**Course Description:**

Students will analyze and interpret biological, chemical and physical properties of soil, water and air. They will determine the source and type of environmental contamination evaluate pollution control measures and monitor treatment processes for potable water, waste water and solid waste. Throughout the course, learners will develop and implement environmental plans using principles governing ecosystems in relation to resource development and industrial processes.

**Strand 1. Business Operations/21st Century Skills**

Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field.

**Outcome: 1.1. Employability Skills**

Develop career awareness and employability skills (e.g., face-to-face, online) needed for gaining and maintaining employment in diverse business settings.

**Competencies**

1.1.1. Identify the knowledge, skills and abilities necessary to succeed in careers.

1.1.2. Identify the scope of career opportunities and the requirements for education, training, certification, licensure and experience.

1.1.3. Develop a career plan that reflects career interests, pathways and secondary and postsecondary options.

1.1.4. Describe the role and function of professional organizations, industry associations and organized labor and use networking techniques to develop and maintain professional relationships.

1.1.5. Develop strategies for self-promotion in the hiring process (e.g., filling out job applications, resumé writing, interviewing skills, portfolio development).

1.1.6. Explain the importance of work ethic, accountability and responsibility and demonstrate associated behaviors in fulfilling personal, community and workplace roles.

1.1.7. Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions.

1.1.8. Identify the correlation between emotions, behavior and appearance and manage those to establish and maintain professionalism.

1.1.9. Give and receive constructive feedback to improve work habits.

1.1.10. Adapt personal coping skills to adjust to taxing workplace demands.

1.1.11. Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them.

1.1.12. Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits and abusive behavior.

**Outcome: 1.2. Leadership and Communications**

Process, maintain, evaluate and disseminate information in a business. Develop leadership and team building to promote collaboration.

**Competencies**

1.2.1. Extract relevant, valid information from materials and cite sources of information.

1.2.2. Deliver formal and informal presentations.

1.2.3. Identify and use verbal, nonverbal and active listening skills to communicate effectively.

1.2.4. Use negotiation and conflict-resolution skills to reach solutions.

1.2.5. Communicate information (e.g., directions, ideas, vision, workplace expectations) for an intended audience and purpose.

1.2.6. Use proper grammar and expression in all aspects of communication.

1.2.7. Use problem-solving and consensus-building techniques to draw conclusions and determine next steps.

1.2.8. Identify the strengths, weaknesses and characteristics of leadership styles that influence internal and external workplace relationships.

1.2.9. Identify advantages and disadvantages involving digital and/or electronic communications (e.g., common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity).

1.2.10. Use interpersonal skills to provide group leadership, promote collaboration and work in a team.

1.2.11. Write professional correspondence, documents, job applications and resumés.

1.2.12. Use technical writing skills to complete forms and create reports.

1.2.13. Identify stakeholders and solicit their opinions.

1.2.14. Use motivational strategies to accomplish goals.

**Outcome: 1.3. Business Ethics and Law**

Analyze how professional, ethical and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

**Competencies**

1.3.1. Analyze how regulatory compliance (e.g., United States Department of Agriculture [USDA], Food and Drug Administration [FDA], United States Department of Interior [USDI], Ohio Livestock Care Standards, water quality standards, local water regulations, building codes) affects business operations and organizational performance.

**Outcome: 1.4. Knowledge Management and Information Technology**

Demonstrate current and emerging strategies and technologies used to collect, analyze, record and share information in business operations.

**Competencies**

1.4.1. Use office equipment to communicate (e.g., phone, radio equipment, fax machine, scanner, public address systems).

1.4.2. Select and use software applications to locate, record, analyze and present information (e.g., word processing, e-mail, spreadsheet, databases, presentation, Internet search engines).

1.4.3. Verify compliance with security rules, regulations and codes (e.g., property, privacy, access, accuracy issues, client and patient record confidentiality) pertaining to technology specific to the industry pathway.

1.4.4. Use system hardware to support software applications.

**Outcome: 1.12. Site and Personal Safety Procedures**

Follow site and personal safety procedures in specific situations with specialized tools and equipment, evaluate the situation and take corrective action.

**Competencies**

1.12.1. Use Occupational Safety and Health Administration (OSHA) defined procedures for identifying employer and employee responsibilities, working in confined spaces, managing worker safety programs, using ground fault circuit interrupters (GFCIs), maintaining clearance and boundaries and labeling.

1.12.2. Interpret safety signs and symbols.

1.12.4. Describe how working under the influence of drugs and alcohol increases the risk of accident, lowers productivity, raises insurance costs and reduces profits.

1.12.5. Identify the location of emergency flush showers, eyewash fountains, Safety Data Sheets (SDSs), fire alarms and exits.

1.12.6. Identify procedures for the handling, storage and disposal of hazardous materials.

1.12.7. Select, use, store, maintain and dispose of personal protective equipment (PPE), appropriate to job tasks, conditions and materials.

1.12.8. Identify safety hazards and take corrective measures.

1.12.9. Identify, inspect and use safety equipment appropriate for the task.

1.12.10. Follow established procedures for the administration of first aid and contact emergency medical personnel when necessary.

1.12.15. Select and operate fire extinguishers based on the class of fire.

*An “X” indicates that the pathway applies to the outcome.*

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management |  | Bioscience | |  | Horticulture |
| X | Natural Resource Management |  | Power Technology | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | |  | Does not apply | | |

**Strand 3. Biotechnology**

Learners apply the skills and knowledge of interpreting laboratory requests, using protective clothing and hazardous material containment, specimen collection procedures, a variety of laboratory testing and techniques, and maintenance of laboratory equipment and supplies.

**Outcome: 3.8. Research and Experiments**

Conduct a problem-based study, applying scientific methodology and using descriptive statistics to communicate and support predictions and conclusions.

**Competencies**

3.8.1. Identify research problems and structure a statistical experiment, simulation or study related to the problem.

3.8.2. Design a research plan, including the significance of the problem, purpose, variables, hypotheses, objectives, methods of study and a list of materials.

3.8.3. Distinguish between dependent, independent and control variables in an experiment.

3.8.4. Establish and implement procedures for systematic collection, organization and use of data.

3.8.5. Select and apply sampling methods that appropriately represent the population to be studied.

3.8.7. Document results of the experiment in a laboratory notebook, including a statement of purpose, experimental designs, observations, results, conclusions and next steps.

3.8.8. Compute measures of central tendency and dispersion to interpret results and draw conclusions.

3.8.9. Describe the relationships among variables using correlations and draw conclusions.

3.8.10. Create, interpret and use tabular and graphical displays and describe the data.

3.8.11. Draw conclusions based on observations and data analyses, recognizing that experimental results must be open to the scrutiny of others.

3.8.12. Prepare and present findings using scientific reports.

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management |  | Bioscience | |  | Horticulture |
| X | Natural Resource Management |  | Power Technology | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | |  | Does not apply | | |

**Strand 4. Power Systems**

Learners apply principles of tool use, power transmission, hydraulics, two- and four-stroke cycle combustion, heating and cooling, exhaust, ignition, starting and charging, steering and lubrication systems to operate, to maintain or repair equipment.

**Outcome: 4.1. Tool, Stationary and Mobile Equipment Maintenance**

Inspect, clean, maintain and perform planned preventative maintenance on tools, machinery, implements and equipment.

**Competencies**

4.1.1. Identify the types of hand tools, power tools and stationary equipment and describe their functions.

4.1.2. Ensure the presence and functionality of safety systems and hardware.

4.1.3. Identify potential hazards and limitations related to the use of hand tools, power tools and stationary equipment.

4.1.4. Maintain machinery, equipment, instrument and facility cleanliness, appearance and safety.

4.1.11. Calibrate metering, monitoring and sensing equipment.

**Outcome: 4.2. Equipment Operations**

Operate and maintain mechanical equipment and power systems.

**Competencies**

4.2.1. Follow manufacturer’s recommended operating procedures and adjustment specifications.

4.2.2. Differentiate among the functions, limitations and proper use of equipment, equipment controls and instrumentation.

4.2.3. Perform pre- and post-operation inspections and adjustments and report malfunctions.

4.2.4. Perform appropriate start-up, operating and shut-down procedures.

4.2.5. Select and operate the equipment and attachments needed to complete the task including levers, pedals or valves.

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management |  | Bioscience | |  | Horticulture |
| X | Natural Resource Management |  | Power Technology | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | |  | Does not apply | | |

**Strand 5. Structural Engineering**

Learners apply the principles of engineering related to electricity, structural repair and design, use of brick, block and concrete, water distribution, and metal working to design, construct, manage and maintain structures and biological systems used in agriculture, food and natural resources.

**Outcome: 5.4. Surveying and Mapping**

Perform surveying procedures to construct a site plan.

**Competencies**

5.4.1. Identify civil drafting symbols and abbreviations.

5.4.2. Interpret maps, topographic site plans, deeds and aerial or satellite imagery for site planning.

5.4.3. Perform site measurements.

5.4.4. Integrate map and surveying data into geographic information system (GIS) or computer aided design (CAD) software.

5.4.5. Identify topographical and existing features of areas, including property lines, benchmarks, utilities, streets and setbacks, on survey maps, parcel maps and plats.

**Outcome: 5.5. Geographic Information Systems (GIS)**

Employ GIS computer applications to interpret data, maps and land use.

**Competencies**

5.5.1. Interpret and evaluate the accuracy of digital imagery and aerial photography.

5.5.2. Explain map projections and the use of scales.

5.5.3. Describe GIS data structures (e.g., vector, grid, triangulated irregular network [TIN]).

5.5.4. Explain digital elevation methods (e.g., digital elevation model [DEM], global positioning system [GPS]).

5.5.8. Determine one’s position on the earth using GPS.

5.5.9. Integrate GPS data into GIS applications.

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management |  | Bioscience | |  | Horticulture |
| X | Natural Resource Management |  | Power Technology | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | |  | Does not apply | | |

**Strand 6. Environmental Science**

Learners apply earth, life, and physical sciences to the production, extraction, processing, protection, use, and renewal of both renewable and non-renewable resources.

**Outcome: 6.1. Soils**

Apply knowledge of soil characteristics and soil information resources to overcome any existing soil use limitations while maintaining or improving soil quality.

**Competencies**

6.1.1. Identify soil forming factors and explain how they produce variability in soils.

6.1.2. Describe the relationship among physical properties of soils.

6.1.3. Collect, test and analyze soil samples for physical and chemical properties.

6.1.4. Identify factors (e.g., climate, vegetation, soil texture, drainage, management practices, landscape) affecting organic matter and its function in soil quality.

6.1.5. Determine land use and identify land capabilities classes.

6.1.6. Apply soil conservation practices to reduce soil erosion and compaction.

6.1.7. Compare and contrast the causes and effects of soil erosion.

6.1.8. Describe soil limitations in agronomic, urban and natural resource practices.

6.1.9. Evaluate soil survey data and implement management decisions.

6.1.10. Assess basic processes of soil reclamation.

**Outcome: 6.2. Water Quality**

Analyze, interpret, and manage the biological, chemical and physical properties of water quality.

**Competencies**

6.2.1. Assess and explain the interactions between human activities and the Earth’s hydrosphere (e.g., septic systems, desalinization, point and non-point source pollution).

6.2.2. Measure pH, dissolved oxygen (DO), biological oxygen demand (BOD), temperature and macroinvertebrate populations to determine water quality.

6.2.3. Measure hardness, nitrogen, phosphorus, vegetation and physical characteristics of lentic and lotic waters to determine water quality.

6.2.4. Explain the hydrological cycle (e.g., condensation, evaporation, transpiration) and how human and animal activity impacts the cycle.

6.2.5. Explain the biotic and abiotic factors affecting water quality.

6.2.6. Monitor and analyze water quality and quantity.

6.2.7. Implement procedures and management practices that maintain or improve water quality.

**Outcome: 6.3. Air Quality**

Analyze, interpret and manage the biological, chemical and physical properties of air quality.

**Competencies**

6.3.1. Determine the chemical and physical properties of air (e.g., composition, density, pressure).

6.3.2. Explain biogeochemical cycles (e.g., nitrogen, oxygen, sulfur) and how they relate to the biosphere, geosphere and atmosphere.

6.3.3. Explain the effects of carbon dioxide sequestration on air quality.

6.3.4. Analyze the importance of air quality to humans and other living organisms.

6.3.5. Explain human and natural factors (e.g., volcanic eruptions, forest fires, greenhouse gases, farming practices, transportation) affecting air quality.

6.3.6. Monitor and evaluate air composition, quality and quantity with direct reading instruments (e.g., combustible gas indicator, oxygen meter).

6.3.7. Assess the potential for air contamination at a specific site.

6.3.8. Implement procedures and management practices that maintain or improve air quality.

**Outcome: 6.4. Water Use and Management**

Collect, analyze and interpret data for a localized water use and management plan.

**Competencies**

6.4.1. Explain the domains of hydrology.

6.4.2. Describe the geological and meteorological principles affecting water supplies.

6.4.3. Conduct a pumping test to determine groundwater potential and discharge rates.

6.4.4. Identify the criteria for water well designs.

6.4.5. Measure surface water volume and discharge rates.

6.4.6. Conduct channel flow analyses.

6.4.7. Evaluate water collection, storage and distribution systems (e.g., wells, ponds, runoff, waterways, irrigation).

6.4.8. Define, delineate and assess the volume of watersheds and streams.

6.4.9. Assess the potential for surface water and groundwater contamination at a specific site.

6.4.10. Implement management practices that conserve and sustain water.

**Outcome: 6.5. Potable Water Treatment**

Monitor the water treatment processes for potable water at a specific site.

**Competencies**

6.5.1. Identify and assess the characteristics of potable water treatment and the sources of water.

6.5.2. Collect and analyze water samples to determine potability.

6.5.3. Describe components of a water treatment facility.

6.5.4. Monitor the water treatment process (e.g., aeration, flocculation, filtration, sedimentation).

6.5.5. Monitor the control and treatment of chemical and biological contaminants (e.g., trihalomethanes, lead, bacteria, nitrates) in water.

6.5.6. Describe taste and odor control in water treatment.

6.5.7. Identify methods for backflow prevention.

**Outcome: 6.6. Wastewater Operations**

Monitor the wastewater collection and treatment methods for a specific site.

**Competencies**

6.6.1. Identify the components of a wastewater treatment system.

6.6.2. Collect and analyze wastewater samples.

6.6.3. Identify, analyze and reconcile the components of wastewater.

6.6.4. Troubleshoot wastewater collection and treatment systems.

6.6.5. Describe the processes in wastewater treatment (e.g., mixing, coagulation, flocculation, disinfection, treatment system, effluent disposal, solids management).

6.6.6. Analyze process optimization and treatment processes for the treatment train, effluent disposal and bio-solids management in wastewater treatment.

6.6.7. Compare methods for cross-connection and backflow prevention.

**Outcome: 6.7. Solid Waste and Renewable Resource Management**

Control and process solid waste using current and alternative technologies.

**Competencies**

6.7.1. Collect, analyze and treat solid waste materials (e.g., mortalities, manure, garbage).

6.7.2. Distinguish the risks associated with solid waste accumulation, utilization and disposal.

6.7.3. Determine an acceptable site for solid waste disposal.

6.7.4. Compare the processes of aerobic and anaerobic waste decomposition.

6.7.5. Describe and monitor solid waste disposal procedures (e.g., landfill, compost).

6.7.6. Describe and implement solid waste management methods (e.g., composting, incineration, recycling, burial).

6.7.7. Explain the control processes and potential uses for solid waste byproducts (e.g., leachate, ash, landfill gas, sludge, methane, manure).

6.7.8. Describe standard operating procedures and identify design requirements for specific purposes (e.g., landfill, lagoon, leachate treatment).

6.7.9. Evaluate site closure methods and post-closure monitoring.

6.7.10. Determine type and volume of solid waste generated by an operation or facility.

**Outcome: 6.8. Contaminants and Pollution Control**

Assess an affected area, determine the source and type of contaminant and respond.

**Competencies**

6.8.1. Collect, record and analyze environmental samples and interpret the results.

6.8.2. Determine the types, sources and impact of natural and man-made contaminants.

6.8.3. Monitor, analyze and quantify levels of contaminants from point and non-point sources.

6.8.4. Monitor radioactive contamination.

6.8.5. Monitor noise and light pollution and recommend abatement measures.

6.8.6. Describe the environmental impact from both industrial and nonindustrial processes.

6.8.7. Identify, comply with and implement contaminant control, remediation and prevention practices (e.g., biological, sanitation, buffer strips).

6.8.8. Recommend a remediation strategy for a release of contaminant to soil, surface water or groundwater.

6.8.9. Monitor and conduct remediation activities.

6.8.10. Develop and implement various emergency response plans.

6.8.11. Identify and contact local emergency response teams.

6.8.12. Analyze environmental conditions that influence environmental response..

**Outcome: 6.9. Hazardous Materials and Waste Management**

Follow and apply handling, storage and recording procedures for hazardous materials and waste.

**Competencies**

6.9.1. Identify and differentiate solid waste, hazardous waste, toxic waste and radioactive waste streams.

6.9.2. Describe health and safety practices for reducing risks from hazardous materials (e.g., safety data sheet [SDS], employer notification forms, personal protective equipment [PPE]).

6.9.3. Demonstrate appropriate responses for major types of hazardous materials disasters (e.g., chemical releases, fires, explosions).

6.9.4. Obtain and use information addressing hazardous substance discharge.

6.9.5. Demonstrate safe management, handling, disposal and recycling procedures for hazardous materials and waste.

6.9.6. Perform site assessments to detect and identify the presence and storage of hazardous materials.

6.9.7. Collect and evaluate samples of hazardous materials and waste.

6.9.8. Prepare hazardous materials for transportation and storage in accordance with regulations.

6.9.9. Prepare and maintain hazardous material handling documentation.

6.9.10. Identify hazardous materials that can be recycled.

**Outcome: 6.10. Ecosystems**

Evaluate biotic and abiotic components and relationships in ecosystems to apply restoration and conservation practices that maintain functionality.

**Competencies**

6.10.1. Describe ecological levels, including population, community, ecosystem and biosphere.

6.10.2. Distinguish the flow of energy through ecosystems.

6.10.3. Identify and classify interactions among organisms, including predation, symbiosis and competition, to determine species interdependent relationships.

6.10.4. Describe the process of succession and its impact on ecosystems.

6.10.5. Connect biotic interactions with the abiotic environment.

6.10.6. Describe biogeochemical cycles (e.g., carbon, nitrogen, phosphorous, hydrological) and their roles in maintaining equilibrium in an ecosystem.

6.10.7. Identify interactions of ecosystems to differentiate biomes.

6.10.8. Select and implement restoration ecology practices to repair damaged ecosystems.

6.10.9. Determine the impact of native and non-native invasive species on ecosystems.

6.10.10. Describe the relationship between evolution and ecosystems.

*An “X” indicates that the pathway applies to the outcome.*

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management |  | Bioscience | | |  | Horticulture |
| X | Natural Resource Management |  | Power Technology | | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | | |  | Does not apply | | |

**Strand 8. Plant Science**

Learners apply principles of plant anatomy, physiology, nutrition and genetics to the research and development, selection and reproduction, planting, fertilization, health, harvesting and management of plants in a domestic and/or natural environment.

**Outcome: 8.3. Pest Management**

Develop and implement an integrated pest management (IPM) plan by scouting and identifying specific plant pests and the damage they cause and apply specialized control methods.

**Competencies**

8.3.1. Identify and classify insect, weed, disease and animal pests.

8.3.2. Examine the interrelationships among plants, pests, humans and the environment.

8.3.3. Analyze and calculate the economic threshold of pest damage.

8.3.4. Determine and implement pest management safety practices (e.g., safety data sheets [SDSs], United States Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA], personal protective equipment [PPE], worker protection standards [WPS], refuge management strategy).

8.3.5. Evaluate the effectiveness of a pest management plan.

8.3.7. Describe the types and functions of biological and mechanical control methods.

8.3.9. Develop an IPM plan, based on pest life cycles, available treatments, application methods and the impact on the environment.

8.3.10. Select application methods and implement an IPM plan.

8.3.11. Evaluate IPM plans and applications for their impact on the environment and their effectiveness.

*An “X” indicates that the pathway applies to the outcome.*

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management |  | Bioscience | | |  | Horticulture |
| X | Natural Resource Management |  | Power Technology | | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | | |  | Does not apply | | |