	E	R	E
89	11	Plant Science		E		R		E	E	R
105	12	Soil Science	E	E		E	E	E	E	R
119	13	Hydrology	E	E		R	E	E	R	E
125	14	Pollution Control I	E	E	R	E		R	R	
129	15	Pollution Control II	E	E	E	E	E	E		
139	16	Chemical Technology	E	E	E	E	E	E	R	
153	17	Environmental Instrumentation	E	E	E	E	E	E		
173	18	Process Technology	E	R	R	R		R		
181	19	Electrical Basics	E	E	R	R				
185	20	Equipment Operation & Maintenance	R	E	R	E	E	E	E	R

Page #	Unit #	Unit	PC	ESA	HS	ECA	HM	WEM	FWM	GIS
PC =		Pollution Prevention and Control								
ESA =		Environmental Sampling and Analysis								
HS =		Health and Safety								
ECA =		Environmental Compliance Assurance								
HM =		Hazardous Materials Handling								
WEM =		Water Environment Management								
FWM =		Fishery and Wildlife Habitat Management								
GIS =		Geographic Information Management System								
191	21	Hydraulics & Pneumatics	R		R	E		E	R	
201	22	Surveying & Mapping	E	E		E	E	R	E	E
211	23	Drafting Technology	E		R	R		R	R	E
217	24	CADD Fundamentals	E			R			R	E
225	25	Waste Management	E	E	R	R	E	R		
245	26	Drinking Water Treatment Operations	E	E	E	E		E		
265	27	Wastewater Treatment Operations	E	E	R	E	R	E		
283	28	Hazardous Materials Management	E	E	E	E	E	R		
309	29	Wetlands Management	R	E	R	R		E	E	R
319	30	Watershed Management	E	E	E	R		E	E	R
325	31	Wildlife Ecology		E		R			E	
329	32	Wildlife Management				R			E	
347	33	Fisheries Management		E		R		E	E	
355	34	Programming Theory		R		R				R
359	35	Database Management System Basics	R	E		E	R			E
365	36	Database Administration	R	R	R	R	R		R	R
375	37	Geographic Information Systems (GIS)	E	E		R	R	E	E	E
393	38	Communication	E	E	E	E	E	E	E	E
399	39	Basic Microbiology	R	E	E	R		E	E	E

## Unit 1: Technical Documentation

**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	P	R
HM	P	R
WEM	I	P
FWM	I	P
GIS	I	P

### Competency 1.1: Record technical information

#### Competency Builders:

Describe various documentation procedures  
Read documentation procedures  
Follow documentation procedures  
Observe process  
Ask open-ended questions  
Record process (e.g., flowchart, step-by-step)  
Compile relevant data  
Identify parameters  
Recognize patterns in data  
Record accurate, truthful data  
Compile cumulative reference notebook/record  
Maintain logs, notes, and records  
Measure appropriate parameters  
Document violation and enforcement notices  
Document test results

**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	P	R
ESA	I	P
HS	P	R
ECA	P	R
HM	I	P
WEM	I	P
FWM	I	P
GIS	I	P

**Competency 1.2: Compose technical reports**

**Competency Builders:**

Compose technical memoranda

Complete forms and checklists

Identify format or report form

Generate charts and graphs

Generate maps

Analyze data

Draw conclusions

Explain analytical methods used

Outline reports and procedures

Write executive summaries

Present reports and procedures

**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	P
FWM	I	P
GIS	I	P

**Competency 1.3: Communicate documentation to others**

**Competency Builders:**

Describe operation(s) to others

Participate in meetings

Interact with customers

Consult with colleagues

Resolve complaints

Refer questions and issues to appropriate authority [E-BIL]

Interact with public on safety environmental, and health issues

Interact with personnel on safety, environmental, and health issues

Compose clear instructions

Interpret prints, diagrams, specifications, and drawings

Interpret charts and graphs

Interpret maps

Draft preventive maintenance and calibration procedures

Identify strategies for communicating with mass media

Describe strategies for communicating with mass media



## Unit 2: Statistical Analysis

**BIL:** Essential – PC, ESA, HS, ECA, HM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	P	R
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS	P	R

**Competency 2.1: Apply basic statistics concepts** [E-GIS]

### Competency Builders:

Describe data collection methods

Collect data

Organize data by flow chart

Interpret data by cause and effect diagrams

Explain nominal, ordinal, interval, and ratio data

Explain mean, median, and mode

Explain significance of standard deviation and correlation coefficient

Explain normal distribution

Differentiate between prevention and detection

Explain statistical score (e.g., t, z)

**BIL:** Essential – PC, ESA, HS, ECA, HM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	P	R
WEM		
FWM		
GIS	I	P

**Competency 2.2: Interpret scattergrams**

**Competency Builders:**

Develop scatter grams

Interpret for positive, negative, or no correlation between X and Y variables

Test for significance

Explain regression analysis

**BIL:** Essential – PC, ESA, HS, HM, GIS  
Recommended – ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS	I	P

**Competency 2.3: Analyze probability theories**

**Competency Builders:**

Explain classical probability

Explain empirical probability

Calculate probability for outcomes

**BIL:** Essential – PC, ESA, HS  
Recommended – ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		P
HS	I	P
ECA	I	R
HM		I
WEM		
FWM		
GIS		

**Competency 2.4: Determine control limits**

**Competency Builders:**

Explain uses of precontrol

Calculate precontrol limits

Explain significance of the limits

Plot values on a precontrol chart

Explain "out-of-control" situation

Make decisions on green (good control range), yellow (reaching control limits) and red conditions (out of control)

**BIL:** Essential - PC  
Recommended – ESA, HS, ECA, HM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		I
WEM		
FWM		
GIS		I

**Competency 2.5: Determine process capability**

**Competency Builders:**

Measure X, R, USL, and LSL (upper and lower specification limits)

Calculate estimated process standard deviation

Plot right hand and left hand tail of process variation

Compute Z value for percent of probable defect for process

Calculate  $C_{PK}$  values that describe process capability

Describe skewed distributions

List probable causes of skewed distribution

**BIL:** Essential - PC  
 Recommended – ESA, HS, ECA, HM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		I
WEM		
FWM		
GIS		I

**Competency 2.6: Prepare control charts**

**Competency Builders:**

- Identify types of control charts
- Interpret attribute data
- Interpret histogram
- Interpret scatter grams
- Interpret NP chart
- Interpret P chart
- Interpret flowchart
- Interpret cause-and-effect diagram
- Construct P (percentage defective) chart for attributes
- Plot control limits of P chart and data points
- Check chart for out-of-control conditions
- Construct an NP (number defective) chart with control limits and data
- Construct C (count of defects) and U (number of defects per unit) charts
- Check data on C and U charts
- Construct flowchart
- Construct cause-and-effect chart

**BIL:** Essential - ECA  
Recommended – PC, HS, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		
HS	I	R
ECA	I	P
HM		I
WEM		
FWM		
GIS		

**Competency 2.7: Construct X and R charts**

**Competency Builders:**

Arrange data into statistical sub-groups

Explain importance of random sampling

Compute X (i.e., average of values) and R (i.e., range of values in subgroup)  
within sample

Plot in X and R on chart

Construct control chart with X (grand average) and R (average range) calculated

Calculate upper and lower control limits for X-chart

Calculate upper and lower control limits for R-chart

**BIL:** Essential – PC, ECA  
 Recommended – HS, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		
HS	I	R
ECA	I	P
HM		I
WEM		
FWM		
GIS		

**Competency 2.8: Evaluate X and R charts**

**Competency Builders:**

- Plot percentages for normal distribution
- Test distribution for normality
- Explain difference between common cause and special cause
- Explain "in-control" process
- Explain significance of an out-of-control point on X or R chart
- Identify patterns and trends on control chart
- Identify run up and run down
- Test for middle third on control chart
- Explain significance of middle third on control chart
- Explain Rule of Sevens



**BIL:** Recommended – PC, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		I
ECA		I
HM		
WEM		
FWM		
GIS		

**Competency 2.9: Conduct process improvement studies**

**Competency Builders:**

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC,  $C_{PK}$ )

Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)

Identify major steps in conducting a study

Integrate results into the total system

## Unit 3: Management & Supervision

**BIL:** Recommended – PC, ESA, HS, ECS, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		I
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM	I	R
GIS		I

**Competency 3.1: Assess progress in assigned areas of responsibility/accountability**

### **Competency Builders:**

Set short- and long-term goals for assigned areas of responsibility/accountability

Demonstrate commitment to established goals and vision

Obtain support for goals

Provide support for goals

Monitor goal achievement

Adjust goals

Communicate goal achievement

Recognize goal achievement

**BIL:** Recommended – PC, ESA, HS, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		I
ECA		
HM		
WEM		I
FWM		I
GIS		I

**Competency 3.2: Hire staff**

**Competency Builders:**

Develop plans and procedures for identifying staffing needs

Identify staffing needs in accordance with plans

Develop job descriptions

Develop hiring and promotion policies and procedures in compliance with state and federal employment laws

Establish guidelines for selecting the most qualified person for a specific position

Identify state and federal employment laws and company hiring policies and procedures

Identify resources for locating candidates

Recruit candidates

Identify most appropriate candidates for position in accordance with established guidelines

Interview candidates for position

Follow up on information provided on job applications

Recommend or select applicants for employment

Orient new employees

Maintain personnel records

Explain unconventional work schedules (e.g., flextime, shared positions)

Identify additional or alternative employee benefits that the company might consider furnishing to employees

**BIL:** Recommended – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		I
ECA	I	R
HM		I
WEM		I
FWM		I
GIS		I

**Competency 3.3: Supervise employee performance**

**Competency Builders:**

- Apply management/leadership style appropriate for situation
- Clarify roles and relationships using organizational charts
- Communicate performance expectations
- Clarify company policies and procedures
- Create and maintain an environment supportive of productivity
- Establish office procedures
- Maintain office procedure manual(s)
- Monitor employee performance
- Maintain performance records
- Document personnel issues
- Evaluate employee performance
- Provide employees with constructive criticism and feedback
- Explain union role and responsibility
- Counsel employees
- Discipline employees
- Make recommendations based on employee performance (e.g., transfer, promotion, or dismissal)
- Manage the change process (e.g., for right-sizing, technological updating, globalization, retraining)
- Identify company policies and federal laws governing discrimination and harassment
- Demonstrate sensitivity to diversity, including differences in gender, culture, race, language, physical and mental challenges, and family structures
- Explain motivational theory in selecting management techniques

**BIL:** Recommended – PC, ESA, HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		I
ECA		
HM		
WEM		
FWM		
GIS		

**Competency 3.4: Design employee development activities**

**Competency Builders:**

Analyze employee development needs (e.g., retraining, updating, stress management)

Select development strategies designed to meet individual and group needs

Identify the benefits of employee development activities offered outside the organization

Secure personnel resources, materials, and equipment needed for employee development activities

Monitor employee development activities

Keep employees informed about development opportunities

Encourage employee participation in development activities

Evaluate employee progress

Provide feedback to employees concerning their progress

Provide formal and informal recognition for employee development

**BIL:** Recommended – PC, ESA, HS, WEM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	R
HS		I
ECA		
HM		
WEM		I
FWM		
GIS	I	R

**Competency 3.5: Manage work flow and operations**

**Competency Builders:**

Plan physical layout and work flow

Develop business or job procedures/operations flowcharts

Prioritize work

Establish and maintain operating policies and procedures

Establish and maintain production standards

Establish and maintain linkages with other departments

Systematize work

Delegate work

Communicate operating policies and procedures, priorities, linkages, and standards to others

Assign work

Monitor progress

Solve work flow/operations problems

Prepare productivity reports

Communicate contents of productivity reports to others

**BIL:** Essential – ECA, WEM, FWM  
Recommended – PC, ESA, HS, HM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	R
HS		I
ECA	I	P
HM	I	R
WEM	P	R
FWM	P	R
GIS	I	R

**Competency 3.6: Plan meetings**

**Competency Builders:**

Set agenda

Schedule meeting

Reserve meeting room

Invite appropriate personnel

Identify need for outside speakers

Assign someone to take minutes

**BIL:** Essential - ECA  
Recommended – PC, ESA, HS, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	R
HS		I
ECA	I	P
HM	I	R
WEM	I	R
FWM	I	R
GIS	I	R

**Competency 3.7: Conduct meetings**

**Competency Builders:**

Make introductions

Invite questions, comments, and group participation

Record appropriate action, time frame, and person accountable for identified tasks

Monitor time

Publish minutes in timely manner



**BIL:** Essential – FWM  
 Recommended – PC, ESA, HS, ECA, WEM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	R
HS		I
ECA	I	R
HM		
WEM	I	R
FWM	I	P
GIS	I	R

**Competency 3.8: Conduct public relations activities**

**Competency Builders:**

- Plan facility tours for the public
- Answer press and public inquiries
- Reassure the public if a potential emergency situation arises
- Identify target audiences
- Assess information needs
- Coordinate multimedia promotional programs
- Prepare articles for publication
- Respond to interview requests
- Coordinate public displays
- Deliver public presentations (e.g., radio and T.V.)
- Prepare media releases
- Coordinate events
- Prepare environmental status reports
- Organize open houses and tours
- Coordinate information sessions
- Develop public awareness campaigns/programs
- Explain the concept of adult education

**BIL:** Recommended – PC, ESA, HS, ECA, HM, WEM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		I
ECA	I	R
HM	I	R
WEM		I
FWM		
GIS		I

**Competency 3.9: Manage budgets**

**Competency Builders:**

Identify the costs of operation

Perform cost surveys

Develop a plan for efficient operations

Explain system-efficiency balance

Identify budget activities and categories of expense accounts

Identify techniques of budget control

Identify statements about budget related activities

Identify factors that are needed to maintain adequate control over supplies on hand  
and on order

Develop productivity goals

Implement productivity goals

Develop attainable tasks/time estimates

**BIL:** Essential - HS  
 Recommended – PC, ESA, ECA, HM, WEM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		I
HS	I	P
ECA	I	R
HM	I	R
WEM		I
FWM		
GIS		I

**Competency 3.10: Develop standard operating procedures (SOPS)**

**Competency Builders:**

Plan and implement an in-house training program that includes safety measures and hazardous or toxic materials in the work place (e.g., HAZ, Com, CHP)

Plan and implement a cross-training program in facility operations

Plan and implement a SOP for a job-related task

**BIL:** Recommended – PC, ESA, HS, WEM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		I
ECA		
HM		
WEM		I
FWM		
GIS		I

**Competency 3.11: Develop facility process optimization and management plans**

**Competency Builders:**

Develop a plan for inventory control

Develop a plan for an analysis of operation and maintenance logs and for the optimum operation of equipment

Develop a plan for facility automation

Develop a plan to achieve efficient, energy-saving, cost-effective operations

Develop a plan for testing and analyzing treatment operations

Develop a plan for the systematic troubleshooting of operations problems

Develop a plan for documenting operations that anticipates and avoids potential problems

Identify facility equipment

Develop a facility staffing plan

Develop a procedure for quality assurance/quality control in a facility

Develop a procedure for obtaining certification for a facility

Develop a sampling/analysis schedule based on sampling requirements

**BIL:** Essential – ESA, FWM  
Recommended – ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	I	P
HS		
ECA		I
HM		I
WEM	I	R
FWM	I	P
GIS		

**Competency 3.12: Explain federal, state, and local rules**

**Competency Builders:**

Explain operational rules

Apply facility management rules

Apply samples and analyses rules

**BIL:** Recommended – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		I
ECA		I
HM		I
WEM		I
FWM		I
GIS		I

**Competency 3.13: Correct facility operational problems**

**Competency Builders:**

Troubleshoot operational problems

Check the accuracy of observed operational problems

Identify appropriate corrective actions for operational problems

Monitor results of corrective actions taken

Identify actions that should be taken to prevent recurrence of identified operational problems

**BIL:** Essential – PC  
Recommended – ESA, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS		
ECA		I
HM		I
WEM		I
FWM		I
GIS	I	R

**Competency 3.14: Manage environmental operations**

**Competency Builders:**

Balance environmental costs and benefits

Explain scope of environmental projects

Investigate complaint

Implement corrective action

Resolve issue with concerned party

Document investigation and rules

**BIL:** Essential – PC, HS  
 Recommended – ESA, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM	I	R
WEM		I
FWM		I
GIS	I	P

**Competency 3.15: Develop contingency plans**

**Competency Builders:**

- Analyze potential emergency situations that can occur in a facility
- Develop a plan for handling problems caused by emergency situations, including what equipment would be used and what sampling would be needed
- Develop a procedure to ensure employee safety
- Develop procedures to ensure continuous operations (e.g., preventive maintenance)
- Practice deployment plan



## Unit 4: Psychology of Stress

**BIL:** Recommended – PC, ESA, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	R
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

**Competency 4.1: Analyze factors that influence response to stress**

### **Competency Builders:**

Describe stress

Differentiate between stress and stressors

Analyze how an individual's perception of stress influences response to stressors

Analyze how internal and external mitigating factors influence one's response to stress

Analyze coping mechanisms used to decrease stress

**BIL:** Essential - HS  
Recommended – PC, ESA, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	R
HS	I	P
ECA	I	R
HM		
WEM		I
FWM		
GIS		

**Competency 4.2: Analyze physiological response to stress**

**Competency Builders:**

Describe the stress response on the body systems (e.g., autonomic, nervous, endocrine)

Analyze how mitigating factors relate to the physiological stress response

Differentiate between immune system response to stressors in children and adults

Describe how stress relates to activation of the disease process

Identify biological adaptive responses to stress

**BIL:** Recommended – PC, ESA, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	R
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

**Competency 4.3: Analyze psychological response to stress**

**Competency Builders:**

Identify psychological stressors

Identify causes and characteristics of post catastrophic stress

Analyze the relationship between personality types and the stress response

Analyze types of coping strategies

Identify selected defense mechanisms

Analyze ineffective coping behaviors

Explain the psychobiologic response of anxiety as it relates to stress

Describe the disequilibrium associated with response to stressors

Describe stress as it relates to teams organizations and groups

Analyze how individual perception of stress influences relationships

## Unit 5: Emergency Response

**BIL:** Essential – HS, ECA, HM  
Recommended - PC

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 5.1: Identify various emergency response plan requirements for a facility**

### **Competency Builders:**

Evaluate hazards

Evaluate and implement evolving contingency plans such as SPCC

Develop site command/operating procedures

Identify mitigation techniques

Participate in field exercises (e.g., drum handling, instrumentation surveying, decontamination procedures, personal protective equipment, medical evaluations)

Identify training needs for emergency responders

Document training

Comply with federal, state, and local regulations

**BIL:** Essential – HS  
 Recommended – PC, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		
HS	I	P
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

**Competency 5.2: Develop an emergency response plan for natural disasters**

**Competency Builders:**

- Assess seriousness of incident
- Identify information to be released to public and media
- Coordinate efforts with other response agencies
- Demonstrate clean-up activities
- Identify mitigation techniques
- Provide first response training
- Document training

## Unit 6: Environmental Safety

**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

**Competency 6.1: Identify general workplace safety hazards** [E-HS]

### Competency Builders:

Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards, non-ionizing radiation, lasers, microwaves, electro magnetic fields)

Identify safety materials/equipment and transportation (e.g., absorbent socks, oil dry)

Explain purpose(s) of OSHA, NIOSH, NFPA and DOT

Identify purpose of emergency evacuation routes, master switch, lockout locations, and safety color coding systems

Identify methods of site protection

Describe methods of evaluating potential hazards (e.g., visual analysis)

Describe methods of correcting potential hazards

Describe corrective procedures for unsafe conditions

Explain precautions required when using toxic or flammable materials

Describe various types of toxicity (e.g., chronic, immediate)

Explain confined space and related requirements

**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	P	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

**Competency 6.2: Apply general workplace safety precautions/procedures**  
[E-HS]

**Competency Builders:**

Identify local, state, and federal rules and regulations

Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses

Identify personal protective wear and equipment

Identify level of personal protective wear required

Identify visual controls (e.g., monitors, read outs)

Identify auditory controls

Interpret hazardous materials notices on containers

Wear personal protective clothing and equipment

Apply workplace safety rules and procedures

Apply personal safety rules and procedures

Apply workplace organization (e.g., housekeeping)

Apply applicable electrical, mechanical, steam, hydraulic and pneumatic safety rules and procedures

Apply fire safety rules and procedures

Interpret material safety data sheets (MSDS)

Perform lockout and tagout

Complete preventive maintenance checklists

Complete confined space entry check sheets

Obtain training for confined space entry

Explain OSHA 1910 requirements

**BIL:** Essential – ECA, HM, WEM  
Recommended – PC, ESA, HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

**Competency 6.3: Acquire and maintain first aid certification**

**Competency Builders:**

- Assist patient with wounds or fractures
- Administer first aid to control bleeding
- Administer first aid for shock
- Administer first aid for burn patient
- Assist with first aid for poisoned patient
- Assist choking patient
- Assist patient having a seizure
- Assist patient having a diabetic reaction
- Assist syncopal patient
- Identify protection from blood-borne pathogens



**BIL:** Essential – ECA, HM, WEM  
Recommended – PC, ESA, HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS	I	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

**Competency 6.4: Acquire and maintain cardiopulmonary resuscitation (CPR) certification**

**Competency Builders:**

Administer CPR to adults

Administer care for obstructed airways for adults

**BIL:** Essential - ESA, GIS  
Recommended – PC, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS	I	P

**Competency 6.5: Respond to medical emergencies**

**Competency Builders:**

Perform head to toe assessment

Describe signs and symptoms of emergency situations

Identify basic emergency procedures and equipment

Contact local emergency assistance

Demonstrate first responder procedures

Identify evacuation techniques

**BIL:** Essential – PC, ESA, ECA, HM, WEM  
 Recommended – HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM	I	P
FWM		
GIS		

**Competency 6.6: Explain purpose of pollution control systems**

**Competency Builders:**

- Describe types of air, water, solid waste, and noise pollution
- Explain purpose of air pollution control systems
- Explain purpose of water pollution control systems
- Explain purpose of solid waste pollution control systems
- Explain purpose of noise pollution control systems
- Explain basic philosophy of "Right to Know" legislation
- Explain purpose(s) of regulatory agencies (e.g., EPA, ODH, ODNR, Army Corp.)
- Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
- Describe ethics of environmental issues

**BIL:** Essential – PC, ESA, ECA, HM, WEM  
Recommended - HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

**Competency 6.7: Describe procedures to comply with environmental regulations**

**Competency Builders:**

- List characteristics of an effective monitoring program
- Differentiate among environmental laws (i.e., CAA, CWA, RCRA, CERCLA, SARA, PPA, TSCA)
- Describe procedures for search warrants, administrative warrants, and criminal search warrants
- Prepare for environmental audit, including multimedia
- Identify process used to develop laws and regulations
- Identify process used to develop policies and procedures
- Document procedures
- Describe procedure for monitoring systems
- Complete compliance reports
- List permit requirements as related to leachate production and control
- List permit requirements as related to vector control, landfill gas and settlement

**BIL:** Essential – PC, ESA, HS, ECA, HM  
Recommended - WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	R
FWM		
GIS		

**Competency 6.8: Maintain environmental health and safety facilities**  
[E-HS]

**Competency Builders:**

Perform safety inspections

Participate in safety audits

Participate in safety, health, radioactive and environmental training

Participate in safety demonstrations, drills, and meetings

Identify safety monitoring equipment

Describe unsafe or potentially unsafe conditions, and acts

Respond to emergencies, alarms, and any abnormal situations

Describe potential health or industrial hygiene problem reporting procedures

Implement federal, state, and local legislation pertaining to environmental, health, and safety regulations

Identify evacuation procedures, emergency numbers, rules, and practices

Identify procedural problems in the workplace

Describe the purpose of various safety related permits

Identify correct material handling procedures

**BIL:** Essential – PC, ESA, HS, ECA, HM  
Recommended - WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	R
FWM		
GIS		

**Competency 6.9: Handle chemicals and safety equipment appropriately**

**Competency Builders:**

- List proper safety equipment (e.g., proper hoods, shields)
- Identify appropriate protective equipment (e.g., eye wear, special clothing)
- Identify specific categories of hazardous chemicals
- Identify hazards associated with collecting samples
- Refer to chemical reference handbooks
- Label all chemicals, materials, tools, and equipment with appropriate safety, health, and environmental details
- Explain importance of appropriate display of warning labels
- Demonstrate safe handling of materials under pressure
- Explain the hazard symbols and toxicology sections of MSDS
- Demonstrate safe handling procedures (e.g., handling cylinders, moving heavy items)
- Classify chemicals according to reactivity
- Identify incompatible combinations of chemicals that could result in potentially dangerous situations
- Organize and store chemicals and equipment properly

**BIL:** Recommended – PC, ESA, HS, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		I
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM		
GIS		

**Competency 6.10: Explain ergonomic procedures** [R-HS]

**Competency Builders:**

Explain risk factor

Explain maximum permissible limit (MPL) and action limit (AL) for lifting (i.e., NIOSH Guide for Lifting)

Identify cumulative trauma disorder (CTD)

Identify susceptibility factors for CTD

Identify ways to minimize extreme joint movement

Identify ways to minimize use of excessive muscle force

Identify ways to minimize repetitive tasks

Comply with repetitive strain standard (OSHA)

Identify ways to minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)

Identify ways to minimize awkward body positions

Explain importance of rest pauses

Explain importance of mats and footrest for standing jobs

Explain importance of appropriate working heights of chairs, stools, workbenches, equipment

Explain importance of adequate lighting

Explain importance of anthropocentric design principles (i.e., centering one's view of everything around man)

**BIL:** Essential – ESA, HS, ECA  
 Recommended – PC, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	R
WEM	I	R
FWM		
GIS		

**Competency 6.11: Assess workplace safety**

**Competency Builders:**

- Describe a work place inspection applying Occupational Safety and Health Administration (OSHA) standards
- Cite specific regulations and standards for items not in compliance
- Develop a written plan of alternative solutions or corrective actions
- Prepare cost and cost benefit statements for specific corrective actions
- Analyze accident incidence statistics
- Explain the purpose and function of a safety committee
- Explain how unions and employee organizations impact on safety procedures
- Develop a site safety plan



**BIL:** Essential – ESA, HS, ECA  
 Recommended – PC, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	R
WEM	I	R
FWM		
GIS		

**Competency 6.12: Assess a safety-training plan**

**Competency Builders:**

Identify job skills or tasks required of different occupations or positions in a work place

Identify OSHA Regulations requiring safety training programs

Develop an outline to train workers to work safely and efficiently

Develop training activities for identified skills that will reduce or eliminate injuries

Develop a job related pre-test and post-test to document competency

Explain the purpose of a job safety analysis (JSA)

Construct a JSA of the activities of a specific worker in a specific industry

Complete an incident report

Develop an incentive program

## Unit 7: Environmental Laws and Regulations

**BIL:** Essential – PC, ESA, ECA, HM  
Recommended – HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS		I
ECA	I	R
HM	I	P
WEM	I	R
FWM		
GIS		

**Competency 7.1: Identify key components of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)**

### **Competency Builders:**

List sections of CERCLA

List key parts of CERCLA site evaluation and remedy selection

List the scores involved with the hazard ranking system and their characteristics

Explain national priority site identification (NPL)

List key elements of toxic substance control act (TSCA) relative to CERCLA

**BIL:** Essential – PC, ESA, ECA, HM  
Recommended – HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS		I
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

**Competency 7.2: Identify requirements of Superfund Amendment Reauthorization Act (SARA)**

**Competency Builders:**

List sections of SARA

List key parts of SARA

Explain Toxic Release Inventory (TRI)

**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	P	R
ESA	P	R
HS	P	R
ECA	I	R
HM	I	P
WEM	I	P
FWM		
GIS		

**Competency 7.3: Identify roles and functions of government**

**Competency Builders:**

Identify the roles and responsibilities of federal, state, and local government

Identify the difference between enabling legislation and implementing regulations

Explain the role of public involvement and participation (public notice, public hearing, public comment)

**BIL:** Essential – PC, ESA, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 7.4: Identify requirements of waste and material transportation**

**Competency Builders:**

Identify generator requirements to transfer hazardous materials and waste to treatment, storage, and disposal facilities

List key elements of C.F.R. 49

**BIL:** Essential – PC, ESA, HS, ECA, HM  
Recommended - WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

**Competency 7.5: Describe job-related activities subject to the Occupational Safety and Health Administration (OSHA)**

**Competency Builders:**

Describe OSHA rules and regulations

Describe commercial diving operations involving the environmental field (IAW OSHA 29 CFR 1910.424)

Describe OSHA 29 CFR 1910.1000 Z Tables

Describe OSHA requirements applicable to blood borne pathogens (IAW OSHA 29 CFR 1910.1250)

Describe requirements set forth under Hazard Communication Laws and Regulations (IAW OSHA 29 CFR 1910.1200)

Describe noise exposure limits (IAW OSHA 29 CFR 1910.95)

Describe use and function of portable fire extinguisher (IAW OSHA 29 CFR 1910.157)

**BIL:** Essential – PC, ESA, ECA, HM  
Recommended – HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	P
WEM		I
FWM		
GIS		

**Competency 7.6: Describe requirements of Resource Conservation and Recovery Act (RCRA)**

**Competency Builders:**

List sections of RCRA

List key components of RCRA

Identify categories of hazardous waste

Describe "cradle to grave" concept

Identify secondary containment requirements for above and below ground storage

**BIL:** Essential – PC, ESA, ECA, HM, WEM  
Recommended - HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM	I	P
FWM		
GIS		

**Competency 7.7: Explain requirements of Clean Water Act**

**Competency Builders:**

List sections of Clean Water Act

List key components of CWA

Identify key components of National Pollutant Discharge Elimination System

Identify key components of 503 Sludge Regulations

Explain pre treatment program

Describe the Great Lakes Initiative (GLI)



**BIL:** Essential – PC, ESA, ECA, HM, WEM  
Recommended - HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	P
WEM	I	P
FWM		
GIS		

**Competency 7.8: Explain requirements of Safe Drinking Water Act (SDWA)**

**Competency Builders:**

List sections of SDWA

List key components of SDWA

Explain purpose of Wellhead Protection Program

Describe Sole Source Aquifer Designation

**BIL:** Essential – PC, ESA, ECA, HM  
Recommended - HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	P
WEM		
FWM		
GIS		

**Competency 7.9: Explain requirements of Clean Air Act**

**Competency Builders:**

List sections of CAA

List key components of CAA, Chrome Reporting, and MACT's

Explain Title V Air Emissions Inventory and Permitting

Explain hazardous air pollutants (HAPs)

**BIL:** Recommended – PC, ESA, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		I
ECA		I
HM	I	R
WEM		
FWM		
GIS		

**Competency 7.10: Identify requirements of the Nuclear Waste Policy Act**

**Competency Builders:**

List key provisions of Nuclear Waste Policy Act

List key agencies involved in high-level radioactive waste management program

List defining characteristics of four categories of nuclear waste

List method of disposal for each category of nuclear waste

Identify locations of storage for each type of nuclear waste

**BIL:** Essential – PC  
Recommended – HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		
HS		I
ECA		I
HM		I
WEM		
FWM		
GIS		

**Competency 7.11: Identify key components of ISO 14000**

**Competency Builders:**

List standards of ISO 14000

Explain purpose of ISO 14000

Explain impact of ISO 14000

## Unit 8: Environmental Science

**BIL:** Essential – PC, ESA, HM, WEM, FWM  
Recommended – HS, ECA, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	IR	P
HS	I	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	IR	R

**Competency 8.1: Identify the components of the earth's atmosphere**

### **Competency Builders:**

Describe the composition of the atmosphere

List the most abundant gases by percent volume which make up the composition of clean, dry air

Explain how water vapor varies within the atmosphere

List the major cycles of atmospheric gases

Explain the relationships that exist within the cycles of atmospheric gases

Describe the dependence of organisms on the atmosphere

Explain the importance and impact of water vapor in air

**BIL:** Essential – PC, ESA, HM, GIS  
 Recommended – ECA, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	P	R
HS		
ECA	P	R
HM	P	R
WEM	I	R
FWM	I	R
GIS	P	R

**Competency 8.2: Explain meteorology**

**Competency Builders:**

- Explain how the atmosphere is composed of layers of air of varying temperatures
- Differentiate among conduction, convection, and radiation
- Differentiate between convection movement and general air circulation
- List reasons for unequal heating of the earth's surface (land and water)
- Explain how latitude affects the amount of energy received from the sun
- Differentiate between weather and climate
- Explain how mountain ranges affect climate
- Differentiate between continental and marine climates
- Identify the processes in the water cycle
- Explain how humidity relates to the amount of water vapor in the air
- Describe how air masses form
- Explain the relationship of fronts to air masses
- Differentiate fronts, temperature, and pressure on a weather map legend
- Identify weather instruments (e.g., barometer, thermometer, anemometer) and atmospheric conditions that they measure
- Identify the major kinds of clouds (e.g., cirrus, cumulus, stratus, and nimbus)
- Identify causes of hurricanes, tornadoes, and thunderstorms
- Describe the characteristics of hurricanes, tornadoes, and thunderstorms
- Describe the function of the ozone layer
- Describe the impact of technology on the ozone
- Interpret a weather map
- Record measurements of local rainfall, temperature, air pressure, relative humidity, cloud cover and type, and wind speed
- Explain the Greenhouse Effect

**BIL:** Essential – PC, ESA, HM, WEM, FWM  
 Recommended – HS, ECA, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM	I	P
FWM	I	P
GIS	I	R

**Competency 8.3: Determine the quality and quantity of water resources**

**Competency Builders:**

Identify present and potential sources of water pollution (e.g., point and non-point sources)

Identify present and potential sources of water pollution in local area

Evaluate quality of given sample of water

Calculate the volume and surface area of ponds, lakes, and streams

Plan improvements of waterways, ponds, stream banks, and shorelines

Determine stream flow

Collect water samples from a representative test site

Label water samples from a representative test site

Store water samples from a representative test site

Determine the quality of water samples by measuring for pH, turbidity, dissolved solids and dissolved oxygen, visual observation

Investigate watershed boundaries and drainage patterns

Monitor water levels of rivers, streams, ponds and lakes

Monitor erosion hazards and environmental quality

Determine quality of water samples by examination of particles

**BIL:** Essential – PC, ESA, HM, WEM, FWM, GIS  
Recommended – HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	P	R
ESA	P	R
HS	I	R
ECA	I	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

**Competency 8.4: Outline the movement and distribution of water in the environment**

**Competency Builders:**

List the areas of distribution of the earth's water

List the properties of water

Differentiate between suspensions and solutions

Illustrate the polar covalent bond between the hydrogen and oxygen atoms in a water molecule

Describe the three physical states of water

Explain evaporation, humidity, and condensation

Illustrate the hydrological cycle and its processes

Identify the functions and uses of water in the environment



**BIL:** Essential – ESA, HM, WEM, FWM, GIS  
Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	P	R
HS	I	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

**Competency 8.5: Analyze the relationships between plants and animals within ecosystems**

**Competency Builders:**

Illustrate the major categories of organisms

Differentiate among biomes

Differentiate among types of ecosystems

Explain the dynamic nature of ecosystems

Identify the functions of producers and consumers

Explain how biotic and abiotic factors affect producers and consumers

Compare the growth and development of various types of plant forms

Categorize the various forms of animal life

Describe the interactions between producers, consumers, decomposers, and antagonists

Illustrate a food chain and food web

**BIL:** Essential – PC, ESA, WEM, FWM, GIS  
Recommended – HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	P	R
ESA	P	
HS	I	R
ECA	I	R
HM		
WEM	P	R
FWM	P	R
GIS	P	R

**Competency 8.6: Analyze the character and value of natural resources**

**Competency Builders:**

Describe the value of natural resources

Describe the major categories of natural resources

Describe the types and distributions of natural resources

Contrast the origins of natural resources

Differentiate between renewable and non-renewable natural resources

**BIL:** Essential – ESA, WEM, FWM, GIS  
Recommended – PC, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	P	
HS	I	R
ECA	I	R
HM	I	P
WEM	P	R
FWM	P	R
GIS	P	

**Competency 8.7: Distinguish between renewable and non-renewable natural resources**

**Competency Builders:**

Explain renewable natural resources

Explain the major categories of renewable natural resources

Identify the origins of renewable natural resources

Describe the value of renewable natural resources

Explain non-renewable natural resources

Explain the major categories of non-renewable natural resources

Identify the origins of categories of non-renewable natural resources

Describe the value of non-renewable natural resources

**BIL:** Essential – ESA, WEM, FWM, GIS  
Recommended – PC, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	P	R
HS	I	R
ECA	I	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

**Competency 8.8: Evaluate the exploitation of natural resources**

**Competency Builders:**

Evaluate natural events that alter the environment

Evaluate various methods used to obtain natural resources

Evaluate the effects of obtaining natural resources on the environment

Identify the primary factor for the exploitation of natural resources

Identify the technological advances contributing to the exploitation of natural resources by industry

Identify the technological advances contributing to the exploitation of natural resources by agriculture

Identify the transportation advances contributing to the exploitation of natural resources

**BIL:** Recommended – PC, ESA, HS, ECA, HM, WEM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM	P	R
WEM	I	R
FWM		
GIS	I	R

**Competency 8.9: Describe how alternative energy sources can reduce fossil fuel consumption**

**Competency Builders:**

Describe the operation of a solar water distiller

Describe the operation of a solar oven

Describe the operation of a wind generated water pump

Describe the operation of a sundial

Describe the mechanical operation of a solar hot water heater

Describe advanced solar technology

Describe alternative energy sources and technology

**BIL:** Essential – PC, ESA, GIS  
Recommended – HS, ECA, HM, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	P	R
ESA	P	R
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM	I	R
GIS	P	R

**Competency 8.10: Evaluate the impact of an increasing human population on the environment and humans**

**Competency Builders:**

Explain how the history and growth of the human population during the past four thousand years has affected the environment

Explain doubling time, natural increase, natural decrease, rate of population change, and zero population growth

Interpret a population profile

Compare the population profile of a developing country to one of a developed country

Analyze the relationship between a country's economic status and its population

Identify the results of increases in the population on the environment

**BIL:** Essential – PC, ESA, HS, ECA, WEM, FWM, GIS  
 Recommended – HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	P	R
HS	I	P
ECA	I	R
HM	I	R
WEM	P	R
FWM	I	R
GIS	P	R

**Competency 8.11: Evaluate the consequences of resource use and abuse on the environment**

**Competency Builders:**

- Identify the results of overuse that occurred from exploitation
- Trace the effects of pollution through a food chain
- Differentiate between biodegradable and non-biodegradable products
- Differentiate between organic farming and farming practices that incorporate the use of biocides and inorganic fertilizers and their comparative effects on the environment
- Describe solid waste disposal methods and groundwater contamination
- Explain how fossil fuels contribute to acid rain and petrochemical pollution
- Evaluate pro and con attributes of nuclear energy
- Describe impact of resource use and abuse on air quality
- Describe impact of resource use and abuse on water quality
- Describe impact of resource use and abuse on soil productivity
- Identify several causes for the reduction of habitat
- Differentiate among the various types of habitat
- Analyze why preservation of habitat is essential
- List examples of threatened, endangered, introduced, extinct and extirpated plant and animal species
- Evaluate causes for the decrease of both plant and animal species
- Explain factors contributing to accidental resource abuse
- Explain factors contributing to incidental resource abuse
- Explain factors contributing to deliberate resource abuse

**BIL:** Essential – PC, ECA  
 Recommended – HS, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		
HS	I	R
ECA	I	P
HM	I	R
WEM	I	R
FWM	I	R
GIS	IR	P

**Competency 8.12: Identify the impact of individuals/organizations on the development of environmental policies and issues**

**Competency Builders:**

- List prominent individuals/organizations involved with environmental issues
- Explain current trends in property rights and compensation
- Identify the major issues addressed by environmental organizations
- Identify major incidents that have resulted in legislation
- Evaluate results of environmental restoration and conservation efforts
- Identify pros and cons of environmental organizations



**BIL:** Essential – PC  
Recommended – ESA, HS, ECA, WEM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS	I	R

**Competency 8.13: Evaluate the effects of research and education on environmental issues**

**Competency Builders:**

Identify the methods of research used by both public and private agencies in restoration and conservation efforts

Identify the process used in restoration and conservation research

Explain the interrelationship between research and education

Evaluate the outcome of environmental research projects

**BIL:** Essential – PC  
Recommended – ESA, HS, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	R
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM	I	R
GIS	I	R

**Competency 8.14: Evaluate government's role in environmental restoration and conservation**

**Competency Builders:**

Evaluate the effects legislation has had on the environment

Identify federal and state agencies and their roles in restoration and conservation

**BIL:** Recommended – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM	I	R
GIS	I	R

**Competency 8.15: Evaluate the impact and implications of environmental restoration, preservation and resource conservation**

**Competency Builders:**

Evaluate the importance of environmental restoration, preservation and conservation

Cite examples of various levels of environmental restoration, preservation and conservation

Evaluate the results of environmental restoration, preservation and conservation

Identify economic issues of environmental restoration, preservation and conservation projects

Identify non-economic benefits of environmental restoration, preservation and conservation activities

**BIL:** Essential – PC, ESA, HS, ECA, GIS  
Recommended – HM, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	P	R
HS	I	P
ECA	I	P
HM	I	R
WEM	P	R
FWM	P	R
GIS	P	R

**Competency 8.16: Evaluate the role of responsible stewardship in maintaining a healthy environment**

**Competency Builders:**

Describe responsible stewardship

Evaluate the need for responsible stewardship and environmental accountability

Identify types of environmental accountability and cite examples of each

Cite results stemming from responsible stewardship

## Unit 9: Energy Sources

**BIL:** Recommended – PC, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		
HS		
ECA	I	R
HM		
WEM	I	R
FWM		
GIS		

**Competency 9.1: Identify conventional energy sources and their environmental impact**

### **Competency Builders:**

Identify natural gas resources and their environmental impact

Identify coal resources and their environmental impact

Identify petroleum resources and their environmental impact

Identify nuclear resources and their environmental impact

Identify hydroelectric resources and their environmental impact

**BIL:** Recommended - PC, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		
HS		
ECA	I	R
HM		
WEM	I	R
FWM		
GIS		

**Competency 9.2: Identify alternate energy sources and their environmental impact**

**Competency Builders:**

Identify geothermal resources and their environmental impact

Identify wind resources and their environmental impact

Identify solar energy resources and their environmental impact

## Unit 10: Environmental Assessment

**BIL:** Essential - ESA  
Recommended – PC, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

### Competency 10.1: Gather data for assessment (Phase I)

#### Competency Builders:

- Identify key elements in Phase I, II, and III assessments
- Describe the importance of a title search
- Gather drainage area data
- Complete field data sheet
- Record physical and topographical data
- Interpret basic soil differences
- Measure ground water level
- Identify flood plain areas
- Measure stream flow
- Complete a title search
- Calculate water run off

**BIL:** Recommended – PC, ESA, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		I
HS		
ECA		I
HM	I	R
WEM		
FWM		
GIS		

**Competency 10.2: Identify past practices (Phase I)**

**Competency Builders:**

Locate regulatory reference materials

Collect background information

Verify accuracy of information

Investigate background of complaint

Interact with various regulatory agencies

Refer to regulatory reference materials



**BIL:** Essential – PC, ESA, HS, HM, WEM, GIS  
 Recommended – ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM	I	P
WEM	I	P
FWM		I
GIS	I	P

**Competency 10.3: Collect physical data: composite; grab; continuous; remote sensing; grid; background; core; auto; biological; air and opacity (Phase II)**

**Competency Builders:**

- Monitor protocol and procedures
- Select appropriate equipment
- Identify safety hazards of materials
- Demonstrate procedures for safe sampling collection and handling
- Develop “Chain of Custody” procedures
- Develop a sampling plan
- Describe federal and state sampling regulations
- Follow appropriate preparation procedures
- Follow appropriate marking procedures

**BIL:** Essential – ESA, WEM  
 Recommended – PC, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM	I	P
FWM		
GIS		

**Competency 10.4: Conduct lab/field analysis: biochemical oxygen demand (BOD); chemical oxygen demand (COD); pH; specific conductivity; dissolved oxygen; suspended solids; nitrates and nitrites; air particulate; percolation.**

**Competency Builders:**

Measure water temperature

Measure water hardness

Measure water level and flow

Measure turbidity

Measure oxygen level (HS)

Measure Lower Explosive Levels (LEL) [R-HS]

Measure air flow rate and temperature [R-HS]

Describe procedures for measuring toxic gasses, organic vapors, and radiation [R-HS]

Measure toxic gases [R-HS]

Measure organic vapors [R-HS]

Measure basic field levels of contamination [R-HS]

Measure radiation [R-HS]

Sample for radon [R-HS]

Measure flashpoint [R-HS]

Measure free liquids

Measure moisture content/dry content (DC)

Measure density

Sample for chlorinated compounds

Identify background analytical data to establish norm for site

**BIL:** Essential – PC, ESA, HS, HM, WEM, GIS  
Recommended – ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM	I	P
WEM	I	P
FWM		I
GIS	I	P

**Competency 10.5: Analyze data**

**Competency Builders:**

Draw conclusions from data

Write technical reports

Explain appropriate QA/QC procedures

Identify provisions of SW846

**BIL:** Essential – PC, ESA, HS, ECA, WEM, FWM, GIS  
Recommended – HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	P
FWM	I	P
GIS	I	P

**Competency 10.6: Demonstrate the use of fundamental of statistics in sampling practices**

**Competency Builders:**

Distinguish a population

Demonstrate the steps of statistical analysis

Identify a random sample from a population

Explain the use a random numbers table

**BIL:** Recommended – PC, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		
HS	I	R
ECA		I
HM	I	R
WEM	I	P
FWM		
GIS		

**Competency 10.7: Identify procedures for site remediation**

**Competency Builders:**

Interpret Data

Identify options

Resolve issue with concerned party(s)

Assess options for corrective action

Implement selected option for correction

Document investigation with summary reports

Identify health and safety activities

**BIL:** Recommended – PC, ESA, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		
ECA	I	R
HM		I
WEM	I	R
FWM		
GIS		

**Competency 10.8: Assess water systems**

**Competency Builders:**

Complete a water quality assessment on a local surface water body

Complete a ground water quality assessment within a well head protection area

Develop a NPDES Plan for a construction site

Complete a surface water assessment within a watershed

Develop a primary and secondary containment system

Evaluate the efficiency of a treatment facility

Conduct a sediment study to determine best management practice

**BIL:** Essential – ESA  
Recommended – PC, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		P
HS		I
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

**Competency 10.9: Assess air systems**

**Competency Builders:**

Conduct air emission inventory

Monitor indoor air quality

Assess pollution control system

Monitor auto emissions

Monitor volatile organic compounds (VOC)

**BIL:** Recommended – PC, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		I
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

**Competency 10.10: Manage solid waste systems**

**Competency Builders:**

Select a municipal solid waste site (MSW)

Audit a MSW

Identify resources available through recycled solid waste

Draft a proposal to improve the control of solid waste management

Develop and maintain satellite accumulation area (SAA)

Draft/revise a chemical hygiene plan (OSHA 29 CFR 1910.1450) [R-HS]



## Unit 11: Plant Science

**BIL:** Essential – ESA, WEM, FWM  
Recommended – ECA

EDU:	12	AD
PC		
ESA	P	R
HS		
ECA	P	R
HM		
WEM	P	R
FWM	P	R
GIS		

### Competency 11.1: Explain plant structure and uses

#### Competency Builders:

List the parts of the plant and their functions including: seed (embryo, cotyledon, groat), root (tuber, rhizome, stolon, corm, bulb), stem (xylem, phloem, pith), leaf (blade, lobe, cotyledon, auricle, ligule), meristem (apical, dominant, terminal, auxiliary bud), and flowers (anther, stamen, style, ovary)

Contrast dicots and monocots based upon meristematic locations and reproductive structures

Describe the uses of plants (e.g., food, feed, fiber, soil, wood, recreation, erosion control, nutrient recycling, medicinal, industrial-dyes, chemicals)

Differentiate among perennials, biennials and annuals

Differentiate between seed crops and vegetative crops

Describe the life cycle of a crop plant (i.e., from seed to vegetative stage to reproductive stage to seed)

Identify the characteristics used in plant identification (e.g., leaf type and arrangement, type of fruiting structures, type of root system, stem characteristics)

**BIL:** Essential – ESA, FWM  
 Recommended – ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	P	
HS		
ECA	I	R
HM		
WEM	I	R
FWM	I	P
GIS		

**Competency 11.2: Describe the physiology of plants**

**Competency Builders:**

Identify the parts of a plant cell and the function of each part

Describe the process of photosynthesis

Describe the function of the chlorophyll molecule

Describe the process of respiration

Write a simplified word and symbol formula of photosynthesis and respiration

List conditions that affect photosynthesis

Compare the processes of photosynthesis and respiration

Explain the process of osmosis

Describe the basic make-up and function of carbohydrates (sugars and starches), lipids (fats and oils) and proteins (structural and enzymatic)

**BIL:** Essential – FWM  
Recommended – ESA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	I	R
HS		
ECA		
HM		
WEM	I	R
FWM	I	P
GIS		

**Competency 11.3: Explain plant nutrition**

**Competency Builders:**

Explain how available nutrients, leaching, element, organic fertilizer, and inorganic fertilizer impact plant nutrition [R-WEM]

Identify the primary elements and their functions in plant growth

Explain green manure crop

Explain the relationship of adequate fertilization to yields

Explain the relationship of tillering in grain crops

Explain the relationship of return on investment in crop production

Describe purpose of inoculation of legume seeds with nitrogen fixing organisms

Explain minimum, optimum, and luxury consumption of soil nutrients by the plant [R-WEM]

Compare nutrients in the soil versus what plants get from air and water

**BIL:** Recommended – ESA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	I	R
HS		
ECA		
HM		
WEM		
FWM		I
GIS		

**Competency 11.4: Evaluate plant fertilization techniques**

**Competency Builders:**

Identify the micro-nutrients needed in plants and their chemical symbols

Identify deficiencies caused by minor element deficiency

Differentiate between organic and inorganic fertilizers

Identify global uses of inorganic and organic fertilizers

Describe the pollution hazards associated with over fertilization

Evaluate the latest techniques used to dispense only required amounts of fertilizer for crops

**BIL:** Recommended – ESA, ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	I	R
HS		
ECA	I	R
HM		
WEM		
FWM		I
GIS		

**Competency 11.5: Identify environmental factors affecting plants**

**Competency Builders:**

Identify external influences on plant growth

Explain photoperiodism and dormancy in plants

Evaluate the effects of plant hormones (e.g., auxins, gibberellins, and cytokinins) on plant growth

Evaluate the commercial uses of auxins

Describe the various tropic responses

Explain the cause of gnostic movement

List some warm and cool season crops

List optimum growth conditions for different types of plants

Explain how crops may be managed to maximize environmental resources (e.g., establishing crop canopies to intercept 100% of light energy prior to fruiting, planting at a date that ensures sufficient biomass to attain maximum yield)

Describe the influence of day length on plant growth

Explain how the cycle of the seasons influences plant growth

Identify how planting date, row spacing, and plant population affect crop yield and quality

**BIL:** Essential – WEM, FWM  
 Recommended – ESA, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	I	R
HS		
ECA		
HM		
WEM		P
FWM	I	P
GIS		I

**Competency 11.6: Conduct vegetation analysis**

**Competency Builders:**

- Demonstrate the proper use of field instruments
- Conduct a quadrant analysis
- Conduct a line transect analysis
- Conduct a belt transect analysis
- Conduct a random pairs analysis
- Perform a comprehensive ecological study of a forest

**BIL:** Recommended – FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		I
GIS		

**Competency 11.7: Explain methods to improve plant seed quality**

**Competency Builders:**

Explain how heredity, genetics, inbreeding, crossing, progeny, self-fertilization, cross-fertilization, mutation, hybrid, systemic pesticide, toxic, and vigor impact seed quality

Explain seed development, morphology and composition

List the characteristics of good seeds

Describe the factors that create poor seed quality

Describe the history of crop improvement

List major aims of plant breeders

Describe three methods of crop improvement

Identify state agency responsible for seed certification

Describe major points and economic aspects to consider when identifying varieties for planting

Explain the danger of monogenetic type crops (e.g., southern corn blight)

Evaluate the possible impact of genetic engineering

Describe breeding for pest resistance (insects, nematodes, and diseases)

Describe the classes of seed (e.g., breeders, registered, certified)

Differentiate between hybrid seed and seed from open pollinated or self-fed plants

Explain how a "hard seed coat" can be used to maintain high quality seed

Explain why plant breeding takes several years

Explain why breeders have to constantly be developing improved varieties

**BIL:** Recommended – ESA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	I	R
HS		
ECA		
HM		
WEM		
FWM	I	R
GIS		

**Competency 11.8: Control weeds**

**Competency Builders:**

List ways weeds spread

List reasons weeds are harmful

Explain the following methods of controlling weeds (e.g., mechanical, biological, IPM)

Explain mode of action of common herbicides

Explain weed resistance to herbicides

Evaluate possible applications of genetic engineering and gene splicing to weed control

Explain how a spray system works (pump, pressure regulator)

Explain how herbicides kill weeds

Explain why some herbicides are applied before or after a crop is planted

Explain why weed problems depend on when they occur during growing season of crop

Identify the major weed species and options available for controlling each

Apply herbicide(s)



**BIL:** Essential – WEM  
Recommended – FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		P
FWM		I
GIS		

**Competency 11.9: Explain moisture control**

**Competency Builders:**

Identify the impact of irrigation, mulch, organic matter, runoff, seepage, subsoiling, and tillage on moisture control

List three methods of moisture control

List the cultural practices used in moisture control (annually and at planting)

Describe importance of internal and external drainage in soils for crop production

Describe importance of irrigation to crops

Describe the methods of irrigation (e.g., drip, furrow, sprinkler, flood)

Explain the unique properties of water

Describe the world's water supply by volume and percent usable

Explain how irrigation causes salinity problems

Describe several regions of the world where salinity has stopped entirely or decreased crop production

Explain salt water intrusion in irrigation wells

Describe desalination possibilities for irrigation water

Explain subsidence caused by removal of irrigation water

Describe methods used to reduce irrigation water loss

Explain the use of tensiometers and moisture meters

Describe the idea of permaculture

Explain irrigation scheduling

**BIL:** Essential – FWM  
 Recommended – ESA, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	P	
HS		
ECA	I	
HM		
WEM	I	P
FWM	I	P
GIS		

**Competency 11.10: Classify plants**

**Competency Builders:**

Describe the classifications system of living things according to the Kingdoms of Monera (Prokaryotic Cells), Protista (Eukaryotic Cells), Animalia, and Plantae

Describe the different levels of classification within the plant kingdom

Explain the differences in the classes Gymnospermae and Angiospermae

Explain Carolus Linnaeus' binomial system of classification for genus and species

Explain the significance of species plant breeding

**BIL:** Recommended – ESA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	P	R
HS		
ECA		
HM		
WEM		
FWM		
GIS		

**Competency 11.11: Evaluate the role of genetics in environmental systems**

**Competency Builders:**

Describe the role played by chromosome, gene, DNA, RNA, genotypes, phenotypes, heterozygous, homozygous, alleles, hybrid, inbreeding, hybrid vigor, polyploidy, molecular biology, genetic engineering, genes, sexual crossing, genome, vectors, gene transfer, natural identification, artificial identification, heredity, chromosomes, gene-splicing, gene cloning, toxins, pathogens, and biological control in genetics

Describe mitosis

Describe meiosis

Explain incomplete dominance

Explain the cause of mutation

Describe the occurrence of multiple alleles

Explain the importance of mass identification

Describe the contributions of scientists to applied genetics (e.g., Burbank, Mendel)

Explain the "Green Revolution"

Evaluate the possible impact of genetic engineering to plant improvement

Evaluate possible applications of genetic engineering and gene splicing on pest control

**BIL:** Essential – FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

### **Competency 11.12: Propagate plants**

#### **Competency Builders:**

Contrast sexual and asexual propagation

Identify factors that affect seed germination

Describe mass propagation through tissue culture

Identify some of the pitfalls to avoid in propagating plants

Describe the soil chemical and physical properties that influence seed germination and emergency

Evaluate anthroculture and gene splicing as methods for genetic improvement

Explain biotechnology as it relates to plant improvement

Compare organic farming to standard production systems

Describe hydroponic crop production

**BIL:** Essential – FWM  
Recommended – ESA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		I
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

**Competency 11.13: Identify plant diseases**

**Competency Builders:**

Identify major causes of plant diseases

Identify the symptoms and effects of major diseases on plants

Identify several methods by which diseases are transmitted in plants

Identify environmental conditions that favor or hinder disease development

**BIL:** Recommended – FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		I
GIS		

**Competency 11.14: Control plant diseases and pests**

**Competency Builders:**

Explain the "disease triangle"

Evaluate cultural practices that may be used to prevent plant diseases

Evaluate the impact of genetic engineering on control of plant disease

Explain how chemicals control diseases

Evaluate how genetic resistance reduces production costs and potential environmental impact from spraying

Evaluate the economic importance of controlling plant diseases

Employ safety precautions in handling pesticides

Control plant diseases through fumigant, fungicide, resistance, sprays, dust, volatile, crop rotation, and sanitation

Identify control methods of plant pests (e.g., insects, slugs, worms, nematodes)

**BIL:** Essential – ESA, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	I	P
HS		
ECA		
HM		
WEM	I	P
FWM	I	P
GIS		

**Competency 11.15: Explain aquatic biology**

**Competency Builders:**

Identify and classify aquatic plants, including algae, fungi and aquatic insects

Explain eutrophication principles

Describe stream pollution and species diversity

Describe effects of algae on water quality

## Unit 12: Soil Science

**BIL:** Essential – ESA, ECA, HM, WEM, FWM  
Recommended – PC

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	P	R
HS		
ECA	P	R
HM	P	R
WEM	I	P
FWM	I	P
GIS		

### Competency 12.1: Describe soil geology

#### Competency Builders:

Identify the four major layers of the earth

Identify classes of rock (e.g., igneous, sedimentary, metamorphic)

Match rock classes with their mode of origin

Classify common rocks (e.g., sandstone, limestone, shale, slate, marble, quartzite, granite, obsidian)

Identify particles of varying size and density

Explain how materials deposited in the ocean form sedimentary rock

Explain how rocks change from one form to another

Explain the relationship of minerals to granite

Describe soil formation

Differentiate among the major types of parent material

Identify the factors that exert the most influence on soil formation

List the forms of plant life found in poor soil conditions

Explain how different climatic conditions affect soil formation

Differentiate between surface soil and subsoil

Identify the soil horizons in a soil profile



**BIL:** Essential – ESA, FWM  
 Recommended – PC, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	P	R
HS		
ECA	I	R
HM	I	R
WEM	I	R
FWM	P	R
GIS		

**Competency 12.2: Describe composition of soil**

**Competency Builders:**

List the main components found in a normal soil

Explain the composition of the solid part of the soil

Describe the main sources of organic matter

List the approximate percentage in which each of the soil properties is found in a normal soil

Differentiate between soil low in organic matter and soil high in organic matter

Explain the value of each soil component with regard to proper growth of plants

**BIL:** Essential – ESA, FWM  
 Recommended – PC, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM	I	R
FWM	P	R
GIS		

**Competency 12.3: Identify physical properties of soil**

**Competency Builders:**

Interpret the organic matter content of the surface soil using soil color

Interpret internal drainage of the subsoil by observing soil color

Differentiate between "light" and "heavy" soils

Determine the texture of a soil sample

Classify soil samples using the textural triangle as a guide

Explain the effects of soil structure on productivity

Explain why dark color is not always due to organic matter content

Explain the effects of organic matter on soil structure

Describe the effects of soil structure on infiltration, percolation, and the potential for ground water contamination

Explain how soil type affects crop identification

Compare root restricting boundaries (plow pan, fragipan, etc.)

Describe factors that contribute to the information of tillage or traffic pans

Describe methods for alleviating traffic pans (e.g., subsoiling, reduced tillage, no-till)

**BIL:** Essential – ESA, FWM  
 Recommended – PC, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM		I
FWM	I	P
GIS		

**Competency 12.4: Describe the biological properties of soil**

**Competency Builders:**

- List the biological properties of soils
- Explain how biological properties affect the nature and conditions of soil
- Identify the microorganisms
- List the soil microorganisms
- List the soil microorganisms beneficial to farmers
- Describe the role of higher forms of plant and animal life in soil
- Explain the nitrogen cycle and phosphorus cycle
- Explain where the energy comes from to carry out the nitrogen transformations
- Identify common bacteria in the nitrogen cycle
- Explain the symbiotic relationship between bacteria and plants
- Specify where bacteria are located in the root of the plants
- Explain nitrogen fixation
- Identify the roles of different types of bacteria in nitrogen fixation
- Describe the concept of mineralization and immobilization of plant nutrients by soil microorganisms
- Explain the biological effects on soils when amended with fertilizers, pesticides, and recyclable materials such as municipal wastes
- Describe the effects of poor drainage or waterlogging on soil properties and plant growth

**BIL:** Essential – ESA, FWM  
Recommended – PC, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM		I
FWM	I	P
GIS		

**Competency 12.5: Describe the chemical properties of soil**

**Competency Builders:**

List the chemical properties of soil

Explain how chemical properties affect the biological properties of soil and the nature and conditions of the soil

Explain the chemical effects on soils when amended with fertilizers, pesticides, and recyclable materials such as municipal wastes

Describe the effect of sand, silt, and clay content on water and nutrient holding ability of soils (CEC-cation exchange capacity)

Explain how charges on clay particles affect nutrient retention

Compare different types of clay to soil nutrient availability

**BIL:** Essential – ESA, FWM  
 Recommended – PC, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM	P	R
FWM	P	R
GIS		

**Competency 12.6: Describe soil acidity and alkalinity**

**Competency Builders:**

Create a chart of the pH scale to show degrees of soil acidity and alkalinity

Conduct laboratory tests for acidity of common products (e.g., fresh milk, sour milk, orange juice, and lemon juice)

Explain how calcium affects soil acidity and the availability of other elements

Explain how pH symbols are used in denoting the degree of acidity and alkalinity in soils

Describe the conditions that lead to soil acidity or alkalinity

List the pH ranges of the major crops

Explain how soil acidity or basicity is corrected

Explain how soil pH affects the availability of nutrients

**BIL:** Essential – ESA, FWM  
Recommended – PC, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM	I	P
FWM	P	R
GIS		

**Competency 12.7: Test soil samples to determine characteristics**

**Competency Builders:**

Collect soil samples from test area

Complete soil data forms

Determine soil pH

Conduct soil mineral and elemental analysis

Record texture, structure, temperature, and color of each soil layer

Construct a soil micro monolith of a soil profile or soil pit

Analyze soil data

Write report

**BIL:** Essential – ESA, FWM  
 Recommended – PC, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS		
ECA		
HM		
WEM		I
FWM	I	P
GIS		

**Competency 12.8: Explain liming to correct soil acidity**

**Competency Builders:**

- List the benefits obtained from liming a soil
- List the steps involved in liming acid soils used for growing plants
- Explain how lime reduces soil acidity
- Explain how to determine the lime requirement for a specific crop
- Identify different kinds of lime materials
- Describe the appearance of plants growing in soils of different pH levels
- List some sources of commercial lime
- Describe different methods of applying lime and the type of equipment used
- Formulate a liming schedule for various crops
- Explain the effect of soil acidity on soil structure, water infiltration and soil aggregation
- List some problems and effects associated with over-liming soil
- Explain how lime particle size affects its ability to reduce soil acidity
- List several materials that can be used to increase soil acidity or lower pH

**BIL:** Essential – ESA  
Recommended – PC, ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS		
ECA	I	R
HM		
WEM		
FWM	I	R
GIS		

**Competency 12.9: Identify nutrient requirements of plants**

**Competency Builders:**

Identify groups into which nutrient requirements of plants are divided

Describe the interactions of nutrient availability levels on nutrient toxicity and deficiency

Identify toxicity symptoms caused by excessive manganese and aluminum

Identify major sources of N, P, K, S, Ca, and Mg in soils

Identify factors that influence the availability of these nutrients in soils

Explain how soil pH affects nutrient availability

Explain how different types of root systems affect plant nutrient uptake



**BIL:** Recommended – PC, ESA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	R
HS		
ECA		
HM		
WEM		
FWM	I	R
GIS		

**Competency 12.10: Differentiate between organic and inorganic fertilizers**

**Competency Builders:**

Identify sources of inorganic fertilizers

Identify sources of organic fertilizers

Identify the main plant nutrients supplied by inorganic and organic fertilizers

Identify multinutrient fertilizers

Explain how plants obtain carbon, oxygen, hydrogen, nitrogen, phosphorus, and potassium

Differentiate between a fertilizer grade and a fertilizer analysis

Explain fertilizer ratio

Explain where most of the nitrogen in the soil is derived

Describe the advantages and disadvantages of dry versus liquid fertilizer

Explain the advantages of foliar fertilization

Identify the factors that influence the efficiency of applied fertilizer such as leaching or fixation

**BIL:** Recommended – PC, ESA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	R
HS		
ECA		
HM		
WEM		
FWM	I	R
GIS		

**Competency 12.11: Describe fertilizer application**

**Competency Builders:**

- Explain variable rate fertilization using GPS
- Explain the economic factors to consider in buying fertilizers
- Describe the methods of applying solid and liquid fertilizers
- Explain the purpose of the different placements of fertilizer in the soil, and the relation these placements have to the seed and the growing plant
- List the ways fertilizer benefits crop production
- Explain how fertilizer applications can decrease crop production
- Identify possible losses of each major nutrient and their influences on quality of water in lakes and streams, groundwater quality, and atmospheric quality

**BIL:** Essential – ESA, WEM, FWM  
 Recommended – PC, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA	I	P
HM		I
WEM	I	P
FWM	I	P
GIS		

**Competency 12.12: Explain classification of soil water**

**Competency Builders:**

Compare gravitational, capillary, and hygroscopic water

Demonstrate the water-holding capacities of sandy and clayey soils

Determine soil water availability

List ways available water can be lost by soils

Identify factors in determining water movement in the soil

Explain the main purpose of water conservation

Explain how production techniques influence the efficiency with which water is utilized by plants

Explain water holding capacity and how to determine field soil moisture

Explain the impact of texture and structure on field capacity

**BIL:** Essential – PC, ESA, WEM, FWM  
Recommended - GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS		
ECA		
HM		
WEM	I	P
FWM	I	P
GIS	I	R

**Competency 12.13: Explain the relationship between soil classifications and land use**

**Competency Builders:**

- List the physical features of land and soil necessary for classifying land
- Explain the characteristics of each of the land classes
- Explain how land capability classes are recorded for use
- Explain how topography results from rock type and the opposition of internal and external forces acting on the land surface
- Construct a simple topographic map from a three-dimensional model
- Demonstrate how chemical and physical weathering work together
- Explain how soil relates to the weathering process
- Differentiate among topsoil, subsoil, and parent (weathered) rock
- Explain permeability
- Differentiate between permeability and porosity
- Identify the equipment needed to classify soils
- Identify the management practices followed to obtain maximum yields and proper soil conservation
- Differentiate among different solid structures and textures
- Differentiate between erosion and weathering
- Describe the role of gravity as the force behind erosion
- Explain how vegetation and type of rock affect weathering rate
- Identify the agents of erosion, their relative effect, and action to gravity
- Explain why and how glaciers move
- List evidences of glaciation
- Explain why water is the principal agent of erosion
- Explain how slope and velocity increase the rate of erosion
- Identify landforms that will result from stream action, (e.g., deltas, meanders, flood plains, oxbow lake, cut bank, sand bars)
- Explain how forces within the earth cause uplift or mountain building
- Explain folding

Differentiate among normal, reverse, and horizontal faults  
Explain plate tectonics (cause) and continental drift (effect)  
Explain convection currents  
Explain how the occurrence of faults relates to earthquakes  
Explain how seismographs record earthquakes  
Differentiate between the focus and the epicenter  
Explain tsunami  
Describe how use of land is affected by soil depth, texture, permeability, slope, surface drainage, and degree of erosion  
Differentiate among types of water erosion  
Explain why soil erosion is very important to land evaluation  
Describe the major types of erosion  
Identify the factors that influence erosion of soil  
Evaluate the effectiveness of erosion prevention procedures  
Evaluate land use for construction purposes

## Unit 13: Hydrology

**BIL:** Essential – PC, ESA, HM, WEM, GIS  
Recommended – ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS		
ECA	P	R
HM	P	R
WEM	I	P
FWM		I
GIS	I	P

### Competency 13.1: Explain hydrology

#### Competency Builders:

Describe the hydrologic cycle

Differentiate between the surface hydrologic system and the subsurface hydrologic system

Explain the role of a hydrologist and a hydrogeologist

Identify terminology used in groundwater hydrology

Explain watersheds in relationship to groundwater table

Describe the basic concepts of flow of groundwater in various well models

Identify geologic conditions for determining the potential groundwater supply in various lithologic settings

**BIL:** Essential – PC, ESA, HM, WEM  
 Recommended – ECA, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS		
ECA	I	R
HM	I	P
WEM	I	P
FWM	I	R
GIS	I	R

**Competency 13.2: Explain geologic and meteorologic principles affecting groundwater supply**

**Competency Builders:**

- Explain evaporation, transpiration, and evapotranspiration
- Describe the relationship between precipitation and aquifer recharge
- Determine basic rock type of drill cuttings and their relative importance to groundwater potential
- Determine the porosity of unconsolidated sediment in relation to grain size, grain distribution and composition
- Determine relative permeability of unconsolidated sediment
- Explain the relationship between specific retention and the specific yield of various rock types and characteristics
- Calculate the basic hydraulics involved with groundwater flow including velocity, hydraulic head, and potential flow
- Describe the basic concepts of flow of groundwater in various well models
- Identify geologic conditions for determining the potential groundwater supply in various lithologic settings

**BIL:** Essential – ESA, WEM  
Recommended – PC, ECA, HM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS		
ECA		I
HM	I	R
WEM	I	P
FWM		I
GIS		I

**Competency 13.3: Conduct channel flow analysis**

**Competency Builders:**

Identify open channel flow equipment

Measure open channel flow

Characterize open channel flow

Calculate open channel flow



**BIL:** Essential - ESA  
 Recommended – PC, ECA, HM, WEM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		P
HS		
ECA	I	R
HM	I	R
WEM		I
FWM		
GIS		I

**Competency 13.4: Identify basic criteria for water well design**

**Competency Builders:**

Identify various forms of well records

Determine subsurface structure and flow patterns

Describe basic methods of drilling

Differentiate between production, injection, and monitoring wells

Describe a basic water well system for production, injection, and monitoring

Identify applicable regulations/permit procedures

Identify well development requirements

Identify problems that may develop over the lifetime of a well

Identify well performance characteristics (e.g., flow rate, draw down)

Identify aquifer characteristics that may affect performance

**BIL:** Essential – PC, ESA, WEM  
Recommended – ECA, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		I

**Competency 13.5: Identify differences in groundwater potential**

**Competency Builders:**

Identify various geologic regions in the state

Describe the occurrences of groundwater in these geologic settings

Identify important aquifers in these geologic settings

Identify groundwater regions of the United States

Identify important aquifers in the United States

**BIL:** Essential – PC, ESA, ECA, HM, WEM  
 Recommended – FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS		
ECA	I	P
HM	I	P
WEM	I	P
FWM		I
GIS		I

**Competency 13.6: Identify environmental hazards associated with groundwater supplies**

**Competency Builders:**

Describe standard water quality tests

Identify various sources of contamination

Identify methods of restoration of groundwater supplies

Explain water law

Explain the environmental policies regarding groundwater supplies

Identify elements necessary for developing a study of potential groundwater contamination

## Unit 14: Pollution Control I

**BIL:** Essential – PC, ESA, ECA  
Recommended – HS, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM		
WEM		I
FWM		I
GIS		

### Competency 14.1: Identify presence of pollution

#### Competency Builders:

Evaluate complaints

Verify complaints

Determine extent of hazard

Prioritize complaints

Determine jurisdictions

Monitor instrumentation

Photograph and/or video site

Analyze data

Interpret results

Report violations

**BIL:** Essential – PC, ESA, ECA  
 Recommended – HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	IR	P
HS	I	E
ECA	I	P
HM		
WEM		I
FWM		
GIS		

**Competency 14.2: Perform environmental sampling**

**Competency Builders:**

- Make and record observations
- Conduct interviews
- Identify sampling instruments
- Identify appropriate sampling protocols
- Calibrate sampling instruments
- Take readings
- Determine sample types
- Identify sampling containers
- Take samples
- Preserve samples
- Analyze samples
- Complete chain of custody

**BIL:** Essential – PC, ESA  
 Recommended – ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		P
HS		
ECA	I	R
HM		
WEM		I
FWM		
GIS		

**Competency 14.3: Describe environmental impact from industrial and non-industrial processes**

**Competency Builders:**

Compare input flow vs output and waste stream flows from industrial as well as non-industrial (agricultural) processes

Identify pollution prevention applications

Describe environmental economic impact statements for an industrial process

## Unit 15: Pollution Control II

**BIL:** Essential – PC, ECA, HM  
Recommended – ESA, HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		I
HS	I	R
ECA	I	P
HM	I	P
WEM		
FWM		I
GIS		

### Competency 15.1: Manage pollution

#### Competency Builders:

Determine applicable regulations  
Control emissions and discharges from sources  
Install containment barriers  
Reroute source  
Implement corrective actions  
Implement contingency plan  
Monitor levels of pollution  
Develop episode control plan

**BIL:** Essential – PC, ESA, ECA, HM  
 Recommended – HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

**Competency 15.2: Quantify extent of pollution**

**Competency Builders:**

- Conduct field survey
- Determine sampling points
- Determine threat to public health and safety
- Sketch site
- Notify appropriate officials/agencies/personnel
- Initiate further studies
- Develop episode control plan



**BIL:** Essential – PC, ESA, ECA, HM  
Recommended – HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

**Competency 15.3: Locate sources of pollution**

**Competency Builders:**

Plan search activities

Examine documentation history

Conduct search activities

Take measurements [R-HS]

Sample for source of pollution

Conduct mechanical tests

Correct mechanical defects

**BIL:** Essential – PC, ESA, ECA, HM  
Recommended – HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

**Competency 15.4: Monitor remediation activities**

**Competency Builders:**

Describe procedure for monitoring pollution abatement at the source

Describe methods for monitoring magnitude of pollution [R-HS]

Describe procedure for monitoring clean-up [R-HS]

Assess impact of the event

Monitor the pollution abatement

**BIL:** Essential – PC, ESA, ECA, HM  
Recommended – HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	R
HS	I	R
ECA	I	R
HM	I	R
WEM		I
FWM		
GIS		

**Competency 15.5: Conduct Remediation Activities**

**Competency Builders:**

Initiate pollution abatement at the source

Investigate alternative technologies

Recommend methods of cleanup

Participate in the implementation of the remediation activity

**BIL:** Essential – PC, ECA, WEM  
Recommended – HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		
HS		
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

**Competency 15.6: Establish pollution management and prevention program** [E-PC]

**Competency Builders:**

- Determine possible sources of pollution
- Assess liability of possible pollution sources
- Establish purchasing policies
- Assess material substitution
- Assess incoming materials
- Develop proper handling procedures
- Communicate importance of RRR (reduce, reuse, and recycle)
- Participate in pollution prevention pledge program
- Recommend/implement process modifications
- Eliminate cross media (pollution) transfer
- Assess research needs and pending legislation

**BIL:** Essential – PC, ESA, ECA, HM, WEM  
Recommended – HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

### **Competency 15.7: Monitor ground and surface water pollution**

#### **Competency Builders:**

Describe aquatic biological systems

Identify types and sources of water contamination

Collect water samples for analysis

Measure water samples for pH, chloride, turbidity, dissolved solids, biotoxicity, and dissolved oxygen

Investigate watershed boundaries and drainage patterns

Monitor water levels of rivers, streams, ponds and lakes

Identify non-point source hazards

Identify accepted water quality standards for effluent

Demonstrate the technology applied to non-point source pollution control (e.g., stormwater and agriculture runoff)

Monitor water quality (in/out)

Monitor water use (in/out)

Determine water conservation options

Implement water conservation strategies

Analyze water samples

Assess treatment options

Explain impact of exotic species and other growth organisms

Monitor water temperature

Monitor receiving water impacts

Describe legal aspects and consequences of water pollution

**BIL:** Essential – PC, ESA, ECA, HM  
Recommended – HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 15.8: Monitor air pollution**

**Competency Builders:**

- List the regulated parameters identified industrial source emissions
- Describe air pollution control devices used to control emissions of sulfur oxides, nitrogen oxides, particulates and volatile organic contaminants
- Measure the air pollutant of a specific source
- Interpret laboratory analyses
- Explain exhaust system maintenance
- Operate IH monitoring equipment
- Explain air make-up system maintenance
- Maintain controls to minimize odor
- Measure vibration levels
- Measure source air emission quality
- Calculate dispersion and emission rates
- Control fugitive emissions
- Assess pollution control system
- Advise engineering design of air pollution systems
- Identify off-property environmental impact
- Interpret meteorological data

**BIL:** Essential – PC, HS, ECA  
Recommended – ESA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	R
HS	I	P
ECA	I	P
HM		
WEM		
FWM		
GIS		

**Competency 15.9: Monitor noise pollution**

**Competency Builders:**

Identify the physical properties of sound

Describe the threshold of hearing, tolerance, and hearing loss

Describe environmental noise

Analyze legal aspects and consequences of noise pollution

List sources of noise pollution

List the control devices for different noise sources

Measure noise levels

**BIL:** Essential – HS, ECA, HM  
Recommended – PC, ESA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	R
HS	I	P
ECA	I	P
HM		P
WEM		
FWM		
GIS		

**Competency 15.10: Monitor radioactive contamination**

**Competency Builders:**

Describe radiation and radioactive decay

Identify types and sources of radiation, including radon

Describe radiation exposure and dosimetry experiments

Describe immediate and long range effects of radiation on plants and animals

Explain nuclear power hazards and safety features

Describe legal aspects and consequences of radioactive pollution

Measure radioactivity

Use radioactive measurement equipment

Identify certifications required for handling radioactive materials



## Unit 16: Chemical Technology

**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM  
Recommended - FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	P	R
ESA	P	R
HS	P	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		I
GIS		

### Competency 16.1: Explain basic chemistry principles

#### Competency Builders:

Explain and describe the properties of matter

Explain chemical terms (e.g., elements, molecules, chemical reactions, bonding, compounds, mixtures)

Describe the organization of the periodic table

Diagram a model of an atom labeling the protons, neutrons, and electrons and their charges

Explain how atoms combine to form molecules

Differentiate among isotopes

Identify the properties of a mixture

Describe solutions and suspensions

Predict the number of different substances in a mixture

Differentiate among acids, bases, minerals, and salts

Differentiate organic and inorganic material

Identify chemical processes and procedures that are controlled or monitored

Describe chemical equations

Explain basic material balancing including the effects of chemical concentrations and solutions

Calculate the amounts of reactants and products in a process reaction (using stoichiometry)

Explain how process variables and catalysts can affect reaction rates

Explain how process variables affect equilibrium reactions

Differentiate between a physical change and a chemical change

**BIL:** Essential – PC, ESA, ECA, HM, WEM  
Recommended – HS, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	P	R
HS	I	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		I
GIS		

### **Competency 16.2: Apply chemical laboratory skills**

#### **Competency Builders:**

Identify chemical abbreviations (e.g., English and AIUPAC)

Interpret chemical equations and specifications

Analyze graphs and charts

Describe common chemical laboratory equipment

Identify safety supplies appropriate to task

Operate safety equipment

Handle hazardous reagents, hot materials, sharp objects, and contaminating materials

Wear appropriate safety clothing

Identify appropriate glassware for task

Weigh chemical reagents to prepare solutions or stains

Mix chemicals to prepare reagents, solutions or stains

Store prepared solutions and stains to maintain optimal condition

Measure pH electronically and manually

Employ extraction procedures on organic analytes

Filter substances to obtain residues

Describe typical laboratory procedures (e.g., heating, cooling, filtration, glassware set-up, distillation, weighing, measuring, pipetting, volumetrics)

Calibrate containers, flasks, balances, safety testing equipment

Clean and decontaminate work areas

Respond to a laboratory spill

Practice safe and proper use of equipment

Identify storage containers that are compatible with the materials to be stored

Mix acids and bases with other materials

Clean with solvents, acids, and detergents

Demonstrate proper titration techniques

Care for desiccators and centrifuges

Describe the physical and chemical properties of common materials and implications for storage  
Prepare dilutions in (grams, milligrams, molarity, normality, and ratios)  
Set up vacuum and pressure transfer system  
Transfer liquids, solids, and gases  
Prepare solutions  
Obtain representative samples  
Maintain electrodes  
Change pressurized cylinders  
Demonstrate the proper use of pressurized cylinders

**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	P	R
HS	I	P
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

**Competency 16.3: Calculate and measure in the laboratory**

**Competency Builders:**

- Calculate quantities needed to perform a test analysis
- Measure volume of a solution to perform a laboratory test
- Measure temperatures
- Calculate unit conversions
- Calculate concentrations
- Measure using MKS system
- Calculate linear regression curves
- Plot calibration curve

**BIL:** Essential – PC, ESA, ECA, WEM  
Recommended – HS, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	P	R
ESA	I	P
HS	I	R
ECA	P	R
HM	I	R
WEM	I	P
FWM		
GIS		

**Competency 16.4: Maintain laboratory equipment and supplies**

**Competency Builders:**

Wash laboratory equipment

Sterilize equipment to decontaminate soiled materials

Inventory supplies and equipment

Prepare equipment for tests

Demonstrate procedures to ensure optimal working condition of equipment and devices

Demonstrate procedures to ensure optimal shelf life of chemicals

Demonstrate procedures to ensure safe storage of chemicals

**BIL:** Essential – PC, ESA, WEM  
Recommended – HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		P
HS	I	R
ECA	I	P
HM	I	R
WEM		P
FWM		
GIS		

**Competency 16.5: Analyze air, water, and solids in the field**

**Competency Builders:**

Monitor stack and fugitive emissions

Sample gases

Analyze gases

Describe pollution control practices

Describe measurements of flow rates

Operate hand-held gas monitor

Monitor and sample wastewater influent and effluent

Analyze physical properties of solids and liquids

**BIL:** Essential – ESA  
Recommended – PC, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

### **Competency 16.6: Design experiments**

#### **Competency Builders:**

Conduct on-line literature search

Identify resources (e.g., people, equipment, chemical, and methods)

Gather chemicals and resources

Create a statistical design for the experiment using a quality model

Design control ranges

Write procedures

Design and run computer simulations

**BIL:** Essential – ESA  
Recommended – PC, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

**Competency 16.7: Implement new experiment methods**

**Competency Builders:**

- Verify method's compliance with regulations
- Initialize automated experiments
- Monitor automated experiments
- Evaluate results
- Present results
- Assess and redesign experiments as necessary
- Implement results as appropriate
- Create and report conclusions or final results
- Document all phases of the work



**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	P	R
ESA	I	P
HS	P	R
ECA	I	P
HM	I	P
WEM	I	P
FWM		
GIS		

**Competency 16.8: Handle chemical materials in accordance with standard safety practices**

**Competency Builders:**

Prepare materials for testing and analysis

Describe the characteristics of chemical materials that are applicable to storage and handling (e.g., toxicity, health effects, flammability, reactivity, sensitivity, stability, and compatibility with other materials)

Classify organic and inorganic compounds

Write generalized formulas

Write the symbols for the elements

Describe the characteristics of the common groupings of elements

Describe the basic reactions that occur between commonly used chemical compounds

Complete the proper paperwork associated with receiving materials

Transfer materials to storage or processing units

Identify containers

Prepare and store samples and materials

**BIL:** Essential – PC, ESA, ECA, WEM  
 Recommended – HS, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	IR	P
HS	I	R
ECA	P	R
HM	I	R
WEM	I	P
FWM		
GIS		

**Competency 16.9: Conduct physical tests: temperature, solids to moisture, paint filter, residual solids, layers, color, odor, vapor pressure, viscosity, slump, and flash/flammability tests**

**Competency Builders:**

- Obtain representative samples
- Prepare samples for tests or analyses
- Choose appropriate test equipment to make a required measurement
- Check instruments for correct operation
- Prepare or acquire calibration standards
- Calibrate equipment
- Test or analyze control "standard" samples
- Calculate results and compare with control values
- Analyze samples within statistical range,
- Troubleshoot causes of error by repeating calibration and instrument check
- Record and report data
- Clean and maintain apparatus
- Characterize the physical properties of gases, liquids, and solids and describe their reactions to changes of temperature and pressure
- Identify appropriate equipment for measuring major physical properties based on specified accuracy and precision requirements
- Apply ASTM and/or other standard procedures for specific chemical and physical tests
- Collect samples to represent bulk materials to be characterized by physical tests
- Develop control charts and determine upper and lower control limits for each

**BIL:** Essential – PC, ESA, WEM  
 Recommended – HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	R
WEM	I	P
FWM		
GIS		

### **Competency 16.10: Perform chemical analysis**

#### **Competency Builders:**

Obtain representative samples

Record characteristics

Respond to problems by reading test documents or procedures and implementing appropriate information

Identify the appropriate equipment for the analysis to be conducted

Gather and clean the necessary glassware, reagents, and chemicals

Calibrate the electrodes and other equipment required to carry out the specified analysis

Prepare and standardize reagents

Analyze standards or control samples using specified techniques

Analyze sample

Calculate results to appropriate significant figures

Present results for single samples and to display trends

Evaluate analytical results and respond appropriately

Identify conditions that indicate need for an analysis to be repeated

Report data

Modify or develop analytical methods to be appropriate to necessary test methods, required analyses, implementing personnel qualifications, and working environment where methods are to be used

Select the proper procedure to sample a bulk material

Prepare samples for analysis, including digesting, ashing, extracting, dissolving, grinding, and removing impurities as appropriate prior to analysis

Use standard separation techniques such as ion exchange and column chromatography

Describe the principles and applications of volumetric analysis

Balance chemical equations involving acid/base, redox, and other chemical reactions

Describe the use of pH in characterizing chemical systems

Measure pH using both wet and instrumental methods  
Calculate normality, gram equivalents, molarity, and molality of solutions  
Describe the characteristics of acids and bases and the chemistry  
Describe the chemical, thermodynamic, and chemical kinetic characteristics of materials that can undergo oxidation/reduction reactions  
Standardize acid and base solutions of different concentrations (e.g., molarity, molality)  
Apply chemistry concepts to measurements  
Conduct analytical tests using acid/base titrations, filtrations, and oxidation/reduction titrations.  
Apply Beer's law for calculating results  
Describe techniques and instruments used for colorimetric analysis  
Identify the techniques and devices appropriate for specific samples and accuracy requirements  
Describe the principles of gravimetric analysis, and the tools used to conduct such analyses  
Describe the processes of filtration and the effect of the filtering medium on the results  
Describe the use of several electrochemical techniques  
Apply specified information in standard procedural manuals and books, including those produced by ASTM, SM, SW846, NIOSH (McCaww EPA 600), AOAC, 40 CFR Part 60 other groups that produce "standards", and government agencies that issue and/or monitor regulations  
Perform extraction techniques including TCLP

**BIL:** Essential – ESA  
Recommended – PC, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		P
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

**Competency 16.11: Discuss methods to analyze unknown materials**

**Competency Builders:**

Identify interfering materials

Modify analytical procedures

Develop new procedures for chemical analysis

**BIL:** Essential – ESA, ECA, HM  
Recommended – PC, HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

**Competency 16.12: Explain basic organic and inorganic chemistry principles**

**Competency Builders:**

Explain molecular structure in terms of chemical bonding

Explain stoichiometric relations to chemical equations

Write formulas of identified compounds from their names and vice versa

Explain the principles of Charles', Boyle's, Graham's and Dalton's laws

Classify compounds into appropriate groups based on their properties

Explain quantitative relationships to express solution concentrations

Identify organic compounds through the interpretation of IR, mass spectroscopy and gas chromatography

## Unit 17: Environmental Instrumentation

**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	
FWM		
GIS		

**Competency 17.1:** Operate basic laboratory equipment and environment monitoring instruments (e.g., pH meter/ISE meter, compound microscope/dissecting microscope, sound level measuring devices, turbidimeter, conductivity meter, chlorine meter OVA, HNMU)

### Competency Builders:

Prepare sample appropriately (e.g., use oil immersion lens, Bunsen/Fisher burner, balance, centrifuge, timing device autoclaves, hot air oven desiccators)

Select appropriate calibration method

Select appropriate calibration standards

Zero the instrument

Span the instrument

Measure samples

Record and store data

**BIL:** Essential – ESA, WEM  
Recommended – PC, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS		
ECA	I	R
HM		
WEM		P
FWM		
GIS		

**Competency 17.2: Perform chemical laboratory sample preparation**

**Competency Builders:**

Perform chemical extractions

Perform gravimetric analysis

Perform wet chemical analysis including filtering, distilling, and titrating

Record anomalies

Calculate statistical uncertainties and deviations



**BIL:** Recommended – PC, ESA, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

**Competency 17.3: Explain the use of chemical analytic instruments**

**Competency Builders:**

Identify the analytical applications of mass spectrometers, chromatographs, spectrometers

Introduce prepared gas or liquid samples into chromatographs

Obtain quantitative chemical results

**BIL:** Essential – ESA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		P
HS		
ECA		
HM		
WEM		
FWM		
GIS		

**Competency 17.4: Perform analytical separation techniques**

**Competency Builders:**

Describe the principles of gas chromatography and typical instrumentation

Separate mixtures of different materials

Describe the principles of liquid chromatography and typical HPLC  
instrumentation

Calibrate, operate, troubleshoot, and maintain apparatus and instruments

Describe principles of I.C.

**BIL:** Essential – ESA  
Recommended – PC, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS		
ECA		I
HM		I
WEM		I
FWM		
GIS		

**Competency 17.5:** Perform spectroscopic analysis using instruments such as: spectrophotometer/auto spectrophotometer, AA/graphite furnace, ICP, GC/MS, oxygen meter, IC, IR, FTIR X-ray diffraction nitrogen analyzer, mercury analyzer, FID/PID analyzer, and RAD meter

**Competency Builders:**

Describe the principles of spectroscopy (e.g., AA, IR, MS, UVIS)

Describe the instrumentation for AA, IR, MS, UVIS

Calibrate, operate, troubleshoot, and maintain spectroscopic instruments

Describe similarities and differences among the various instruments

**BIL:** Essential – ESA  
Recommended – PC, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS		I
ECA		I
HM		I
WEM		
FWM		
GIS		

**Competency 17.6: Operate advanced laboratory and field equipment and instruments (e.g., HPLC, GC, bomb calorimeter, geiger mueller counter, explosimeters specific gas meters, carbon analyzer, microwave)**

**Competency Builders:**

- Prepare sample appropriately (e.g., use oil immersion lens, Bunsen/Fisher burner, balance, centrifuge, timing device autoclaves, hot air oven desiccators)
- Select appropriate calibration method and standards
- Zero and span the instrument
- Measure samples
- Record and store data
- Make back-up copies of data
- Demonstrate appropriate shut-down procedures

**BIL:** Essential – ESA  
Recommended – PC, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS		
ECA		I
HM		
WEM		I
FWM		
GIS		

**Competency 17.7: Use computers to interface with chemical analytical instruments**

**Competency Builders:**

Explain how instrument output is collected and stored by the computer

Collect and store data

Manipulate and recall stored data from analytical instrument operations

Create graphs and data tables using computer applications prepared for chemical analysis instruments

Operate chromatographs, mass spectrometers, and electron microscopes using a computer interface

Use computers to determine instrument status and to troubleshoot chemical analytical instruments

**BIL:** Essential – ESA  
Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM		
FWM		
GIS		

**Competency 17.8: Maintain instruments using gas systems**

**Competency Builders:**

Change gas cylinder

Troubleshoot instruments

Start systems after unplanned and planned down time

Discuss use of diagrams to troubleshoot

Bring vacuum systems up and take vacuum systems down

Maintain maintenance and use logs

Maintain gas systems, including plumbing lines, reattaching regulators

Identify regulators and pressures

**BIL:** Recommended – PC, ESA, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

**Competency 17.9: Calibrate chemical analytical instruments**

**Competency Builders:**

Adjust filament voltages to tune mass spectrometers

Introduce standard compounds into gas chromatographs and change columns as needed to calibrate chromatograph

Run computer checks, components checks, and system checks

Adjust apertures and beam widths

Identify various deuterated solvents, and their chemical shifts

Recognize "spinning side bands" and ferromagnetic impurities

Run quality control samples

**BIL:** Recommended – PC, ESA, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

**Competency 17.10: Operate mass spectrometers**

**Competency Builders:**

Prepare samples for introduction into a mass spectrometer

Introduce samples into a mass spectrometer

Obtain mass spectra of specific compounds using a mass spectrometer as a single instrument or as part of a gas chromatograph, ion trap chromatograph, or inductively coupled argon plasma system

Calibrate mass spectrometers using appropriate calibration standards and by adjusting filament voltage

Clean the ion source

Maintain a mass spectrometer

Troubleshoot a mass spectrometer as a single instrument or as part of a gas chromatograph, ion trap chromatograph, or inductively coupled argon plasma system

Describe the abilities and limitations of chromatographs

Describe the physics of mass spectrometry

Perform spectral interpretation

Describe the relationships between thin layer, column, paper, gas chromatograph, ion chromatograph, supercritical fluid chromatograph



**BIL:** Recommended – PC, ESA, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

### **Competency 17.11: Operate chromatographs**

#### **Competency Builders:**

Prepare samples for introduction into a chromatograph

Inject samples into a chromatograph

Calibrate a chromatograph using appropriate calibration standards and by cleaning or changing columns

Maintain a chromatograph, including changing cryogenic gas cylinders

Troubleshoot a chromatograph

Describe the capabilities and limitations of chromatography

Describe the physics of chromatography

**BIL:** Recommended – PC, ESA, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

**Competency 17.12: Operate electron microscopes**

**Competency Builders:**

Prepare samples for introduction into an electron microscope

Introduce samples into an electron microscope, including closing and opening the electron gun, emptying and restoring vacuum, and placing the sample

Obtain magnified images of organic and inorganic samples

Obtain elemental analysis of the surface of samples using an energy dispersive system coupled to an electron microscope

Adjust aperture, beam width, voltage, and current to obtain optimum image resolution

Calibrate an electron microscope and energy dispersive system

Maintain an electron microscope and energy dispersive system, including gas fills

Troubleshoot an electron microscope and energy dispersive system

Describe the mechanics of the electron gun, the vacuum system, and the sample stage

Describe the physics of electron microscopy for image magnification and energy dispersion for elemental analysis

Describe the relationships between resolution and aperture, beam width, voltage, magnifications, and current

**BIL:** Essential – ESA  
Recommended – PC, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS		
ECA	I	R
HM		
WEM		
FWM		
GIS		

**Competency 17.13: Interpret quantitative and graphic output from chemical analysis instruments**

**Competency Builders:**

Identify elements and/or chemical compounds present in a sample from graphic output

Identify relative concentrations of chemical elements and/or compounds present in a sample from graphic output

Quantify results of chemical analyses using numerical output

Record deviations and anomalies (interferents)

Write reports

**BIL:** Essential – ESA  
 Recommended – PC, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

**Competency 17.14: Perform instrumental analysis**

**Competency Builders:**

- Obtain representative samples
- Determine appropriate treatment of the sample prior to conducting an analysis
- Prepare a sample for analysis
- Identify the analytical instrument to be used as appropriate to the results needed and other constraints
- Start up instrument by checking all connections, gas cylinders, and implementing procedures to ensure reliable results
- Set all the instrumental parameters properly using manual and/or program microprocessor settings
- Calibrate and standardize equipment and materials
- Develop necessary calibration charts
- Analyze standards and control materials
- Evaluate results of testing or analyzing standards and control materials
- Readjust operating parameters as necessary
- Conduct analyses
- Review and interpret results
- Record results
- Report results as appropriate
- Perform routine maintenance
- Shut down instrument
- Clean up work area
- Maintain and/or order spare parts necessary to ensure consistent operation

**BIL:** Essential – ESA  
 Recommended – PC, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM		I
FWM		
GIS		

**Competency 17.15: Operate and maintain flow instrument systems**

**Competency Builders:**

- Identify flow measuring sensors
- Explain flow measuring principles
- Identify instrument calibration standard units
- Analyze systems using troubleshooting flow sheet
- Identify displacement measurement methods
- Identify the properties of fluid flow measurement
- Identify primary and secondary measuring devices for fluid flow
- Identify applications for variable area instruments
- Identify open channel flow devices
- Identify applications for positive displacement meters, turbine flow meters, magnetic flow meters, ultrasonic flow meters
- Identify solid particle flow metering methods
- Install flow instruments
- Identify control valves
- Identify control element applications

**BIL:** Essential – ESA  
 Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM		
FWM		
GIS		

**Competency 17.16: Operate and maintain pressure test instruments (e.g., manometers, vaccum pumps, pressure and vacuum gages)**

**Competency Builders:**

- Identify pressure measuring sensors
- Explain pressure measuring principles
- Identify instrument calibration standard units
- Analyze systems using troubleshooting flow sheet
- Identify pressure principles
- Install, maintain, and service pressure instruments
- Identify force, stress, and strain measurement units
- Identify weight and mass measuring instruments
- Identify pneumatic and hydraulic actuators
- Identify applications of vacuum measuring methods

**BIL:** Recommended – PC, ESA, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM		
FWM		
GIS		

**Competency 17.17: Service thermal measuring instruments**

**Competency Builders:**

Identify temperature measuring sensors

Explain temperature measuring principles

Determine temperature measuring instrument and sensor failures

Troubleshoot temperature measuring instruments and sensors

Remove and replace temperature measuring instrument and sensor components

Check and make adjustments to temperature measuring instruments and sensors

Determine calorific value measuring instrument failures

Troubleshoot calorific value measuring instrument

Remove and replace calorific value measuring instrument components

Check and make minor adjustments to calorific value measuring instruments

Identify and explain bimetallic and fluid-filled temperature measuring instruments

Identify instruments that use electrical methods of measuring temperature

Identify pyrometers

Install temperature measuring instruments

**BIL:** Recommended – PC, ESA, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM		
FWM		
GIS		

**Competency 17.18: Service physical property (sample control) measuring instruments**

**Competency Builders:**

- Identify physical property measuring instruments
- Explain the principles of physical property measuring instruments
- Identify instrument calibration standard units
- Analyze systems using troubleshooting flow sheet
- Identify level measurement instruments
- Identify electrical methods for level measurement
- Maintain and service level measuring instruments
- Identify final control elements in process loops
- Identify on-site safety standards and maintenance practices
- Describe electrical and electronic servicing stations
- Describe troubleshooting requirements
- Troubleshoot and repair density and specific gravity measuring instruments
- Check operating systems
- Adjust density and specific gravity measuring instruments
- Troubleshoot and repair humidity measuring instruments
- Check humidity measuring instruments operating systems
- Adjust humidity measuring instruments
- Troubleshoot and repair moisture content measuring instruments
- Check systems moisture content measuring instruments
- Adjust systems moisture content measuring instruments
- Troubleshoot and repair viscosity measuring instruments
- Check viscosity measuring instruments
- Adjust viscosity measuring instruments



**BIL:** Recommended – PC, ESA, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		I
ECA	I	R
HM		
WEM		
FWM		
GIS		

**Competency 17.19: Service chemical property measuring instruments (e.g., O<sub>2</sub> meter, spectrophotometer, atomic absorption spectrophotometer inductively coupled plasma, ion chromatography, infrared)**

**Competency Builders:**

Troubleshoot and maintain analytical measuring instruments

Perform operating systems checks and make minor adjustments to analytical measuring instruments

Troubleshoot and maintain pH measuring instruments

Check and make minor adjustments to pH measuring instruments

Troubleshoot and maintain liquid conductivity measuring instruments

Check and make adjustments to liquid conductivity measuring instruments

Troubleshoot and maintain chromatograph measuring instruments

Check and make minor adjustments to chromatograph measuring instruments

Troubleshoot and maintain mass spectrometer measuring instruments

Check and make adjustments to mass spectrometer measuring instruments

Troubleshoot and maintain gas analyzer measuring instruments

## Unit 18: Process Technology

**BIL:** Essential – PC  
Recommended – ESA, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

### Competency 18.1: Operate and control continuous processes

#### Competency Builders:

Describe the characteristics of a continuous process

Describe the major industrial continuous processes, by (1) describing the characteristics of each, (2) the chemical/physical properties of materials important to the operation, (3) the environmental regulations and safety concerns that are related to each operation, and (4) how the operations usually are interrelated

Interpret process diagrams

Describe the various components and streams of a continuous process

Describe the types and operations of control loops and sample collection devices

Identify typical valves, pumps, and other equipment

Draw a simplified process diagram

Check equipment to ensure safety for electrical loading, physical stressing, and temperature variation

Start up continuous process according to specified procedures

Review checklists associated with a continuous process

Complete required reports to describe process activities, discrepancies, and maintenance

Adjust control equipment as specified by procedures

Set operating parameters

Identify abnormal conditions that require reporting

Record operating parameter information from gauges, instruments, and meters

Adjust operating parameters to optimize conditions

Correct deviations

Respond to alarms

Collect appropriate samples

Conduct on-site inspections

Submit samples for analysis  
Record data  
Report data  
Shut down continuous processes  
Shut down continuous processes in emergency situations  
Maintain piping networks  
Write documentation for an operating procedure  
Describe a troubleshooting strategy for a continuous process in upset conditions  
Describe the operation, characteristics, and limitations of process measurement equipment (e.g., thermocouples)  
Describe process flows (both gas and liquid streams)  
Describe the concepts associated with process optimization  
Describe when, where, and why samples are taken for analysis and how sampling techniques relate to quality products

**BIL:** Essential – PC  
 Recommended – ESA, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

**Competency 18.2: Operate and control batch processes**

**Competency Builders:**

Describe the characteristics of a batch process

Check equipment safety for electrical loading, physical stressing, and temperature variation

Start up batch processes

Review checklists associated with a batch process

Complete required reports to describe process activities, discrepancies, and maintenance

Adjust control equipment as specified by procedures

Set operating parameters

Identify abnormal conditions that require reporting

Measure raw materials

Explain disposition of “off-spec” batch

Monitor operating parameters by recording information from gauges, instruments, and meters,

Adjust pumps and valves

Adjust operating parameters to optimize conditions

Correct deviations

Respond to alarms

Collect appropriate samples

Conduct on-site inspections

Submit samples for analysis

Record data

Report data

Shut down processes according to procedures

Start up after an emergency shutdown

Describe the major industrial batch processes including common chemical, refinery, water, and waste treatment processes by (1) describing the operation of each; (2) characterizing the chemical/physical properties of

- materials that are important to the processes; (3) writing the molecular formulas and chemical structures for substances involved in the processes;
  - (4) describing the chemical reactions involved in each process;
  - (5) describing the chemical equilibrium, kinetics, and chemical reactivity relationships that characterize the processes or may impact safety; and
  - (6) identifying relevant environmental regulations and safety concerns
- Read process diagrams
  - Describe the various components and streams of a batch process
  - Describe the types and operations of control loops and sample collection devices
  - Identify typical valves, pumps, and other equipment
  - Draw a simplified process diagram
  - Write documentation for an operating procedure that meets regulatory requirements
  - Describe a troubleshooting strategy for a batch process given a variety of upset conditions
  - Describe the operation, characteristics, and limitations of process measurement equipment (e.g., thermocouples)
  - Start up and shut down different kinds of electric motors
  - Describe the concepts associated with process optimization
  - Demonstrate ability to add solids, liquids, and gases
  - Describe the relationship of vacuum and pressure upon boiling point
  - Operate various types of heat exchangers
  - Perform filtrations, extractions, distillations, drying, blending, milling, and packaging
  - Retrieve data and information
  - Provide shift transfer notes

**BIL:** Essential – PC  
Recommended – ESA, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

### **Competency 18.3: Analyze materials**

#### **Competency Builders:**

- Collect appropriate samples for analysis from process streams or products (solids/liquids/gases)
- Inspect samples visually to ensure adequate representation of the sampled materials
- Determine response is required
- Label samples
- Deliver samples
- Prepare necessary reagents and standards required to conduct tests
- Identify quality control standards and appropriate precision levels
- Perform appropriate physical and chemical tests
- Calculate results
- Determine if resampling and reanalyzing are necessary
- Maintain analysis area to ensure correct results will be produced repeatedly
- Report results to appropriate personnel
- Adjust process parameters as necessary
- Enter data into appropriate logs
- Review trends of process variations and sample analyses
- Compare sample analyses with control values
- Submit samples to the laboratory
- Characterize gases, liquids, and solids
- Obtain representative samples of solids
- Describe sampling devices for use with gases under pressure
- Use typical sampling devices
- Sample a flowing liquid stream
- Identify proper containers for a variety of solids, liquids, and gases with a wide range of physical properties
- Identify common and standard chemical names
- Use standard labeling procedures

Calibrate and measure pH  
Explain standard measurement and analytical procedures (e.g., ASTM, AOAC)  
Calculate normality, molality, and molarity  
Prepare standard solutions  
Describe physical properties and measurement methods of materials (e.g., specific gravity, density, flash point, and viscosity)  
Conduct chemical analyses using volumetric techniques (e.g., acid-base titrations, redox titrations)  
Explain the use of instrumental methods such as gas chromatography, infrared, basic spectrophotometry, and colorimetry  
Describe pressure and temperature relationships for all states of matter  
Balance simple chemical equations

**BIL:** Essential – PC  
Recommended – WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		P
ESA		
HS		
ECA		
HM		
WEM		I
FWM		
GIS		

**Competency 18.4: Program programmable logic controllers (PLC's)**

**Competency Builders:**

Interpret ladder logic

Identify troubleshooting procedures

Develop process program

Evaluate data generated

Identify trends



## Unit 19: Electrical Basics

**BIL:** Essential – PC  
Recommended – ESA, HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	R
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS		

### Competency 19.1: Explain electrical concepts

#### Competency Builders:

- Describe the relationship of basic atomic structure to electricity
- Describe the relationship between electrical and magnetic properties
- Describe the electrical and magnetic properties of a magnet
- Describe the photoelectric effect
- Describe the thermocouple effect
- Describe the electrical effect of friction
- Identify sources of electricity
- Explain Ohm's Law
- Explain Kirchoff's Laws
- Identify power formulas
- Describe effects varying degrees of electricity have on the human body

**BIL:** Essential – PC, ESA  
Recommended - HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		P
HS	I	R
ECA		I
HM		
WEM		
FWM		
GIS		

**Competency 19.2: Maintain basic electrical systems**

**Competency Builders:**

Replace electrical cords

Replace batteries

Replace fuse(s)

Replace switches and other sensors

Replace plugs

Maintain lockout/tagout

**BIL:** Recommended - ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

**Competency 19.3: Explain DC circuit principles**

**Competency Builders:**

Identify characteristics common to most conductors

Identify materials that can be used as insulators

Identify conductors of electricity

Explain the purpose of insulating material around electrical wiring

Identify different situations where insulation can be employed other than around electrical wiring

Measure resistance and current of conductors and insulators

Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters

Build series, parallel, and combination circuits

Measure current, voltage, and resistance in DC circuits

Explain DC generator action

Explain DC motor action

Identify classes, voltage ratings and/or polarity of electronic components

Identify use of circuit protective devices (e.g., fuses, breakers)

Apply Ohm's Law

Solve problems in electrical units utilizing metric units

Describe the principles and operation of electrochemical supplies

Apply Kirchoff's law

Measure properties of a circuit using analog and digital meters

**BIL:** Recommended - ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

**Competency 19.4: Explain AC circuit principles**

**Competency Builders:**

Analyze properties of an AC signal

Describe principles and operation of characteristics of sinusoidal and non-sinusoidal wave forms

Identify AC sources

Describe principles and operation of characteristics of capacitive circuits

Demonstrate the operation of capacitive circuits

Operate capacitive circuits

Describe principles and operation of characteristics of inductive circuits

Demonstrate the operation of inductive circuits

Operate inductive circuits

Describe principles and operation of the principles of transformers

Analyze power in AC circuits

Measure power in AC circuits

Identify use of circuit protective devices (e.g., fuses, breakers)

Describe basic motor theory and operation

Describe basic generator theory and operation

Measure current, voltage, and resistance in AC circuits

Calculate power factor in AC circuits

## Unit 20: Equipment Operation & Maintenance

**BIL:** Essential – WEM, FWM  
Recommended – ESA,HS, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		I
HS		I
ECA		
HM		
WEM	I	P
FWM	I	P
GIS		I

**Competency 20.1:** Operate vehicles (pickup trucks, four-wheel-drive vehicles, tractors, vehicles with attachments, rig-up trucks, graders, backhoe tractors, front-end loaders, excavators, scrappers, cranes, and watercraft)

### Competency Builders:

Explain the safety features of the vehicle

Perform a safety inspection on the vehicle

Drive vehicle

Demonstrate defensive vehicle operation

Back vehicle with attachments into confined space

Control vehicle equipment

Explain procedures for transporting hazardous materials in appropriate vehicles

Interpret operator's and manufacturer's manuals

**BIL:** Essential – ESA, WEM  
 Recommended – PC, HS, ECA, HM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS		I
ECA		I
HM		I
WEM	I	P
FWM		I
GIS		

**Competency 20.2: Operate applicable pumps (diesel and gas engines, centrifugal pumps, positive displacement pumps, air and gas compressors)**

**Competency Builders:**

- Follow appropriate safety precautions
- Prime pump when appropriate
- Start the pump
- Adjust the flow rate
- Shut pump down

**BIL:** Recommended – PC, HS, HM, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		I
ECA		
HM		I
WEM		I
FWM		I
GIS		

**Competency 20.3: Operate applicable miscellaneous equipment (hoists, winches, pulleys, boilers and associated equipment, drilling equipment)**

**Competency Builders:**

Identify function of equipment

Follow appropriate safety precautions

Set up equipment

Use equipment for desired purpose

Shut down equipment

**BIL:** Recommended – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	R
HS	I	R
ECA		I
HM		I
WEM	I	R
FWM	I	R
GIS	I	R

**Competency 20.4: Operate applicable electronic equipment (electrical distribution systems, electronic survey equipment, generators)**

**Competency Builders:**

Identify health hazards

Describe safety practices

Identify source of electricity

Set up electrical equipment

Lay electrical cords within safety standards

Conduct survey

Monitor generator

Shut down electronic system



**BIL:** Essential – ECA  
 Recommended – PC, ESA, HS, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		I
HS	I	R
ECA	I	P
HM		I
WEM	I	R
FWM	I	R
GIS		I

**Competency 20.5: Maintain a preventive maintenance schedule**

**Competency Builders:**

- Observe and record any deviations from normal operations
- Initiate work requests
- Implement a preventive maintenance schedule
- Inspect equipment
- Prepare equipment for maintenance
- Set up a maintenance schedule
- Open lines and equipment
- Change seals and valves on on-line equipment
- Change seals and packing on pumps and valves
- Change and replace pipes
- Check fluid levels in process equipment
- Conduct vibrational analysis
- Conduct steam tracing techniques
- Test and replace pressure release valves
- Check standards
- Complete maintenance logbooks
- Complete calibration records/logbooks
- Reference O & M (Operations and Maintenance) manuals

**BIL:** Essential – ECA, HM, FWM  
 Recommended – PC, HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		
HS	I	R
ECA		P
HM		P
WEM	I	R
FWM	I	P
GIS		

**Competency 20.6: Maintain equipment according to owners' manual specification**

**Competency Builders:**

- Add lubricant and fuel
- Analyze engine performance
- Make necessary adjustments to engine
- Check and adjust tire air pressure
- Inspect and service battery
- Inspect and service/replace spark plugs
- Inspect and service/replace air cleaners
- Check and refer for service thermostats, fans, and radiators
- Inspect and refer for service water pumps, lines, and connections
- Perform seasonal service on cooling systems
- Conduct voltage, current, resistance, charging and load tests
- Clean, repair, and paint

## Unit 21: Hydraulics & Pneumatics

**BIL:** Essential – ECA, WEM  
Recommended – PC, HS

EDU:	12	AD
PC		I
ESA		
HS		I
ECA	I	R
HM		
WEM		P
FWM		
GIS		

### Competency 21.1: Describe fluid flow concepts

#### Competency Builders:

Explain Pascal's Law

Explain Boyle's Law

Explain Bernoulli's Principle

Describe flow velocity

Explain how heat and pressure relate to power and transmission

Describe physical and chemical properties of a fluid

Describe fluids in motion in closed conductors

Describe continuity of mass flow

Identify types of fluids

Identify properties of fluids

Identify English and metric units of measurement for pressure, density, and viscosity

**BIL:** Essential – ECA, WEM  
Recommended – PC, HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

**Competency 21.2: Describe energy considerations**

**Competency Builders:**

Differentiate work and power

Differentiate potential and kinetic energy

Explain energy conservation concept

Explain hydraulic horsepower

Explain work of compression in compressible fluids

**BIL:** Essential – WEM  
Recommended – PC, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		
ECA		I
HM		
WEM		P
FWM		
GIS		

**Competency 21.3: Describe system losses**

**Competency Builders:**

Differentiate turbulent and laminar flow

Explain Manning's formula for friction

Explain friction factor

Explain pressure losses

Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)

**BIL:** Essential – ECA, WEM  
Recommended – PC, HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

**Competency 21.4: Describe hydrostatics**

**Competency Builders:**

Explain pressure, density, and viscosity

Explain buoyancy

Explain equilibrium

**BIL:** Essential – WEM  
Recommended – PC

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		
ECA		
HM		
WEM		P
FWM		
GIS		

**Competency 21.5: Calculate energy**

**Competency Builders:**

- Explain application of Pascal's Law in energy calculation
- Explain application of Bernoulli's Principle in energy calculation
- Explain application of Boyle's Law in energy calculation
- Calculate work and power
- Calculate potential and kinetic energy
- Calculate hydraulic horsepower
- Calculate flow velocity and pressure
- Calculate pressure losses
- Calculate laminar flow
- Calculate pump capacity
- Calculate system requirements

**BIL:** Essential – WEM  
Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

**Competency 21.6: Describe hydraulic component operation**

**Competency Builders:**

Identify functions and operation of hydraulic components

Identify functions and operation of pneumatic components

Explain application(s) of different materials (e.g., plastic, copper, PVC, CPT)



**BIL:** Essential – WEM  
Recommended – PC, ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		
ECA		I
HM		
WEM		P
FWM		I
GIS		

**Competency 21.7: Assess pipe flow characteristics**

**Competency Builders:**

- Determine head and pressure and loss
- Determine weir flow
- Determine full flow
- Determine pressure flow
- Determine friction loss
- Determine gravity flow
- Determine cubic feet per second (CFS)
- Determine wing walls
- Determine stability and capacity

**BIL:** Recommended – PC, ECA, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		
ECA		I
HM		
WEM		I
FWM		I
GIS		

**Competency 21.8: Maintain piping and accessories for high and low pressure fluid power systems**

**Competency Builders:**

Identify components of a piping system

Explain maintenance features of both metallic and non-metallic piping systems

Explain types of valves and their operation and maintenance

Explain use and maintenance of strainers, filters, and traps in piping systems

Join common fittings

Join pipe

Join copper and steel tubing

Bend copper and steel tubing

Cut copper and steel tubing

Flare tubing

**BIL:** Recommended- PC, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		
ECA		I
HM		
WEM		I
FWM		
GIS		

**Competency 21.9: Maintain and repair pump**

**Competency Builders:**

Identify types and operating features of pumps

Identify pump capacity and system requirements

Explain packing and seal requirements

Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)

Disassemble pumps

Reassemble pumps

Perform shaft alignment

## Unit 22: Surveying & Mapping

**BIL:** Essential – PC, FWM, GIS  
Recommended – ESA, ECA, HM, WEM

EDU:	12	AD
PC		P
ESA	I	R
HS		
ECA		I
HM	I	R
WEM	I	R
FWM	I	P
GIS	I	P

### Competency 22.1: Identify civil drafting symbols and abbreviations

#### Competency Builders:

Identify standard symbols and abbreviations

Set up a map legend

Locate symbols and features on a U.S.G.S. map

List common types of symbols used in civil drafting

Identify abbreviations for words commonly used in civil drafting

Identify factors that determine when an abbreviation should be used

State purposes of symbols on maps

Draw examples of north arrow symbols

Describe general rules for drawing map symbols

Describe methods used in drawing symbols

Match color codes with corresponding map symbols

Identify common material symbols used in structural and architectural drawings

Identify common welding symbols

**BIL:** Essential – PC, ESA, ECA, HM, FWM, GIS  
Recommended - WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS		
ECA	I	P
HM	I	P
WEM	I	R
FWM	I	P
GIS	I	P

**Competency 22.2: Read maps**

**Competency Builders:**

Identify major classes of maps

Explain terms related to map scales and measurement

Create chart of standard measures and their equivalents

Identify characteristics of map scales

Describe ways map scales are expressed

Identify ranges of map scales and their classifications

Identify factors affecting the selection of a map scale

Match types of maps with their common scales

Identify characteristics of a quadrangle scale

Match quadrangle scales commonly used on U.S.G.S. topographic maps with their one-inch equivalencies

Identify characteristics of graphic scales

Explain published map accuracy standards

Describe types of scales used in civil drafting

Convert a representative fraction to a graphic scale

Read a vernier scale

Measure with a civil engineer's scale

Measure acreage on maps

Differentiate between latitude and longitude

**BIL:** Essential – FWM, GIS  
Recommended – PC, ESA, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM	I	P
GIS		P

**Competency 22.3: Utilize surveying skills**

**Competency Builders:**

Describe survey methods used to determine distances and positions of points

Identify types of horizontal and vertical angles

Explain stationing

Explain purpose of field notes

Describe the arrangement of field notes in the field book

Identify types of field notes

Record field notes

Explain traverses

Differentiate between a bearing and an azimuth

Convert azimuths to bearings and bearings to azimuths

Describe common methods for plotting traverses

**BIL:** Essential – GIS  
 Recommended – ESA, ECA, HM, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		I
HS		
ECA	I	
HM	I	R
WEM		I
FWM	I	P
GIS	I	P

**Competency 22.4: Perform site measurements**

**Competency Builders:**

- Determine location and distance from maps
- Identify major parts of a compass
- Read a compass
- Sight along a given bearing
- Describe compass declination and variation
- Explain surveying [R-HM]
- Differentiate among accidental and systematic errors and mistakes
- Explain use of principal surveying equipment
- Describe types of surveys and their uses [R-HM]
- Measure distance in field [R-HM]
- Measure area in field [R-HM]
- Measure elevations in field [R-HM]
- Reference datum [R-HM]
- Pace horizontal distance [R-HM]
- Tape horizontal distance [R-HM]
- Explain differential leveling [R-HM]
- Explain profile leveling
- Explain cross-sectional leveling
- Measure horizontal angles
- Measure vertical angles
- Use planimeter [R-HM]
- Compare microcomputer surveying and mapping application programs
- Apply GPS technology in surveying [R-HM]

**BIL:** Essential – GIS  
 Recommended – PC, ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		
ECA		I
HM		
WEM		
FWM		I
GIS	I	P

**Competency 22.5: Draft maps**

**Competency Builders:**

- Explain terms related to map drafting procedures
- Identify characteristics of drafting media
- List types of lettering used in civil drafting
- Identify rules for good lettering
- Differentiate among map registration methods
- Describe reprographic techniques used in civil drafting
- Identify types of pressure-sensitive films
- Describe methods used for coloring maps
- Describe aerial photography
- Interpret aerial photographs and maps
- Record measurements on photos or in records
- Describe the standard sheet format for a set of civil drawings
- Label components of a map layout
- Identify the steps for drafting a map or drawing
- Make rough tracings of maps
- Describe common mistakes made in map drafting
- Differentiate among types of planimeters
- Label the parts of a polar planimeter
- Produce finished map of area
- Identify underground surveying techniques
- Ink a mapped area
- Apply transfer film and press-on letters
- Register a map



**BIL:** Essential – GIS  
 Recommended – FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		I
GIS	I	P

**Competency 22.6: Prepare topographic maps**

**Competency Builders:**

- Explain how elevation is shown on a topographic map
- List uses of topographic maps
- Describe types of surveys used in topographic mapping
- Identify field methods for obtaining topography
- Identify factors affecting the selection of the field method to be used for a topographic survey
- Differentiate between horizontal and vertical controls for topographic surveys
- Lay out a topographic survey
- Determine topography
- Describe methods used to establish contours
- Identify national standards for horizontal and vertical accuracy on topographic maps
- Create a chart of scale ratios used in the USGS topographic series
- Describe the selection of contour intervals
- Identify characteristics of contour lines
- Match contour line features with their correct configurations
- Identify common methods used to calculate area from a topographic map
- Calculate cut and fill using the contour area method
- Plot a profile from profile leveling notes
- Develop a profile from a contour map
- List three methods for plotting contours lines
- Explain how to fix a grade line
- Describe aerial photogrammetry
- Identify advantages and disadvantages of using aerial photography for mapping
- Identify applications of aerial photogrammetry
- Explain aerial photo control
- Interpolate contours from a grid survey

217

Prepare profiles from the contour map  
Set up contours in isometric  
Calculate grades in percents

**BIL:** Recommended – GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS		I

**Competency 22.7: Map transportation system**

**Competency Builders:**

State the purpose of route surveys

Describe the fundamentals of a route survey

Describe superelevated roadways

Identify elements of a horizontal circular curve

Explain mathematical formulas used for computing a horizontal curve

Describe circular curve layout by tangent offsets

Describe vertical curves

Describe plan views for route surveys

Identify characteristics of profiles for a route survey

Identify characteristics of cross sections for a route survey

Describe field note reduction for a cross section

Explain plotting cross sections

Differentiate among methods used to determine areas of cross sections

Identify formulas for calculating earth volume

List drawings included in a set of highway plans

Identify common horizontal and vertical scales used in transportation mapping

List items that appear on a typical title sheet for a set of highway plans

Describe detail sheets

Draft plan views, profiles, and cross sections

Layout open traverses

Layout a survey alignment for a road

Plot field notes for horizontal control, topography, profile, and cross section for a proposed road

**BIL:** Essential – GIS  
 Recommended – HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM	I	R
WEM		I
FWM		
GIS	I	P

**Competency 22.8: Map municipal infrastructure**

**Competency Builders:**

- Explain terms related to municipal mapping
- Identify types of utilities
- List agencies who develop and maintain municipal maps
- Identify users of municipal maps
- Describe types of drawings used in municipal mapping
- Describe methods of presenting utilities on maps
- Describe the surveying and mapping of municipal maps
- List support information needed to develop utility drawings
- Explain utility easements
- Identify types of valves and valve housings
- Identify types of gas piping and devices
- List information included on utility drawings
- Describe types of sewers and sewer lines
- Research the plats for local utilities

## Unit 23: Drafting Technology

**BIL:** Essential – PC, GIS  
Recommended – ECA, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		
HS		
ECA		I
HM		
WEM		I
FWM		I
GIS	I	P

### Competency 23.1: Apply basic drafting skills

#### Competency Builders:

Identify line styles, weights (alphabet of lines)  
Select proper drawing scale, introduction to different types  
Prepare title blocks and other drafting formats  
Apply freehand and other lettering techniques  
Develop multi-view drawings  
Develop multi-view sketches  
Develop orthographic views  
Develop change control block  
Describe change control block/revision block  
Measure angles  
Draw horizontal, vertical, angular, parallel, and perpendicular lines  
Transfer an angle  
Construct tangent lines (to arcs) and tangent arcs (to arcs)  
Bisect angles and arcs  
Bisect lines  
Divide lines  
Construct three-point circle  
Construct regular hexagon, pentagon, and octagon  
Reproduce a drawing  
Develop single-view drawings  
Develop dimension drawings  
Interpret notes and dimensions to determine part  
Draw arcs, circles, and conics  
Transfer measurements

**BIL:** Essential – GIS  
 Recommended – PC, ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		
HS		
ECA		I
HM		
WEM		
FWM		I
GIS		P

**Competency 23.2: Prepare drawings**

**Competency Builders:**

- Describe types of blueprints and their applications
- Demonstrate isometric, oblique and perspective sketching techniques
- Prepare isometric, oblique and perspective sketches
- Prepare sectional views
- Prepare auxiliary views
- Identify ANSI symbols
- Describe systems drafting techniques
- Dimension drawings using ANSI, 14.5 standards
- Describe purpose of auxiliary and sectional views
- Prepare pictorial drawings
- Prepare schematics
- Draw conics
- Interpret basic pneumatic/hydraulic standard and symbols

**BIL:** Essential – GIS  
Recommended – PC, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		I
ECA		I
HM		
WEM		I
FWM		
GIS		P

**Competency 23.3: Interpret machine, hydraulic and pneumatic, instrument, electrical, process flow, P & ID diagrams, and detail and assembly drawings/prints/schematics**

**Competency Builders:**

Identify the types of information found on floor plans, elevation plans, flow diagrams, piping and instrumentation diagrams, and electrical diagrams

Identify commonly used symbols and abbreviations

Explain how to trace diagrams

Explain how to use diagrams to locate actual components

Visualize object from drawing

Analyze orthographic projections

Analyze isometric views

Analyze sectional views

Explain dimensions

Explain tolerances

Identify GD&T symbols

Identify basic mechanical standards and symbols

**BIL:** Essential – GIS  
 Recommended – PC, ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		
ECA		I
HM		
WEM		
FWM		I
GIS		P

**Competency 23.4: Analyze structural drawings**

**Competency Builders:**

- Explain structural drawing
- List types of structures
- Identify types of materials used for structures
- Describe types of steel members
- Identify structural steel shapes
- Explain drawing practices for steel members
- Describe the placement of gage lines for steel members
- Describe fastener sizes and spacings
- Explain dimensioning procedures for steel structures
- Label a structural steel callout
- Explain structural steel marking
- Describe anchor bolts
- Differentiate among types of concrete
- Identify types of concrete reinforcement
- Identify standard pre-stressed concrete units
- Describe foundation parts
- Describe types of structural drawings for concrete
- Create chart of symbols and abbreviations for concrete placing drawings
- Identify standard practices for documentation of rebar
- Identify typical details of concrete structures
- Describe wood construction
- Identify types of wood connectors
- Identify types of framing connectors
- Describe components of wood construction
- Explain heavy timber construction
- Prepare detail drawings of structural steel members
- Draw to scale a concrete engineering drawing
- Detail a wood truss



**BIL:** Recommended – PC, ECA, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM		
GIS	I	R

**Competency 23.5: Demonstrate dimensioning techniques**

**Competency Builders:**

Convert dimensions and tolerances to and from metric to English units

Construct arrowheads using various styles/disciplines

Apply symbols for surface and texture control

Add labels/notes to drawing

Interpret decimal tolerance dimensions

Prepare dimensional drawing of arcs, angles, curves, rounded-end shapes, spherical objects, cylindrical objects, cones, pyramids, prisms, features on circular center line, theoretical point of intersection, object using rectangular coordinate system, object using polar coordinate system, object using tabular coordinate system, object using ordinate dimensioning system

## Unit 24: CADD Fundamentals

**BIL:** Essential – PC, GIS  
Recommended – ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		P
ESA		
HS		
ECA		I
HM		
WEM		
FWM		I
GIS	I	P

### Competency 24.1: Identify computer mapping applications

#### Competency Builders:

Classify hardware used in a CAD system as input, output, or neither

Explain data input

List types of data output

Differentiate between digital and interactive computer graphics

Identify types of computer drawings

List methods of storing graphic information

List advantages of using computers for mapping applications

Describe an interactive data management system for mapping

**BIL:** Essential – PC, GIS  
Recommended – ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		P
ESA		
HS		
ECA		I
HM		
WEM		
FWM		I
GIS	I	P

**Competency 24.2: Operate a CADD system**

**Competency Builders:**

- Boot system/start up procedure
- Log on terminal
- Load start file
- Use keyboard input
- Use screen and tablet menus
- Use other input devices (e.g., scanner, digitizer)
- Create scaled plots
- Operate a pen plotter
- Operate a printer-plotter (i.e., laser plotter)
- Access on-line help for commands
- Convert files
- Transfer data
- Manage files
- Plot out drawings
- Store a file
- Shut down a system
- Log off

**BIL:** Essential – PC, GIS  
Recommended – FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		P
ESA		
HS		
ECA		
HM		
WEM		
FWM		I
GIS	I	P

**Competency 24.3: Change existing drawings or details**

**Competency Builders:**

- Plan drawing changes
- Find drawing file
- Load drawing file
- Execute changes
- Obtain approvals/check drawing changes
- Plot out drawing
- Update file

**BIL:** Essential – PC, GIS  
Recommended – FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		P
ESA		
HS		
ECA		
HM		
WEM		
FWM		I
GIS	I	P

**Competency 24.4: Compose drawings**

**Competency Builders:**

- Plan original drawing
- Employ system commands
- Manipulate geometry
- Select geometry
- Add text
- Rotate views
- Move views
- Scale views
- Dimension a drawing
- Store files

**BIL:** Essential – GIS  
 Recommended – PC, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		
ECA		
HM		
WEM		
FWM		I
GIS	I	P

**Competency 24.5: Create 2-D orthographic drawings**

**Competency Builders:**

- Create primitive drawing entities
- Draw utilizing absolute Cartesian coordinates
- Draw utilizing relative Cartesian coordinates
- Draw utilizing polar coordinates
- Draw using construction aides (e.g., snaps, grid, snap)
- Change drawing attributes
- Edit drawing entity properties (e.g., color, layer, thickness, linetype)
- Construct drawing entities (e.g., offset, timer, extend, break, mirror)
- Edit drawing entities
- Set system variables (e.g., units, scale)
- Annotate orthographic drawings
- Create layers
- Identify layers
- Manipulate layers
- Save files
- Create back-ups
- Create hatches, patterns, symbols
- Recall drawing templates/blocks
- Create text styles
- Edit text styles
- Select text styles
- Apply notes
- Create dimensions
- Edit text
- Control dimension variables/models
- Apply view control while drawing (e.g., zoom and pan)
- Control view resolution (e.g., viewers)
- Save views

Display views

Add or remove entities separately

Add or remove entities using a window

Add or remove entities with a crossing-box

Select entities using a fence

Select entities by other methods (e.g., last, previous, type)

231

**BIL:** Essential – PC, GIS  
Recommended – ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		P
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM		I
GIS	I	P

**Competency 24.6: Extract entity and drawing information**

**Competency Builders:**

Measure distances

Measure areas

Identify locations

List entity characteristics (e.g., length, size, location, properties, etc.)



## Unit 25: Waste Management

**BIL:** Essential – PC, ESA, HM  
Recommended – HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	P
WEM		I
FWM		
GIS		

### Competency 25.1: Collect waste materials

#### Competency Builders:

- Identify source of waste materials
- Monitor collection of waste materials
- Document collection of waste materials
- Determine sampling method
- Prepare sampling container
- Collect sample
- Prepare chain of custody
- Test waste materials
- Document waste materials testing
- Identify hazardous materials/waste
- Determine compatibility of waste materials
- Separate waste materials
- Identify container type
- Contain waste materials
- Label waste materials
- Review waste material labels
- Document contained-waste collection
- Identify regulations

**BIL:** Essential – PC, ESA  
 Recommended – ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		P
HS		
ECA		I
HM		I
WEM		
FWM		
GIS		

**Competency 25.2: Treat waste materials**

**Competency Builders:**

- Separate waste materials
- Verify operating parameters
- Determine test method
- Add additional chemicals to material
- Monitor efficiency of additions
- Document compliance with treatment standards
- Document raw-materials usage
- Maintain inventory of supplies
- Sort treated materials
- Release treated materials
- Seek markets for recovered materials
- Match recovered materials with end users
- Identify regulations

**BIL:** Essential – PC, ESA, HM  
Recommended – HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		P
HS	I	R
ECA		IR
HM	I	P
WEM		
FWM		
GIS		

**Competency 25.3: Manage waste**

**Competency Builders:**

- Monitor instrumentation
- Determine material needs
- Verify the operation of the equipment
- Reroute source
- Troubleshoot equipment
- Identify source of waste materials
- Document contained-waste collection
- Identify hazardous materials
- Determine compatibility of waste materials
- Separate waste materials
- Contain waste materials
- Label waste materials
- Document contained-waste collection
- Store material containers
- Load/unload storage containers
- Transport waste materials
- Repair leaking containers
- Clean up container leaks
- Verify operating parameters
- Determine test method
- Add additional chemicals to material
- Monitor efficiency of additions
- Document raw-materials usage
- Sort treated materials
- Initiate pollution abatement at the source
- Document non-reusables
- Monitor pollution abatement at the source
- Determine disposal method

Identify container for non-reusables  
Label non-reusables  
Monitor clean-up  
Arrange for transportation of non-reusables  
Sample waste before disposal  
Transport non-reusable  
Monitor disposal by contractor  
Dispose of non-reusables  
Destroy non-reusables  
Perform routine maintenance on implements  
Perform routine maintenance on test instruments  
Remove trash

236

**BIL:** Essential – PC, HM  
 Recommended – ESA, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		I
HS		
ECA	I	R
HM	I	P
WEM		I
FWM		
GIS		

**Competency 25.4: Manage waste systems**

**Competency Builders:**

- Develop waste system training
- Coordinate mandatory consultation programs
- Manage and implement three R's program (i.e., reduce, recycle, reuse)
- Characterize all waste
- Register subject waste
- Arrange waste collection
- Arrange waste disposal
- Prepare manifest for subject waste
- Conduct waste audits including compliance and pollution prevention components
- Establish waste reduction work plans
- Manage internal waste disposal operations
- Monitor leachate collection systems
- Process leachate
- Assess leachate treatment options

**BIL:** Essential – PC, ESA, ECA  
Recommended - HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS		
ECA	I	P
HM	I	R
WEM		
FWM		
GIS		

**Competency 25.5: Identify characteristics of solid waste treatment**

**Competency Builders:**

Explain solid waste

List sources of solid waste

Identify types of solid waste

Identify physical and chemical compositions of waste

Correlate typical source with locations and type of solid waste

Describe landfill alternatives (reduction, separation, processing, waste of energy and application)

Describe characteristics of a sanitary landfill

List reactions that occur as a landfill matures

**BIL:** Essential – PC, ESA  
Recommended – ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

**Competency 25.6: Identify the risks associated with solid waste accumulation and disposal**

**Competency Builders:**

Describe the composition, sources, and quantity of solid waste

Describe methods of solid waste disposal

Describe various solutions to solid waste accumulations and disposal

Describe the legal aspects and consequences of solid waste pollution

Describe the construction features of a safe landfill

Describe the possibilities of contaminants (leachates) seeping into the groundwater

Describe the need to have monitoring wells located around a sanitary landfill

Identify those wastes that are permitted by state and federal regulation to be disposed at a landfill site

**BIL:** Recommended – PC, ESA, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	R
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

**Competency 25.7: Describe methods of site identification and acceptance**

**Competency Builders:**

List typical factors that may restrict or eliminate a potential location from consideration as a future landfill site

Develop a plan to identify and manage the parts of the waste stream

List factors that determine waste acceptability

Identify liquids that may be excluded from landfill

Describe management options for lead acid batteries, used oil, eludes and infectious waste

Identify radioactive waste

Describe operational/equipment limitations that would prevent materials from going into landfills and disposal options



**BIL:** Essential – PC, ESA  
Recommended – HS, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	IR	P
HS		I
ECA		
HM	I	R
WEM		
FWM		
GIS		

**Competency 25.8: Describe the process of waste decomposition**

**Competency Builders:**

- Categorize waste by method of decomposition and by-products created
- List factors that effect the rate of decomposition
- List events that occur in a landfill as a result of decomposition
- Explain subsidence
- Explain differential settlement
- Describe settlement control
- Identify methods to determine whether settlement is occurring
- Explain landfill gas operation [R-HM]
- Describe composition of landfill gas and gas generation cycle [R-HM]
- Explain landfill gas migration [R-HM]
- List items that intercept migration routes [R-HM]
- Describe techniques for recognition and control of landfill migration [R-HM]
- Explain leacheate generation [R-HM]
- Characterize leacheate
- Describe leacheate impact [R-HM]
- List controlling factors in establishing leacheate quality [R-HM]

**BIL:** Essential – ESA  
Recommended – PC, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

**Competency 25.9: Describe sanitary landfill procedures**

**Competency Builders:**

- Describe aspects of site security
- Describe the importance of excluding unacceptable waste from the landfill
- Describe the careful execution of a monitoring permit
- Identify the size of working at the operations field station
- Identify access for vehicles at operations field station
- Describe landfill equipment operation
- Identify compaction practices at operations field station
- Describe scope of work at operations field station
- Describe nuisance conditions at operations field station including litter control, odors, and noise
- Describe cover at operations field station
- Classify field station operation (e.g., daily, intermediate, and final)
- Describe drainage control (i.e., run-on, run-off, depressions, erosions) at operations field station
- Describe liner integrity at field operations site including vegetation, sand blanket, erosion, waste placement, and traffic
- Describe other factors at field operations site including leachate seeps and vegetation screening
- List recommended procedures for maintaining monitoring well
- Complete chain of custody record for equipment at operations field station
- Describe an area of the field operations site that illustrates the best type of soil for different methods of operation
- Describe resource recovery and source reduction procedures

**BIL:** Essential – ESA  
Recommended – PC, HS, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	IR	P
HS		I
ECA		
HM		I
WEM		
FWM		
GIS		

**Competency 25.10: Monitor sanitary landfill procedures**

**Competency Builders:**

Explain safety rules and the importance of each

Identify individual safety items needed for landfill personnel to be appropriately equipped

Identify waste types received at operations field station including liquids, hazardous wastes, special wastes

Obtain samples from monitoring well at field operations site including the purging of a well

Complete laboratory analysis form

List various types of soil and their best use

Operate equipment used in soil sampling

Take a meter reading

**BIL:** Recommended – PC, ESA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	R
HS		
ECA		
HM	I	R
WEM		
FWM		
GIS		

**Competency 25.11: Describe methods to operate a composting facility**

**Competency Builders:**

Identify materials acceptable in a compost facility

Describe the steps necessary to construct a facility

Identify procedures used in receiving material

Describe operational procedures

Describe records/management document

**BIL:** Essential – HM  
Recommended – PC, ESA, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		I
ECA	I	R
HM	I	P
WEM		
FWM		
GIS		

**Competency 25.12: Describe methods to incinerate waste**

**Competency Builders:**

- Identify materials acceptable to be received at facility
- Describe methods employed in incineration of waste
- Describe material flow in incinerators
- Explain methods employed in separating waste
- Identify data management procedures

**BIL:** Essential – PC, HM  
Recommended – ESA, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	R
HS		
ECA		I
HM	I	P
WEM		
FWM		
GIS		

**Competency 25.13: Describe recycling methods**

**Competency Builders:**

Identify materials appropriate to recycle

Describe the economic and physical drivers associated with recycling

Identify methods to receive recycling material

Describe recycling management procedures

Identify markets for recycling material

Identify market factors associated with recycling

**BIL:** Recommended – PC, ESA, HS, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	R
HS		I
ECA		
HM		I
WEM		I
FWM		
GIS		

**Competency 25.14: Explain control processes for landfill gas and leachate**

**Competency Builders:**

- List characteristics of decomposition, leachate, and landfill gas
- Describe process for determining the potential for landfill gas
- Describe process for locating test wells
- List types of test wells
- Describe monitoring process used to detect the presence of methane
- Describe control methods for landfill gas
- Describe methods for landfill gas recovery and use
- Describe process which prevents leachate contact with groundwater [R-WEM]
- Describe control process of surface water [R-WEM]
- List characteristics of leachate migration [R-WEM]
- Describe controls for surface discharge of leachate [R-WEM]
- Describe methods for detecting leachate discharge to groundwater [R-WEM]
- List methods for control of leachate migration [R-WEM]
- Describe remedial actions which may be taken where leachate is contaminating groundwater [R-WEM]
- List types of leachate treatment systems [R-WEM]
- Describe methods of leachate recirculation [R-WEM]
- List representative leachate treatment technologies both biological and physical/chemical and give characteristics of each [R-WEM]
- List characteristics of an effective groundwater monitoring program [R-WEM]

**BIL:** Essential – HM  
 Recommended – PC, ESA, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		
ECA		I
HM	I	P
WEM		
FWM		
GIS		

**Competency 25.15: Identify design requirements for sanitary landfills**

**Competency Builders:**

Explain how specifications are used in the construction of landfills

Describe the basic types of plans necessary to show how a facility is to be developed

List items essential to following facility plans

Describe methods of measuring horizontal distance determining compliance with a facility plan



**BIL:** Recommended – PC, ESA, HS, ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	R
HS		I
ECA		I
HM		I
WEM		I
FWM		
GIS		

**Competency 25.16: Describe standard operational techniques for sanitary landfills**

**Competency Builders:**

- Identify elements that dictate facility operations
- Read sanitary landfill plans
- Identify elements of a design plan
- Identify elements of an operational plan
- Identify items an operator must control for a successful operation
- List methods for controlling moisture
- List methods for controlling run-off
- List methods for controlling waste
- Explain confinement methods
- Explain compaction methods
- Explain ratio of slope to compaction in an ideal landfill situation
- Describe the advantages of using proper soil for use as cover
- Describe types of cover and their functions
- Describe operation of a lined sanitary landfill
- Describe what must be accomplished to ensure a lined system will function
- Identify operational problems that are exacerbated by weather
- Identify strategies to resolve weather related problems
- Identify hard-to-handle wastes
- Describe operational problems exacerbated by hard to handle wastes
- Explain how to handle hard-to-handle wastes
- Identify failures of site operation principles that could result in environmental and health problems
- Identify potential nuisance and health problems
- Identify controls that can be used to reduce nuisance and health problems

**BIL:** Recommended – PC, ESA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		
ECA		
HM		
WEM		
FWM		
GIS		

**Competency 25.17: Explain sanitary landfill equipment procurement and maintenance**

**Competency Builders:**

Identify types of equipment and their advantages and disadvantages in the operation of a sanitary landfill

Describe daily maintenance of equipment program

Describe shutdown procedures

Describe a periodic maintenance program

Describe the role of accurate records of maintenance in the decision to depreciate and replace equipment

Identify costs that are common to maintain a sanitary landfill

Explain the bid process

List methods of equipment financing

Perform a total cost evaluation (TCE) of equipment considered for purchase or lease-purchase

**BIL:** Recommended – PC, ESA, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

**Competency 25.18: Describe site closure methods and post-closure considerations**

**Competency Builders:**

Describe goals that must be met for successful site closure

Describe steps in preplanning the closures

Describe the process that should occur three months prior to closure

Describe steps that should occur at closure

Describe things that need to be done three months after closure

Describe landfill gas control systems and their usefulness in long-term maintenance of a closed landfill

Explain use of data gathered from landfill gas and leachate monitoring systems

Explain how surface water and settlement can effect the containment of waste in a closed landfill

Describe some end uses for closed sites

Describe buffer layer, gas channel, filter layer, barrier, topsoil, and vegetation

Identify guidelines for constructing the final cover system

Identify desirable characteristics for vegetation on final cover

Explain how to determine soil suitability for planting and plant requirements for nutrients

Describe method for planting and protecting the seed

Identify methods for controlling run-on and run-off on a closed site

List information used by inspectors to determine acceptability of closure

Describe methods of financing closure and post closure

## Unit 26: Drinking Water Treatment Operations

**BIL:** Essential – PC, ESA, ECA, WEM  
Recommended - HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM		
WEM	I	P
FWM		
GIS		

**Competency 26.1: Identify characteristics of drinking water treatment**

### **Competency Builders:**

- Identify constituents inherent to groundwater and/or surface water
- Describe the pH scale and its importance in the water-treatment process
- Correlate treatment processes to types of facility influent and solids
- Identify commonly measured drinking water items
- Identify factors affecting raw drinking water
- Identify waterborne diseases
- Identify gases found in drinking water

**BIL:** Essential – PC, ESA, ECA, WEM  
Recommended - HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	IR	P
HS	I	R
ECA	P	R
HM		
WEM	I	P
FWM		
GIS		

**Competency 26.2: Sample drinking water**

**Competency Builders:**

Identify the reasons for sampling and the types of samples (e.g., simple, representative, grab, composite)

Describe methods of sample collection and handling

Identify process control samples (biological or chemical)

Identify representative sampling points

Determine the significance of process control sample results (biological or chemical)

Identify the basic procedure for quality control/quality assurance in sampling

Identify the significance of the flow measurement on process control

Identify pathogenic organisms, including bacteria, protozoa, and virus, and describe their disease associations

Identify applicable regulatory sampling guidelines

Test for bacteria

Explain sample chain of custody

Apply correct sample-collection procedures for inorganic and organic analyses

Describe the need for chemical analyses in water treatment

Determine whether the finished water is acceptable or unacceptable

**BIL:** Essential – PC, ESA, ECA, WEM  
Recommended - HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	P	R
HM		
WEM	I	P
FWM		
GIS		

**Competency 26.3: Identify constituents of water entering water-treatment facility**

**Competency Builders:**

Differentiate between turbidity and the microbiological quality of raw water

Describe the uses of chemical analysis in water-treatment operations

Identify commonly used units of constituent measurement

Explain the importance of water treatment for the control of coliform bacteria and algae

**BIL:** Essential – PC, ESA, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM		
WEM		P
FWM		
GIS		

**Competency 26.4: Analyze the constituents of drinking water**

**Competency Builders:**

Analyze the specific physical, chemical, and biological characteristics of drinking water

Identify ranges in drinking water treatment and limits on facility discharges

**BIL:** Essential – ESA  
Recommended – PC, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		I
ECA	I	R
HM		
WEM	I	R
FWM		
GIS		

**Competency 26.5: Explain the aeration process in water treatment**

**Competency Builders:**

Differentiate between aeration and air stripping

Identify types of aeration systems

Explain the benefits of aeration

Describe the components of an air-stripping system

Describe process control methods for aeration systems



**BIL:** Essential – ESA, WEM  
 Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS		I
ECA		I
HM		
WEM		P
FWM		
GIS		

**Competency 26.6: Monitor the mixing, coagulation, and flocculation processes in water treatment**

**Competency Builders:**

- Explain turbidity, color, coagulation, and flocculation
- Identify the kinds of equipment used in the coagulation process
- Identify coagulant chemicals used in water-treatment facilities
- Identify the steps of coagulation
- Identify specific sampling locations for control in a coagulation process
- Identify factors that would contribute to poor floc formation
- Compute the feed rate in pounds per day (lbs/d)
- Compute the dosage (mg/l) of coagulant
- Compute the dosage rate that is needed to treat a different flow (MGD) at the current dosage

**BIL:** Essential – ESA, WEM  
 Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS		I
ECA		I
HM		
WEM		P
FWM		
GIS		

**Competency 26.7: Monitor the filtration and sedimentation process in water treatment process**

**Competency Builders:**

- Explain concepts related to filtration including types of filters, filter-system components, and the steps for normal filtration operations
- Explain common problems of filtering systems including head loss, mudballs, filter media loss, and blinding
- Determine when to backwash a filter
- Identify the steps for backwashing a filter
- Explain filter backwash rates
- Explain concepts of sedimentation, including types of classifiers, sedimentation system components and steps for normal operation
- Measure sedimentation rates

**BIL:** Essential – ESA, WEM  
 Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

**Competency 26.8: Monitor the water-softening process in water treatment**

**Competency Builders:**

Identify treatment processes used for water softening

Describe types of hardness

Describe alkalinity and its components

Calculate the distribution of bicarbonate, carbonate, and/or hydroxide ions when given the total alkalinity and phenolphthalein alkalinity

Describe carbonate removal

Identify the important zones of an upflow clarifier unit

Identify the appropriate chemical(s) to use in chemical-precipitation softening process

Compute lime demand from raw-water analyses

Describe the reasons for recarbonization

Compute hardness removal when the ion-exchange capacity is known

**BIL:** Essential – ESA, WEM  
Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM		P
FWM		
GIS		

**Competency 26.9: Monitor the stabilization process in water treatment**

**Competency Builders:**

Identify the chemicals used in stabilization

Identify two stabilization indices

Conduct marble test

Conduct Langelier index

**BIL:** Essential – ESA, WEM  
 Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS		I
ECA		I
HM		
WEM		P
FWM		
GIS		

**Competency 26.10: Monitor the corrosion-control process in water treatment**

**Competency Builders:**

- Describe problems that can be created by corrosive waters
- Describe an electrochemical reaction
- Identify the factors that influence corrosion
- Explain cathode film formation
- Describe the conditions for calcium carbonate film formation
- Identify the chemicals used in corrosion control
- Describe cathodic protection and its application in water-treatment
- Describe the basic concepts of electrolysis
- Describe effects of lead and copper rule

**BIL:** Essential – ESA, WEM  
 Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM	I	P
FWM		
GIS		

**Competency 26.11: Monitor the disinfection process in water treatment**

**Competency Builders:**

- Identify chemicals used in primary disinfection
- Identify non-chemical methods in primary disinfection
- Identify commonly used chlorinators and hypochlorinators
- Determine the maximum amount of chlorine gas (in pounds) that may be taken from a cylinder in a 24-hour period
- Identify proper maintenance procedures for equipment chlorination
- Identify terminology related to chlorination and disinfection
- Identify common safety problems or emergency situations that might occur during chlorination
- Identify the properties of chlorine and its use in water treatment
- Explain the points at which chlorine is applied most effectively in water treatment
- Compute the feed rate (lbs/d)
- Compute the feed rate (lbs/d) of a hypochlorite compound
- Compute the new rate of flow and the feed rate that will be needed to maintain the current dosage
- Compute the feed rate needed to treat a given amount of water

**BIL:** Essential – ESA, WEM  
Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM	I	P
FWM		
GIS		

**Competency 26.12: Monitor the control and treatment of trihalomethanes in water**

**Competency Builders:**

Describe the formation of total trihalomethanes (TTHM)

Collect samples to determine trihalomethane levels

Compute the quarterly average and the annual TTHM measurements

Identify processes that remove trihalomethane precursors

Identify processes that remove trihalomethanes after they are formed

Identify the benefits of alternate disinfectants

Describe chloramination as a control of TTHM

**BIL:** Essential – ESA, WEM  
Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

**Competency 26.13: Monitor the iron and manganese removal processes in water treatment**

**Competency Builders:**

Describe the importance of controlling iron and manganese

Explain the occurrence of iron and manganese in source water and in treated water

Perform sample-collection and analysis procedures for iron and manganese



**BIL:** Essential – ESA, WEM  
 Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

**Competency 26.14: Describe taste and odor control in water treatment**

**Competency Builders:**

Identify common types of complaints about water quality

Identify causes of tastes and odors

Explain how microbial growths affect tastes and odors

Explain how eutrophication contributes to surface-water tastes and odors

Describe a cross-connection

Identify the chemicals used in the control and treatment of tastes and odors

Describe the Threshold Odor Number (TON) test

Determine the TON when dilution volumes and positive samples are given

**BIL:** Essential – ESA  
 Recommended – PC, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		P
HS		I
ECA	I	R
HM		
WEM		I
FWM		
GIS		

**Competency 26.15: Describe the demineralization processes in water treatment**

**Competency Builders:**

- Explain concepts related to demineralization (e.g., reverse osmosis (RO), flux, feedwater, permeate, salinity)
- Describe the structure, composition, and performance of an RO membrane
- Describe feedwater impurities, physical parameters, and conditions potentially harmful to the RO process
- Identify items included in a typical RO-facility-operation checklist
- Describe the common causes of membrane damage
- Describe the procedure for membrane cleaning
- Compute the percent of recovery
- Compute the percent of mineral rejection
- Describe the basic concepts of electrodialysis (ED), such as the cathode and anode relationship and the removal of typical inorganic salts
- Describe the most common problem of ED operation in a facility
- Explain how the cation membrane and the anion membrane differ
- Describe the multi-compartment unit used in the ED process
- Describe ED operating procedures in detail
- Describe the most common chemical solutions used to flush ED stack membranes

**BIL:** Essential – ESA, WEM  
Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS		I
ECA		I
HM		
WEM	I	P
FWM		
GIS		

**Competency 26.16: Monitor the fluoridation process in water treatment**

**Competency Builders:**

Identify the basic concepts of fluoridation and the kinds of chemicals used

Identify the properties of fluoride and its use

Identify the types of equipment used in fluoridation

Describe proper maintenance procedures for fluoridation equipment

Describe potential safety problems or emergency situations in the fluoridation process, and ways to avoid them

Compute the feed rate of chemicals used in the fluoridation process

**BIL:** Recommended – PC, ESA, HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		I
ECA		
HM		
WEM		I
FWM		
GIS		

**Competency 26.17: Correct facility operational problems in water treatment**

**Competency Builders:**

Describe common facility operational problems in the treatment train, effluent disposal, and solids management

Identify appropriate corrective actions for common problems in disposal, and solids management

Troubleshoot coagulation and flocculation

Troubleshoot sedimentation

Troubleshoot disinfection

Troubleshoot filtration

Troubleshoot corrosion control

Troubleshoot taste and odor control

Troubleshoot iron and manganese control

Troubleshoot fluoridation

Troubleshoot softening

Troubleshoot demineralization

Troubleshoot trihalomethanes

**BIL:** Essential – PC, ESA, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS		P
ECA	I	P
HM		
WEM	I	P
FWM		
GIS		

**Competency 26.18: Explain state and federal environmental protection agency (EPA) rules for drinking water**

**Competency Builders:**

Describe the operator's duties and responsibilities, certification requirements, testing, renewal, staffing, and facility classification

Complete a EPA monthly operating report (MOR) form

Describe OSHA, EPA, and local health department rules for procedures such as reclaimed water, reuse, and biosolids residuals management

Describe federal rules that apply to the operation of a drinking water-treatment facility

**BIL:** Essential – PC, ESA, WEM  
Recommended – HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	IR	P
HS	I	R
ECA	I	R
HM		
WEM		P
FWM		
GIS		

**Competency 26.19: Analyze environmental microbiological techniques**

**Competency Builders:**

Perform coliform analyses

Perform sterilization techniques

Describe cultivation of microorganisms

Perform a standard plate count

Perform pressure presence/absence in membrane filter colifon analysis

**BIL:** Essential – PC, ESA  
Recommended – HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		P
HS		I
ECA		I
HM		
WEM		I
FWM		
GIS		

**Competency 26.20: Identify methods for backflow prevention**

**Competency Builders:**

Explain cross-connection

Identify purposes and consequences of backflow prevention

Identify approved backflow prevention devices

271

## Unit 27: Wastewater Treatment Operations

**BIL:** Essential – PC, ESA, WEM  
Recommended – HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	R
WEM	I	P
FWM		
GIS		

### Competency 27.1: Identify characteristics of wastewater treatment

#### Competency Builders:

Identify constituents inherent to groundwater and/or surface water

Describe the pH scale and its importance in the water-treatment process

Correlate treatment processes to types of facility influent and solids

Identify biological organisms used in treatment processes

Identify commonly measured wastewater items

Identify factors affecting raw wastewater

Identify waterborne diseases

Identify gases found in wastewater



**BIL:** Essential – PC, ESA, ECA, WEM  
Recommended - HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

## **Competency 27:2 Sample wastewater**

### **Competency Builders:**

Identify the reasons for sampling and the types of samples (e.g., simple, representative, grab, composite)

Describe methods of sample collection and handling

Identify process control samples (biological or chemical)

Identify representative sampling points

Determine the significance of process control sample results (biological or chemical)

Identify the basic procedure for quality control/quality assurance in sampling

Identify the significance of the flow measurement on process control

Identify laboratory tests required by the NPDES permit

Identify pathogenic organisms, including bacteria, protozoa, and virus, and describe their disease associations

Identify regulatory sampling guidelines

Perform coliform analyses

Describe cultivation of microorganisms

Test for bacteria

Explain sample chain of custody

Apply sample-collection procedures for inorganic and organic analyses

Describe the need for chemical analyses in wastewater treatment

Determine whether the finished water is acceptable or unacceptable

**BIL:** Essential – PC, ESA, ECA, WEM  
Recommended - HS, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		P
HS	I	R
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

**Competency 27.3: Describe wastewater collection systems**

**Competency Builders:**

Identify types of wastewater collection systems

Identify flow variations and conditions that affect plant treatment including infiltration, inflow, and lift stations

Describe methods to detect and correct infiltration and inflow

Identify dissolved gases in wastewater and the effect of their presence/absence on treatment

**BIL:** Essential – PC, ESA, ECA  
Recommended – HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM		
WEM		
FWM		
GIS		

**Competency 27.4: Identify constituents of wastewater entering wastewater treatment facility**

**Competency Builders:**

Describe the uses of chemical analysis in wastewater-treatment operations.

Identify commonly used units of constituent measurement

Identify pollutants, chemical, and microbial in raw water

**BIL:** Essential – PC, ESA, ECA, WEM  
Recommended –HS, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		P
HS		I
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

**Competency 27.5: Analyze the constituents of wastewater**

**Competency Builders:**

Analyze the specific physical, chemical, and biological characteristics of wastewater

Analyze attached and suspended growth, respiration, gas production, aerobic and anaerobic conditions, differences in effluent disposal, and biosolids management

Identify ranges in wastewater treatment and limits on facility discharges

**BIL:** Essential – ESA, WEM  
 Recommended – PC, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS		
ECA		I
HM		
WEM	I	P
FWM		
GIS		

**Competency 27.6: Troubleshoot collection system**

**Competency Builders:**

Explain the significance of dissolved gases in the influent and the effects of dissolved gases on treatments

Explain the sources of infiltration and inflow and the effects of infiltration and inflow on treatment processes

Detect infiltration and inflow

Correct infiltration and inflow

Explain the effect of lift-station performance on the overall treatment process

Implement solutions for lift-station problems, such as surging flows, septic conditions, and power outages

**BIL:** Essential – ESA, WEM  
 Recommended – PC, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS		
ECA	I	R
HM		
WEM		P
FWM		
GIS		

**Competency 27.7: Describe the mixing, coagulation, and flocculation processes in wastewater treatment**

**Competency Builders:**

- Identify coagulant chemicals used in wastewater-treatment facilities
- Identify the steps of coagulation
- Identify specific sampling locations for control in a coagulation process
- Identify factors that would contribute to poor floc formation
- Compute the feed rate in pounds per day (lbs/d)
- Compute the dosage (mg/l) of coagulant
- Compute the dosage rate that is needed to treat a different flow (MGD) at the current dosage

**BIL:** Essential – ESA  
 Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS	I	R
ECA	I	R
HM		
WEM		
FWM		
GIS		

**Competency 27.8: Describe the disinfection process in wastewater treatment**

**Competency Builders:**

- Identify chemical disinfection methods
- Identify non-chemical disinfection methods
- Identify commonly used chlorinators and hypochlorinators
- Determine the maximum amount of chlorine gas (in pounds) that may be taken from a cylinder in a 24-hour period [R-HS]
- Identify proper maintenance procedures for equipment chlorination
- Identify terminology related to chlorination and disinfection [R-HS]
- Identify terminology related to ultraviolet disinfection
- Identify common safety problems or emergency situations that might occur during chlorination
- Identify the properties of chlorine and its use in waste water treatment
- Explain the points at which chlorine is applied most effectively in waste water treatment
- Compute the feed rate (lbs/d)
- Compute the feed rate (lbs/d) of a hypochlorite compound
- Compute the new rate of flow and the feed rate that will be needed to maintain the current dosage
- Compute the feed rate needed to treat a given amount of water

**BIL:** Essential – ESA, WEM  
 Recommended – PC, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS		
ECA	I	R
HM	I	R
WEM		P
FWM		
GIS		

**Competency 27.9: Describe the treatment train, effluent disposal, and solids management in wastewater**

**Competency Builders:**

- Describe concepts related to preliminary and primary treatment
- Describe the types of preliminary-treatment equipment, the way they function, and the relationship of each to the treatment train
- Describe the types of primary-treatment equipment, the way they function, and the relationship of each to the treatment train
- Describe concepts related to secondary treatment, including attached growth, aeration, and clarification
- Describe process control methods for aeration systems
- Describe the types of secondary-treatment equipment, the way they function, and the relationship of each to the treatment train
- Describe concepts related to tertiary-treatment processes, including sand filtration, nitrification/denitrification, oxic/anoxic, activated carbon, and artificial wetlands
- Describe the types of tertiary-treatment equipment, the way they function, and the relationship of each to the treatment train
- Describe concepts related to disinfection and effluent disposal, including surface water, reuse reclamation, deep well, and ocean outfall
- Describe the types of disinfection and the types of effluent-disposal equipment, they way they function, and the relationship of each to the system
- Describe concepts related to solids management, including thickening, aerobic and anaerobic digestion, stabilization, dewatering, and reuse
- Describe the types of solids-management equipment, the way they function, and the relationship of each to the system



**BIL:** Essential – ESA, WEM  
 Recommended – PC, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS		
ECA		I
HM		I
WEM		P
FWM		
GIS		

**Competency 27.10: Analyze process optimization for the treatment train, effluent disposal, and biosolids management in waste water treatment**

**Competency Builders:**

Interpret laboratory data commonly obtained on incoming wastewater to monitor the efficiency of the identified treatment

Describe possible adjustments to achieve process optimization for handling influent

Interpret laboratory data commonly obtained on wastewater during primary treatment to monitor the efficiency of the identified treatment

Describe possible adjustments to achieve process optimization for handling primary treatment

Interpret laboratory data commonly obtained on wastewater during secondary treatment to monitor the efficiency of the identified treatment

Describe possible adjustments to achieve process optimization for secondary treatment

Interpret laboratory data commonly obtained on wastewater during tertiary treatment to monitor the efficiency of the identified treatment

Describe possible adjustments to achieve process optimization for tertiary treatment

Interpret laboratory data commonly obtained on reclaimed water during disinfection and disposal to monitor the efficiency of the identified treatment

Describe possible adjustments to achieve process optimization for disinfection and disposal processes

Interpret laboratory data commonly obtained during solids management, including solids-content tests, to monitor the efficiency of the identified treatment

Describe possible adjustments to achieve process optimization in solids management

Identify proper disposal of solids based on the analysis of constituents, including accountability records and costs

**BIL:** Essential – ESA, WEM  
 Recommended – PC, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS		
ECA		I
HM		I
WEM		P
FWM		
GIS		

**Competency 27.11: Analyze treatment process control for the treatment train, effluent disposal, and biosolids management in wastewater**

**Competency Builders:**

- Describe grit-removal process
- Describe laboratory tests performed on influent
- Describe primary-clarifier removal efficiencies including settleable solids, suspended solids, total solids, BOD, and bacteria
- Describe sampling points, frequency of sampling, and the laboratory tests and results that are used for the proper operation of the primary clarifier
- Identify and plot on a trend chart the parameters for primary clarification
- Describe advanced laboratory tests taken in the primary sedimentation tank
- Evaluate the performance of secondary-treatment processes including attached growth, suspended growth, aeration, and clarification
- Describe sampling points, the frequency of sampling, and the laboratory tests and results used for proper operation of the secondary-treatment processes
- Identify and plot on a trend chart the parameters for secondary clarification
- Describe advanced laboratory tests taken in the secondary-treatment processes
- Evaluate the performance of tertiary-treatment processes, including sand filtration, phosphorus removal, and nitrogen removal
- Describe sampling points, the frequency of sampling, and the laboratory tests and results used for checking the proper operation of tertiary treatment
- Identify and plot on a trend chart the parameters for tertiary treatment
- Describe advanced laboratory tests taken in advanced or tertiary treatment
- Evaluate the performance of effluent-disposal processes, including disinfection and dechlorination
- Describe sampling points, the frequency of sampling, and the laboratory tests used for checking the proper operation of effluent disposal
- Identify and plot on a trend chart the parameters for effluent disposal
- Describe the chemical and physical properties of chlorine

Describe the reactions of chlorine with water, ammonia compounds, and sulfides  
Describe the safe storage and handling of chlorine, including the use of testing compounds  
Explain the points of application of chlorine in wastewater treatment  
Describe methods of dechlorination  
Describe methods commonly used to dispose of wastewater effluents, including reuse applications  
Describe laboratory tests commonly used on the reuse of effluent  
Describe types of sludge and their characteristics  
Evaluate the performance of solids management, including sludge thickening, digestion, dewatering, and disposal processes  
Describe sampling points, the frequency of sampling, and the laboratory tests and results used for checking the proper operation of solids management  
Describe advanced laboratory tests for disinfection, effluent disposal, and solids management  
Identify 503 sludge regulations  
Identify various recycling methods

**BIL:** Essential – ESA, WEM  
 Recommended – PC, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS		
ECA		I
HM		
WEM		P
FWM		
GIS		

**Competency 27.12: Inspect and maintain equipment for the treatment train, effluent disposal, and biosolids management in wastewater**

**Competency Builders:**

- Identify equipment used in the treatment train, effluent disposal, and solids
- Identify the maintenance needs of equipment used in the treatment train, effluent disposal, and solids management
- Document the results of inspections
- Develop preventive maintenance plans for equipment used in preliminary-, primary-, secondary-, and tertiary-treatment processes, and for equipment used in effluent disposal and solids management
- Explain trends analysis used in preventive-maintenance planning for all treatment processes, effluent disposal, and solids management
- Describe the monitoring of facility-equipment operation and usage with remote sensing equipment

**BIL:** Essential – ESA, WEM  
Recommended – PC, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS		
ECA		I
HM		
WEM		P
FWM		
GIS		

**Competency 27.13: Describe common facility operational problems**

**Competency Builders:**

Check accuracy of observed operational problems in preliminary, primary, secondary, and tertiary treatment, effluent disposal, and solids management

Identify appropriate corrective actions for common problems in disposal, and solids management

Describe the methods for monitoring results of corrective action taken for common problems in preliminary, primary, secondary, and tertiary treatment, effluent disposal, and solids management

Identify sedimentation problems

Identify disinfection problems

Identify filtration problems

**BIL:** Essential – PC, ESA, ECA, WEM  
Recommended – HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		P
HS		I
ECA		P
HM		
WEM	I	P
FWM		
GIS		

**Competency 27.14: Explain state and federal environmental protection agency (EPA) rules for waste water**

**Competency Builders:**

Describe the operator’s duties and responsibilities, certification requirements, testing, renewal, staffing, and facility classification

Explain rules concerning samples and analysis at wastewater-treatment facilities

Complete an EPA monthly operating report (MOR) form

Complete a National Pollution Discharge Elimination System (NPDES) MOR form

Identify OSHA, EPA, and local health department rules for procedures such as reclaimed water, reuse, and biosolids residuals management

Identify federal rules that apply to the operation of a wastewater-treatment facility

**BIL:** Essential – PC, ESA  
Recommended – HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		P
HS		I
ECA		I
HM		
WEM		I
FWM		
GIS		

**Competency 27.15: Identify methods for cross-connection and backflow prevention**

**Competency Builders:**

Identify purposes and consequences of backflow prevention

Identify approved backflow prevention devices



**BIL:** Essential – ESA, WEM  
Recommended – PC, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS		I
ECA	I	R
HM	I	R
WEM		P
FWM		
GIS		

**Competency 27.16: Identify industrial pretreatment program**

**Competency Builders:**

Identify categorical industries

Identify non-categorical industrial

Identify purpose of industrial pretreatment

Describe federal and state pretreatment regulations

## Unit 28: Hazardous Materials Management

**BIL:** Essential –ESA, ECA, HM  
Recommended – PC, HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

### Competency 28.1: Describe risks related to hazardous materials

#### Competency Builders:

Define hazardous material

Differentiate hazardous materials incidents from other emergencies (First Responder Awareness-FRA; First Responder Operations Level-FRO; Hazardous Materials Technician-HMT; Hazardous Materials Specialist-HMS)

Differentiate between hazardous materials and waste with non-hazardous materials (FRA, FRO, HMT, HMS)

Differentiate between acute and chronic hazards

Describe the properties /nomenclature of hazardous materials

Describe physical, chemical, biological hazards (including explosion/fire hazards)

Describe the routes of exposure for hazardous materials

Describe the fundamentals of chemical hazards including but not limited to vapor pressure, boiling points, flash points and pH (FRA, FRO, HMT, HMS)

Describe fire and explosion hazards of chemicals including typical ignition sources (FRA, FRO, HMT, HMS)

Describe viral and bacteriological hazards of biological materials

Describe types of radiation and their effects

Identify examples of a confined space

Describe the hazards related to confined space (FRA, FRO, HMT, HMS)

Describe general safety hazards (e.g., electrical hazards, powered equipment hazards motor vehicle hazards, walking-working surface hazards associated with working in hot and cold temperature extremes (FRA, FRO, HMT, HMS)

Identify routes by which hazardous materials enter the human body upon exposure

Describe the basic principles of toxicology  
Describe the human signs and symptoms as responses to exposures to chemical,  
biological and radiological hazards

291

**BIL:** Essential – ESA, HS, ECA, HM  
 Recommended – PC, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

**Competency 28.2: Describe health and safety practices to reduce risks from hazardous materials**

**Competency Builders:**

Describe protocol to control stress from noise

Describe the exposure guidelines for hazardous materials (threshold limit value, permissible exposure limits)

Explain the impact of basic nutrition on the risks from hazardous materials

Describe the elements of a spill control program (FRO, HMT)

Describe examples of engineering controls, equipment and safety technology or safety procedures (FRO, HMT)

Identify typical design and construction of containers, bulk and non-bulk packaging used to store, process, or transport hazardous materials (e.g., bags, bottles, boxes, cans, carboys, drums, fixed tanks, intermodal portable tanks, piping tank cars, tank trucks, and trailers (FRO, HMT)

**BIL:** Essential – ESA, HS, ECA, HM  
Recommended – PC

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.3: Demonstrate appropriate responses for major types of hazardous materials disasters (e.g., chemical, fire and explosion, general safety hazards) (FRA, FRO, HMT, HMS)**

**Competency Builders:**

Describe the principles and practices of establishing exposure zones, and medical surveillance stations and procedures (HMT, HMS)

Describe how MSDS (material safety data sheet) may be used to obtain hazard and response information

Identify risk assessment considerations of hazardous materials (e.g., size and type of container and quantity involved; nature of the container stress; potential behavior of the container and its contents; level of resources available; exposure potential to people, property, environment, and systems; and weather conditions and terrain) (FRA, FRO, HMT, HMS)

Describe the procedures for implementing continuing response actions consistent with local emergency response plan, the organizations standard operating procedures, and the current edition of Department of Transportations’s ERG including extended emergency notification procedures and follow-up communications (FRA, FRO, HMT, HMS)

Demonstrate decontamination procedures

Describe the advantages and limitations of each of the following methods of decontamination: absorption, adsorption, neutralization, and solidification (HMT, HMS)

Identify the steps in critiquing a hazardous materials incident

**BIL:** Essential –PC, ESA, HS, ECA, HM  
Recommended – WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

**Competency 28.4: Describe appropriate use of Personal Protective Equipment (PPE)**

**Competency Builders:**

Describe the following terms as associated with chemical protective clothing:  
degradation; penetration; and permeation

Identify the physical and psychological stresses that can affect users of specialized protective clothing

Identify various types of protective breathing apparatus and the advantages and limitations of each at a hazardous materials incident (FRO, HMT, HMS)

Interpret chemical compatibility chart for chemical protective clothing (FRO, HMT, HMS)

Explain the four levels of PPE (A, B, C, D) (FRO, HMT, HMS)

Identify the equipment used with each of the four levels of PPE

Identify the conditions under which it is safe to enter a space with each of the four levels of PPE

**BIL:** Essential – ESA, ECA, HM  
 Recommended – PC, HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

**Competency 28.5: Explain hazardous substance regulations**

**Competency Builders:**

- Describe the role of federal, state and local agencies in developing and implementing regulation
- Describe the core elements of an occupational safety and health program as identified in 29 CFR1910.120 (q) (FRA, FRO, HMT, HMS)
- Describe the components of an effective site safety and health plan consistent with the requirements of 29 CFR1910.120 (b)(4)(ii)
- Describe what activities are controlled by OSHA 29 CFR1926 regulations
- Describe the record keeping requirements for workmen’s compensation, OSHA (100 &200), Department of Transportation, and the Environmental Protection Agency
- Explain the rights and responsibilities of employers and employees under applicable OSHA and EPA laws
- Describe confined space considerations as outlined in 29 CFR 1910.146 and lock-out tag-out standards
- Explain OSHA’s hazard-communication standard (29 CFR 1910.1200)
- Explain the impact of the following regulations on hazardous substance:
  - CERCLA- Comprehensive Environmental Response Liability and Compensation Act (Super Fund)
  - RCRA- Resource Conservation and Recovery Act
  - TSCA- Toxic Substance Control Act
  - SDWA- Safe Drinking Water Act
  - CWA -The Clean Water Act
  - CAA- Clean Air Act
  - HM181- Hazardous Materials Regulations
  - NFPA-704- National Fire Protection Association No. 704 Code of Federal Regulations
  - SARA- Super Fund Amendment and Reauthorization Act

Explain the competencies of the First Responder at the Awareness level as covered in the National Fire Protection Association Standard No. 472 Professional Competence of Responders to Hazardous Materials Incident (FRA)

Explain the competencies of the First Responder at the Operations Level covered in the National Fire Protection Association's Standard No. 472 Professional Competence of Responders to Hazardous Materials Incident (FRO)

Explain the competencies of the Hazardous Materials Technician covered in the National Fire Protection Association's Standard No. 472 Professional Competence of Responders to Hazardous Materials Incident (HMT)

Explain the competencies of the Off-Site Specialist Employee covered in the National Fire Protection Association's Standard No. 472 Professional Competence of Responders to Hazardous Materials Incident (HMS)



**BIL:** Essential – ESA, ECA, HM  
 Recommended – PC, HS, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS	I	P
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

**Competency 28.6: Demonstrate an ability to obtain and use information addressing hazardous substance release**

**Competency Builders:**

Identify chemical reference materials (i.e., NIOSH)

Describe the use of mapping

Identify suppliers and technical resources

Identify responders

Demonstrate competency using the U.S. Department of Transportation's  
 Emergency Response Guidebook (ERG) (FRA, FRO, HMT)

Demonstrate competence using manufacturer material safety data sheets,  
 CHEMTREC//CANUTEC, shipper or manufacturer contacts, and other  
 sources of information addressing hazardous substance release (FRO, HMT)

Demonstrate competence using hazardous materials computer databases and  
 response models (HMT)

Utilize computer networking

**BIL:** Essential – PC, ESA, ECA, HM  
Recommended – HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

### **Competency 28.7: Conduct environmental sampling**

#### **Competency Builders:**

Determine reason for sample

Define risks associated with sampling

Identify sampling protocol

Follow chain of custody procedures

Determine frequency of sampling

Identify testing plan

Define QA/QC protocol

Identify potential sample interferences

Demonstrate preventive maintenance and testing procedures, including operational and calibration checks, for sampling and monitoring equipment

Demonstrate appropriate use of equipment (e.g., bailers, hand augers, organic-vapor analyzers, pumps, radioactivity measuring equipment, split spoons, combustible gas detector, oxygen meter, elorimetric tubes, pH papers and strips, CO meter, radiation detection instruments, colorimetric indicator, combustible-gas indicator, organic-vapor analyzer, OVA, HNU, PID and explosimeter)

Demonstrate container sampling and safeguarding procedures (e.g., general drum/container handling procedures, special requirement for laboratory waste packs, shock-sensitive wastes, and radioactive wastes (HMS))

Sample ground water, waste water, sewer line, drum, air, soil, unknown materials, personnel

Perform field tests (i.e., HAZCAT)

Perform OVD test

Identify proper preservation and storage procedures for hazardous materials samples

Demonstrate the appropriate use of the Perform personnel-exposure monitoring  
Follow chain-of-custody procedures

**BIL:** Essential – PC, ESA, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.8: Demonstrate safe handling procedures for hazardous materials and hazardous waste**

**Competency Builders:**

List and describe containers used to store hazardous chemicals and waste (HMS)

Describe safe handling procedures for hazardous materials

Describe different types of hazardous substance transportation vehicles (HMT)

Demonstrate appropriate selection and use of the various types of equipment available for plugging or patching transportation containers, vessels or vehicles (HMS)

Implement safe chemical-handling procedures (e.g., bonding fire control, grounding, storage, vapor control, ventilation)

Demonstrate safe handling procedures for bulk chemical containers, drums, and portable and stationary tanks (HMT)

Prepare to ship sample to laboratory (per Department of Transportation)

**BIL:** Essential – PC, ESA, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.9: Demonstrate record keeping**

**Competency Builders:**

Explain why and how long hazardous materials incidents should be documented including training records, exposure records, incident reports, and critique reports

Keep an activity log and exposure records for a hazardous materials incident

Explain the importance of daily record keeping

Keep time sheets

Keep a field diary of sampling activities

Keep inventory records

Prepare chain of custody for sample

Prepare documentation of laboratory results

Prepare documentation of monthly preventive checks and services

Maintain an equipment log

Develop schedules

**BIL:** Essential – ESA, ECA, HM  
Recommended – PC, HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS		I
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.10: Evaluate laboratory results**

**Competency Builders:**

- List criteria for the selection of the laboratory
- Identify laboratory methodology
- Identify laboratory instrumentation
- Identify laboratory quality control procedures

**BIL:** Essential – ESA, HS, ECA, HM  
Recommended – PC

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.11: Demonstrate health and safety practices to reduce risks from hazardous substances**

**Competency Builders:**

Demonstrate lead and asbestos safety procedures

Demonstrate confined space safety procedures

Demonstrate decontamination procedures

Demonstrate the procedures to carry out a respirator program to comply with 29 CFR 1910.134 (FRO, HMT)

Demonstrate methods of communication including those used while wearing respirator protection

Demonstrate the donning and doffing of protective equipment (FRO, HMT, HMS)

Write a site safety plan

Conduct a site safety meeting

Obtain first aid/CPR certification

**BIL:** Essential – PC, ESA, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.12: Demonstrate methods for identifying hazardous material**

**Competency Builders:**

Describe the advantages, disadvantages, and limitations of placards, labels, container markings, and shipping papers used in the transportation of hazardous materials

Describe the shipping papers found in various modes of transportation, the individual's responsible for the papers, and location where carried and found during an incident

Explain circumstances for use of the following terms: hazardous substances, hazardous chemicals; extremely hazardous substances; hazardous wastes; hazardous materials; and dangerous goods

List the advantages and disadvantages of each of the following information sources: MSDS; reference guidebooks; hazardous materials data base; technical information centers such as CHEMTREC; technical information specialist; monitoring equipment; and NIOSH pocket guide to chemical hazards

Explain labeling of hazardous materials by the chemical and physical properties of color, corrosivity, density, flammability, reactivity, specific gravity, toxicity, and viscosity

Identify hazardous wastes according acute toxicity, corrosivity, ignitability, reactivity, and toxic characteristic leachate procedure (TCLP)

Demonstrate proper labeling for hazardous wastes

Label containers of repackaged materials with appropriate warnings and expiration information

**BIL:** Essential – ESA, HS, ECA, HM  
Recommended – PC

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.13: Detect hazardous materials**

Detect toxicity, flammability, reactivity, radioactivity, corrosively, and oxygen deficiency

Use MSDS in obtaining hazard and response information to determine isolation and evacuation distances

Use air reactivity; catalysts and inhibitors; concentration; corrosivity; critical temperature and pressure; instability; oxidation ability; pH; polymerization; radioactivity; self-accelerating decomposition temperature (SADT); strength; sublimation; surface tension; viscosity; volatility; and water reactivity in the risk assessment process

Explain the use of threshold limit value (TLV-TWA); lethal concentration and dose (LD 50/100); parts per million/billion (ppm/ppb); immediately dangerous to life and health (IDLH); permissible exposure limit (PEL); short-term exposure limit (TLV-STEL); and ceiling level (TLV-C)

Explain the importance of chemical interactions; dose-response relationship; local and systemic effects; acute, subacute, and chronic exposure; and ingestion, absorption, inhalation in the risk assessment process

Explain half-life, time, distance, and shielding in reference to radiation hazards

Demonstrate the analysis procedure for identification of unknown hazardous materials, their physical and chemical properties, and the likely behavior of the hazardous substance and its container, vessel, or vehicle (HMS)

Compare laboratory and field sample analysis against regulatory limits

Identify considerations associated with the placement, location, and set up of a decontamination site

Identify which activities are required in terminating the emergency phase of a hazardous materials incident

Describe the preparation of a required report with supporting documentation

Describe the process for implementing the Incident Command System for hazardous materials emergencies



**BIL:** Essential – PC, ESA, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.14: Perform site evaluation**

**Competency Builders:**

- Activate site assessment plan
- Notify appropriate authorities
- Check for immediate dangers to life and health
- Determine site topography and accessibility
- Determine wind direction
- Implement appropriate site health and safety plan
- Describe the emergency-response program
- Establish boundaries
- Restrict site access
- Orient zones
- Determine needs for PPE
- Record findings
- Report findings to appropriate authorities
- Control site
- Monitor site and personnel
- Close site

**BIL:** Essential – PC, ESA, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	R	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.15: Retrieve and evaluate hazardous materials and hazardous waste sample data**

**Competency Builders:**

Interpret prints, charts, curves, graphs, maps, plans, and spreadsheets from plotted and tabulated data

Tabulate data using calculators, computers, databases, graphics, and/or spreadsheets

Perform mathematical calculations

Compare appropriate laboratory and/or field sample analyses against regulatory limits

**BIL:** Essential – PC, ESA, HS, HM  
Recommended – ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.16: Respond to mock hazardous materials emergency situations**

**Competency Builders:**

Maintain certification in first aid and CPR

Describe the elements of a spill control program

Follow a written contingency plan

Use proper chain of command

Ensure that adequate spill-control equipment and supplies are available

Contact appropriate hazardous materials public and private resources (HMS)

Implement an emergency-response program consistent with local emergency response plan, and the organization's standard operating procedures (HMS)

Select the appropriate strategy for approaching a release site and continuing or stopping the release (HMS)

Implement an Incident Command System for a hazardous materials emergency

Demonstrate competency in first aid, CPR and emergency response

Identify considerations associated with the placement, location, and set up of a decontamination site

Implement decon

Organize and direct the use of multiple teams of hazardous materials technicians in a Command System (ICS) (HMS)

Identify which activities are required in terminating the emergency phase of a hazardous materials incident

Prepare the required report with supporting documentation for a hazardous waste Emergency

Follow media protocol

**BIL:** Essential – ESA, HM  
Recommended – PC, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	R	P
HS		I
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.17: Describe use of equipment related to hazardous materials and hazardous-waste operations**

**Competency Builders:**

Explain appropriate equipment-decontamination procedures

Identify appropriate operations and maintenance procedures, plans, and manuals

Identify skill and certification requirements

Describe proper use of drum crushers, hand tools, heavy equipment, monitoring and sampling equipment, instrumentation, motorized lifting devices, power tools, pumps, valves, meters, vehicles

Employ communication systems, eyewashes, safety showers, fire extinguishers, and first aid

**BIL:** Essential – PC, ESA, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.18: Prepare hazardous-materials for transportation and storage in accordance with regulations**

**Competency Builders:**

Prepare documentation related to the shipment of hazardous materials and hazardous wastes

Identify incompatible combinations of chemicals that could result in dangerous situations

Describe safe and healthful procedures for packaging, loading, documenting, and shipping of hazardous materials and hazardous wastes

Inspect hazardous-waste storage areas for compliance with appropriate rules and regulations following a checklist

Segregate and store incompatible hazardous materials and hazardous wastes

Employing a hazard category list

**BIL:** Essential – HM  
 Recommended – PC, ESA, HS, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		I
ECA	I	R
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.19: Demonstrate ability to operate treatment and disposal systems for hazardous-materials and hazardous-waste**

**Competency Builders:**

- Record and maintain documentation of operations activities
- Contribute to the development and revision of plans and reports
- Identify appropriate drums and containers
- Document activities of hazardous-waste treatment and disposal contractors
- Recommend improvements in the reduction, reuse, recycling, or disposal of waste streams
- Describe the collection and disposal of empty hazardous materials containers
- Describe the preparation of accumulated hazardous waste for proper disposal
- Describe treatment, removal and disposal systems such as: bio-remediation, chemical and physical, deep-well injection, incineration, vitrification, and volatile organic compounds
- Describe hazards associated with abatement of materials such as: asbestos, fiberglass, and lead
- Describe hazards associated with treatment, removal, and disposal systems and operations
- Demonstrate decontamination programs including personnel, equipment and hardware; including level A, B and C ensembles and appropriate decontamination lines

**BIL:** Essential – PC, ESA, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA		P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.20: Maintain required documents for hazardous-materials and hazardous-waste management activities**

**Competency Builders:**

Demonstrate manifest procedures

Maintain documentation of chain of custody, equipment calibration and maintenance, exception reports, field notebooks, incident documentation, laboratory data, manifests, MSDS, purchase orders, shipping documents, and vendor invoices

Maintain compliance reports

Ensure current MSDS are available in the workplace

Maintain auditable record-keeping systems

Maintain a hazardous-materials inventory

Maintain a hazardous-waste inventory

Maintain an inventory of empty and full containers

**BIL:** Essential – ECA, HM  
 Recommended – PC, ESA, HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		I
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

**Competency 28.21: Audit regulatory compliance**

**Competency Builders:**

- Describe Phase I and Phase II audits
- Describe closure reports
- Describe the penalties for noncompliance
- Follow organization’s policies and procedures
- Create master file (e.g., data base for record management)
- Create/follow audit schedule
- Audit records
- Interview personnel
- Inventory materials and equipment
- Assess environmental factors and conditions (e.g., on-site visits)
- Write contamination assessment report
- Propose corrective action
- Verify follow-up activities
- Maintain confidentiality
- Control dissemination of report finds
- Critique the audit process



**BIL:** Recommended – PC, ESA, HS, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		I
ECA		I
HM		I
WEM		
FWM		
GIS		

**Competency 28.22: Contract for services**

**Competency Builders:**

- Define scope of work/needs
- Write or review specifications
- Consult with legal staff
- Consult with purchasing department
- Provide cost justifications
- Research qualified contractors/vendors for services and products
- Conduct on-site visits
- Select contractor
- Secure and award bid
- Obtain permits
- Train contractors
- Evaluate and verify vendor's performance

**BIL:** Essential – ECA, HM  
Recommended – PC, ESA, HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS		I
ECA		P
HM		P
WEM		
FWM		
GIS		

**Competency 28.23: Conduct preplanning activities**

**Competency Builders:**

Explain need for preplanning

Identify type of preplanning needed

Identify agency involvement

Identify contamination zones

Preplan for hurricanes, tornadoes, floods, fires, nuclear accidents, and earthquakes,

Describe preplanned deployment

Write a contingency plan

## Unit 29: Wetlands Management

**BIL:** Essential – ESA, WEM, FWM  
Recommended – PC, ECA, GIS

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		I

### Competency 29.1: Identify properties of wetland

#### Competency Builders:

Explain differences between uplands, wetlands and open bodies of water

Identify the conditions necessary for wetlands to exist

Identify sources of water in wetlands

Describe wetland formation

Describe key elements used to define wetlands

Describe a wetland

Describe characteristics of hydric soils

Describe physical differences between wetlands and upland soils

Describe characteristics of hydrophytic plants

Describe factors which influence the distribution and extent of wetlands

Differentiate between temporary and permanent wetlands

List factors used by the U. S. Army Corps of Engineers and the Environmental Protection Agency to define an area as a wetland

Compare definition of wetlands used by the U. S. Fish and Wildlife Service and the Natural Resources Conservation Service of the U. S. Department of Agriculture

**BIL:** Essential – ESA, WEM, FWM  
 Recommended – PC, ECA, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		I

**Competency 29.2: Explain wetlands classification**

**Competency Builders:**

- List common types of wetlands
- Differentiate between coastal and inland wetlands
- Describe types of vegetated wetlands
- Describe types of non-vegetated wetlands
- Explain common characteristics associated with each major type of wetland
- Identify qualities that distinguish one type of wetland from another
- Distinguish between a wetland type and wetland habitat complex
- Explain wetland class, form and type

**BIL:** Essential – ESA, WEM, FWM  
Recommended – PC, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		

**Competency 29.3: Explain the function of wetlands**

**Competency Builders:**

Identify reasons wetlands are important

Identify ecological functions of wetlands

Identify the role of wetlands as a pollutant removal mechanism

Describe the use of wetlands as part of a comprehensive waste water treatment program

Describe how wetlands can provide a flood control benefit and help prevent soil erosion

Explain the role of wetlands in preserving water quality

Interpret the role of plants in water purification

Explain the role of wetlands in coastal protection

Describe the function of wetlands in ground water discharge and recharge

Describe the ability of wetland soils to filter pollutants from water

Describe the benefits of wetlands in serving as sediment traps

Explain how wetlands can impact atmospheric equilibrium

Describe the filtering ability of wetland plants

Describe how wetland plants remove pollutants from water

List several factors that contribute to wetlands performance in processing waste

Explain the role of wetlands as habitats for commercially important fish, bird and animal populations

Describe the role of the wetlands in primary biological production

Describe the role of wetlands in agricultural production

**BIL:** Essential – ESA, WEM, FWM  
Recommended – PC, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		

**Competency 29.4: Describe the living components of wetland habitats**

**Competency Builders:**

Identify common animals (mammals, reptiles, amphibians, macro-invertebrates) that live and use wetlands

Describe the habitats of these animals

Identify common wetland plants

Describe how plants and animals have adapted to the environmental conditions present in wetlands

Explain morphological, physiological and reproductive adaptations of plants common to wetlands

Identify animals and plants in a wetland food web and describe their role

Describe interrelationships among wetland organisms

Classify selected wetland plants

List some obligate wetland plants

List some facultative wetland plants

Describe the common characteristics of waterfowl family

Explain the role played by wetlands in waterfowl production

Identify fish species of the wetlands

**BIL:** Essential – ESA, WEM, FWM  
Recommended – PC

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA		
HM		
WEM		P
FWM		P
GIS		

**Competency 29.5: Assist in wetland delineation**

**Competency Builders:**

- Explain wetland delineation
- Identify steps used in offsite determination of wetlands
- Determine circumstances where offsite method is most useful
- Explain use of National Wetlands Inventory (NWI) maps in wetland determination
- Explain use of SCS soil survey maps and county hydric soil lists in wetland determination
- Explain aerial photos in offsite determination
- Delineate offsite wetland
- Contrast offsite and onsite methods of wetland delineation
- List equipment and materials needed in routine methods of onsite determination
- Identify dominant vegetation by strata
- Explain measures of plant species dominance
- Determine plant species dominance for a particular stratum
- Explain criteria used to determine presence of hydrophytic vegetation
- Analyze vegetation
- Explain hydrophytes
- Record indications of wetland hydrology
- Record indications of hydric soil
- Determine when soil is hydric
- Explain routine onsite determination for small areas
- Explain routine onsite determination for large areas
- Explain transects in onsite determination of large areas
- Explain comprehensive method of onsite determination
- Delineate onsite wetland
- Explain problems in delineating wetlands in drumlins, seasonal wetlands, prairie potholes and vegetated flats

**BIL:** Essential – ESA, WEM  
 Recommended – PC, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA		
HM		
WEM	I	P
FWM	I	R
GIS		I

**Competency 29.6: Explain impact of an increasing human population on wetlands**

**Competency Builders:**

- Explain the historic decline of wetlands
- Explain factors that can cause wetland destruction
- Explain nutrient overloading
- Describe how nitrogen and phosphorus get into a wetland
- Explain the effects of oil spills, acid rain and human wastes on wetlands
- Describe how wetlands can be harmed by pollution
- Explain the use of bio-monitoring to determine pollution
- Describe how an overload of pollutants can affect the filtering ability of plants
- Explain the potential impact of dams and levees on a wetland
- Identify ways land alteration affects wetlands
- Explain effects of alteration on wetland hydrology
- Explain effects of alteration on wetland soils
- Explain effects of alteration on wetland vegetation



**BIL:** Essential – WEM  
 Recommended – PC, ESA, ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	R
GIS		

**Competency 29.7: Explain government’s role in wetland restoration and conservation**

**Competency Builders:**

- Distinguish the role played by federal and state agencies in wetland restoration and conservation
- Explain Section 401 of the Clean Water Act and the agencies responsible for compliance oversight
- Explain Sections 9 and 10 of the Rivers and Harbors Act and the agency responsible for compliance oversight
- Explain Section 404 of the Clean Water Act and oversight agencies involved
- Describe the National Environmental Policy Act (NEPA)
- Explain the Coastal Management Act and identify the oversight agency
- Explain how flood plain management programs have potential impact on wetlands
- Explain the North American Waterfowl Management Plan
- Explain “swampbuster” provisions in Food Security Act
- Identify problems in current wetland regulation
- Compare economic, social and environmental tradeoffs in various wetland conservation
- Explain the “takings” issue
- Describe the pros and cons of a “no net loss” policy in wetlands management

**BIL:** Essential – WEM, GIS  
 Recommended – PC, ESA, ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM		P
FWM		I
GIS		P

**Competency 29.8: Identify techniques used in wetland management, enhancement and restoration programs**

**Competency Builders:**

- Identify key elements in a wetlands management program
- Describe steps involved in an impact assessment program
- Explain how Geographic Information Systems (GIS) are used to analyze wetland habitats
- Explain how aerial photography, satellite imagery, wetland, and topographic maps are used in wetland management
- Determine wetland hydrological disturbance
- Determine wetland soil disturbance
- Determine wetland vegetation disturbance
- Explain wetland restoration
- Explain hydroperiod restoration
- Explain proper wetland topography reestablishment
- Describe how changes in watershed may impact restoration
- Describe ways to control invasion of undesirable wetland plants
- Describe ways to control destructive wildlife
- Describe techniques in using wetlands to treat wastewater

**BIL:** Essential – WEM  
 Recommended – PC, ESA, ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM		P
FWM		I
GIS		

**Competency 29.9: Identify principles used in wetland mitigation and restoration**

**Competency Builders:**

- Explain wetland mitigation
- Explain wetland mitigation banking
- Explain factors to consider in determining a site for wetland development
- Describe elements used in design of surface-flow wetlands
- Describe elements used in design of subsurface flow wetlands
- Describe factors used to determine appropriate plant selection
- Describe factors used to attract and stock wildlife
- Explain various approaches to wetland design, (e.g., rule of thumb, regression-based empirical and rational approaches)
- Compare properties of created and natural wetlands

## Unit 30: Watershed Management

**BIL:** Essential – PC, ESA, HS, WEM, FWM  
Recommended – ECA, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		I

### Competency 30.1: Identify properties of watersheds

#### Competency Builders:

Explain how watersheds are formed

Identify different types of watersheds and the significant characteristics of each

Explain basic watershed processes and their interrelated nature

Explain how watersheds function

Identify the benefits of a healthy watershed

Explain how change occurs in watersheds

Evaluate the effects of natural and human disturbances on watersheds: landslides, floods, forestry, urbanization, and agriculture

Identify the three zones in a watershed (waterbody, riparian, and upland)

Explain water born pathogen movement in a watershed

**BIL:** Essential – PC, ESA, WEM  
 Recommended – HS, ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		

**Competency 30.2: Explain watershed management**

**Competency Builders:**

- Explain terms associated with watershed ecology
- Explain contemporary issues in watershed ecology
- Identify different types of watershed management
- Identify the principles of long-term watershed management
- Identify successful watershed management framework
- Identify watershed management benefits
- Explain the effect of the 1998 Clean Water Initiative on watershed planning
- Identify problems and political aspects of watershed management
- Explain how watershed analysis and planning can mitigate watershed disturbances
- Explain how human activities within a watershed affect it
- Explain the purpose of stream stabilization
- Explain methods of stream stabilization (e.g., stream mechanics, natural channel geometry, bank paving, stone dikes, bendway weirs, longitudinal peaked toe, willow pole curtain)
- Explain stream hydraulics
- Explain sediment transport

**BIL:** Essential – ESA, WEM  
 Recommended – PC, HS, ECA, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		P
HS	I	R
ECA	I	R
HM		
WEM	I	P
FWM		I
GIS		I

**Competency 30.3: Delineate watersheds**

**Competency Builders:**

Identify watersheds on topographic maps

Identify watersheds in the field

Determine the true water-parting divide

Explain the consequences of the surface and sub-surface water-parting divides  
 being different

Explain the use of BASINS software to map watersheds

Prepare source maps

**BIL:** Essential – PC, ESA, WEM  
Recommended – HS, ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		P
FWM		I
GIS		

**Competency 30.4: Assess source water**

**Competency Builders:**

Identify methods to assess watershed conditions

Identify factors that impact quality of water

Apply segmentation and risk hierarchy concepts to water

Conduct contaminant inventories

**BIL:** Essential – WEM  
 Recommended – PC, ESA, HS, ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	R
HS	I	R
ECA	I	R
HM		
WEM	I	P
FWM		I
GIS		

**Competency 30.5: Identify elements of a watershed management plan**

**Competency Builders:**

- Identify boundaries of the watershed
- Determine topography of the watershed
- Determine soil types within the watershed
- Identify land uses within the watershed boundary
- Determine the natural resources of the watershed
- Identify social trends, particularly economic and employment data, which may affect the watershed
- Determine human activities within the watershed
- Identify animals and vegetation in the watershed
- Assess risks
- Identify stakeholders
- Identify environmental objectives
- Prioritize issues



## Unit 31: Wildlife Ecology

**BIL:** Essential – ESA, FWM  
Recommended – ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	P	R
HS		
ECA	I	R
HM		
WEM		
FWM	I	P
GIS		

### **Competency 31.1: Identify representative animal species**

#### **Competency Builders:**

Identify representative mammals and their life histories

Identify representative birds and their life histories

Identify representative reptiles and their life histories

Identify representative amphibians and their life histories

Identify representative invertebrates and their life histories

Identify representative fish and their life histories

**BIL:** Essential – ESA, FWM  
Recommended – ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	P	R
HS		
ECA	I	
HM		
WEM		
FWM	I	P
GIS		

**Competency 31.2: Identify representative amphibians, reptiles, birds, invertebrates, fish, and mammals typical of Ohio**

**Competency Builders:**

Determine the order, family and other appropriate taxonomic categories

Describe differentiating characteristics of the taxonomic groups

Identify examples of Ohio species in each taxonomic group

Identify animals (field and laboratory)

Identify animals from laboratory specimens and field observations

**BIL:** Essential – ESA, FWM  
Recommended – ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	P	R
HS		
ECA	I	
HM		
WEM		
FWM	I	P
GIS		

**Competency 31.3: Explain animal biology**

**Competency Builders:**

Describe the basic anatomy of amphibians, reptiles, birds, invertebrates, fish, and mammals

Describe the major systems of amphibians, reptiles, birds, invertebrates, fish, and mammals with major emphasis on the digestive and reproductive systems

Describe the nutritional requirements of amphibians, reptiles, birds, invertebrates, fish, and mammals

Explain the role of genetics in the biology of amphibians, reptiles, birds, invertebrates, fish, and mammals

## Unit 32: Wildlife Management

**BIL:** Essential – FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

**Competency 32.1: Identify the major factors that affect the growth and regulation of animal populations**

### **Competency Builders:**

Compare ecosystem, population, and biotic community

Explain environmental resistance, environmental support, biotic potential, natality, mortality, immigration, emigration, density dependent, and density independent, etc.

Graph and label growth curves

Diagram and label age structures for populations that are increasing, decreasing, or stable

Diagram three types of survivorship curves

Identify the characteristics of populations with low densities and populations with high densities

List the major types of population regulation mechanisms

Distinguish between R and K selected species

Explain the basic principles of population genetics and natural selection

Explain the Hardy-Weinberg Principle

**BIL:** Essential – FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	P	R
GIS		

**Competency 32.2: Explain interdependency of ecosystem**

**Competency Builders:**

Identify communities

Identify relationship between communities of ecosystem

Identify major plant biomes

Differentiate renewable and nonrenewable resources

**BIL:** Essential – FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	P	R
GIS		

**Competency 32.3: Analyze current trends in the populations of wildlife species in Ohio**

**Competency Builders:**

List the current population trends for various species in Ohio

Explain the reasons for stable, increasing, or decreasing populations

Identify potential problems

**BIL:** Essential – FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

**Competency 32.4: Control pests that affect wildlife**

**Competency Builders:**

Identify the major external parasites that affect birds and mammals

Identify the major internal parasites that affect birds and mammals

Identify the major vertebrate pest species that affect man and wildlife

Identify appropriate control measures for both invertebrate and vertebrate pest species

Distinguish control measures for invertebrate and vertebrate pest species

**BIL:** Essential – FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

**Competency 32.5: Perform population estimates, food habits analyses, aging and sexing, and necropsy exams**

**Competency Builders:**

Identify types of population density surveys

Identify the measurements made on wildlife species that are used to assess the condition of the wildlife population

Calculate sex ratios, average measurement data on antler beam, and number of points

Set up and run NACSM and grid trap lines for mark-recapture and removal studies

Calculate or determine population size estimates using the Lincoln-Peterson Index plus selected modifications and several removal techniques

Perform food habits analyses on both herbivores and carnivores

Identify the dentition of deer

Explain how replacement of deciduous teeth and wear of teeth serve as age indicators

Identify the major external sexing criteria for bird and mammal species

Identify the major internal organs of birds and mammals

Dissect birds and mammals



**BIL:** Essential – FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

**Competency 32.6: Immobilize wildlife**

**Competency Builders:**

Employ safety procedures when handling and firing a cap-chur gun and related equipment

Hit a target when firing a cap-chur gun on the range

List the major drugs used in the immobilization of wildlife

List the integral components of a radiotelemetry system used in wildlife management

Operate a wildlife materials radiotelemetry unit in the tracking and locating of a collared animal

**BIL:** Essential - FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

**Competency 32.7: Trap animals**

**Competency Builders:**

Identify reasons for trapping

Identify basic types of traps

Identify common animals that are trapped

Identify basic sets of each species trapped

Identify other equipment needed in trapping

Maintain trapline

Maintain records

**BIL:** Essential - FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

**Competency 32.8: Apply animal control techniques**

**Competency Builders:**

Operate restraining mechanisms

Tag legs

Identify animal control purposes

Operate small animal carrier, rabbit restrainer, metabolism cage, and shoebox cage

**BIL:** Essential - FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

**Competency 32.9: Control damage from wildlife**

**Competency Builders:**

Identify potential areas of human-animal conflict and methods to minimize their impact

Identify problems caused by wildlife

Select appropriate wildlife control method(s) for the situation

Apply wildlife control method(s)

**BIL:** Essential – FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

**Competency 32.10: Explain ecological principles required for habitat evaluation and manipulation**

**Competency Builders:**

Diagram energy flow through food chains and food webs

List examples of organisms which occupy each trophic level

Distinguish between autotrophic and heterotrophic based food webs

Describe both gaseous and sedimentary biogeochemical cycles

Distinguish between primary and secondary succession

List the various serial stages that occur for typical successional patterns in Ohio

List the ecosystem development characteristics for early, intermediate, and late successional stages

Explain the use of bio-monitoring to evaluate habitats

List the physical, chemical, and biological factors that affect microclimate and how they influence the plant and animal communities

**BIL:** Essential - FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

**Competency 32.11: Evaluate habitats**

**Competency Builders:**

Calculate, and interpret visual obscenity measurements using a vegetation density board

Explain the use of 1/660 aerial photographs in making a cover map

Field verify cover maps

Correct cover maps

Collect quantitative vegetation

Analyze quantitative vegetation data

Interpret quantitative vegetation

Explain the use of plant indicators, plant condition, soil type, soil moisture, and nutrient conditions in habitat evaluation

Explain the role of maps (including glacial, geologic, physiographic, topographic, and vegetation) in habitat evaluation

Compare the different methods used for habitat evaluation

Use GIS in habitat evaluation

**BIL:** Essential – FWM  
Recommended - ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM	P	R
GIS		

**Competency 32.12: Identify endangered species in Ohio**

**Competency Builders:**

Explain the Endangered Species Act and its primary objectives

Explain why species are endangered

Explain the efforts to save endangered species in Ohio

**BIL:** Essential – FWM  
Recommended - ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM	P	R
GIS		

**Competency 32.13: Identify the habitat requirements for Ohio’s major wildlife species and for endangered species**

**Competency Builders:**

- List the habitat requirements for species found in early successional stages, such as rabbit, quail, pheasant and dove
- List the habitat requirements for species found in intermediate successional stages, such as deer and grouse
- List the habitat requirements for species found in late successional stages, such as turkey and squirrel
- List the habitat requirements for species found in wetland types of habitat, such as waterfowl
- Identify factors which limit selected endangered species



**BIL:** Essential - FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

**Competency 32.14: Develop a wildlife management plan**

**Competency Builders:**

Identify reasons for wildlife management

Explain wildlife management practices for forest game, farm game, furbearers, waterfowl, nongame species, and endangered species

Identify animals associated with forest game, farm game, furbearers, waterfowl, and nongame species

Identify types of equipment used in wildlife management

Explain advantages and disadvantages of introduction of wildlife species to new habitats

Explain the importance of healthy wildlife population to local economy

Determine what species of wildlife are to be managed

Establish management practices

Identify management strategies possible in the regulation of ecological succession

**BIL:** Essential – FWM  
Recommended - ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM	P	R
GIS		

**Competency 32.15: Analyze the role the Ohio Division of Wildlife plays in the total management program of Ohio**

**Competency Builders:**

List the major research units of the ODNR Division of Wildlife

Explain the roles of the major research units of the ODNR Division of Wildlife

Distinguish between the roles of the major research units and the roles played by the various wildlife area crews in Ohio

**BIL:** Essential – FWM  
Recommended - ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM	P	R
GIS		

**Competency 32.16: Identify wildlife laws used in the regulation of species populations**

**Competency Builders:**

List the types of wildlife laws

Explain how wildlife laws help in the harvesting of animals needed to maintain a viable sustained yield

**BIL:** Essential – FWM  
Recommended - ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM	P	R
GIS		

**Competency 32.17: Explain regulations**

**Competency Builders:**

Explain boating regulations

Explain fishing regulations

Explain littering regulations

Explain swimming regulations

Explain park regulations

Explain game laws

Explain stream, lake, pond, and groundwater laws

Explain outdoor burning regulations

## Unit 33: Fisheries Management

**BIL:** Essential – ESA, FWM  
Recommended – ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	I	P
HS		
ECA		I
HM		
WEM		I
FWM	I	P
GIS		

**Competency 33.1: Describe the anatomy and taxonomy of fish species**

### **Competency Builders:**

Identify the major parts of the external anatomy of fish species, including all fins and other structures used in taxonomic keys

Identify the family level fish species common to Ohio

Identify the species level selected game fish

Identify the major structures in the internal anatomy of fish useful in species identification, reproductive condition, food habits studies, etc.

**BIL:** Essential – ESA, WEM, FWM  
Recommended – ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		

**Competency 33.2: Identify the major physical, chemical, and biological features of standing water (lentic) and running water (lotic) habitats that affect fish and their distribution**

**Competency Builders:**

Distinguish between lentic and lotic aquatic habitats

Identify the physical factors, such as flow rates, depth, bottom substrate, temperature, etc. affecting the distribution of fish and other aquatic organisms

Identify the chemical factors, such as dissolved oxygen, pH, hardness, alkalinity, etc. in the distribution, reproduction, and growth of fish

Identify the natural assemblages of aquatic organisms that would normally be found in: pools vs. riffles; lentic vs. lotic habitats; polluted vs. clean water habitats; cold vs. warm water habitats; etc.

Describe changes in the physical, chemical, and biological components of aquatic habitats on a seasonal basis, which will affect fish and their distribution

**BIL:** Essential – ESA, FWM  
Recommended – ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		P
HS		
ECA		I
HM		
WEM		I
FWM	I	P
GIS		

**Competency 33.3: Conduct fish population surveys**

**Competency Builders:**

Distinguish among the different types of nets used to sample fish populations including seines, trammel nets, gill nets, trap (fyke) nets, and hoop nets

Identify the major components of electrofishing gear used for small stream surveys and in boat shocking systems

Conduct seining and electrofishing surveys on river/stream and lake/pond habitats  
Survey shoreline

Interpret data obtained from a 24-hour shoreline survey

**BIL:** Essential – ESA, WEM, FWM  
Recommended – ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		

**Competency 33.4: Analyze water quality**

**Competency Builders:**

Obtain water samples from lakes and rivers

Explain use of portable field kit procedures for analyzing dissolved oxygen, pH, hardness, alkalinity, phosphate, conductivity, and temperature

List procedure manuals and books that contain the wet chemistry methods for in-lab analyses

Run pH and dissolved oxygen tests on water samples

Run a static bioassay test using selected aquatic organisms



**BIL:** Essential – ESA, WEM, FWM  
Recommended – ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		P
HS		
ECA		I
HM		
WEM	I	P
FWM	I	P
GIS		

**Competency 33.5: Conduct studies on fish populations and their habitats**

**Competency Builders:**

- Explain the basic parameters of fish population dynamics in terms of rate functions and limiting factors
- Explain the use of bio-monitoring to evaluate habitats
- Sample aquatic organisms used as forage species for fish and/or as pollution indicators
- Identify aquatic organisms used as forage species for fish and/or as pollution indicators
- Distinguish among the several types of scales
- Determine the age of fish
- Explain the major techniques used to tag or mark fish
- Identify the types of data obtained from mark/recapture studies
- Conduct a fish population estimate
- Explain the Lincoln/Peterson Mark-Recapture procedure
- Set up a water quality study on a river and lake system
- Calculate species diversity index values for fish community data
- Run an index of biotic integrity on fish community data
- Write a life history report for a major fish species

**BIL:** Recommended – ECA, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		I
FWM	I	P
GIS		

**Competency 33.6: Manage aquatic vegetation**

**Competency Builders:**

Identify owner or agency objectives of water area

Explain physical, chemical, cultural, and biological vegetative control methods

Evaluate advantages and disadvantages of aquatic vegetation related to recreation

Analyze water quality parameters

Determine surface area to be treated

Determine volume to be treated

**BIL:** Essential – FWM  
Recommended - ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		I
HM		
WEM		
FWM	I	P
GIS		

**Competency 33.7: Manage fisheries**

**Competency Builders:**

Identify the components and reasons for making a creel survey

List the types of data obtained in a creel survey

List the major reasons for seasons, bag limits, and restrictions for methods of capture of fish in Ohio

List the reasons for stocking or not stocking fish in aquatic systems

Identify fish stocking guidelines

Identify the types of fish hatcheries and the specific warm and cold water species they produce

List the major manipulation techniques that will improve the quality of aquatic habitats for fish

Describe the procedures for culturing fish

Explain the principles of fisheries management as applied to recreational and commercial fisheries

Interpret fisheries management data

Determine appropriate techniques to reach management objectives

## Unit 34: Programming Theory

**BIL:** Recommended – ESA, ECA, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		I

### **Competency 34.1: Explain programming language concepts**

#### **Competency Builders:**

Explain the concept of physical representation of digitized information (e.g., data, text, image, voice)

Describe the hardware-software connection

Explain the concepts of data and procedural representation

Explain the function and operation of compilers and interpreters

Explain the basic principles for analyzing a programming language

Explain the basics of structured, object-oriented, and event-driven programming

Explain how a programming language can support multitasking and exception-handling

Identify current key programming languages and the environment they are used in (e.g., C, C++, Visual Basic, Java, RPG, COBOL, Assembler)

**BIL:** Recommended - ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

**Competency 34.2: Describe the stages of program development**

**Competency Builders:**

Identify the use of program design tools

Explain structured/modular programming

Explain the information system (IS) life cycle

Describe the characteristics and uses of batch processing

Describe the characteristics and uses of interactive processing

Describe the characteristics and uses of event-driven, object-oriented processing

**BIL:** Recommended - ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

**Competency 34.3: Compile technical documentation associated with software development**

**Competency Builders:**

Secure needed information

Analyze specifications

Identify constraints

Identify input and output (I/O) requirements

Prepare logic using a program flowchart

## Unit 35: Database Management System Basics

**BIL:** Essential – ESA, GIS  
Recommended – PC, ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM		I
WEM		
FWM		
GIS	I	P

**Competency 35.1: Describe Database Management System (DBMS) basics**

### **Competency Builders:**

Interpret terminology associated with relational databases

Identify the features, functions, and architecture of a DBMS

Identify the uses of a DBMS in business organizations

Explain the concepts necessary to access organizational databases

Analyze the organization of data in a DBMS

**BIL:** Essential – ESA, ECA, GIS  
Recommended – PC, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS		
ECA	I	P
HM		I
WEM		
FWM		
GIS	I	P

**Competency 35.2: Develop a report from a database**

**Competency Builders:**

Produce formatted reports

Produce single- and multiple-level control break reports and subtotal and final totals

Query a relational database



**BIL:** Recommended – PC, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

**Competency 35.3: Develop database programs**

**Competency Builders:**

Write programs that allow the user to make a menu choice to carry out an appropriate action

Write programs that require statements to be executed multiple times by using structured programming

Write programs that access multiple files

Design an information system within a database environment

Develop a data model for computation

**BIL:** Recommended – HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

**Competency 35.4: Build DBMS applications**

**Competency Builders:**

Analyze and model organizations using Entity-Relationship and Object technologies

Remove data anomalies through the process of normalization

Create and update a relational database

Query data from an organizational repository

Perform database administration tasks

**BIL:** Recommended - HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

**Competency 35.5: Monitor a DBMS**

**Competency Builders:**

Coordinate security requirements

Identify desired levels of access and security

Select monitoring tools and procedures

Identify monitoring methodologies

Identify problems

Document problems

Propose solutions that are congruent with application requirements

Implement solutions to problems

Calibrate DBMS configuration parameters for optimum performance

**BIL:** Recommended - ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM		
GIS		

**Competency 35.6: Explain computational and logical operations in software**

**Competency Builders:**

Identify programs that use arithmetic operations

Identify programs that use relational operators and compound conditions

Identify programs that use control breaks

Identify programs that use subtotals and final totals

## Unit 36: Database Administration

**BIL:** Recommended – PC, ESA, HS, ECA, HM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA		I
HS	I	R
ECA	I	R
HM	I	R
WEM		
FWM		I
GIS		I

**Competency 36.1: Apply databases to actual situations and business problems**

### **Competency Builders:**

Derive database design from a workflow drawing or other requirement documents

Design a database for a Geographic Information System (GIS)

Identify the relationship between database components

Sort data on multiple fields

Add and remove filters

Create queries with multiple criteria

Create and apply different types of queries

Join tables in a query

Enhance the design of a form

Create needed subforms

Group data in reports

Make a calculation on a report

Imbed data and graphics

Import data and graphics

Link data and graphics

**BIL:** Recommended – ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		I
HM		I
WEM		
FWM		
GIS		

**Competency 36.2: Apply data modeling techniques**

**Competency Builders:**

Interpret terminology associated with data models

Compare/contrast various data models

Analyze data models

Develop a data model to describe an application's data

**BIL:** Recommended – HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

**Competency 36.3: Create conceptual data models**

**Competency Builders:**

Analyze model requirements

Identify business entities and the relationships between them

Identify data in an integrated data dictionary

Facilitate user access

**BIL:** Recommended – HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

**Competency 36.4: Validate conceptual data models**

**Competency Builders:**

Present conceptual data model to client

Resolve issues with client

Secure client approval for model

Revise model based on client recommendations

Document validation process



**BIL:** Recommended – HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

**Competency 36.5: Integrate conceptual data models with enterprise models**

**Competency Builders:**

Modify conceptual data model to ensure consistency with enterprise model (e.g., entity names, relationships, and definitions)

Develop conceptual schema

Secure client approval for modifications in enterprise models

**BIL:** Recommended – HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

**Competency 36.6: Reconcile conceptual models with appropriate-level process models**

**Competency Builders:**

Verify consistencies between models

Identify areas of overlap

Verify that data entities in process model have a corresponding entity data model

Document changes or modifications in either model

**BIL:** Recommended – HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

**Competency 36.7: Create logical data models**

**Competency Builders:**

Map data model to a relational model

Identify attributes of model entities and relationships between them

Verify that logical model is consistent with conceptual model

Specify integrity constraints

**BIL:** Recommended – HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

**Competency 36.8: Evaluate environment/platform for physical data models**

**Competency Builders:**

Research potential computer environments/platforms

Identify platform capabilities and limitations

Select environment/platform based on technical, business, and skill information gathered

Secure approval of target environment/platform

**BIL:** Recommended – HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

**Competency 36.9: Identify backup and recovery requirements for physical models**

**Competency Builders:**

Establish backup requirements consistent with corporate policy and business needs

Document established backup procedures

Control access to database to maintain security

**BIL:** Recommended – HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

**Competency 36.10: Identify physical database characteristics**

**Competency Builders:**

Identify name, type, and length of attributes

Employ table and file names that conform to naming conventions

Group/assign tables to disk files

Index files for performance and integrity

Verify that data types are consistent between attributes

Employ normalization and modeling as cross-checking techniques

## Unit 37: Geographic Information Systems (GIS)

**BIL:** Essential – PC, ESA, WEM, FWM, GIS  
Recommended – ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	P	R
HS		
ECA	I	R
HM		I
WEM	I	P
FWM	I	P
GIS	P	R

### Competency 37.1: Explain GIS Basics

#### Competency Builders:

- Explain what a Geographic Information Systems (GIS) is
- Identify basic terms associated with geographic information
- Identify the advantages of digital maps over paper maps
- Explain why geographic information systems are important
- Identify some primary uses of GIS
- Identify the steps of a GIS project
- Explain how GIS helps define and solve geographic questions
- Describe primary environmental applications

**BIL:** Essential – GIS  
Recommended - ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA	I	
HM		
WEM		
FWM		
GIS	I	P

**Competency 37.2: Explain the basic principles of remote sensing**

**Competency Builders:**

Explain remote sensing

Explain electromagnetic energy

List measurements of electromagnetic waves

Explain how frequency and wavelength are related

Explain why the relationship between photon energy levels and wave energy levels is important to remote sensing

Explain Planck's Law and its manipulation

Explain the various types of scattering which occur when electromagnetic energy passes through the atmosphere

Explain absorption



**BIL:** Essential – GIS  
Recommended – ECA, HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		I
HM	I	R
WEM		
FWM		
GIS	I	P

**Competency 37.3: Explain the basic principles of aerial photography**

**Competency Builders:**

- Identify various camera types
- Identify various film types
- Explain basic photographic terms
- Explain photographic resolution
- Explain forward motion compensation
- Identify characteristics of CIR film
- Explain the use of filters
- Explain photographic scale
- Explain the geometry of aerial photography
- Explain parallax displacement
- Explain stereoscopic photography

**BIL:** Essential – GIS  
 Recommended – ECA, HM, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		I
HM	I	R
WEM		I
FWM		I
GIS	I	P

**Competency 37.4: Interpret aerial photographs**

**Competency Builders:**

- Explain the role of a photo interpreter
- Explain how aerial photographs differ from regular photographs
- Identify the image elements used in interpretation
- Identify the steps in interpretation
- Explain interpretation strategies
- Explain photogrammetry
- Explain relief displacement
- Arrange photos for stereo viewing
- Determine non-distorted coordinates, horizontal ground distance and angles from measurements on a single vertical photo
- Calculate object height from relief displacement
- Calculate heights from image parallax measurements
- Explain interpretive software

**BIL:** Recommended – GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS		I

**Competency 37.5: Plan the collection of new photos**

**Competency Builders:**

Identify the initial considerations

Write a specification sheet

Provide a flight map

**BIL:** Essential – GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS	I	P

**Competency 37.6: Evaluate accuracy of aerial photographs**

**Competency Builders:**

Explain accuracy, precision, thematic accuracy, cartographic accuracy, and ground truth

Identify general sources of errors

Identify sources of classification errors and factors affecting the errors

**BIL:** Essential - GIS  
Recommended – ECA, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		I
FWM		I
GIS	P	R

**Competency 37.7: Explain map projections**

**Competency Builders:**

Explain map projection

List the three general classifications of map projections

Explain the properties of an ideal map (i.e., conformality, equivalence, equidistance, and true direction)

Describe the construction, major property and primary use of various map projections

Explain datum as related to map projections

**BIL:** Essential - GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS		P

**Competency 37.8: Describe data structures**

**Competency Builders:**

Describe the three file types (i.e., simple list, sequential, indexed)

Describe the three types of database file structures (i.e., hierarchical, network, relational)

Compare vector and raster data structures

Describe methods of storing raster data

Describe methods of storing vector data

Describe polygon data structures

Describe a polygon network structure

**BIL:** Essential – GIS  
Recommended – HM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM	I	R
WEM		
FWM		
GIS		P

**Competency 37.9: Explain digital elevation methods (DEM)**

**Competency Builders:**

Explain DEMs

List the important uses of DEMs

List methods of representing DEMs

Explain interpolation techniques

Describe products derived from DEMs

**BIL:** Recommended – GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS		I

**Competency 37.10: Explain spatial interpolation**

**Competency Builders:**

Explain spatial interpolation

Explain tessellation

Explain planar ordinary Voronoi diagram

Explain ordinary Voronoi polygons

Explain Delaunay triangulation

Explain polygonal methods of interpolation

Explain triangular methods of interpolation

Explain contour generation and 3-D surface plotting

Explain landscape metrics



**BIL:** Recommended – GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS		I

**Competency 37.11: Explain two-dimensional functional spatial analyses**

**Competency Builders:**

- Explain area/perimeter/distance calculations
- Explain vector-to-raster conversion
- Explain raster-to-vector conversion
- Explain overlays
- Explain Thiessen polygons
- Explain querying/theming
- Explain corridor analysis
- Explain proximity analysis
- Explain network analysis
- Explain planning rings

**BIL:** Recommended – GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS		I

**Competency 37.12: Explain three-dimensional functional spatial analyses**

**Competency Builders:**

Explain contour lines

Explain how a DEM is created

Explain slope and aspect derivations

Explain orthographic/perspective views

Explain draping

Explain threshold tables

Explain surface filtering

Explain interviewability

Explain surface modeling

**BIL:** Essential – GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS	I	P

**Competency 37.13: Explain ranging methods**

**Competency Builders:**

Explain standard deviation

Explain equal interval

Explain natural breaks

**BIL:** Essential – ESA, GIS  
 Recommended – ECA, HM, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	I	P
HS		
ECA	I	R
HM		I
WEM		I
FWM		
GIS	I	P

**Competency 37.14: Identify sources of possible error in GIS**

**Competency Builders:**

Explain accuracy, precision, data quality, and error

Explain the importance of error, accuracy and precision

Identify obvious sources of error (e.g., age of data, areal coverage, map scale, density of observations, relevance, format, accessibility, cost of new vs old data)

Identify errors due to natural variation or from original measurements (e.g., positional accuracy, accuracy of content, sources of variation in data)

Identify errors arising through processing (e.g., numerical errors, errors in topological analysis, classification and generalization problems, digitizing and geocoding)

Explain error propagation

Explain cascading of error

Explain the dangers of undocumented data

Explain how to determine data quality

**BIL:** Essential – ESA, GIS  
 Recommended – HM, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA	I	P
HS		
ECA		
HM		I
WEM		R
FWM		R
GIS	I	P

**Competency 37.15: Determine position on the earth**

**Competency Builders:**

- List the major global georeferencing systems
- Explain why different coordinate systems have been developed to record location
- Explain how the shape of the earth is related to geographic position and to the measurement of distance
- Explain how geographic coordinates can be assigned to street address and postal codes using discrete georeferencing
- Identify the difficulties and errors that arise in discrete geocoding
- Explain what a GPS is
- List the major GPS segments as defined by the Department of Defense
- Explain how a GPS receiver computes position and time from GPS signals
- Explain major sources of GPS errors
- Explain the methodological differences between single-user and differential GPS
- Explain the practical differences between using GPS for low-precision and high-precision positioning
- Determine location and calculate distances using global coordinate systems (latitude-longitude and UTM)

**BIL:** Recommended – ECA, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		I
HM		
WEM		
FWM		
GIS		I

**Competency 37.16: Identify legal issues relating to GIS**

**Competency Builders:**

Explain how public access rules affect GIS

Identify liability issues related to accuracy and reliability of GIS information

Identify privacy issues related to GIS data

Explain the use of GIS data as evidence in court cases

**BIL:** Essential – GIS  
Recommended – FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		
HM		
WEM		I
FWM		
GIS	I	P

**Competency 37.17: Develop a GIS plan**

**Competency:**

- Conduct a needs assessment
- Develop a database model
- Determine available data
- Evaluate GIS hardware and software
- Evaluate potential data sources
- Develop a detailed database design
- Perform pilot study and benchmark tests
- Construct the database
- Integrate the various components of the GIS
- Develop GIS database applications
- Maintain the GIS

**BIL:** Essential – GIS  
 Recommended – ECA, HM, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		
ESA		
HS		
ECA		I
HM		I
WEM		I
FWM		I
GIS		P

**Competency 37.18: Analyze GIS tools**

**Competency Builders:**

- Identify the hardware required for an operational GIS
- Describe various GIS software packages and their characteristics
- Explain the importance of a DBMS to a GIS
- Explain layers and coverages
- Explain items to consider when acquiring digital map data
- Identify sources of digital map data
- Explain media conversion
- Explain geographic data conversion
- Explain coordinate transformation
- Explain tiling and edgematching
- Describe the digitizing issues to be considered
- Automate map features and attribute data associated with map features
- Link map features to a database
- Design data tables and layers
- Determine answers to spatial questions related to the planning objectives of the GIS application
- Organize the output of information based on the analyses
- Develop a custom user interface for a GIS application that will simplify and increase user productivity



## Unit 38: Communication

**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	P	R
ESA	P	R
HS	P	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

### Competency 38.1: Apply communication skills

#### Competency Builders:

Guide communication activities using established rules for grammar, spelling, and sentence construction

Follow written and/or oral instructions

Apply creativity in oral and written communications

Proofread documents

Interpret oral, written, and nonverbal communications

Evaluate audience (e.g., specific interests, level of technical knowledge)

Adjust communication style to fit audience (e.g., use of jargon, level of technical details)

Determine means of communications appropriate for given situations (e.g., telephone, meeting, electronic mail, and written communication)

Reinforce intended message using nonverbal communication

Influence listeners' perceptions through precision questioning

Practice active listening skills (e.g., paraphrasing)

Obtain needed information using questioning techniques

Adjust message and/or its delivery based on feedback from listeners (verbal and nonverbal)

Participate in group discussions and meetings

Assess and refine communication skills

**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	P	R
ESA	P	R
HS	P	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

**Competency 38.2: Compose documents**

**Competency Builders:**

Identify the characteristics of different approaches to writing (e.g., direct, indirect, and persuasive)

Identify components of an effective message (e.g., clear, concise, complete, accurate, and courteous)

Evaluate audience

Gather information

Organize information

Develop outline

Draft document

Verify spelling, grammar, and punctuation

Verify accuracy of content

**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	P	R
HS	I	P
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

**Competency 38.3: Demonstrate sensitivity in communicating with a diverse workforce**

**Competency Builders:**

Identify factors (e.g., culture, ethnicity, equity, special/exceptional needs) that impact communication

Identify strategies for successful communication with a diverse workforce

Determine communication style appropriate for listener(s)

Bridge communication styles

Establish guidelines for dealing with conflict

**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	P	R
ESA	P	R
HS	P	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

**Competency 38.4: Deliver oral presentations**

**Competency Builders:**

Prepare presentation and supporting materials (e.g., handouts, transparencies, electronic slide shows)

Practice presentation

Deliver presentation

Obtain feedback

**BIL:** Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	P
ESA	P	R
HS	I	P
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

**Competency 38.5: Build interpersonal skills with individuals and other team members**

**Competency Builders:**

Analyze the interdependence of empathetic listening, synergy, and consensus building

Define roles within the group decision-making process

Explain group dynamics

Promote teamwork, leadership, and empowerment

Identify strategies for fostering creativity

Analyze the effect of influence, power, and politics on communication

Establish negotiation guidelines

## Unit 39: Basic Microbiology

**BIL:** Essential – ESA, HS, WEM  
Recommended – PC, ECA

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	P
ECA	I	R
HM		
WEM		P
FWM		
GIS		

### **Competency 39.1: Apply microbiological principles and procedures**

#### **Competency Builders:**

Explain microbial taxonomy and classification

Explain bacterial metabolism, reproduction, cell structures, and their functions

Disinfect and sterilize

Explain classification, composition, and preparation of culture media

Collect, handle and culture specimen

Identify bacteriologic culture techniques necessary for isolation and identification of organisms

Test for antibiotic susceptibility

Identify commonly encountered aerobic bacteria through morphological, physical, and biochemical properties

Prepare Gram stains

Explain collection and handling of specimens for fungal, mycobacterial, and viral specimens

Prepare specimens

Examine specimens

Identify difference between autotrophic and heterotrophic microbes

**BIL:** Recommended – PC, ESA, HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA		I
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS		

**Competency 39.2: Explain immunological procedures**

**Competency Builders:**

Explain immune system and normal immune response

Explain physical and chemical properties of immunoglobulins and complement and their reaction in vitro

Explain principles of basic agglutination, flocculation, and precipitation procedures

Perform basic agglutination, flocculation, and precipitation procedures

Explain principles of complement fixation, immunoelectrophoresis and enzyme immunoassay

Explain clinical significance of commonly performed serological tests

**BIL:** Essential – ESA, HS, WEM  
Recommended – PC, ECA, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS	I	P
ECA		I
HM		
WEM		I
FWM		I
GIS		

**Competency 39.3: Describe roles of microorganisms in the environment**

**Competency Builders:**

Categorize common microorganisms (e.g., viruses, bacteria, protozoans, etc.)

Categorize common pathogenic organisms and common microorganisms found in the environment

Describe how microorganisms impact nutrient cycles

Explain microbial decomposition and use of microbes in degrading pollutants



**BIL:** Essential – ESA  
 Recommended – PC, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

**Competency 39.4: Perform common microbiology procedures**

**Competency Builders:**

Operate microscope, compound microscope, incubator, colony counter, and other basic microbiology and analytical equipment

Identify microorganisms and cells

Quantify microorganisms and cells

Isolate pure cultures

Maintain pure cultures

Analyze fermentation materials

Harvest cells

Transform hosts

Stain cells and/or bacteria

Prepare media

Identify sterile techniques used during handling, sampling, and analytical procedures

Explain Koch's Postulates and their use in determining primary and secondary pathogens

**BIL:** Essential – ESA  
 Recommended – PC, HS, ECA, WEM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC		I
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

**Competency 39.5: Conduct bioassay tests**

**Competency Builders:**

Explain bioassay [R-WEM]

Identify the purposes of bioassay testing [R-WEM]

Conduct acute/chronic, freshwater/marines NPDES Permit Bioassays for 1, 2, or 3 species

Conduct sediment bioassays

Conduct LC50 and percent survival bioassays

Conduct hazardous waste bioassays

Conduct terrestrial bioassays

Conduct bioaccumulation studies

Conduct biodegradation testing

Conduct whole effluent toxicity testing

Conduct Toxicity Identification Evaluations/Toxicity Reduction Evaluations (TIE/TRE)

**BIL:** Essential – ESA  
Recommended – PC, HS, ECA, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	P	R
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		I
GIS		

**Competency 39.6: Contrast prokaryotic and eukaryotic cells**

**Competency Builders:**

List parts of prokaryotic and eukaryotic cells

State function of each cell structure

Distinguish between those parts that are common to both and those that are not always present

Identify the giant polymeric molecule constituting the cell wall

Explain endospore

Identify conditions that favor the formation of endospores

Explain plasmid

Describe nutritional patterns of fungi

Describe fungal identification and cultivation

**BIL:** Essential – ESA  
Recommended – PC, HS, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	R
ECA		
HM		
WEM		I
FWM		I
GIS		

**Competency 39.7: Identify groups of microorganisms**

**Competency Builders:**

- Identify various bacterial organisms by shape
- Identify various cell arrangements or groupings
- Identify organisms by cell wall types
- Identify groups of fungi
- Identify groups of algae
- Describe types of parasite life cycle

**BIL:** Essential – ESA  
Recommended – PC, HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	P	R
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS		

**Competency 39.8: Analyze factors affecting microbial growth**

**Competency Builders:**

- Correlate how sources of nutrients overlap
- Explain microbial nutrition type (carbon)
- Compare inorganic and organic nutrients

**BIL:** Essential – ESA  
Recommended – PC, HS

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	P	R
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS		

**Competency 39.9: Describe influence of environmental factors on microbes**

**Competency Builders:**

Explain various temperature requirements

Describe various gas requirements

Describe major types of microbial interaction

**BIL:** Essential – ESA  
Recommended – PC, HS, ECA, WEM, FWM

<b>EDU:</b>	<b>12</b>	<b>AD</b>
PC	I	R
ESA	I	P
HS	I	R
ECA	I	
HM		
WEM		I
FWM		I
GIS		

**Competency 39.10: Explain microbial growth**

**Competency Builders:**

Correlate bacterial binary fission with generation time

Describe normal bacteria population growth curve

Indicate methods of enumerating bacteria and measuring bacterial growth

Explain closed bacterial culture

Identify phases of bacterial growth curve



*U.S. Department of Education  
Office of Educational Research and Improvement (OERI)  
National Library of Education (NLE)  
Educational Resources Information Center (ERIC)*



## **NOTICE**

### **Reproduction Basis**

- This document is covered by a signed "Reproduction Release (Blanket)" form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.
- This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").