

Career-Technical Credit Transfer (CT)²
Horticulture Career-Technical Assurance Guide (CTAG)
Created: October 18, 2016
Updated: February 2020 and August 2023

Introduction

The following programs/courses, indicated by a Career-Technical Articulation Number (CTAN), are eligible for transfer among Ohio's Public Secondary (CT)² approved programs/courses and state institutions of higher education. This document presents the course in this CTAG:

- 1. CTHOR002- Landscape Maintenance**
- 2. CTHOR003 - Equipment Operation and Maintenance**
- 3. CTHOR004 - Plant and Horticulture Science**
- 4. CTHOR005 - Turf-Grass Management**

NOTE: CTHOR001 - Floral Design and Marketing expired Summer 2023.

These CTANs identify the learning outcomes that are equivalent or common in introductory technical courses. For students to receive credit under these agreements, the career-technical programs and the state institutions of higher education must document that their course/program content matches the learning outcomes in the CTANs. In accordance with Ohio Revised Code 3333.162, industry standards and certifications provide documentation of student learning.

Accessing Credit

Students that have met the requirements for credit for each CTAN will appear in the CTAV system that public colleges and universities access to award credit. Institutions must have the student's permission to officially post the CTAG to their transcript. Students can grant this permission as part of the WebXam. If a student did not grant permission as part of the WebXam, they will still need to confirm with colleges and universities that they want credit for the CTAG course.

Institutional Approval

Secondary: Secondary institutions must have pathway approval from the Ohio Department of Education. Certificate of Affirmation assurances are now incorporated into the CTE-26 application process.

Colleges/Universities: Postsecondary institutions must submit course through the CEMS for review and approval by a faculty panel.

Course Description: Principles and practices of landscape maintenance are examined and implemented. Included are proper techniques in pruning, planting and transplanting, mulching and ground cover, nutrient management, species selection, pest management, water management, and soil preparation.

Requirements for Credit:

- Successfully complete ODE secondary course **Landscape Hardscapes (010640)** and earn a qualifying score on the corresponding End-of-Course examination.
- Within 3 years of completing the approved secondary program, matriculate to an institution of higher education with an approved or comparable program.

Learning Outcome Alignment

All learning outcomes that are considered essential are marked with an asterisk*.

Post-Secondary Learning Outcomes The student will be able to:	Competencies in ODE Career Field Technical Content Standards
1.* Analyze landscape sites for development of a maintenance program integrating aesthetic and environmental aspects.	5.3.1 Identify and interpret symbols, drawings, prints, and blueprints. 5.3.2 Apply proportional measurement and scale techniques. 5.3.3. Complete a site inventory and analysis including physical conditions, code and utilities requirements, and environmental impact. 5.3.4. Develop a program list, including intended use, budget, economics, customer wants and needs and maintenance. 5.3.8. Calculate the space requirements and compute various attributes, including length, angle measurement, surface area and volume. 5.3.9 Identify construction documents, common scales, specifications and materials used in construction or fabrication. 5.3.10 Identify material, inputs and equipment needs based on availability to calculate costs in production or application. 5.4.3. Perform site measurements. 6.1.6 Identify and describe soil conservation practices to reduce soil erosion and compaction. 6.2.7 Identify and describe best management and industry (e.g., agriculture, timber production, construction) production practices that maintain or improve water quality. 8.4.2 Identify plant anatomical structures and their functions.

	8.4.16 Analyze plant water requirements and describe methods of irrigation.
2.* Describe, calculate amounts, and correctly apply a variety of mulches and landscape materials to achieve aesthetic and environmental goals	6.1.6 Identify and describe soil conservation practices to reduce soil erosion and compaction. 6.10.5 Connect biotic interactions with the abiotic environment. 6.10.8 Select and implement restoration ecology practices to repair damaged ecosystems. 8.4.10 Understand the environmental and artificial factors that influence plant germination, growth and development.
3.* Assess the pruning needs of a woody plant for plant health and environmental improvement.	8.4.10 Understand the environmental and artificial factors that influence plant germination, growth and development. 8.4.15. Control plant growth through mechanical and chemical means.
4.* Describe and demonstrate proper pruning techniques.	8.4.15. Control plant growth through mechanical and chemical means.
5.* Describe and demonstrate proper planting techniques including soil physical properties needed for successful landscape establishment	6.1.6. Identify and describe soil conservation practices to reduce soil erosion and compaction. 8.4.11. Select, evaluate and prepare soil or media for planting. 8.4.14. Evaluate and implement transplanting practices.
6.* Evaluate site suitability and prepare soil for planting landscape plants and needs for improving soil health and environmental quality	6.1.2. Describe the relationship among physical properties of soils. 6.1.5. Determine land use and identify land capabilities classes. 6.1.6. Identify and describe soil conservation practices to reduce soil erosion and compaction. 8.4.11. Select, evaluate and prepare soil or media for planting.
7.* Describe proper water management practices used in the landscape including soil health, water holding capacity and water relations to plant health	6.1.6. Identify and describe soil conservation practices to reduce soil erosion and compaction. 6.2.7. Identify and describe best management and industry (e.g., agriculture, timber production, construction) production practices that maintain or improve water quality. 8.4.10. Understand the environmental and artificial factors that influence plant germination, growth and development. 8.4.16. Analyze plant water requirements and describe methods of irrigation.
8.* Describe and demonstrate soil nutrient assessment, nutrient cycling, fertilization application techniques and practices	6.1.3. Collect, test and analyze soil samples for physical and chemical properties. 6.1.4. Identify and describe factors (e.g., climate, soil texture, mineralogy, soil organisms, drainage co-efficient, land use, vegetation types, management practices) affecting organic matter and its function in soil quality. 6.1.6. Identify and describe soil conservation practices to reduce soil erosion and compaction.

	<p>8.1.8. Calculate nutrient requirements and select nutrient sources and additives for the highest potential yield.</p> <p>8.1.10. Determine the nutrient content of organic and inorganic fertilizers.</p> <p>8.1.11. Select the methods and time of nutrient application and apply nutrients.</p> <p>8.4.10. Understand the environmental and artificial factors that influence plant germination, growth and development.</p>
<p>9.* Demonstrate safe and correct use of large and small hand/power equipment (e.g., shears, shovels, power trimmer/blowers, riding and walk behind mowers, skid steer loaders, truck and trailers, etc.)</p>	<p>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.</p> <p>1.12.2. Interpret safety signs and symbols.</p> <p>1.12.7. Select, use, store, maintain and dispose of personal protective equipment (PPE), appropriate to job tasks, conditions and materials.</p> <p>1.12.8. Identify safety hazards and take corrective measures.</p> <p>1.12.10. Follow established procedures for the administration of first aid and contact emergency medical personnel when necessary.</p> <p>4.2.1. Follow OEM (original equipment manufacturer) recommended operating procedures and adjustment specifications as found in the operators manual.</p> <p>4.2.2. Differentiate among the functions, limitations and proper use of equipment, equipment controls and instrumentation.</p> <p>4.2.3. Perform pre- and post-operation inspections and adjustments and report malfunctions.</p> <p>4.2.4. Perform appropriate start-up, operating and shut- down procedures.</p> <p>4.2.5. Select and operate equipment and attachments needed to complete the task per the OEM (original equipment manufacturer) operators manual.</p>
<p>10.* Develop a landscape maintenance schedule taking into account aesthetic and environmental concerns</p>	<p>6.2.6. Monitor and analyze water quality and quantity.</p> <p>6.2.7. Identify and describe best management and industry (e.g., agriculture, timber production, construction) production practices that maintain or improve water quality.</p> <p>6.10.8. Develop a management plan for the restoration and sustainability of a specific habitat using environmental practices that enhance biological diversity.</p> <p>8.1.11. Select the methods and time of nutrient application and apply nutrients.</p> <p>8.3.7. Develop an IPM plan, based on pest life cycles, available treatments, application methods and evaluate its impact on the environment (e.g. drift, application rate and long term soil health).</p> <p>8.4.10. Understand the environmental and artificial factors that influence plant germination, growth and development.</p> <p>8.4.15. Control plant growth through mechanical and chemical means.</p>

<p>11.* Determine landscape maintenance practices according to specific ecosystems characteristics</p>	<p>6.1.4. Identify and describe factors (e.g., climate, soil texture, mineralogy, soil organisms, drainage co-efficient, land use, vegetation types, management practices) affecting organic matter and its function in soil quality.</p> <p>6.1.6. Identify and describe soil conservation practices to reduce soil erosion and compaction.</p> <p>6.10.3. Identify and classify interactions among organisms, including predation, symbiosis and competition to determine a species interdependent relationship.</p> <p>6.10.5. Connect biotic interactions with the abiotic environment.</p> <p>6.10.8. Select and implement restoration ecology practices to repair damaged ecosystems.</p>
--	---

CTHOR003 - Equipment Operation and Maintenance

Credits: 3 Semester Hours

Course Description: Students will learn equipment selection, operation, safety and maintenance for the green industry. Small engine operation, diagnostics and repair, preventative maintenance and overhaul are included.

Requirements for Credit:

- Successfully complete ODE secondary course **Landscape Systems Management (010615)** and earn a qualifying score on the corresponding End-of-Course examination.
- Within 3 years of completing the approved secondary program, matriculate to an institution of higher education with an approved or comparable program.

Learning Outcome Alignment

All learning outcomes that are considered essential are marked with an asterisk*.

<p>Post-Secondary Learning Outcomes The student will be able to:</p>	<p>Competencies in ODE Career Field Technical Content Standards</p>
<p>1.* Demonstrate safety rules and regulations for green industry equipment operation.</p>	<p>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.</p> <p>1.12.2. Interpret safety signs and symbols.</p>

	<p>1.12.7. Select, use, store, maintain and dispose of personal protective equipment (PPE), appropriate to job tasks, conditions and materials.</p> <p>1.12.8. Identify safety hazards and take corrective measures.</p> <p>1.12.10. Follow established procedures for the administration of first aid and contact emergency medical personnel when necessary.</p>
<p>2.* Understand the principles of operation of different types of engines/power sources, and power transfer systems commonly associated with green industry equipment.</p>	<p>4.3.1. Assess the physical and mechanical principles of engine operation, including motion, friction, and thermodynamics.</p> <p>4.3.2. Retrieve and record stored on-board diagnostics (OBD) trouble codes and clear codes where applicable.</p> <p>4.3.3. Locate data plate and determine engine specifications.</p> <p>4.3.4. Analyze, evaluate, and troubleshoot an engine.</p> <p>4.3.5. Compare and contrast two-cycle and four-cycle engines and their operating principles.</p> <p>4.3.6. Evaluate engine head and engine block components to determine serviceability per the OEM (original equipment manufacturer) specification.</p> <p>4.3.8. Perform the requirements of engine servicing per OEM (original equipment manufacturer) specification to maintain emissions requirements.</p> <p>4.4.1. Explain principles of engine lubrication and cooling.</p> <p>4.4.2. Perform pressure and sensor test on lubrication and cooling systems.</p> <p>4.4.8. Test, drain, flush and refill coolant and bleed the cooling system per OEM (original equipment manufacturer) specification.</p> <p>4.7.1. Identify and describe the features, benefits, and applications of power transmission components.</p> <p>4.7.2. Identify and describe the physical and mechanical principles of mechanical, hydraulic, pneumatic and electrical power transfer.</p>
<p>3.* Demonstrate proper diagnostic and repair procedures for green industry equipment.</p>	<p>4.1.1. Inspect, clean, maintain and perform preventative maintenance on equipment.</p> <p>4.1.2. Identify types of hand tools, power tools and equipment and describe their functions.</p> <p>4.1.3. Ensure the presence and functionality of safety equipment.</p> <p>4.1.4. Identify potential hazards and limitations related to the use of equipment.</p> <p>4.1.5. Maintain organization, and cleanliness of facilities, machinery, equipment, and tools for safety and appearance.</p> <p>4.1.6. Inspect and service electrical systems and components.</p> <p>4.1.7. Inspect for fluid leakage, fluid levels and the condition of fluids.</p> <p>4.1.8. Inspect, clean, lubricate, and adjust equipment for safe operation.</p> <p>4.1.9. Select fluids, maintain fluid levels and replace system filters per OEM (original equipment manufacturer) specification.</p>

	<p>4.1.10. Inspect and maintain fluid conveyance and storage components.</p> <p>4.1.11. Identify and maintain accuracy of tooling, machinery, and equipment when performing preventive maintenance and repairs.</p> <p>4.1.12. Compare alternative sources of power for equipment.</p>
<p>4.* Operate according to the manufacturer specification within operator's manual, a variety of industry standard large and small landscape equipment, including; skid loaders, compact utility loaders, trucks and trailers, and zero turn mowers.</p>	<p>4.2.1. Follow OEM (original equipment manufacturer) recommended operating procedures and adjustment specifications as found in the operators manual.</p> <p>4.2.2. Differentiate the functions, limitations, and proper use of equipment, equipment controls, and instrumentation.</p> <p>4.2.3. Perform pre- and post-operation inspections and adjustments and report malfunctions.</p> <p>4.2.4. Perform appropriate start-up, operating and shutdown procedures.</p> <p>4.2.5. Select and operate equipment and attachments needed to complete the task per the OEM (original equipment manufacturer) operators manual.</p>
<p>5.* Develop equipment preventative maintenance schedules</p>	<p>4.1.1. Inspect, clean, maintain and perform preventative maintenance on equipment.</p> <p>4.1.2. Identify types of hand tools, power tools and equipment and describe their functions.</p> <p>4.1.3. Ensure the presence and functionality of safety equipment.</p> <p>4.1.4. Identify potential hazards and limitations related to the use of equipment.</p> <p>4.1.5. Maintain organization, and cleanliness of facilities, machinery, equipment, and tools for safety and appearance.</p> <p>4.1.6. Inspect and service electrical systems and components.</p> <p>4.1.7. Inspect for fluid leakage, fluid levels and the condition of fluids.</p> <p>4.1.8. Inspect, clean, lubricate, and adjust equipment for safe operation.</p> <p>4.1.9. Select fluids, maintain fluid levels and replace system filters per OEM (original equipment manufacturer) specification.</p> <p>4.1.10. Inspect and maintain fluid conveyance and storage components.</p> <p>4.1.11. Identify and maintain accuracy of tooling, machinery, and equipment when performing preventive maintenance and repairs.</p> <p>4.1.12. Compare alternative sources of power for equipment.</p> <p>4.3.4. Analyze, evaluate and troubleshoot an engine.</p> <p>4.3.8. Perform the requirements of engine servicing per OEM (original equipment manufacturer) specification to maintain emissions requirements.</p> <p>4.4.1. Explain principles of engine lubrication and cooling</p>

Course Description: Course Description: This course focuses on skills and technologies essential for horticultural plant production including cultural and sustainable production practices. Students will apply scientific knowledge of plant development, nutrient management, abiotic stress mitigation, pest management, and growth regulation. Aspects of water management, chemical and nutrient application and environmental impact, and soil conservation will be evaluated.

Requirements for Credit:

- Successfully complete ODE secondary course **Plant and Horticulture Science (010155)** and earn a qualifying score on the corresponding End-of-Course examination.
- Within 3 years of completing the approved secondary program, matriculate to an institution of higher education with an approved or comparable program.

Learning Outcome Alignment

All learning outcomes that are considered essential are marked with an asterisk*.

<p>Post-Secondary Learning Outcomes The student will be able to:</p>	<p>Competencies in ODE Career Field Technical Content Standards</p>
<p>1.* Identify plant anatomical structures and describe their physiological functions.</p>	<p>8.4.2. Identify plant anatomical structures and their functions. 8.4.4. Identify and classify plants and describe management decisions at all stages. 8.4.5. Explain the requirements of photosynthesis and identify the products and byproducts. 8.4.7. Understand aerobic respiration and its relationship to plant growth and management. 8.4.6. Explain the process and importance of transpiration in plant growth and development. 8.4.20. Distinguish between biotic and abiotic factors that influence plant stress.</p>
<p>2.* Identify plants by taxonomy at all growth stages.</p>	<p>8.2.3. Compare and contrast variations of plant reproductive systems among plant species. 8.4.1. Identify and classify plants using taxonomy. 8.4.2. Identify plant anatomical structures and their functions. 8.4.3. Identify and classify seeds. 8.4.4. Identify and classify plants and describe management decisions at all stages.</p>

<p>3. Identify reproductive plant structures, assess environmental effects on plant reproduction and describe sexual and asexual reproduction.</p>	<p>8.2.1. Identify the reproductive anatomy of plants and describe their physiological functions.</p> <p>8.2.2. Describe how biotic and abiotic factors (e.g., insects, light, temperature, microorganisms, moisture, location) influence plant reproduction.</p> <p>8.2.3. Compare and contrast variations of plant reproductive systems among plant species.</p> <p>8.2.4. Describe how artificial selection methods are used in plant breeding to improve plant traits.</p> <p>8.2.5. Select and apply methods of asexual plant propagation.</p>
<p>4. Demonstrate basic plant nutrition, identify causes and symptoms of nutrient deficiencies, and determine proper methods of nutrient selection and application.</p>	<p>8.1.1. Compare and contrast organic and inorganic sources of macronutrients and micronutrients.</p> <p>8.1.2. Describe the functions of macronutrients and micronutrients in plants and the role that microorganisms play in plant nutrition.</p> <p>8.1.3. Identify and describe the nutrient recommendations of a plant for a desired production setting.</p> <p>8.1.4. Identify symptoms and causes of plant nutrient deficiencies and toxicities.</p> <p>8.1.5. Collect soil and plant tissue for testing and analysis using standard industry practice.</p> <p>8.1.6. Analyze and draw conclusions from soil and plant tissue test data and determine management recommendations for increase production, increase profitability, enhance environmental protection and improved suitability</p> <p>8.1.7. Distinguish between biotic and abiotic factors (e.g., soil type, minerals, pH, microorganisms) that influence and optimize the availability of nutrients for plants.</p> <p>8.1.8. Calculate nutrient requirements and select nutrient sources and additives for the highest potential yield.</p> <p>8.1.9. Calculate nutrient requirements and select nutrient sources and additives for highest return on investment.</p> <p>8.1.10. Determine the nutrient content of organic and inorganic fertilizers.</p> <p>8.1.11. Select the methods and time of nutrient application and apply nutrients.</p> <p>8.1.12. Describe and apply the 5 R's of nutrient management: (1) right source of fertilizer at the (2) right rate at the (3) right time in the (4) right place with the (5) right irrigation method.</p>
<p>5. Develop plant management strategies for optimizing the end goal utilizing sustainable practices taking into account biotic and abiotic factors influencing plant growth and development.</p>	<p>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).</p> <p>6.2.2. Measure pH, dissolved oxygen (DO), biological oxygen demand (BOD), and temperature and macro invertebrate populations to determine water quality.</p> <p>6.2.3. Measure vegetation, temperature, turbidity, macroinvertebrate populations,</p>

	<p>and bacterial quality in lentic and lotic waters to determine water quality.</p> <p>6.2.4. Explain the hydrological cycle and how human and animal activity impacts the cycle.</p> <p>6.2.5. Explain the biotic and abiotic factors affecting water quality.</p> <p>6.2.6. Monitor and analyze water quality and quantity.</p> <p>6.2.7. Identify and describe best management and industry (e.g., agriculture, timber production, construction) production practices that maintain or improve water quality.</p> <p>8.3.1. Identify and classify insects, weeds, pathogen, animal pests, and describe the damages they cause.</p> <p>8.3.2. Examine the interrelationships of the disease triangle among host, pathogen and environment.</p> <p>8.4.10. Understand the environmental and artificial factors that influence plant germination, growth and development.</p>
<p>6.* Discuss fundamental plant genetics towards cultivar development stressing the importance of plant and genetic diversity</p>	<p>8.2.1. Identify the reproductive anatomy of plants and describe their physiological functions.</p> <p>8.2.2. Describe how biotic and abiotic factors (e.g., insects, light, temperature, microorganisms, moisture, location) influence plant reproduction.</p> <p>8.2.3. Compare and contrast variations of plant reproductive systems among plant species.</p> <p>8.2.4. Describe how artificial selection methods are used in plant breeding to improve plant traits.</p> <p>8.2.5. Select and apply methods of asexual plant propagation.</p> <p>8.3.2. Examine the interrelationships of the disease triangle among host, pathogen and environment.</p>

CTHOR005- Turf-Grass Management

Credits: 3 Semester Hours

Course Description: Course Description: Students will learn scientific and engineering principles for establishment, culture and maintenance of lawns, athletic and recreational turf. Experience is gained in propagation, care, and production of turf-grass. Students will learn to practice safe operation and maintenance of specialized equipment. Environmental awareness, conservation practices, aspects of climate change and water quality will be demonstrated and reinforced.

Requirements for Credit:

- Successfully complete ODE secondary course **Turf Science and Management (010635)** and earn a qualifying score on the corresponding End-of-Course examination.
- Within 3 years of completing the approved secondary program, matriculate to an institution of higher education with an approved or comparable program.

Learning Outcome Alignment

All learning outcomes that are considered essential are marked with an asterisk*.

Post-Secondary Learning Outcomes The student will be able to:	Competencies in ODE Career Field Technical Content Standards
1.* Analyze the structure of the turf-grass plant as it relates to growth, recommended uses and maintenance requirements.	8.4.1 Identify and classify plants using taxonomy. 8.4.2. Identify plant anatomical structures and their functions. 8.4.3. Identify and classify seeds. 8.4.4. Identify and classify plants and describe management decisions at all stages. 8.4.5. Explain the requirements of photosynthesis and identify the products and byproducts. 8.4.6. Explain the process and importance of transpiration in plant growth and development. 8.4.7. Understand aerobic respiration and its relationship to plant growth and management. 8.4.8. Explain primary and secondary plant growth.
2.* Select proper turf grass cultivars for the intended use in lawns, athletic and recreational fields and urban parks comparing and contrasting turf establishment methods.	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 and describe factors (e.g., climate, soil texture, mineralogy, soil organisms, drainage co-efficient, land use, vegetation types, management practices) affecting organic matter and its function in soil quality. 6.1.5. Determine land use and identify land capabilities classes. 6.1.6. Identify and describe soil conservation practices to reduce soil erosion and compaction. 6.1.8. Describe soil limitations in agronomic, urban and natural resource practices. 6.1.9. Evaluate soil survey data and implement management decisions. 8.2.4. Describe how artificial selection methods are used in plant breeding to improve plant traits. 8.4.3 Identify and classify seeds. 8.4.10. Understand the environmental and artificial factors that influence plant

	<p>germination, growth and development.</p> <p>8.4.11. Select, evaluate and prepare soil or media for planting.</p> <p>8.4.12. Understand and evaluate the process by which plants are selected in relation to production use.</p> <p>8.4.13. Evaluate and implement planting practices.</p> <p>8.4.14 Describe factors related to seed quality, treatment, and density that affect emergence, stand uniformity and seedling health.</p> <p>8.4.15. Evaluate and implement transplanting practices.</p> <p>8.4.16. Control plant growth through mechanical and chemical means.</p> <p>8.4.17. Analyze plant water requirements and describe methods of irrigation.</p>
<p>3.* Calculate the water requirements of turf grass for lawns, athletics, and recreational uses. Compare and contrast methods to provide these requirements and implement practices to reduce water consumption.</p>	<p>5.8.1. Calculate water demand for specific applications.</p> <p>5.8.2. Compare the types, applications and operating principles of pumps and controls.</p> <p>5.8.4. Identify components of supply and drainage systems and describe their functions.</p> <p>5.8.6. Describe factors that are considered when planning and installing a supply and drainage system</p> <p>5.8.9. Select supply and drainage components based on their application for a given purpose.</p> <p>5.8.14. Prevent freezing and mechanical damage to pipes.</p> <p>5.8.15. Describe how water moves from the source through the water distribution system to the fixture.</p> <p>5.8.16. Test a water supply and drainage system for leaks and pressure using soap, inert gas, electronic sensors and fluorescent dye.</p> <p>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).</p> <p>6.2.2. Measure pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), nitrogen and phosphorus in lentic and lotic waters to determine water quality.</p> <p>6.2.3. Measure vegetation, temperature, turbidity, macroinvertebrate populations, and bacterial quality in lentic and lotic waters to determine water quality.</p> <p>6.2.6. Monitor and analyze water quality and quantity.</p> <p>6.2.7. Identify and describe best management and industry (e.g., agriculture, timber production, construction) production practices that maintain or improve water quality.</p> <p>8.4.16. Analyze plant water requirements and describe methods of irrigation.</p>

<p>4.* Develop an annual nutrient management system specific to the turf use and site consistent with contemporary environmental concerns</p>	<p>8.1.1. Compare and contrast organic and inorganic sources of macronutrients and micronutrients.</p> <p>8.1.2. Describe the functions of macronutrients and micronutrients in plants and the role that microorganisms play in plant nutrition.</p> <p>8.1.3. Identify and describe the nutrient recommendations of a plant for a desired production setting.</p> <p>8.1.4. Identify symptoms and causes of plant nutrient deficiencies and toxicities.</p> <p>8.1.5. Collect soil and plant tissue for testing and analysis using standard industry practice.</p> <p>8.1.6. Analyze and draw conclusions from soil and plant tissue test data and determine management recommendations for increase production, increase profitability, enhance environmental protection and improved suitability.</p> <p>8.1.7. Distinguish between biotic and abiotic factors (e.g., soil type, minerals, pH, microorganisms) that influence and optimize the availability of nutrients for plants.</p> <p>8.1.8. Calculate nutrient requirements and select nutrient sources and additives for the highest potential yield.</p> <p>8.1.9. Calculate nutrient requirements and select nutrient sources and additives for highest return on investment.</p> <p>8.1.10. Determine the nutrient content of organic and inorganic fertilizers.</p> <p>8.1.11. Select the methods and time of nutrient application and apply nutrients.</p>
<p>5.* Identify pests and diseases, analyze control methods, and implement controls according to integrated pest management and contemporary environmental practices</p>	<p>8.3.1. Identify and classify insects, weeds, pathogen, animal pests, and describe the damages they cause.</p> <p>8.3.2. Examine the interrelationships of the disease triangle among host, pathogen and environment.</p> <p>8.3.3. Analyze and calculate the economic threshold of pest damage.</p> <p>8.3.4 Determine the components of an integrated pest management plans and related safety practices.</p> <p>8.3.6. Describe the types and functions of biological, mechanical, and chemical control methods.</p> <p>8.3.9. Develop an IPM plan, based on pest life cycles, available treatments, application methods and the impact on the environment.</p> <p>8.3.7. Develop an IPM plan, based on pest life cycles, available treatments, application methods and evaluate its impact on the environment (e.g. drift, application rate and long term soil health).</p>
<p>6.* Analyze and develop proper turf-grass management practices including water use efficiency and nutrient management</p>	<p>8.4.1. Identify and classify plants using taxonomy.</p> <p>8.4.2. Identify plant anatomical structures and their functions.</p> <p>8.4.4. Identify and classify plants and describe management decisions at all stages.</p>

	<p>8.4.5. Explain the requirements of photosynthesis and identify the products and byproducts.</p> <p>8.4.6. Explain the process and importance of transpiration in plant growth and development.</p> <p>8.4.7. Understand aerobic respiration and its relationship to plant growth and management.</p> <p>8.4.10. Understand the environmental and artificial factors that influence plant germination, growth and development.</p> <p>8.4.15. Control plant growth through mechanical and chemical means.</p> <p>8.4.16. Analyze plant water requirements and describe methods of irrigation.</p>
<p>7.* Demonstrate accepted maintenance techniques and safe operation of turf-grass equipment</p>	<p>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.</p> <p>1.12.2. Interpret safety signs and symbols</p> <p>1.12.7. Select, use, store, maintain and dispose of personal protective equipment (PPE), appropriate to job tasks, conditions, and materials.</p> <p>1.12.8. Identify safety hazards and take corrective measures.</p> <p>1.12.10. Follow established procedures for the administration of first aid and contact emergency medical personnel when necessary.</p> <p>4.1.1. Inspect, clean, maintain and perform preventative maintenance on equipment.</p> <p>4.1.2. Identify types of hand tools, power tools and equipment and describe their functions.</p> <p>4.1.3. Ensure the presence and functionality of safety equipment.</p> <p>4.1.4. Identify potential hazards and limitations related to the use of equipment.</p> <p>4.1.5. Maintain organization, and cleanliness of facilities, machinery, equipment, and tools for safety and appearance.</p> <p>4.1.6. Inspect and service electrical systems and components.</p> <p>4.1.7. Inspect for fluid leakage, fluid levels and the condition of fluids.</p> <p>4.1.8. Inspect, clean, lubricate, and adjust equipment for safe operation.</p> <p>4.1.9. Select fluids, maintain fluid levels and replace system filters per OEM (original equipment manufacturer) specification.</p> <p>4.1.10. Inspect and maintain fluid conveyance and storage components.</p> <p>4.1.11. Identify and maintain accuracy of tooling, machinery, and equipment when performing preventive maintenance and repairs</p> <p>4.2.1. Follow OEM (original equipment manufacturer) recommended operating procedures and adjustment specifications as found in the operators manual.</p>

	<p>4.2.2. Differentiate among the functions, limitations and proper use of equipment, equipment controls and instrumentation.</p> <p>4.2.3. Perform pre- and post-operation inspections and adjustments and report malfunctions.</p> <p>4.2.4. Perform appropriate start-up, operating and shut-down procedures.</p> <p>4.2.5. Select and operate equipment and attachments needed to complete the task per the OEM (original equipment manufacturer) operators manual.</p>
8. Identify component costs of turf grass management including forecasting increasing water demands	<p>1.10.8. Use promotional techniques to maximize sales revenues (e.g., advertising, sales promotions, publicity, public relations).</p> <p>5.3.4. Develop a program list, including intended use, budget, economics, customer wants and needs and maintenance.</p> <p>5.3.10. Identify material, inputs and equipment needs based on availability to calculate costs in production or application.</p> <p>6.2.6. Monitor and analyze water quality and quantity.</p> <p>6.2.7. Identify and describe best management and industry (e.g., agriculture, timber production, construction) production practices that maintain or improve water quality.</p>

Each CTAN identifies learning outcomes that are equivalent or common in introductory technical courses. For students to receive credit under these agreements, the career-technical secondary programs and the postsecondary institutions must document that their course content matches the learning outcomes in the CTANs. In accordance with Ohio Revised Code 3333.162, industry standards and certifications provide documentation of student learning.

Requirements and Credit Conditions:

1. The receiving institution must have a comparable program, major, or course that has been approved through submission to the Ohio Department of Higher Education (CT) ² approval process for the CTAN listed in this document.
2. Credits apply to courses in the specified technical area at Ohio's public institutions of higher education, if the institution offers courses in the specific technical area. In the absence of an equivalent course, and when the institution offers the technical program, the receiving institution will guarantee to grant and apply an equivalent credit value of the Career-Technical Articulation Number (CTAN) toward the technical requirements of the specific degree/certificate program.
3. A career-technical student seeking credit under the terms of this CTAG must apply and be accepted to the college within three years of completing a career-technical course, unless otherwise noted.

4. A career-technical student who meets all eligibility criteria will receive the credit hour value for the comparable course as offered at the receiving state institution of higher education.
5. The admission requirements of individual institutions and/or programs are unaffected by the implementation of (CT)² outcomes.
6. The transfer of credit, through this CTAG, will not exempt a student from the residency requirements at the receiving institution.

**Horticulture Pathway Panel Participants
2013-2015**

Dr. Susan Everett	Clark State Community College	SCTAI Lead Panel Expert (initial development)
Dr. Margaret McMahon	The Ohio State University	SCTAI Lead Panel Expert (realignment/finalization)
Mark Deacon	Cincinnati State Technical & Community College	SCTAI Panel Expert
Andy Freeman	Hocking College	SCTAI Panel Expert
Ruby Beil	Lorain County Community College	SCTAI Panel Expert
Thomas Smith	Southern State Community College	SCTAI Panel Expert
Dr. Susan Everett	Clark State Community College	Item Writer
Dr. Larry Everett	Clark State Community College	Item Writer
Ed Tuhela	Gates Mills Environmental Center	Item Writer
Brett Joseph	Lorain County Community College	Item Writer
Jason Lipt	Washington County Career Center	Item Writer
Cyndi Brill	Ohio Department of Education	Program Specialist
Kevin Williams	Ohio Department of Education	Education Program Specialist
E. Craig Wiget	Ohio Department of Higher Education	SCTAI Special Coach
Misty McKee	Ohio Department of Higher Education	Assistant Director, SCTAI
Anne Skuce	Ohio Department of Higher Education	Senior Associate Director, SCTAI
Jessi Spencer	Ohio Department of Higher Education	Administrative Coordinator of SCTAI